JUNE 24, 1976

MICROPROCESSORS IN ACTION: START OF A SERIES/110

How bright is the June job picture?/70

V-MOS field-effect transistors handle 25 watts/98

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Electronics

VIDEO GAMES
They're set for a big score

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The 4261A's auto-ranging feature gives you almost instant readings: inductance from 0.1 microhenries to 1900 henries; capacitance from 0.1 picofarads to 19.00 millifarads; resistance from 1 milliohm to 19.00 megohms; and dissipation factors from zero to 1.9. And you get all this measurement capability for only $1,740.*

Options add computing power. The 4261A gives you a wide choice of optional configurations too, such as back-panel inputs and outputs that are compatible with the HP Interface Bus (conforming to IEEE 488-1975), for automated testing or data gathering under calculator or computer control. You can also order the HP 4261A with optional BCD outputs, and remote control features.

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The Useables-
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096/42

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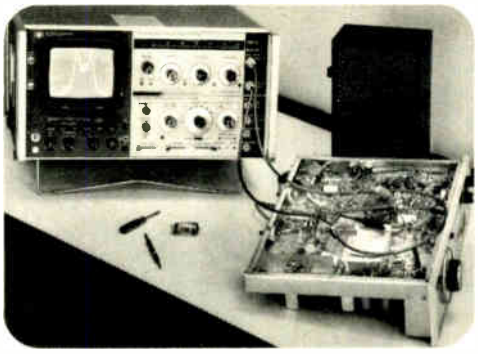
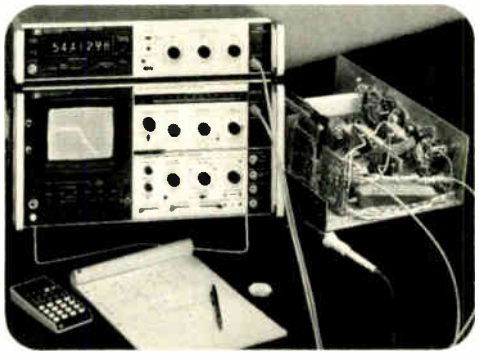


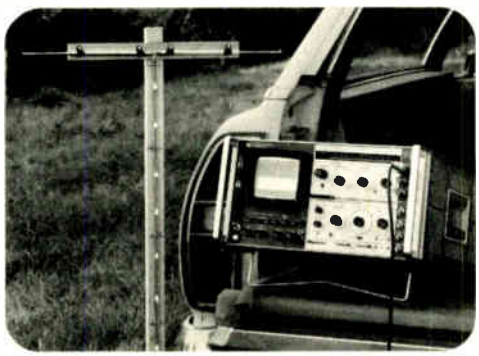
20 Hz to 300 kHz

The 8556A tuner covers 20 Hz to 300 kHz and comes with a built-in tracking generator. It's calibrated for measurements in both 50 and 600 ohm systems, with accuracies better than ±1 dB.



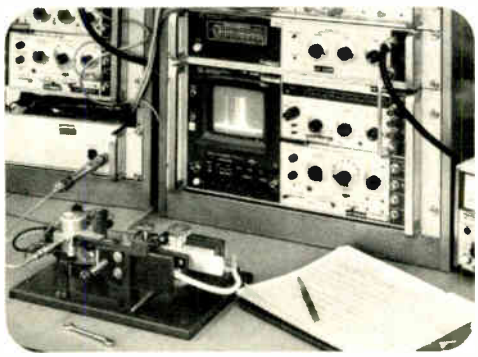
1 kHz to 110 MHz

The 8553B takes you from 1 kHz to 110 MHz with −140 dBm sensitivity. Signals can be measured with ±1¼ dB accuracy. Choose the companion tracking generator/counter for wide dynamic range swept frequency measurements and precise frequency counting.



100 kHz to 1250 MHz

Use the 8554B tuning section to cover the 100 kHz to 1250 MHz range. Measure with ±1¾ dB accuracy. Its companion tracking generator (500 kHz to 1300 MHz) also works with the 8555A tuning section.



10 MHz to 40 GHz

For 10 MHz to 40 GHz, choose the 8555A. Its internal mixer covers to 18 GHz, accessory mixer for 18-40 GHz. Maximum resolution is 100 Hz. Measure with ±1¾ dB accuracy to 6 GHz, ±2¾ dB to 18 GHz. For wide scans free from unwanted response between 10 MHz and 18 GHz, add the automatic preselector.

45603

No matter what range you're working in, you need reliable unambiguous answers. HP's spectrum analyzers give you accurate measurements over wide, distortion-free dynamic ranges, time after time. Easy operation too, with front panel markings that really help reduce the possibility of operator error.

But there's much more. Call your nearby HP field engineer or write for the full story on HP's spectrum analyzer spectrum.

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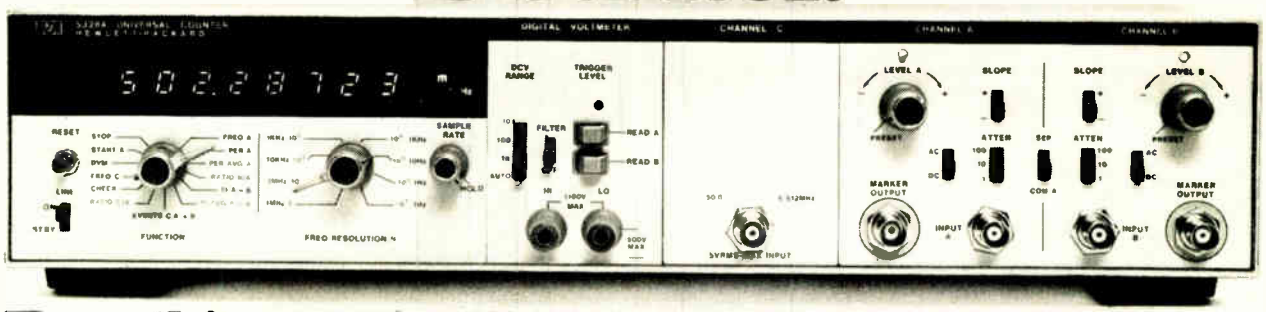
Circle 1 on reader service card

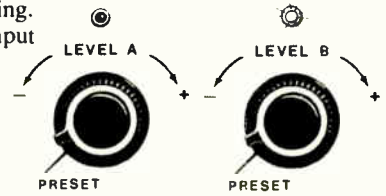
The Universal Universal Counter.



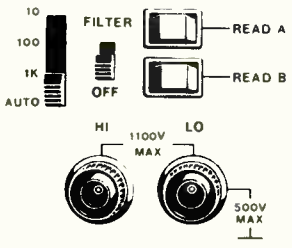
Everything you're likely to need. The HP 5328A.

Here's a counter so versatile, it can really be called universal. You get high accuracy, operating ease and a low price tag of just $1300.* It's modular so you can buy the capability you need. Not more. Not less. Start with the basic 8-digit instrument with 100 MHz frequency range and 100 ns single shot T.I. resolution. You also get period, 10 ps time interval averaging, ratio, scaling and totalizing. Then you can add more: 512 MHz with 9 digits and 15 mv sensitivity; time base aging $<5 \times 10^{-10}$/day; and 10 ns single shot time interval with improved averaging. But look what else you get:

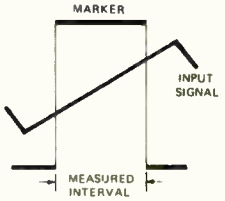
UNIQUE TRIGGER LIGHTS tell you what's happening. They're on when the input is greater than trigger level and vice versa. And they blink when the input channel is triggering from 0 to 100 MHz. Standard.



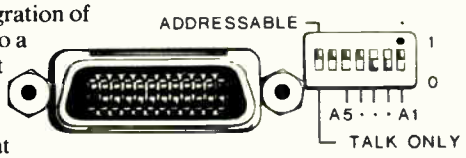
UNIQUE BUILT-IN DVM gives an instant accurate digital display of trigger levels. Or use this option to measure external voltages 10 μv to 1100V auto-ranged, integrating, full floating, high common-mode rejection with switchable input filter. Optional.



HIGH SPEED MARKERS show just what your counter is doing with your input waveform. Use the markers on the second channel of your scope to see where the counter is triggering. Really useful thanks to the 5328A's 100 MHz ECL outputs. Standard.



EASY SYSTEMS INTERFACE with the HP Interface Bus simplifies integration of the counter into a system. You get this programmability plus standard format data output with a single connector. Optional.



ARMED MEASUREMENTS solve difficult dynamic measurement problems. The counter goes to work when your command tells it to. Ideal for burst frequency or sweep generator linearity measurements. Standard.

These are just a few things, of course. There are many more thoughtful engineering innovations that combine to give you everything you're likely to need in a general purpose, medium-priced counter for a long time to come. We talk about them in our 12 page booklet. Write for one or ask your nearby HP field engineer for a copy. We want you to find why we call this universal counter universal.

*Domestic US Price only

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02521

Electronics
The International Magazine of Electronics Technology
Vol. 49, No. 13 • June 24, 1976

Highlights

The cover: Electronic games flourish, 89
It looks as though games will be the next major consumer electronics market. Expansion to include more home video games and more arcade and pinball machines is being fueled by large-scale integration. And new companies aimed at the market are vying with established firms.

Cover illustration is by Bob Clarke.

The crowd gets bigger around the 8080, 76
Does the addition of National Semiconductor to the camp of 8080 second sources mean that the Intel family is on its way to becoming the standard in the general-purpose 8-bit microprocessor market?

MOS finds a new home in power applications, 98
A family of field-effect transistors with the V-groove MOS structure brings the pluses of metal-oxide-semiconductor technology to power applications up to 25 watts. Solid-state power switching and linear power designs should benefit from this move beyond low-power circuitry.

Microprocessors solve design problems, 110
Four descriptions of the applications of microprocessors inaugurate our new series of designers' reports on how they tackled specific engineering problems with specific devices.

And in the next issue . . .
A compact data-acquisition system in a single package . . . an approach to microprocessor programing . . . a new family of dedicated microcontroller chips.

Electronics

Publisher's letter

With all the action in the microprocessor area these days, it's a tough job keeping track of all the members of the ever-growing microprocessor families. Trying to stay abreast of all specifications, characteristics, applications, and the like for each and every microprocessor is a heavy burden.

So we're expanding our coverage of applications with a new design series—Microprocessors in Action. You'll find the first installment on page 110, where, in the initial four articles, we detail how individual designers or design groups successfully applied a microprocessor to solve a particular circuit need.

We invite contributions to this new series. If you are tickled with the way you and a microprocessor surmounted an engineering problem, let us know about it, so we can share the details with other readers.

Things are looking up again in the job market—and not just for those graduating from engineering school. But, while there are indications that hiring of EEs in general is expanding, there are still disappointments for the EE with 15 or 20 years of experience. Those, in a nutshell, are the conclusions of a recent survey of schools and companies conducted by *Electronics*.

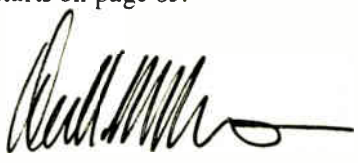
Associate editor Jerry Walker, who conducted the survey, says that the general business upturn has generated the rosier hiring picture. "A burst of job openings has come since May, a sign that electronics companies had hedged their confidence in the strength of business recovery until they got a look at second-half projections. Nevertheless, engineering schools from coast to coast report that newly minted bachelors, masters, and Ph.D.s are now getting jobs."

For a complete rundown of what qualifications are in demand and where salaries are going, turn to our Probing the News story on page 70.

The issue of competition in the telecommunications industry is an explosive one. Giant AT&T and numerous independent telephone companies are lined up on the side of renewing or even stiffening the old noncompetitive telecommunications ground rules. The Federal Communications Commission, the White House Office of Telecommunications Policy, and a number of common-carrier and equipment companies are lined up on the side of increasing competition. Both sides say their approach is more truly in the public interest.

The Congress, which is inundated by bills relating to the issue, has decided that an election year is not the time to sort out the complexities of the problem. Instead, serious consideration of legislation that would reestablish AT&T's noncompetitive position has been put off till next year, when another Congress will be in session.

But, while the debate may become muted for the next few months, the hot potato is still very much on the fire. For a summary of the controversy over monopoly vs competition in telecommunications, read our Probing the News article that starts on page 65.



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Readers' comments

Updating Ispice's results . . .

To the Editor: In "Choosing the right programs for computer-aided design" [April 29, p. 102], Fig. 1 shows execution time for the central processing unit versus the number of inverter stages for different programs running on an IBM 370 computer. The data displayed for the Ispice program is, in actuality, virtual processing units, a measure of computational capacity used by National CSS. To obtain a reasonably accurate estimate of actual CPU time on an IBM 370, one should divide the VPUs by 10. This means that Ispice actually is considerably more efficient than implied by the figure.

Alan W. Schwartz
National CSS Inc.
Norwalk, Conn.

■ *"Ispice is a good program and very cost-competitive," says Prof. James C. Bowers, who directed the study on which the article was based. "However, the VPU is a fictional unit used by National CSS in marketing the program. Conversion of VPUs to CPU time is not meaningful, and hence no validated time comparison of Ispice to other programs is possible. A note to this effect appears in the final report, now at the printer."*

. . . and revising Uccap's figures

To the Editor: Since we performed the circuit analyses upon which the Uccap graphs in Fig. 2 of the April 29 article on computer-aided design are based, we accept the blame for the large errors shown. But the circuits we analyzed are not the circuits shown.

The trouble occurred because the Uccap capacitor model contains built-in series and shunt resistors. The default value for the series resistor is 0.1 Ω, which, for most applications, is a reasonably small value and causes no problems.

The two circuits used in the study, however, contained only 1-Ω resistors. Thus the 0.1-Ω resistor became a significant factor in the circuit analyses. When the two circuits were reanalyzed using 0.001 Ω for the series resistor, the results improved dramatically. One of the early time points showed a 16% error, and the other errors in both circuits were under 3%.

In all fairness, several other programs evaluated in the study also contain capacitors with built-in resistors. This probably accounts for most of the large errors shown for these programs.

A computer run of the two circuits analyzed with and without significant values for the series resistor can be obtained by writing me.

Ed Lewis
University Computing Company
Dallas, Texas

It's all in the sharing

To the Editor: I take issue with the statement that our Telecommunications Management and Control System has application only for users with monthly toll billing of $12,000 or less [April 15, p. 30].

The inherent cost advantages of sharing the most expensive and complex portion of the telecommunications-control system—the central computers—allows TDX to price services competitively with any stand-alone system.

In addition, other service features—including 24-hour central-facility maintenance, TDX-generated call-detail reports, automatic updates on tariff changes, modular expansion capability, and ongoing facilities-management support—make our services an attractive alternative to any customer, regardless of size, who needs to control long-distance communication expenses.

William E. Richards
TDX Systems Inc.
McLean, Va.

Correction

The AMD bipolar microprocessor described in "Designers gain new freedom as options multiply" [April 15, p. 99] uses 11 types of chips, not 11 single chips. The 16-bit system in Fig. 10 would take 34 devices (not including interrupt-control and bus-interface chips), compared to about 200 TTL packages.

Our thanks to Gopal Ramachandran of Intersil Inc. and Dan Wilnai of Fairchild Semiconductor for pointing out this error.

The Flathead Transformer

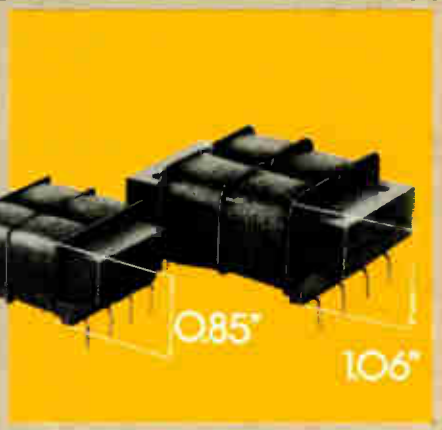
For optimum powering of 1" spaced PC boards—and shipped with the pronto challenge

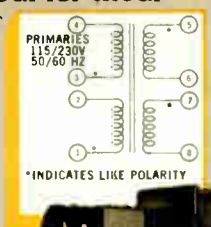
Here are the first *flat* power transformers for your high density PC board packaging problems—from Signal, the world leader in off-the-shelf transformers and chokes.

Flat. LP's deliver 6VA in less than 0.85" height or, you can squeeze 12VA into 1.06" of head room.

Field-Free: LP's use Signal's split-bobbin, balanced-coil, hum-bucking construction. This semi-toroidal configuration significantly reduces magnetic field radiation which can cause havoc with sensitive IC's or low-level circuits. And the LP's split-bobbin provides unprecedented insulation and isolation. Minimal electrostatic coupling suppresses line noise and prevents false triggering of digital circuits. Ideal for medical, industrial or other low leakage applications!

Flexible: 115/230V 50/60Hz dual primaries are standard. Each of the 22 standard designs provide dual secondaries for either dual isolated DC outputs, series connected for dual complementary supplies with common return, or paralled for double current rating.





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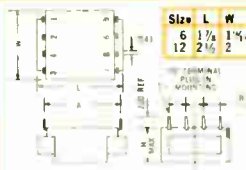
LP-12-900	12	12.6V CT @ 900 MA	6.3V @ 1.8 A	9.40
LP-16-350	6	16V CT @ 350 MA	8V @ 700 MA	7.60
LP-16-700	12	16V CT @ 700 MA	8V @ 1.4 A	9.40
LP-20-300	6	20V CT @ 300 MA	10V @ 600 MA	7.80
LP-20-600	12	20V CT @ 600 MA	10V @ 1.2 A	9.60
LP-24-250	6	24V CT @ 250 MA	12V @ 500 MA	7.80
LP-24-500	12	24V CT @ 500 MA	12V @ 1A	9.60
LP-34-170	6	34V CT @ 170 MA	17V @ 340 MA	7.80
LP-34-340	12	34V CT @ 340 MA	17V @ 680 MA	9.50
LP-40-150	6	40V CT @ 150 MA	20V @ 300 MA	7.80
LP-40-300	12	40V CT @ 300 MA	20V @ 600 MA	9.80
LP 56-100	6	56V CT @ 100 MA	28V @ 200 MA	8.00
LP 56-200	12	56V CT @ 200 MA	28V @ 400 MA	9.80
LP-88-65	6	88V CT @ 65 MA	44V @ 130 MA	8.00
LP-88-130	12	88V CT @ 130 MA	44V @ 260 MA	10.00
LP-120-50	6	120V CT @ 50 MA	60V @ 100 MA	8.00
LP-120-100	12	120V CT @ 100 MA	60V @ 200 MA	10.00
LP-230-25	6	230V CT @ 25 MA	115V @ 50 MA	8.00
LP-230-50	12	230V CT @ 50 MA	115V @ 100 MA	10.00

*Regulation of Size 6 units is 30%, i.e., no load secondary voltage is 30% higher than full load. Regulation of Size 12 units is 20%.



Size	L	W	H	A	B	Oz.
6	1⅞	1¾	0.850	1.600	0.375	7
12	2⅛	2	1.065	2.000	0.500	11

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News update

■ SMC Microsystems Corp. of Hauppauge, N.Y., is still in the throes of developing a synchronous data-link control for Digital Equipment Corp., the Maynard, Mass., minicomputer maker. DEC is funding the device's development program [*Electronics*, June 26, 1975, p.25]. Arthur Sidorsky, SMC vice president for sales, says his firm is still pushing the program hard and is not far from making circuits. "We are still in the design stages, as we more or less have been trying to hit a moving target," he says. One of the changes in the program that has caused a delay is the switch from a fixed to a variable information control field. Initial deliveries to Digital are expected in the near future, says SMC.

The whole concept of synchronous data-link control, pioneered by IBM, is backed by the makers and purchasers of data-transmission equipment, not to mention semiconductor manufacturers who would like to sell SDLC devices. Simply, it is a bit-oriented, fully duplex protocol; most present protocols are half duplex and character oriented. It also promises to overcome propagation delay and improve line utilization by permitting more frames to remain temporarily unacknowledged.

■ While the Air Force has been forced to put off its study of emitter-follower logic [*Electronics*, Jan. 22, 1976, p. 35], TRW's Defense and Systems Group is going full speed ahead. It is marketing a 16-bit multiplier that uses ECL to achieve a 200-nanosecond multiply time. The bipolar LSI device, with compatible TTL inputs and outputs, is described by the firm as a "very ambitious logic chip," incorporating some 5,000 logic gates. It is capable of replacing 50 equivalent MSI parts, says a spokesman, and is intended for minicomputers, aerospace dedicated signal processing, and specialized instrumentation. The multiplier is the first of a bipolar LSI line to be introduced in the next few months by the TRW group.

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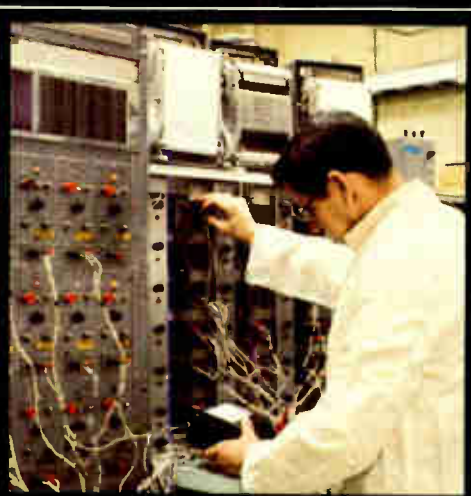


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Circle 9 on reader service card

Micro-processing becomes a buyer's market.

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If you're shy, and you're just not sure how to say thank you, an order would be really nice.

Write or phone Advanced Micro Devices, The Buyer's Market.

Ours and Theirs.

(The 9080A)

Specification	AMD	Intel
Minimum Instruction Cycle Time	1 microsecond	1.3 microseconds
Maximum Power Dissipation (at 1.3 microsec (0 70°)	829 milliwatts	1307 milliwatts
Output Drive	3.2mA 4V	1.9mA 45V
Minimum Input High Voltage	3.0V	1.3V
MIL STD 883	Standard	Special
Price per 100	$21.00 Am9080A	$40.00 (C8080A)

Ours and Ours.

(Am9080A System Circuits)

AMD Part Number	Description	Availability
	CPU	
Am9080A/-2/-1/-4	Speeds to 250 nsec. 0 to 70°C	In Dist. Stock
Am 9080A/-2	Speeds to 380 nsec. -55 to +125°C	In Dist. Stock
	Static Read/Write Random Access Memories	
Am9101A/B/C/O	256 x 4 22 Pin Speeds to 250 nsec.	In Dist. Stock
Am91L01A/B/C	256 x 4 22 Pin Speeds to 300 nsec.	In Dist. Stock
Am9102A/B/C/O	1K x 1 16 Pin Speeds to 250 nsec.	In Dist. Stock
Am91L02A/B/C	1K x 1 16 Pin Speeds to 300 nsec.	In Dist. Stock
Am9111A/B/C/O	256 x 4 18 Pin Speeds to 250 nsec.	In Dist. Stock
Am91L11A/B/C	256 x 4 18 Pin Speeds to 300 nsec.	In Dist. Stock
Am9112A/B/C/O	256 x 4 16 Pin Speeds to 250 nsec.	In Dist. Stock
Am91L12A/B/C	256 x 4 16 Pin Speeds to 300 nsec.	In Dist. Stock
Am9130A/B/C/O/E	1024 x 4 22 Pin Speeds to 200 nsec.	In Dist. Stock
Am9140A/B/C/O/E	4096 x 1 22 Pin Speeds to 200 nsec.	In Dist. Stock
	Dynamic Read/Write Random Access Memories	
Am9050C/O/E	4K x 1 22 Pin Speeds to 200 nsec.	In Dist. Stock
Am9060C/O/E	4K x 1 18 Pin Speeds to 200 nsec.	In Dist. Stock

AMD Part Number	Description	Availability
	Mask Programmable Read-Only Memories	
Am9208/B/C/O	1K x 8 Speeds to 250 nsec.	Available Now
Am9214	512 x 8 500 nsec.	Available Now
Am9216B/C	2K x 8 300 nsec.	Available Now
	Erasable Read-Only Memories	
Am1702A	256 x 8 1.0 μsec.	In Dist. Stock
Am2708	1024 x 8 450 μsec.	3rd Q. 1976
	Processor System Support Circuits	
Am8212	8 bit I/O Port	In Dist. Stock
Am8216	Non Inverting Bus Transceiver	3rd Q. 1976
Am8224	Clock Generator	In Dist. Stock
Am8226	Inverting Bus Transceiver	3rd Q. 1976
Am8228	System Controller	In Dist. Stock
Am9557	Direct Memory Access Controller	1st Q. 1977
Am9559	Priority Interrupt Controller	1st Q. 1977
Am25LS138	1 of 8 Decoder	In Dist. Stock
Am25LS139	Dual 1 of 4 Decoder	In Dist. Stock
*Am25LS240	8 bit Inverting Bus Transceiver	3rd Q. 1976
*Am25LS241	8 bit Non Inverting Bus Transceiver	3rd Q. 1976
*Am25LS273	8 bit Common Clear Latch	3rd Q. 1976
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*Am25LS377	8 bit Common Enable Latch	3rd Q. 1976

*All combine high performance and low power in space saving 20 pin package

CPU: 9080A = 480 nsec. -2 = 380 nsec -1 = 320 nsec -4 = 250 nsec. **MEM:** A = 500 nsec B = 400 nsec C = 300 nsec D = 250 nsec E = 200 nsec

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Circle 258 on reader service card

Editorial

Facing up to corporate responsibilities: to the public . . .

To hear some people talk, the free enterprise system is on its last legs. One of the biggest symptoms, they say, is the sudden and rapid decline in public confidence in business. David Packard, chairman of Hewlett-Packard Co., for example, told the recent Spring Conference on Consumer Electronics that "the confidence and the respect of the people of this country in business and industry is at the lowest level that I can recall."

But, where other observers are content to cite outside influences, from excessive Government regulations to hyperactive consumerism, Packard moves an important step further. He says of the crisis: "American business managers have not lived up to their responsibility to our society." Had business taken the lead in some crucial areas, such as equal employment, safety in the workplace, and consumer protection, there would have been no pressure on the legislators to force a change in corporate attitudes. The flood of illegal payoffs, of course, has served to confirm the public's poor opinion of business.

Yet despite the best intentions of the more responsible corporate leaders, a decision or action somewhere down the organizational chart can damage the company in the public's eye. Therefore, to be fully responsible, management must go all out to convey its sense of what is expected of all its employees. It is essential for the code of ethics, often unwritten, that guides a corporation's top management to be communicated to—and constantly and consistently applied by—all a company's members.

. . . and to the employees

Once again the pace of hiring engineering graduates has followed the pickup in the pace of business in the electronics industries. But as the newly minted EEs move out into industry it's worth pausing to wonder if their choice of career will offer a lifetime of employment.

There's a familiar pattern at work. Increased recruiting and more job offers for the degree winners, at slightly higher salaries than last year, are accompanied by enthusiastic reactions among the representatives of the engineering education industry. Job prospects for EEs with less than five years' experience improvement, although the veteran engineer still meets a cold reception.

Indeed, what about those engineers in the upper wage brackets who each year see the new flock of graduates as a potential threat? The employment structure seems designed to have the older, experienced EEs either leap onto management career ladders or else drop out in order to make room for the newcomers.

Only in recent years has it become clear that EEs face a mid-career crisis and that this year's enthusiastic graduate may be another year's frightened veteran. The solutions offered do not seem to be immediately workable. There are those who say forget the lifetime career, engineering is an excellent preparation for other livelihoods. Still others have responded with calls for more training and job counseling. Some would put limits on number of EEs entering the field. And others want to increase the employment base by expanding Government spending on technology-related programs.

More and more EEs are coming to the idea that an engineers' union would provide enough muscle to guarantee seniority in holding jobs. On the other hand, a good number believe that the present system is self-regulating, albeit with a certain amount of oscillation in supply and demand, and should not be altered artificially.

It is one of the responsibilities of top management to take a hand in this career dilemma. It's time for top management to review hiring and firing policies, not just because of the legal implications, but simply because it's right to do so—not a bad way to improve industry's image.

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People

The package and the design go hand in hand for Malk

Industry lore holds that hard-nosed product-development engineers look down on industrial designers as "artsy" types who only put a pretty package around the important hardware that's inside.

This is certainly not the case at Beckman Instruments Inc., says David J. Malk, who manages corporate industrial design. "We're so highly regarded that we report directly to the director of R&D," he explains. The close cooperation between industrial and electronic design that results finds an excellent illustration in Beckman's metabolic-measurement cart. A mobile unit for testing the body functions of athletes and hospital patients, it integrates into a single package the instruments for making 19 measurements of nine body variables. The cart will be used at the upcoming summer Olympic games in Montreal. Malk's team took part in each major design decision.

"We want Dave's group to see our products at the very beginning from our customer's point of view," says Malk's boss, R&D director Richard Nesbit. "Our philosophy is to mold marketing into design and manufacturing, not make a product and then hand it to somebody to sell."

Early involvement. To carry out this mandate, Malk and his staff of 10 are involved in every new product developed throughout Beckman's 11 divisions. "We're integrated at every level of development," says the 20-year Beckman veteran. In fact, because his participation often takes the form of challenging how new product functions are carried out, the industrial-design element enters technical decisions early in the development cycle.

Malk points out that it was his group's probing several years ago into how best to take pH measurements that led to the development of a brand-new type of electrode with detachable leads. In turn, this formed the basis for Beckman's line of cordless Futura electrodes.

Challenger. David Malk's industrial designers question product decisions at Beckman.

The enthusiastic Malk, who holds a bachelor's degree in art from UCLA, looks forward to more contributions in the future. In fact, it would describe his staff's jobs better if they were called "product architects," he maintains.

Hilford sees microprocessors boost numerical control

A proposed job for the microprocessor, serving at the center of numerical control systems for machine tools, could be its most important use yet.

That's the view of Michael H. Hilford, who designed such a system for Rockwell International's Microelectronic Device division, Anaheim, Calif. "It will make possible labor savings and big gains in efficiency," he says, "and give our industry a towering lead over the rest of the world that doesn't have this technology."

Mini replacement. Hilford has been leading the design of a system built around Rockwell's PPS-8 microprocessor for a major machine-

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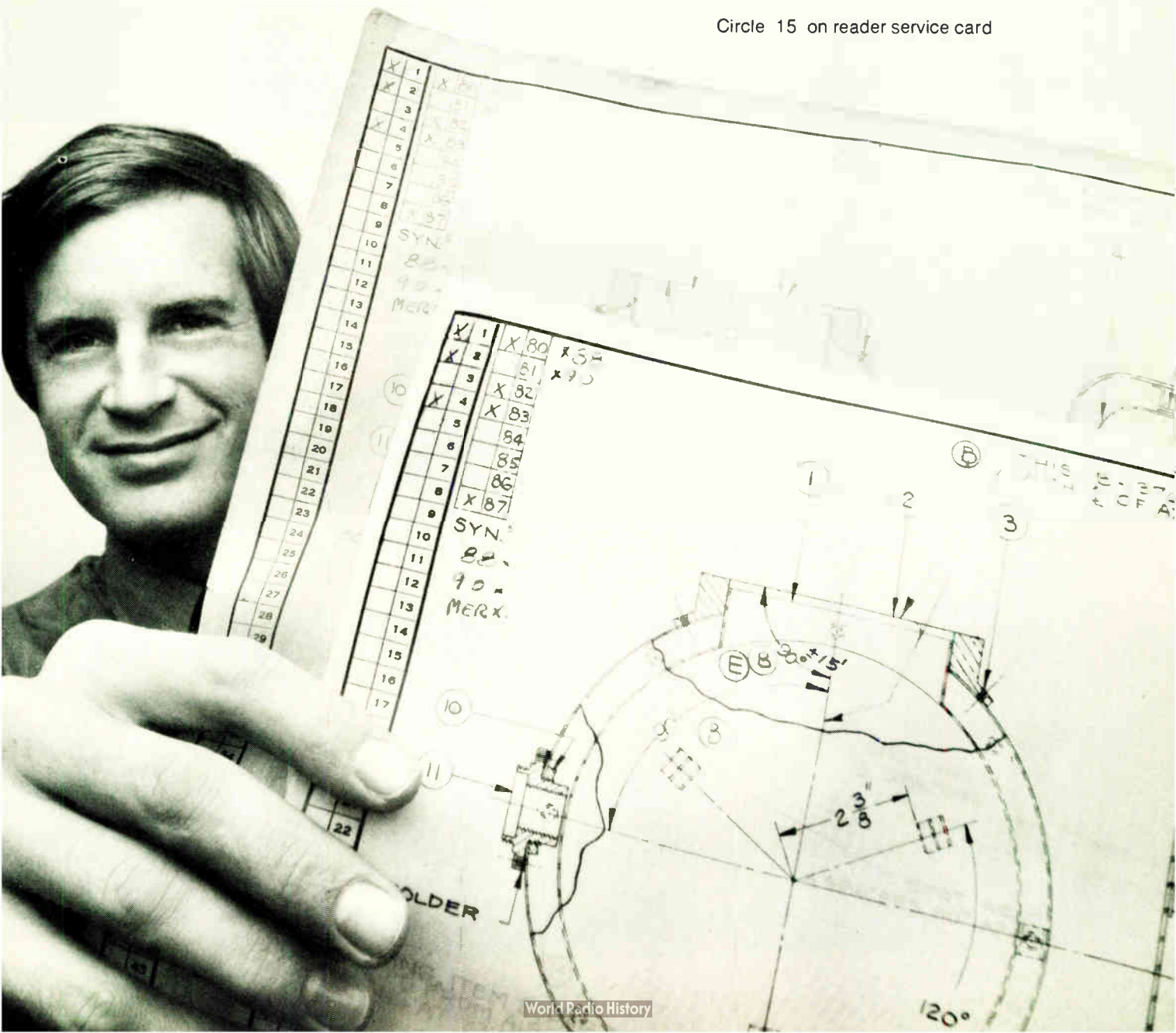


People

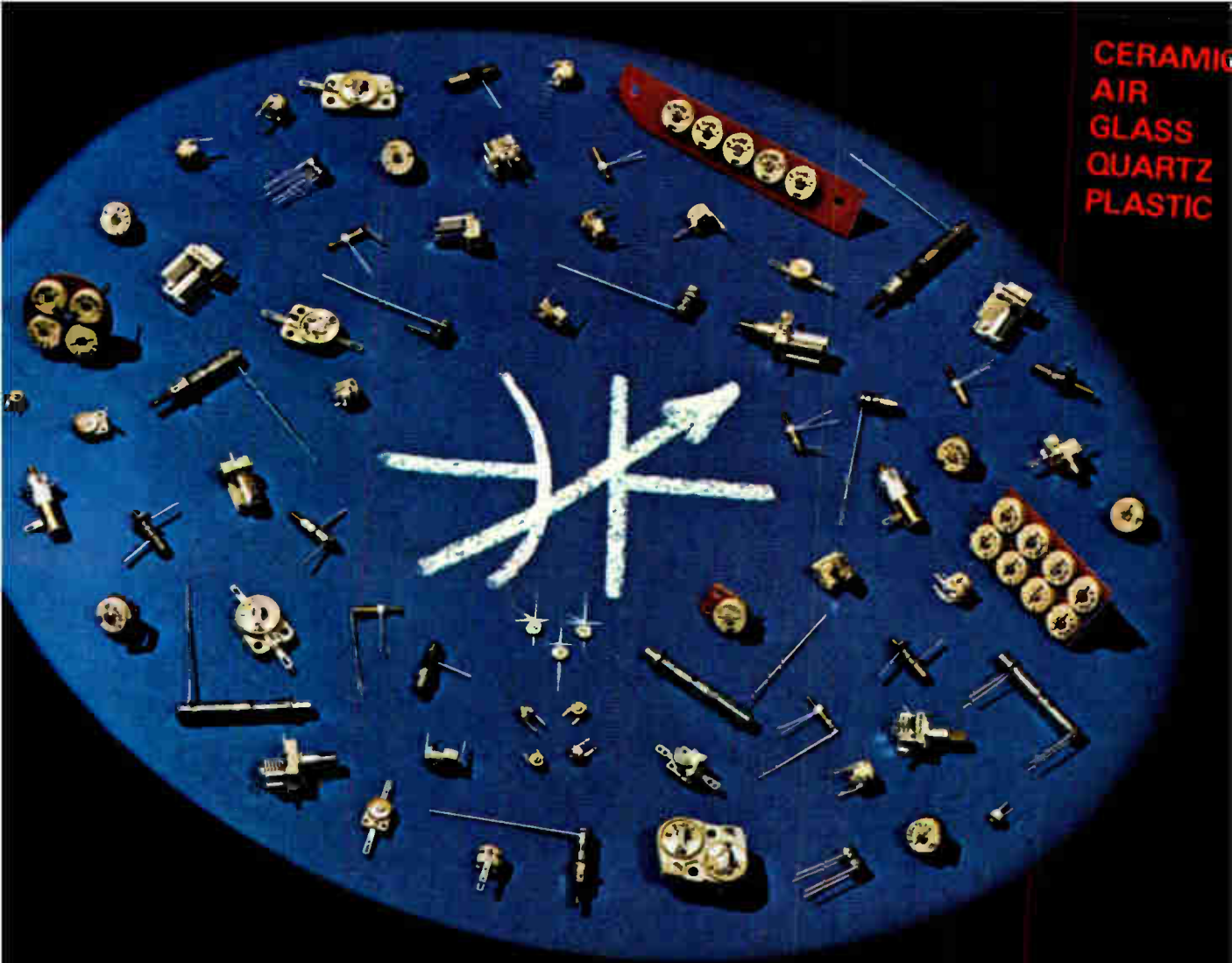
Booster. Microprocessors make machine tools more efficient, says Rockwell's Hilford.

tool manufacturer (see p. 38). At about $100 in quantity, the microprocessor-based system is intended to replace $2,000-and-up minicomputers that are used in many of today's numerical control systems. Complete systems, with sensors and input/output devices, sell for upwards of $20,000.

But the $100 microprocessor could have a sizeable effect on machine-tool operations, according to Hilford. "The tools will operate much more efficiently," he predicts, and it will be possible to install the microprocessor-based controllers on tools used in the ever-smaller machine shops.

Hilford is a true believer when it comes to microprocessors; that's useful, since his job as applications engineer is to find ways to put the processor to work. He worked on systems for several companies earlier this year, and it took only about a month to put together the first, which uses the 4-bit PPS-4, he says. "It is comparatively easy to upgrade to the (8-bit) PPS-8, because of the similarity between the two."

The lean, well-conditioned 41-year-old Hilford not only designs and develops hardware for Rockwell's line of p-channel processors, he also conducts classes to teach industrial customers how to use them. Besides being fun, he says, these training courses themselves contribute to better design. "The processors are so easy to work with, that even the new users see ways to do something in a simpler fashion."



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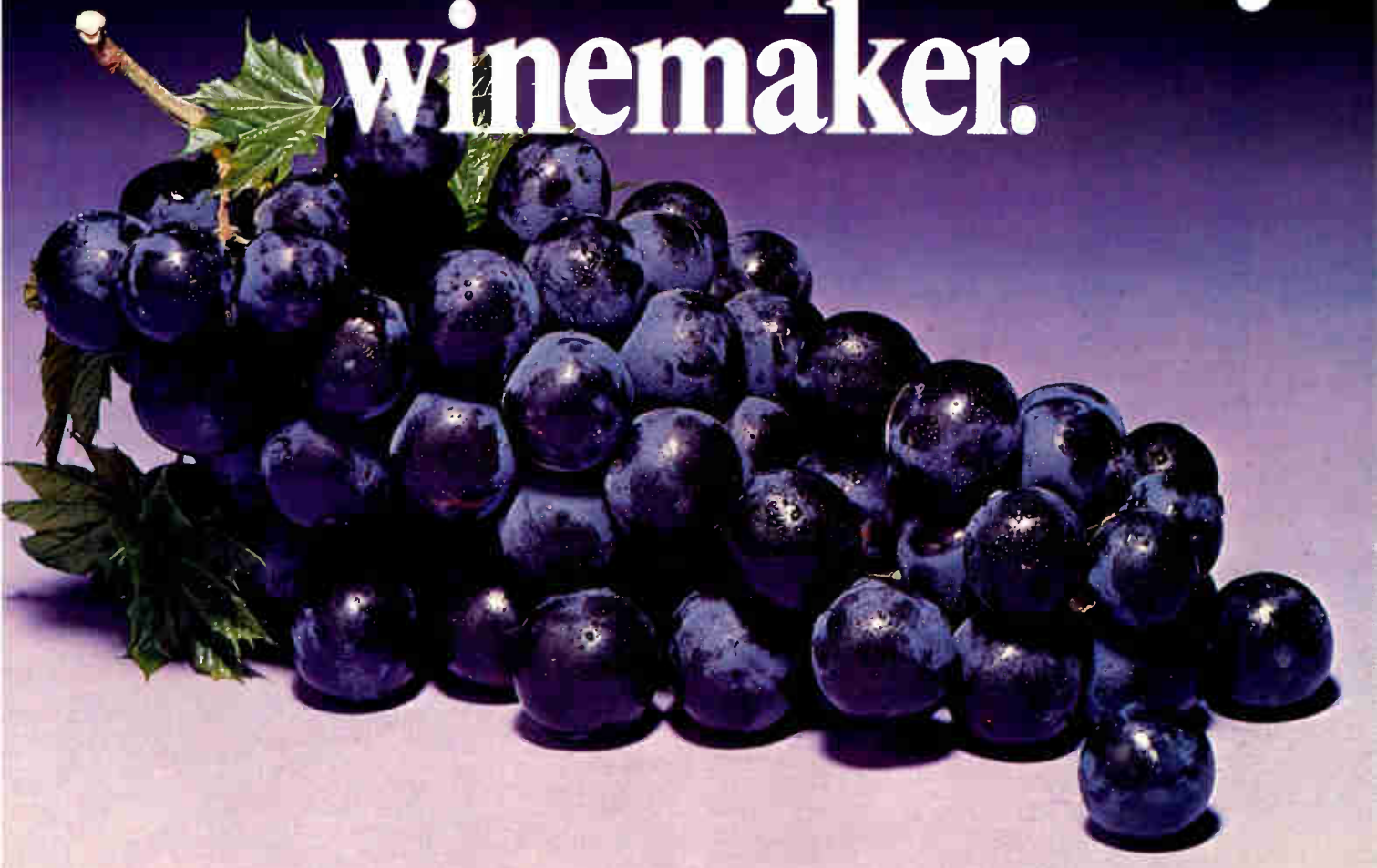

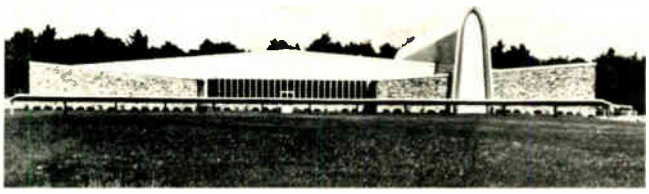

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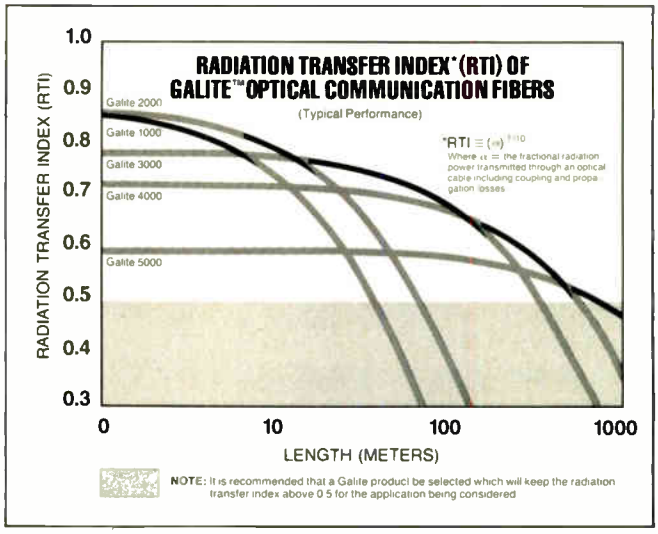

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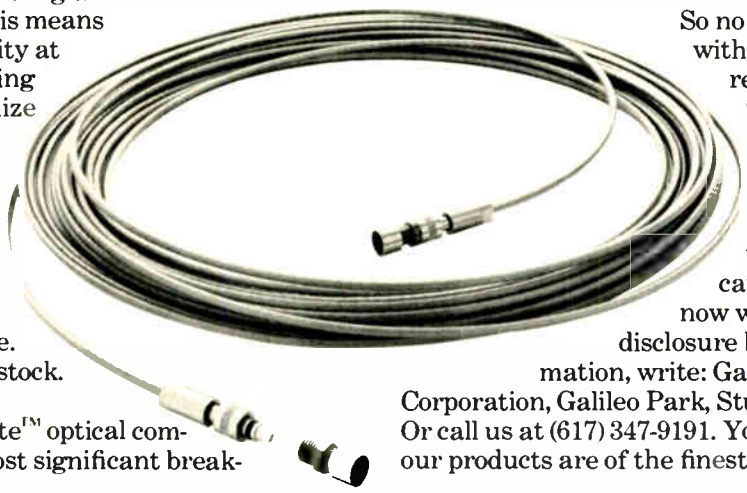

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Sixth Annual Intersociety Conference on Environmental Systems, ASME, AIAA, *et al.*, Town and Country Hotel, San Diego, July 12–15.

Power Engineering Society Summer Meeting, IEEE, Portland Hilton Hotel, Portland, Ore., July 18–23.

International Omega Association Meeting, IOA (Arlington, Va.), Sheraton National Motor Hotel, Arlington, Va., July 27–29.

Nuclear and Space Radiation Effects Conference, IEEE, University of California, San Diego, July 27–30.

International Microwave Power Symposium, International Microwave Power Institute, (Edmonton, Alberta, Canada), Louvain, Belgium, July 27–30.

1976 Joint Automatic Control Conference, IEEE *et al.*, Purdue University, Lafayette, Ind., July 27–30.

International Conference on Computer Communication, International Council for Computer Communication, Royal York Hotel, Toronto, Canada, Aug. 3–6.

Symposium on Control in Transportation Systems, IFAC, IFIP, and IFORS, Ohio State University, Columbus, Aug. 9–13.

20th Annual SPIE Technical Symposium and Instrument Display, Society of Photo-Optical Instrumentation Engineers, Town and Country Hotel, San Diego, Aug. 23–27.

Compcon 76 Fall, IEEE, Mayflower Hotel, Washington, D.C., Sept. 7–10.

International Machine Tool Show, National Machine Tool Builders' Association (McLean, Va.), International Amphitheatre and McCormick Place, Chicago, Sept. 8–17.

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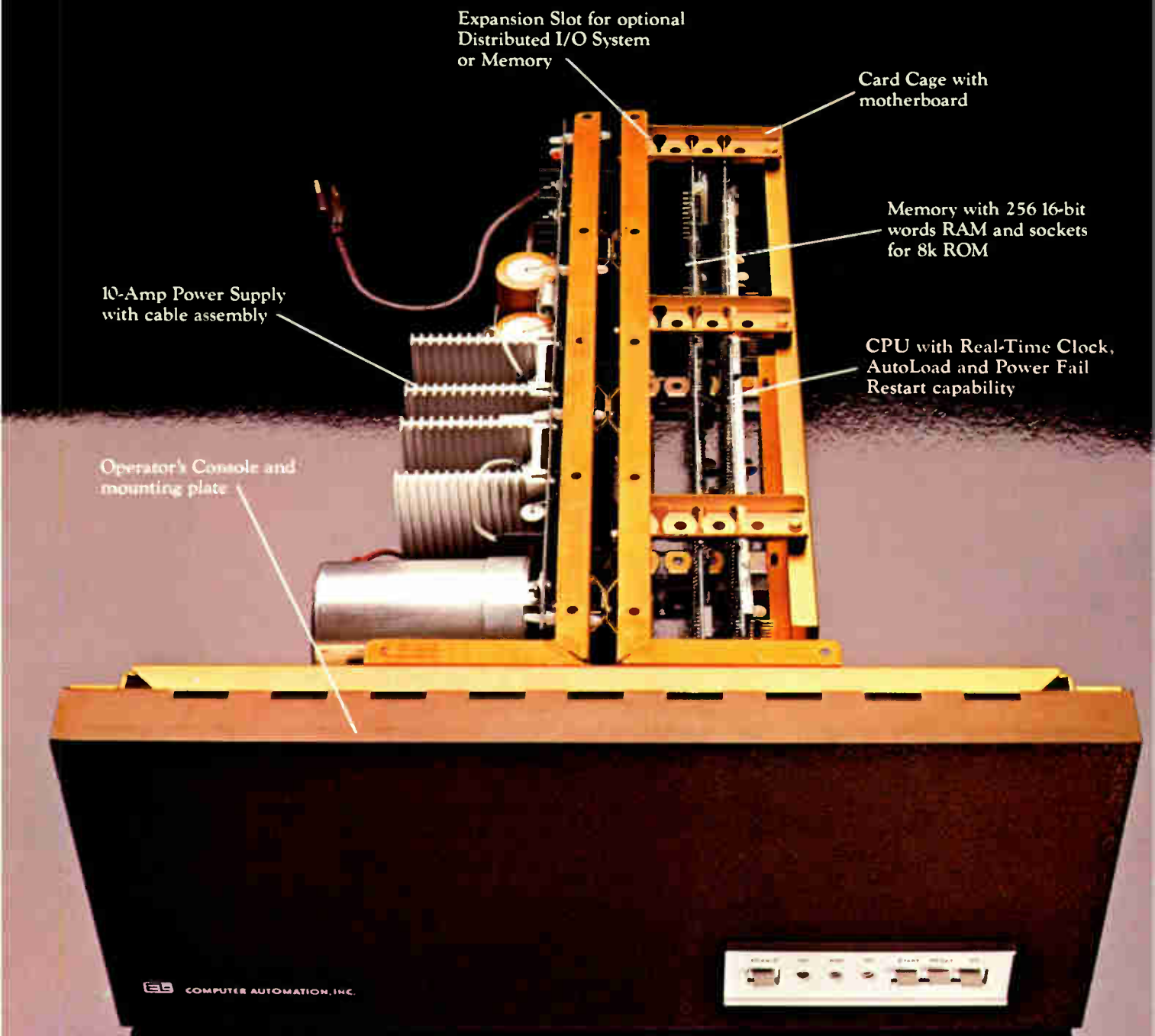

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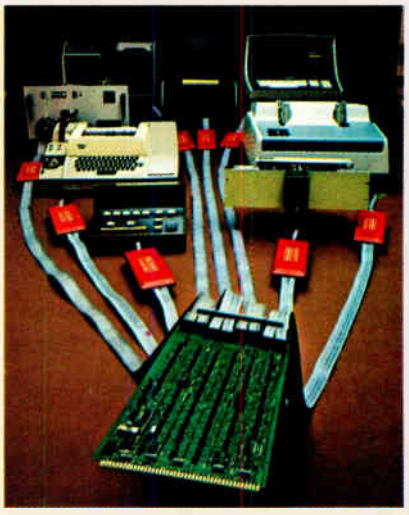

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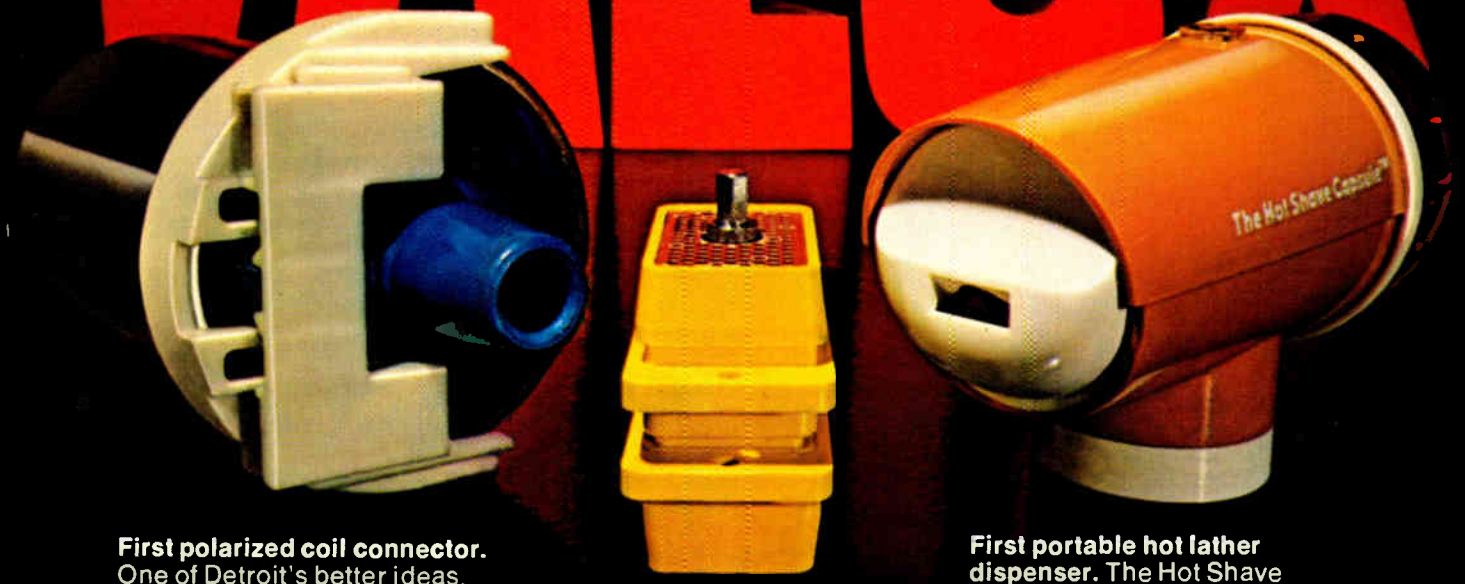

First polarized coil connector. One of Detroit's better ideas, the polarized connector for ignition coil systems was conceived in VALOX resin. Unlike nylon, VALOX resin offered superior electricals and dimensional stability in both high heat and moist environments plus outstanding chemical resistance and excellent flexural strength for the unique snap-fit design.

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Circle 24 on reader service card

Electronics newsletter

Raytheon decides to use sapphire for fault-tolerant computer

Raytheon Co. has opted for C-MOS on sapphire for the arithmetic logic unit of the fault-tolerant spaceborne computer being built for the Air Force Space and Missile Systems Organization [*Electronics*, Dec. 25, 1975, p. 36]. Raytheon's C-MOS on sapphire work isn't new, but like that of Hewlett-Packard Co. [*Electronics*, June 10, p. 34] **it's surfacing as a means of attaining more computer speed.** Raytheon's Equipment division expects to deliver a brassboard to the Air Force in November.

Jack Stiffler, consulting scientist for the computer, which must have 95% probability of operating in space for five years, says the C-MOS sapphire is being used to achieve the specified speed of 200,000 operations per second. Complexity of the LSI arrays is about 300 gates using some 1,700 transistors per chip in a standard array designed by the Raytheon Missile System division Microelectronics Laboratory. The Bedford, Mass., lab provides masks from which Solid State Scientific Inc. of Montgomeryville, Pa., fabricates the arrays. A brassboard is functionally equivalent, but not necessarily built to the same size constraints, as a prototype, which will be the next step in the fault-tolerant computer program.

Interdata 5/16 joins one-board minicomputers

Interdata Corp. is the latest manufacturer to offer a microprocessor-based one-board minicomputer, which it is calling the 5/16. The unit joins a group of such machines, including Digital Equipment Corp.'s LSI-11, Data General's microNova, and General Automation's GA-16/11. **But the 5/16 is about twice as fast as its competitors,** says Interdata, because it has bipolar bit-slice microprocessors (Advanced Micro Devices 2901), rather than MOS, parts in its central processing units.

Interdata, of Oceanport, N.J., adds another twist to the product by giving users access to an input/output bus that can interface directly with the new families of I/O peripheral-control chips now coming out to work with the Intel 8080 and Motorola M6800 microprocessors. Simultaneously, Interdata is introducing a model at the upper end of its 16-bit series, the 8/16, that it claims is faster and less expensive than its prime competitors, DEC's PDP 11/35 and Data General's Nova. 3.

Motorola to build solar-cell arrays for battery chargers

Motorola's Semiconductor Products Group plans to enter the commercial solar energy field this fall with **cell arrays for powering battery-charging equipment.** The firm apparently is the first of the major semiconductor houses to get into this business, until now largely the domain of smaller specialty companies.

Michael Coleman, who manages process-technology development for the solar-energy department in Phoenix, says the first samples of the panel arrays will produce from 1 to 25 W, suitable for trickle charging of remote communication and lighting equipment. While the present market is dominated by the Energy Research and Development Agency's ambitious solar program, run by the Jet Propulsion Laboratory, Motorola sees a "long-term market of significant size." But this will not become a commercial reality before five years or so, Coleman says.

Electronics newsletter

HP lists programable, nonvolatile memory calculator models

Hewlett-Packard Co. in July and August will start selling two portable 224-step programable calculators, the hand-held HP 67, retailing for $450, and the thermal printer/display HP 97, priced at $750. The latter will be programed with a new type of card pack designed especially for the internal processor, **but these cards will not be compatible** with the HP 65 program cards now on the market.

In addition, HP has announced a version of its scientific calculator, the HP 25C, with a nonvolatile memory, which will sell for $200. It uses a C-MOS memory, refreshed by a trickle drain from the battery pack. Finally, the company has dropped the prices on two other calculators—the HP 25 is now $145 and the HP 21 is now $80—to be more competitive with scientific calculators from Texas Instruments and others.

Watch prices: now a $13.95 model surfaces

After straining since January to get the $19.95 digital LED watch in its plastic case to market, U.S. semiconductor watch makers were confronted at Chicago's Consumer Electronics Show (June 13-16) with the specter of a $13.95 version coming out of Hong Kong. A company called Promoters Ltd., among others, showed a few samples that it says will be assembled with Japanese watch chips and displays. The immediate result: by show's end, **the prediction of a $9.95 digital watch by the end of the year** hardly fazed anyone.

Motorola to offer 1-chip microcomputer

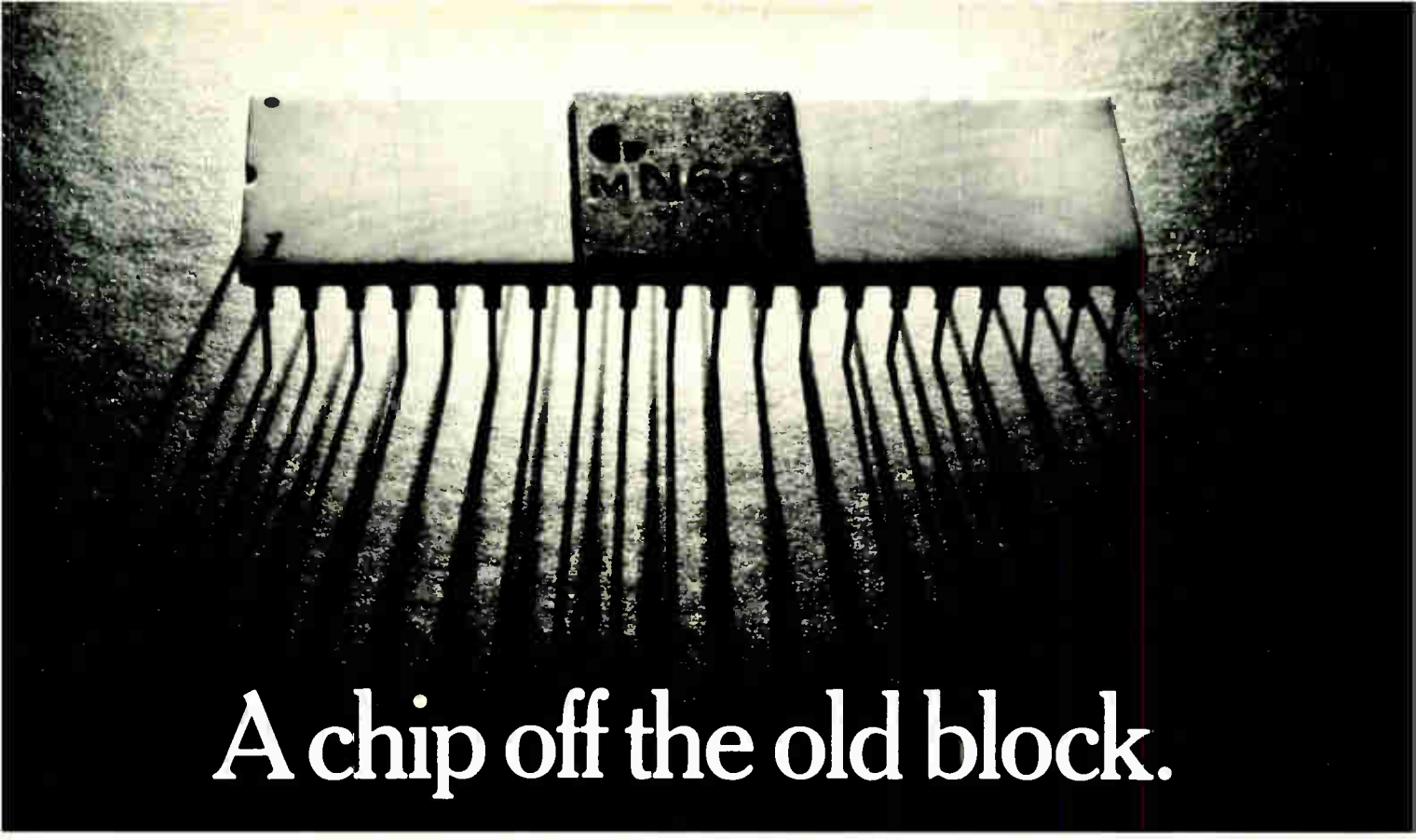
Motorola Semiconductor Products Group will join the one-chip microcomputer race, probably late this year, with an 8-bit, stand-alone controller it calls the MC-6802. The part is not completely defined yet, but the firm plans to make the device with **a memory expandable to 2,048 bits.** Among the manufacturers in the one-chip derby are Intel Corp., and Texas Instruments also plans an entry.

Siemens to get $1.6 million for auto testers

Siemens AG has landed an order worth approximately $1.6 million from Bavarian Motor Works in Munich, West Germany, to develop and supply an estimated 1,000 units of a new automobile diagnostic test system. Designated the model 451, **the timing tester will use a Motorola M6800 8-bit microprocessor** to diagnose ignition systems in late-model BMW vehicles. The testers are being built by Siemens Corp. in Cherry Hill, N.J., with initial deliveries to BMW set for later this year.

LMT simulators win international sales

The Simulator and Electronics division of France's le Matériel Téléphonique is making substantial headway in the international market. Britain's Civil Aviation Authority has approved use of LMT's Concorde simulator for accreditation purposes by British Airways pilots. The firm also expects the U.S. Army to purchase a prototype of an M60 tank-driving simulator, with prospects for sales of more than 300 simulators during the next five years. **Unless the "buy American" doctrine is invoked, LMT is expected to win the Army contract, despite a strong bid by Singer Link.**



A chip off the old block.

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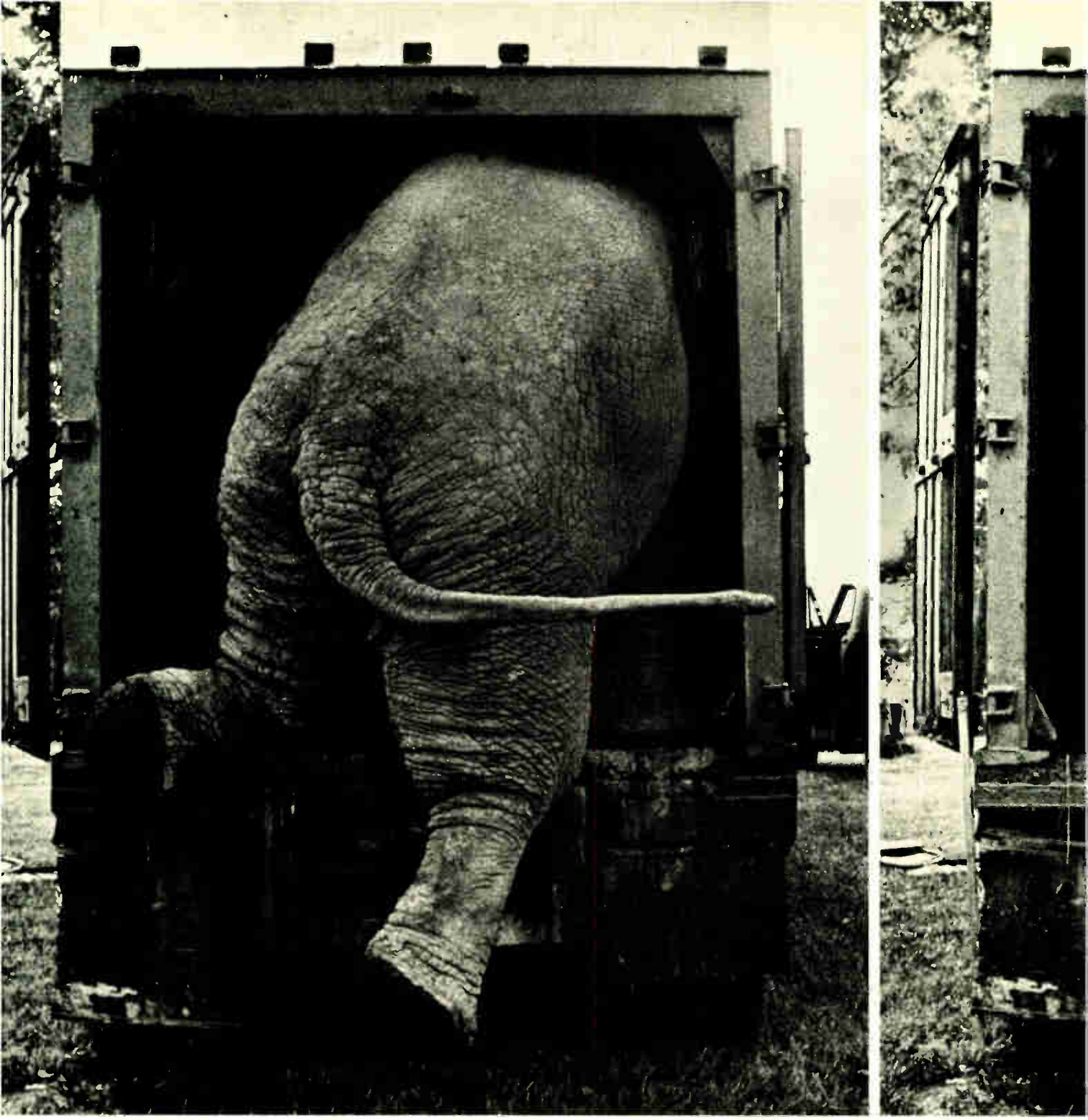
Circle 27 on reader service card



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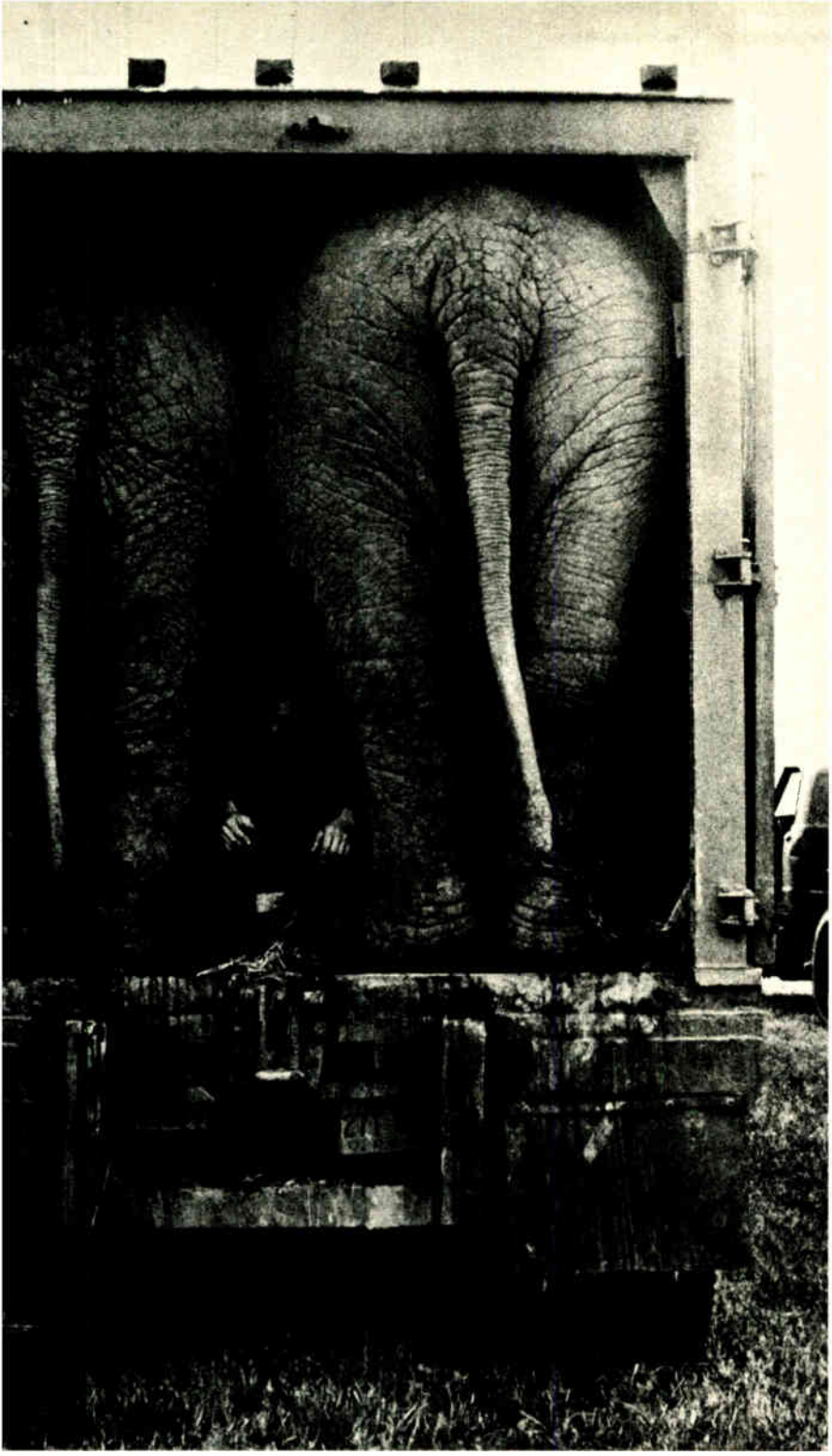
CMOS	4703			4705	4704	4706	4707	4710	4702
I²L (TTL Compatible)	To Be Announced 4th Qtr	9408	More to Come						



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Magnetic heads to be built with thin films

Applied Magnetics building product prototypes; densities of 8,000 b/in., frequencies to 7.5 MHz have been obtained

Thin-film technology is finally making it into the production of magnetic read/write heads. Applied Magnetics Corp., Goleta, Calif., says that prototypes of the heads, based on transducer technology it licensed last year from the French firm of Cie. Internationale pour l'Informatique, are to be delivered to a major manufacturer of disk drives by September. And Burroughs Corp., Detroit, also says it is offering a head-per-track disk file that uses thin-film heads.

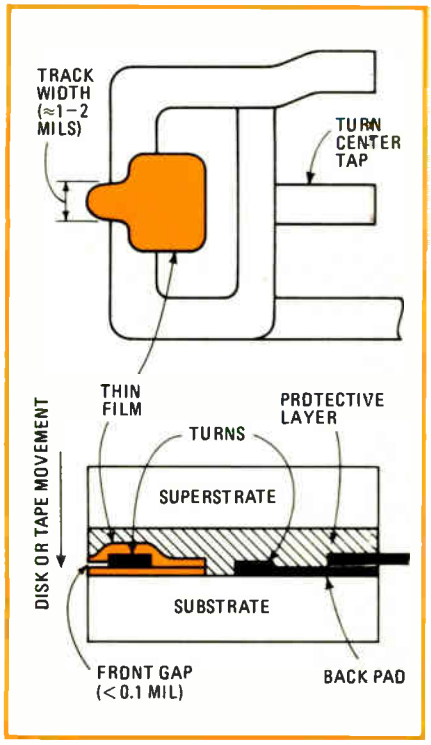
With its small, batch-fabricated structures and high frequency response, the thin-film technology has looked promising for several years as an improvement in the cost and performance of the read/write heads used in magnetic tape and disk storage units.

Vacuum deposition. According to O.M. Fundingsland, marketing and sales manager for heads at Applied Magnetics, tests now are being run on units made with production-type vacuum-deposition equipment that could easily be cranked up for full-scale production. The company says it has demonstrated heads that allow bit-packing densities of 8,000 bits/in. and frequency ranges up to 7.5 megahertz, using the same electronics packages as in conventional ferrite heads.

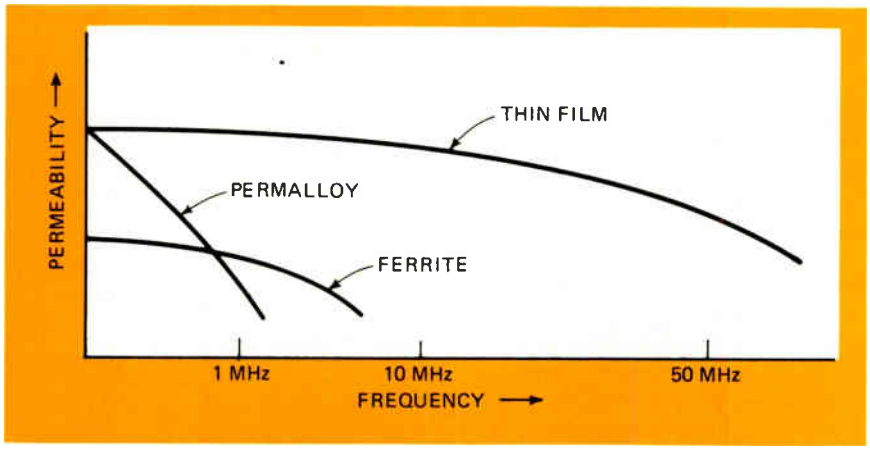
Within two years, says Ray Freeman, vice president of marketing, "we expect our heads to enable bit-packing densities of over 10,000 bits/in. and a frequency range above 10 MHz. These results will be accomplished with conventional media and electronics."

Technology limits. Present head technology based on mu-metal and ferrite materials has just about reached the limit in terms of cost-performance, according to Fundingsland. The heads used in disk drives such as IBM's 3350, for example, are ferrite and operate at about 6,400 bits/in. and 4.8 MHz.

Fundingsland's firm sells such heads to other manufacturers and he says improvements can only be achieved now at what would probably be prohibitive costs. (In fact, he notes, most improvements in head technology in recent years have not been in electrical performance, but rather in aerodynamics, allowing the heads to ride closer to the media surface.) Thus, he sees the thin-film



Sensor. Thin laminated films of permalloy make up the magnetic sensing element in batch-fabricated read/write head. Track width can be held to less than 2 mils.



Response. Permeability of thin-film material used in the read/write head stays fairly constant out to very high frequencies, unlike that of more conventional head materials.

heads as opening up a new era of head designs that will extend the performance to new levels at acceptable costs.

Heads of permalloy. The heads are built by depositing magnetic material—"in the permalloy family," according to the firm—and conductive material—"in the copper family"—on a substrate. The magnetic material is deposited in layers to create laminations, which are necessary to avoid formation of domain walls that create noise due to the Barkhausen effect, according to the company. One pole piece is about 4 to 8 micrometers thick.

The conductors are similarly deposited in layers, with glass-like insulation in between, to create multiturn structures. Generally, about 10 to 30 turns are used, whereas Burroughs' thin-film heads may be using a single-turn and thus require more complex electronics.

Overall, the completed head is about 2 mils thick, while conventional heads are about 50 to 200 mils thick. The head is designed with the aid of a computer, which solves a complex equation taking into account fringing fields and the depth of penetration of the magnetic field into the media. The curve at the bottom of p. 31 show the thin-film head's permeability, which determines the signal output, remaining at an acceptable level out to 50 MHz, far beyond that of bulk permalloy and ferrite. □

Citizens' band

Transceiver sets tested by FCC flunk interference requirements

The Federal Communications Commission is not happy with the electromagnetic interference it's seeing from citizens' band transceivers, so earlier this month it took a step toward tighter control of manufacturers and importers seeking the type acceptance needed to market equipment.

The score so far: FCC: 25; CB: 0.

"We took hardware samples, and we found that 25 out of 25 failed type acceptance upon examination of the equipment," says Ray Spence, the FCC chief engineer. The 25 sets that the FCC tested were from about 20 different manufacturers, both domestic and foreign, and much of the equipment was already on distributors' shelves awaiting the go-ahead to be sent out to retailers.

"Before we started, I guessed about 50% would pass," Spence says. "Now I'm not so optimistic; I'm afraid to look any further."

All to be checked. Nevertheless, he will. "And, until we start seeing a 100% compliance rate, we'll continue looking at 100% of the equipment that's submitted for type acceptance." Previously, the FCC handled CB type acceptance by reviewing only the documentation that was submitted. However, it always reserved the right to screen equipment. Based on documentation filings alone, all but one of the 25 would have passed.

More failures expected. Spence's disclosures—made to dealers attending last week's Consumer Electronics Show in Chicago—are bound to send manufacturers back to their drawing boards. The commission has received 80 or 90 applications for CB type acceptance since it started screening the initial 25. And there's bound to be more: an FCC report and order is expected next month that will probably expand the 27-megahertz class D citizens' band service from 23 to 40 or 45 channels by early next year.

"We expect to see a couple of hundred applications within the first couple of months after the rule making," Spence says. "After all, most manufacturers already have the expanded 27-MHz equipment designed. All that equipment will be reviewed also."

As for transceivers that are already out in the field or waiting to be sold on dealers' shelves: "There is no way to recall a CB. But we'll start looking at equipment already

CB exhibitors top 100 at consumer show

Despite the FCC's crackdown on out-of-spec citizens' band gear, the mood of the industry remains ebullient. Last week's noisy, bustling Consumer Electronics Show in Chicago found over a hundred manufacturers and importers of CB-related gear lining the aisles, with no firm signs of the inevitable shakeout in sight.

Estimates of 1976 factory sales were as volatile as ever—ranging from $500 million to over $1 billion—even though backlogs have begun to soften for low-end transceivers. On the high end, however, it's still a seller's market, with much fanfare about such features for the hobbyist as noise blanking, squelch, automatic noise limiting, and standing-wave-ratio meters included in the equipment.

The appeal to the hobbyist will also spark the growth of in-dash and combination (a-m/fm/CB) units and hasten the trend to digital synthesis and channel display. Digital controls also make remote units possible: all user controls are mounted on the mike, and the radio is relegated to the trunk, alleviating the problems of theft and dashboard clutter. And increased use of phase-locked loop circuitry with which the various channel frequencies are derived has eased the crystal shortages prevalent a year ago, although some manufacturers remark that signal/output meters are now in short supply.

For those makers and sellers that survive the shakeout—which consensus puts a year or so away—business should remain strong for another four years. Or perhaps seven, some say, figuring 50% saturation of a total potential market of 230 million units.

on the market as soon as time permits," he says.

Not all of the applications were rejected; manufacturers of units which might go over 100% modulation were given 60 days to correct the problem. "But we're going to reject the others," he says. Overmodulation—usually at high voice levels—causes splatter into adjacent channels, and the interference stays within the CB band.

Serious problems included high levels of spurious harmonics due to poorly designed filters, and transient emissions occuring between the time that talk starts and the modulation limiter is applied. Both generate frequencies outside the CB service; the latter, he adds, is difficult to measure, as well.

"I suspect that many people don't have the necessary equipment to test their own product to make sure it complies," Spence says. "I'd guess that less than 50% of the sets sold are tested to our specs by the manufacturer." That's especially true of imported units, which are tested under contract by independent labs. "But we were surprised to find U.S. manufacturers in the lot that was rejected. They should have known better." □

Magnavox tries built-in games

While most of the video games competitors have claimed that no U.S. television receiver company would put a game chip inside a set, Magnavox Corp., the maker of Odyssey games, has now done it. At the Consumer Electronics Show in Chicago last week the firm unveiled one 19-inch color-receiver model that contains three games.

Designed around a General Instrument Corp. chip, the game/receiver combination will retail for $499 starting in September. The games, hockey, tennis, and handball, add between $70 and $80 to the price of the 19-inch model.

To play the games, the user pushes a button on the front of the set that deactivates the broadcast reception. Paddle controls are plugged into sockets at the rear. With the GI chip, the games have vertical paddle control only, rather than both vertical and horizontal control as in the separately packaged Odyssey games that have Texas Instruments devices. The two detachable controls have 12-foot cables to permit players to sit well back from the screen.

Photovoltaics

Thin-film cells reach 5% efficiency

A technique being developed for building polycrystaline, rather than the usual single-crystal, silicon solar cells is promising production devices by 1980 that will sell for less than 50 cents per peak watt.

"We're making faster progress than we expected," says Ting L. Chu, head of the research team at Southern Methodist University in Dallas. Conversion efficiencies of greater than 5% for the thin-film photovoltaic cells measuring 30 square centimeters are being achieved, and many smaller cells exhibit more than 6% efficiency.

"This time last year, we were seeing a 2½% efficiency level," Chu says, "and that was only on small-area cells, of about 10 square centimeters." Efficiencies aren't yet as high as with single-crystal silicon solar cells for terrestrial use, which run from 10% to 12%, he admits, "but we're doing it with less expensive material and fewer process steps. We're shooting for a production price of 50 cents per peak watt by 1980, and we hope to be less than 30 cents per peak watt by 1985," he says.

Commercially available single-crystal solar cells built from 2- or 3-inch diameter wafers (about 20 and 46 cm^2) now sell for about $20 a peak watt in purchases of 1 to 10 kilowatts, and often as high as $40 a watt for smaller buys.

Thin-film funds. The Energy Research and Development Administration's short-term goals in its photovoltaic energy-conversion program are centered around cutting the price of the silicon devices to about 50 cents a watt by 1985. But ERDA concedes that it must consider other solar-cell configurations in addition to single-crystal approaches if photovoltaic devices are to be used economically.

The Washington, D.C.-based agency published a request for proposals in March, and, in the next few months, it is expected to fund several programs, aimed at developing low-cost thin-film solar cells. Besides polycrystaline silicon, candidate materials include gallium arsenide, indium phosphide, and copper indium selenide—all thin films on suitable substrates.

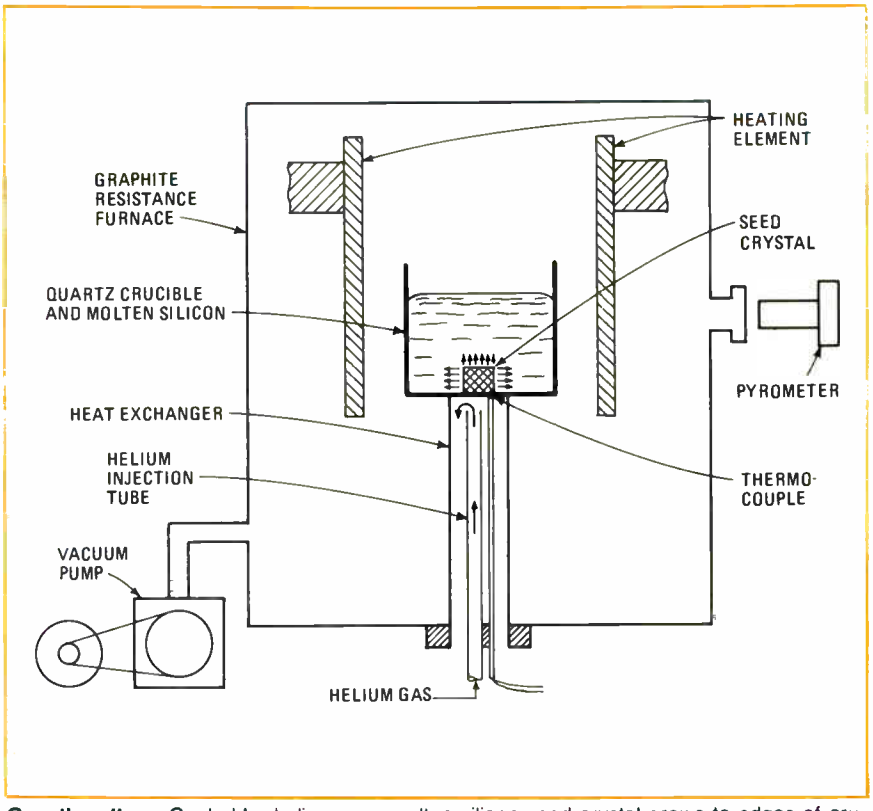
"The SMU work has been the prime thrust in the thin film area to date," concedes an ERDA official, "and we think it shows a lot of promise." Chu is confident that he will have solar cells with 8% efficiencies within two years, maybe even as early as next summer. "And by the time we get to 8%, manufacturers will be interested in setting up pilot-production lines to demonstrate production feasibility," he says. "An 8% cell won't be suitable yet for very-large-scale [power] generation, but it will work in specialized applications, such as highway call boxes, remote military equipment, and pleasure applications, like recharging the batteries on a boat."

Metallurgical grade. Chu's group starts with metallurgical grade silicon, the 98%-pure material used in the aluminum and steel industries that sells for about $1 a kilogram. To get the larger silicon grains that yield higher conversion efficiencies, the silicon is first melted and recrystalized on an inexpensive graphite substrate, and chlorine gas is run through the molten silicon to remove some of the impurities, such as boron and aluminum.

Then, to get the pn junction that

makes the solar cell, Chu uses chemical-vapor deposition to deposit a layer of semiconductor-grade silicon 20 to 30 micrometers thick, changing the dopant gases in midstream to get a 20- to 30-μm p-type layer and a 0.5-μm n-type layer. A titanium-silver contact, used on single-crystal solar cells, is applied to the top surface, and the graphite substrate serves as the second contact. (ERDA is also funding work at NASA's Lewis Research Center, in Cleveland, to get thick-film contacts that can be painted on the solar cell.)

"We think our devices can be manufactured using current techniques with a few modifications," Chu says. "We'll have to develop a process for the recrystalization, but chemical-vapor deposition is a common technique." □



Growth pattern. Cooled by helium gas, molten silicon seed crystal grows to edges of crucible. Six-inch-diameter single-crystal silicon ingot is initial goal of Crystal Systems.

Silicon ingot going to 6 inches

Frederick Schmid was confident enough in his heat-exchanger method for growing single-crystal sapphire ingots to found Crystal Systems Inc., in Salem, Mass.

With the firm profitable after five years, he is convinced the same method can be used to grow large-diameter single-crystal silicon. These ingots could yield solar cells with conversion efficiencies of at least 10%, close to what is being produced today from silicon generally 2 or 3 inches in diameter, Schmid believes. However, he wants to at least double the diameter.

The company has a contract from the Energy Research and Development Administration to demonstrate the feasibility of its technique for producing silicon ingots 6 inches in diameter. Schmid delivered a paper detailing the process this week at the 1976 Electronic Materials Conference of AIME, the American Institute of Mining, Metallurgical and Petroleum Engineers, at the University of Utah in Salt Lake City.

Crystal Systems' contract is part of the low-cost silicon solar array project at ERDA [*Electronics*, March 6, 1975, p. 29]. Schmid says that after six months of effort he feels "very positive. We've been able to handle silicon nicely in a vacuum and we have good control of the whole system. We haven't seen anything that indicates trouble."

No pulling. The heat-exchanger method differs from the Czochralski crystal-growing technique chiefly in that the crystal grows, without being pulled, upward and outward from a seed at the bottom of a crucible. It assumes the shape of the crucible. The crucible is in a graphite resistance furnace, and the whole system is in a vacuum. The Czochralski process does not use a vacuum, and the boule or ingot is pulled from the top of a melt as the crystal rotates.

Schmid calls the actual growing process "directional solidification." It has produced sapphire ingots 10 inches in diameter, and Crystal Systems has an Air Force contract to extend that to 14.5 inches. The ERDA contract also covers techniques for slicing the ingots (see "Getting the most from the ingot," p. 36).

Crystal Systems starts with a seed crystal centered on the bottom of a quartz crucible loaded with low-purity silicon stock, as shown in the drawing above. The furnace's heating elements surrounding the crucible melt the silicon, so that some nucleates around the seed crystal. At this point, the flow of cooling helium gas through the heat exchanger on which the seed rests is increased, the temperature of the furnace (and the molten silicon) is lowered, and the crystal starts growing in all directions.

A thermocouple at the top of the helium-injection tube allows close control of the temperature of the growing solid crystal. A simple feedback loop permits independent control of the molten silicon temperature. Once crystal growth is completed, the ingot is annealed in place just below the melt temperature to relieve solidification stresses.

During growth, there is no move-

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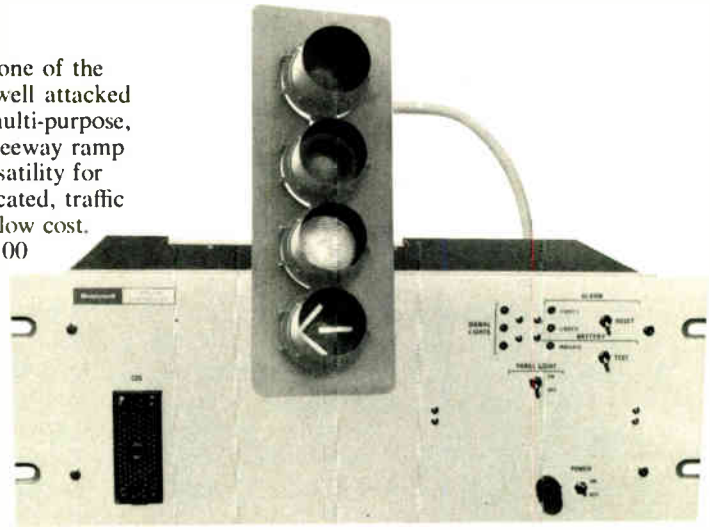
Vehicular traffic management is recognized as one of the great practical transportation problems. Honeywell attacked this problem head-on, with the programmable, multi-purpose, Type 140 controller for both intersection and freeway ramp applications. It has the speed, capacity, and versatility for uses from simple, fixed, time control to sophisticated, traffic responsive, centrally directed operation, yet it's low cost. The central processing unit is Motorola's MC6800 microprocessor.



HYCEL

It's a desk-size, 30-channel, automated blood analyzer for medical laboratories. It performs over 3,000 tests per hour, selectively and sequentially, while continuously tracking patient identity and sample status. It's fast. Maximum test time is ten minutes, from sample pickup to completion. The HYCEL M is big news in the medical test instrument field, and HYCEL calls it the "ultimate analyzer." All machine functions are automatically controlled by the instrument's Motorola's MC6800 microprocessor.

CHRYSLER

Chrysler developed the lean burn system to permit engines operating in their cars to meet emission standards without catalysts, while giving improved fuel economy on either leaded or unleaded gas. Servicing this innovative system also called for an innovative new concept in diagnostic testing. Chrysler has called the MC6800 microprocessor based portable diagnostic tester they designed to meet this challenge "an ideal service tool," for its versatility and economy.

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MOTOROLA M6800

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Getting the most from the ingot

Besides delivering silicon ingots, Crystal Systems will also report on an improved way to slice them as part of its ERDA contract. The company has modified a Varian Associates wafer-slicing saw to work with closely spaced diamond-impregnated wires. The goal is to get 100 wafers per inch—2½ times as many wafers as is now possible, says Crystal Systems president Frederick Schmid.

Only 10 mils of silicon will be used for each wafer, leaving a wafer about 6 mils thick after each cut consumes 4 mils. Schmid, who has used the cutting technique experimentally to slice sapphire, says it should be possible to have thousands of wire blades per machine.

ment of the crystal, crucible or furnace, an important advantage Schmid cites over the Czochralski method. In addition, the crystal is protected from contaminants by being in a vacuum and from vibration by the liquid mass above it as it grows. The Czochralski method also employs expensive argon gas flowing over the melt to carry off silicon monoxide impurities.

The biggest problem with the Crystal Systems technique, Schmid notes, is in the initial growth stage where "it's a bit difficult to see the position of the crystal or the shape of the solid-liquid interface. There's a lot of trial and error until we see that we have a good start, and we throw away a lot of crystals." Even so, he expects to produce single-crystal ingots in the last quarter of the one-year contract.

"We're seeding back into the crystal now, determining meltback rates and proper temperatures." □

Industrial

Lasers are applied to grade lumber and monitor oil spills automatically

Neither lumber inspection nor oil-spill monitoring has yet been automated. But both tasks appear ready to succumb to laser technology, according to speakers at the recent IEEE/Optical Society of America conference on laser and electro-optical systems in San Diego.

Bendix Research Laboratories, Southfield, Mich., is field-testing a laser system that inspects rough planed boards. Installed at a lumber mill belonging to American Forest Products Corp., a San Francisco-based subsidiary of Bendix Corp., the system locates and identifies cracks, knots, holes, edge flaws, and other imperfections in the board, all despite a confusing background of varying grain sizes, board colors and color markings. The system then calculates the best way to cut the board to eliminate the defects while marking the wood for later cutting so it will yield its greatest market value.

Contrast. "We must be able to see cracks as narrow as 4 mils, and to get this resolution we needed a laser," says Raymond T. Hebert, former project engineer for scanner development at Bendix and now with laser manufacturer Spectra-Physics Inc., Mountain View, Calif. "Spectral analysis showed that a helium-neon laser offered the best contrast between flaws and the wood."

Light reflected from a board, traveling at 100 feet per minute under a scanning laser beam, strikes photomultiplier tubes whose outputs are processed through two filters—a high-pass filter to detect small flaws like splits, and a low-pass filter for gross imperfections like knots. Filter outputs that exceed a threshold adjusted automatically for wood colorings are digitized and processed by a 16-bit minicomputer.

The computer looks for anomalies in the reflected signal and stores the scan in which they appear. Each side of the board, which can be from 1¾ to 6 inches wide, is scanned 24 times per inch. Each type of flaw produces a characteristic signature which the computer compares against models stored in its memory. Eventually, the system will be connected to an automatic saw, Bendix says.

Oil detector. To replace manual sampling as the chief means of detecting oil spills, Texas A&M University, College Station, has developed an automatic inspection system that will be delivered to the Coast Guard this summer. The system uses an 8–10-mW helium-cadmium laser with a repetition rate up to 500 kilohertz. The beam is expanded to a 2-in. diameter, wide enough to lower the power density below the level dangerous to the human eye.

"With the high repetition rate and synchronous demodulation techniques, we can recover very, very small signals," points out William Hulse, director of the Electro-optics Systems Laboratory at Texas A&M. "This makes the system extremely sensitive—we can detect oil films 100 nanometers thick from a range of 1,000 ft under varying sunlight conditions. But sensitivity can be adjusted, depending on the waterway, to prevent false alarms."

The laser, on a motor-driven mount, scans the waterway automatically. Light reflected from the water is focused through spatial and spectral filters, then divided by a polarization tube into horizontal and vertical components.

Each component is picked up by a photomultiplier tube, and its output is converted to a voltage by a transresistance amplifier, scaled, and then mixed with the laser frequency to compensate for fluctuations in laser output that occur with time and temperature changes.

The mixing stage produces a dc component for the horizontal and vertical channels, which is again scaled, digitized, and delivered to an Intel 8080A microprocessor as 12-

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SOC 5-3	A	5V	3.0	2.4	1.8	32
SOC 5-6	B	5V	6.0	4.9	3.8	54
SOC 5-10	C	5V	10.0	8.0	6.5	67
SOC 12-1.6	A	12V	1.6	1.3	1.0	32
SOC 12-4.0	B	12V	4.0	3.0	2.5	54
SOC 12-6.0	C	12V	6.0	5.0	4.2	67
SOC 15-1.5	A	15V	1.5	1.2	1.0	32
SOC 15-3.0	B	15V	3.0	2.6	2.2	54
SOC 15-5.0	C	15V	5.0	4.2	3.5	67
SOC 24-1.0	A	24V	1.0	.75	.55	32
SOC 24-2.2	B	24V	2.2	1.9	1.6	54
SOC 24-3.5	C	24V	3.5	2.9	2.4	67
SOC 28-0.8	A	28V	0.8	.64	.45	32
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SOC 28-3.1	C	28V	3.1	2.6	2.0	67

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bit serial data. The microprocessor calculates such parameters as the data's mean and variance and handles the decision algorithms that are solved to determine oil thickness and turbidity. The results are read from a hexadecimal display, recorded on magnetic tape, or used to sound an alarm.

If the Texas A&M model meets the Coast Guard's expectations, the next step will be to open bids for a production version. Tentative plans are to place the scanners on ships and around harbors and along waterways. □

Numerical control uses MPU chip

In minicomputer-based numerical control systems, the high speed of the general-purpose devices has been needed to handle the simultaneous and complex tasks, such as position control and curve generation, that must be carried out. Microprocessors, on the other hand, are just too slow. Until now, at least.

Matching mini throughput. By using parallel "processing" techniques that overcome the speed problem, Rockwell International's Microelectronic Device division, has built for a machine-tool maker a microprocessor-based system for numerical control. Based on the PPS-8 microprocessor, its system not only matches the performance of minis in total throughput, but offers a big price advantage, claims Michael H. Hilford, the Rockwell applications engineer directing the project.

"The system will sell for about $100 in quantity, compared with $2,000 to $3,000 for the minicomputers it replaces," he says. "And that doesn't take into account its simplicity and the flexibility that permits varied configurations." While the PPS-8 offers a considerable savings over minis in numerical control systems that themselves cost from $20,000 up, this is just the beginning in Hilford's opinion. "As microprocessors penetrate the machine-tool business, the total N/C system cost will come down."

The Anaheim, Calif., division of Rockwell built a prototype system this spring for a customer described as "a major vertically integrated machine-tool company." This company is likely to be aiming at announcing a tool using the Rockwell system at the 1976 International Machine Tool Show in Chicago next September. In the meantime, Rockwell is offering its system to other machine-tool and numerical-control manufacturers.

Rockwell's first system incorporated its 4-bit, p-channel PPS-4 processor because the customer wanted to start out simply, Hilford says. But design has already been completed for an improved system using the 8-bit PPS-8, which also is off-the-shelf hardware.

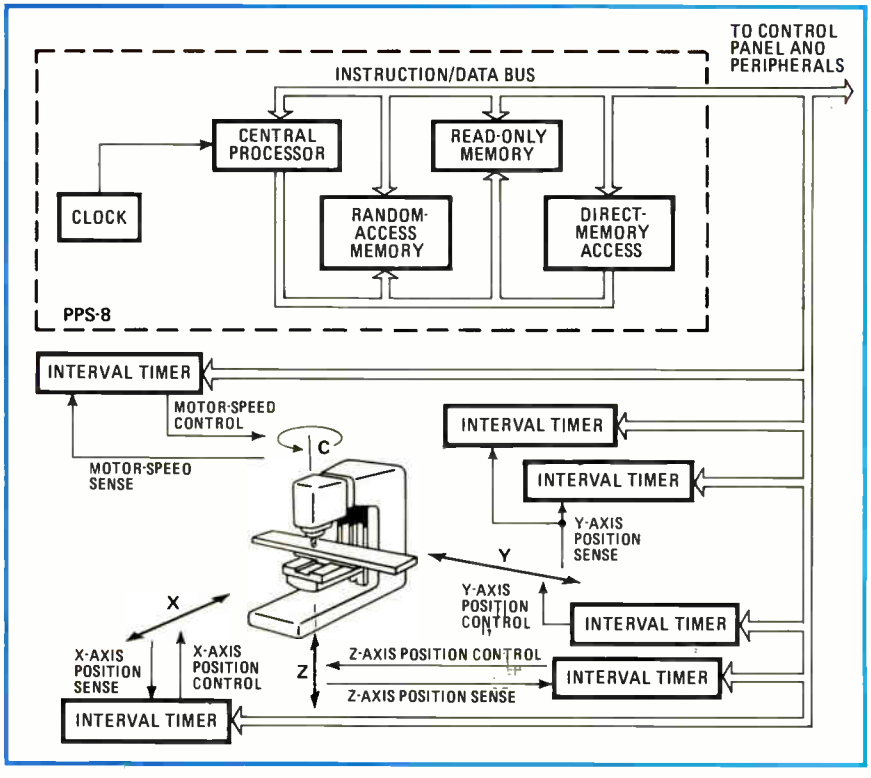
Distributed elements. In developing the system, Rockwell banked on its experience with parallel processing techniques developed to keep the speed of systems using its slower p-channel devices close to the speeds possible with its n-channel competitors. Thus, logic elements are distributed as peripherals—called interval timers but actually real-time event controllers—where they each perform part of the total processing task.

An interval timer, built on a large-scale-integrated chip, consists of four binary counters that receive input from tool sensors such as the one for monitoring position, for example; three 12-bit and one 8-bit buffer memories that hold the data needed to operate the tool, and two discrete output ports and a 4-bit bidirectional input/output port.

In a typical numerically controlled milling machine, for example, these timers would control the overall motor speed, while sensing and adjusting the positioning of the tool along three axis as shown in the diagram.

"The limits of each operating parameter are programed from the microprocessor into each timer," Hilford explains. "Then, in real time, the timers perform the individual

Shared chores. Numerical controller built around Rockwell PPS-8 microprocessor uses interval timers—or event controllers—to share the load in control tasks.



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In one instrument, the Model 802 offers frequency coverage from 1 Hz to 20 MHz, or 0.01 Hz to 20 MHz as an option, for an extremely stable source of signals typically requiring more than one instrument. Frequency accuracy is ± .001%, or by using the Model 802's phase lock input, it can be slaved to an external frequency standard for even higher accuracy. Options include BCD programming, ASCII programming (compatible with IEEE STD 488-1975), several output impedances, low frequency extender (to 0.01Hz), and rack mounting adapters.

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control tasks without intervention of the central processing unit." However, the MPU communicates with the timer, updating the numbers for positioning and control. The timer chip itself controls the electromechanical elements—such as stepping motors and tool speeds—of the machine tool.

The amount of time spent by the microprocessor on control-related operations is 8% on average, 12% for the most extreme case—as against about 50% for a minicomputer, according to Hilford. The time freed up is then available for non-real-time functions such as calculation of curve data, data manipulation, and housekeeping jobs. In this way, Rockwell compensates for the relatively slow speed of the PPS-8—4-microsecond add/subtract time versus 1 μs for a minicomputer.

The $100 PPS-8 system in a configuration for milling operations comes with 2,048-bits of read-only memory and 256 by 8 bits of random-access memory. Included are six time-interval counters. Programming is in an assembly language using simple mnemonics like add, subtract, and store. The system permits varied configurations of floppy disk memory, printers, and displays for virtually any numerical-control task, Hilford says. □

Teletext in the U.S.? Not soon

It is doubtful that the decoding circuitry developed for the UK and Europe can be easily converted for use in the U.S. Besides the basic display differences—625 lines in Europe (except France) vs 525 lines—there is not enough bandwidth available in the U.S. broadcast standard to allow transmission at 7 megabits per second. The Public Broadcasting Service, however, is trying to set a standard for data transmission in its proposal to the Federal Communications Commission for digitally encoded transmission on the signal retrace to be used for captioning programs for the deaf.

There is, however, probably more concern by U.S. broadcasters for the concept, rather than the details, of Teletext. Unlike the British Broadcasting Service, which is supported by an annual license fee for television receivers, U.S. broadcasters depend on advertising revenues. They may not wish to offer their audiences an alternative to commercial-filled programing.

Consumer

I²L chip decodes Teletext for TI

Now that Britain's digitally transmitted television "magazine" is operational, set makers there are gearing up to include the decoding and display logic in their receivers. And it looks as if the early business will go to Texas Instruments Ltd., still the only firm that's announced decoding circuitry, called Tifax, to meet the ambitious specifications of the data service called Teletext [*Electronics*, Feb. 5, p. 68].

The first modules will be used in an add-on decoder to be introduced later this year by Labgear Ltd., a Philips-owned firm. Other sets with a built-in TI decoder probably will be announced next year by ITT and by Thorn Consumer Electronics, the largest British set maker.

Heading for $50. TI's Tifax will sell for just under $230 when shipments begin this summer; set manufacturers, however, may add their own markups. In volume, the firm has quoted prices below $180, says Bryan Norris, applications manager for the company's Advanced Technology Centre in Bedford, England, "and we expect to have it down to $50 by 1980."

Teletext decoders must capture, decode, and display pages of data, transmitted at about 7 megabits per second during the blanking interval between the analog TV pictures. The Teletext requirement is complex: it requires alphanumerics and graphics, flashing and boxed characters, and seven colors. It has the capability for keyboard addressing, mixed text and TV-picture displays, and more. Details of the module were first disclosed at the IEEE's Spring Conference on Broadcast and TV receivers in Chicago this month.

Fourteen chips. The company has implemented the decoder in 14 chips powered by a single 5-volt supply and connected to the TV receiver by not more than six connections. Input to the modules is handled by a bipolar linear IC that separates the 7-megahertz data signal from the composite video signal, and squares up the pulses to be compatible with the transistor-transistor-logic levels in the decoder.

To get the TTL waveforms, the gain-bandwidth product of the chip's linear section must be greater than 500 MHz, and, to get that speed, TI used a non-saturated, low-impedance design. That, together with power dissipation limits, results in an optimum supply voltage of 5 volts. The linear chip also performs clock generation and synchronization separation for the system.

But the key to the approach is a large 1,300-gate computational chip built with integrated injection logic. It decodes and stores the keyboard-entered page number, decodes the incoming information for that page, and generates the random-access-memory addresses for both loading and displaying. The company went with I²L because of its high packing density, along with its high speed and electrical compatibility with the low-power Schottky TTL in the module, Norris notes.

Character rounding. Surrounding the linear and I²L chips on a 4-by-6-inch board are four low-power Schottky chips used for converting the incoming data into 8-bit parallel form and for clock control, output logic, and character rounding, which adds half-dots to the 5-by-7-dot matrix to improve legibility.

A modified Schottky process is also used for the character generator—a 5,670-bit read-only memory containing 128 characters. The other seven chips are 1,024-bit static n-channel random-access memories. They store a full Teletext page until

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the transmission is complete; the 24 rows of 40 characters require 6,720 bits of RAM organized as 960 words of 7 bits each and operated from the single 5-volt supply. □

Packaging & production

New case adjusts to fit instrument

Nearly every piece of electronic equipment requires a specially designed and tooled case to house its circuit boards and hardware. But, perhaps taking their cue from the stretch-sock manufacturers who promise "one size fits all," designers at Ballantine Laboratories Inc., a Boonton, N.J., instrument maker, have developed a case that's stretchable.

"The basic case will be applicable to a whole family of new instruments we're going to introduce in the coming year," says Ballantine president Fred Katzmann. "It will cut our tooling costs drastically." Ballantine has developed a half-rack-size, metal-plated plastic case that can be set to heights between 2½ and 3½ inches. In its other dimensions, the case is 8⅛ inches wide and 8 11/16 inches deep, and it can be tapered to different heights at front and back.

Push together. The molded case is made of shock-resistant and flame-retardant acrylonitrile butadiene styrene (ABS). Its top and bottom are identical flat pieces with two curved up sides resembling a long, flat letter C in cross section. The ends fit into identical side pieces, as shown on page 44, to form the instrument box.

Four threaded spacer pins, pushed up through holes in the bottom, slide through receiving tubes molded into the sides and then screw into threads in the top. The length of the spacer pins determines the height at which the case is locked.

To accommodate different printed-circuit-board configurations, a series of card guides, bosses and pins are molded into the top and bottom. As an example, the case could house one large pc board horizontally, five vertically mounted pc boards locked in the guides and held by the pins, or a large horizontal motherboard with up to five boards plugged into it.

Along with its special mechanical features, the Ballantine case has its

News briefs

Zider to head National's Consumer Products
LeRoy S. "Roy" Zider last week was named a corporate vice president and general manager of National Semiconductor Corp.'s Consumer Products division, Sunnyvale, Calif. The 34-year-old Zider, most recently chief operating officer at Iowa Beef Processors Inc., fills the post held for the last nine months by National president Charles E. Sporck. The division markets hand-held electronic calculators, digital watches and clocks. "It's the kind of job in which a chief operating officer has to use and understand innovative merchandising," says Sporck, discounting Zider's newcomer status to the electronics industry.

New word processors from Wang
Wang Laboratories Inc., Tewksbury, Mass., this week introduced three new word-processing systems ranging in price from $12,000 to more than $75,000. Each cathode-ray-tube work station in the new line is microprocessor controlled. The low-end Word Processor 10 is a stand-alone, single-diskette system for typical office applications. The Word Processor 20, a dual-diskette unit, supports up to three work stations and three printer stations, and the Word Processor 30 is a large disk and diskette-based multiprocessor system supporting up to 14 work stations and printer stations.

NCC Attendance Sets Record
The National Computer Conference and Exposition held in the New York Coliseum surpassed the expectations of its sponsors, AFIPS, with a final attendance tally of 35,085. But it fell far short of the bullish 50,000 hoped for by conference chairman Carl Hammer. The figure made the show the largest computer conference ever held in the U.S., topping the previous high of 34,500 at the 1969 Spring Joint Computer Conference. Of the total, less than 8,000 were paid, and a like amount included exhibitor personnel and program participants. The bulk of the attendance, about 19,500, represented exhibitor guests, complimentary passes, and press. Conference officials felt they met all their objectives. Next year's conference will be in Dallas, where some 200 exhibitors already have booked over 800 booths.

Single board holds most TV set circuits
Quasar Electronics Corp. has put 75% of the circuitry of its new 19- and 25-inch television chassis onto a single printed-circuit board. The original "works-in-a-drawer" chassis introduced by then-owner Motorola Inc. in 1967 had 11 modules. Called Super-Module, the new board performs most of the signal and picture functions and holds user-accessible front controls. Parts count has been reduced to 550 from the 640 on four modules in the older chassis from the Franklin Park, Ill., subsidiary of Matsushita Electric Corp. Price is less than $100; less than $40 when exchanged for a defective board. Prices for the new receivers start at $460.

TI introduces games chip
Texas Instruments is making its play in the booming market for video game chips by aiming at the low end with an integrated-injection-logic device that will handle only two games—tennis and hockey—in black and white. It will sell for a mere $4 in quantity, starting in the fourth quarter. The chip is likely to end up in games retailing for about $30. It does not provide on-screen scoring, but this can be had by adding another I^2L chip that TI will be making. The firm also is said to be developing more expensive chips that could play more games and operate in color.

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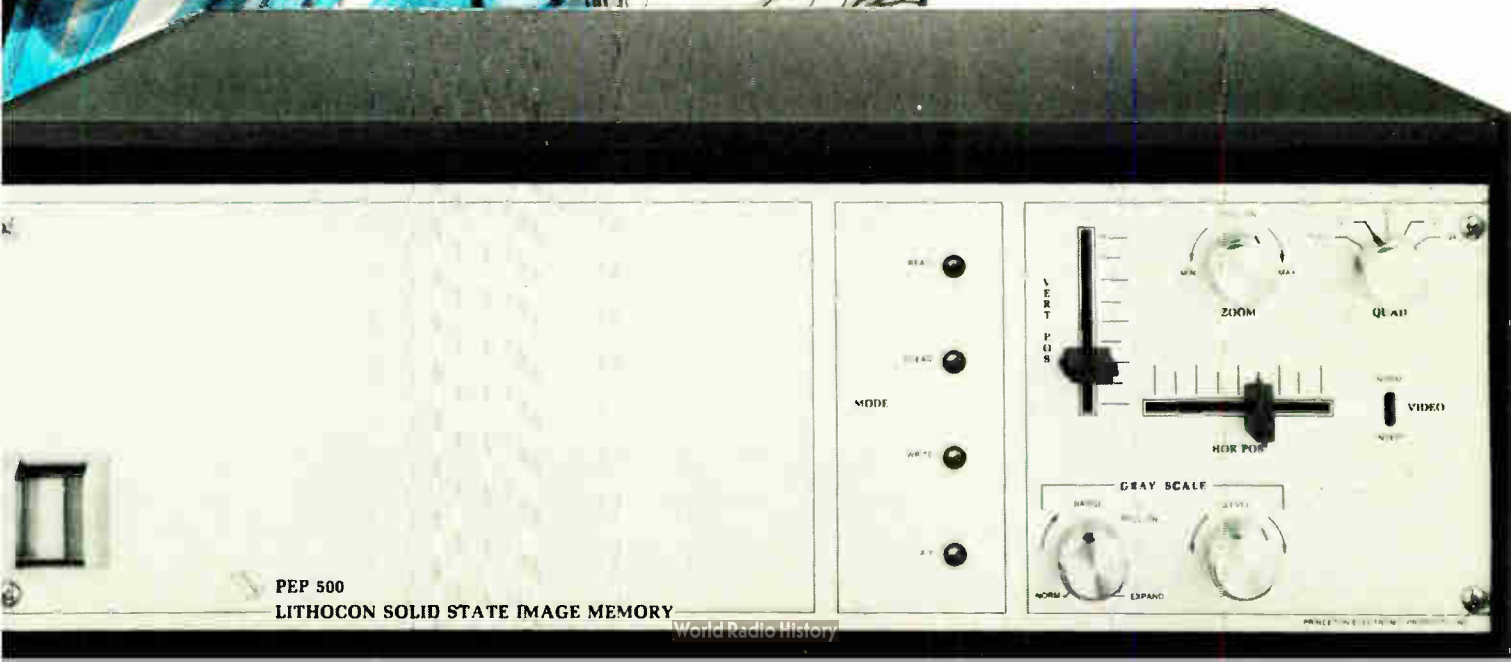

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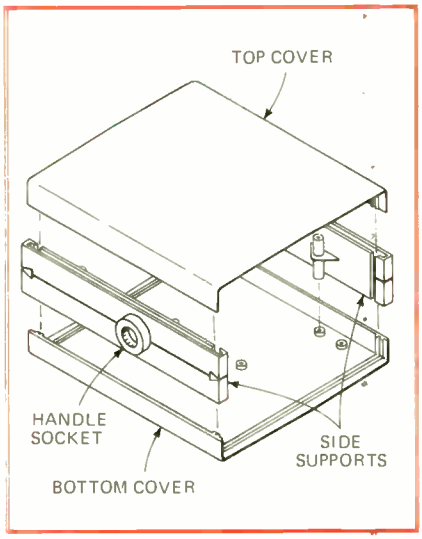


Case in point. Height of plastic case from Ballantine is adjustable as top and bottom pieces are slid into side pieces.

inner surfaces coated with a 5-mil-thick aluminum conductive layer. This provides shielding against radio-frequency interference that meets MIL STD 462, Katzmann says. Additionally, the conductive coating can be used as a guard shield for high-performance voltmeters.

Ballantine's first instrument to be sold in the new case is the model 3028A 3½-digit digital multimeter, and the next will be a counter. Patents are pending on the design, and Ballantine has already licensed other companies to use some aspects of the enclosure. □

Test system stores crystal parameters

Few crystals are exactly the same, so when it comes to precision applications a lot of data has to be known about each and every crystal. Burdened with the increasing documentation—3.3 million data points by the time its crystal output reached 50,000 per month—McCoy Electronics Co. turned to a minicomputer-based data-acquisition system. Being time-shared, the system also opened the door to a wide variety of crystal-related computer-aided design work, as well as more conventional accounting and production-control uses.

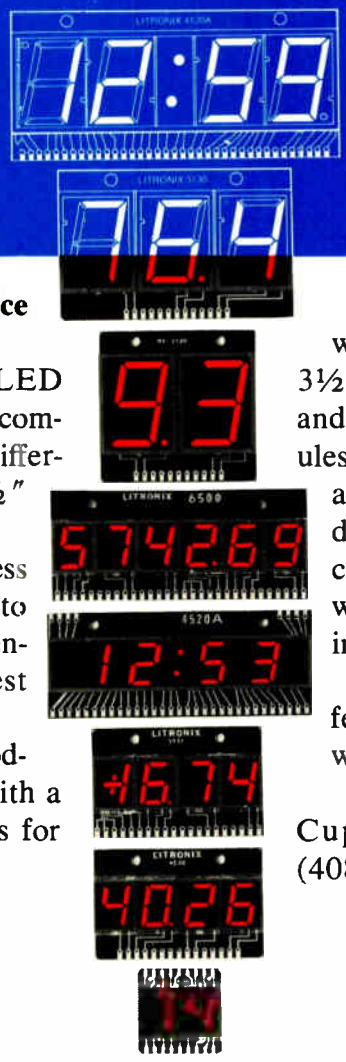
Each crystal is customarily supplied complete with data on its frequency-versus-temperature and frequency-versus-resistance characteristics. Because McCoy was handling this data manually, it was swamped with numbers, handwritten test sheets, and analog plots. Early this year, to cut through this paperwork and to reduce operator errors caused by the sheer volume of work, the Mount Holly Springs, Pa., company put in a special test interface and a 24-terminal time-shared minicomputer from Basic Timesharing Inc. of Sunnyvale, Calif.

The test interface, a microprocessor-controlled automatic crystal-test system from Saunders and Associates, Phoenix, Ariz., can test 24 crystals over a specified environmental range. The system runs unattended and handles a new group of crystals every 2½ hours. Unprocessed digital data from the tester is fed into the BTI 3000 minicomputer and stored in a 50-megabyte disk drive. The stored data is available for quality control, engineering design, and even crystal inventory maintenance.

Multiple use. McCoy is using 21 terminals out of the 24 available for both its crystal operation and for accounting. Some of the terminals used in a data-acquisition system allow an operator to retrieve stored data on a crystal in hard-copy form, eliminating the reams of paper formerly used to record all tests. Other terminal stations use a program that allows engineers to use stored crystal data to solve temperature-compensation equations. These equations set the component values for crystal temperature-compensation networks. Before the time-shared system these equations were solved, only approximately, by manual calculations.

Still other stations are used for design of crystal-filter networks and of temperature-compensated voltage-controlled crystal oscillators. The rest of the terminals are used for accounting and production-control programs. □

sticks sticks sticks!



Preassembled LED displays cut price per digit and save labor

Big Sticks are what's new in LED packaging. And naturally Litronix is coming on first and strongest with eight different preassembled displays of 1″ and ½″ digits.

Price per digit is 20% to 25% less than earlier single-digit mounts. Add to that the saving in assembly and inventory costs and you've found the best LED display bargain of the year.

Inch-high displays come in modules of 2, 3, and 4 digits—the last with a colon for clocks and indicator lamps for AM, PM and alarm.

Half-inch displays are available with 2, 3½, 4 and 6 digits per stick. The 3½ digit module has plus and minus signs, and can be combined with the other modules to create instrument displays of almost any length. There are two half-inch 4-digit modules, one for general use with closely spaced digits, and one for clocks with a colon, built-in multiplexing, and indicator lamps for AM, PM and alarm.

If you need big digits, you'll prefer Big Sticks. Can we throw some your way?

Litronix, 19000 Homestead Road, Cupertino, California 95014. Phone (408) 257-7910.

No wonder we're No.1 in LEDs

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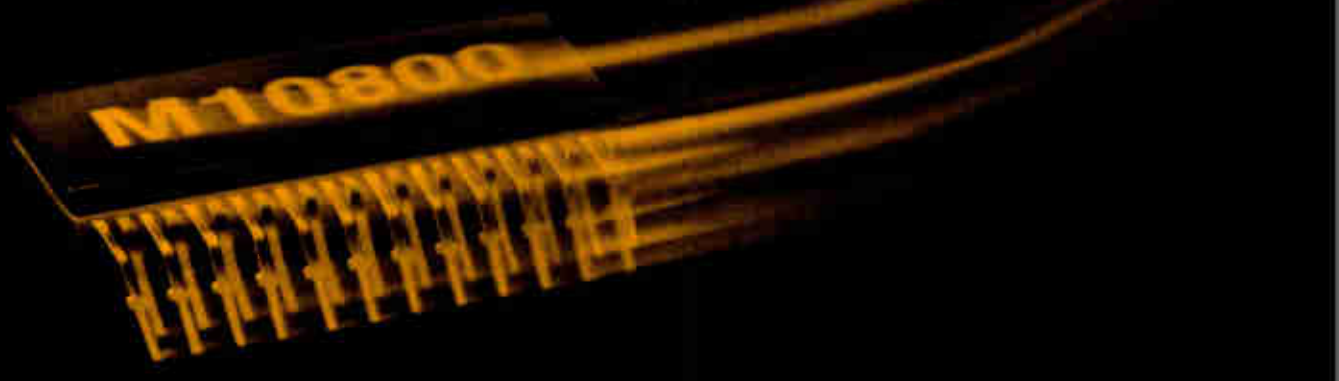
MOTOROLA introduces

M10800



- System microcycle times under 100 ns
- Versatile "slice" approach
- Bus-oriented architecture
- Standard MECL* LSI
- MECL Memory compatibility
- State-of-the-art packaging
- Microprogrammable

...the world's fastest LSI processor family.

Speed...Figured at more than twice as fast as any earlier LSI. Flexibility...Inherent in the expandable building block approach of the slice concept. System density...Concentrated with the space-saving 48-pin QUIL* package. All enhanced by bus-oriented architecture.

Whether you're after improved performance for existing slower SSI-MSI designs or a package reduction in ECL systems, whether it's in signal processing, communications, or instrumentation, whether you're designing high performance peripheral controllers or high-end minis, when speed is the object, M10800 is your LSI.

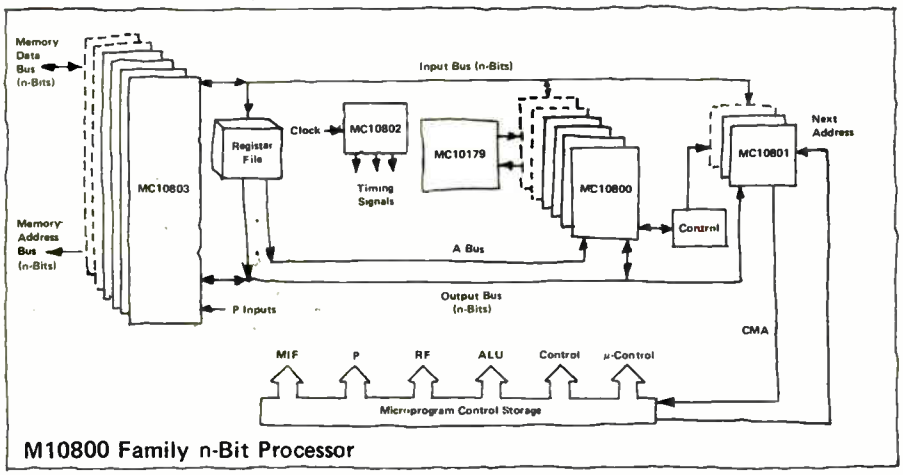
The MECL Heritage

The M10800 Family inherits its superior performance naturally. Motorola originated ECL, and developed it over the years to the present MECL 10,000 level. M10800 is the LSI extension of this high speed logic line. With MECL memories, it's a high performance team.

The industry's first standard ECL LSI device is the MC10800 4-bit ALU slice, available now through all Authorized Motorola Distributors and Motorola Sales Offices. Sampling and introduction of additional defined family units are scheduled in the order of each part's general system significance.

MC10800

The MC10800 performs the logic, arithmetic, and shift functions required for execution of machine instructions. The slice is 4 bits wide and parallel to data flow. It is fully expandable to any practical word size in 4-bit increments.



M10800 Family n-Bit Processor

The MC10800's data processing power and versatile I/O structure allow the advantages of LSI in high performance systems without restricting word size or processor architecture.

MC10801 — Microprogram Control

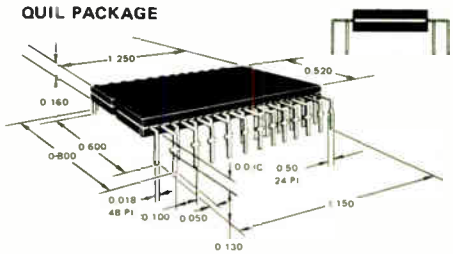
Control of the microprogram storage is a vital function, and the MC10801 provides powerful sequencing and addressing control without restricting storage size or organization. Microprogram sequencing similar to machine level addressing techniques helps reduce system development time.

MC10803 & MC10802 — Memory Interface and Timing

The MC10803 Memory Interface Circuit brings MECL LSI technology to system I/O functions, memory addressing, and data transfer. For maximum speed, data routing and memory overhead operations are performed in parallel with the rest of the system. The MC10802 Timing Circuit combines the complex start — stop control and clock phase generation logic in one LSI device, and also provides diagnostic capability.

QUAD-IN-LINE QUIL PACKAGE

Dimensions in Inches



The QUIL Package

Introduction of the M10800 Family also introduces a brand new package tailored to meet the exacting requirements of a new generation of LSI designs. Among many features, this 48-pin package maintains the desired in-line configuration, offers a 30% density improvement over the standard 40-pin type, and offers excellent thermal characteristics, all at low package costs.

Brochure Available

The new M10800 Family brochure, M10800 High Performance MECL LSI Processor Family, is a full description of the family, the package, and system design-performance information. Circle the reader service number, or send your request to Motorola Semiconductors, P.O. Box 20912, Phoenix, AZ 85036.

MOTOROLA Semiconductors

— High performance M10800 LSI

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Circle 47 on reader service card

Should you buy your calculator chips from National or General Instrument?

No, you're not seeing wrong.

NOVUS is a calculator made by National Semiconductor. And this is an ad made by General Instrument. The point is, we don't make a "General Instrument" calculator.

We make calculator chips. Millions of them.

We've made more of them for more independent calculator makers than any other company.

We'll repeat that.

General Instrument has made more calculator chips for more independent calculator manufacturers than any other company.

That includes National and all the others.

Moreover, we make more types. 18 different calculator chips to National's 11. From a simple 4/5 function to a full scientific. We say full because our scientific chips have advanced features you won't find in National's. Like 10^x and scientific notation. Like two levels of parenthesis, x^2 and change sign.

So, if you're a calculator manufacturer who competes with the family NOVUS, or others like them, there's one name you would do well to remember.

That's the name you won't find on any calculator.

It's the biggest name on no machine.

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Washington newsletter

Navy ELF expansion slowed by fund cuts in Seafarer

Navy plans to expand use of extremely low frequencies beyond projected use in shore-to-ship communications with submerged missile-firing submarines will be curtailed by fiscal 1977 budget cuts by Congress. Reports to industry by the Navy that it will have to hold back R&D on broader applications of ELF were confirmed in the Pentagon after the House Armed Services Committee cut $15 million from the Navy's Seafarer program, **halving the money for the submarine communications system.**

ERDA signs three to design new electric cars

The electric car is back in the Government's good graces following a flurry of interest during the Middle East oil embargo [*Electronics*, March 7, 1974, p. 70]. The Energy Research and Development Administration says that, by the end of June, **it will sign design contracts worth about $500,000** for three electric cars with Garrett Corp.'s AiResearch Manufacturing Co., Torrance, Calif., AMF Advanced Systems Laboratory, Goleta, Calif., and General Electric Co., Schenectady, N.Y.

The six-month design contracts call for a four-passenger car with a top speed of 55 mph and a range of 75 miles on one charge. At least one test car based on these preliminary designs will be built within 2½ years. Other goals are a mass production potential by 1981, at a cost to consumers of not more than $5,000 in 1975 dollars.

Senate action on FCC vacancies seen keyed to Fogarty

Two vacancies on the Federal Communications Commission seem likely to go unfilled **until after the inauguration of a new President in January,** according to both congressional and commission sources. The reason: the White House is having trouble finding a nominee for the Republican vacancy of a two-year term that will be created by the July 1 resignation of Charlotte T. Reid following her marriage. Nor is the Administration anxious to nominate Democrat Joseph R. Fogarty to the full seven-year term of departing Glenn O. Robinson.

Unless one nomination is of Fogarty, counsel to the Senate Commerce communications subcommittee and protége of retiring chairman John O. Pastore (D., R.I.), no confirmation is expected. Confirmation of Illinois lawyer Thomas J. Houser as director of telecommunications policy is not expected to become part of the political problem, however, since the post has no fixed term and its holder serves at the pleasure of the President.

Addenda

Dollar value of new orders for electronic parts **rose 56.7% in the first five months of 1976** from the January to May level last year, according to the Electronic Industries Association. The data from 23 manufacturers reflects order changes for capacitors, coils, connectors, filters, relays, switches, resistors, sockets, transformers, reactors, and loudspeakers. . . . EIA also says a 7.3% May rise in color TV sales to dealers **pushed volume to nearly 474,000.** The first five months' sales of 2.5 million color sets put volume 12.7% ahead of 1975. Monochrome sales of 1.76 million, however, were up less than 1%. . . . The Postal Service has awarded $2.2 million to RCA Corp., Camden, N.J., for a two-year feasibility **study of an electronic message service system** that will explore communications satellites, terrestrial networks, facsimile, optical character readers, and word-processing equipment.

Why AT&T brought in the Congress

Since the 1968 Carterfone decision, American Telephone & Telegraph Co., along with its Bell System operating companies, has been steadily losing ground before the Federal Communications Commission and the courts in its efforts to stem competition and maintain its control of the American telephone system. With the introduction of its Consumer Communications Reform Act before Congress, the issue began coming to a head [Electronics, *March 4, p. 33*]. *Although final congressional action on that legislation will not come before 1977 (see p. 65),* AT&T's *executive vice president Thomas S. Nurnberger made his company's case earlier this month before the Electronic Industries Association. Significant excerpts from the Nurnberger argument follow.* —Ray Connolly

One of the concepts we use in our planning looks at the evolution of our industry—and our company—as the working out of interactions among technology, structure, and doctrine. Change in any one causes changes or pressure on the other two, requiring a constant process of adaptation.

When there are several different ways to carry out a specific task like the bridging of a river or furnishing of communications, to determine which of several alternate plans is "best" depends on the weight one gives to various subjective criteria. For example, is the "best" arrangement that which gives: maximum access and use, lowest first cost, lowest long-run cost, highest reliability, concentrated accountability, highest quality, a close matching of individual prices and costs, or maximum technological innovation?

The political process

Selection of the criteria of effectiveness is a preference for one doctrine over others and has great influence on the selection of the technical and organizational means most appropriate for their achievement. This process of choosing priorities and selecting preferences is rooted in human motivation, not scientific deduction. In short, it is a political process and demands the use of political methods.

For openers, I believe that everything we know or think we know about the effect of competition on this industry and its customers should be considered before final and irreversible decisions are made. What is happening in our industry is no mere tinkering with rate schedules or marginal jurisdictional disputes, but goes to the ultimate foundations of national policy.

Let me set out succinctly the foundations of the universal-service doctrine which originated in the minds of our founders, but which was politically and socially ratified by innumerable hearings and orders of Governmental bodies for nearly a century. The idea that every home and business in the country should have access to a telephone at as reasonable a price as possible drove our technological development and dictated the structure and pricing policies of the Bell System.

This structure and concept have stood the test of time, have "delivered the goods," and been strong and flexible in adapting to emerging service needs and opportunities. We in the industry know that if any of the fears we have for the integrity of the service or its pricing should actually occur, we will be the target for public hostility, not those who originated the policies. For this reason the telephone industry urgently needs to be assured of the intent of Congress toward the place and role of competition in the industry.

Competition or con game?

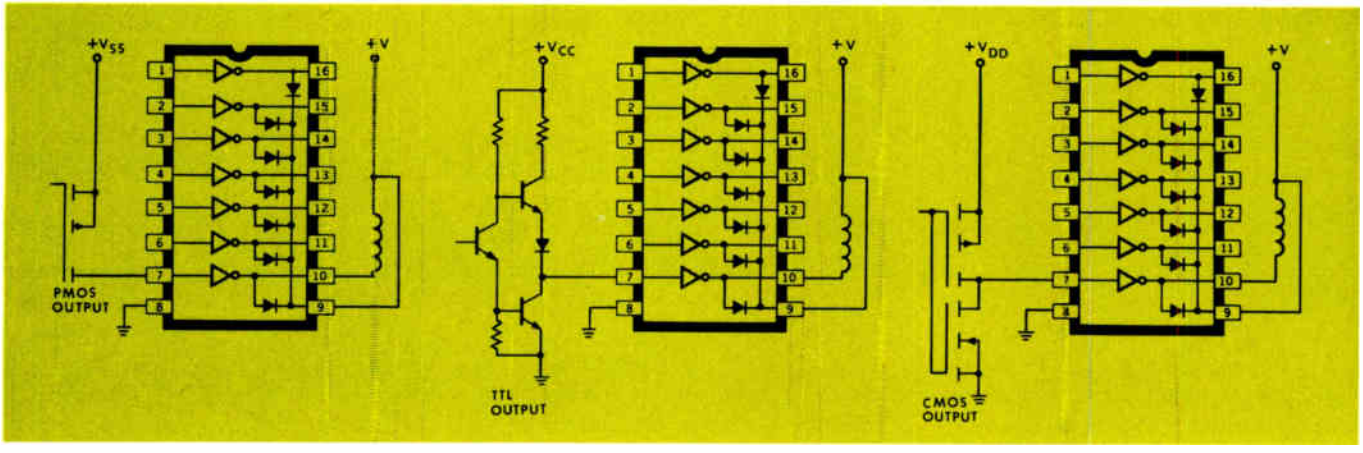
The conditions and rules developed for the competitive areas should be fair to all. Our worst fear is that a competitive policy may degenerate into one of "regulated competition," a contradiction in terms which has had such a melancholy record in transportation. To use competition as a cosmetic label, to use it in a contrived way, to fragment markets artificially into cartelized segments to protect so-called "infant" industries, will be to work a gigantic confidence trick on the public.

These are only some of the aspects of the large questions attending a radical shift in telecommunications doctrine, and we believe they should be addressed in open debate at the congressional level, where the public can be made aware of the options open to them.

Up to the recent past, this nation has embraced a policy encouraging the widest access to basic telephone service by supporting it from profitable lines of business. Under competitive doctrine, that support will either have to come from somewhere else, or the current terms of access will be limited by increased prices. That is the central question we hope will be clarified by the legislation supported by the telephone industry, and we are eager for a definitive and early resolution.

INTERFACE ACE

For High-Voltage, High-Current Interface with PMOS, CMOS, TTL, DTL . . . Sprague Darlington Transistor Arrays Have No Equal



A new exclusive Sprague development, Series 2000 Transistor Arrays are high-voltage, high-current integrated circuits comprised of seven silicon NPN Darlington pairs on a common monolithic substrate. They feature open collector outputs and integral suppression diodes for inductive loads.

Supplied in 16-pin dual in-line plastic, these devices greatly reduce the number of discrete components used to interface between digital logic and high-voltage and/or high-current loads. In some applications, all discrete components can be replaced by a single DIP, resulting in substantial space and cost reduction.

With broad commercial/industrial application, these unique arrays are an excellent choice for interfacing to LEDs, solenoids, relays, lamps, and small stepping motors in printing calculators, cash registers, and control equipment.

Type ULN-2001A is a general-purpose array, pinned with inputs opposite outputs to facilitate circuit board layout. Type ULN-2002A is designed for use with 14 to 25 V PMOS inputs. Type ULN-2003A interfaces with TTL or CMOS operating at a 5V supply voltage. ULN-2004A has series input resistor to allow operation directly from CMOS and PMOS outputs utilizing 6V to 15V supplies.

For more information, write or call George Tully, Semiconductor Division, Sprague Electric Co., 115 Northeast Cutoff, Worcester, Mass. 01606. Tel. 617/853-5000.

For Engineering Bulletin 29304, write to Technical Literature Service, Sprague Electric Co., 35 Marshall St., North Adams, Mass. 01247.

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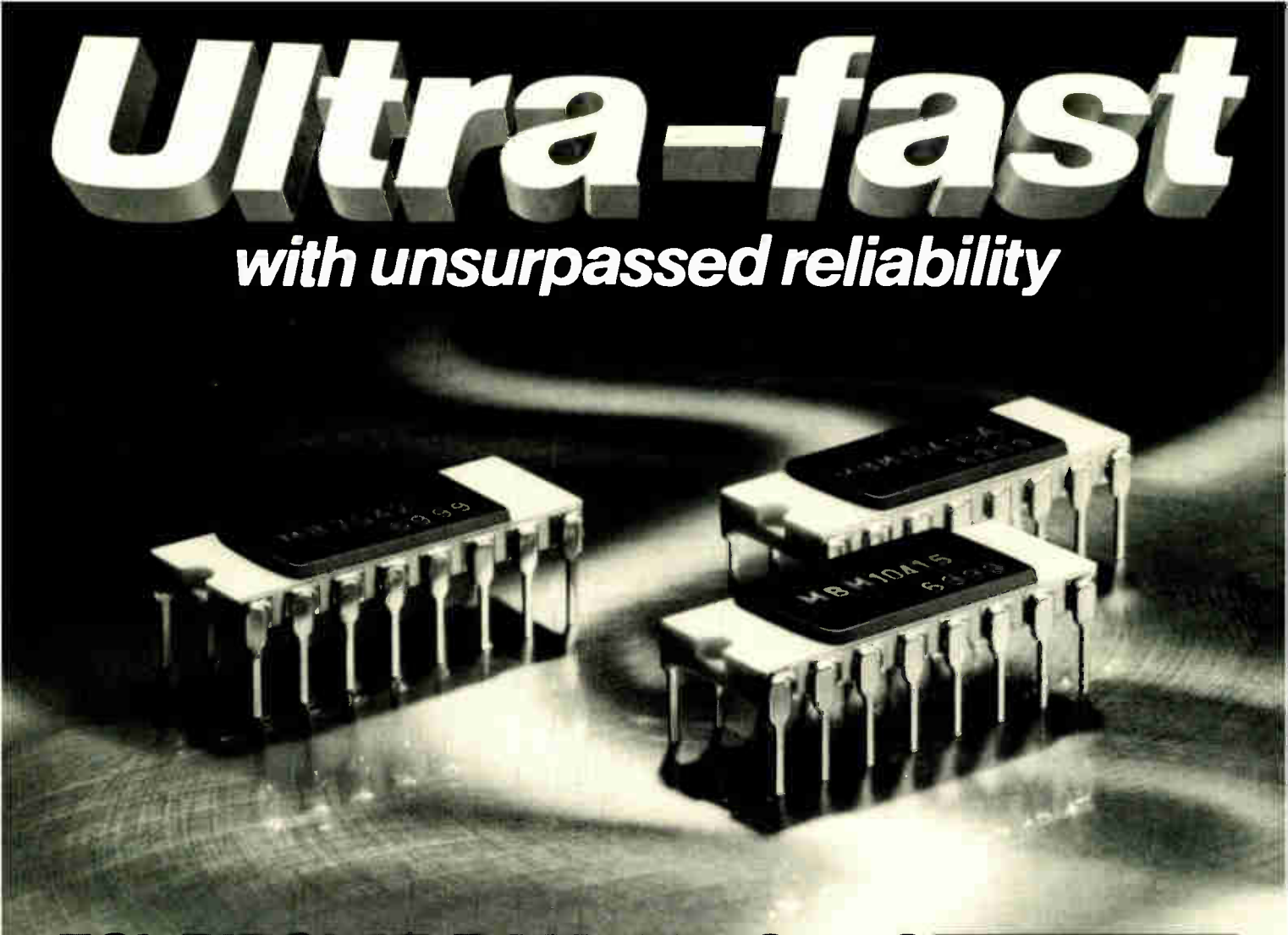

ECL BIPOLAR RAM MEMORIES
MB7042·MBM10415/A

FUJITSU SEMICONDUCTOR

By now, just about everyone's read about our great lineup of MOS semiconductor memories—they're the talk of the industry. So we're equally proud to announce bipolar ECL devices offering excellent speed and high device reliability via the application of the most advanced fabrication techniques. Yes, Fujitsu is fast making your present devices obsolete by offering newer, faster, and more reliable products to meet your semiconductor needs. So take a good look at these outstanding new Fujitsu state-of-the-art products.

World's fastest 256-bit memory
While other makers can only claim, Fujitsu can deliver the world's fastest 256-bit read/write bipolar RAM—The fantastic Fujitsu MB 7042. It offers a typical access time of only *9ns*. And the MB 7042 offers more, like full compatibility with the industry-standard 10k-series ECL logic in an improved device with full on-chip voltage compensation for improved noise margin. Yes, the MB 7042, fabricated using Fujitsu's patented DOPOS (doped polysilicon) process for shallower junctions that mean higher speed, delivers the top performance others can't.

World's smallest ECL 1k RAM chip
The new Fujitsu MBM 10415/A chips offer unbeatable speed (typ. access times of 35 and 25ns) in the world's smallest ECL 1k chip. Perfect for high-speed scratch-pad, control and buffer storage applications, these devices feature top performance via DOPOS and IOP (Isolation by Oxide and Polysilicon) processing. And, they're fully compatible with your present 10k-series ECL families. Great second sources at prices that can't be beat.

Proven reliability and available now
The Fujitsu MB 7042 and MBM 10415/A bipolar RAMs are built by Fujitsu, a maker with proven reliability. Our stringent production and testing standards and our capability to meet your requirements, all add up to savings and performance that can't be beat. So, contact Fujitsu now for the MB 7042, MBM 10415/A, or any of your other semiconductor requirements (including our MB 7047, 128-bit RAM). Availability is NOW!

Write or call for more information to Fujitsu California, Inc., Laboratory Division, 1280 East Arques Ave., Sunnyvale, California 94086, phone: 408-735-0735 telex: 346393.

FUJITSU LIMITED
Communications and Electronics
Tokyo, Japan

Circle 52 on reader service card

In-house data link made in Japan uses two wire pairs and is PCM-compatible

The Universal Link developed by Nippon Electric Co. is a digital highway designed to simplify installation and maintenance of in-house data systems without coaxial cable. The link normally transmits through two twisted pairs of standard voice-grade telephone cable within a plant or other facility. A large volume of data can be transmitted two kilometers or more between repeaters, and a complete link may be as long as 100 kilometers.

A system controller and a synchronizer are located at a convenient point, and terminal data stations are placed near data-terminal equipment or the central processing unit.

These terminal data stations include a number of line units to connect to terminals, much as peripheral equipment is connected to computer line units. Line-unit interfaces of the standard communications type connect data terminals to modems so that the system is plug-compatible with conventional data terminals.

PCM-compatible. The new system operates at the same 1.544-megahertz clock rate as the 24-channel pulse-code-modulated systems commonly used for public communications and can use components developed for PCM installations. Although the basic signal format is the same as in PCM voice communications, it is used in a different manner.

Each frame consists of 24 channels of 8 bits each and a single synchronizing bit, for a total of 193 bits each. The frame rate is 8,000 a second for a total bit rate of 1.544 megahertz and an information rate of 1.536 MHz, the same as voice PCM communications. To obtain a large number of channels easily, 20 frames are handled as one superframe, which is repeated at intervals of 2.5 milliseconds. This technique gives a total of 480 separate subchannels with individual bit rates of 3.2 kilobits per second.

The actual capacity of the system is somewhat smaller, though. The first bit of each subchannel is used for off-hook operation, and the last bit is used for carrier detection, leaving a data capacity of only 2.4 kb/s. What's more, since 20 of the subchannels are used for error prevention and synchronization, 460 basic subchannels operate at 2.4 kb/s. Synchronous signals are sent at the basic 2.4-kb/s rate or multiples of it, including 4.8, 9.6, and 48 kb/s. Asynchronous signals are sent by a multibit sampling technique with at least eight sampling bits for each input bit. In that way, the basic 2.4-kb/s channel can carry a single 300-baud or slower asynchronous signal. There are no limits to the combinations of different-speed channels—any combination within the overall capacity limitation can be used. □

Around the world

French simulator trains tank gunners

France's le Matériel Téléphonique has developed a simulator that duplicates actual tank-gunnery and battlefield conditions. LMT, the former ITT subsidiary recently sold to France's Thomson-Brandt group, expects European and American armies to snap up its new $1.1 million simulator.

The simulator's artificial display system projects a combination of slides, televised pictures, and computerized images into the gunner's aiming optics. At the gunner's side is a full-size copy of a tank's turret controls, electrical equipment, and aiming and firing system. A recoil simulator subjects the gunner to movements, smoke, and noise.

The simulator is constructed around a CII Mitra-15 minicomputer that coordinates operations of the simulated movements. The computer is programed to vary the target tank's speed and movement through any of 20 landscapes and many exercises chosen by the instructor, who monitors a color-television screen. Both the instructor and gunner observe shell flight, follow the trajectory of the tracers, and compute trajectories that comply with ballistic laws of elevation and dispersion.

German nonimpact printer is fast and quiet

Speed and quiet operation are the prime characteristics of an AEG-Telefunken nonimpact printer that the company says can fill the gap between expensive, super-fast printers and the small impact versions. The DSM 48 uses a nonmoving print head with electrodes that burn the characters into metalized paper by emitting short, 50-microsecond electrical discharges.

The unit produces 20 lines of 80 characters per second—a speed that Telefunken says is more than adequate when the DSM 48 is used for fast printouts. In general, the equipment is applicable wherever the use of continuously operating high-speed printers costing $40,000 and more would be uneconomical, says Telefunken. The new printer is expected to sell for less than $4,000, if it goes into full production.

The nonmoving print head, a flat comb-like device, is about 190 millimeters wide, roughly the width of standard-format paper. With its 480 chromium-nickel-steel electrodes arranged in one line, the head produces alphanumeric characters in a five-by-seven-point matrix as the paper moves past the head. By varying the speed of the paper, it is possible to produce characters of different height. The close spacing of the electrodes also allows graphic data to be printed. The DSM 48 uses paper from AEG-Telefunken's paper-capacitor production facility in West Berlin costing less than $5 for a 100-meter roll.

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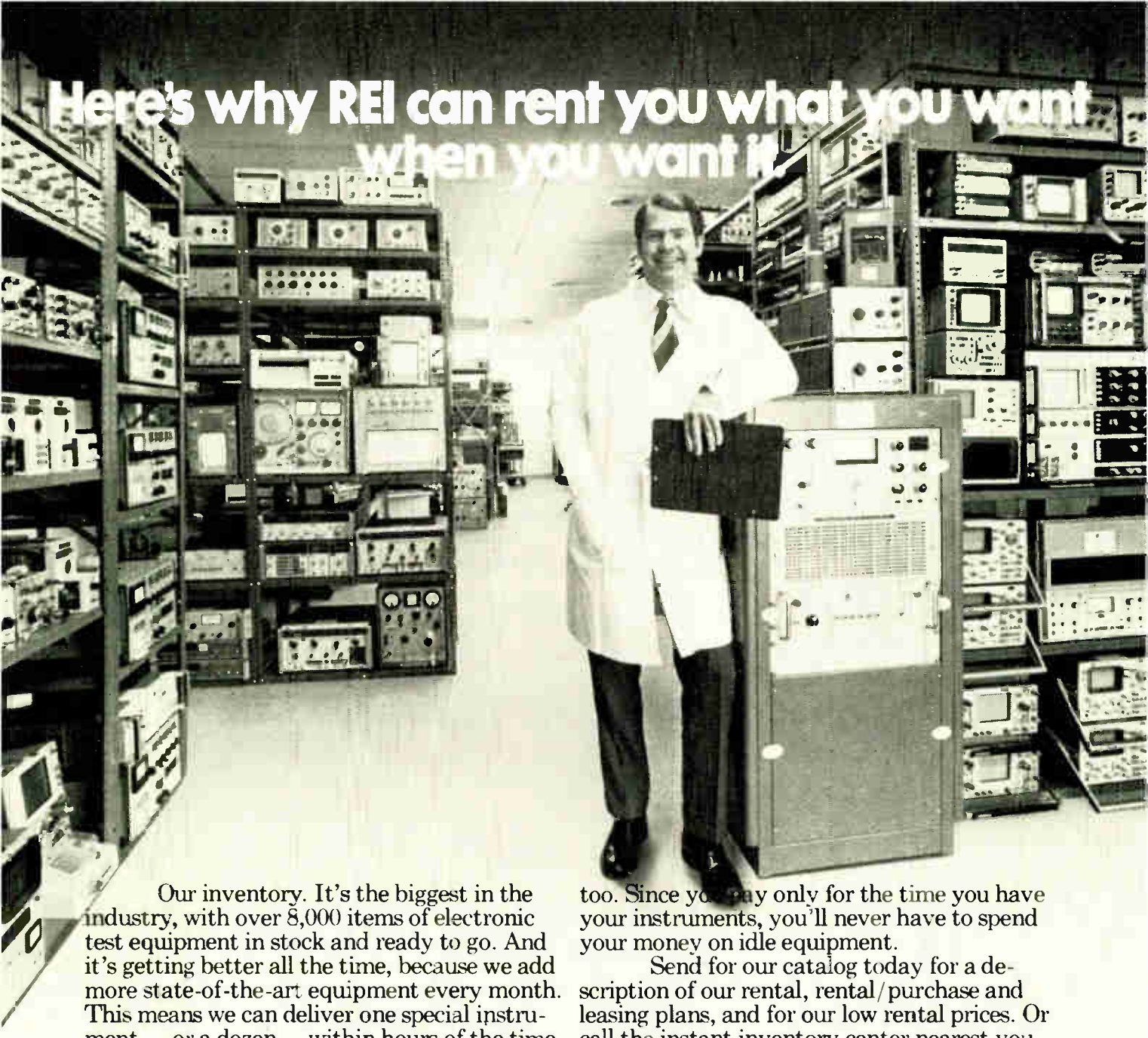

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Circle 54 on reader service card

International newsletter

Japanese develop 65-kilobit RAM for computers

In the race to keep ahead of IBM Corp. in the computer market, Fujitsu Ltd. has developed an experimental 65-k kilobit random-access memory for use primarily in large machines, even as U.S. makers are trying to get 16-k devices into production. However, Fujitsu will not confirm or reveal any details.

The new memory was developed in a joint project to provide advanced technology for the next generation of time-shared computers installed as part of the Nippon Telegraph and Telephone Public Corp.'s DIPS information-processing system and also for next generation of NTT's Dex electronic exchanges. **Other companies participating in the project are Nippon Electric Co. and Hitachi Ltd., which have reached a similar level of development.** The project is run by NTT's Musashino Electrical Communications Laboratoes.

Thomson managers to continue thrust of late president

The new management of France's Thomson Electronics group intends to continue the policies of its late president, Paul Richard, who died June 7. However, the death of Richard, who spearheaded Thomson's acquisition of le Matériel Téléphonique, has materially altered the structure of the Thomson group itself. Rather than maintaining a single head of all Thomson activities, two presidents have been appointed. **Michel Walhain heads Thomson-Brandt, and Jean-Pierre Bouyssonnie heads Thomson-CSF.**

The new officials plan to concentrate on establishing substantial international telecommunications sales, as well as renovating France's domestic telephone system. Thomson, which has concluded the takeover of former ITT subsidiary LMT, **will also use LMT technology and personnel to help penetrate markets throughout the world.**

Philips launches Signetics line of D-MOS devices

Philips Gloeilampenfabrieken in the Netherlands is about to launch in European markets a family of Signetics-developed subnanosecond devices made with double-diffused MOS (D-MOS) technology. Designed for variety of switching and driver applications, the family includes the **SD5000 series of four-channel switch arrays, the SD5100 series of four-channel multiplexers, and the SD5200 series of 30-volt drivers.**

The devices have a propagation delay of only 600 picoseconds and an input capacitance of only 2.4 picofarads. Among the potential applications are analog switching up to very-high-frequency ranges, and multiplexing.

Microprocessor shifts automatic truck transmission

A prototype microprocessor-based module, is designed as a plug-in replacement for conventional controllers of automatic truck transmissions. Built by British Leyland's Bus and Truck division, it is potentially cheaper than either solenoid-relay systems or controllers built with integrated circuits. **Commands derived from the driver and vehicle sensors are multiplexed through simple interface circuits from an Intel 8008 microprocessor to the transmission actuator.** However, a microprocessor with better noise immunity than the 8008 may be needed as development continues. The developer, the University of Manchester Institute of Science and Technology, says the controller's use of software programs for self-testing with the aid of digital readout equipment as well as for control is its advantage.

International newsletter

Matsushita's 30-in. color-TV tube gets 170 characters in line . . .

Japan's Matsushita Electronics Corp. has added a 30-inch color-picture tube to the top of its high-resolution line, which includes tubes that measure 22, 20, 16, and 14 inches on the diagonal. The company, profiting from the experience of other makers, **has increased the width more than the height so that the effective width is 24.8 inches and height is 15 in.** for an aspect ratio of 3:5. And since the CRT has a capacity of 170 7-by-9-dot-matrix characters per line, the number on most available printers, its first applications will probably be for graphics and character displays. However, the tube was first demonstrated at the laboratories of NHK, Japan's public-service broadcast network, to show the quality possible in a 1,125-line television system that might be broadcast in the future on super-high-frequency channels.

. . . and begins selling VTR for $700

After successfully test-marketing its half-inch video-tape recorders last fall on Shikoku Island, Matsushita has begun selling VTR for $700 in the Osaka/Kyoto area. The price is low on the single-head machine in part because **it needs no loading to extract the 100-minute tape from the relatively large cassettes.** Sony's Betamax sells for $1,000 in Japan.

Intertechnique scope displays 5-GHz signals

Intertechnique, a French instruments and minicomputer maker that did some $55 million of business last year, maintains it has edged ahead of French electronics giant Thomson-CSF in fast oscilloscopes with its 5-gigahertz IN-100 model priced "around $43,000." Like Thomson's 4-GHz TSN 660, Intertechnique's new scope was developed for the French atomic energy agency and built around a special helix tube that contains a channel-electron multiplier.

The edge, explains project engineer Jacques Guillard, comes from **vertical-amplifier circuits that take advantage of parasitic resonances in the deflection plates and employ transistors working in an avalanche mode to get a rise time faster than 80 picoseconds.**

BPO buys first high-speed digital telephone links

The British Post Office, beginning a vast program to upgrade Britain's trunk telephone network, has awarded production contracts totaling about $1 million to GEC Telecommunications and Standard Telephones and Cables Ltd. for 120-megabit-per-second digital transmission equipment.

Europe's first civilian high-speed phone digital links are to be operational by January 1978 to connect eight Midlands communities, capped by Birmingham. For example, STC's portion, connecting Coventry with Birmingham, Northampton, and Leicester, includes six terminals, three power-feeding generators and 67 dependent repeaters. The contracts follow field trials, between Guildford, Portsmouth, and Southampton.

Philips introduces two new products at Swedish plant

Svenska AB Philips introduced two new products—an electronic teletypewriter and an on-line cash-dispensing unit—when it dedicated the $10 million addition to its industrial-electronics plant outside of Stockholm. The teletypewriter, called the PACT 200, is undergoing tests by the Swedish telecommunications administration, and Philips hopes to win its first orders for the Swedish-made machine by year-end. The price was not revealed. **The quiet, modular machine, which contains a Philips microcomputer, can be equipped with tape or electronic memory.**

The era of personal programming is here.

SR-56
Key programmable

SR-52
Card programmable

Now you can make better decisions. More decisions. Faster.

You can put personal programming to work now. It's easy and economical.

Economical programmable calculators may well be more significant to business and industry than were slide rule calculators introduced just a short time ago. They represent a step function increase in computing capability. Capability you can use for: Optimization. Projections. Forecasting. Data reduction. What-if matrices. Iteration. Risk analysis. Probability. Mathematical modeling. Worst case analysis.

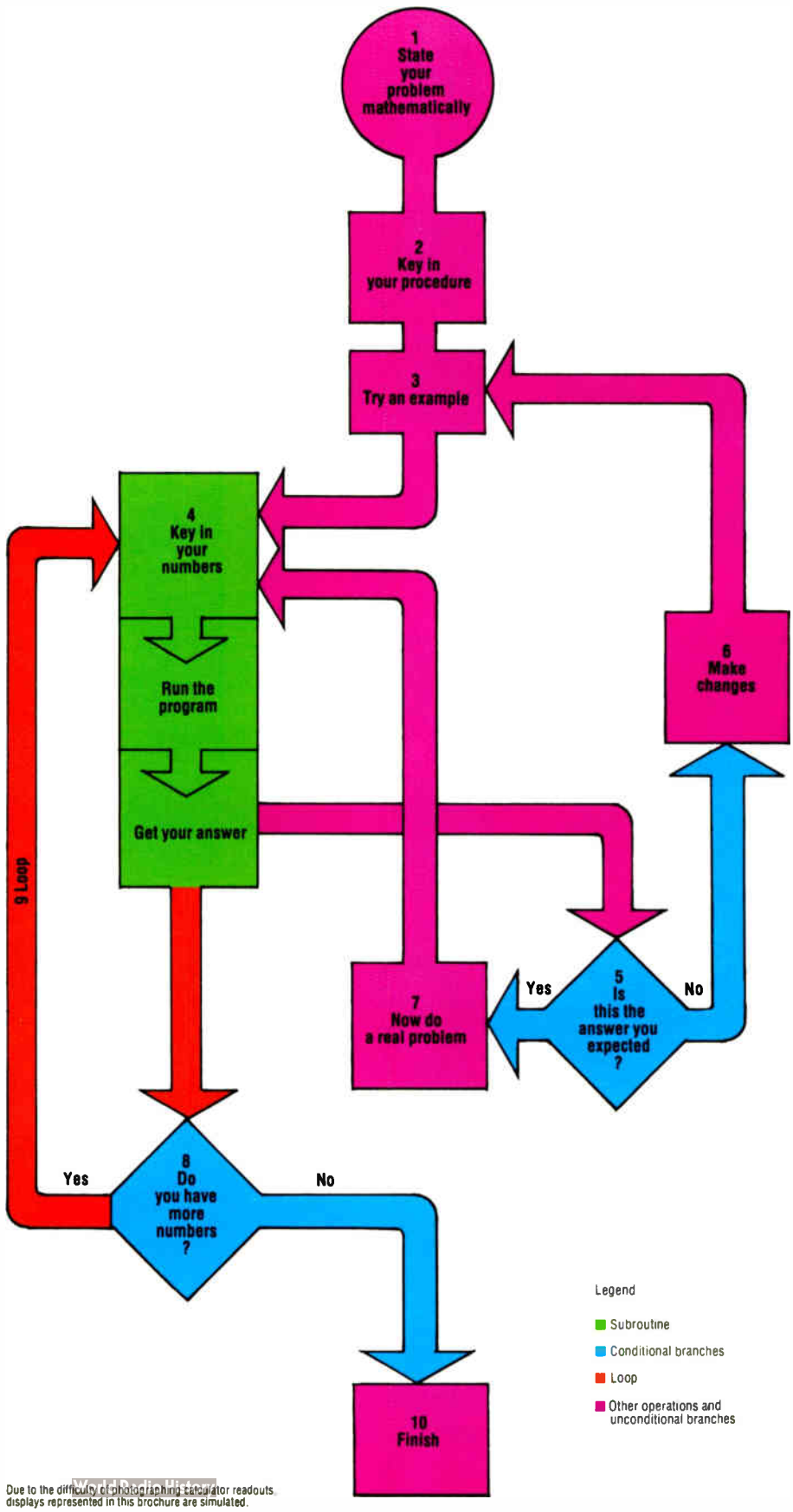
You may already be using these techniques, assuming you have the time. If not, you get in line to go on the computer. Or settle for something less.

Now personal programmables can help you cope with more data, explore with more insight, far more successfully than ever before. So you make better decisions chosen from more options—better decisions founded on a broader data base. More decisions. Faster. On the spot.

Programming is just logical thinking. Every problem has a logical flow. There may be constants to inject and variables to be put in. You have to compensate for these. The same is true when you program.

Let's follow the flow chart and step through a program on how to program:

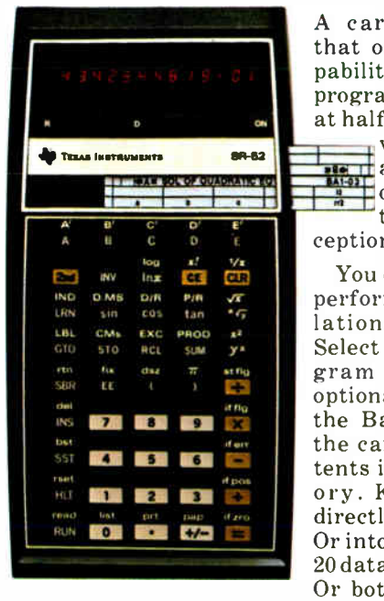
1. **State your problem mathematically.** Gather the equations and determine how you want it done.
2. **Key in your procedure.** List the keystrokes required to do the problem manually. Key them in. The programmable remembers.
3. **Try an example.** Before you do a real problem, be sure of your program.
4. **Key in your numbers.** Let the programmable try it. Making the calculations keyed-in in Step 2.
5. **Is this the answer you expected?** If not, you'll want to re-examine what you keyed-in and...
6. **Make changes.** Step forward or backward through the program to edit it. Try your example again. At Step 5 the answers should look good.
7. **Now do a real problem.** Your program is structured and tested—ready for your numbers. No need to key-in the program again. Only the variables. The programmable does the work.
8. **Do you have more numbers?** Here you can explore options: Ask *what-if?* Optimize. Or, determine what happens under worst-case conditions—take the Yes path.
9. **Loop.** Here's the real value of a true programmable. The work is done. From here on you get answers—all the answers you need. Automatically.
10. **Finish.** With an SR-52 you can record your program permanently on magnetic cards to use again and again. Or, with the optional PC-100 you can print the full contents of your program memory.



Due to the difficulty of photographing calculator readouts, displays represented in this brochure are simulated.

SR-52

$395.00*



A card programmable that offers twice the capability of the only other programmable in its class at half the price.† TI's advanced technology and start-to-finish quality control are the keys to this exceptional value.

You can process data or perform complex calculations automatically. Select a prerecorded program from one of the optional libraries or from the Basic Library. Load the card and put its contents into program memory. Key-in variables directly into the program. Or into one or more of the 20 data memory registers. Or both. Run a program as often as needed. Change values of variables if you wish. The stored program is unaffected.

Learns your way of solving problems. In just a few hours, you could be writing programs. Using its 224-step program memory, the SR-52 will handle programs you may have thought required a computer. Press LRN to store each following keystroke. Press it again and the SR-52 has learned your program. It's ready to RUN. Record your program on a blank magnetic card, and make it part of your personal library.

Computer-like branching. Offers three types of unconditional branching: Go to. Subroutine. Reset. And 10 conditional branches: Six display tests. Two flag tests. Two looping tests. Also, 10 user-defined keys.

Direct or indirect access to 20 data memories. Store numbers directly in memory registers. Or, store a number in a data memory specified by another register (indirect addressing). Add, subtract, multiply, divide within registers. Exchange display with memory.

Edit and debug. Move through a program a step at a time. Forward or backward. Insert. Delete. Or write over steps.

Basic Library of 22 prerecorded programs. Twenty-two prerecorded program cards come with an SR-52. You can put them to work right away. You also get a 96-page Basic Library manual. Each prerecorded program card is supported with sample problems, user instructions and program listings. See optional libraries on the back cover.

• Conversions (1,2) • Solution of Quadratic Equation • Hyperbolic Functions • Prime Factors of an Integer • Complex Arithmetic • Checkbook Balancing • Compound Interest • Ordinary Annuity (1,2) • Trend Line Analysis • Permutations and Combinations • Statistical Means and Moments (1,2) • Random Number Generator • High Pass Active Filter • Low Pass Active Filter • Dead Reckoning • Lunar Landing Game • Diagnostics

SR-56

$179.95*

Easily becomes an integral part of your work. As a powerful slide rule calculator that also does double-duty as an economical, powerful key-programmable. Capable of solving many problems handled by computers with its: 100 programming steps. Eight-register stack (handles up to seven pending operations). Nine levels of parentheses. And 10 data memories.

Branches like a computer. Capable of direct addressing, which includes: Go to. Reset. Subroutine (4 levels). And six conditional branches: Two for loop control. Four test register comparisons.

Unique independent test register. Compare the value in the display with a value in the t-register—without interfering with processes in progress. If your test conditions are met, then a conditional branch takes place. Otherwise the sequence continues.

10 memories to do your tough problems. Store and recall data. Add, subtract, multiply or divide within a memory register. Without affecting the calculation in progress.

A unique pause key works two ways. Using this key in a program will display any step you designate for a ½-second. Hold the key down and you'll see the result of every step in the program for ½-second.

Easy editing. Single-step and back-step keys let you sequence through program memory to examine what you've done. If you pressed a key incorrectly, you can go back and write over it (NOP).

Also a powerful slide rule. 74-pre-programmed functions and operations. Handles basic math. Logs and trig. Advanced statistical problems. Polar/rectangular conversions.

An applications library, too. A 192-page collection of programs. All pre-written. Select a program. Follow the listing (putting in your own data, of course). And, you'll immediately begin using your SR-56's computing power to solve your own problems.

Every program in the Applications Library was chosen specifically on the basis of occupational demands. Each program contains a thorough description of how it works and the conditions under which it operates. There are also extensive examples of each program in typical problem solving situations.

• Math (10 programs) • Statistics (12 programs) • Finance (11 programs) • Electrical Engineering (11 programs) • Navigation (7 programs) • Miscellaneous and games (5 programs)

*Suggested retail price.

†Based on suggested retail prices of models available at the time of this printing.

A new unique Algebraic Operating System helps make TI programmables easy to use.

With the introduction of the SR-50 slide rule calculator a few years ago, Texas Instruments had a choice: algebraic entry or Reverse Polish Notation (RPN). TI chose algebraic entry because it's the most natural and easiest to use.

Now, with the new SR-52 and SR-56 programmable calculators, TI takes another major step forward in power and ease of use—the unique Algebraic Operating System.

What is AOS?

Actually, it's easier to use than to explain. AOS is more than just algebraic entry. It's a *full* algebraic hierarchy coupled with multiple levels of parentheses. This means more pending operations, as well as easy left-to-right entry of expressions—both numbers *and* functions.

Algebraic hierarchy.

This is the universally recognized order of performing calculations. Functions first. Powers and roots. Multiplication or division. Then addition or subtraction. AOS performs calculations in this order. But you have the option to change the order whenever you wish by using the parenthesis keys.

Why pending operations are so important.

Because you can compute complex equations directly. For example, a seemingly simple calculation like this:

$$1 + 3 \times \left[4 + \frac{5}{\left(7 - \frac{2}{9}\right)}\right] = ?$$

contains six pending operations as it's written. An SR-52 or SR-56 programmable calculator with full AOS easily handles it just as it's stated, left-to-right. You don't have to rearrange the equation, or remember what's in the stack as with RPN.

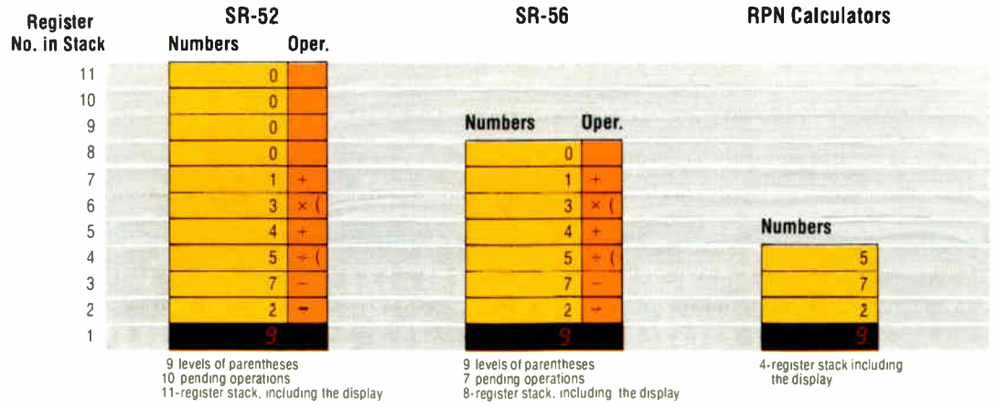
A calculator with "full AOS *remembers* both the numbers and functions in its register stack. And performs them according to algebraic hierarchy. As more operations become pending, the stack fills up (as shown in the diagram). Finally, when the equals key is pressed, the operations in the register stack are performed to give you the answer (15.21311475). Automatically.

AOS makes the calculator part of the solution. Not part of the problem.

The case for AOS is strong. That's why TI uses it. Whether you own a calculator with ordinary algebraic entry, or RPN or no calculator at all, we think you'll prefer AOS. Because you begin using it immediately. There's no new language to learn. Even if you are conditioned to RPN, the added value and power of TI's programmable calculators with unique AOS is well worth the easy transition.

Here's how AOS stacks up.

AOS remembers both numbers and operations, so you key-in your equation left-to-right. RPN only remembers numbers, you have to remember operations and the order.



Mail the coupon and we'll send you a new 16-page brochure that delves deeply into the features of the SR-52, SR-56 and PC-100. We'll also send you a prerecorded program card and instructions so you can try an SR-52 at your TI retailer.

Check one. Send me: ☐ EE program card ☐ Statistics ☐ Finance

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TIIRDSAMDE

Circle reader service number 200

And when people put programmables to work, they discover how immensely useful they can be.

Some of the early users of hand-held programmables were at Texas Instruments. Their goal—like yours—to make increasingly better decisions. Programmables helped them. They can help you too.

"A programmable can iterate 10, 20, or as many times as you want it to. The more you iterate the better your accuracy." Ken Davis. Circuit Design Engineer.

"I've developed a program that evaluates the output voltage of a saturated transistor buffer amplifier. It's a calculation that has to be iterated many times. The programmable can do it in seconds. It would take a good half-hour to do it by hand.

"I've got another program which is a real help in designing MOS transistors. I input the process parameters and the DC operating point. The programmable calculates the dimensions. We often use it in the lab to evaluate a prototype circuit. If we find out that one of the components is not up to spec, we can check the numbers and make an on-the-spot evaluation of the design."

"I think its greatest value is the 'sensitivity' it gives you for variables." Wally Rhines. Research Project Manager.

"I save trips to the computer. At my desk, I can say, for example, 'Ok, if I double the oxide thickness, what does it do to the capacitance?' Once I have a mathematical model I can make any relationship I want.

"Off the job I use it to evaluate stock options using statistical modeling. I define my risks more accurately, then I can decide if I am willing to take them. I increase my sensitivity for the way stocks move—seeing instantly what would happen to my option if the stock should move up or down several points."

"All I have to do is put in sales dollars. Then it computes: local tax, state tax, total tax." Robbie Askew. Accounting Supervisor.

"I used to figure these taxes manually. It took a good eight hours if I didn't have any interruptions. Now in an hour-and-a-half I am finished. The programmable does all the work."

"I have instant turn around... examining different alternatives very rapidly... replacing intuition with insight." Tony Barlow. Systems Designer.

"In systems design you depend on how rapidly you look at alternatives. That's what determines your effectiveness. In one case—cost control in software development—I was able to examine more alternatives than I would have been able to examine in a week's time—or even a month's time. The result was the best understanding we ever had of the factors that influence software costs."

"And I'm having a ball using it for things at home—from photography to games and puzzles."

"Now, because I can track complex contours with equations that generate NC tape data, we can develop more advanced tooling techniques." Harold Larsen. Tooling Engineer.

"The advantage is that you can work with the numbers instead of going to the model shop for mockups, which are expensive. Writing a program cuts down turn-around time, since you don't have to go through all this. And with reduced lead time and longer tool life we can cut our costs dramatically without cutting back on quality."

"We're getting yield improvements and therefore cost reductions. Because we can spot what's causing the problem quicker." Bob Wolters. Production Engineer.

"We're constantly running data reductions, evaluating yield and related process parameters. Before, it was all done by hand or on a big computer. Now, we're finding a lot more answers that are useful to us. Because the programmable calculator is right here. It's available. It's quick. A technician can do statistical correlations in a couple of hours where it used to take me all day.

"I also use a programmable in my hobby—amateur radio. I am technical director of the state VHF-FM relay league. We've developed test tables to increase the range of mobile units—extremely valuable in emergencies."

PC-100 printer. Turns an SR-52 or SR-56 into a quiet, high-speed printing calculator $295.*

Imagine the convenience of getting a hard copy printout of: Data. Intermediate results. Answers. Imagine the efficiency of listing your entire program at the push of a key. Or, printing the calculator's entire data memory contents with a simple program. And now imagine seeing every step of your program as it's executed—both the number and the function. Imagine no more. TI's exclusive PC-100 printer is here. Ready to print ballistic trajectories or unit conversions. Complex tax analyses or simple cost/price margins.

Optional libraries of prerecorded programs for the SR-52. $29.95*

Math Library. Hyperbolic functions, quadratic and cubic equations, simultaneous equations, interpolation, numerical integration, differential equations, matrix operations, base conversions, triangle solutions, complex functions, and more. 34 program cards.
Electrical Engineering Library. Active filters, resonant circuits, T-π networks and transformations, transmission lines, phase-locked loops, transistor amplifiers, Fourier series, coils, power transformers, controlled rectifier and power supply circuits, and more. 25 programs.
Statistics Library. Means, moments, standard deviations, random numbers, permutations and combinations, t-statistics, analysis of variance, regression analysis (linear, power curve, exponential, logarithmic, quadratic), multiple regression, histograms, 12 distributions (normal, chi squared, Poisson, Weibull, hypergeometric, etc.) 29 programs.
Finance Library. Ordinary annuities, compound interest, accrued interest, sinking fund, annuity due, bond yield and value, days between dates, annuities with balloon payments, interest rate conversions, add-on rate installment loans, loan amortization, interest rebate, depreciation (SL, DB, and SOYD) and crossover, variable cash flows, internal rate of return, capital budgeting, and more. 32 programs.
More libraries on the way. Navigation. Surveying. Aviation.

*Suggested retail price.

Compare the SR-52 and SR-56 with other programmables in their class.

Programming capability	SR-56	HP-25	SR-52	HP-65
Program steps	100	49	224	100
Merged prefixes	•	•	•	–
Merged register ops. & comparisons	–	•	–	•
Program read/write on mag. cards	–	–	•	•
User defined keys	–	–	10	5
Possible labels	–	–	72	15
Absolute addressing	•	•	•	–
Subroutine levels	4	–	2	1
Program flags	–	–	5	2
Decrement & skip on zero (loop)	•	–	•	•
Conditional branching instructions	6	8	10	7
Unconditional branching	3	1	3	2
Indirect branching	–	–	•	–
Editing: Step	•	•	•	•
Backstep	•	•	•	–
Insert, delete	–	–	•	•
NOP	•	•	–	•
Single step execution	•	•	•	•
Pause	•	•	–	–

Operating characteristics	SR-56	HP-25	SR-52	HP-65
Logic System	AOS	RPN	AOS	RPN
Maximum number of pending operations	7	3†	10	3†
Parentheses levels	9	–	9	–
Memories	10	8	20	9
Store & recall	•	•	•	•
Clear memory	•	•	•	•
Sum/Subt to Memory	•	•	•	•
Mult/Div to Memory	•	•	•	•
Exchange display with memory	•	–	•	–
Indirect memory addressing	–	–	•	–
Exchange x with y	–	•	–	•
Exchange x with t	•	–	–	–
Fixed decimal option	•	•	•	•
Calculating digits	12	10	12	10
Angular mode Deg/Rad	•	•	•	•
Grad angular mode	•	•	–	•
Digits displayed (mantissa + exponent)	10 + 2	8 + 2	10 + 2	10 + 2

†RPN Calculators only store numbers, while AOS stores both numbers and functions in its stack.

Calculating characteristics	SR-56	HP-25	SR-52	HP-65
Log, ln x	•	•	•	•
10^x, e^x	•	•	•	•
X^2, $\sqrt{X}$	•	•	•	•
1/X, π	•	•	•	•
y^x	•	•	•	•
$\sqrt[x]{y}$	•	–	•	–
X!	•*	•*	•	•
Int X (integer part)	•	•	•*	•
Fractional part	•	•	•*	•
Trig functions & inverses	•	•	•	•
Hyperbolic functions & inverses	•*	•*	•*	•*
Deg/min/sec to decimal deg & inverse	•*	•	•	•
Deg to Rad conversion & inverse	•*	•*	•	•*
Polar to rectangular conversion & inverse	•	•	•	•
Mean, variance & standard deviation	•	•	•*	•*

*Programmable functions

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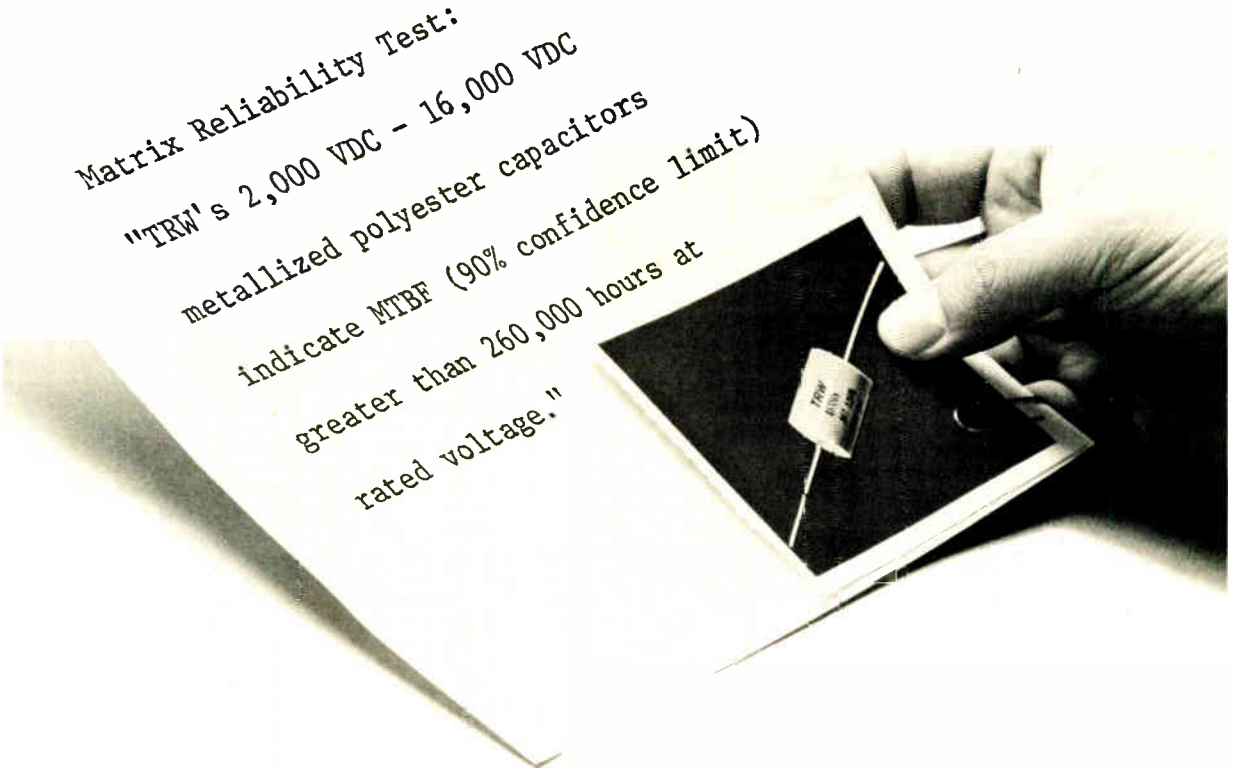
Reliability test results:



TRW's X675HV series is designed to meet the requirements of voltage multipliers and high voltage filters in high density, high voltage power supplies, instrumentation, data displays, pulse modulators and copiers.

They're smaller, lighter, self-healing and eliminate wet components which can bleed, crack and wreck a board.

The standard design is metallized polyester with axial leads, tape wrap and epoxy endfill case. Insulation resistance is 30,000 megohms x MFD and the dissipation factor is less than 1% at 1000 Hz.

The X675HV series can replace traditional dielectrics in many applications with substantial savings in size at comparable lower costs. *On quantity orders, modifications can be made to your specifications.*

Want to know more? Use the coupon for complete specs on the X675HV series — or information on any dielectric you require.

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- ☐ Please send me specs on your new X675HV capacitors.
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TERADYNE'S J401: THE FULL CAPABILITY IC TEST SYSTEM EVERY ENGINEER CAN USE.

Until now, the complexities of test programming have kept all but a few specialists from using IC test systems. Everyone else had to queue up at the programmer's desk or do without the kind of information that was really needed.

Now there's a J401. A fully programmable test system for T^2L ICs with up to 24 pins, complete with built-in CRT, printer, and mag tape unit, that any engineer can learn to use in minutes.

For IC producers this means immediate access to vital process control information. For IC users it means the data necessary to choose components and vendors intelligently. And the ability to extract from field returns the information needed to improve product quality and yield.

The performance and flexibility of a large, computer-operated test system.

The J401 delivers the flexibility ordinarily associated only with larger, more expensive systems. It can datalog any forced or measured function and it can generate an x-y plot of any two parameters. The system also operates as a high throughput go/no-go tester for the production line or incoming inspection.

Product data fast. Higher product yield.

For the semiconductor manufacturer, the easy-to-use J401 allows errors to be spotted before they can begin to multiply. QC engineers can use it to evaluate devices, determine test margins, and check device lots.

The electronic equipment manufacturer will find the J401 useful in monitoring vendor-to-vendor and lot-to-lot variations. It enables him to spot device characteristics that could be contributing to problems. And QC personnel can use the system to analyze failures and reduce service costs.

A system for meeting the real objectives of incoming inspection.

The J401 gives you fast go/no-go testing with an important difference. It gives control over the *way* devices are tested. By pushing a few keys you can change test conditions, bin out top-quality ICs, or have datalogging to support returns. All in seconds. This is incoming inspection as it should be.

It's a Teradyne.

Each J401 is built for hard use on the factory floor. Each is supported by Teradyne's ten-year circuit module warranty, a 24-hour telephone trouble-shooting service, and a world-wide field service backed up by local parts stocking centers.

For complete information on the J401, write:
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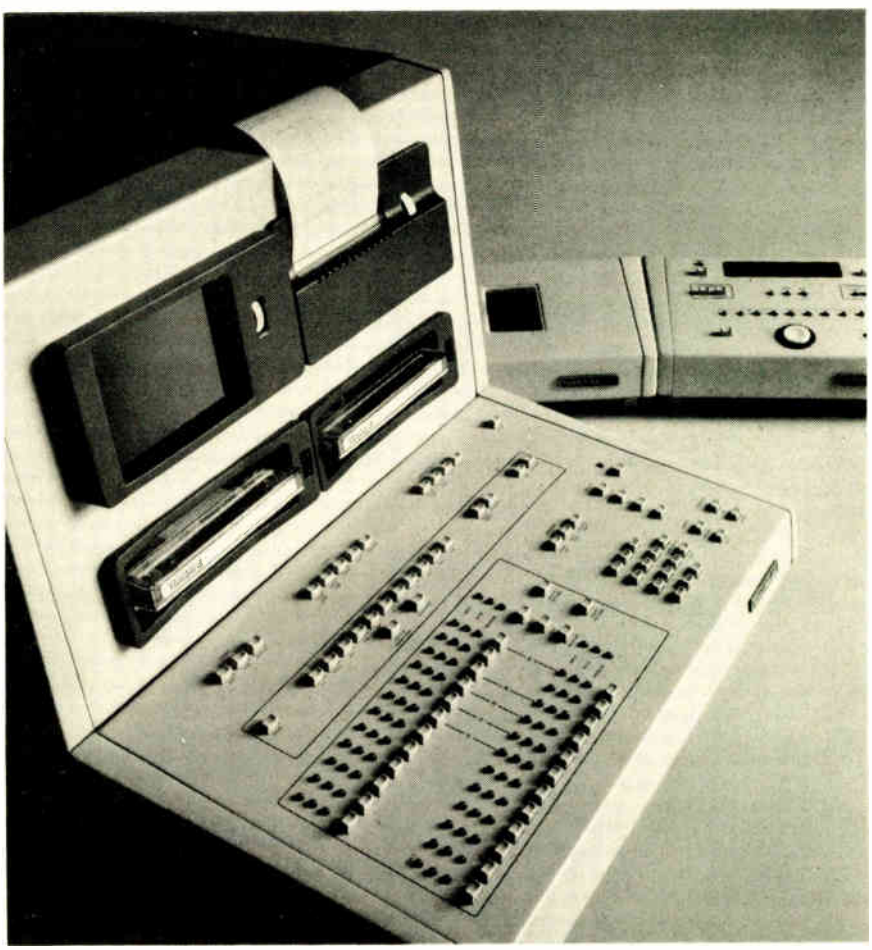

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Action put off on phone measure

Debate heats up as OTP and FCC back competition for AT&T and independent carriers in specialized areas

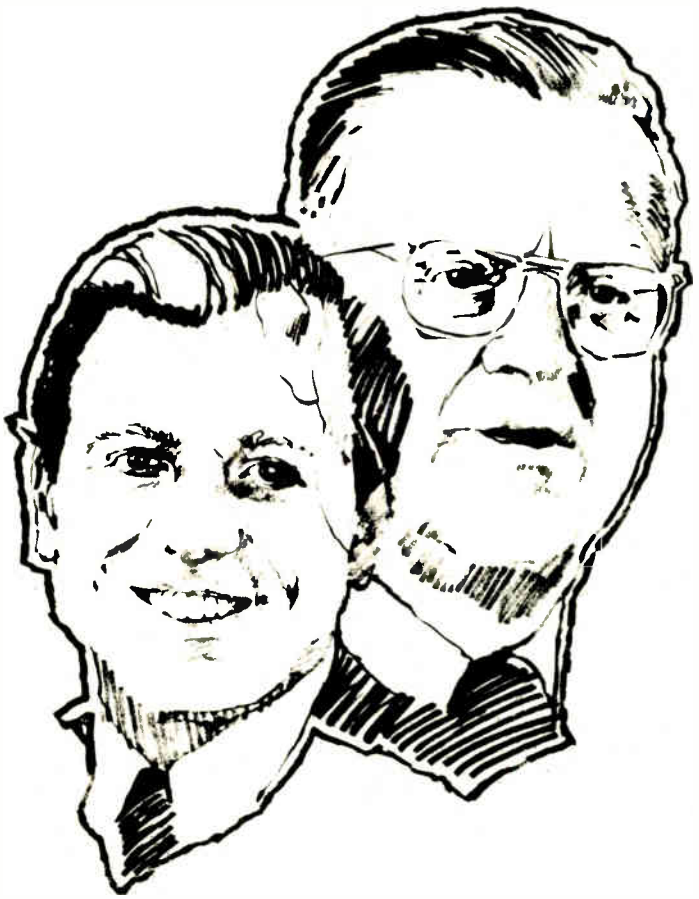
by Ray Connolly, Washington bureau manager

Despite a large and increasing number of sponsors in the House and Senate, congressional leaders have put off until next year any meaningful consideration of the telephone industry's Consumer Communications Reform Act. Thus, the hot potato of monopoly or competition in America's telecommunications industry will land in the lap of the 95th Congress that will convene in January with new leaders at every level.

With new chairmen of the Commerce communications subcommittees in each chamber both facing reelection, the postponement was not unexpected. But the decision was hastened as the complex and explosive nature of the issues became apparent. As a concession to the more than 128 sponsors on the House side, however, chairman Lionel Van Deerlin (D., Calif.) is scheduling three days of "exploratory" hearings on the bill for late September. But Sen. Vance Hartke (D., Ind.), in line to succeed chairman John Pastore (D., R.I.), who is retiring, has called only for a committee staff study of the issues during the remainder of this year.

Softening? The study proposed by Hartke, first senator to introduce the bill in the upper chamber earlier this year, is widely viewed as a softening of his strong support for the telephone industry's proposal that would effectively stifle competition for telecommunications-terminal equipment and such specialized carrier services as value-added networks and domestic satellites. "We must prepare ourselves carefully and thoroughly with an open ear to all sides," he explains.

But postponement of congressional hearings has failed to deter industry criticism of American Telephone & Telegraph Co., key sponsor of the bill along with the U.S. Independent Telephone Association [*Electronics*, March 4, p. 34]. In separate actions, Litton Industries Inc., and the MCI Communications Corp. have charged AT&T and its affiliates with illegal political contributions and payoffs to maintain its dominant industry position (see "Pressure on AT&T intensifies," p. 66).



Adversaries. John Eger, left, head of Office of Telecommunications Policy, opposes bill pushed by AT&T chairman John deButts, right.

On the Government side, the FCC, led by chairman Richard Wiley, wants competition for AT&T. And the White House Office of Telecommunications Policy has called the proposed legislation "a deceptive bill" and charged AT&T with using "totally unsubstantiated scare tactics of rising costs and technical harm."

The blast by OTP's John Eger, soon to resign as acting director, was unquestionably the strongest Government criticism thus far of the telephone-industry bill. (President Ford has nominated Illinois lawyer Thomas Houser, who served briefly as an FCC commissioner, to take over at OTP.) Eger, addressing a June communications seminar of the Electronic Industries Association, also labeled "sheer folly" the bill's premise that "development of telecommunications might best be

served by a single vested interest, free to regulate the pace of technological growth and unencumbered by the stimulating effect of aggressive competition."

The attack on AT&T came on the heels of a New York meeting between company chairman John deButts, who is the bill's principal advocate, and Eger. The AT&T chairman's adamant opposition to compromise led to a redraft and sharpening of Eger's speech.

Six points. Eger urged deregulation by the FCC of telecommunications-terminal hardware as one means of encouraging increased innovation through competition. "We must also insure that services determined by the commission not to be 'natural monopoly' common-carrier services [such as phone service] should nonetheless be offerable by common carriers," he added, "provided that they establish for that purpose subsidiary corporations with separate accounts and records. This would involve, for example, detariffing [seller to determine price] of all terminal equipment."

Beyond those two points, Eger offered four others for congressional consideration in regulatory reform. To assure a basic commitment to a free market where competition is workable, Eger said carriers opposing a new market entry should bear the burden of proving it, rather than placing the burden on entrants as the telephone-industry bill proposes. He also called for new interjurisdictional separation procedures, as well as revision of cost-allocation procedures and accounting principles to eliminate possible cross-subsidies and predatory pricing.

Defending the proposed legislation, AT&T executive vice president Thomas S. Nurnberger says that the future direction of national telecommunications "doctrine" is a job for Congress, not regulators. "This process of choosing priorities and selecting [technological and organizational] preferences is rooted in human motivation, not scientific deduction," the AT&T executive says.

Fragmentation. To limit AT&T's "universal service doctrine and rate averaging," Nurnberger argues, would fragment the large-volume market needed to stimulate high technology, slowing its introduction since "economic cross-over points recede as volume declines."

Seeks competition. FCC chairman Richard Wiley wants to open AT&T's markets.

"Our worst fear," he says, "is that a competitive policy may degenerate into one of 'regulated competition.' We fear this outcome because we have already encountered indications of it. We are told 'you can't go into that business at all because it's already reserved for others,' or 'you can't tariff that device because it isn't priced right'."

The AT&T executive says he is concerned that OTP's Eger "obviously wants to keep Congress out of this debate," a charge that the OTP has subsequently rejected, saying it merely wants the debate to involve all relevant issues, not just the telephone industry bill.

The AT&T position, reiterated by Nurnberger, that consumer telephone service is subsidized by business rate-payers was challenged by OTP. It cited recent state studies in New York and Massachusetts in opposition. A larger question on the subsidy issue, OTP said, is the need to determine "if, in fact, it is ultimately determined that the public interest is served by subsidizing particular classes of users, is the telephone rate structure the means whereby the desired subsidies ought to be brought about?" □

Pressure on AT&T intensifies

"It is getting rougher and it's going to get dirtier," contends one Government telecommunications official of the dispute over competition between AT&T and the independent carriers on one hand and the Federal Communications Commission, the Office of Telecommunications Policy, specialized carriers, and hardware suppliers on the other. That conclusion gained support in early June as Litton Industries Inc. and MCI Communications Corp. separately charged AT&T and some of its Bell System subsidiaries with illegal actions to preserve their domination of U.S. telecommunications markets.

Two Litton subsidiaries have filed a $111 million antitrust suit in a New York federal court against AT&T, Western Electric, Bell Laboratories, and seven AT&T operating companies. The suit alleges Bell System has monopolized the telephone-terminal-equipment market. Sixteen other AT&T operating companies were cited as nondefendant conspirators. The four-count suit, which seeks treble damages, also alleges that the defendants, in restraint of trade, conspired to prevent subscribers from connecting their own terminals to the Bell system.

Coincident with the Litton suit, MCI in Washington called for a new investigation of AT&T by the FCC, the Justice Department, the Securities and Exchange Commission, the U.S. Senate and House of Representatives. MCI based its petition on an investigatory report of the Southwestern Bell Telephone Co. by the Texas senate subcommittee on consumer affairs. Southwestern, the 147-page report says, "squandered time, energy and brainpower on a continual quest for political influence, when it might have better employed such energies in economizing its own operations."

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CA3140 vs. 741 at a glance

	CA3140T,S	CA741CT,S
Input Resistance R_I (MΩ)	1,500,000	2
Input Current I_I (pA)	10	80,000
Slew Rate, SR (closed loop) (V/μs)	9	0.5
Gain-Bandwidth Product, f_T (MHz)	4.5	1.0

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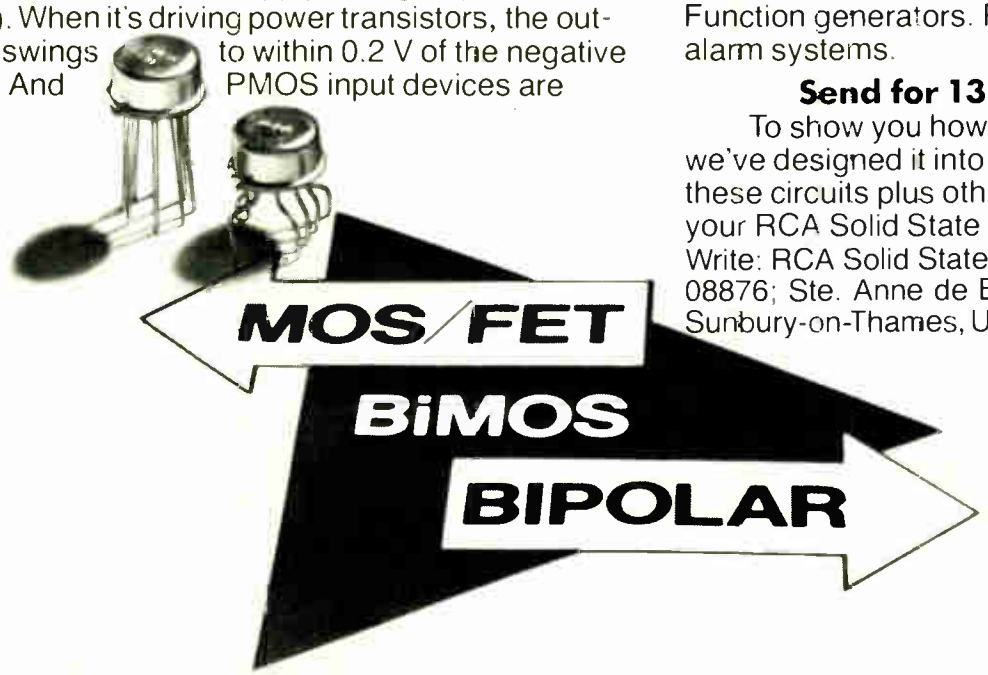

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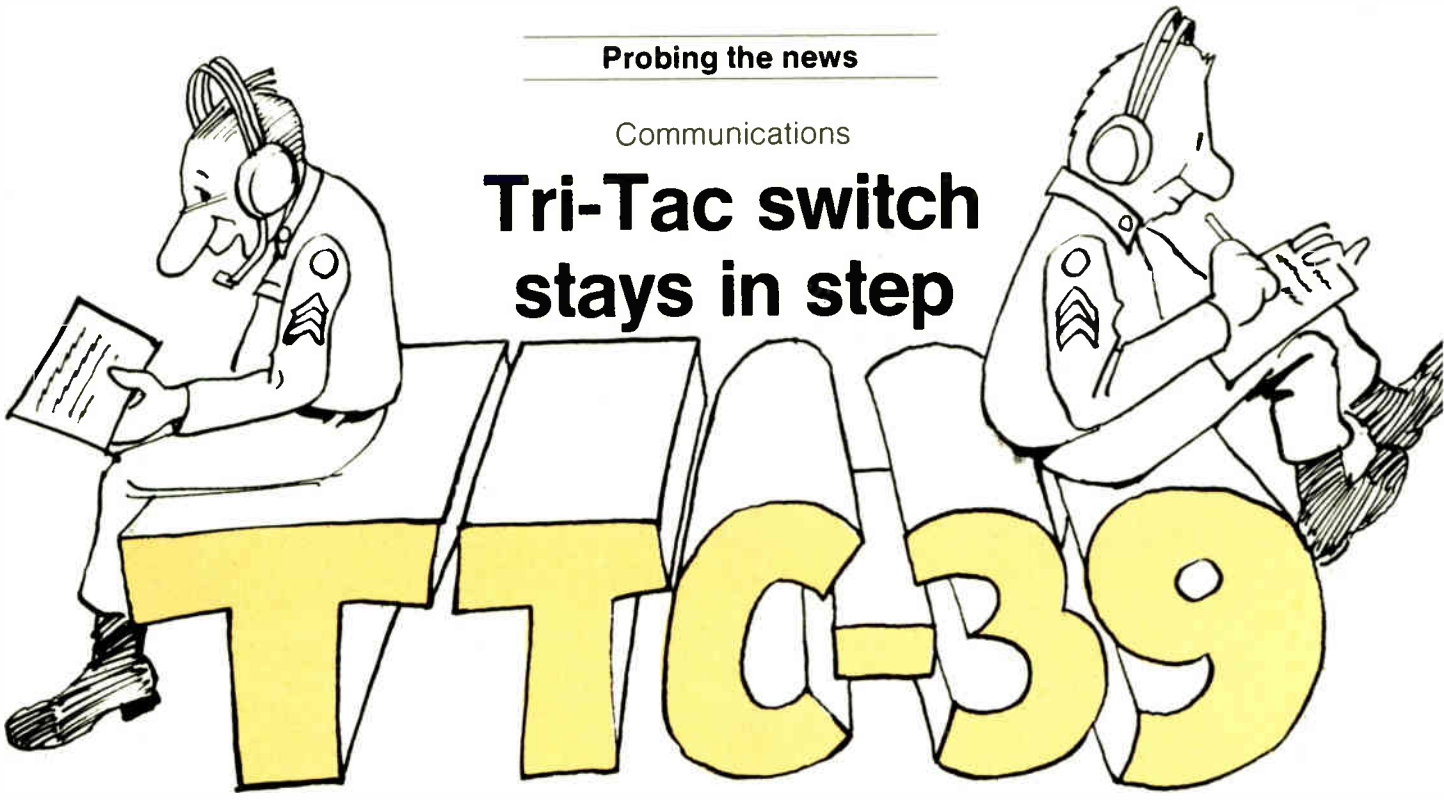

by Lawrence Curran, Boston bureau manager

Visitors to this month's Washington meeting of the Armed Forces Communications and Electronics Association got their first look at the U.S. Army's AN/TTC-39 switch, a kind of telephone central office, at least in mockup form. But the Army's prime contractor for the tactical communications trunking and switching system, GTE Sylvania Inc., has gone well beyond the mockup stage. Installation of some hardware in shelters began in April, and subsystem components are also moving along in development at Needham Heights, Mass., where Sylvania's TTC-39 effort is concentrated in the Electronic Systems group's eastern division.

The TTC-39 performs two primary functions—electronic circuit switching and message switching. It is analogous to a commercial telephone system's central office, except that the computer-controlled TTC-39 has difficult size and weight constraints: it has to be at the same time completely redundant and small enough to fit into a two- or three-man shelter, transportable by air, capable of surviving nuclear attack, and able to accommodate subscribers using both analog and digital data and voice terminals. Those terminals include voice telephones, teletypewriters, other switching systems, and exchanges—such as the Autovon and Autodin exchanges—and data adapters that provide the interface with radio links.

Sylvania has made widespread use of low-power Schottky TTL medium-scale integration to conserve power and make the module smaller and lighter in weight than earlier military communications-switching gear. It has also incorporated Sylvania-designed large-scale-integrated p-channel MOS to help in reducing size and weight. MOS LSI has been employed for functions ranging from simple repetitive ones, such as shift registers and large gate arrays for decoding, right up to modems, Golay encoders and decoders, and data-synchronization logic.

Sylvania won a contract worth some $48 million in April 1974, calling for delivery of these major items in Phase II of the TTC-39 program: nine circuit switches or switching centers accommodating 300 to 2,400 lines or subscribers; seven message switches, each handling 25 to 50 lines; two communications security shelters housing Government-furnished cryptographic equipment; operational maintenance software; ancillary equipment; training support; technical manuals, and maintenance kits.

The system is presently conceived as a corps- and division-level switching system, but Resnick says it could ultimately serve smaller units. It's intended to become operational in the 1980s and is the first major hardware development under the direction of the Defense Department's Joint Tactical Communications (Tri-Tac) Office. The Tri-Tac organization provides system definition and engineering of tactical communications equipment and coordinates its development and production.

There will be five configurations of the circuit-switching part of the TTC-39, two using single shelters and seven employing dual shelters. Each shelter is designed to fit on a 2½-ton truck. Phase II calls for five configurations of the message switches. The circuit-switching function connects one subscriber to another via hard wires. Message switching transmits a message between subscribers when the "called" subscriber is ready to receive and therefore employs a computer-controlled store-and-forward technique

to hold on a disk any message for a busy or unavailable line.

Each single-shelter circuit switch, Resnick says, handles up to 300 digital or analog lines or a combination of both, with at least 150 of them digital. This configuration also includes redundant L3050 computers supplied by the Data Systems division of Litton Industries, the biggest subcontractor in the TTC-39 program.

The two-shelter circuit-switch cluster includes the same processors, cryptographic equipment, and operator stations as the single-shelter version, all built into a control shelter. Added to that is the circuit-switching shelter, which will accommodate up to 600 analog or digital lines with their switching matrixes.

The message switch is a two-shelter configuration—one a message-processing shelter, and the other a communications-interface shelter. The processing shelter houses three operator stations and some of the same modules as the circuit switch, including the L3050 computers and a 67-million-bit disk system to help with the store-and-forward function. "The communications interface shelter has some of the same kind of hardware," Resnick says, "except that it's full of modems, but we've replaced several hundred pounds of modems in several racks with printed-circuit-card modems in one rack."

The modems interface the switch to standard strategic and tactical communications lines from the various types of terminals. While the aim is to use off-the-shelf components as much as possible to keep costs down, the varying data rates feeding into the switch dictated the design of a data-adapter terminater unit that does all the complex rate correcting and compensation. Philip Schleuter, chief electrical and hardware designer for the message switch, says eight of the p-channel MOS metal-gate custom LSI chips on that terminator board replace about 50 TTL packages.

Similarly, Sylvania-designed custom p-channel MOS LSI is used on at least two key portions of the circuit switch: its space-division adapters and NATO interface terminals, which are required to interface switchboards and instruments that are special in the system, says John Condon, circuit-switch electrical task manager. The circuits were designed to shrink pc boards. In all, about 12 custom MOS devices have been designed by Sylvania for the system, with masks furnished to the Nitron division of McDonnell Douglas Corp., Cupertino, Calif., for fabrication.

Resnick points out that all of these size and weight reductions lead to economies in the life-cycle cost of the system, adding that there could be more if the TTC-39 were all digital. "But we have to accommodate all of the instruments in today's communications inventory, and a lot of them are analog, so we'll go to the field as a hybrid, although some of the modules can be used for all-digital secure communications now." □

Milestones in the TTC-39 program

GTE Sylvania Inc.'s Eastern division has been working on the Phase II AN/TTC-39 contract for 24 months and is scheduled to deliver major portions of the system in December 1977 for developmental testing. Officials at the Army's TTC-39 program office at Fort Monmouth, N.J., say that, after the latest bimonthly review, there's every indication that Sylvania can deliver developmental hardware to Fort Huachuca, Ariz.

The Fort Huachuca tests will last nine months. The first six or seven will consist of developmental testing, the rest of operational testing, an Army source at Fort Monmouth says. The TTC-39 elements will then remain at Fort Huachuca for continuing tests with other elements of Tri-Tac hardware as they become available.

After a high-level review of all test results, including a Defense System Acquisition Review Council study, production of the system would begin at a low rate, in three successively larger stages about one year apart and full-scale production a long way out in the future.

You and Your Career

EE job market improves gradually

June graduates are finding positions more easily than last year; salaries are up, and demand is good for computer specialists

by Gerald M. Walker, Associate Editor

Although far from a stampede, the hiring of electrical engineers, both recent graduates and experienced practitioners, appears to be increasing across the country. A spot check of electronics companies, engineering schools, and employment agencies indicates that the general business upturn has generated a cautious expansion in engineering departments, as well as a movement to fill vacancies left open by attrition and previous layoffs.

However, it's not yet clear whether the influx of new graduates is being absorbed entirely by this expansion or at the expense of older, higher-salaried EEs forced out of their positions. On the positive side, more and more unemployed engineers seem to be finding positions that suit their previous experience and incomes. On the other hand, none of the companies questioned by *Electronics* reported any particular need for EEs with 15 to 20 years of experience.

A burst of job openings, the sampling indicates, has come since May, a sign that electronics companies had hedged their confidence in the strength of the business recovery until they got a look at the second-half projections. Nevertheless, engineering schools from coast to coast report that new bachelors, masters, and Ph.D.s are now getting jobs.

Optimism. "It's a very nice year to be in electrical engineering," observes John G. Young, director of the engineering-placement service for the college of engineering at the University of Michigan. "People have been much more serious about hiring. Last year, there was very much pessimism, and companies were hiring only a bare minimum. This year, things are looking up."

Concurring with that assessment, Robert K. Weatherall, director of placement for Massachusetts Institute of Technology, adds, "Firms came out of the woods at the end of the recruiting season. We're back in the same sort of numbers as 1969–1970." In that academic year, 256 companies sent respresentatives to the MIT campus. That number dropped to 179 in 1972–73 and increased to 203 last year. This year, 220 firms sent recruiters to MIT.

A good indication of the rapidly growing importance of microprocessor applications is the increasing demand for EEs specializing in digital electronics, computer hardware and software, and semiconductor technology. This increasing need is not only true for recent grads, but also for engineers with three to five years' experience in industry, according to company personnel directors. In addition to computer-mainframe manufacturers, instrument companies and consumer firms are swelling the demand for EEs to work with microprocessors.

Increases. Salary offers are up too, though there are several $1,000-to-$2,000-a-year discrepancies between what companies say they are paying newcomers and what university placement offices say their graduates have been offered. Personnel directors want to keep the lid on pay checks, while engineering-school officials want to inflate the value of a degree from their institutions. For what it's worth, here's what the schools are reporting for beginning salaries:

- University of California at Los Angeles. Bachelor EEs, average, $14,700 a year; masters, $16,275; and Ph.D.s, $21,000. All are 5% higher than last year.
- MIT. BS degree, $14,400 a year;

Self-help helps, too

There's been improvement in the demand for experienced EEs, as well as for June graduates. The San Fernando Valley section of the IEEE, using institute funding, last year started a program to find jobs for out-of-work engineers, and this year it's paying off.

With a three-man team working part-time, the program has been steadily placing unemployed EEs, Larry Matonak, a Litton Data Systems division employee, reports. One problem is that many who got jobs through the program didn't bother to report back. However, he says that many more than 15 known placements have been made. Presently, 60 to 80 resumés are on file, and the staff is trying to match these with about 40 openings. This year, calls advising of job openings are coming in about twice weekly. Many involve up to six individual positions, compared to one a week last year.

"Our first priority is for the unemployed; then we would help those looking for a job change, says Matonak, who is heading the program. Nonmembers also may request assistance, but would be asked to join the chapter.

MS, $16,380; and Ph.D., $22,020. In 1975, offers were $12,900, $15,300, and $18,800, respectively.

- Cornell University. BSEE, average, $1,158 a month; median, $1,170; highest, $1,325; and lowest, $967. MSEE, average, $1,293 per month; median, $1,334; highest $1,520; and lowest, $1,083. No comparable figures were available for 1975.
- Northeastern University. BS, average, $13,800 a year, compared to $12,600 in 1975.
- University of Michigan. BS, averages $1,135 per month, compared to $1,076 last year.
- Cooper Union. BSEEs, $12,500 to $13,000 per year, 5% higher than in 1975.
- Polytechnic Institute of New York. BSEEs, average, $13,300 a year, compared to $12,800 in 1975.

Decisions. Recruiting for women and minority engineers was definitely on the upswing this year to fulfill Federal hiring mandates. However, one engineering-school placement official notes that women and minority EEs seem to get preferential treatment only in the initial contacts. In follow-up interviews, in which the decision to hire is based on technical ability, these groups are evaluated the same as the majority of white males. Therefore, the official points out, sex or race does not seem to be a determining advantage either way.

"It's tough to find top recent grads," states William Benning, manager of personnel administration for Rockwell Corp.'s electronics operations. "The competition is keen." The company expects to hire 250 to 300 new EEs this year, a few more than in 1975. "Minorities are in a good spot currently for job consideration anywhere in the engineering or computer-sciences field," he declares. But in contrast to the peak years of the electronics boom, an offer of a job in Southern California does not mean certain acceptance.

The same holds true for most electronics companies across the country, as they carefully hire engineers while keeping an eye on the sales charts. The personal director for an East Coast computer firm remarks, "There's no national jump in hiring that we can detect." □

Companies

Giant Philips flexes semiconductor muscle

by John Gosch, Frankfurt bureau manager

Overseer. Tony Opstelten, as manager of Elcoma division's solid-state activities, oversees Philips' semiconductor operations. The aerial photo is an overall view of the sprawling Philips complex at Eindhoven.

If a European company wants to make good in the world semiconductor market, it must establish an American base. By following that dictum and taking over Signetics Corp. in Sunnyvale, Calif., last year, Philips Gloeilampenfabrieken in the Netherlands has catapulted itself into a front-running position among the world's leading semiconductor suppliers.

Not that the Dutch company was in the minor leagues before the Signetics acquisition. While ranking semiconductor makers is less than an exact science, its 1974 sales in Europe of nearly $400 million probably make Eindhoven-based Philips the Continent's largest non-American supplier of solid-state components, and it trails only Texas Instruments Inc. and Motorola Semiconductor. In integrated circuits alone, the company's 1974 European business totaled about $100 million—almost two thirds more than the sales of Siemens AG, the second-ranking European semiconductor firm.

But with Signetics under its wing, Philips' performance must be compared with those of the biggest of U.S. producers. In fact, Philips now claims the No. 1 spot among the world's makers of discrete semiconductors. That's the view of Tony Opstelten, manager of solid-state activities at the Electronic Components and Materials division—Elcoma, for short.

There also has been a major shift in worldwide standings in ICs. With combined Philips and Signetics IC sales of almost $160 million in 1975, "we are on a par with Fairchild and National Semiconductor, sharing with them the No. 2 position after TI," Opstelten says. By 1980, he adds, Elcoma's semiconductor sales will exceed those of television-picture tubes, which account for most of the division's $1-billion-plus components sales.

More products. The Signetics takeover has also triggered an explosion in the Philips product mix. The company's forte has been in linear circuits, mainly for TV and audio applications, but it is now strong in digital devices as well, Opstelten notes. The Elcoma-pioneered Locmos (for local-oxidation complementary MOS) family and its large array of emitter-coupled-logic circuits has been augmented by Signetics' families of industrial and military transistor-transistor-logic devices of all kinds and by the U.S. firm's broad line of analog circuits. The only product line that needs strengthening, the Elcoma manager says, is n-channel MOS.

During the next few years the cross-Atlantic tie will benefit Philips most in microcomputers. "This is where our current marketing efforts are concentrated," Opstelten says. Elcoma is banking heavily on the Signetics 2650 microprocessor system to give it a fast European start.

The Philips-Signetics force has ambitious microprocessor-sales goals for the next few years. "We are aiming for a 50% share of the world's bipolar microprocessor market by 1980," Opstelten says. And in MOS versions, "our goal by the end of this decade is a position equal to that of Intel."

Opstelten cites several factors to

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Our knowledge of the custom LSI approach to instrumentation products can help you to evaluate its potential benefits in your own terms. This can lead to your acquisition of a protectable, fully proprietary circuit. If your need is immediate, we invite you to contact Rich Koury, Manager, or ask for Instrumentation Product Marketing at (408) 247-5350.

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support his confidence. For one thing, "together with our American affiliate, we have the world's strongest semiconductor research and development capability," he says. Elcoma can tap six Philips research labs in Europe—one each in the Netherlands, Belgium, France, and England, and two in Germany.

For another thing, "there's Signetics' proven microprocessor-manufacturing know-how and our combined marketing capability," he points out. In Europe, Philips commands a components sales force that blankets virtually every country. Elsewhere in the world, its affiliates and network of distributors ensure good coverage.

"And then, of course, we have the financial resources," Opstelten adds with a smile. Philips, the largest electronics company outside the U.S., had 1974 sales of more than $10 billion.

Opstelten predicts that the West European microprocessor market will double each year from its 1976 level of an estimated $10 million to about $170 million in 1980, with about one fifth of the market for bipolar systems and two fifths each for standard 8-bit MOS and dedicated systems. What Elcoma is gunning for is about half of Western Europe's bipolar and roughly one quarter of its MOS-microprocessor markets.

Looking beyond what Philips and Signetics already have on the microcomputer market, Theo Holtwijk, Elcoma's group leader for semiconductor systems and memories, cites the 2650-1 and the 2650A-1 microprocessors. Both are redesigned versions of the 2650 and will be introduced by September. The chip is 50% smaller than the original, and the cycle time is 1.5 microseconds instead of 2.4 μs.

In addition to microprocessors, the Philips-Signetics catalog lists more than 100 semiconductor memories. And coming this year is a variety of new devices. Among them are Schottky TTL and ECL parts, erasable programable read-only memories, and low-power Schottky circuits. There also will be an 18-pin 4,096-bit random-access memory compatible with TI's 4050. And early next year, the company will introduce a dynamic 16,384-bit, a static 4-k-by-1-bit, and 1-k-by-4-bit MOS RAMs.

The Signetics acquisition also adds a strong line of linear circuits and a broad range of 560 logic parts—in standard TTL, low-power Schottky TTL, Locmos, and ECL. Holger Beckett, Elcoma's group leader for linear devices, promises a strong Philips push into European military markets, while Pieter Fitters, group leader for logic circuits, says 50 low-power Schottky versions will be introduced this year.

Philips claims 6% to 7% of the European TTL market, but Fitters is convinced that by 1979 or 1980, his company can overtake the 23% of the No. 2 Fairchild. Texas Instruments leads with 40%. □

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2160A is a panel-mount, 4-digit thermometer capable of resolving 1°C or 1°F over the entire temperature range of any of eight thermocouple types (J, K, E, T, R, S, B, C). 2165A is the portable, bench-top version of the 2160A.

2166A expands the basic capabilities of the 2165A to include monitoring of up to ten thermocouples of the same type with a front panel selection switch.

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2168 is another portable, 1° single-point instrument. It can, however, accept any one of eight thermocouple types as input.

2170A is a panel-mount, 4-digit thermometer capable of 0.2° (°F or °C) resolution over a temperature range of −99.8° to +999.8°, for four thermocouple types (J, K, T, E). 2175A is the portable, bench-top version of the 2170A.

2176A expands the basic capabilities of the 2175A to include monitoring of up to ten thermocouples of the same type with a front panel selection switch.

Options for the new series of instruments include rechargeable battery power, an isolated parallel BCD output, an isolated analog output, a multi-point switch unit, and a Hi-Lo set point comparator.

And if you're wondering what the reaction to these new products has been, well, it's pretty typical.

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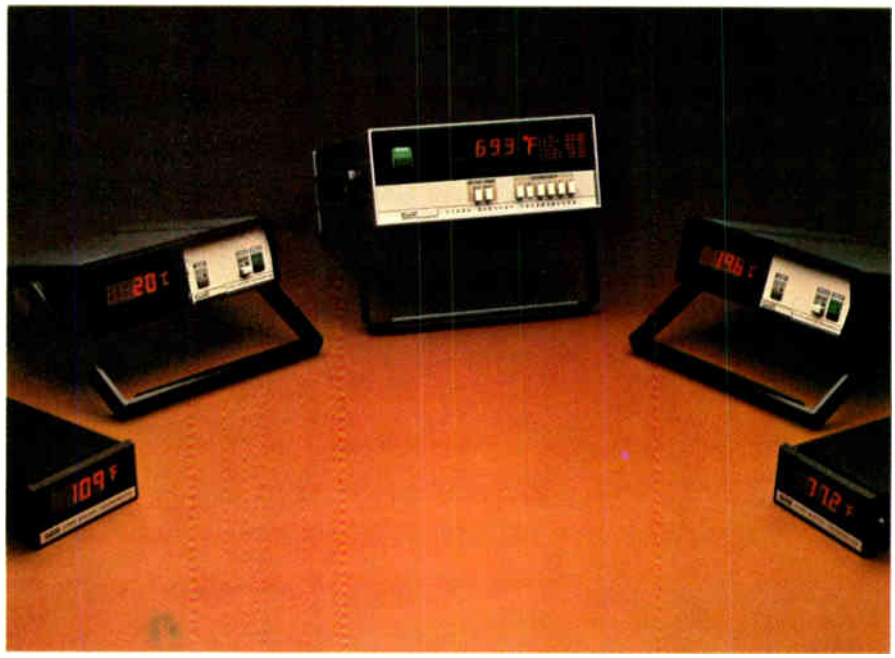

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Microprocessors

The 8080 looks like a bandwagon

Addition of National to second sources pushes Intel family toward status of standard in market for general-purpose 8-bit machines

The 8080 microprocessor family has won another convert: National Semiconductor is beginning to make the full line of Intel Corp. parts.

As a result, industry observers see a quickened movement forming around the family. With such major suppliers as Texas Instruments, Advanced Micro Devices, and National, as well as Japan's Nippon Electric Co., West Germany's Siemens, and others joining the Intel bandwagon and in some cases making their own innovations in the family of parts, those observers speculate that the 8080 is fast becoming the closest thing the industry has yet seen to a standard in the general-purpose 8-bit microprocessor market.

According to Bill Baker, who directs National's microprocessor operations, the company has already begun stocking distributors' shelves with the central-processing-unit group—the 8080A-CPU, clock-generator, and system-controller chips. Production has started on the 8-bit input/output port and communications and peripheral interface chips, he says. The other parts will follow over the next six months.

National now has four microprocessor families on the market: PACE, a 16-bit CPU chip for industrial process-control applications; the 8080; SC/MP, for low-cost controller applications, and the calculator types, such as the 5799, for very-high-volume, very-low-cost consumer applications. What National's decision means to its exchange agreement with Rockwell International is still unclear. Neither firm appears to be seriously working to supply the other's products.

THE 8080 FAMILY

CPU GROUP

8-bit central processing unit, 2-μs cycle
Clock generator
System controller

CPU OPTIONS

1.3-μs cycle
1.5-μs cycle
2-μs cycle (−55° to +125°C)

INPUT/OUTPUT

8-bit I/O port (15-mA drive)
Programable communication interface
Programable peripheral interface

PERIPHERALS

1-out-of-8 binary decoder
Dynamic RAM driver (8107B)
Priority interrupt control unit
Bidirectional bus driver, noninverting (50 mA)
Bidirectional bus driver, inverting (50 mA)
Dynamic RAM refresh controller (8107B)
Programable interval timer
Programable DMA controller
Programable interrupt controller

The cross-fertilization represented by the long list of 8080 second sources can benefit users. An example is TI's recently introduced 5501 multifunction input/output controller—a single chip that performs the asynchronous communications interface, data I/O buffer, interrupt control, and interval-time functions spread out over three chips in the standard family.

Indeed, the expansion of the 8080 family by several sources strikes some as analogous to the early days of the standard transistor-transistor-logic family, where cross-fertilization among several suppliers of the 54/74 logic family accelerated its popularity at the expense of other versions.

Intel's microcomputer marketing manager, Dale Williams, already sees it happening, calling the 8080 family "the 54/74 of the seventies." But he also points out that any supplier of 8080 parts had better be willing to invest in the whole family and not just in the CPU and a few peripherals. "The CPU is quickly becoming the $10 part of a $100 problem," he says.

But such cross-fertilization is unlikely, according to a spokesman for Motorola's Semiconductor Products group, where the 6800 is the major competitor of the 8080 in the 8-bit market. Colin Crook, group operations manager for microproducts in Austin, Texas, recalls the days when the TTL logic families were growing, but points out, "The name of the game then was to come out with about 100 parts, which was easy to do since they were SSI and MSI. But with LSI, you don't have that capability, and trying to second-source a whole variety of peripheral chips can be costly."

Thus, Crook opines, there will be a wide variety of peripheral chips coming from different people that no one will second-source. In fact, rather than a bandwagon, he says, "We're seeing a fragmentation of the 8080 market."

It would have been more interesting, he says, if the second-sources for the 8080 had done enhancements, such as Zilog's Z-80. "That would have been fascinating, and to that extent, I'm glad there's not a Z-6800." Crook does note however, that Motorola does have such an enhancement program. □

SHOULDN'T YOUR FREQUENCY COUNTING DOLLARS BUY TIME, TOO?

It used to be that to get time *and* frequency measurements you paid extra.

No more.

For about what you would pay for frequency measurement only, Fluke's 1900A counter gives you multi-function capability.

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We give you a broad frequency range from 5 Hz to 80 MHz with sensitivity of 25 mV, typically 15 mV.

Four manually selected gate times give resolution down to 0.1 Hz.

Then, true to its name, the 1900A multi-counter gives you a period mode. With it you can measure the duration of a single input cycle, useful for high resolution of low frequencies.

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You can't do that with "frequency only" counters.

Another extra built into the 1900A is the totalize mode. With six-digit LED display, the 1900A will totalize 10^6 events and provide overflow indication after that. And annunciation in MHz, kHz, ms or μs is automatic.

We've also built ease of operation into the 1900A. For times when training is a bottleneck, you get autoranging.

This feature automatically selects the most suitable gate time (or period averages) for the highest signal resolution without overflowing.

Simple to use.

And the 1900A has autoranging hysteresis that makes it easy to measure signals full of a lot of frequency or phase modulation.

Redundant up- and down-ranging is eliminated.

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Of course, you can expect Fluke quality in the 1900A. LSI/MOS circuitry design is standard. That means high performance with low power consumption.

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And leading zero suppression will give you an unambiguous display.

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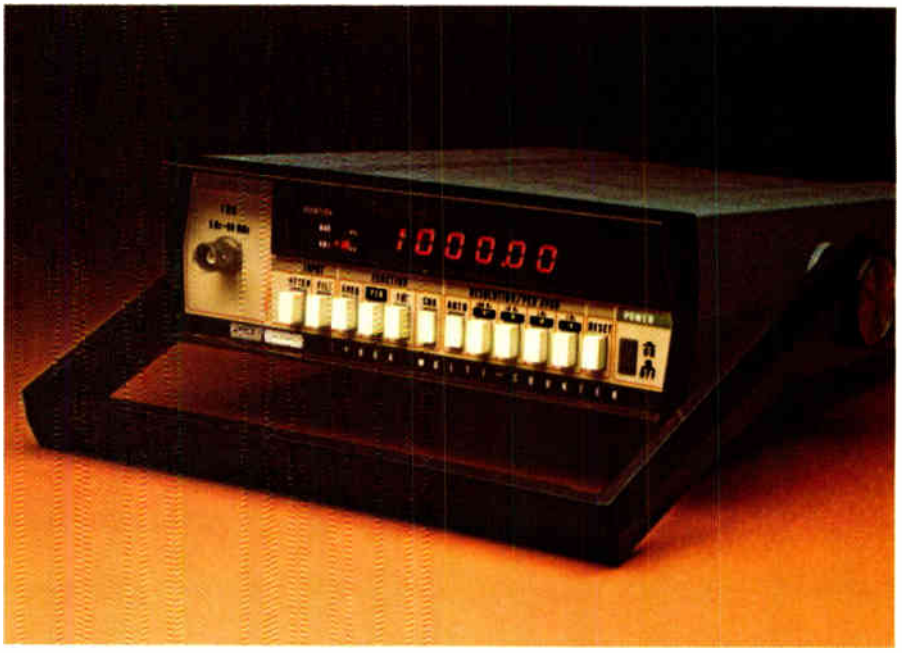

MULTIFUNCTION 1900A COUNTER. FLUKE®

For demonstration circle 76 on reader service card

For literature circle 77 on reader service card

BEFORE YOU GO BACK TO THE BENCH, TAKE A LOOK AT WHAT YOU SHOULD FIND THERE.

Fluke spends a lot of time paying attention at test and measurement benches across the industry.

Out of what we hear, we develop new products.

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The Fluke 6010A Signal Generator incorporates a microprocessor for free-form entry of frequency in Hz, kHz, or MHz. The unit stores and recalls up to ten frequencies, modulation, and attenuator settings by pushing a single button—a feature unique in signal generation.

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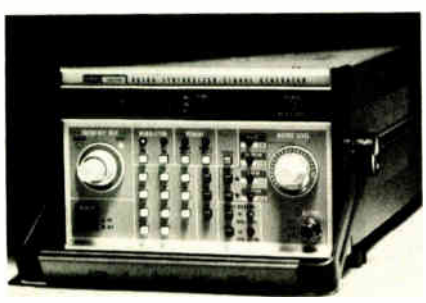
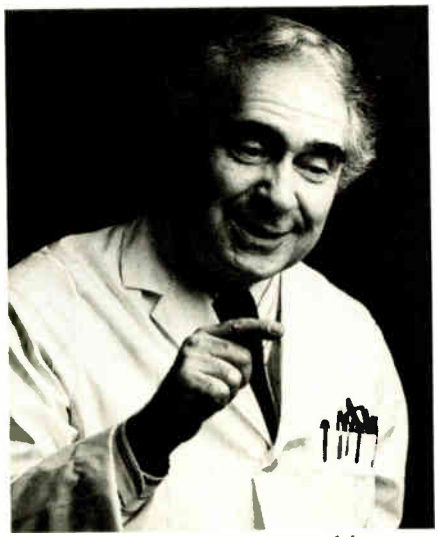
Put this intelligent, amiable fellow to work for you for only $2495*.



6010A Signal Generator



"I'll take one of those. And one of those, too!"

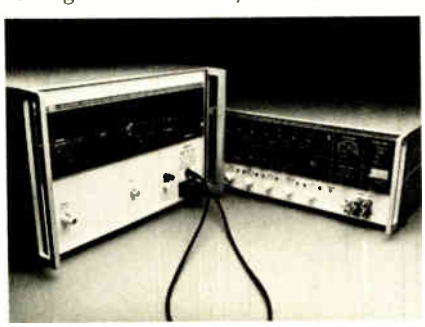
Keep up the standards on the bench.

From Fluke. A fully programmable ac cal setup with range, stability and accuracy that's hard to beat for the price.

Together, the 5200A Precision AC Calibrator and the 5205A Precision Power Amplifier can calibrate ac devices up to 1200 volts rms. Frequency range is dc to 1.2 MHz. DC output of 1600 volts is available. Maximum output current is 200 mA and will drive a 1500 pF capacitance load. Long-term stability is 200 ppm/ 6 months, midband accuracy is 0.02% overall, and response is a fast 0.5 sec.

Both instruments are short-circuit proof, fully guarded and interlocked. Phase lock availability and quadrature output are standard features.

The system interfaces easily with almost any system. Field installable serial and parallel isolated programming options are available. This unbeatable team goes to work for you for $8990*.

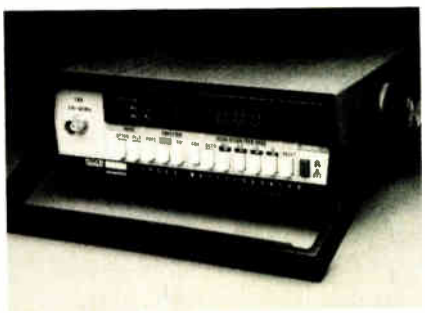


5200A AC Calibrator and 5205A Power Amplifier

Basic counting.

A new Fluke multi-function counter, the 1900A features autoranging in both frequency and period modes, with 20% hysteresis to eliminate annoying range switching. There's leading zero suppression and autoreset in all functions for easy and correct readings every time. A large 6-digit LED display with automatic range of 5 Hz to 80 MHz. Exceptional sensitivity of 25 mV (typically 15 mV). Event counting to 10^6 counts. Signal input conditioning. Frequency. Period. Totalize.

At only $375*, you could say we've stayed close to the basics.



1900A Counter

Shhhhhhhhhh.....

Are you doing NMR or microwave spectroscopy? Be quiet about it. Use the new Fluke 6160B Frequency Synthesizer with the best signal-to-noise ratio available and a guaranteed spurious spec of greater than −83 dB. A range of 1 to 160 MHz with 1 Hz resolution, and from 1 to 20 MHz the spur spec is −100 dB. BCD programmable frequency control. Switching speeds less than a millisecond. Modular construction for custom tailoring to your needs. And all of this quiet costs $5895*.

6160B Frequency Synthesizer

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For demonstration on the 1900A circle 230
For information on the 5200AAC circle 231
For demonstration on the 5200AAC circle 232
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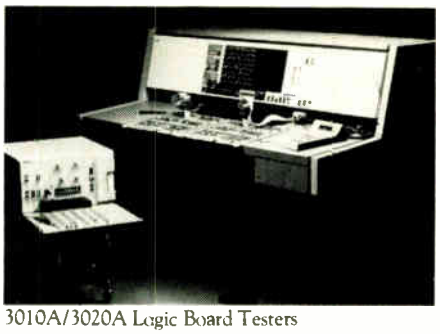
For demonstration on the 6160B circle 236



3010A/3020A Logic Board Testers

Common sense logic board testing.

With the Fluke Trendar 3010A/3020A testers, you can perform logic board testing without software, programmers and lots of money.

The 3020A is a console for high-volume production applications. It comes complete with 128 pins for under $30,000*. The 3010A is a compact version for field service and low-volume production at less than half that price.

The test engineer doesn't program in the conventional sense. He simply develops a test plan which consists of selecting the appropriate stimulus algorithm for each input.

And once the test program is entered into memory, you can record it easily on a handy little magnetic credit card that looks exactly like those credit cards in your wallet. The programmed card will function interchangeably with the production Model 3020A, or the field service 3010A.

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Digital thermometers, with options.

Fluke's new series 2100A digital thermometers offer temperature range of −320°F to +3200°F with 0.1° resolution in three models.

And they've got options for maximum versatility.

Like an analog output in four offset ranges, both linearized and isolated. The linearized feature gives direct temperature readings on a strip chart recorder with no interpolation. And because it's isolated, there's no worry about ground loops.

2100A Digital Thermomerer

The 2100A has a digital BCD output that monitors six thermocouple types (J, K, E, T, R and S) and two millivolt ranges: 40 and 400 mV. The unit operates from line, 12V dc or self-contained battery pack (7 hours off-line). And you can expand up to 100 points with the 2150A option.

In addition, these units are rated for a minimum 10,000-hour MTBF, have excellent noise rejection and come in tough, all-metal cases. Prices for the three basic models are $795* (2100A-03, single-point type), $995* (2100A-10, multi-point type), and $1095* (2100A-06, multi-thermocouple type).

5½-digit DVM extravaganza.

Whatever you need in a DVM—Fluke has it. We're the leader.

Let's say you need resolution to 5½ digits. Look at these three instruments.

The 8800A is a ± 0.005%, 200,000-count bench DVM with 1 μV sensitivity. It's light and small, has full guarding and autoranging, and sells for $985*. Accuracy is a guaranteed ±0.01% for 90 days over a temperature span of 18° to 28°C. Five ranges of dc volts from +200 mV to +1200V. Four ranges of ac volts from 2V to 1200V. True 4-wire resistance measurements on all ranges, 200 ohms to 20 megohms, with 3.3V maximum open post voltage. 10,000-hour MTBF. And overload protection of at least 1000V on any ac or dc range, 250 V rms or dc on any ohms range—the best in the industry. A wide range of accessories includes high-frequency probes, high-voltage probe and clamp-on ac current probe. An isolated printer output option is available.

For systems applications, Fluke offers the 8375A. Standard unit measures 5 ranges of dc volts and 4 ranges of true-rms ac volts. Basic dc accuracy is ±0.003%. Basic ac accuracy is ±0.1%. Resistance measurements are made in 7 ranges from 10 ohms to 12 megohms with 100 micro-ohms sensitivity. Fluke's patented Recirculating Remainder A-to-D conversion technique with autozero circuit provides reliable long-term accuracy and linearity. A quick check of all measurement functions is provided by the unique self-test feature. Field-installable systems options include remote control, data output and dc external reference.

The 8400A is the same basic box as the 8375A, with some different features. To the capabilities of the 8375A add ±0.002% basic dc accuracy, plug-in ac, resistance and ac or dc ratio options, switched filter for dc, ac resistance and ratio, automatic settling or time-out delays and serial or parallel data output.

Both instruments, the 8375A and 8400A, offer full autoranging, auto-polarity, 20% overranging, pushbutton selection and 10,000-hour MTBF.

Both sell for $2195*.

**Domestic price only.*

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8800A, 8375A, and 8400A Digital Voltmeters

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DTS 517	5	500V	250V	1.6V	0.25 μsec
DTS 518	5	600V	275V	1.4V	0.25 μsec
DTS 519	5	700V	300V	1.4V	0.25 μsec
2N6573	5	500V	250V	1.5V	0.25 μsec
2N6574	5	600V	275V	1.5V	0.25 μsec
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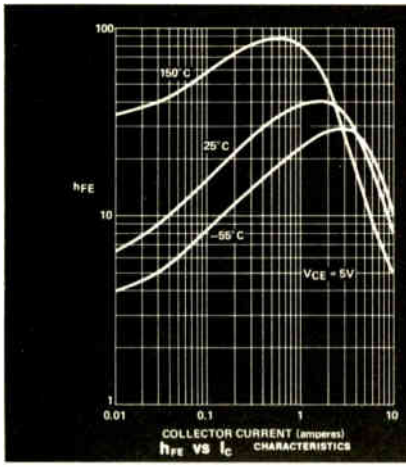
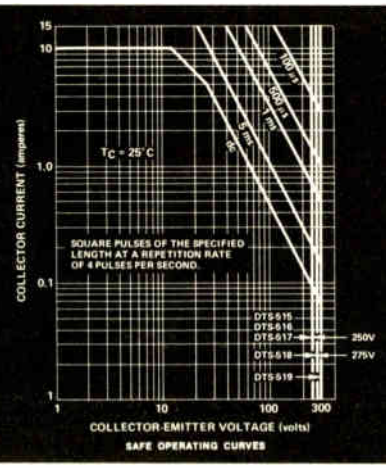
And, of course, these high-energy silicon power transistors come in Delco's solid copper TO-3 packages to ensure low therma resistance.

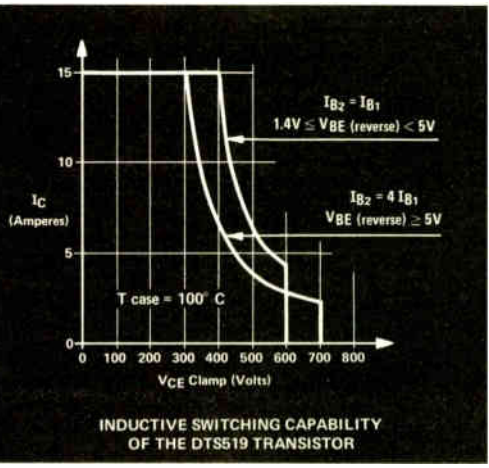
The accompanying curves, charts and circuits tell part of the story. Prices, applications literature and electrical data from your nearest Delco sales office or Delco distributor can supply another part.

But the most important part of the story is how well these new transistors function in your applications.

You can order them today; they're in stock at your Delco distributor's.







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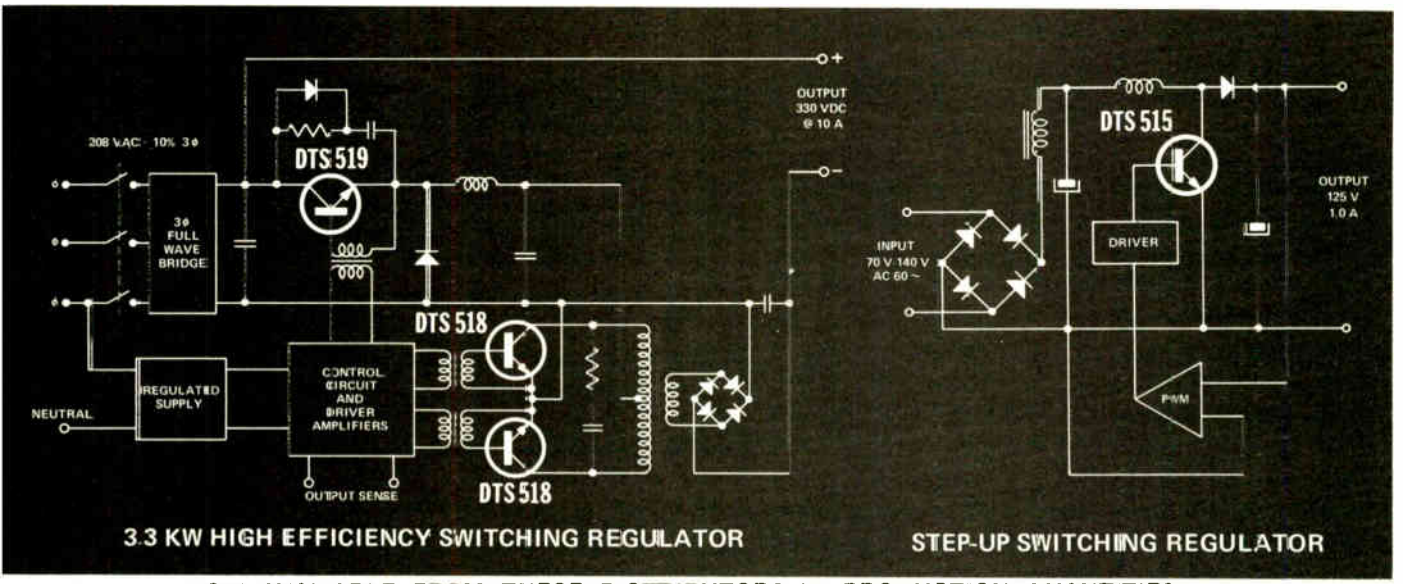

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TOP QUALITY MIL IC'S FROM HI-REL FACILITY

(Left) Rigorous inspection and testing procedures insure compliance with Mil Specs (Right) ITT Semiconductors dedicated High Rel facility in West Palm Beach, Florida

Continuing its commitment to MIL-M-38510 JAN microcircuits, ITT Semiconductors introduces 3 new qualified products. They are the 54H00 high speed quad 2-input positive NAND gate, the 54H04 high speed inverters, and the 5408 quad 2-input positive AND gate.

Results of life tests performed for the Defense Electronic Service Center show that these circuits met all demanding military requirements.

ITT also has received JAN TXV approval for its 2N718A transistor, used in the Dragon missile.

ITT was the first IC supplier to receive full part I approval for MIL-M-38510 by the Defense Electronic Supply Center. ITT now has 44 approvals for TTL, DTL, driver/interfaces, and linear devices – one of the broadest lines of hi-rel digital bipolar ICs in the industry. ITT also has class A certification for digital ICs from NASA, and makes a wide series of JAN TXV and JAN TX transistors and diodes that meet MIL-S-19500.

ITT adheres strictly to these MIL standards at its dedicated hi-rel facility. Circuits and devices are manufactured in West Palm Beach, Florida, starting with raw material and going through packaging, burn-in, and test. Inspections are performed to military standards and methods. There are facilities for government and customer source inspectors as well.

And because ITT realizes that it is important for military contractors to be on schedule, its customers receive weekly open order status reports. These keep the customer up-to-date on all phases of his military device orders and give accurate delivery dates.

In addition to the high level of technical competence, ITT strives to keep its military products price competitive.

Circle #1 for more information.
(Or reader service #210)

ITT makes long term commitment for germanium diodes.

High efficiency, low power devices will never go out of style. That's why ITT Semiconductors continues its long-term commitment to produce 100% US-made germanium diodes in quantity. With over 200 different devices, ITT has the most complete line of 80 milliwatt germanium gold bonded diodes available. It is the number one supplier in the field.

Diode features include inherently low capacitance, low forward voltage drop, and switching time as fast as 10 nanoseconds. Maximum power dissipation is 80 milliwatts and input voltage can range up to 200 volts. The diodes are hermetically sealed in DO-7 glass packages.

The low forward voltage drop means low power consumption – improving available power output – perfect for battery applications. And the diodes' high efficiency characteristics are useful in RF detection applications up to 800 MHz. JAN approved versions are available for military applications.

Circle #3 for more information.
(Or reader service #212)

ITT makes linear and digital consumer circuits for televisions, automobiles, clocks, and audio equipment.

Transistors available in volume.

Need an alternate source for transistors, in volume, now? ITT Semiconductors can meet the demand. It makes a wide variety of small signal planar transistors, in both chip and finished package forms. And they are available in volume, many of them off-the-shelf, an important consideration in this era of extending lead times.

The line of silicon transistors includes general purpose NPN and PNP amplifiers, NPN core and film drivers, NPN high speed switches, and PNP switches and drivers. ITT also offers a wide range of EIA registered and standard plastic transistors in TO-92 packages with lead forming capability. Transistors are also available in TO-18 and TO-5 metal cans.

ITT transistors are suited for applications in the consumer, industrial, automotive, and computer industries.

In addition, popular types are also available to JAN TXV specifications from ITT's hi-rel facility, for use in military applications.

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conductor News

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38510 part 1 approvals.

New ITT memory drivers are fast, Intel-compatible.

Two new high speed MOS memory drivers have joined ITT Semiconductors' line of hi-rel industrial interface circuits. The ITT3207A bipolar-to-MOS level shifter and driver, and the high-voltage version ITT3207A-1, are both second sources for Intel devices.

The circuits are fast; maximum delay plus transition time over temperature with a 200 pF load is 45 nsecs. Both operate from standard bipolar and MOS supplies and have TTL and DTL compatible inputs. Input breakdown voltage is a high 19 volts.

High output current and voltage drives MOS circuits. The 3207A is compatible with Intel's 1103 and 1103A memory chips, and the 3207A-1 with the 1103-1. Both ITT devices come packaged in hermetically-sealed 16-pin ceramic DIPs.

Included with ITT's complete inventory of 86 other interface circuits, these devices represent the company's commitment to continued expansion of the interface line. Samples are available now. All offer superior performance at competitive prices.

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INTERFACE IC CHOICE MADE EASY BY ITT.

ITT Semiconductors' pocket-sized selector card makes it easy to choose the correct interface circuit for any application. The card gives a complete list of ITT's 88 interface circuits, plus part numbers, descriptive information, and type cross-references.

In addition, a chart shows which ITT circuits to use in the four major applications areas. Applications internal to a digital system include semiconductor logic or memory and core memory interface. External applications include line transmission and peripheral interface.

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Special Bulletin

ITT has T²L. Available now. Off-the-shelf.

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Act now to ensure delivery. All ITT T²L devices are pin-to-pin compatible with competitive devices, at competitive prices.

With the wide variety of circuit functions available, both SSI and MSI, and with four different product categories, the designer can find the right device for his application.

The 107 devices in the ceramic/plastic-packaged 5400/7400 series are intended for high-speed, general purpose digital applications.

Higher speed applications call for one of the 37 ceramic/plastic-packaged devices in the 54H00/74H00.

The 9000 series includes 15 different devices supplied in hermetically sealed ceramic packages. There are 10 devices in the complex function devices 9300 series MSI.

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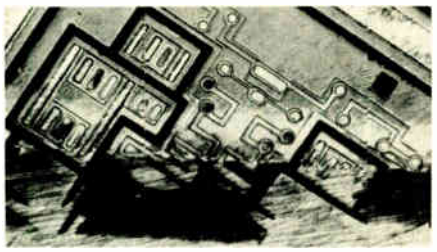
ITT TAKES LEAD IN I²L TECHNOLOGY



An example of the anodized silicon isolation process as used in the new generation of I²L devices.

Integrated injection logic, fast, dense, and simple to build, is emerging as among the most important bipolar LSI processes. And ITT Semiconductors is leading the way in I²L development by extending its capabilities through anodized silicon isolation.

The anodized silicon process, unique to ITT, promises even faster, simpler and denser devices and lowers the cost of production. Its use should extend I²L performance to compete with TTL. ITT is now matching its technology to product needs.

Silicon anodization is a low-temperature process that produces the dielectric to isolate the active elements on a chip in one step. This eliminates the usual, and more costly, two or three step high-temperature device-isolation process.

Performance is improved by lowered capacitance between elements and increased transistor gain and speed. Typically I²L devices with anodized silicon will be significantly faster than n-channel devices.

Anodized silicon I²L devices will have important applications in memories, microprocessors, and many other areas of digital equipment, signal processing, and combined linear and digital applications. Conventional I²L is already being used in products with low current and low voltage applications such as watch circuits with integrated segment and digit drivers.

An I²L design kit for low current applications is now available from ITT. It includes a booklet and a 15 building block product set.

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GAMES

By using large-scale integrated circuits as the basis for ever more exciting video versions of tennis, volleyball, and other games, manufacturers plan to create products with the same huge popular appeal as digital watches

by Gerald M. Walker, *Consumer Electronics Editor*

☐ Yet another large, broad-based market may be opening up in consumer electronics. Following the successful application of LSI technology to calculators and digital watches, the manufacturers of electronic games are about to launch a major drive with more interesting LSI-based video games for both the home and the amusement arcade.

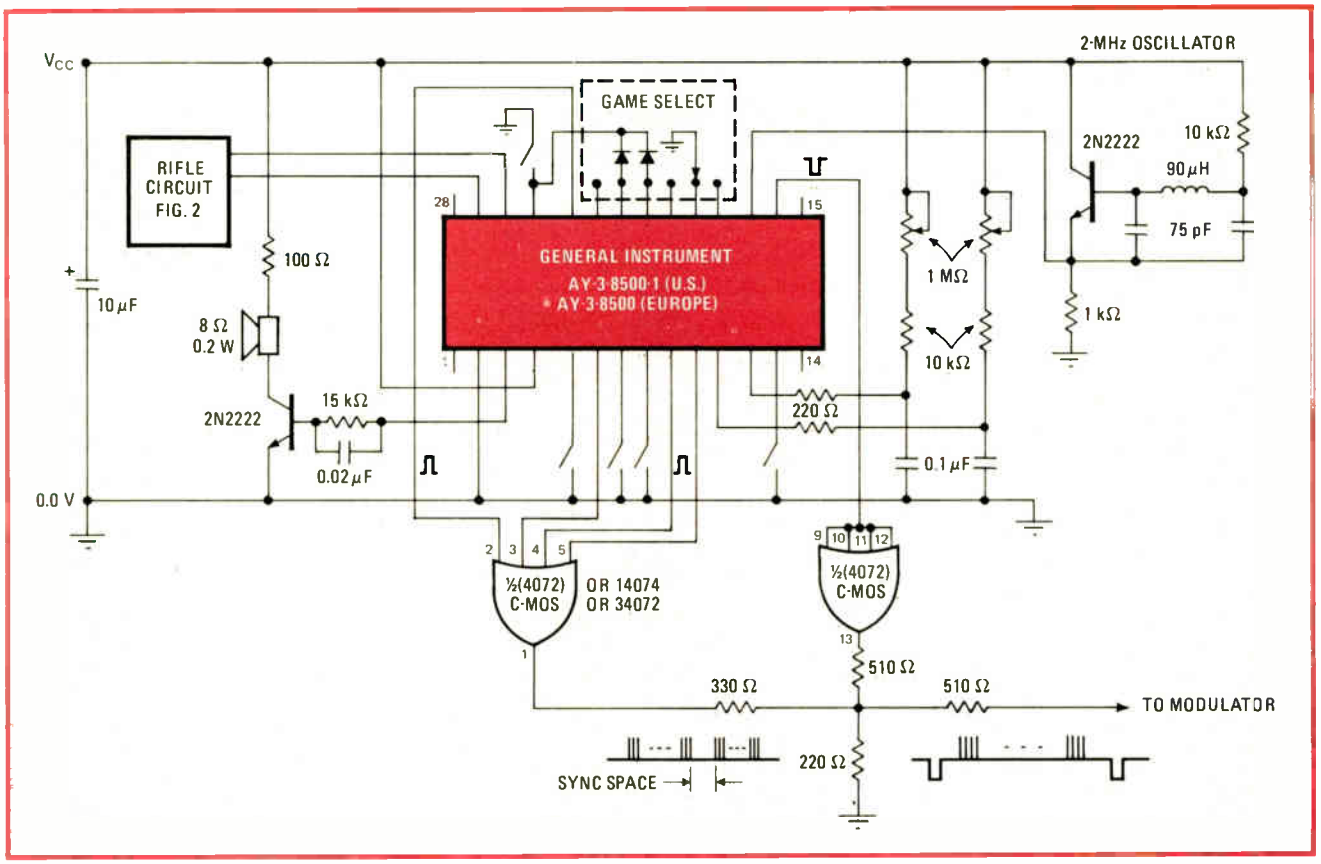
Semiconductors have already begun their invasion of these markets. They're the basis for an entirely new range of products used in conjunction with the home television receiver and costing anywhere between $60 and $120. They have also revolutionized the traditional arcade business by replacing electromechanical functions with electronic ones and by creating new forms of coin-operated amusements. Prices of these games range from $1,200 to $3,000.

Participating companies include both newcomers to the field and established firms, much as in the watch industry since the arrival of the digital watch. The new are the semiconductor houses plus the electronics firms that have sprung up in the last few years specifically in response to the electronic-games market. The old include coin-op pinball- and slot-machine firms and toy companies that are adopting electronics as a tool to serve their traditional interests. Not surprisingly, a couple of TV-receiver companies are using their regular sales networks to sell these new video products, too.

Of the semiconductor firms getting into the game arena in the U.S. and overseas, four in particular stand out. The leading supplier of metal-oxide-semiconductor large-scale integrated circuits for games is undoubtedly General Instrument Corp.'s Microelectronics division in Hicksville, N.Y. National Semiconductor Corp. of Santa Clara, Calif., will also have a game chip in production, and Novus, its consumer-product marketing arm, will have a home video game built around the chip. Intermetall, ITT's West German subsidiary, is coming out with a chip for the European market. And Texas Instruments, Dallas, will enter later this year.

In addition, all of the microprocessor makers stand to benefit from the popularity of video games. Some coin-op machines already contain microprocessors, both 4-bit and 8-bit types, and a few microprocessor-based home games are due in the stores shortly.

In the front line of the battle for the consumer dollar are the new firms grounded in electronics know-how. Some concentrate on home video sales, others are taking on the established arcade- and pinball-machine firms, and still others are setting their sights on both the home and the arcade. However, the makers of the electromechanical arcade and pinball machines have reacted faster to the changes created by electronics than



1. **Play chip.** With General Instrument's n-MOS chip, it is possible to build a six-game video display unit with only a few outboard circuits: an oscillator for clock pulse, two pots for paddle control, loudspeaker, and video processing circuits, plus a video modulator not shown.

happened in the last two semiconductor invasions of consumer markets, both of which took the electromechanical-adding-machine companies and the analog-watch makers by surprise. Perhaps forewarned by this, the established games companies have added electronic R&D and design engineering departments well before they could be swept aside. So between the determined old-timers and the aggressive newcomers, there's going to be quite a contest, one just as interesting as any electronic game available today.

Games people play

What are these games that are causing all this stir? The arrival of the video display games in bars and amusement centers did a lot for getting the business off and running. The first of the solid-state arcade games were basically transistor-transistor-logic machines. In the case of the trivia questions game made by Ramtek Corp., Sunnyvale, Calif., the "software" was a standard audio-tape-cartridge player, "playing" questions and answers on a Motorola television screen.

Atari Inc.'s first paddle-type arcade game was also TTL. Its uniqueness lay in its sound generator, which the Los Gatos, Calif., firm put together from basic computer-generated sound effects. (This kind of electronics expertise has since enabled Atari to snare a large share of both the arcade and the home video game market.)

Other early attractions were the "feel" of the controls and the introduction of two-, then four-, and eventually eight-player contests. Then color was added to the display, and the challenge of the contest increased by programing the game electronics to adapt to the players' skills. With the microprocessor, players will also be competing against the computer in card games and the like, as well as against each other.

Now, besides the paddle and racquet arcade games, there are auto racing games, games of aggression such as sea battles, tank skirmishes, and cowboy shootouts, and games that are just plain wacky such as swimming past a video shark or launching a space ship through a shower of electronic meteors. Another factor affecting this business, unrelated to electronics, is that arcades have been shaking their sleazy reputation and are becoming more respectable hangouts. Many are family amusement centers modelled after the shopping mall.

The first home video game, Odyssey, was introduced in 1972 for a price of over $100 by Magnavox Consumer Electronics Co., Fort Wayne, Ind.—still the only U. S. television manufacturer directly in this business. (Philips, the European TV maker, also has a home video game and later this year will be selling games from its U.S. subsidiary, Magnavox.)

Today, Odyssey is no longer the only game on the block. By the beginning of this month, half a dozen companies had won the Federal Communications Commission's approval of their video games, and applications for over a dozen more were pending (see "Video game makers often outpointed by the FCC," p. 91).

But Odyssey hasn't stood still either. Last year's 200 model added the sound and on-screen scoring that

Video game makers often outpointed by the FCC

A manufacturer's enthusiasm for the lucrative new market in home video games has one tough obstacle to overcome—the Federal Communications Commission. Games that link on to a TV antenna must have approval from the FCC, or else, says FCC chief engineer Ray Spence, they "cannot be turned on—much less sold—which makes them kind of hard to demonstrate, even." Moreover, games for which type approval is still pending must bear labels to that effect.

A few would-be companies have already been sidelined by the commission—two just prior to this month's Consumer Electronics Show in Chicago. According to the FCC, those companies that have had trouble have been careless and failed to follow the established test procedures.

There were more than a dozen new games awaiting a go-ahead a month ago at the FCC's Laboratory division, in suburban Washington. They must be approved as Class I TV devices, conforming to specifications set down in Part 15 of the FCC rules.

For manufacturers, the approval process "is an arduous one," comments John Robinson of the Laboratory division, "since most devices don't comply the first time around." While unwilling to discuss problems specific to individual makers, Robinson says that the commonest fault is excess rf radiation, particularly rf output of the game at the isolation switch box located at the TV antenna.

FCC rules call for a maximum field strength of 15 microvolts per meter at a distance of 1 meter from the receiver. "It is difficult to keep rf off the connection," Robinson explains, "since there is usually a load mismatch between the game and the set. There are usually standing waves on the control cables themselves, even in the outside braided shielding in some cases. Then there is often leakage around the switch, making the output greater and affecting the required 60-decibel isolation."

Applicants could make the type-approval process far less time-consuming, Robinson suggests, by paying more attention to and increasing their shielding, grounding and bypassing of a cable out of the receiver, as well as tightening their bonding processes. "These changes usually are fairly minor and not very difficult to accomplish, but take some work," he adds.

As of mid-May, chief engineer Spence's office had issued 13 approvals for home video games, most operating on channels 3 and 4 at 60 and 72 megahertz. Magnavox now has six type-approved units. Two approvals each have been granted to Coleco Industries, Hartford, Conn., and Universal Research Laboratories, Elk Grove, Ill., while Executive Games, Boston, and First Dimension Corp., Nashville, Tenn., have each received one type approval since the first of the year. Atari Inc. also was issued an approval in April for one game model.

Initial filing fee is $1,500, and subsequent filings are $1,125. Each new model of a home video game requires type approval, even if previous models have met the requirements.

nowadays are essential for sales, and its six ICs produce all the moves needed for the games of hockey, tennis, and smash (handball). Magnavox has maintained from the start the importance of having both vertical and horizontal paddle controls, and its three models for 1977 which are built around integrated-injection-logic circuits, will continue to offer this feature. Like most recently developed games, the new Odyssey line has full color, and the ball or puck is automatically put in play after each point. In addition, the top-of-the-line model 500 generates player figures on the screen, instead of just the usual paddle lines.

Games chips play

It doesn't take much of an investment today to get into the home video games business (though it may take considerable ability to stay in). With the introduction late last year of a single dedicated LSI chip, the guts of a multi-game unit are only a purchase order away, although chip availability is presently limited.

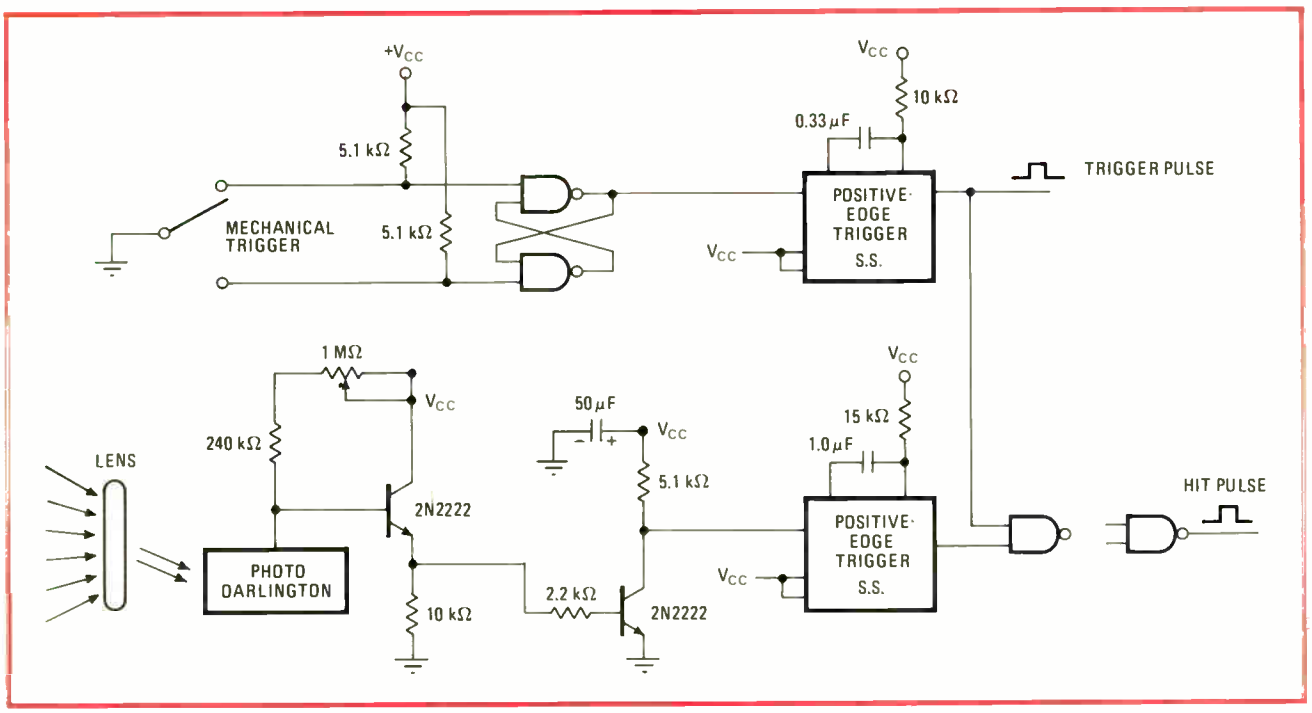
Besides the chip, the would-be games maker needs an oscillator-modulator and a handful of potentiometers and capacitors, plus a case of some sort to house the electronics. A power supply is also needed, whether a battery, a battery plus regulator to extend battery life, or an ac adapter. In addition, the FCC won't approve a game unless it is equipped with an antenna switch to decouple it from the TV antenna when it's not in use. (Home video games have to be attached to the regular TV antenna terminals, in order to play on the screen, but this arrangement makes them a source of rf radiation and therefore subject to FCC regulation.)

A big stride toward getting the home video game market off and running came late last year when General Instrument Corp.'s Microelectronics division announced a dedicated n-channel MOS chip originally designed at its facility in Glenrothes, Scotland. The company now has two versions of the chip, one for use with the 525-line, 60-half-frames-per-second NTSC system in the U.S. and Japan, and the other for the 625-line, 50-half-frames-per-second PAL system in Europe.

The 165-by-175-mil chip contains the logic and controls for six games: tennis, hockey featuring a goalie and a forward for each side, squash, practice (one-man squash), and two types of rifle shooting. It provides automatic scoring and on-screen score display from 0 to 15, and it operates with a real-color generator. A major design demand was that the chip be able to vary the difficulty of the games.

GI has therefore made it possible to select bat (or racquet) size and ball speed and to choose between four different angles of return off the racquets—two at sharp angles at the extreme top and bottom and two at flat angles toward the center of the racquets. In addition, ball service may be automatic or manual—players can control how the on-screen generated ball is put in play after each point—and the device also generates a sound signal, a major feature in today's games.

The chip operates at a 2-megahertz output rate, which is fast for TV but provides better resolution on screen than did the original TTL-based games. Because most game consoles run off batteries, this MOS chip also



2. Bang, bang. One of the circuits available for the GI game chip is a "rifle" for the shooting game. It must be connected to a trigger pulse pin of the chip package to count the number of shots taken and to a hit pulse pin to score the number of shots on target at the screen.

had to be able to maintain this output speed over the wide voltage range typical of any battery-powered instrument.

Once the game chip was designed, testing proved to be "the real challenge in getting it to the market in volume," observes Bernard J. Rohbacher, vice president and general manager of the Microelectronics division at Hicksville. "A game is played in a random fashion, but when you want to test six different games, plus all the variables, with an organized computer-controlled system, you've got a big job." GI's test-equipment supplier, Microdata Corp., Irvine, Calif., designed and built six special test systems and even made them programable so that they will be able to adapt to the next two or three generations of chips.

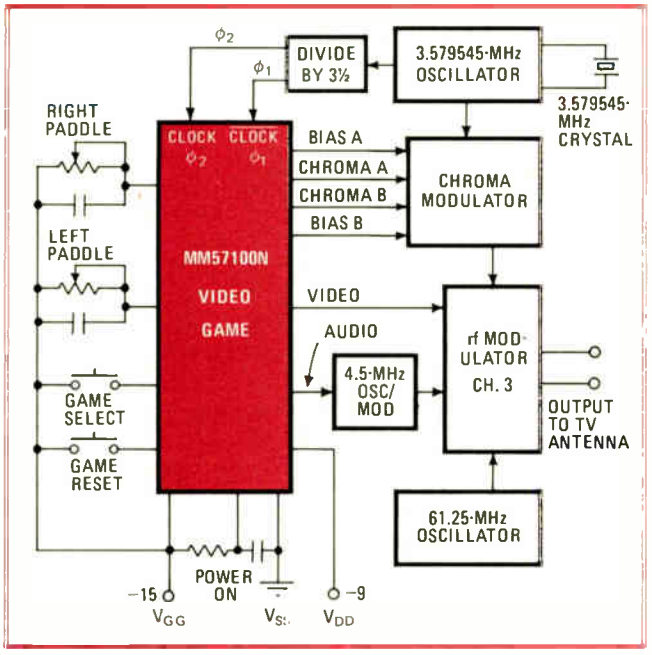
Production of the chip involves all of GI's facilities at home and abroad—not only the ones in Scotland and New York but also the operations in Chandler, Ariz. (purchased originally when Bowmar's calculator business bombed) and on Taiwan, where most of the labor-intensive work is done. Even so, GI admits that it is unable to meet the demand booked.

The games manufacturer who buys the chip has to interface it with other components. He only needs a few, even if the game is quite elaborate. Figure 1 shows how the chip could be used to provide a very simple black-and-white picture game. An oscillator supplies the chip with a 2-megahertz clock pulse. An external loudspeaker and amplifier may be provided for the sound effects or, alternatively, the audio generated by the chip can be used to modulate the carrier transmitted to the TV set. To the right of the chip are two 1-megohm potentiometers used by the players to control the paddle positions. Below the chip, to the left, is a C-MOS OR gate that takes the four video signals from the chip and combines them into one monochrome TV signal. Next to it is a C-MOS inverter for summing the low-impedance sync output of the chip with the video signal before the combination is transmitted to the receiver. Not shown is the required video modulator.

In the rifle shoot, a large target, initiated by the serve switch, bounces randomly about the screen. A photocell in the rifle (Fig. 2) is aimed at the target. When the trigger is pulled, the shot counter is incremented. If the rifle is on target, the hit counter is incremented, a hit noise is generated, and the target is blanked for the duration of the hit pulse. After 15 shots the score appears on screen—total shots and number of hits—but the game can still continue without additional scoring. The rifle circuit must be connected to two rifle pins on the control chip. The trigger pulse is connected to a shot input pin to count the total attempts up to 15, and the photo Darlington sight is connected to the hit pin to record the number of times the rifle was on target when the trigger was pulled. The only other circuits required for the six games are a very-high-frequency modulator—the game chip is designed to operate on either channel 3 or channel 4—and the antenna decoupling switch.

Built-in economies possible

Such a chip could be built into a TV receiver from the start, although American TV set makers are currently showing little interest in doing so. Yet there would be several economies in going this route, says Les Penner, head of MOS design at GI Hicksville. The set maker could eliminate the crystal oscillator, the modulator, the power supply, and the antenna decoupling switch. More importantly, there would be no need for FCC approval, the cause of so much hassle at present, since no rf radiation would be generated outside the set.



3. Colorful player. The National Semiconductor three-game chip due next month has a simple interface with the television receiver. The chroma information phase modulates the 3.58-MHz burst signal before going to the video moculator for transmission to the set.

The game chip designed by National Semiconductor Corp., Santa Clara, Calif., plays three games—hockey (or soccer) plus tennis and handball. It, too, includes a feature that enables the player to adjust the game's complexity to keep the game interesting. Besides the automatic scoring, sound, and serve, this MOS chip is designed to produce true color, has eight-segment paddles to determine the angle at which the ball will rebound upon incidence, and has independently adjustable paddle sizes to provide a handicap if one player is better than the other. In addition, after four successive volleys—determined by the times the ball rebounds off the paddles without hitting the sides—the ball's speed automatically doubles. The ball is always served by the player who has won the last point. It comes 1.6 seconds after a score and is served from the paddle.

The inputs are game select, game reset, left and right paddles, clock time generated by a 3.579545-megahertz crystal through a divide-by-3½ circuit, and power supply voltage. There are just three outputs: a composite video signal (consisting of black and white, blanking, and syncing information), audio information, and chroma information for color (Fig. 3). With the addition of modulators for chroma, radio, and rf, the device interfaces directly to the TV antenna terminals.

Full color is transmitted to the receiver in the same way as in broadcasting, except that the LSI circuit first processes the chroma information in a unique way. Basically, the color signals are treated as two vectors defined by B (blue) − Y (luminance) and R (red) − Y (luminance) labeled A and B respectively. As indicated in Fig. 4, the chip includes a series of field-effect-transistor switches and a resistor matrix. The chip logic is programed to produce the appropriate colors in any portion of the line being scanned. By controlling the switching resistor matrix, it sets up the proper voltage across two output points, which then creates the vectors A and B to produce the desired color signal. Whatever voltages are at A and B, they are fed into a chroma modulator having a stable color transmission frequency provided by the 3.58-MHz crystal oscillator shown in Fig. 3. The signal is then phase-modulated and transmitted to the receiver.

Like the GI chip, the National Semiconductor device could be built directly into a television receiver. In addition, the games maker can choose whether to make a simple or a deluxe model. For example, a high-priced unit could have a separate audio speaker rather than tying into the TV set. For a low-priced unit, the color portion could simply be eliminated to provide a monochrome game. The 3.58-MHz clock could then be replaced by a less expensive R-C 1-MHz oscillator.

Add steeplechase and volleyball

In Europe, ITT's West German subsidiary, Intermetall, has developed a home video game chip that produces soccer, steeplechase, volleyball, and table tennis. TV sets with built-in games are probably going to be made in Europe, and this chip is well suited for this application. Instead of the vhf signal transmission to the TV set, the receiver and the game control box would be connected via cables that transmit dc signals only. For controlling the games, Intermetall is also working on a digital ultrasound command system to execute the functions performed by conventional potentiometers, thus eliminating the dc-signal cables entirely.

In the soccer game, the IC automatically switches between the offensive and defensive roles. But to make the game seem realistic, the ball travels at a horizontal speed that decreases logarithmically until it's returned.

For volleyball, the on-screen field appears as a side view so that the players observe the ball's altitude. A trajectory generator (Fig. 5) controls the ball's path both horizontally and vertically. To add variety to the game, the ball's initial velocity and trajectory may be altered.

The control circuitry for table tennis is the same as that for volleyball, although certain inputs of the signal-generating circuitry must be switched. Triggering then occurs with a vertical synchronization pulse, since the players move in a vertical direction. The IC is also programed to require that the ball bound in the opposing court to be in play.

Ferranti Semiconductor in Great Britain is "very close" to developing yet another game chip using uncommitted-logic-array (ULA) technology—a method of processing a chip leaving unconnected devices that can be interconnected into custom logic patterns with only one layer of metalization. "While other companies are designing custom sets of chips or microprocessors for this market, we've already been delivering ULA-based products to one sector," states Brian Down, sales and marketing manager for Ferranti. This chip, which measures 145 square mils with 187 unconnected cells, allows a designer to connect his own logic cheaply. This device would be for low-volume arcade-type games rather than mass-market home units.

As consumer demand for more sophisticated games

Ping pong or tennis anyone?

The TTL-based video game of tennis or ping pong has hardly changed since the first arcade machines became popular.

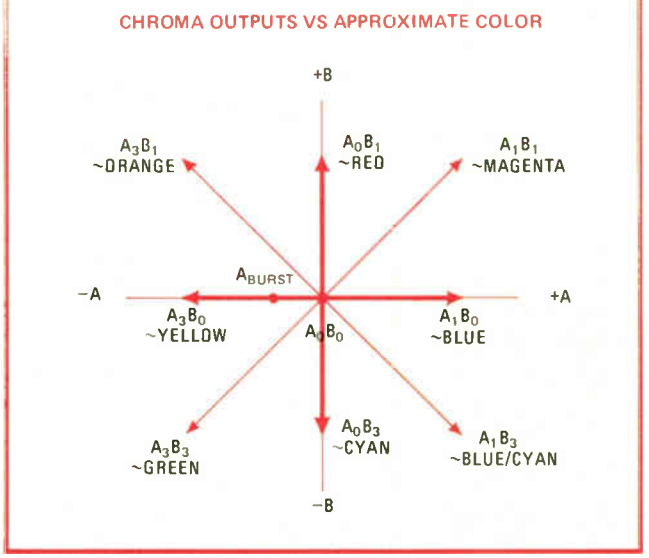
Inside the Atari Pong game, for instance, a power supply provides the correct voltage, and an oscillator produces the master timing signal for the entire system. A horizontal sync circuit divides this clock frequency into clock submultiples, which are variously combined to generate horizontal reset, blanking, and sync. A vertical sync circuit divides the horizontal reset into vertical submultiples for combination into vertical reset, blanking, and sync. The two sync signals are usually combined into a composite sync, the signal that synchronizes the TV monitor with the game logic.

On screen, the stationary images that make up the background are generated by a playfield display section. All other images are generated by an object display circuit and moved around at various speeds by horizontal and vertical motion circuits, which are closely related to the sync circuits.

As for scoring, a storage circuit counts each "unreturned ball," stores the information, and directs a display circuit to present the correct score on the CRT. Some sort of game length circuit—either a timer or a score-counting arrangement—determines when the player is finished and outputs a signal that disables the game.

A sound circuit is operated whenever a point is scored and by such other occurrences in the game as the ball striking a paddle. The sound signals are amplified before entering a speaker although, in the case of a home video game, they could be transmitted to the TV set. All the video signals come together in a video summing network before entering the TV monitor.

CHROMA 1 AND CHROMA 2 OUTPUTS	APPROXIMATE COLOR
A_0, B_0	LIGHT GRAY
A_0, B_1	RED
A_0, B_3	CYAN
A_1, B_0	BLUE
A_1, B_1	MAGENTA
A_1, B_3	BLUE CYAN
A_3, B_0	YELLOW
A_3, B_1	ORANGE
A_3, B_3	GREEN
A_{BURST}, B_0	COLOR BURST



4. Coloring chip. To get true colors with the National chip, the program logic uses vectors A, representing blue minus luminance, and B, representing red minus luminance, so that the proper voltage value appears at the chroma output as each line is scanned.

has increased, the use of microprocessors has become more and more appealing, despite the cost premium. Initially, in the commercial machines whose prices can justify it, and now in home games, the microprocessor is moving into the competition.

Games microprocessors play

Among the first home games with a microprocessor is one that does not necessarily require a video display. To be marketed by Cardinal Industries Inc., Brooklyn, N.Y., the game is a chess simulator. It's built around a Fairchild F-8 microprocessor with a program that stores a chess algorithm developed by second-source Mostek Corp., Carrollton, Texas. The prototype demonstrated earlier this year was packaged in a unit that looked very like a hand-held calculator (Fig. 6).

This prototype is a 2.5-by-4-in. printed-circuit board with the F-8 3850 microprocessor, a 3853 static-memory interface device, a 2,048-by-8-bit read-only memory, a 256-by-4-bit random-access memory, two 7-segment drivers, and an 8-digit, 7-segment light-emitting-diode display that shows the chess moves. (It's also possible to interface the game with a television display showing the board and chess pieces.)

The chess set uses a standard chessboard with each square identified by eight ranks, numbered 1 through 8, aligned vertically along each row of the chessboard, and eight files, lettered "a" through "h," aligned horizontally along the bottom of the board. The keyboard shown in Fig. 6 has eight buttons, each labeled for a letter and a number.

To enter a move, the user presses control keys specifying the from-to squares in terms of ranks and files, giving the letter and number of each square, and then he depresses "Enter." To extract a countermove from the microprocessor, he depresses the "Play" key from 1 to 8 times, thus instructing the processor to analyze the move at ever-increasing levels of complexity—out to a maximum of nine moves and countermoves. The higher the level, the more time the processor requires to come up with a countermove. At the first level, its countermove response is instantaneous. At the second, it may take three seconds. A fourth-level response comes back in about 30 seconds. And at level eight, in the middle of the games, when the number of alternative moves is greatest, the response may take over three hours. If the game were started at the most sophisticated level, it might take two months to complete, says Van Lewing, microcomputers marketing manager for Mostek.

The entire chess game program is executed in 1,000

bytes of memory and was developed by Mostek to demonstrate how easy it is to program the F-8 microprocessor. The chess algorithm is skewed in such a way that the moves are not repeated in exactly the same way from game to game.

"We have not tried to compare the F-8 level of play with that of a minicomputer or a medium-scale computer," Lewing remarks, "but I'll bet the other computers could not play chess using just 1-k of memory."

For children, too

Fairchild Camera & Instrument Corp.'s Exetron division, Santa Clara, Calif., has announced a home video game based on its two-chip F-8 microprocessor. The first five-game console has a digitally encoded tape cartridge containing the game programs. In the complete system, it will be possible to change the games by plugging any of 10 program cartridges into the console—a more flexible arrangement than having a fixed group of games on a dedicated chip. The programs play "Doodle," a drawing game for children, "Shooting Gallery" for adults, and Tic-Tac-Toe, besides the same paddle-and-ball games, complete with sound and color, as are available with the hard-wired LSI-based games.

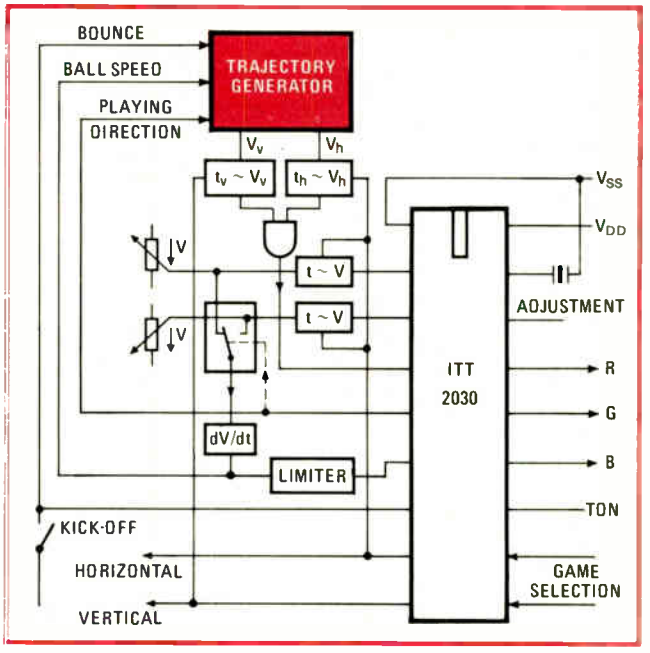
Fairchild plans to pursue the consumer market only, according to E.R. Williams, manager of the games program, because the company "already has channels of distribution in the consumer area." The company will continue to sell components to coin-op manufacturers, however. Also, Fairchild semiconductor components division has already agreed with Mirco Games Inc. of Phoenix, Ariz., to develop a video game for the home, with Fairchild providing a dedicated chip and Mirco designing and marketing the end product. It will be a home version of Mirco's highly successful "Challenge," a tabletop coin-op video game.

Mirco, meanwhile, is using a Motorola MC6800 microprocessor as the brains of its "Spirit of '76" arcade pinball machine. "The microprocessor provides features far in advance of the traditional electromechanical machines," says Mirco president Tom Connors, who was formerly head of Motorola Semiconductor Products Group. "These include all kinds of bonus setups, carrying scores between games, special audiovisual effects, and more."

The pinball machine was introduced in October and first shipped in November, but problems shelved further production until March. Connors attributes the delay to the usual kind of bugs, since ironed out. Mirco is shipping at peak rates now, he says.

Advantages all round

To Bally Manufacturing Corp., Chicago, the appeal of the microprocessor in a coin-op game has already been proven in three important ways. The company's Bally Alley, a bowling game designed around an Intel 4004, has had the largest manufacturing run of any game produced by Bally. Apparently that's because of the player appeal that the game derives from the microprocessor, the low cost of manufacturing due to the reduction in parts count effected by the microprocessor, and the outstanding after-sales service record contributed by the microprocessor's reliability. The 4004 provides the logic needed to make Bally Alley as close to real bowling as possible—the odds for hitting the pins and the hook of the ball as well as the ball's velocity.



5. Video volleyball. The game chip from Intermetall displays the side view of a volleyball game, so that the trajectory generator is needed to establish the altitude of the shots. Table tennis is handled similarly, except the ball must hit the table before it is in play.

"The heart of our product is the design for play appeal of the game. The public doesn't care if it's constructed with state-of-the-art electronics," Ross B. Scheer, director of marketing for Bally points out. "They just want to enjoy themselves."

"We evaluate microprocessors from the point of view of cost, availability, and functions performed for what we need," adds Frank Bracha, assistant engineering vice president. "The microprocessor itself is not the dominant cost in the games, but the added components that have to go along with it—the memory devices, the I/O devices, and so on—to achieve the total capability we need increase the costs."

Bally is going into 8-bit processors and is getting set to enter the consumer games field with a home version of the flipper pinball machine, which will also have an 8-bit processor. The firm's subsidiary, Midway Manufacturing Co., Chicago, has moved into the 8-bit arena with an Intel 8080 used in its Gun Fight video display game. In this game, two figures are displayed on screen. and the players try to get them to "shoot" each other by maneuvering them on screen and pressing trigger controls. Also on screen are images of covered wagons for the figures to hide behind.

The microprocessor was adapted for use with the video display by storing the gunfighter and covered-wagon picture information in a large RAM and reading it out on the screen one bit at a time, while conventional horizontal and vertical deflection circuits generate the raster as in any home TV set. Since the pattern on the screen is 224 horizontal lines, each 256 dots long, the

RAM must hold the 224 by 256 bits of information that determine whether the individual dots are bright or dark, thus depicting the figures moving on the screen.

"Changing to the microprocessor has cut development time by 75%," says T. George Blahuta, engineering manager, "and designing around the microprocessor has increased game complexity by two to five times."

Ramtek Corp., Sunnyvale, Calif., has had a similar experience in converting games from TTL to microprocessor control. To control one video game, for example, in which two airplanes each fired four bullets, used to require four TTL printed-circuit boards and one mother board. A similar but more complex game, built around an Intel 8080A microprocessor, has since been introduced on one pc board—it controls four war ships, four torpedoes and eight mines, plus two islands as obstacles on the playing field.

Now Ramtek is about to come out with another 8080-based game, called Hit Me, in which three players compete against the processor in a game of Black Jack. Cards, randomly dealt, are shown on the screen along with totals, and players can be "hit" by pressing a command button. The processor plays out the game as the "dealer" and lights up the display of the winners.

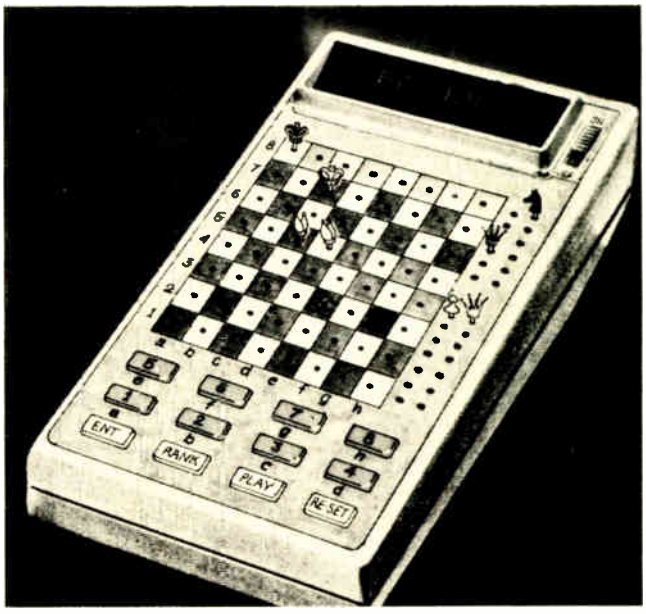
The real payoff of the microprocessor, Charles E. McEwan, Ramtek president, explains, is that game programs can be worked out, field-tested, and changed before the product is released. In a business where variety and rapid changeover mean life or death, it's vital to be able to change a game's characteristics right up to the last minute before going to market.

With the microprocessor, summarizes Donald G. Swatek, president of Electronic Design and Assembly Inc., Tempe, Ariz., "we're limited only by our own imaginations." EDA has just finished designing a new coin-op game around a Motorola 6800 microprocessor. It will have three games in the same cabinet, and the user will be able to reprogram it to a different format.

Beginning two years ago, EDA started shipping its Tele-Tennis, which is a basic paddle-and-ball-type game. After stubbing its toe on a home video game that was far too expensive for consumers, the company has concentrated on coin-op machines. The new player-programable machine, set to sell for $2,500 to $3,000, is undergoing software shakedown for sales later this year.

A difference of opinion

Not every electronic-game company is completely sold on the microprocessor, however. John Chaundry, president of Project Support Engineering Inc., Sunnyvale, Calif., states: "It seems that the reason to use microprocessors is for changeable games. But it's not feasible to change games in the field; you need new controls and cabinets. I don't think you can market an unlimited number of games with the same controls." Therefore, he says, "the microprocessor of today is not really usable in today's games." What is needed, Chaundry claims, is a "semi-intelligent microprocessor—that is, a dedicated design with high speed." The advantage over a standard microprocessor is that "in games there are a limited number of things a microprocessor is required to perform." They don't require



6. Checkmate. Using a Fairchild F-8 microprocessor programed by second-source Mostek Cardinal Industries plans to market a hand-held unit similar to this prototype that will let users play chess against the processor. Players may choose from eight levels of difficulty.

the capacity of general-purpose microprocessor, yet the game manufacturer still has to go through the time and expense of working up all of the software steps.

While most of the interest in using a microprocessor in coin-op game centers on how it will enhance the game itself, yet another factor is important to the manufacturers: controlling the coin operation. But, according to Wayne Koci, solid-state project engineer for Chicago Coin Corp., Chicago, the microprocessor has a tough time outperforming the tried-and-true electromechanical devices for coin control.

Cash validation

Coin control boils down to coin recognition—necessary to prevent coin-op players from cheating—and in coin recognition, relay circuits tend to be more stable than solid-state circuits. That's primarily because of the latter's inability to distinguish between a normal signal and a static charge, Koci explains. So transient noise protection must be designed into the solid-state circuits, tending to complicate the overall coin-op design for determining coin-drop duration.

Fortunately, the situation is improving. Games with solid-state coin controls that have been produced in the last six months are about 98% static-free, compared to 10% to 15% three or four years ago. Nevertheless Koci fears that coin-circuit reliability will still be less than 100% with a microprocessor.

Despite the reservations about the role of the microprocessor in today's games, the future appears to belong to them—not to the general-purpose types available now, perhaps, but certainly to a customized programable device. Chaundry of Project Support Engineering predicts: "The microprocessor will remove animation in games from its infancy. What we're headed for is a real picture on the screen." □

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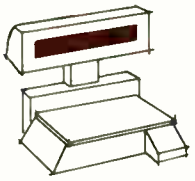

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MOS moves into higher-power applications

V-groove structure enables family of field-effect transistors to handle up to 25 watts with linear output and high impedance

by Marvin Vander Kooi and Larry Ragle
Siliconix Inc., Santa Clara, Calif.

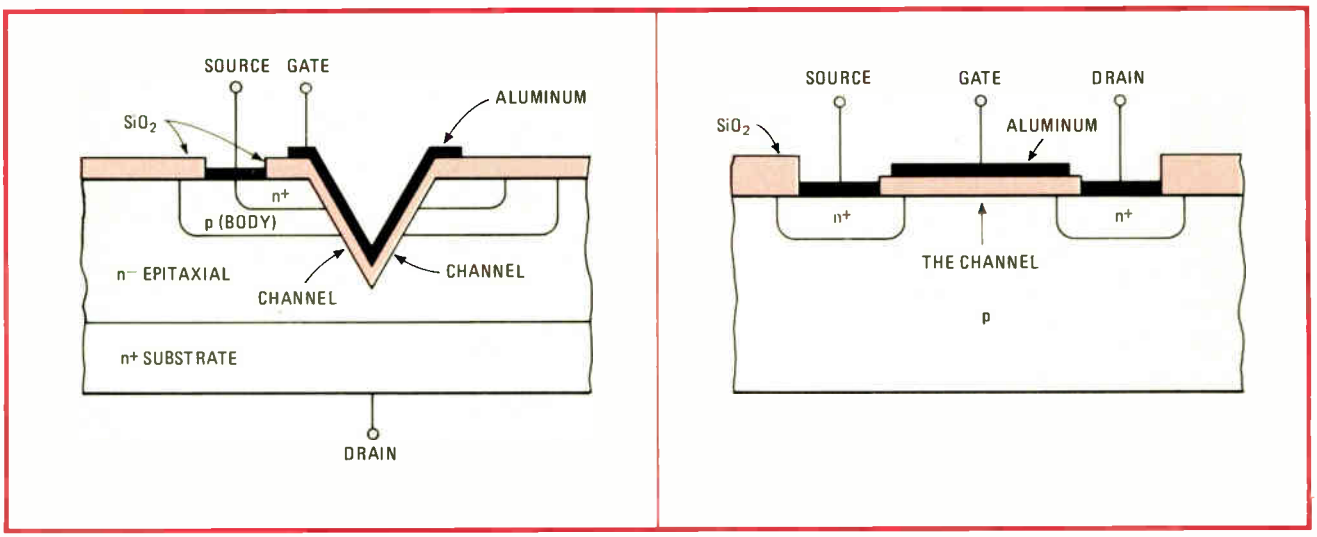
☐ Metal-oxide-semiconductor technology, heretofore considered only applicable to small-signal, low-power devices is now ready to take on higher-power chores. Applied exclusively to low-power circuitry, it has provided a combination of performance advantages and low cost in logic and memory. Now a new version, V-MOS, for vertical metal-oxide semiconductor, brings these same advantages to power applications.

Families of V-MOS power field-effect transistors with 10-ampere current-handling capability, breakdown voltages of up to 200 volts, and on resistances of a fraction of an ohm will appear later this year. Right now power MOSFETs that can handle up to 25 watts and switch 2 amperes are available in TO-3 power transistor packages, TO-39 cans, or a ceramic flange-mounted stripline package for higher frequency use. They are available with typical breakdown voltages of 35 V with an on resistance of 1.4 Ω, 60 V at 2.2 Ω, and 90 V at 3.4 Ω. And advances in this technology will soon bring 400-V devices with much higher wattage ratings.

V-MOS gives high current density and linear transfer characteristics over a wide range of current, high source-to-drain breakdown capability, and low gate-to-drain feedback capacitance—characteristics simply not attainable with conventional MOS transistors.

Added advantages

Bipolar transistors, which are current-controlled minority-carrier devices, have been the only solid-state linear power devices available. V-MOS power field-effect transistors, which are voltage-controlled majority-carrier devices, have many advantages. They have a much higher input impedance because of the lack of conduction path between the gate and the channel, fast switching speed because of the absence of minority carrier storage, and no secondary breakdown because their negative temperature coefficient limits excessive drain current. Moreover, their transfer characteristics are linear from 400 milliamperes to over 2 amperes—essen-



1. In the groove. Current travels vertically through the four layers (n+, p, n−, and n+) of a V-MOS transistor, whereas conventional metal-oxide semiconductors are lateral structures having only three regions (n+, p, and n+). V-MOS current handling capability is much greater.

tial in linear power amplifiers. V-MOS technology combines these advantages in a practical power device and thus opens up a new degree of freedom for design engineers.

V-MOS technology results from knowledge of metal-oxide semiconductors and bipolar processing. The first step is to diffuse channel and source regions in a fashion similar to the base and emitter diffusions in bipolar transistors. Then a V-shaped groove is etched through the channel and source regions, using an anistropic or preferential etchant to assure precise dimensions. These dimensions are determined only by the width of an oxide window and the crystalographic structure of silicon. The process is completed by growing silicon dioxide over the V-groove gate region and then applying metalization.

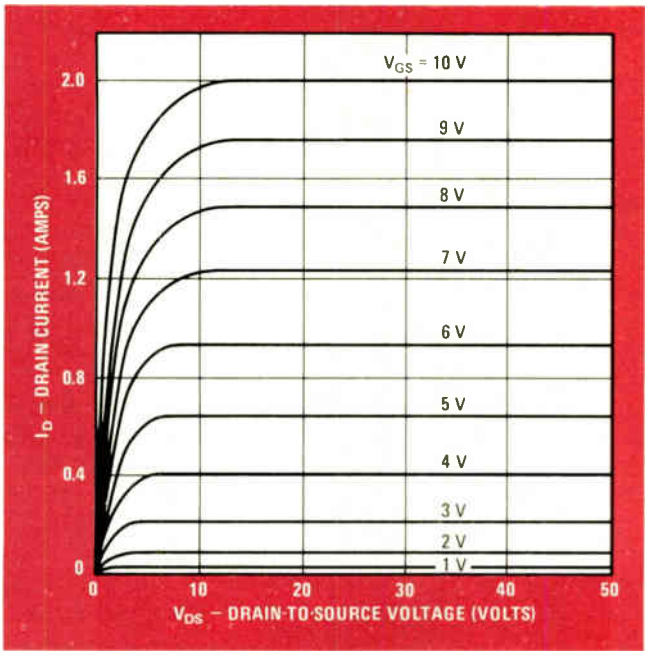
Vertical travel

Current travels vertically in the semiconductor chip; hence the "V" in V-MOS. A cross section (Fig. 1) shows the four layers—n^+, p, n^-, and n^+—whose critical dimensions are controlled precisely by diffusion processes. Conventional MOS transistors are lateral structures with less well-controlled dimensions, since a photolithographic fabrication process is used. Furthermore, such structures have only three regions—n^+, p, and n^+. The four-layer construction and vertical features of V-MOS provide power transistors with the tight tolerances needed for high-performance power devices.

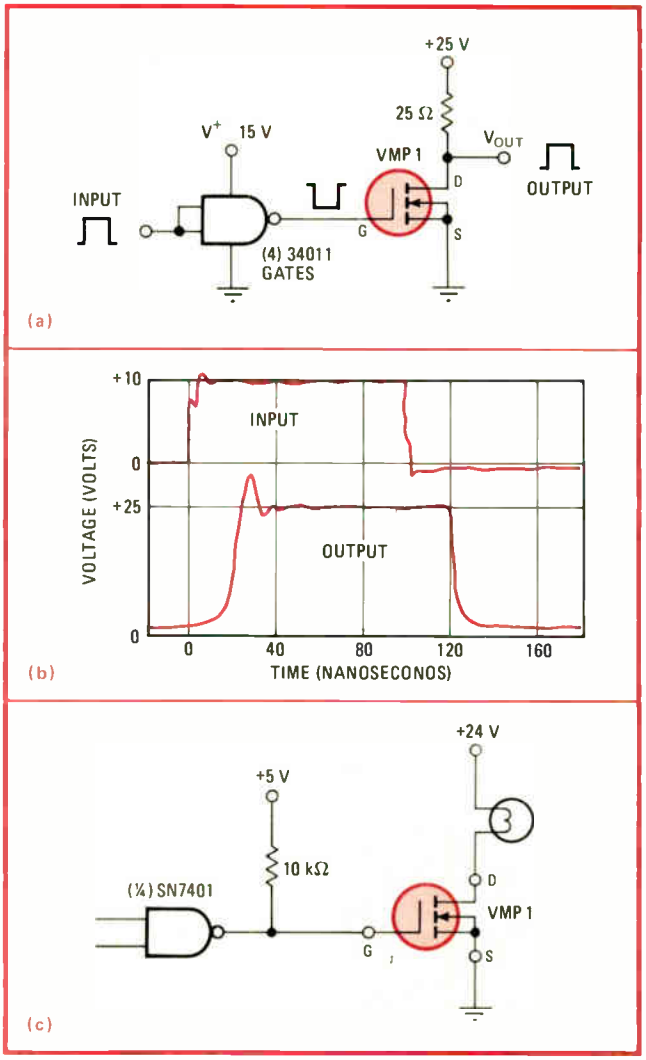
The high density of V-MOS results partly from the short channel spacing, which is about 1.5 micrometers compared with 5-μm spacing of state-of-the art conventional MOS transistors. In addition, each side of the gate groove increases the current density, because two current paths are available for a single gate finger. Still another factor aiding the high current capability is location of the drain on the back of the chip, where it does not take up valuable silicon area.

The high breakdown voltage and low feedback capacitance of V-MOS result from the extra n region. The relatively low impurity concentration of that region allows the channel-drain depletion region to spread out into the drain, reducing the peak electric field across the junction and thereby increasing the breakdown voltage capability. The gate-to-drain capacitance of the V-MOS device is reduced by the buffering effect of the depletion region.

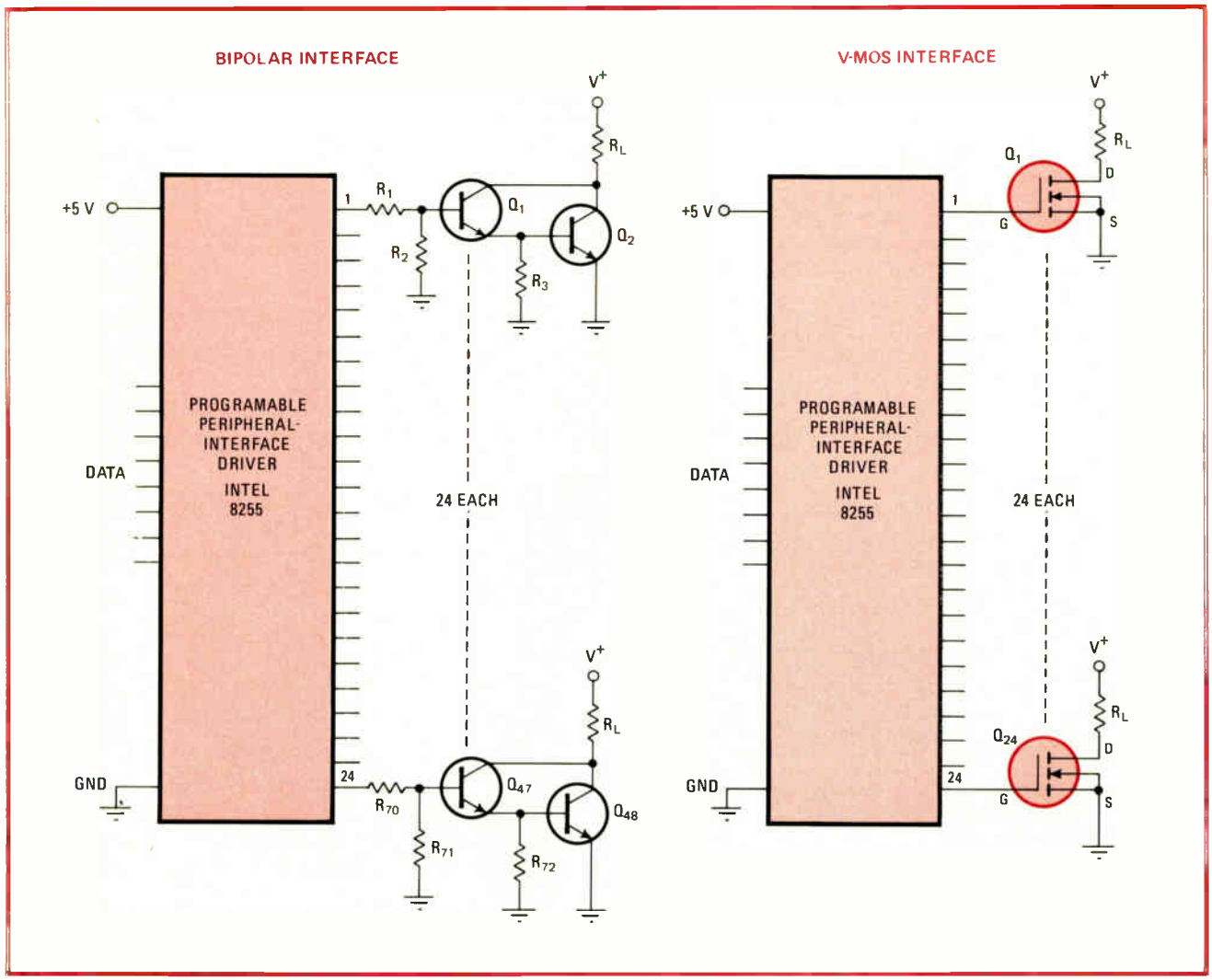
Still another important feature of V-MOS is the linear relationship of drain current and gate voltage over a wide range of drain current. Conventional MOS transistors are "square-law" devices in which the drain current is proportional to the square of the gate voltage. In V-MOS, however, a short channel length causes a carrier-velocity-saturation effect, which, in turn, causes a linear relationship between the drain current and the gate



2. Linear operation. The short channel length of V-MOS produces a carrier saturation effect, which, in turn, results in a very linear drain-current versus gate voltage relationship.



3. Logic compatible. Four paralleled C-MOS logic gates provide sufficient drive to turn on the 1-ampere V-MOS FET switch (a) in 20 nanoseconds (b). Using only a single logic gate increases switching time to about 50 ns. Open-collector TTL logic can easily turn on the V-MOS FET driving the lamp circuit in (c). In such applications the TTL pull-up resistor can range from 1 kilohm to 100 kΩ.



4. Cutting components. Twenty-four V-MOS FETs replace twice as many bipolar transistors and 72 resistors and cut power consumption from 240 milliwatts to 1.2 microwatts in the interface circuit used to drive power control devices such as printers, solenoids, and actuators.

voltage above about 400 milliamperes (Fig. 2).

With a vertical structure akin to the conventional bipolar transistor, V-MOS offers the advantages of high voltage breakdown, high-current capability, and high-frequency operation without the performance disadvantages of bipolars.

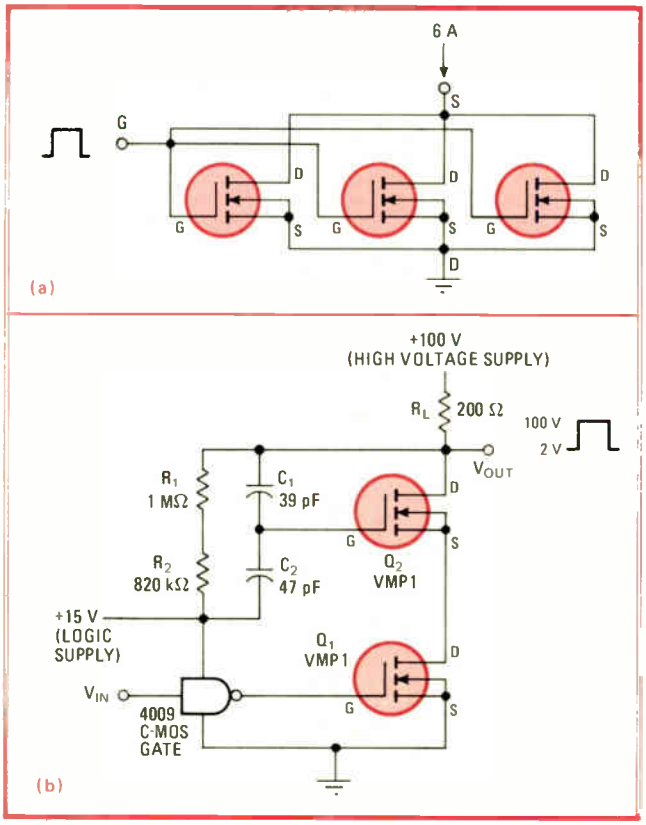
Better switch

The power MOSFET offers several significant advantages for high-power, solid-state switching. A typical device such as the VMP 1 can switch 1A in 4 nanoseconds, more than 200 times faster than a Darlington bipolar transistor of equivalent size. And with an input resistance of 1000 megohms, the V-MOS FET requires no special high-current drive circuits or amplifiers to buffer it from the complementary-MOS logic-gate drive circuits.

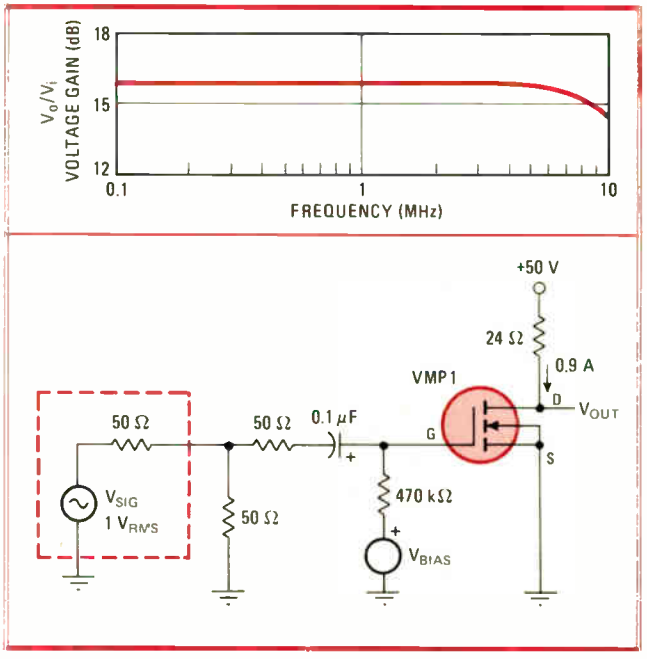
Since it is an enhancement-mode device, a 0-V input will turn off the device (leakage current is less than 0.5 microampere). With a 10-V gate voltage, it will support a guaranteed minimum drain-to-source current, I_{DS} of 1 A with a 2-Ω on resistance, r_{DS}. Switching on a bipolar transistor in less than 1 microsecond takes at least 200 mA, and then it must be driven with a negative voltage to turn off quickly. But the power FET with its high input impedance needs practically no current at all. Only microamperes of drive current are needed to charge the input capacitance of about 40 picofarads to turn it on in less than 1 μs.

The simplicity of logic-compatible high-current switch designs (Fig. 3) using V-MOS FETs eliminates the need for external resistors usually required for input current limiting, pull-up, or leakage protection. The input waveform to the logic gate drives the output waveform full on in typically 20 ns (Fig. 3b). If a single 4011-type C-MOS gate were used instead of four, the delay would increase to about 50 ns because of the reduced drive available to charge the 40-to-60-pf input capacitance of the VMP 1.

Open-collector transistor-transistor-logic circuitry can be used to drive the FET in much the same manner as in the lamp-driver circuit of Fig. 3c. Decreasing the value of the 10-kilohm TTL pull-up resistor will speed up the circuit slightly. However, for lamp applications such as these, any value would be adequate if enough power were available. A 1-kΩ resistor would draw 1 mA; a 100-kΩ resistor would draw 50 μA.



5. Up the power. Paralleling several power FETs for increased current handling capability (a) requires no additional components to assure equal current sharing. And two power FETs connected in series (b) greatly increased high-voltage capability.



6. Broadband linear gain. A single VMP 1 power FET provides a voltage gain of 16 dB from dc to 10 megahertz. Harmonic distortion varies from 0.075% at 1 V_{rms} to 0.8% at 10V_{rms}.

Replacing bipolar transistors with power MOSFETs can greatly reduce the components needed, thus increasing reliability. Consider the circuit in Fig. 4, which uses an 8000 series programable peripheral-interface-driver circuit designed for an 8080-type microprocessor to control printers, solenoids, displays, actuators, etc. Seventy-two resistors and the 48 bipolar transistors can be replaced by 24 V-MOS devices.

The much higher 1,000-mΩ input impedance of the FET cuts circuit power consumption. Each of the Darlington pairs of bipolar transistors requires 2 mA of drive current. At a supply voltage of 5 V, the bipolar circuit would draw 240 milliwatts of power. Assuming as much as 10 nanoamperes of leakage current in each of the FETs, the total circuit would draw 240 nA at 5 V, or only 1.2 microwatts.

Handling higher current

When more than 2 A must be switched, two or more power FETS can be paralleled. This is as easy as paralleling C-MOS gates for greater drive capability. Moreover, special precautions aren't needed to insure an even distribution of load current among devices. The positive temperature coefficient of the drain-to-source resistance limits excessive current by any one device effectively. The negative temperature coefficient of bipolar devices tends to do just the opposite. It increases current flow in the hottest devices because the resistance of bipolar transistors drops with increasing temperature. This causes a thermal runaway condition, which causes the device to fail very quickly.

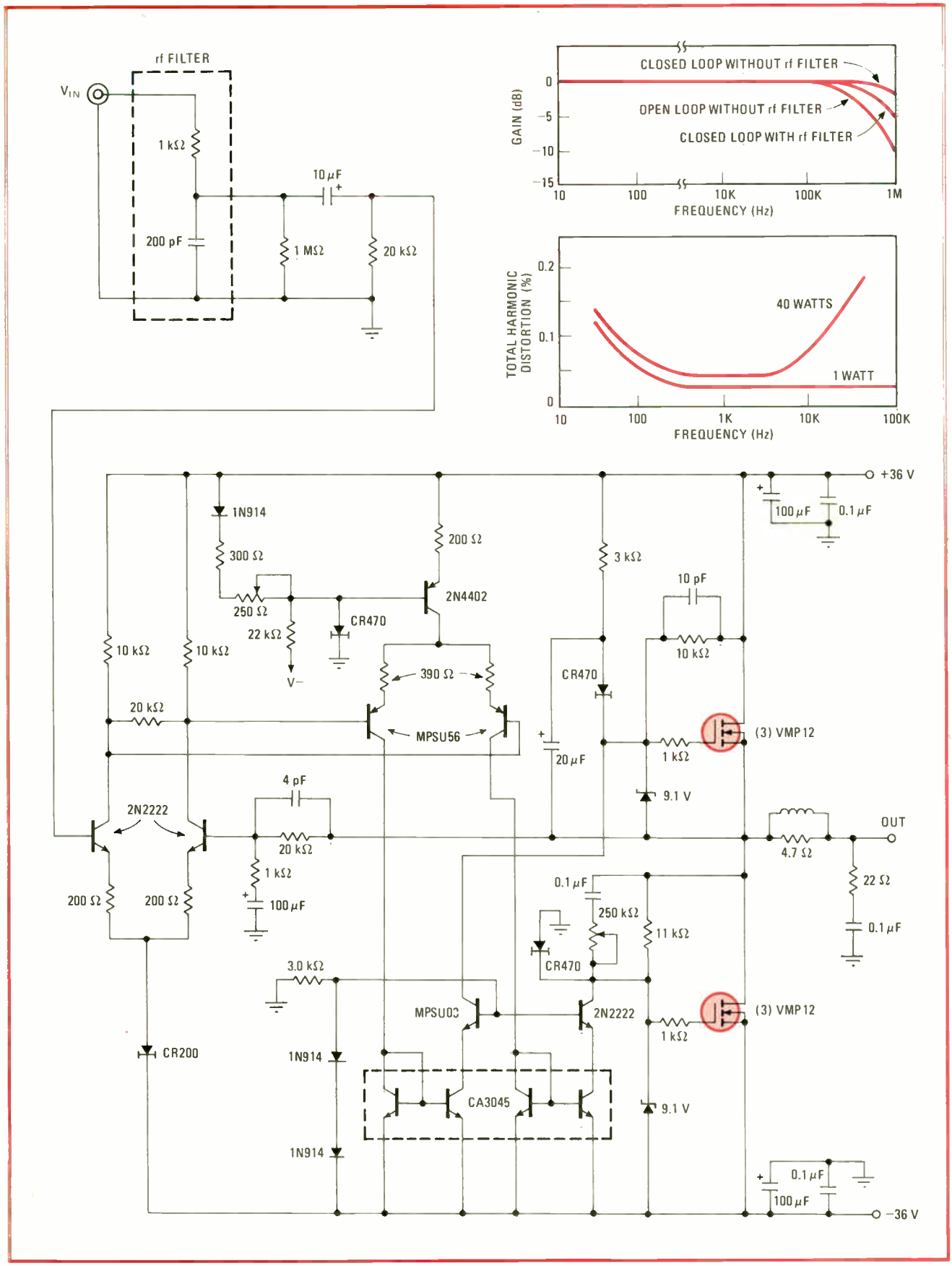
The circuit of Fig. 5a illustrates the simplicity of paralleling three VMP 1 2-A power FETs to form a 6-A switch without any external components. That circuit, or one paralleling six devices for a 12-A switching capability, could be driven from a single 4000-series C-MOS gate, sacrificing only switching speed.

In applications requiring higher-voltage operation than a single power FET can handle, several devices can be connected in series (Fig. 5b). In the on condition the gate of Q_1 is at +15 V with a drain voltage of about 1 V because of its $I_{DS} \times r_{DS}$ drop from drain to the source of Q_1. Transistor Q_2 also is on because of its positive gate voltage. The voltage divider, resistors R_1 and R_2, apply 55% of the +15-V supply to the gate of Q_2 and, considering the +2-V drain along with the 1-V on the source, produce a very adequate +8.15-V enhancement to Q_2—turning it on hard. In the off condition, the gate of Q_1 is held at ground by the C-MOS logic gate and less than 1 μA of current flows through Q_1.

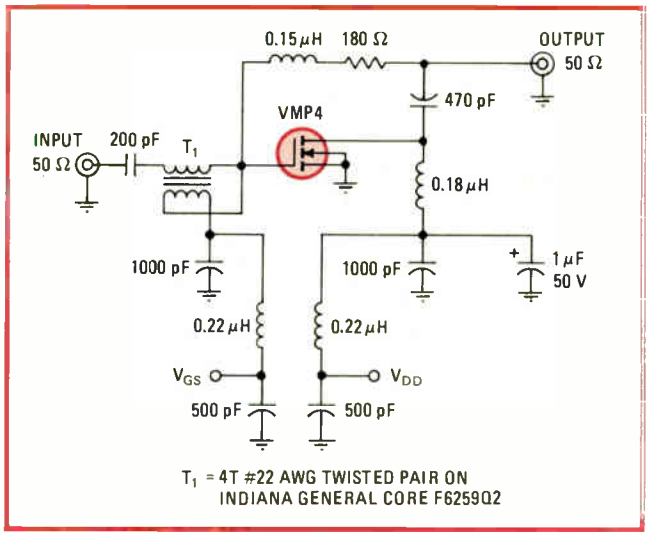
The resistive voltage divider now sees the 85-V differential between the high voltage supply and the logic supply. This places the gate of Q_2 at about +53V. Q_2 then acts as a source follower supporting only microamperes of drain-to-source current. Therefore its gate-to-source voltage is essentially 0, which causes a 53-V drop across Q_1, with the remaining 47 V dropped across Q_2. This distributes the high-voltage fairly evenly between both FETs.

To assure this voltage division is maintained under transient conditions, the value of capacitors C_1 and C_2 is chosen to make the R_1C_1 and R_2C_2 time constants equal. And the values of these capacitors are large enough to balance the input capacitance of Q_2.

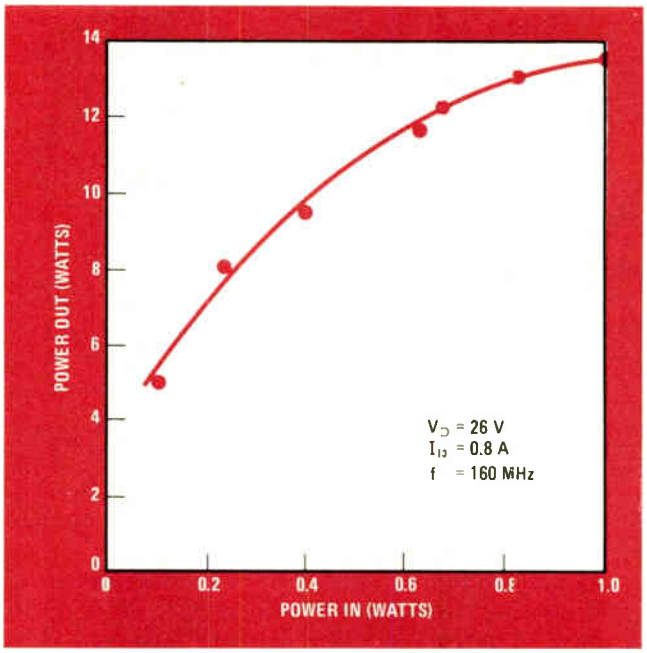
The current-handling capability of a three-phase mo-



7. High quality audio. One channel of an 80-watt stereo amplifier uses six power FETs in a push-pull arrangement. A total harmonic distortion of less than 0.04% is achieved with only 22 dB of negative feedback, compared to about 40 dB usually used with bipolar transistor stages.



8. Wideband vhf amplifier. A single VMP 4 rf power FET delivers 12 watts into a 50-ohm load from 40 to 180 MHz and can work into an infinite-load voltage-standing-wave-ratio without damage and without the need for any special protection circuitry.



9. Drive dependent. The in-band power gain of the amplifier circuit of Fig. 8 is a function of input power to the stage. Although in the curve above, the power gain is plotted at a frequency of 160 MHz, it's typical for any frequency within the amplifier bandpass.

tor control may be extended simply by adding extra power FETs in parallel with the original ones. Since these power switches are directly logic-compatible and have high input impedance, it is quite feasible to have 2-, 4-, 6- or 8-A pulse-width-modulation constant-torque motor controls operating from a single 4000-series C-MOS gate driving each leg. And the low switch-drive requirements have the added benefit of allowing the upper legs to be driven with low power optoisolators rather than with bulky pulse transformers.

Linear applications abound

For analog circuits, the V-MOS FET has several advantages. Its current gain is essentially equivalent to that of an infinite-beta bipolar device because of the approximately 1,000 mΩ input impedance. It has a 600-megahertz unity-gain frequency response because of the majority-carrier field-effect mode of operation. The highly linear gain characteristic at drain-to-source current from 400 mA to 2 A make it useful in linear power applications.

Perhaps the simplest analog application of V-MOS FETs is as a switch. A low-resistance analog switch has from 1.5 to 3 ohms of on resistance, depending on device type, for signals of from 0 to 10 V. The off leakage current is less than 0.5 μA. Since the body of a 3-lead power package must be connected to the source of the FET, the analog current should always be made to flow from drain to source. Reverse current flow would encounter the forward-biased pn diode existing from body to drain.

The test circuit and frequency response of the circuit in Fig. 6 show the simple circuitry needed for a dc-to-10-MHz broadband amplifier. The VMP 1 under test has a transconductance, g_m, of approximately 0.27 mhos and, with a 24-ohm load, provides a circuit gain (g_m × load resistance R_L) of 6.5. The total harmonic distortion for this circuit varies from 0.075% at 1 V_{rms} output to 0.8% at 10 V_{rms}.

These devices make high-quality audio amplifier stages. An 80-watt stereo amplifier (one channel shown in Fig. 7) uses six power FETs in a push-pull arrangement. Harmonic distortion is as low as 0.04% using very little negative feedback for a frequency response within 3 decibels from 1 hertz to 800 kHz. Only 22 dB of feedback were needed with the FETs, whereas 40 dB are usually used with bipolar transistor stages.

The distortion, which depends on the output power, is shown for various combinations of open and closed loop operation, with and without rf filtering. An extra bonus when using the FETs is that the output of the amplifier is inherently short-circuit protected and free from secondary breakdown and thermal runaway.

Higher frequency use

The same chip geometry is available in an rf family, the VMP 4, which uses flange-mounted stripline techniques. Again, its very high input resistance and lower input capacitance, compared to an equivalent bipolar transistor, makes it useful in the design of vhf broadband power amplifiers.

For example, a single power FET used in the circuit in Fig. 8 has a power gain of 15 dB flat to within ±1 dB from 40 to 180 MHz—not easily achieved with equivalent bipolar power transistors. The circuit can deliver 10 to 12 W into a 50-Ω load, depending on input (Fig. 9). A key feature is the circuit's ability to withstand infinite-load voltage-standing-wave ratios without any special circuitry power.

These V-MOS devices are the first in a growing family of power MOSFETs that should prove extremely useful in solid-state power switching and linear power designs. They should find use in both new designs and as retrofits for older designs. □

Auto intrusion alarm uses C-MOS circuits

by F. E. Hinkle
Applied Research Laboratories, University of Texas, Austin, Texas

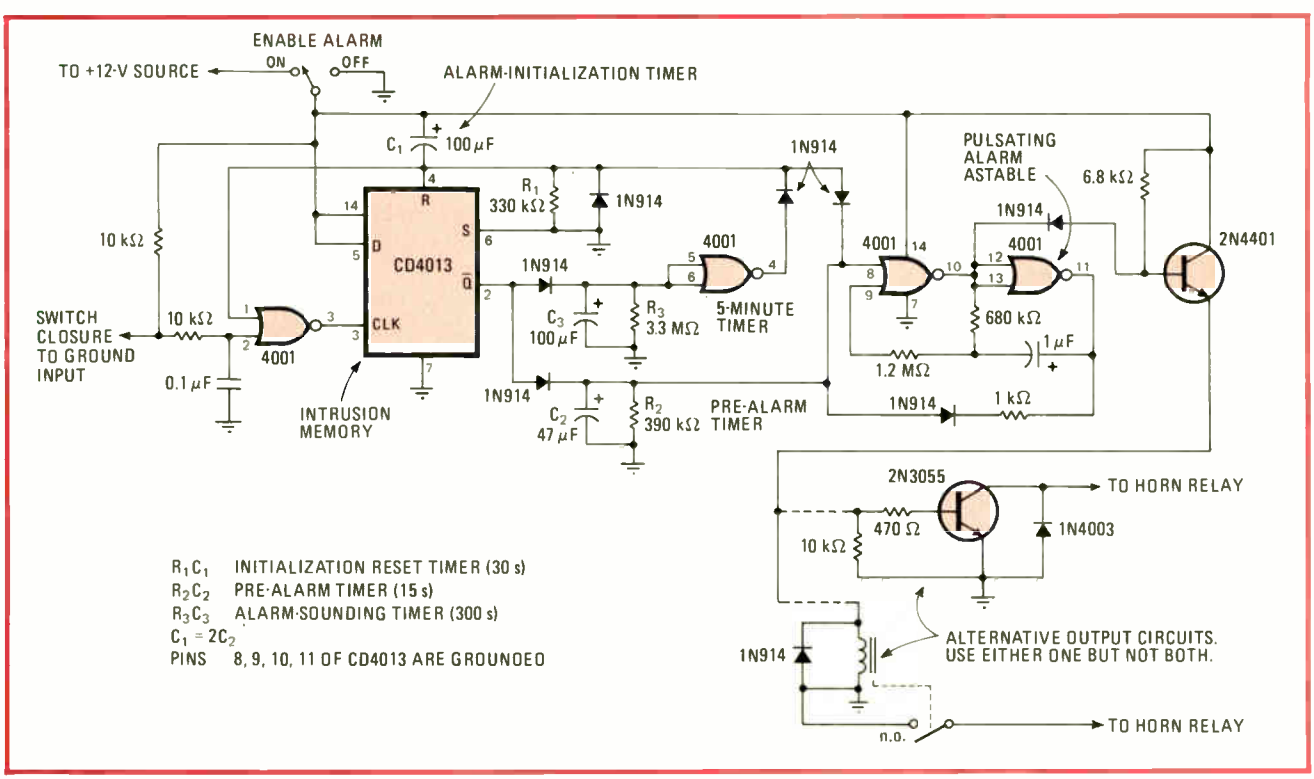
A sophisticated alarm circuit that uses the horn of the car and incorporates multiple time delays has been designed around two C-MOS packages—a natural choice for use in automobile intrusion alarm systems because of their extremely low power consumption.

The circuit, which is armed by a hidden switch located inside the car, has a short delay period after it is enabled, to permit the driver to leave the car without tripping the alarm. Thereafter, opening a door or trunk lid will trigger the alarm and, following another short interval (to permit the driver to enter the car and disable the alarm) the horn is pulsed approximately 60 times per minute, so as not to sound stuck. After several minutes, the alarm circuitry resets itself, ready for another intrusion. All of the time delays can be adjusted by changing resistor values.

The figure shows the schematic of the alarm circuit using a CD4001 quad NOR gate and a CD4013 D-type flip-flop. The input to the circuit is taken from the door switches that control the dome light and short to ground when any door is opened. The alarm's input signal is normally 12 volts and also goes to ground when the doors are opened. The driver enables the alarm by a hidden spdt switch connecting 12 V to the circuitry.

Resistor-capacitor combination R_1C_1 develops a reset command signal to the intrusion memory when the alarm is enabled. This time delay permits the driver and passengers to leave the automobile prior to the arming of the flip-flop. Once the reset time delay expires, the flip-flop is ready to detect a switch closure to ground at the input. When a closure to ground occurs, a positive-going signal clocks the D-type flip-flop. Capacitors C_2 and C_3 were initially charged to 12 V during the reset interval, and they begin to discharge. R_2C_2 discharges below the NOR gate input threshold first, causing the 1-hertz astable oscillator to turn on. This astable is used to drive a small relay or transistor that turns the horn relay in the car on and off. If C_1 equalled C_2, the voltage on the reset of the CD4013 at turn-on would be half of the supply voltage, which is not a valid state. Therefore C_1 is made twice C_2, giving a reset voltage of two thirds the supply voltage. R_3C_3 discharges below the NOR gate input at a much later time, generating a reset command to the intrusion memory. Thus, the complete process can repeat itself if another intrusion is detected.

When the driver enters the car, the alarm is turned off but will be initialized instantly if turned on again. In



Smart alarm. C-MOS intrusion detector for an automobile uses only two ICs, yet provides a high degree of flexibility. Delay times are provided to aid in the arming and disarming of the alarm. Once the pulsating-horn alarm is sounded, it resets automatically after several minutes.

practice, a time delay of 30 seconds was chosen for the R_1C_1 time constant. R_2C_2 was chosen to be 15 seconds, and R_3C_3 is 300 seconds. Either a relay or an npn transistor may be used to trigger the horn relay in the car, depending on how much current must be controlled: both these alternative output circuits are shown in the diagram. Since only two C-MOS ICs are used, the circuit fits easily on a small circuit board and mounts under the dash. If the trunk or hood switch is paralleled with the door switches, then it too will trip the alarm. □

Hardware helps in tracing microprocessor program

by Jeffrey L. Zurkow
Hampshire College, Amherst, Mass

Debugging microprocessor programs can be especially difficult because most microprocessors lack full control panels and register displays. Software "debug packages" can of course be written, but they are complicated because they must continually modify the user's program in order to trace and control its execution. However, much of their complexity can be eliminated if hardware is added that triggers an interrupt after the execution of each instruction in the user program.

As with any interrupt, the computer saves the address of the next instruction and branches to an interrupt service routine. The service routine can recover this address and print it out along with the contents of the machine's registers, halt and accept operator instructions, set breakpoints, and modify registers before returning to program execution.

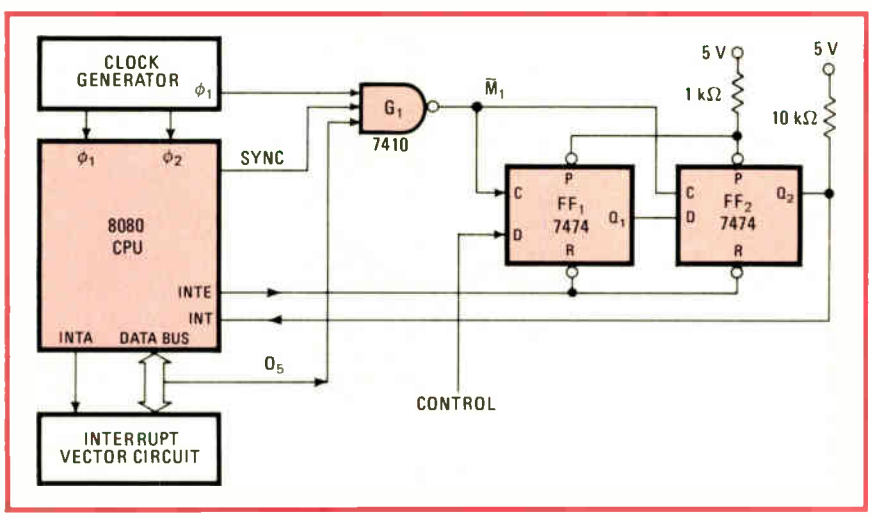
The two circuits shown here are for use with the Intel 8080 microprocessor, but a similar approach should work for other machines. Both circuits perform essentially the same function, but the first latches its interrupt request until the central processing unit responds, while the second saves one flip-flop on the assumption that request latching takes place in the external interrupt-vector circuit. The interrupt-vector circuit, assumed to be present in both cases, is responsible for strobing a restart instruction onto the data bus whenever the CPU outputs an interrupt-acknowledge signal: the restart causes the CPU to save the address of the next instruction (the return address) on its stack, and branch to the interrupt service routine.

An interrupt is requested by driving the 8080's interrupt line high. If interrupts have been enabled by the execution of an interrupt-enable instruction, the interrupt will occur upon the completion of the current instruction. Interrupts will automatically be disabled, and an interrupt-acknowledge signal will be output. The CPU interrupt-enable output line indicates whether interrupts are enabled (high) or disabled (low).

The beginning of each instruction is marked by a CPU status signal called M_1, determined by the coincidence of the signals SYNC, $\phi 1$, and D5. SYNC and D5 are 8080 output pins, while $\phi 1$ is a TTL-level signal representing phase 1 of the two-phase processor clock. The circuits of Figs. 1 and 2 cause an interrupt request on the *second* M_1 pulse following an interrupt-enable instruction. The next instruction should be a return or jump to the program being traced; an interrupt occurring on the return from the service routine would result in an infinite loop, so this instruction is intentionally not traced.

In the circuit of Fig. 1, the two flip-flops are held reset as long as interrupts are disabled. After an interrupt-enable instruction, which turns the line labelled INTE on, the first M1 pulse sets FF_1. The next M1 pulse sets FF_2, causing an interrupt request to be issued via Q_2. Acknowledgment of the request turns INTE off, resetting the flip-flops.

In Fig. 2, the first M1 pulse after an interrupt-enable sets FF_1. The next M1 pulse causes the output of NAND gate G_2 to go low, thus again requesting an interrupt. The line labeled control in both figures may be used to disable the instruction-interrupt feature; interrupts will not occur while control is held low. In practice, this signal comes from a latch which can be set and reset as an



1. Instruction interrupt. When CONTROL is high and interrupts are enabled by the program, the circuit shown requests an interrupt at the beginning of each CPU instruction. The 8080 CPU completes the instruction before honoring the request. Flip-flops FF_1 and FF_2 cause the first instruction following an interrupt enable to be ignored, thus allowing successful return from the interrupt-handling routine.

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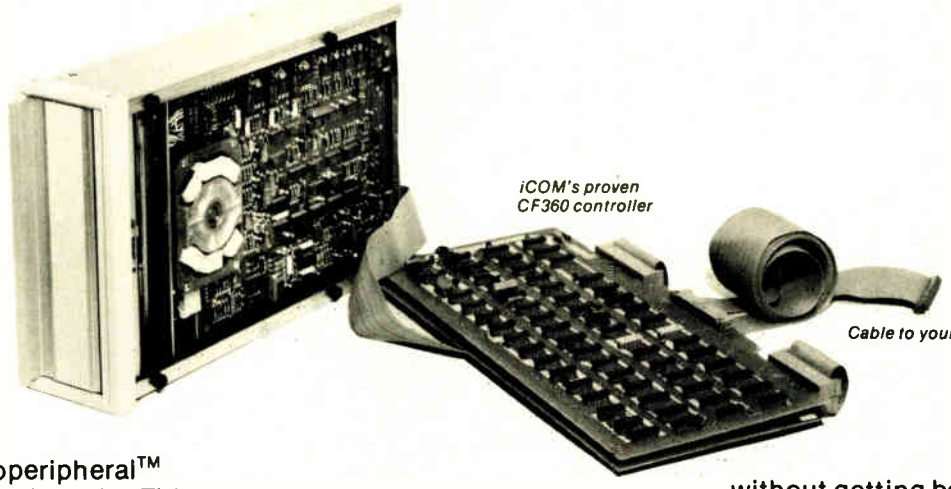

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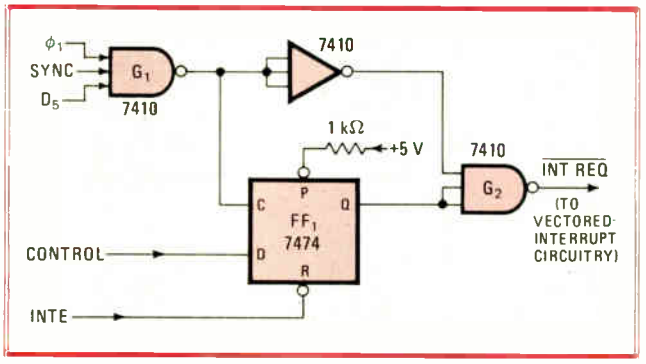
2. Simplification. When the microprocessor system already includes hardware that latches the interrupt request, this simplified circuit can be used. The other flip-flop in the 7474 package is available for use as a control signal latch



output device under program control, allowing tracing to be turned on or off.

The only special requirements for the interrupt service routine are that it not re-enable interrupts until ready to return, unless it first turns off tracing. The return linkage is standard: interrupt-enable, immediately followed by return. □

One-op-amp oscillator keeps sine-wave amplitude constant

by Dale Hileman
Sphygmetrics Inc Woodland Hills, Calif

A sine-wave oscillator needs precisely controlled feedback to keep its output amplitude constant. But this need complicates its design. A typical unit contains two or three operational amplifiers and perhaps a dozen other components, not to mention an awkward split-stator variable capacitor if a wide, adjustable frequency range is necessary, as in a laboratory sine-wave generator.

The circuit in the diagram, however, maintains a constant output amplitude over a 10-to-1 frequency range without being unduly complex. From only a single op amp, a half-dozen other parts, and just one variable resistor to adjust frequency, it generates a nearly perfect sine wave.

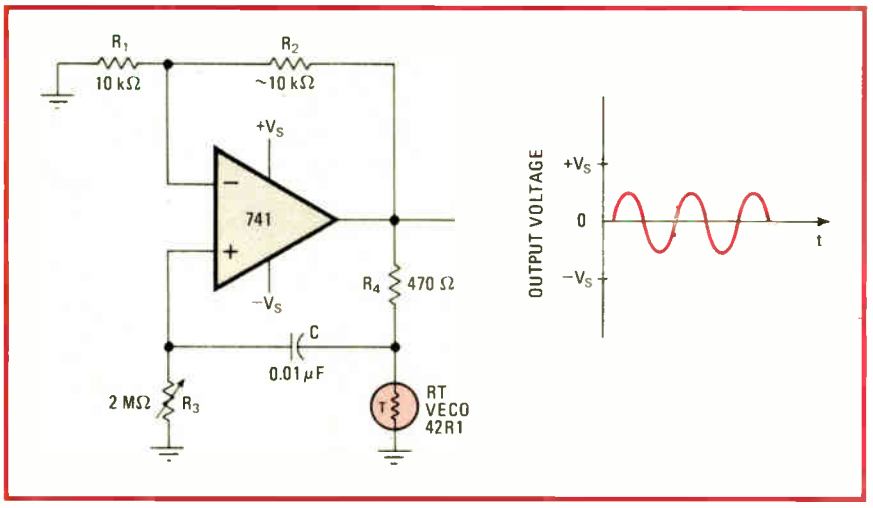
To produce this sinusoidal output waveform, the circuit includes a voltage divider consisting of R_1 and negative-temperature-coefficient thermistor RT in the feedback loop to the noninverting input. The thermistor stabilizes the feedback: if the output increases, the resistance of RT decreases and thus reduces the regeneration. Resistors R_1 and R_2 in the negative-feedback path prevent oscillations from building up to become distorted.

The amplitude of the output signal in this oscillator configuration is extremely sensitive to feedback variations, so only a small change in the thermistor resistance is required to stabilize the output signal. This principle has the same effect that a very high loop gain would have in any other servo-type system. As a result, the output level is held constant over a wide frequency-adjustment range.

The frequency of oscillation, which is an inverse function of the product R_3C, is controlled by varying R_3. A clean sinusoidal output ranging from 2 to 20 kilohertz is generated as the frequency is varied. A resistor may be connected in series with R_3 to avoid distortion near the extreme low-resistance setting. A different value for C of course gives a different tuning range.

Supply voltage is not critical—values of $\pm V_S$ can be in the range from 3 to 18 volts. The amplitude of the output sine wave, which must be substantially less than V_S to avoid distortion, is set by selection of R_2. If this resistor is a potentiometer, it must not be a noisy one because noise in the feedback loop produces a disproportionately noisy output. A ±10-V supply typically allows an output sine wave of 10 V peak to peak. □

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



Watch the sines. Voltage divider, consisting of R_1 and NTC thermistor RT, controls the positive feedback in op-amp oscillator circuit to produce clean constant-amplitude sine waves over the 2-to-20-kHz frequency range. Resistors R_1 and R_2 in negative-feedback path hold overall amplifier gain near unity; amplitude is set by value of R_1.

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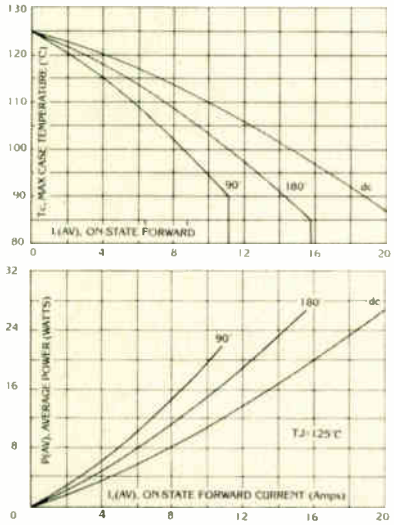

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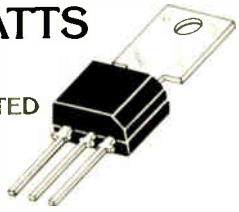

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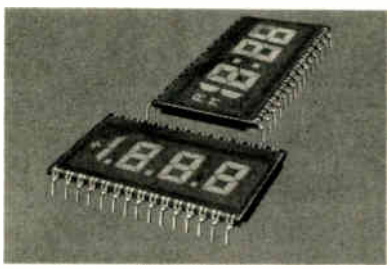

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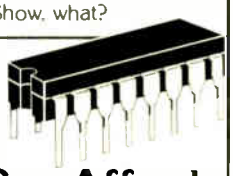

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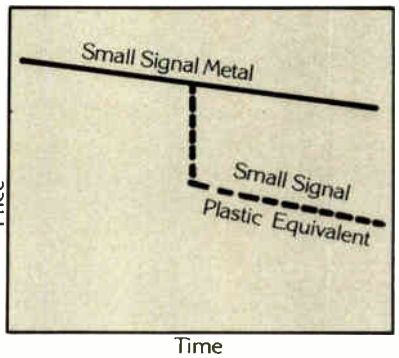

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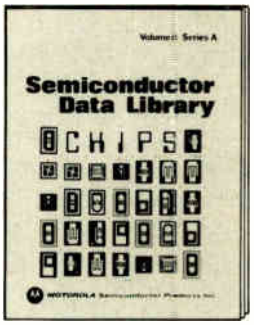

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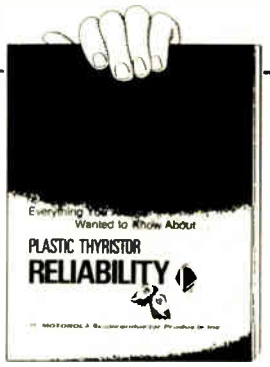

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microprocessors in action

While it is possible to write down general rules and procedures for designing with microprocessors, the continuing proliferation of component families, each with their own unique characteristics, puts an extra burden on system designers. They must make appropriate choices and then engineer the result.

On the theory that nothing is as instructive as the success (or failure) of others, *Electronics* is initiating this continuing series of articles describing how microprocessors have been successfully applied to a wide variety of problems. The series actually had its genesis in our April 15 special issue on microprocessors, with 14 case histories.

Readers who have applied microprocessors to engineering problems are invited to describe them for this series. Show briefly the aspect of the design that only a microprocessor could successfully implement, give the reasons for choosing the specific microprocessor, describe the system configuration, and indicate relevant programing details and any design problems that had to be overcome.

8-bit microprocessors can control data networks

by G. D. Forney and J.E. Vander May
Codex Corp. Newton, Mass.

☐ It generally pays to concentrate the traffic of a data-communications network into the smallest possible number of linking lines. That was a stumbling block for the earliest microprocessors: they were too slow to control such a network, even at modest data rates like 2,400 or 9,600 bits per second.

However, 8-bit microprocessors of the 8080 and 6800 types can pass full-duplex data at these rates and still have enough time over to perform some useful communications processing. This has permitted the development of a microprocessor-based network processor that fills the gap between time-division multiplexers—generally inexpensive, hard-wired devices with limited capabilities—and concentrators—typically realized in large computer or minicomputer programs and more expensive than TDMs.

A major design goal for these communications processors was to meet the varying speed requirements within a network while employing a common, modular architecture. Within one network, there may be small nodes supporting only a few ports over a single link, as well as large backbone nodes passing traffic from many sources over multiple, high-speed links. Trunk speeds commonly range from 2,400 to 9,600 b/s, but links of 19.2 and even 50 to 56 kilobits per second may be justifiable in larger networks.

Another design goal was to achieve transparency in the data network. That is, replacement of existing communications subsystems must have no hardware or software impact on the associated terminals and computers. Transparency implies minimal delays within the network, which required the development of an efficient character-oriented link protocol to handle trunk speeds as low as 2,400 b/s. Individual characters have to be assembled, buffered, encoded for data compression, and routed to the appropriate link, with the reverse pro-

cesses taking place at the network's receiving end.

Studies showed that a 6800-type microprocessor, with some hardware assists, could perform these functions with full-duplex throughputs in the 4,800-to-9,600-b/s range. Thus, a single-microprocessor machine could handle many point-to-point applications, but more than one microprocessor would be required for multinode networks without a constriction on capacity.

Linking the processors.

The next decision involved interconnecting the microprocessors. Typical multiprocessor architectures dedicate each microprocessor to a subset of the tasks that have to be performed. Instead, a parallel, or symmetric, multiprocessor architecture was chosen. Every microprocessor is equally capable of picking up any task so that any number of the devices from one to the maximum physical limit (chosen here to be eight) can be used. This yields a modular machine whose power can be tailored from single-processor systems adapted to typical small-node applications to eight-processor systems that approximate the communications-processing power of two mid-size minicomputers and can support on the order of 50 to 56 kb/s of full-duplex throughput.

The desire for high bus-transfer rates and compact physical dimensions made a high-speed synchronized mainframe bus the natural choice to link the devices with each other, with the program and data memories, and with the microprogramed master controller. Communications with the external ports, on the other hand, are handled as an asynchronous and lower-speed process taking place over greater physical distances, so a separate input/output bus with its own asynchronous protocol seemed desirable.

In the resulting network processor (see figure), the mainframe bus supports up to eight microprocessor modules and a mixture of up to six random-access and read-only memory modules, with any microprocessor able to access any memory. The I/O bus connects the mainframe to the individual ports—external data sources and sinks. Up to 32 ports can be accommodated in a port nest, which is a separate subassembly. Up to eight port nests can be attached to one mainframe.

A master controller module controls the I/O bus, interfaces it to the mainframe bus, and performs other functions. An option module interfaces an operator's console to the master controller and supports other optional features.

Adding memory

The design of the memory system is critical to getting effective utilization of all the microprocessors. A single global memory is attractive on grounds of simplicity and of facilitating interprocessor communication. However, there must not be excessive interference between accesses of the memory by the microprocessors, or else speed will be unduly degraded.

A typical instruction mix for the 6800 requires a memory access on the average of two out of every three microprocessor cycles. At a 1-megahertz processor cycle time, eight microprocessors will generate five to six million memory accesses per second.

Therefore, a system bus with a 6-MHz transfer rate was designed. The bus has separate 16-bit address and 8-bit data lines and is pipelined, in the sense that an address presented on one cycle will result in data being returned on a subsequent cycle. For fast memories (access times less than 200 nanoseconds), the data returns on the next cycle, while, for slower memories (access of 200–367 ns), it returns two cycles later. The bus operates from the same clock as the memories and microprocessors so that the entire mainframe system is effectively synchronized.

The bus will accommodate various types of memory. There are two types of RAM modules, accommodating either 8,192 or 16,384 bytes. The former uses 22-pin 4,096-bit dynamic n-channel metal-oxide semicon-

ductor RAM circuits, and the latter uses 16-pin 4-k circuits. The access time of these memories is in the 200–367-ns range, and their cycle time is 500 ns. Each module is partitioned into two banks, to which there can be independent access in an interleaved fashion. In addition, two adjacent RAM modules on the bus jointly do a four-way interleave—*i.e.*, four cycles can be in progress at once. This gives an effective cycle time of 125 ns, substantially faster than the bus cycle time.

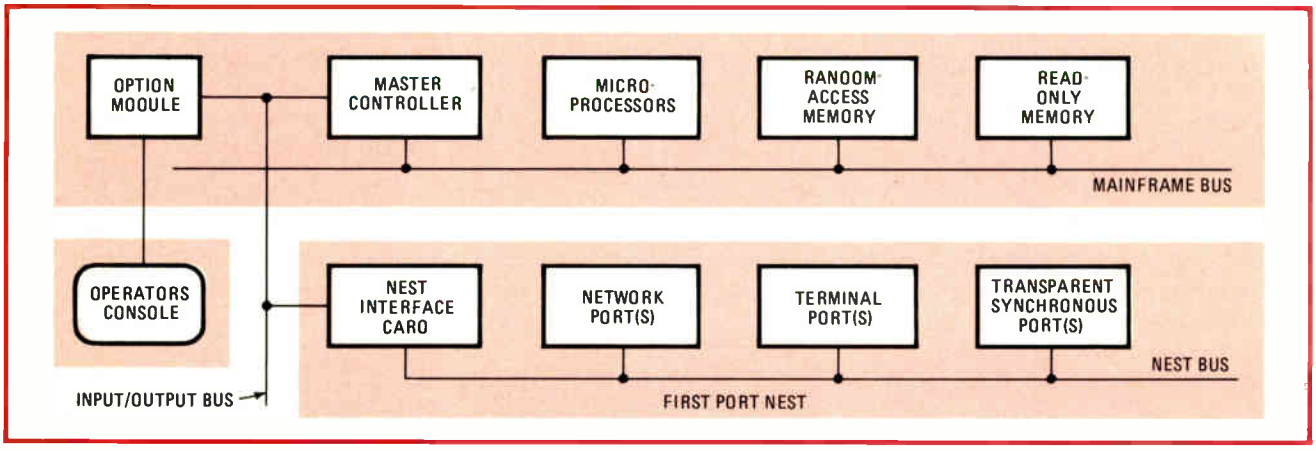
Two types of ROMs

There are also two types of ROM modules. One type accommodates up to 24 kilobytes of a memory that is erasable by ultraviolet light (Intel 2708), a type used for software development. A second module accommodates up to 16-k bytes of a conventional fusible-link programable ROM used for program memory in standard systems. Software can be executed directly out of the PROM, thus avoiding duplicate RAM memory. The ROM modules have access and cycle times less than 200 ns.

The master controller handles all input/output transfers and implements the task-dispatching procedure. It also executes such functions as real-time clock generation, memory refresh, operator-console control, and configuration control. The controller, a microprogramed minicomputer using the Intel 3000 series of bipolar 2-bit slices, operates at the 6-MHz cycle time of the system bus. It uses 8-bit data words and 32-bit microinstructions. It also executes a variety of "super-instructions," which augment the 6800 instruction set and unload considerable processing overhead from the microprocessors.

The network processor communicates with the outside world via a number of port types. The principal type is the terminal port, a programable device that can support either asynchronous start-stop protocols or character-oriented synchronous protocols. It performs character assembly/disassembly and buffering, character parity checking, insertion and deletion of idle fill, control of interface signals, and other similar functions. The principal component is a Western Digital Astro, which requires little augmentation for this application.

The second port type is the network port, which is designed to support the intranetwork protocol which was developed for this family of processors. The third port type is the transparent synchronous port, which merely combines external synchronous data streams by time-division multiplexing at a half or a quarter of the trunk rate with network-port intranetwork data, thus allowing piggybacking of such data within the network.



Lots of support. The mainframe bus of this network processor can support up to eight microprocessor modules and a mixture of up to six ROMs and RAMs. Up to 256 input/output ports can be accommodated, since the I/O bus can support eight port nests of 32 ports each.

Controller has high speed, bit-manipulation capability

by W. H. Seipp
Eagle Signal, Industrial Controls Division, Davenport, Iowa

Microprocessors can stand up to the rough and tumble environment of industrial controllers, but they present several serious problems of their own in such applications—slow response time, limited applicability of the instruction set, and complicated communication between the user and the controller.

In a real-time environment, a microprocessor-based controller must be able to respond to input changes in a matter of milliseconds. To minimize the controller's response time, the microprocessor should require a minimum number of instructions for a given operation and be able to execute them at high speed.

However, a large number of instructions in itself is not useful. Industrial logic calculations like relay and Boolean logic are generally single-bit manipulations, so the microprocessor should preferably have high-speed bit-manipulation capability.

At the same time, users of programed-logic controllers often do not understand computer technology and have no desire to learn it simply to program a controller. To overcome these problems, the controller should

use Boolean-logic and relay-logic ladder-diagram programing. With such software, the user doesn't know that he is using a computer device.

In the Eptak control system, these requirements are met by combining an Intel 8080A—a high speed device with a comprehensive instruction set—with external logic that adds bit-manipulation capability. In the bit mode of operation, bits are always fed to the 8080A in the D_0 (data zero) position of the 8-bit data word, and the remaining seven bits are forced to logic 0. The standard 8080A instructions then become bit-manipulation instructions.

This maximizes the efficiency of input- and output-address allocation and eliminates the need for software subroutines to shift and mask data in order to obtain bit information. It significantly increases calculating speed in logic-intensive industrial systems and reduces software costs.

Three languages

To simplify communication for the user, the Eptak process-control system is programable in four languages: relay diagram or Boolean logic, Eptak control language, assembly language, and Eptak process control language. These languages and appropriate hardware configurations make the Eptak system a family of controllers for the range between programable logic controls and microcomputers.

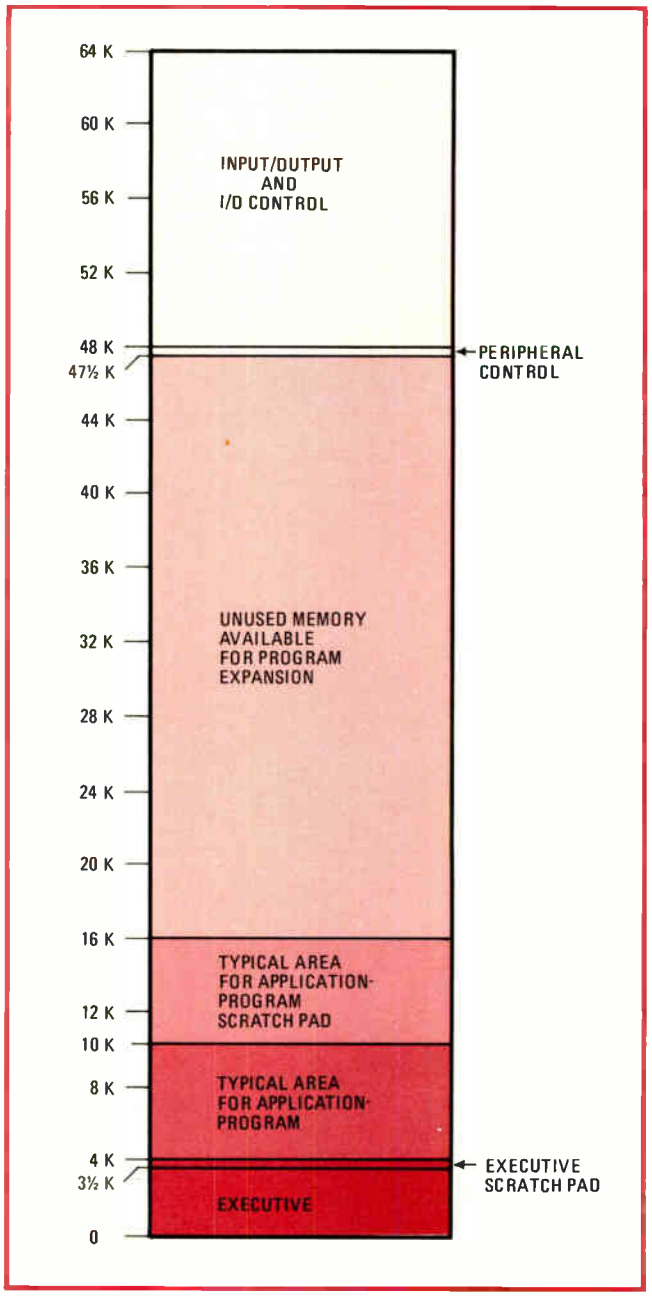
The circuitry for each Eptak module was designed with software requirements in mind. An example of this is in the analog-input scanner. This consists of an analog-to-digital converter module and several analog-input modules, each having eight inputs. Software is necessary to scan the input circuitry, but the input module that has been selected automatically starts the a-d conversion. The real-time clock independent of the user's logic program controls the scanning. This method allows the system to control up to 100 analog loops per second—each loop using the three-mode proportional-integral-derivative technique—with about 11% of the total 8080A computation time used. Almost 90% of the microprocessor's time is available for other functions such as the user's logic program.

The a-d converter can also be operated under interrupt control so that a minimum of software overhead is required for input scanning. The analog system was implemented within the chassis and under software control of the central processing unit to reduce the cost of the system and to simplify its implementation for programable-logic-controller use. Analog capability is realized by adding appropriate input modules in much the same way as selecting an external analog plug-in controller. Simple software statements are used to operate the analog subsystem.

The CPU module incorporates all the basic features necessary for a control system. These include an eight-level priority-interrupt system (which can be expanded externally by an additional 255 levels), an internal real-time clock with user-selected 1- or 10-millisecond interrupt rates, power-fail restart circuitry, direct memory access, and expandability of the system.

A control system's primary task is to monitor and control the process. Operator interaction occurs only a small percentage of the time. Therefore there's no need to continuously poll peripherals to other I/O devices such as keyboards. Instead, action is taken when the specific device interrupts the processor, indicating that a problem has arisen. The external interrupt system creates fast response with minimum system overhead.

High-speed I/O capability was achieved by using a memory map (see figure). The upper 16,384 of the possible 65,536 total memory addresses available are reserved for I/O circuits. This memory may be a semiconductor random-access memory with a battery backup



Memory map. Reserving a section of the memory for input/output and I/O control speeds these functions. The lower area stores the executive, as the algorithm is called that has the function of transforming the user program into machine language.

for memory retention, an ultraviolet-eraseable programable read-only memory, or a magnetic core.

Three of the address bits are control bits. One selects I/O circuits within the chassis. The second selects the bit mode as opposed to the standard byte mode of the 8080A. The third determines whether data is brought into the CPU in the true or inverted state, thereby increasing the instruction set to include such instructions as AND/INVERT, OR/INVERT, etc.

The I/O modules generally may operate in either bit or byte mode. Some, such as the data-display module, may be operated only in a byte mode because this module contains more than one eight-bit data word.

Three address bits are reserved for selection of bits or bytes of data on I/O modules. Chassis I/O modules also include such modules as thermocouple or other analog-input modules, a-d converter modules, digital-to-analog output modules, and other special function modules.

Strictly bit mode

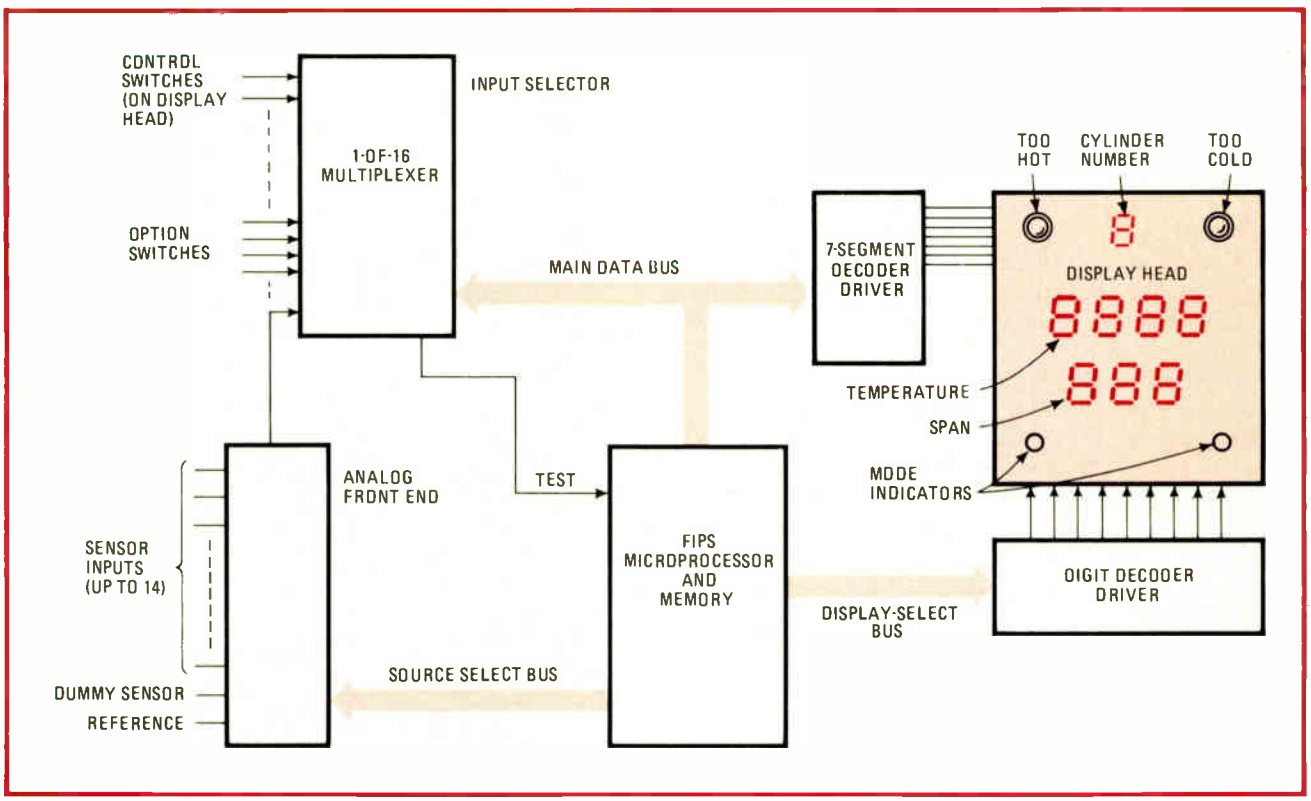
The external or remote I/O system operates in a strictly bit mode. It consists of individual input/output blocks, each with a unique address. Each of the up-to-2,048 blocks may be mounted remotely from the CPU by as much as 500 feet of interconnecting cable. Because of the line delays of the cable and the logic delays in the interface logic circuits, the remote system will not operate at speeds as high as the CPU module. However, the interface seems local to the CPU, since signals from this system are buffered through a scanner. Thus, the advantages of remote I/O are obtained with the advantages of high-speed local I/O.

Engine-temperature monitor warns pilot of danger

by Michael Cope, *Interphase Associates, Richardson Texas*
and Wayne L. Pratt, *Avicon Development Corp Richardson, Texas*

Nothing is so chilling to the hearts of light-plane flyers as the sound of an engine missing—so pilots tend to spend a lot of air time looking at the instrument panel. A newly developed microprocessor-controlled system makes life easier by advancing the monitoring of cylinder temperatures to a level of sophistication previously precluded in most general-aviation aircraft by constraints on size, weight, and cost.

Cylinder temperatures, measured in the cylinder head or in the exhaust system, are vital to safe and efficient operation of reciprocating engines. SAFE, for Smart Automatic Flight Engineer, automatically scans thermocouples in each exhaust stack or cylinder, digi-



Inside the SAFE. The microprocessor-controlled Smart Automatic Flight Engineer instrument for monitoring aircraft engine temperatures converts thermocouple voltages to digital temperature values, displays them, and flashes warnings if they lie outside the prescribed range. The 0.14-ft³ module uses only about one tenth as many components as would be required in a hard-wired version.

tizes the analog readings, and indicates them on a cockpit light-emitting-diode display.

Based on the National Semiconductor FIPS (Four-bit Integrated Processing System) microprocessor, the system occupies a standard 2¼-inch hole, takes up less than 0.142 cubic feet, and weighs under two pounds. The cost is roughly comparable to a manual system that shows the temperature of only one cylinder at a time. Since production began in June 1975, 80 units have gone out into the field, with orders for another 90.

10 checks a second

The system samples a different probe every tenth of a second, which means the entire engine is checked every 0.4 s if it has four cylinders or every 0.6 s if it has six cylinders. This cycling rate is faster than necessary for accumulation of meaningful data, so the relatively slow 4-bit processor is more than adequate for the job—and it's inexpensive.

Not only does the system indicate individual readings, but it makes comparisons among readings and displays temperature relationships. Moreover, its program allows adaptation of a single model to various configurations of engines and cylinders commonly found in light planes.

In the automatic mode, the instrument displays the highest temperature among the cylinders, as well as the span between this and the lowest temperature. Using either preset or pilot-selected temperature limits, it flashes warning lights whenever any cylinder exceeds the maximum or drops below the minimum. In the manual mode, the instrument allows the pilot to get temperature readings for diagnosing potential engine problems.

In addition to the FIPS microprocessor, the processing system (see figure) consists of two read-only memories of 256 8-bit words each, a random-access memory of 80 4-bit words, and a clock-generator—all in 16-pin packages. Output is via the integrated RAM and ROM input/output ports. All input is via a single test input fed from a 1-of-16-lines multiplexer.

Analog-to-digital conversion employs an unusual combination of hardware and software. Analog switches select any one of 14 signal sources, a reference source, or a dummy sensor. The only other hardware is an operational amplifier serving as an integrator and a comparator serving as a zero-signal detector. Software handles the actual conversion.

Data processing

After data collection, the system compiles the data, and, under ROM-program control, computes the information to be displayed and drives the multiplexed LED display on the instrument panel.

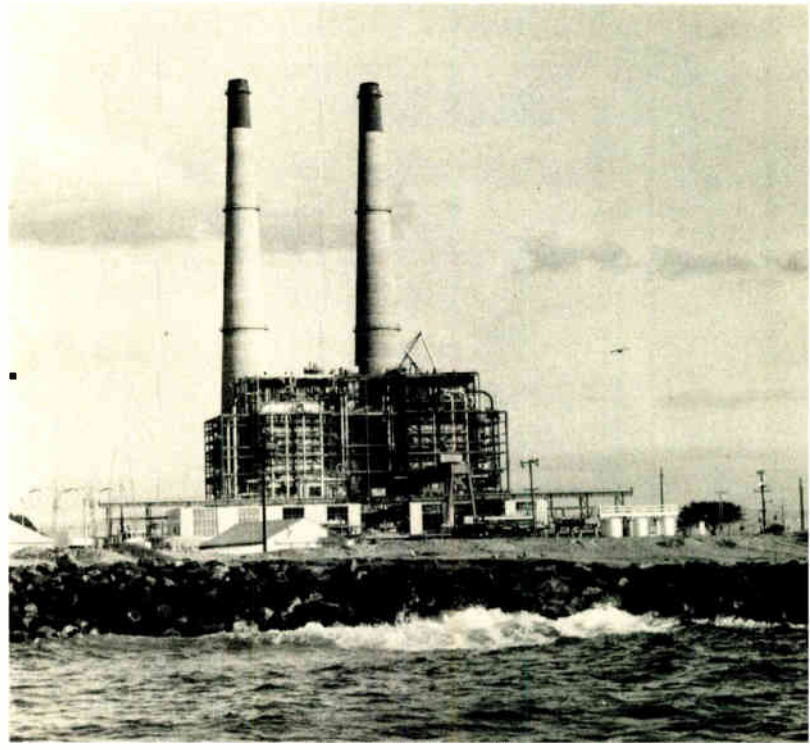
When the data-collection sequence is finished, the microprocessor determines the mode in use (automatic or manual), computes the data to be displayed from the raw collected data, and stores it in binary-coded-decimal form.

During both collection and computation phases, the multiplexed display is refreshed continually. Each display item is refreshed about every 3 milliseconds by putting the BCD information on the main data bus (the ROM output port) in coincidence with the digit to be refreshed on the display select bus (the RAM output port).

In addition, a slave display-head can be driven to show data for a second engine, as can a remote audible alarm and several other peripheral devices. Moreover, no interrupt is needed or desired for any of the functions.

Soot blowers respond to orders of CPU chip

by Richard G. Barnich
PCS Inc., Flint, Mich



The insect-size microprocessor has established control over the gargantuan boiler-cleaning systems in modern power plants. Although the equipment is huge, the motors that drive it must be precisely controlled and continuously monitored.

The motors drive a large number of soot blowers, which are long steel tubes that blow air, steam, or water against the tubes inside the boilers to remove coal- or oil-soot build-up that reduces heat-transfer efficiency. These blowers, or lances, which may be 60 feet long and weigh several tons, are driven in and out of the boiler from various points in a variety of patterns.

Designing and building the hard-wired logic that has controlled these systems in the past has become too time-consuming and costly. Each customer's controller must be custom-designed, and, after a controller is installed, the system cannot be changed without the costly process of shutting down the boiler and rewiring the

controller. Exactly such a process became necessary during the recent energy crisis when many customers had to change their controls to accommodate the change in the type of fuel they burned.

Easy field changes

However, these modifications are easy to make in the field with a microprocessor-based controller, which is also inexpensive to produce and test. The software package, which performs all the functions necessary to operate the controller, enables an engineer to configure a customer system in a matter of days. What's more, he can reprogram the system easily any time the fuel or any other variable is changed. With this package, the engineer simply specifies the customer's system parameters, such as the number and types of lances and travel-time limits.

Instead of 100 to 150 circuit boards of 15 different types, only 30 boards of only three types are required by the new controller. These three types, shown in the figure, are a microprocessor and memory board, a general-purpose digital input/output board, and a "personality" board, which can be tailored to handle a variety of special I/O requirements.

For such flexibility, semiconductor memory, which is available from many sources, is much more cost-effective than core. Despite its low speed, semiconductor memory is used because of the system's small read/write requirement. The program requires approximately 8,000 bytes or 4,000 words of 16-bit memory.

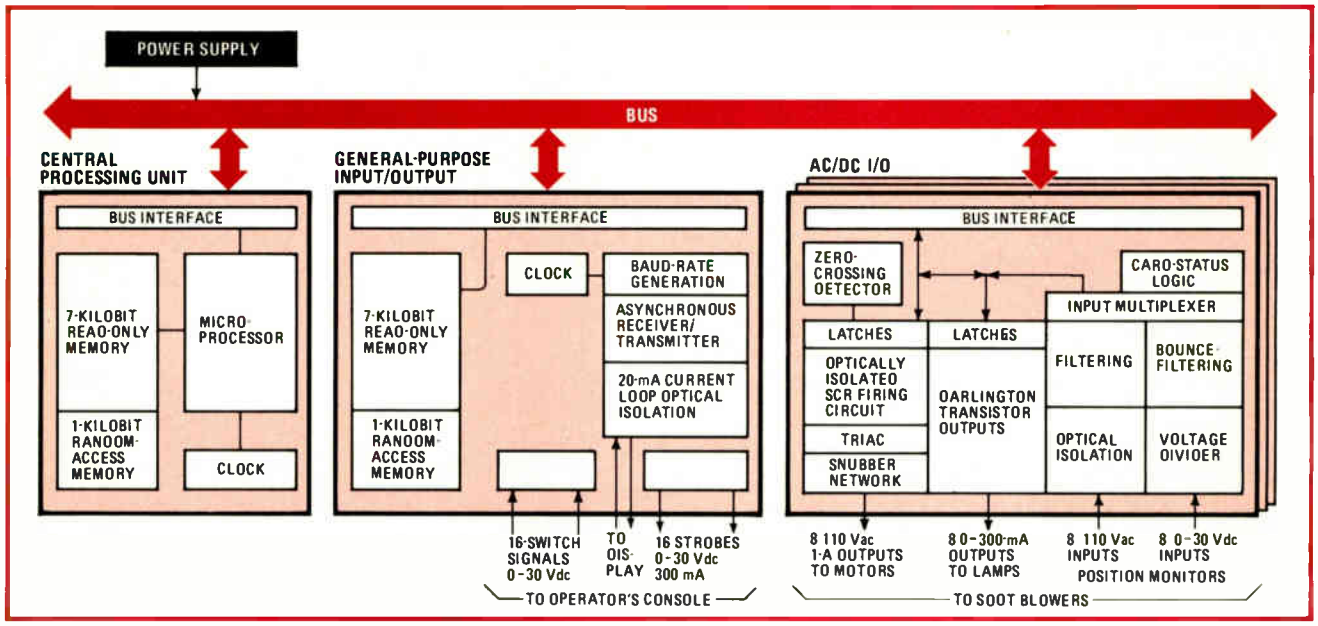
The central-processing-unit board includes an 8080-type microprocessor, 7 kilobits of electrically programmable read-only memory, and 1 kilobit of random-access memory. The general-purpose I/O board holds an additional 7 kilobits of E-PROM, 1 kilobit of RAM, 16 adjustable-threshold digital inputs (0 to 30 volts), 16 latched digital outputs that consume 300 milliamperes at 30 V, and a serial port for outside communications to the operator's console. Typically, each personality board includes eight 110-V/1-A ac outputs, eight 110-V ac inputs, eight 30-V/300-mA dc outputs, and eight 30-V dc inputs.

Because the microprocessor-based controller is installed in a sealed cabinet without fans or ventilation of any kind, system modules are made almost entirely of low-power complementary-metal-oxide-semiconductor logic. Each personality board, for example, draws less than 25 mA. However, because C-MOS is slowed down by the capacitive nature of a bus structure and the system must be bus-oriented to meet the need for a modular, easily expandable system, transistor-transistor logic increases the speed in the bus driver of the CPU card.

High bus speed

To provide bus speed as high as possible, individual I/O modules indicate to the processor their relative speeds so that the processor can adjust its bus speeds to compensate for the slower modules. Any type of peripheral can be used with the system because the 8080 microprocessor can operate asynchronously. The CPU generates a WAIT signal and requires a READY signal from each I/O or memory device. When the READY signal is high, the processor operates at its maximum speed, which is approximately 500 nanoseconds.

When an I/O or memory device is too slow to operate at maximum speed, the processor adjusts for those speeds by removing the READY signals for a predetermined period. The bus cycles are thus stretched from 500 ns to a microsecond to allow for longer propagation delays in the C-MOS logic. □



Controls the cleaning. Microprocessor-based controller for boiler-cleaning system uses 30 boards, 28 of which are for ac/dc input/output, instead of the 100 to 150 boards required for hard-wired system. The boards are directly connected to a bus to facilitate communications.

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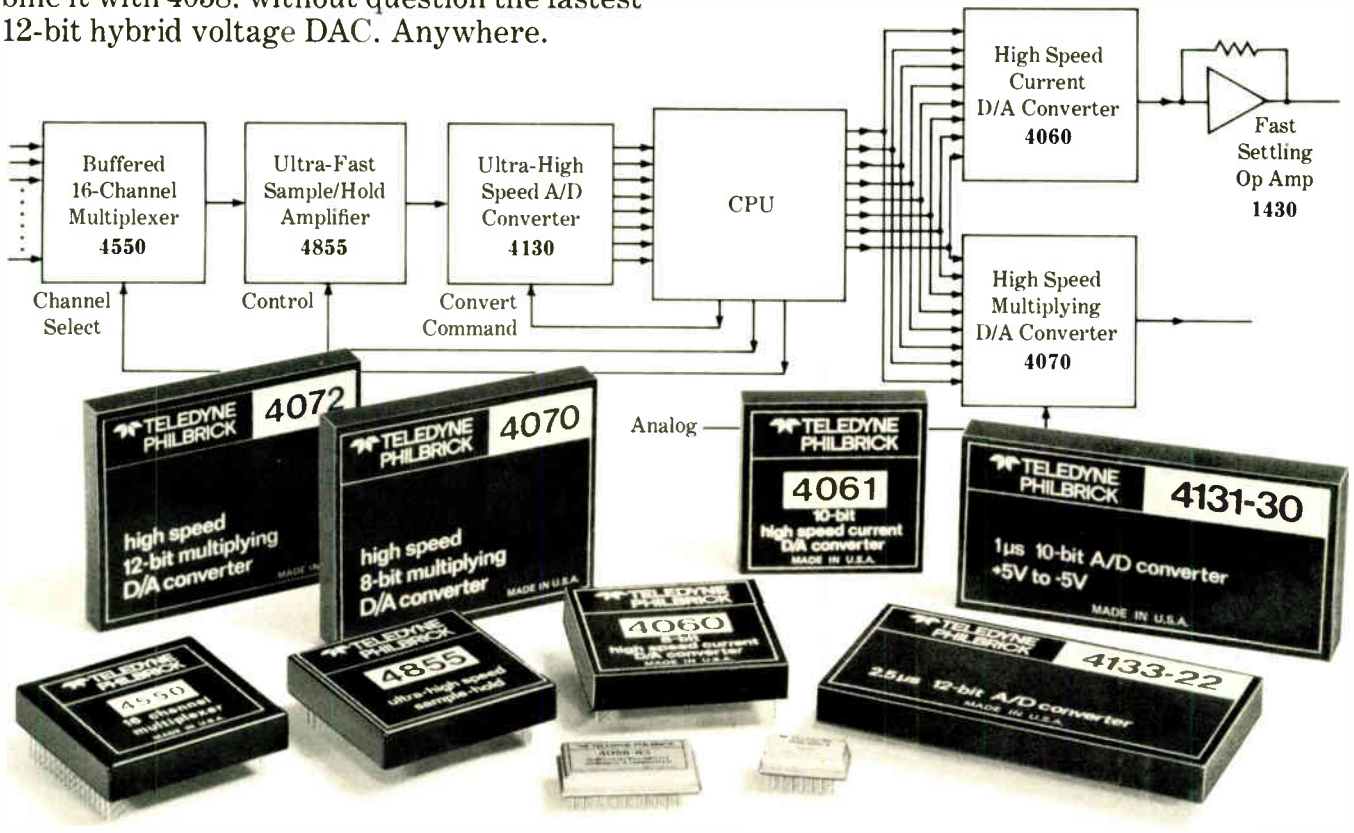


Module converts voltage to inverse square

by S. Ashok
Rensselaer Polytechnic Institute, Troy, N.Y.

Measurements of junction capacitance as a function of voltage are frequently used in semiconductor work to determine the doping profile of materials and the barrier potential of pn and Schottky junctions. The evaluation of these parameters actually requires a plot of the inverse square of the junction differential capacitance against reverse voltage, because the doping concentration is given by the slope of $1/C^2$ with voltage, and the barrier potential is found by extrapolation of that line.

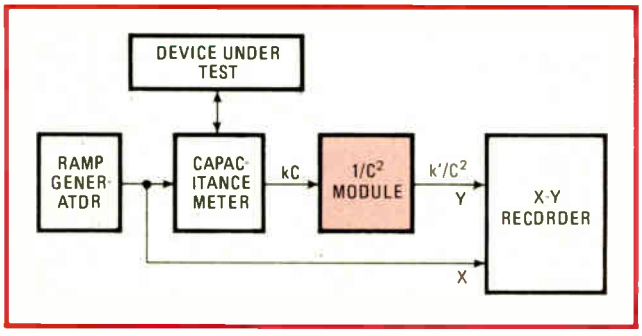
In the absence of sophisticated doping profilers, the plot of $1/C^2$ vs V is usually deduced point by point from swept C-vs-V data. However, the present availability of precision nonlinear-function modules at low cost enables one to obtain swept plots of $1/C^2$ against V directly by adding a simple circuit to the standard swept C-V setup.

Figure 1 shows the block diagram of the setup to obtain swept $1/C^2$-vs-V data. The ramp generator applies a linearly increasing reverse voltage to the device under test through the bias-input terminals of the capacitance meter. The recorder output of the meter gives a voltage that is proportional to the differential capacitance of the device. The $1/C^2$ module converts this voltage to its inverse square so that $1/C^2$ is plotted as a function of V directly on the X-Y recorder.

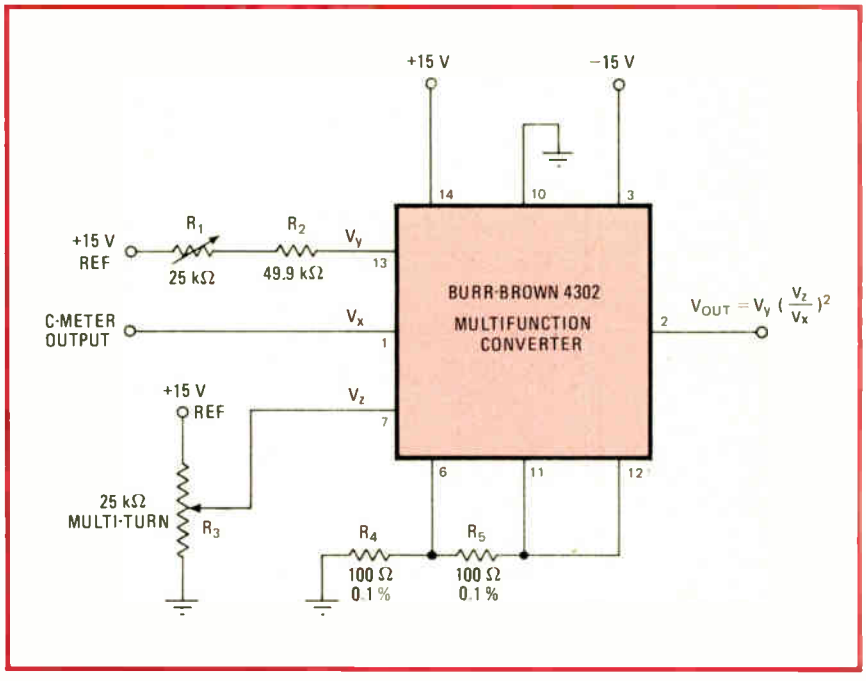
The schematic diagram of the $1/C^2$ module is shown in Fig. 2. It employs a Burr-Brown Model 4302 multifunction converter IC that gives an output voltage

$$V_{out} = V_y(V_z/V_x)^m$$

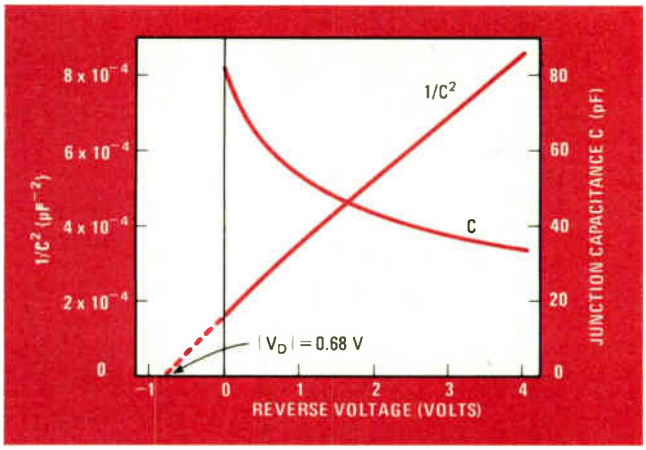
where the exponent m can be adjusted to any value from 0.2 to 5 by proper choice of R_4 and R_5 and their interconnection with the IC. The voltages V_x, V_y, and V_z should all be positive. For the $1/C^2$ plotter, V_x is the output of the C meter while V_y and V_z are constant voltages. Variable resistor R_1 controls the "gain" of the circuit and may be adjusted to give a V_{out} of +10 V for $V_z = V_x$. Since semiconductor-junction capacitance decreases with reverse voltages, V_z should be adjusted to equal V_x at the maximum sweep voltage. This is



1. The secret is in the box. Block diagram shows arrangement for swept-voltage measurements of capacitance. The box that converts C to $1/C^2$ produces an X-Y plot that directly indicates the doping profile of a semiconductor junction



2. Here's what's inside. The $1/C^2$ module of Fig. 1 is a multifunction converter IC, with appropriate external resistors added to give an output signal that's proportional to the inverse square of input signal. The proportionality constant is adjusted by R_1.



3. The plot revealed. X-Y plots of C and $1/C^2$ vs reverse bias are shown for a GaAs Schottky-barrier diode. The $1/C^2$ plot calculated from the C-V curve is practically coincident with the output of the $1/C^2$ plotter; the discrepancy of about 1.5% seen at the extremity (4 volts bias) is simply due to scaling error. Extrapolation of the $1/C^2$ plot gives the diffusion potential V_D, and the slope gives the doping.

achieved with the multiturn potentiometer R_3.

Typically, capacitance meters give a full-scale output of about 2 V, so an accuracy in $1/C^2$ of better than 1% has been obtained for C-meter readings down to a tenth of full-scale. The accuracy may be enhanced by using the voltage trimming features of the IC. Sometimes it is desirable to obtain a plot of $1/C^3$, and this is readily achieved by changing R_4 to 50 ohms.

A sample swept-voltage X-Y plot of C and $1/C^2$ for a gallium-arsenide Schottky-barrier diode is shown in Fig. 3. The net doping concentration, in donors per cubic centimeter, is calculated from the expression:

$$Doping = 1.1 \times 10^7/(A^2)(slope)$$

where A is the junction area in square centimeters and the slope is the rate of change of $1/C^2$ in picofarads with V in volts. Here A was 0.95×10^{-3} cm², so the doping concentration is 7.1×10^{16} per cm³. The extrapolated $1/C^2$-vs-V plot yields a diffusion potential of 0.68 V. The deviation from linearity at low reverse voltages is due to traps in the material. □

Four-function calculators time chess matches

by Steven Sutphen
University of Alberta, Edmonton, Canada

Two 4-function calculators are the heart of a digital clock for chess matches. Really two decrementing clocks, this chess timer:

- Displays the time remaining from an initial two hours for each player.
- Allows the users to add extra time.
- Provides an accuracy to within 1/100 of a minute.

The clock is portable, runs on 9-volt rechargeable batteries, and costs less than $30 for parts. Almost any kind of 4-function calculator can be used; the only requirement is that pressing the = key must cause an operation to repeat.

The complete clock assembly includes two calculators, two extra 4½-digit displays so that the White player (playing the white pieces) can see the timing remaining on the Black player's calculator and vice versa, momentary-contact START WHITE and START BLACK switches, and a four-pole, double-throw RUN/STOP switch that also initially starts White's clock decrementing. An oscillator and some logic gates complete the hardware.

To set up the chess clock for a match, the RUN/STOP switch is placed in the STOP position. In this state, the two calculators operate normally, and each player makes the following keyboard entries: 120.01 − .01 =. This sets the initial time to two hours (120.00 minutes) for each player.

When the match is ready to begin, the RUN/STOP switch is placed in the RUN position, thus starting White's clock decrementing every 1/100 minute. After White has completed his move, he presses the START BLACK switch, which stops his own clock and starts Black's.

When additional time is to be added, the procedure involves simply STOPing the clock and ADDing in the additional time. For example, to add in one hour (60 minutes), the players enter: +60 = −.01. If mistakes are made, the normal calculator operations will correct them.

The calculators perform normally when the RUN/STOP switch is in the STOP position. With the switch in the RUN position and the clock powered up, capacitor C_1 takes a while to charge, thus allowing the R-S flip-flop formed by the two NAND gates to set. This action is the same as would have happened if Black had pressed the START WHITE switch.

The portion of the circuit consisting of four inverters, capacitor C_2, and the MC14040 divide-by-2^{12} integrated circuit form a (5/3)-hertz oscillator that generates a pulse every 0.01 minute. The output of this oscillator gates the D_3-digit drive-pulse from the calculator into the K_2 keyboard input of the calculator. This gating is done on whichever of the two calculators is currently turned on by the CD4013 D-type flip-flop. The effect of this gating is the same as pressing the = key one hundred times per minute, thereby causing the calculator to subtract .01 one hundred times per minute.

The D flip-flop synchronizes the clock and the enabling transitions. The FDZ37 light-emitting-diode displays are added, along with their 8864 drivers, so each player may see both his own and his opponent's time. It is assumed that the chess players will not depress the START buttons simultaneously; the rules of the game prohibit this.

For lower power consumption, liquid-crystal displays can be used instead of LEDs. The requirements of the display are 4½ signed digits. For a more accurate clock,

Digital chess timer. Less than $30 worth of parts, including two 4-function calculators and a duplicate LED display for each, make this portable timer with dual decrementing clocks. The assembly shown here uses APF Electronics Mark 40 calculators but, with minor modifications to the digit-drive/keyboard-input gating portion of the circuit, almost any type could serve.

a crystal oscillator should be used, with more stages of division. Including an audio alert to indicate negative times is an obvious refinement. □

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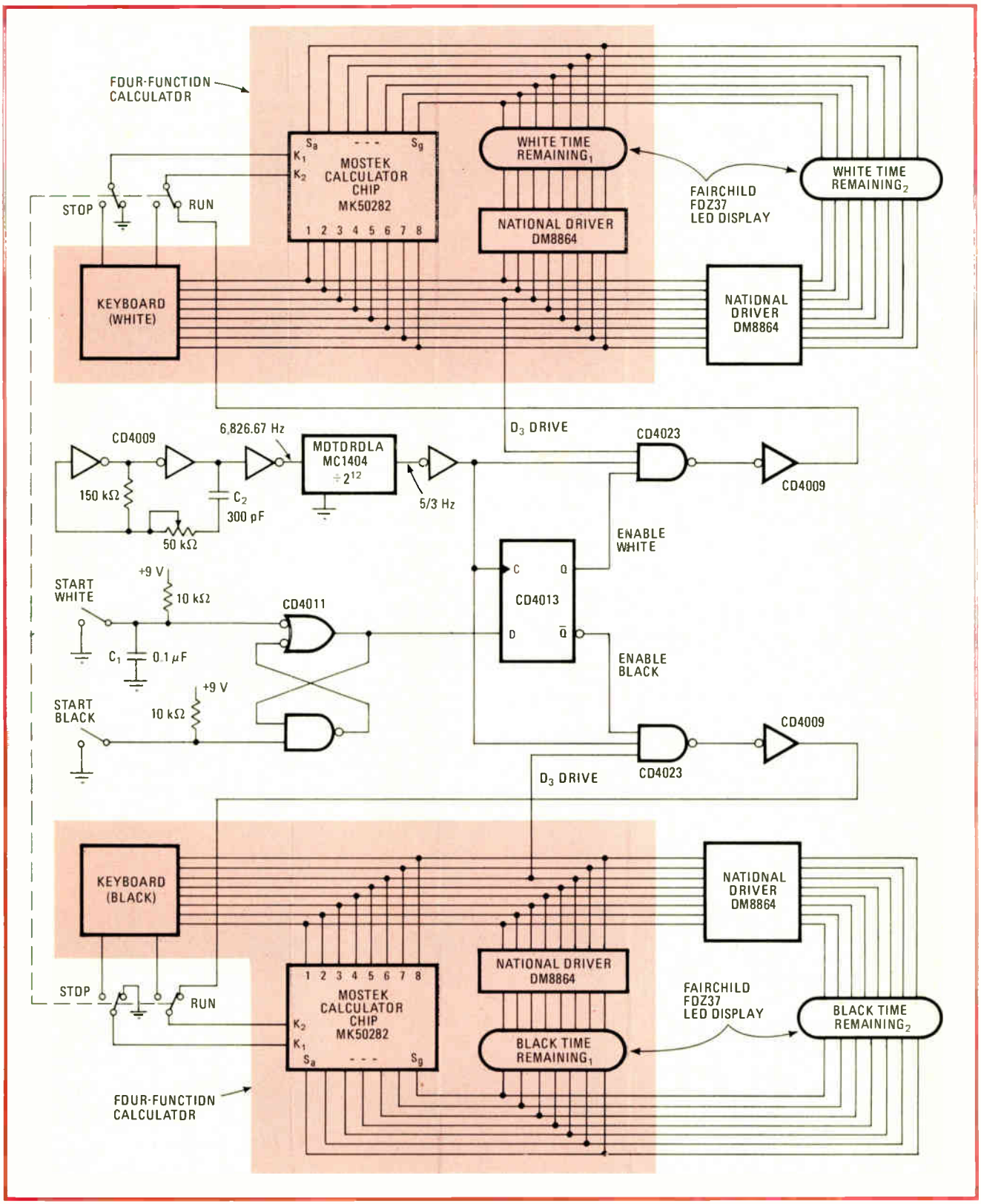

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Terminal Systems Division — Ithaca

Circle 121 on reader service card

Engineer's newsletter

Two of SR-52's program memories are available for data

William S. Morgan, of LeTourneau College, Longview, Texas, has a tip for users of the Texas Instruments SR-52 programable calculator. While most of its accessible memories are reserved for program storage, memories 98 and 99 are not. There is direct access from the keyboard, and they are not cleared by the clear-memory button. **This makes them ideally suited for storing information** that is to be retained as long as power is applied to the calculator. Storing new information automatically removes the old contents, or the memories may be cleared by storing 0.

Monolithic converters could be the best d-a or a-d route

If you're looking around for a data converter—digital-to-analog, or analog-to-digital—be sure to check out the monolithics. They've come a long way in the last two years and, in fact, complement the broad array of high-resolution hybrid units. Moreover, they often cost half as much.

But watch out: for the most part, monolithic converters are not self-contained. They may require an out-board operational amplifier, a voltage reference, or both in the case of d-a converters, or an out-board reference, comparator, clock, or some combination of the three in the case of successive-approximation a-d converters. **But the monolithics could be your best route, unless you're really pressed for board space, or need particularly tight linearity, or cannot tolerate moderately slow conversion times.**

Moreover, they are generally available with resolutions of 8 and 10 bits, which are good enough for over half of today's converter applications. Hybrids still have the 12-bit area almost to themselves. But within the next 6 to 12 months, complete 12-bit d-a monolithic converters will start to become available, as well as almost-complete 12-bit a-d monolithic converters (minus the reference), and even LSI chips that incorporate a-d circuitry coupled to a microprocessor.

72-hour service offered for ion implantation

Need fast turnaround on ion implantation? Simulation Physics Inc., Burlington, Mass., is offering 72-hour service on wafers up to three inches in diameter. **Ion species from atomic masses 1 through 210 are available with energies of 5 to 200 kiloelectron-volts.** The most commonly required ions—B^{11+}, P^{31+}, and As^{75+}—at densities to 10^{14} ions per square centimeter are available at a charge of $2 per wafer, subject to a minimum-quantity charge. Other ions are provided at a set-up cost plus a charge for running time.

Guide to buzz words aids nonspecialist in data communications

Mired in a bog of communications jargon? An expanded edition of "Sherry's Guide to Data Communication Buzz Words" is available from International Communications Corporation. First published in 1972, **the pocket-sized booklet is a good aid for the nonspecialist in the data-communications field.** The updated version has 24 pages with hundreds of definitions. It now includes terms relating to terminals and data processing. Copies are free from Public Relations Department, International Communications Corporation, 8600 N.W. 41st Street, Miami, Fla. 33166.

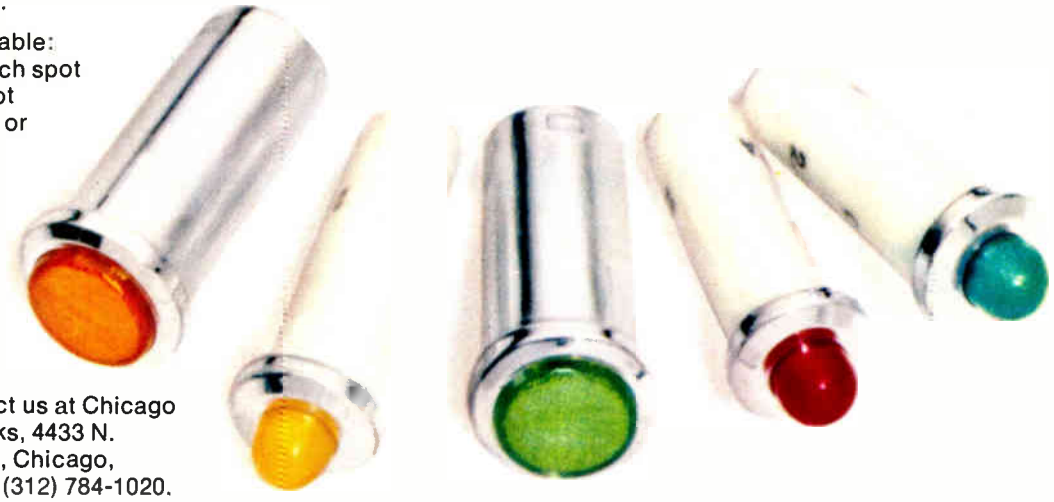
—Laurence Altman

is there a truly REVOLUTIONARY INDICATOR?

Yes. We call it the ULTRALITE.

These high-efficiency solid state indicator lights easily rival current conventional models for brightness and efficiency. Plus, they offer solid state longevity, durability, and low-power drain. Consider the advantages in applications where life, shock, vibration, and heat/power consumption are crucial factors.

The key is a unique package we designed from the ground up . . . from chip to functional chrome housing. The result takes real advantage of the LED light. In fact, our larger lamp puts out up to 13 mcd! And along with brightness comes an incredible field of indication up to 160°.



Three sizes are available: standard LED, .30-inch spot diameter, and .40 spot diameter. Order with or without resistors. Colors are red, amber and green. Options include voltage, current, lenses. and more.

ULTRALITE! You really have to see it to believe it. Contact us at Chicago Miniature Lamp Works, 4433 N. Ravenswood Avenue, Chicago, Illinois 60640. Phone (312) 784-1020.

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Circle 123 on reader service card 123

They're gonna make you a star.

In just a very short while, we'll be giving static RAM users the same thing we've already given dynamic RAM users.

The fastest MOS device on the market.

Using the same super technology that gave you the world's first 150ns 4K dynamic RAM, we'll soon be giving you the μPD410 series of 4K static RAMs with speeds down to 100ns.

So right now you can start designing products where that kind of speed at that kind of density can really help make you a star.

For your present applications, we'll also have slower versions you'll want to use right away.

In addition to access times down to 100ns, our n-channel silicon gate 4K x 1 static RAMs will also feature cycle times down to 200ns, 12 μW/bit maximum standby power, three-state output, proven cross-coupled Flip-Flop storage cell structure to eliminate soft errors and the need for refresh circuitry.

And they'll be pin compatible with the industry standard 22-pin dynamic part.

The μPD410 series of 4K static RAMS.

For people into terminals, add-on memories, mainframes, and minis, it's quite a coming attraction.

NEC Microcomputers, Inc., Five Militia Drive, Lexington, MA 02173. 617-862-6410.

NEC microcomputers, inc.

(Data sheets now at reps and distributors.)

REPS: East—C & D Sales 301-296-4306, Contact Sales 617-273-1520, Trionic Assoc. 516-466-2300; South—Merino Sales 214-233-6002, Perrott Assoc 305-792-2211, 305-275-1132, 813-585-3327, Wolffs Sales Serv. 919-781-0164; Midwest—K-MAR Eng. & Sales 816-763-5385, McFadden Sales 614-221-3363, R.C. Nordstrom 313-559-7373, 616-429-8560, R.F. Specialists 312-698-2044; West—Mike Duffy Assoc. 303-934-7392, Electronic Component Marketing 714-524-9899, 714-295-6122, 213-340-1745, Summit Sales 602-994-4587, Trident Assoc. 408-734-5900, Tri-Tronix 505-265-8409, 206-454-0940; Canada—R.F.Q. Ltd. 416-626-1445, 514-626-8324 DISTRIBUTORS: Century Electronics, Diplomat (Chicopee Falls, Woodbury, Mount Laurel, Little Falls, Newport Beach, Clearwater, Dayton, Elk Grove Village, Farmington, Minneapolis, St. Louis, Salt Lake City, Sunnyvale), G.S. Marshall (Sunnyvale), Harvey Electronics (Lexington, Norwalk, Woodbury, Fairfield), Intermark (Santa Ana, San Diego, Sunnyvale, Seattle), Lionex Corporation, Mirco Electronics, R-M Electronics, Semiconductor Specialists, Technico.

Button holds multimeter display

Probe switch simplifies tests; five-function, 3½-digit unit measures 20 ohms full scale; voltage, resistance ranges selectable manually or automatically

by Andy Santoni, Instrumentation Editor

Of all the varieties of portable digital multimeters, by far the most popular are 3½-digit units. This resolution is sufficient for all but the most exacting applications, without the expense of additional digits.

Hewlett-Packard's latest entry in the 3½-digit multimeter market, the model 3435A, has all five standard functions—ac and dc voltage and current, plus resistance—with automatic range selection when measuring voltage or resistance. An accessory probe allows an operator to make voltage measurements without keeping the probe on the test point while reading the meter.

With the model 34112A accessory probe, priced at $40, the user presses the hold switch while the probe is in contact with the test point, removes the probe, then reads the multimeter display. In this way the probe cannot slip off to some other point or create a short on the board under test while the user is looking at the display.

The model 3435A multimeter, priced from $335, automatically selects the appropriate voltage range, from 200.0 millivolts to 1,200 volts full scale. For dc voltage measurements, accuracy is within ±(0.1% of reading + 2 digits) on the 200-mV range and ±(0.1% of reading + 1 digit) on other ranges. For ac voltage measurements, accuracy is within ±(1.5% of reading + 3 digits) from 30 to 50 hertz, ±(0.3% of reading + 3 digits) from 50 Hz to 20 kilohertz, and ±(1.5% of reading + 10 digits) from 20 to 100 kHz.

When making dc voltage measurements, maximum safe input level is 1,200 V dc plus peak ac. When the ac voltage function is selected, maximum safe input is 1,700 V dc plus peak ac or 10^7 volt-hertz, whichever is lower. Input impedance is 10 megohms ±1% on dc ranges and 5 MΩ across less than 50 picofarads on ac ranges.

Autoranging also operates in the resistance mode. Full-scale ranges from 20 ohms to 20 MΩ yield a resolution of 10 milliohms, low enough to measure the resistance of contacts or coil windings. Accuracy is ±(0.5% of reading + 6 digits) on the 20-Ω range, ±(0.2% of reading + 2 digits) on the 200-Ω to 2-MΩ ranges, and ±(0.8% of reading + 2 digits) on the 20-MΩ range. Maximum input is 250 V rms.

When measuring alternating or direct currents, ranges from 200 microamperes to 2,000 milliamperes can be manually selected. Accuracy is within ±(0.3% of reading + 2 digits) from 200 μA to 200 mA, ±(0.6% of reading + 2 digits) on the 2,000-ampere range, for dc. Accuracy is better than within ±(2% of reading + 3 digits) on all ranges for signals between 30 Hz and 10 kHz on ac.

The model 3435A is available in three configurations. The standard model, priced at $400, includes rechargeable batteries and a recharger. The 001 version (3435A-OPT001), priced at $335, is for operation from ac lines only, and the 002 version, priced at $365, is a line-power unit in a case designed for rack-mounting.

The batteries of the standard version are leakproof lead-acid cells and provide more than 10 hours of continuous use with a full charge. When a quick recharge is needed, they can take a charge for four hours, then operate for eight hours.

An automatic shut-off circuit is activated when battery power is low, and the lead-acid batteries characteristically recharge themselves a small amount if not loaded. Away from ac power, a user can leave the instrument off for a few minutes, then make a few additional measurements without a recharge.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. 94304 [338]

Components

Rotary switches take new turn

Pc board rotates with shaft, and wipers are stationary; first entry aims at CB sets

The test-equipment and communications markets are booming and—among communications areas—citizens' band radio in particular is flourishing. To satisfy the switching needs of these markets, and others that require binary-coded-decimal outputs, Oak Industries is tooling up for a family of devices it calls the Communicator Series.

First in the family is designated the Big 10-4. It's a rotary switch that delivers BCD outputs for up to 56 CB channels. The device includes a star-wheel-and-roller indexing mechanism that can handle that many detents. An optional external detenting device can be used on switches requiring less than about 20 positions.

Oak has deviated from traditional rotary-switch design in developing this unit, which is intended for high-volume, automated production, explains P. Mike Hassett, marketing vice president for the switch division. The device has a printed-circuit board that rotates with the shaft (see photo). Wipers are stationary and built into the switch housing, instead of being tied to the shaft as in many conventional designs.

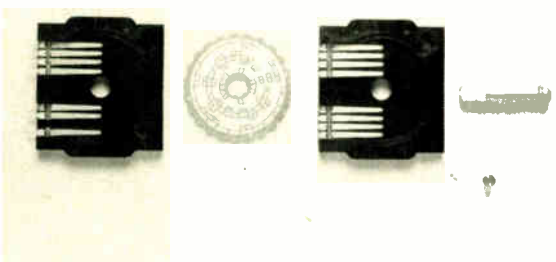
The switch is programable: the customer provides the truth table, and Oak designs metalization layout for the double-sided pc board that will deliver the desired BCD outputs. All custom work is limited to the pc board, which nestles into a standard thermoset housing that holds the wipers. The number of switch positions is programed by changing the number of scallops cut into the board's perimeter.

As the switch shaft is rotated, the wipers contact "live" surfaces on a metal maze on the surface of the board. And, unlike most traditional pc-board switches, contacts on the Oak unit never touch the laminate, Hassett says. Instead, the metalization pattern also contains metal pads isolated from the electrical circuit. "In this way," Hassett says, "precious metal is not wiped across the board, creating shorts, and insulating material isn't wiped back onto the metal conductors." The edges of the raised metal pads and paths give the switch a self-wiping action.

When an additional double-sided board is ganged onto the switch, the device can drive two seven-segment display digits. The metalization pattern is composed of silver plate over a copper-clad laminate; and silver-plated copper contacts will switch 0.125 ampere at 28 volts.

The switch measures 1.665 by 1.5 inches, and the switch body is 0.4 in. deep. Minimum behind-panel space required for a bushing mount is $\frac{5}{8}$ in. Life tests aren't finished yet, Hassett says, but the switch has successfully completed 25,000 cycles. In quantities of 1,000, a one-section switch will sell for $2.29; with driver section included, it will go for $3.62. The device is now in limited production.

Oak Industries Inc., Switch Division, Crystal Lake, Ill. 60014 [341]



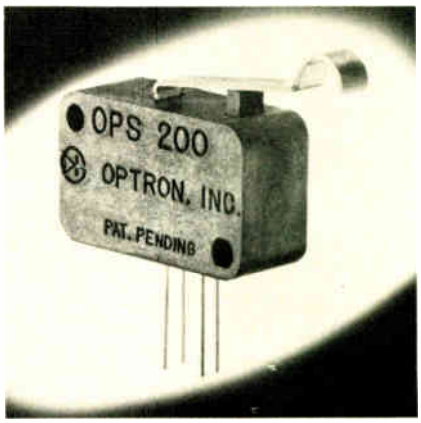
Digital delay line is continuously variable

Designed for applications that require very precise clock-delay adjustment, a digital delay line offers delay increments as small as 0.5 nanosecond. The unit can be adjusted over the range from 10 ns to 30 ns, and it has an inherent delay of approximately 10 ns at the minimum delay setting. Compatible with TTL levels, the series DDU-39 fits standard 16-pin dual in-line sockets. Temperature coefficient is 200 ppm/°C; and rise time is typically 4 ns. The delay line requires a supply voltage of 5 v dc ±10%. The price, in hundreds, is $13 each.

Data Delay Devices, 253 Crooks Ave., Clifton, N. J. 07011. Phone (201) 772-1106 [343]

Snap-action optical switch is compatible with TTL

The OPS 200 is an optically coupled limit switch that uses a snap-action mechanism to interrupt the light path between a gallium-arsenide

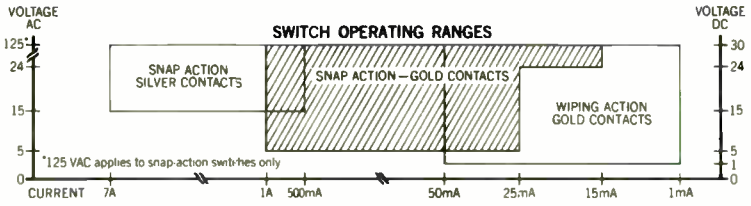


light-emitting diode and a silicon photosensor. This combination of conventional mechanical actuation and contactless switching eliminates such problems as contact bounce and contamination. The device uses a high-gain npn phototransistor output for TTL compatibility at a LED drive current of 30 milliamperes. A companion device, designated the OPS 200A, contains a Schmitt trigger output with a current-sinking capability of 140 mA to eliminate the need for amplifiers in most applications. The OPS 200 sells for $2.75 each in thousands. Both switches are available from stock in

Dialight sees a need:

(**Need:** A switch for all reasons.)

Reason 1: Dialight offers three switch configurations to meet all your needs—*snap-action switches with silver contacts* for moderate-level applications, *snap-action switches with gold contacts* for intermediate-level applications, and *wiping-action switches with gold contacts* for low-level applications. Each of these ranges is served by two switching actions—momentary (life: 600,000 operations) and alternate (life: 250,000 operations).

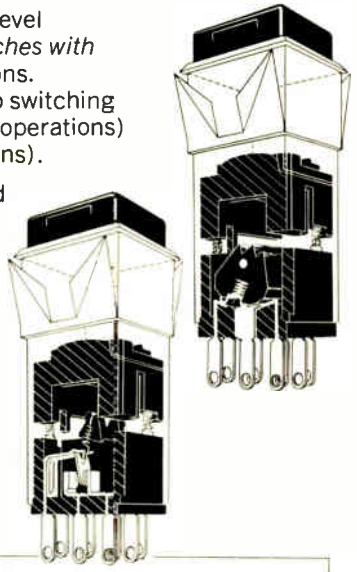


Reason 2: Dialight's snap-action and wiping-action switches come in a new modular design concept . . . a common switch body for either high or low current operation. All 554 series switches and matching indicators have the same rear-panel projection dimensions.

The snap-action switching mechanism guarantees a fast closing and opening rate. This insures that contact force and contact resistance are independent of the switch's actuation speed.

In the wiping-action switch, the contacts are under constant pressure (A unique Dialight design). This insures long life with a minimum build-up of contact resistance.

Both switch types are tease-proof.



PRODUCT SELECTOR GUIDE

SWITCHING ACTIONS	Snap-Silver contacts		Snap-Gold contacts		Wiping-Gold contacts	
	SPDT	DPDT	SPDT	DPDT	SPDT	DPDT
MOMENTARY	○	○	○	○	○	○
ALTERNATE	○	○	○	○	○	○

OPTIONS

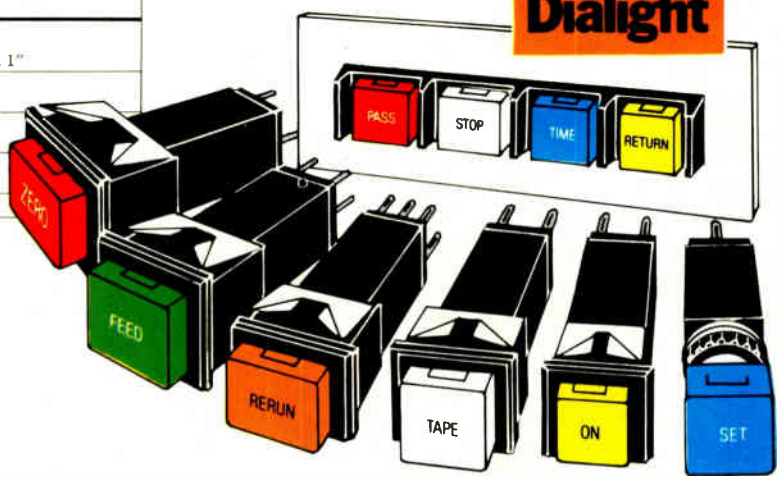
	PUSH BUTTON CAP SIZES				
	½" Sq.	⅝" Sq.	⅝" x ¾"	¾" Sq.	¾" x 1"
BEZEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
BEZEL MOUNTING WITH BARRIERS TO ACCOMMODATE		○	○	○	○
PANEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
MATCHING INDICATORS	○	○	○	○	○

Reason 3: Dialight offers a wide variety of panel and snap-in bezel mounting switches with momentary and alternate action configurations in SPDT and DPDT types. There are over 240 switch variations to choose from.

The 554 illuminated switch, designed for front of panel lamp replacement, gives you a choice of five different bezel sizes . . . ¾" x 1", ⅝" x ¾", ¾" square, ⅝" square, and ½" square. The first four sizes are also available with barriers. You also get a choice of six cap colors . . . white, blue, amber, red, green, and light yellow . . . four different underlying filter colors . . . red, green, amber, and blue and a variety of engraved or hot-stamped legends . . . over 300 cap styles . . . over 100,000 combinations.

There is also a variety of terminal connections . . . solder blade, quick connect, and for PC board insertions.

Reason 4: Dialight's 554 series is designed as a *low cost* switch with *computer-grade quality.*



DIALIGHT
A North American Philips Company
203 Harrison Place, Brooklyn, N.Y. 11237
(212) 497-7600

Circle 127 on reader service card

Introducing the new AMP Zero Insertion Force pc connector. We call it failsafe for good reason.

Because it eliminates all the force you once needed to install printed circuit boards. No force, no failure.

Also, a unique side-entry capability lets you use all sides of the board for edge-type I/O connections, which opens new design latitudes.

This AMP innovation does it all with a simple camming mechanism that opens the contacts for push-free p.c. board insertion.

And allows them to return to their failsafe operating position just as gently.

As much as 110 lbs. of push can be eliminated when you're installing a dual, 110-pin-count daughter card.

The versatility of the ZIF connector is best demonstrated in terms of your specific need. Your AMP sales engineer is trained to help with your problems.

With both of you keeping watch on the mechanics—and economics—it's hard to go wrong.

To find out how ZIF connectors can take the force out of high pin-count applications, call Customer Service at (717) 564-0100.
AMP Incorporated,
Harrisburg, PA 17105.
It might take some pressure off you, too.

AMP
INCORPORATED

Circle 128 on reader service card

AMP is a trademark of AMP Incorporated.

either normally open or normally closed conditions.

Optron Inc., 1201 Tappan Circle, Carro lton, Texas 75006. Phone (214) 242-6571 [344]

Fuse holder accepts 3AG and 5-by-20-mm fuses

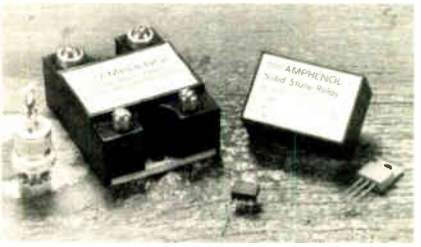
Just as the 3AG fuse is the standard instrument fuse in North America, the 5-by-20-millimeter device is the European standard. Instrument makers who want to sell their products on both sides of the Atlantic need now install only one type of fuse holder—the model FEC—to serve both markets. When the instrument is ready for shipment, an appropriate fuse and carrier can be inserted.

All current-carrying parts of the fuse holder are recessed to make accidental contact with them virtually impossible. The fuse is inserted first into the insulated carrier, after which the carrier is inserted into the socket, completely isolating the fuse from possible contact. Rated at 10 amperes by Underwriters Laboratories and SEV (the Swiss safety agency), the model FEC is rated at 6.3 A by VDE (Germany) and Semko (Sweden). In thousands, the unit sells for 54 cents for a holder plus one carrier. Delivery is from stock.

Panel Components Corp., 2015 Second St., Berkeley, Calif. 94710. Phone (415) 548-1966 [345]

Solid-state relay has 4,000 V ac isolation

Offered with current ratings from 2 to 40 amperes, a family of solid-state relays has input/output isolation-voltage ratings of 4,000 V ac and a maximum output-voltage rating of 1,200 V. Designed for nominal line voltages of 120, 340, and 330 V ac over the frequency range from 47 to 63 hertz, the relays have control voltages from 3 to 32 V dc. For direct interfacing with complementary-MOS circuitry, special models are available that will turn on

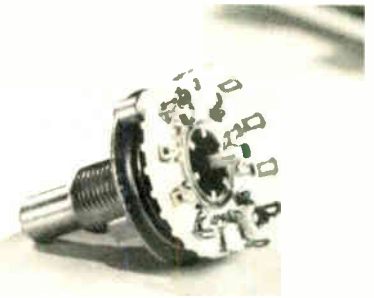


with a control current of 1.5 milliamperes at 10 V dc. The relays feature zero-voltage switching and include an internal RC network across the output to minimize the effects of line transients. The relays are listed by Underwriters Laboratories for use in both industrial and medical/dental equipment and also meet the applicable isolation requirements set by regulatory bodies in Germany, Switzerland, and the United Kingdom. Prices of the 815 series start at $5 each in quantities of 1,000. Delivery is from stock.

Bunker-Ramo Sales Division, Component Marketing Service, 2875 South 25 Ave., Broadview Ill. 60153. Phone Larry Edwards at (312) 345-4260 [347]

12-position switch is only 1 inch in diameter

Measuring only 1 inch in diameter and 1.36 in. deep, the Monodex 12-position rotary switch is intended for such consumer applications as home entertainment equipment. The unit's silver-plated brass contacts can carry 5 amperes and break 0.5 A at 28 V dc or 0.25 A at 110 V ac. Contact resistance is 3 to 15 milliohms. A molded stator helps



achieve high dielectric strength.
Oak Switch Division, Crystal Lake, Ill. 60014. Ask for bulletin SP-742 or phone (800) 435-6106 for price/delivery quotations [346]

Miniature crowbars switch in less than 10 μs

Half the size of conventional dc crowbars, series LVC-1 units require less than 10 microseconds after sensing an overvoltage to switch from an open circuit to a virtual short. Recovery is automatic when power is momentarily removed.

Series LVC-1 crowbars are available with trip voltages to 600 V dc. Prices range from $6 to $65 each in hundreds; delivery time is two weeks.
MCG, 279 Skidmore Rd., Deer Park, N. Y. 11729. Phone Mike Coyle at (516) 586-5125 [348]

Resistor networks designed for emitter-coupled logic

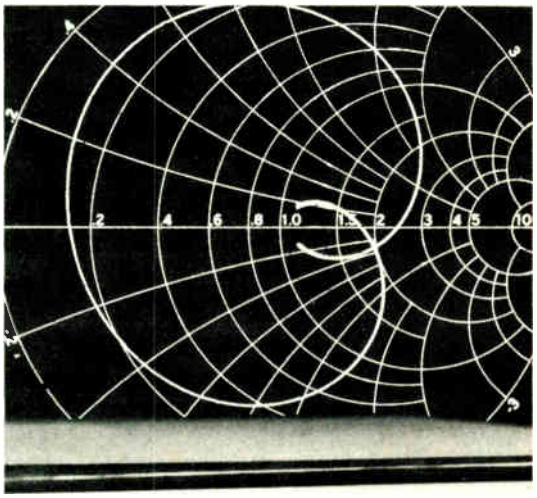
Using thick-film construction and housed in dual in-line packages, two resistor-network circuits are built for use with emitter-coupled logic. Series DP16-08 functions as a 2-volt emitter-coupled-logic terminator, and SDP16-09 provides a 5.2-V ECL pull-down. Other SDP series networks in production include pulse-squaring transistor-transistor-logic terminators and TTL-to-emitter-coupled-logic translators.
Dale Electronics Inc., Dept. 860, Box 609, Columbus, Neb. 68601. Phone (402) 371-0080 [349]

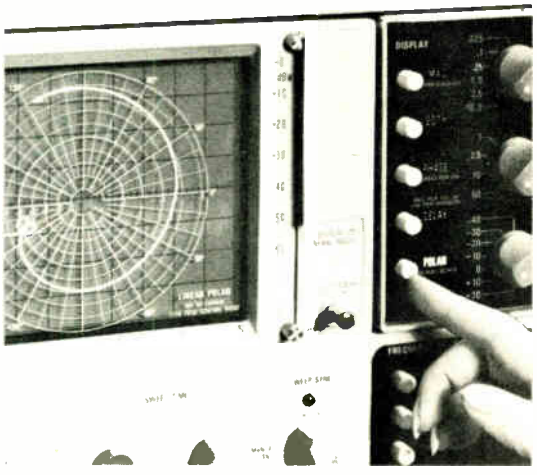
GR's Network Analyzer Costs Less and Performs Better

In the market for a high-performance network analyzer? The choice usually boils down to three instruments. All three are excellent products and the final selection typically centers around how important certain specifications are to one's applications. If *overall value* is the deciding criteria, then GR's widely used 1710 RF Network Analyzer has a definite edge. Here's why:

	GR 1710	HP 8407*	HP 8505*
Price	$9,850	$10,625	$22,500
Frequency Range	0.4 to 500 MHz	0.1 to 110 MHz	0.5 to 1300 MHz
Polar Display	Yes	Yes	Yes
Group Delay	$495 option	No Option	Yes
Dynamic Range	115 dB	80 dB	100 dB
Resolution	0.025dB	0.25 dB	0.1 dB

*Based on information contained in HP's 1976 Catalog





Now, of course, there are many more specs to compare and GR doesn't win in all areas, but the specs cited above are among the most important... including price. Unfortunately, one important feature of the GR 1710 that doesn't show up in the specs is its convenience of operation. Nothing can be more simple than GR's pushbutton switching from displays of magnitude to phase, or to both magnitude and phase, to delay, or to polar.

To get the full story on the capabilities of the GR 1710 request a copy of "RF Network Analysis", a 12-page brochure that describes the 1710 plus all its options and accessories. We'll also include a copy of Application Note 7, which describes how simple it is to make measurements with a GR 1710 at frequencies up to 2000 MHz or even higher.

Write to GenRad, 300 Baker Avenue, Concord MA 01742 or call one of the numbers listed below:

Atlanta 404 394-5380
Boston 617 646-0550
Chicago 312 992-0800
Dallas 214 234-3357
Dayton 513 294-1500
Los Angeles 714 540-9830
New York (NY) 212 964-2722
(NJ) 201 791-8990
San Francisco 408 985-0662
Washington, DC 301 948-7071
Toronto 416 252-3395
Zurich (01) 55 24 20

GR 1710 prices start at $9700. Order now (after you make your own comparison, of course).

GenRad

Instruments

Signal source is programable

Constant-voltage, -current supply is aimed at computer-controlled tests

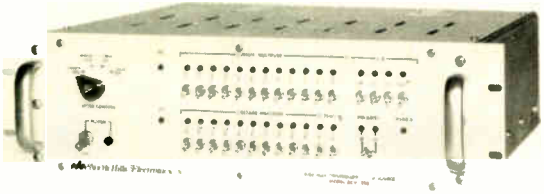
Automatic test systems often require precise sources of both constant current and constant voltage. The model DCVS-220 from North Hills Electronics meets these needs by operating in either the constant-current or constant-voltage mode. In addition, the unit is digitally programable.

Remote selection of voltage is made through 12 binary bits plus one polarity bit, and current is selectable through 16 bits. For local, manual control, the operator uses front-panel switches.

Once a voltage and current limit is set on the instrument, it selects the proper mode based on the load resistance. That is, if the load resistance is too high to provide the proper current without exceeding the voltage limit, the constant-voltage mode is selected. If the resistance is too low to provide the selected constant voltage, the instrument switches to the constant-current mode.

Currents from 2.5 microamperes to 300 milliamperes and voltages from 0.025 to 100 volts can be programed. Voltages may be of either polarity.

Output regulation of the unit is 25 parts per million from no load to full load and 5 ppm for input-line variations. Temperature coefficient is 15 ppm/°C over a temperature range of 15°C to 35°C.



Among applications of the current-voltage source are computer-controlled testing of semiconductors, thermistors, gyroscopes, and relays; meter calibration, and precision voltage and current settings for X-ray, welding, and electron-microscope beams.

The model DCVS-220 is priced at $2,800. Digitally controlled separate current and voltage sources, models DCS-30 and DVS-40 respectively, are priced at $2,400. Availability is stock to 30 days.

North Hills Electronics Inc., Glen Cove, N.Y. 11542. Phone (516) 671-5700 [351]

8-channel digital analyzer operates up to 12 megahertz

The model 80-M digital analyzer records and displays up to eight channels of digital data on any conventional oscilloscope. Capable of operating at speeds up to 12 megahertz (20 MHz, typically), the unit

has a variable threshold for handling a wide range of logic families. Recording capacity is 1,024 bits on each of the eight channels. Special features include 15-nanosecond-spike detection, provision for both internal and external clocking, and manual and automatic triggering. The analyzer, with one set of probes, sells for $1,595. Additional probe sets cost $45 each. The model 40-M, which handles only four channels, is priced at $995. Delivery time is from stock to 60 days.

Digital Broadcast Systems Inc., P. O. Box 381, Madison, Ala. 35758. Phone Winton Churchill at (205) 837-2183 [354]

Test clip checks many logic families

When troubleshooting digital circuits, often all that's needed is some way to view the activity at individual integrated-circuit pins. A low-cost instrument that permits the user to perform this function is a logic clip like Hewlett-Packard's $105 model 548A.

The 548A is the last in HP's new kit of low-cost digital troubleshooters, which also includes a pulser, a probe, and a current tracer. As with the other testers, the 548A is multifamily; it can test transistor-transistor, diode-transistor, resistor-transistor, complementary-MOS, and high-threshold logic devices. Operation is automatic for all logic families employing supplies from 4 to 18 volts dc.

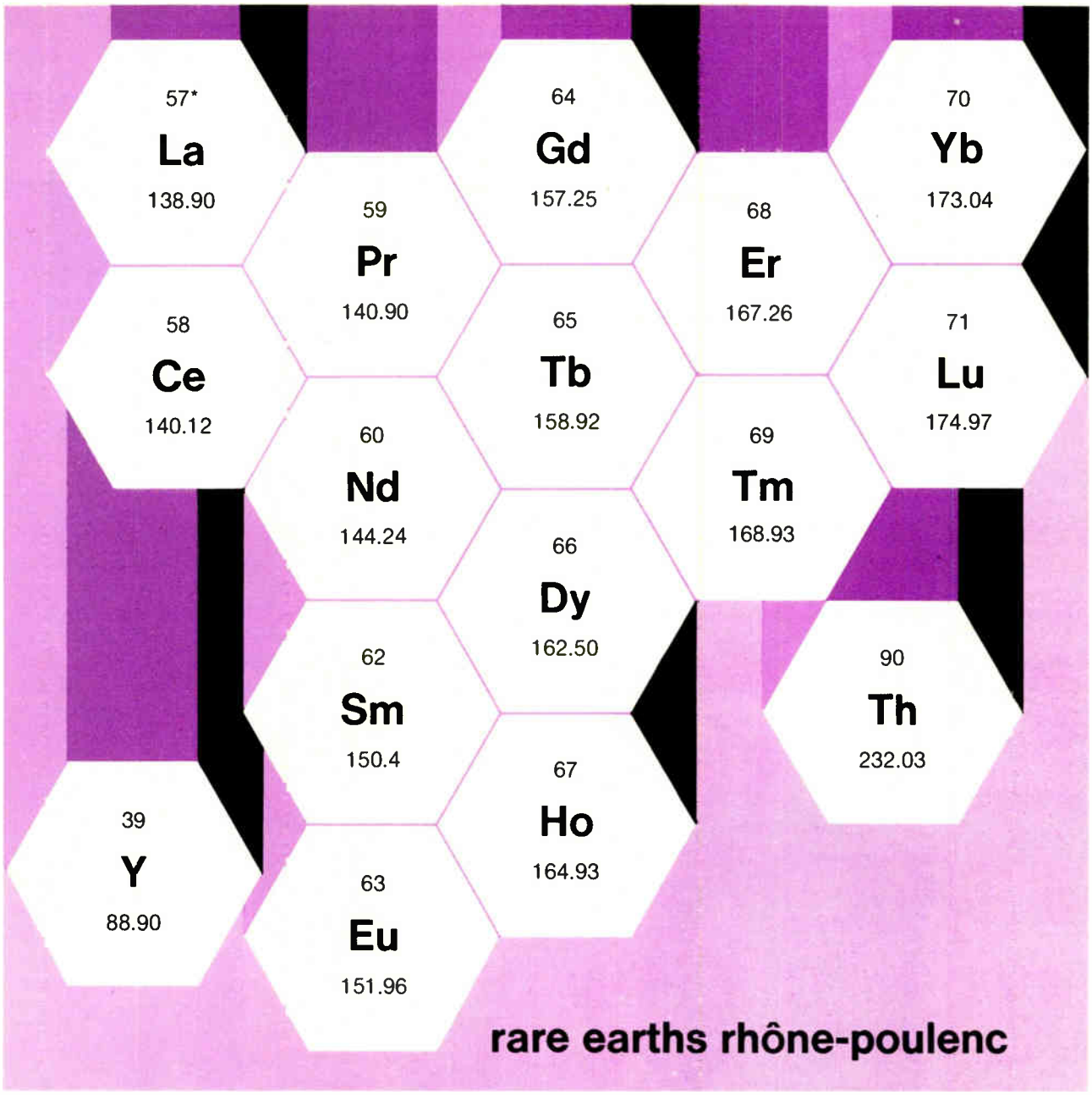
The test clip is powered from the device under test, except for 3-volt C-MOS, which requires an external supply of 4.5 V. The instrument locates the supply and ground pins automatically.

The 548A indicates a logic 1 when the input level exceeds (0.40 ± 0.06) times the supply voltage. Inputs can withstand up to 25 V dc for one minute without damage.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [353]

30-MHz delay-line scope sells for only $820

Supplied complete with a 160-nanosecond delay line that allows the user to view the leading edge of the triggering waveform, the model 1474 oscilloscope is a two-channel instrument with a sensitivity of 5 millivolts per centimeter and a bandwidth of 30 megahertz. Priced at only $820, the scope features



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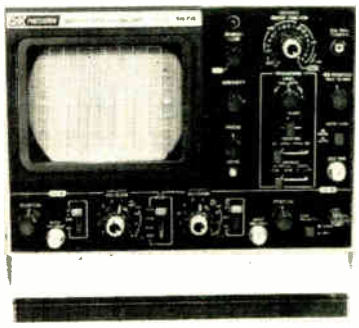
New products

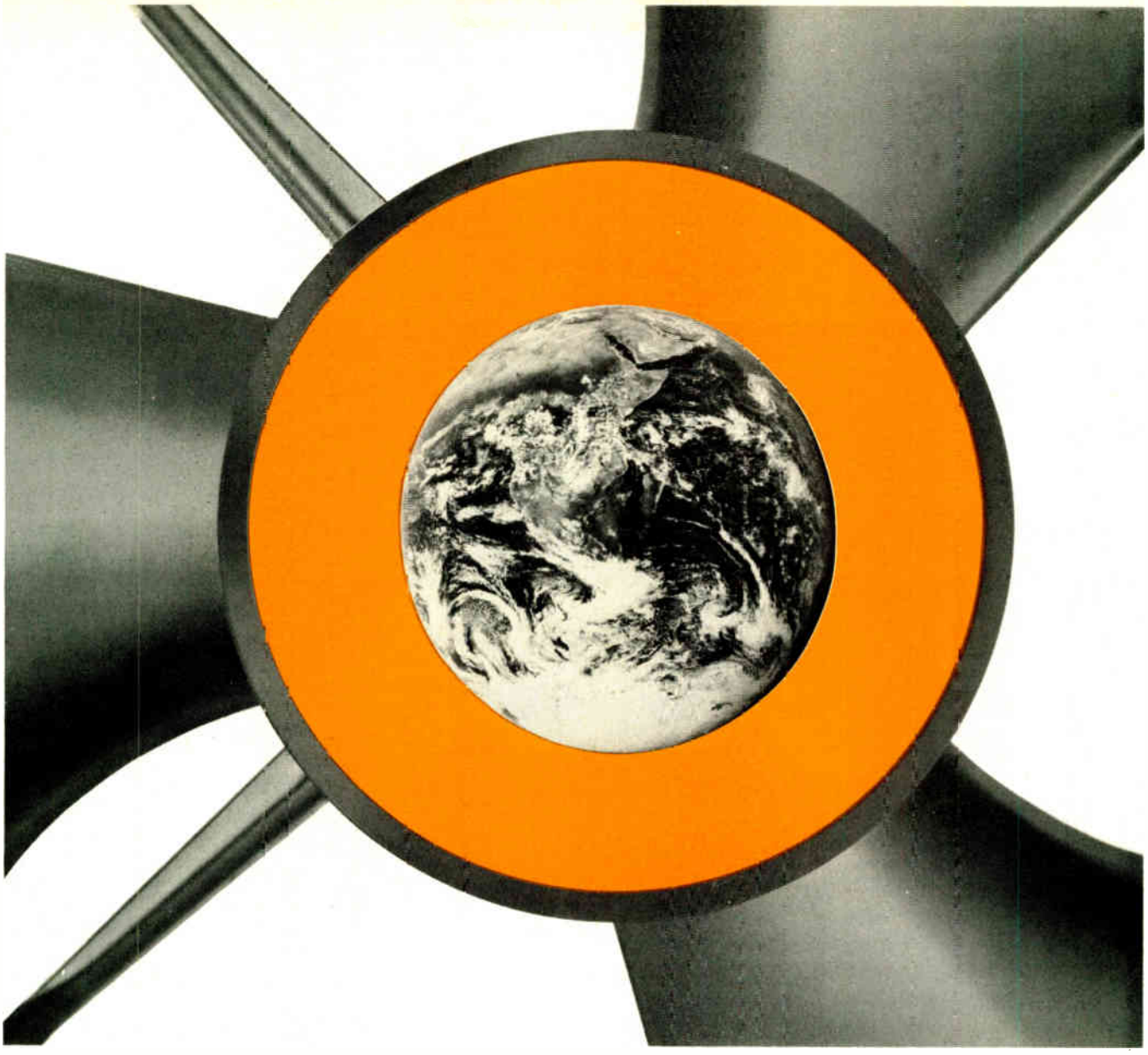


automatic triggering, automatic selection of chopped or alternate mode of display by the time-base switch, and built-in high-pass and low-pass filters for the triggering circuitry. The unit is available from B&K-Precision distributors.

B&K-Precision, Dynascan Corp., 6460 W. Cortland Ave., Chicago, Ill. 60635. Phone (312) 889-8870 [355]

Autoranging portable DMM has a liquid-crystal display

The model 6000 digital multimeter is a portable battery-operated unit whose low-power liquid-crystal display allows its two 9-volt transistor batteries to last an average of 200 hours. The autoranging 3½-digit meter measures ac and dc voltages from 200 millivolts full scale to 1 kilovolt, ac and dc current from 2 milliamperes full scale to 10 amperes, and resistance from 200 ohms full scale to 20 megohms. Zeroing and polarity detection and indica-



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18514

tion are both automatic. Housed in an impact-resistant Lexan case, the rugged instrument weighs less than two pounds. It sells for $195.

Weston Instruments Division, 614 Frelinghuysen Ave., Newark, N.J. 07114. Phone (201) 242-2600 [356]

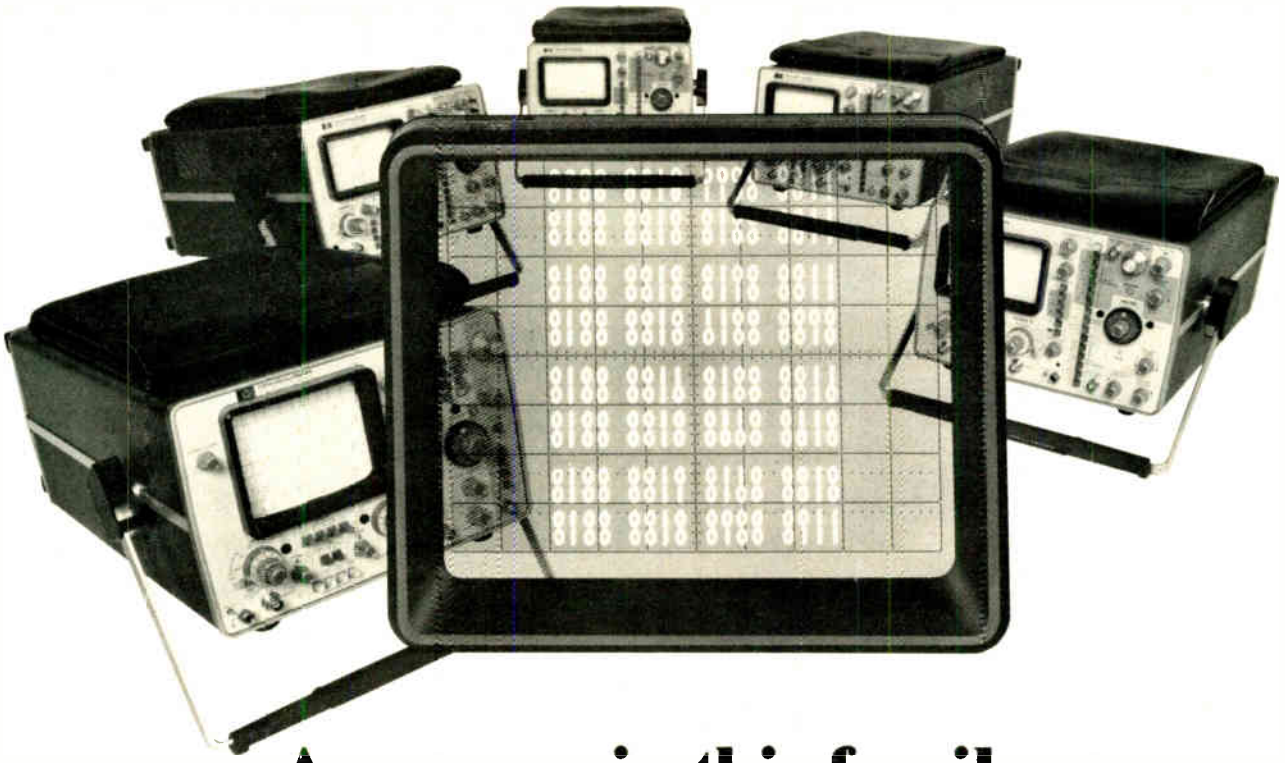
Hall-effect gaussmeter resolves 0.01 gauss

A 3½-digit Hall-effect gaussmeter, the model 511, has five measurement ranges: 10, 100, 1,000, 10,000, and 100,000 gauss, full-scale. On the lowest of these, the unit can resolve 0.01 gauss. Maximum error is 0.5% of full scale plus one count. The instrument measures both dc fields and ac fields to 1 kilohertz. Axial, transverse, and special probes are available. An analog output, calibrated to provide 1 volt at full scale, is provided for driving an oscilloscope or chart recorder.

LDJ Electronics Inc., 1064 Naughton Ave., Troy, Mich. 48084. Phone (313) 689-3623 [357]

5-MHz pulse generator is priced at $125

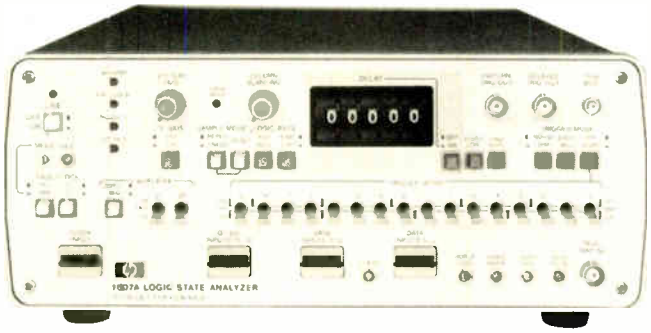
The DM-4 pulse generator provides symmetrical and asymmetrical pulses over the frequency range from 0.5 hertz to 5 megahertz. Priced at only $124.95, the unit has a positive output from 100 millivolts to 10 volts, and rise and fall times of



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

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

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



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

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

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

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

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

*Domestic U.S.A. prices only

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New products

less than 30 nanoseconds. Pulse width and spacing are independently adjustable from 100 ns to 1 second in seven overlapping ranges. A TTL-compatible sync pulse, which leads the main outputs by 40 ns, is also provided.

Continental Specialties Corp., 44 Kendall St., Box 1942, New Haven, Conn. 06509. Phone (203) 624-3103 [358]

Spectrum analyzers have four-digit frequency readout

A family of three microwave spectrum analyzers from Nelson-Ross features four-digit LED frequency display, direct-reading absolute-level calibration, 70-decibel on-scale dynamic range, and internal self-checking of amplitude and frequency calibration. The 630 and 631 each covers the frequency range

from 10 megahertz to 40 gigahertz—the former in seven overlapping bands and the latter in six such bands. The model 632 (shown) spans the range from 500 kilohertz to 2 GHz in a single band. The units can display frequency spans up to 2 GHz and, at the other extreme, have

Stop waiting for a better NOVA*.

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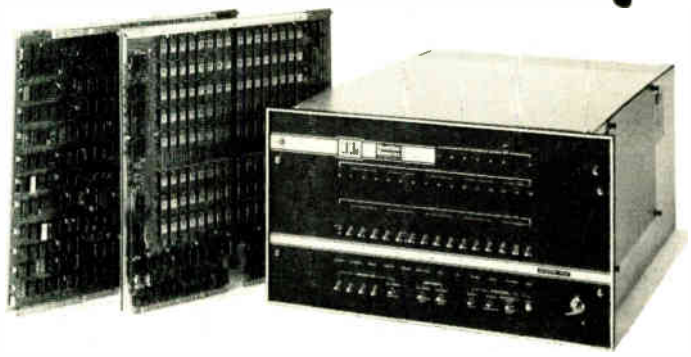

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CONFIGURATION	NOVA 2/10	μMINI 3/09	NOVA 3/12
CPU, Chassis, P.S., Front Panel	✓	✓	
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PM/AR	✓	✓	
MPY/Div	✓	✓	NOVA 3 WHERE ARE YOU?
Real Time Clock	✓	✓	
TTY Control	✓	✓	
PTR Control	✓	✓	
PTP Control	✓	✓	
Slots used	5	2	
List Price	**$13,800**	**$9,450**	

Above pricing derived from Data General April 1, 1975 price list and MMI May 15, 1976 price list. Single unit prices.

For more information, or to arrange a hands-on demo, call TWX, write Al Trejo, or contact your local representative.

United States
Monolithic Memories, Inc.
1165 E. Arques Avenue
Sunnyvale, CA 94086
Phone: 408/739-3535
TWX: 910-339-9229

Europe
Monolithic Memories,GmbH
8000 Munich 80
Mauerkircherstr. 4
West Germany
Phone: (089) 982601
Telex: (841) 524385

Far East
MMI Far East Ltd.
Parkside-Flat Building
4-2-2 Sendagaya
Shibuya-Ku
Tokyo 151, Japan
Phone: (3) 403-9061

* Nova is a trademark of the Data General Corporation

Monolithic Memories

New products

phase-locked circuits that provide narrow-band analysis with a resolution to 300 kHz. Pricing is $7,750 for the 630, $7,100 for the 631, and $5,975 for the 632. Delivery time for all three is 15 weeks.

Nelson-Ross Electronics, 5 Delaware Dr., Lake Success, N.Y. 11040. Phone (516) 328-1100 [359]

3½-digit panel meter sells for $69

Priced at only $69 in unit quantities, the DM-350D1 is a unipolar 3½-digit panel meter that pulls only 1.5 watts from a 5-volt supply. Other members of the DM-350 family include bipolar and ac-powered versions, the most expensive of which, the DM-350A2, is both ac-powered and bipolar and sells for $89 in unit quantities. All four members of the family use 0.43-inch red LED displays, have a sampling rate of two samples per second regardless of signal level, and have a maximum uncertainty of 2 counts. Bias current is typically 45 nanoamperes, 500 nA maximum. Polarity indication for the bipolar models is automatic, and temperature drift does not exceed 10 millivolts over the operating range from 0 C to 50 C.

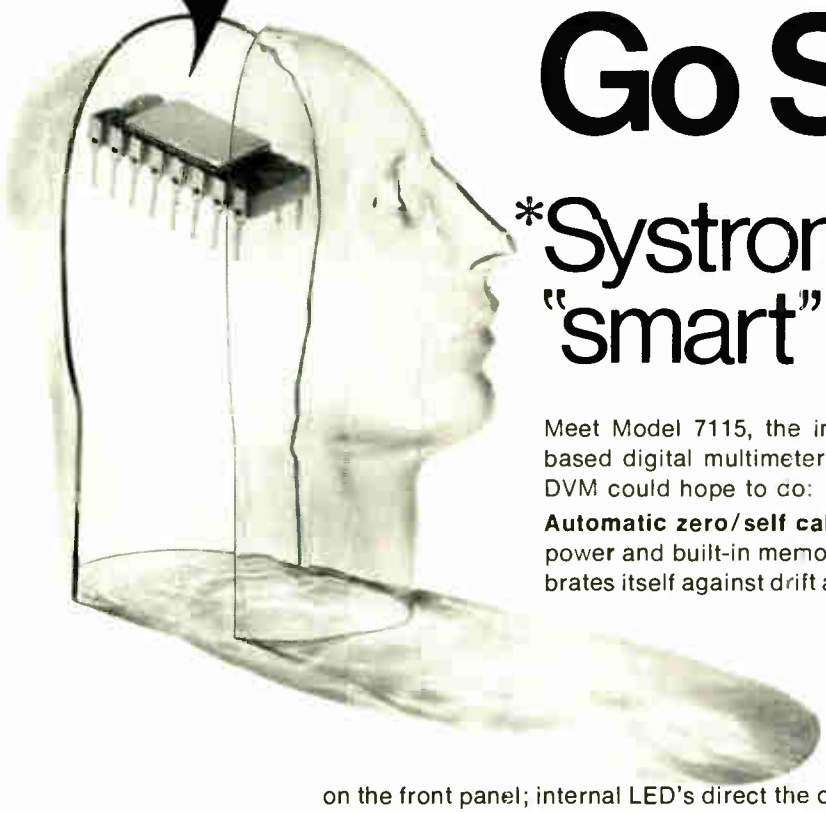
Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone (617) 828-8000 [360]

TOPICS

Instruments

Tele-Dynamics, Fort Washington, Pa., has announced that all 30 models of its HR series of modular dc supplies have been given component recognition by Underwriters Laboratories. . . .

Bird Electronics Corp., Cleveland, Ohio, has announced price reductions on three of its Thruline directional rf wattmeters. The model 4314 has been reduced from $475 to $395, the battery-powered 4311 from $450 to $395, and the rack-mounted 4511 from $495 to $395.



Go SDVM*

*Systron-Donner "smart" DVM

Meet Model 7115, the industry's first **microprocessor**-based digital multimeter. It does what no conventional DVM could hope to do:

Automatic zero/self calibration. Using its computing power and built-in memory, Model 7115 continually calibrates itself against drift and component aging. Similarly, it detects and corrects for zero drift and offset error. Result: accurate readings all the time!

Self-diagnosis. Microprocessor power again. Out-of-limit conditions or failures are signalled on the front panel; internal LED's direct the operator to their location inside.

High-speed autoranging. A rapid new S-D autoranging technique finds the correct range, goes there immediately and reads. It's not only a big improvement for bench use, but systems users can now use autoranging.

Command performances. An optional keyboard for programming the Model 7115 allows it to linearize and normalize, run comparison programs for checking out-of-tolerance conditions, multiply by a constant, average readings . . . and much more.

These features, too. Up to 100 readings/sec. • DC accuracy of ±0.002% rdg. • Parallel programming or ASCII option • True RMS AC volts option • High accuracy resistance measuring option.

Get the full story on the first SDVM from Scientific Devices, or contact us at 10 Systron Drive, Concord, California 94518. Phone (415) 676-5000. Overseas, contact Systron-Donner in Munich; Leamington Spa, U.K.; Paris (Le Port Marly); Melbourne.

SYSTRON DONNER

17 days from now this trace will look the same as it does today. Now that's storage!

The Gould OS-4000 Digital Storage Oscilloscope . . .
will store any signal up to 450 kHz for as long as you need, while providing the performance of a conventional 10 MHz scope as well. The OS-4000 opens the door for entirely new viewing possibilities involving low frequency measurements. It is ideal for displaying and recording transient waveforms for medical, electrical, vibration, dynamic testing and pulse testing applications.

The digital storage capability provides a non-flickering, full trace at low frequencies and a unique "Dot Joining" technique.

The OS-4000 will allow you to simultaneously view stored and real time signals. These may even be superimposed to reveal small changes.

The OS-4000 also allows you to examine a single event trace prior to, as well as after, a trigger point; and it's stored indefinitely as long as power is supplied to the unit.

If you'd like a hard copy of a stored trace, you can record it in either analog or digital form on your recorder by using the Gould 4001 Output Unit.

Find out how the unique Gould OS-4000 Digital Storage Oscilloscope and the companion 4001 Output Unit can make your work more efficient and easier. Call your nearest Gould Sales Engineer for details. Or write Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114.

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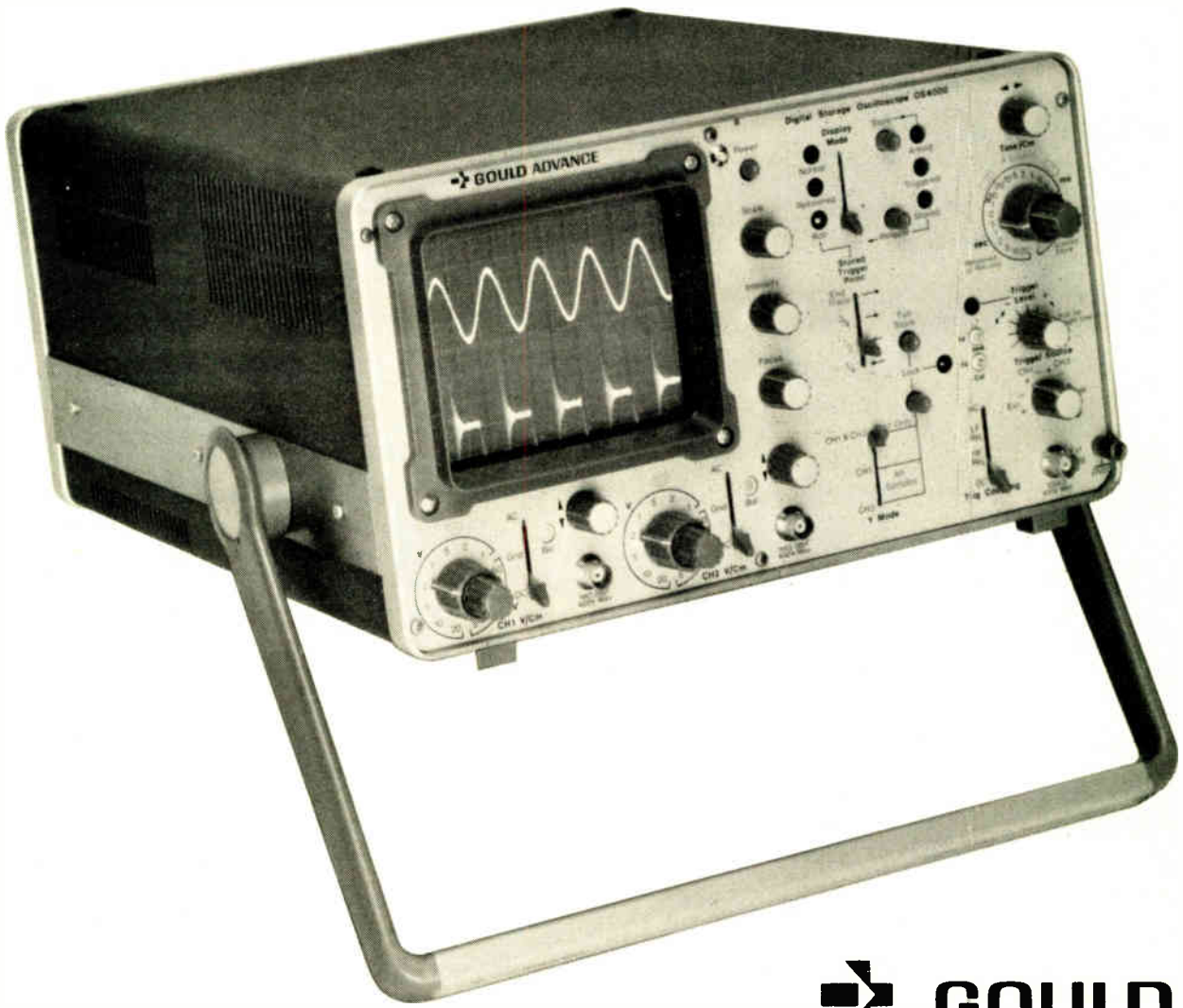


GOULD

Subassemblies

Rms-dc module spans 8 MHz

Converter, suited for DVMs, offers accuracy within 0.5% in 5-volt operation

Manufacturers of digital voltmeters, of noise sources, and of in-house test equipment for calibration will be among those interested in a wideband true-rms-to-dc converter from Analog Devices Inc. The model 442 extends the capability of models 440 and 441, introduced earlier by the company's Modular Instrument division.

Fred Pouliot, marketing manager for analog modules in the division, says the model 440 "has had a good portion of the rms-to-dc-converter market," but the 442 tops it in bandwidth, a feature that DVM makers, in particular, are looking for. The 442 offers 8-megahertz bandwidth accurate to within ±0.5% for crest factors up to 10. A crest factor is a measurement of the shape of a waveform; it equals the peak value divided by the true rms value of the waveform.

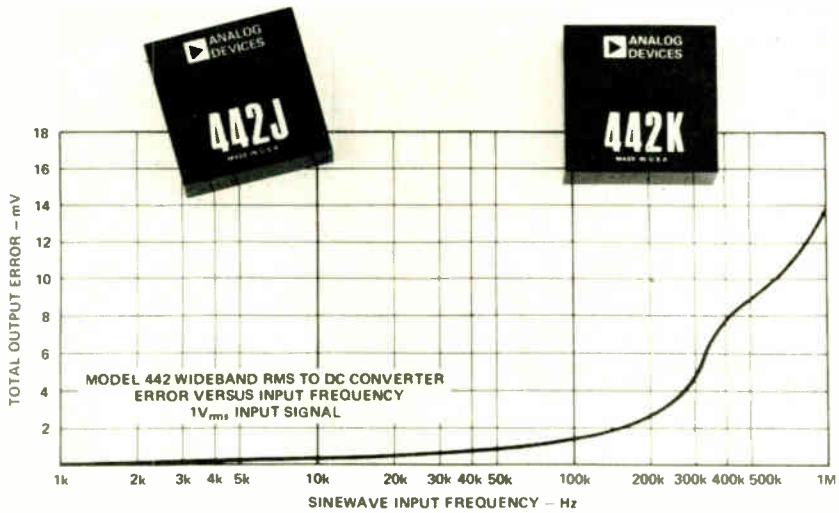
Further, the 442 holds error down to ±2 millivolts ±0.15% of reading over a wide input signal range, 0 to 2 V rms, without external adjustment. The package measures 1½ by 1½ by 0.4 inches, and the price starts at $95 for one to nine.

Pouliot notes that it's not too difficult to deliver good accuracy in an rms-to-dc converter operating at 1 V, "but users need it to operate at 5 V, and with a 10-millivolt input, they want it to respond at 500 kilohertz. They also want that accuracy to 0.5% at 5 V—and that's where this product shines, essentially offering three decades of performance (e.g., 5 mV to 5 V, 7 mV to 7 V) with that accuracy."

Two correction circuits yield the accuracy. One of them results in better crest-factor performance (reading error increases by only 0.5% for crest factors up to 10), and the other provides higher frequency response for various input signal levels down to that low-level 10 mV.

Essentially, the 442 improves on Analog Devices' own model 440 by a factor of 10 in accuracy and has increased the bandwidth by two orders of magnitude, Pouliot says. Accuracy is virtually independent of the shape of the input waveform because the model 442 converter responds to the total effective dc heating value of the ac and dc components of the input.

The unit is available from stock in three drift selections, each of which is specified from 0 to 75°C: the 442L



New products

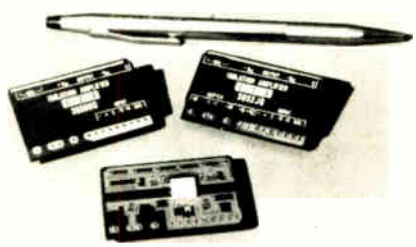
with ±35 mV/°C ±0.01% of reading/°C maximum drift, priced at $145 for one to nine; model 442K with ±50 mV/°C ±0.01% of reading/°C maximum drift, priced at $120; and the model 442J with maximum drift of ±100 mV/°C ±0.01% of reading/°C, priced at $95. Substantial OEM discounts are available, the company says.

Analog Devices Inc., P.O. Box 280, Route One Industrial Park, Norwood, Mass. 02062. Call Lowell Wickersham at (617) 329-4700 [381]

Isolation amplifiers are optically coupled

Although widely used in digital circuits, optical couplers have been regarded as too nonlinear and unstable for use in precision analog applications. Burr-Brown has overcome these problems in its model 3650 and 3652 isolation amplifiers with a technique that combines a LED emitter with a matched pair of photodiodes. One of the two diodes provides the optical coupling and isolation while the second provides negative feedback to the input circuit. This not only greatly reduces gain nonlinearity, it also compensates for light-output degradation caused by LED aging. Other design features of the isolation amplifiers are laser-trimmed thick-film hybrid circuitry, special insulation materials, and a low-leakage ceramic substrate, as well as thick-film glass passivation.

The resulting amplifiers have a continuous isolation-voltage rating of 1,500 V although each unit is 100% tested at 4,000 V. Isolation-mode dc rejection is 120 decibels, and isolation resistance and capaci-



tance are 10^{12} ohms and 3 picofarads, respectively. Leakage current is less than 500 nanoamperes at a voltage of 240 V rms and a line frequency of 60 hertz. Two levels of linearity are offered. The H-grade devices have a maximum nonlinearity of 0.3% while the J-grade units are rated at 0.1%.

The 3650 has a transconductance transfer function of 1 volt per microampere. A pair of gain-setting resistors added to the input will convert the unit to a voltage-in/voltage-out device. The 3652 consists of the isolation stage of the 3650 plus two FET-input buffer-amplifier stages. This provides a three-wire input with an input impedance of 10^{11} ohms and a common-mode rejection ratio of 80 dB at 60 Hz with a 5-kilohm source-resistance imbalance. Both devices are housed in compact ceramic dual in-line packages that measures 1.75 inches by 1.15 in. by 0.22 in. In lots of 100 pieces, prices on the 3650 start at $26.50, while those on the 3652 start at $35.50.

Burr-Brown, P. O. Box 11400, Tucson, Ariz. 85734. Phone Dennis Haynes at (602) 294-1431 [383]

Photosensitive ICs are housed in transparent DIPs

A family of optoelectronic integrated circuits consists of various combinations of integrated circuits and photodetectors housed in single dual in-line packages molded out of an optically clear epoxy material. The eight-pin DIPs make it easy to employ optical filtering to tailor the response of the various devices to specific wavelengths. An example of a device in the "Seeing-IC" family is the MCC-401—a photo-switch/optical detection device which includes a photodetector, an amplifier, a voltage-operated trigger, and a voltage reference. It is used in applications where illumination must be converted into a linear electrical signal. Other devices in the family are intended for exposure and aperture control systems, smoke detec-

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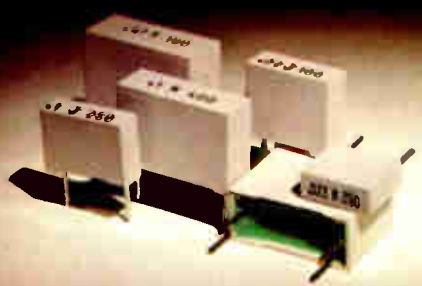

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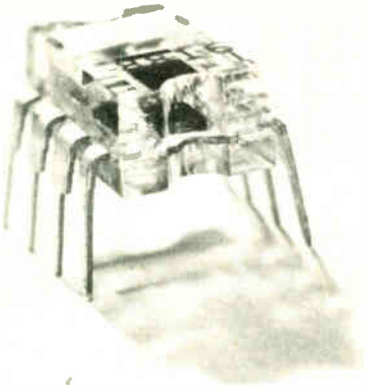
Circle 146 on reader service card

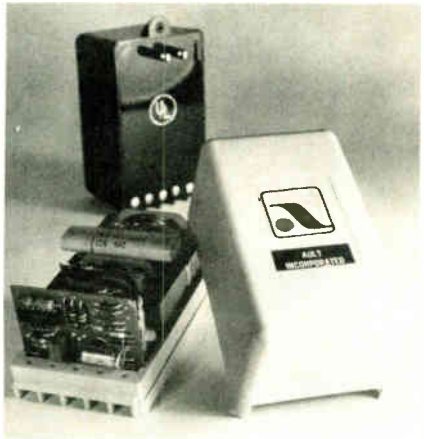


tion, headlight dimming, and other industrial and commercial applications. Pricing on the various devices currently runs from $2.75 to $4.95 each in thousands down to $1.50 each in lots of 100,000.

Micro Components Corp., 99 Bald Hill Rd., Cranston, R. I. 02920. Phone (401) 463-6000 [384]

Plug-in power supply delivers 500 mA at 24 V dc

A compact power supply that plugs directly into any convenient wall outlet delivers 500 milliamperes at 24 volts. (Another version puts out 250 mA at 48 V.) Believed to be the most powerful wall-mounted, plug-in supply ever to get UL approval, the PowerPak is regulated to within 1% for line-voltage variations of 10%. Overall dimensions of the supply are 5 inches high by 2.5 in. wide by 2.2 in. deep. Cases for the PowerPak have an integral eyelet for at-



If you spend more than 20 minutes picking a P.C. connector

It's your guide to the broadest line of printed circuit connectors made by any single manufacturer. We have just about everything and in more combinations and more depth than anyone – more types of contact terminations, insulator materials, mounting styles, contact designs, types of plating.

Send for our catalog. Browse through it and you'll discover that picking out the right printed circuit connector for your job is as simple as it should be.

Quick delivery.

And you can get your hands on our connectors, too – in a hurry if need be. We keep a large inventory; so do our distributors.

Our "Whatever-you-need-we've-got" department.

As you can guess, we have a lot of tooling filed away. Our production engineers have a unique talent at taking an existing bit of tooling, fiddling with it, and turning out a "custom" connector that's exactly what you need. Your extra cost is only a modest set-up charge... a long way from a full retooling cost.

Use the coupon.

...you don't have this catalog.

Ok. Send me: ☐ Your latest printed circuit connector catalog.
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TITLE: _____ TELEPHONE: _____

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Viking CONNECTORS

Viking Industries, Inc./21001 Nordhoff Street
Chatsworth, CA 91311 U.S.A./(213) 341-4330/ **DATACON DIVISION**

tachment to the wall outlet.
Ault Inc., 1600H Freeway Blvd., Minneapolis, Minn. 55430. Phone (612) 560-9300 [385]

Five-output power supply has high efficiency

A 375-watt switching power supply which is up to 80% efficient, puts out five regulated voltages. The principal output is 5 volts at up to 75 amperes. The remaining four outputs can be selected from among the following six: 2 V at 5 A, 5 V at 5 A, 12 V at 3 A, 15 V at 3 A, 18 V at 3 A, and 24 V at 2 A. The model MM-250 has a maximum peak-to-peak ripple and noise specification of 1% or 50 millivolts, line regulation to within 0.4%, and load regulation to within 0.4%. Response time is 200 microseconds to within 1% for a 25% load change. The price is $595.
LH Research Inc., 1821 Langley Ave., Irvine, Calif. 92714. Phone (714) 546-5279 [386]

TOPICS

Subassemblies

Kepco Inc., Flushing, N.Y., is offering its first switching-mode dc power supplies. Made in Japan by TDK, the switchers are available in 15 models with three power ratings: 50, 100, and 150 watts. . . . **Electronic Devices Inc., Yonkers, N. Y.,** has announced a new rating in their small, round Minibridge quick-disconnect rectifier designs. The model PKF is rated at 12 amperes and is offered with voltage ratings from 50 to 1,000 volts. . . . **Deltron Inc., North Wales, Pa.,** has received approval per UL 478 for the 40 models of its Q series of open-frame power supplies. . . . **Preston Scientific Inc., Anaheim, Calif.,** has introduced a new series of optional controls and outputs that interface with data-acquisition systems and automated instrumentation. The options are for the company's 8300 XWBRC instrumentation amplifiers.

Data handling

Cartridge holds 10 megabytes

Microdata technique permits recording density of 6,400 bits/inch on 3M-type unit

By doubling recording density to 6,400 bits per inch, Microdata Corp. can pack more than 10 megabytes of data into a single 3M-type data cartridge.

The new cartridge-tape drive,

called Lodestar, is intended for use by original-equipment manufacturers in minicomputer and microcomputer systems and also as a potential replacement for reel-to-reel drives and floppy disks.

The drive's recording technique—modified frequency modulation—is similar to that used on IBM's 3330-type magnetic-disk drives and results in a flux-change density of 3,200 changes per inch, half the bit density. According to William Zeissner, head of the development project at Microdata, one major problem was in designing the decoding circuitry to work with tape speed variations as wide as ±25%.

Data is recorded on the 300-foot, ¼-inch-wide tape in four serial tracks at 30 inches per second, for a transfer rate of 192,000 bits per second. In the search mode, the tape moves at 90 in./s.

Any 3M-type cartridge may be used in the drive, Zeissner says, but at the higher density, use of standard tape could result in errors attributable to the tape itself. To ensure error-free operation, Microdata says, it will offer cartridges that are certified to be error-free at the higher density. Data error rate of the drive is less than 1 bit in 10^8.

Overall, a single-cartridge drive measures 4.25 by 6.96 by 10 inches. When mounted in a rack, single and dual-cartridge units take up only 5.25 in. of rack space. Up to four drives may be mounted in a rack space of 7.25 in.

Lodestar offers an industry-standard interface and is available with a formatter that is plug- and software-compatible with existing controllers designed for reel-to-reel transports. "This will not only simplify integration of the drive into the user's system, but will allow him to evaluate and prove the unit's reliability on his own system without unnecessary expense," says Bud Bleininger, Microdata vice president for peripherals.

Prices for the cartridge tape drive start at $1,000 each in quantities of 100.

Microdata Corp., 17481 Red Hill Ave., Irvine, Calif. 92713. Phone (714) 540-6730 [361]

Optical character reader uses simple scan technique

Optical character recognition machines usually carry big price tags because they're computer-controlled and have sophisticated laser-scanning systems. Context Corp. has

taken the same simple scanning technique incorporated in its model 101 bar-code reader [*Electronics*, Oct. 2, 1975, p. 129] and applied it to a machine that reads OCR font B at a price that reflects the machine's simplicity. Context Corp. was formerly known as Taplin Business Machines Inc.

The model 201 is aimed at original equipment manufacturers and will sell for $14,900, but Context president Gordon Baty stresses that "deep OEM discounts are possible, comparable to those of disk drives, because our customers are systems builders." He foresees the model 201 character reader becoming a computer peripheral in small word-processing and business data-processing systems, as well as small printing or editorial text-preparation shops.

The unit, which reads up to 400 characters per second, has an inexpensive light bulb and photodiode array as its light source and sensor, respectively, instead of a much more costly laser light source and vidicon sensor. Nor is there a positioning servo for paper acceleration or direction changes; the paper moves at a constant speed below a spinning drum containing the light source, mirrors and sensor array.

An automatic stack feeder accommodating 50 pages is standard, permitting unattended operation. A hard-wired processor is employed for the recognition function, instead of a more expensive minicomputer. This processor uses a combination of matrix-matching and feature-analysis techniques.

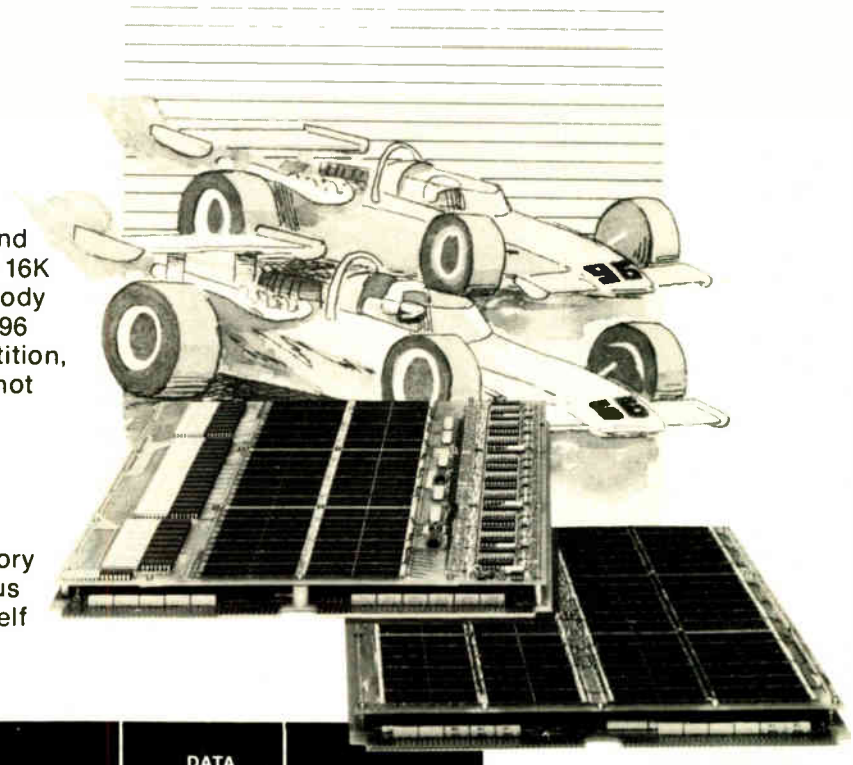
Context Corp., 4 Ray Ave., Burlington, Mass. 01803. Phone (617) 273-2222 [362]

Infotek offers floppy disk for HP 9830A calculator

Production of add-on or replacement subsystems for the widely used Hewlett-Packard 9830A scientific calculator is becoming big business for a small California firm, Infotek Systems. Its latest offering is a floppy disk that would replace the

Who's the performance winner in 16k and 32k memory systems?

Check the specs.



Fabri-Tek has packed more speed and total performance into single-board 16K and 32K memory systems than anybody else in the business. Compare our 696 and 698 systems against the competition, and you'll see what we mean. We'll not only beat them in specifications—we're the only company that offers you total upward compatibility to 32K. At competitive prices, too. It's what you'd expect from a company with years of leadership in the memory business. Go with the winner—call us today for the best in both off-the-shelf and custom memory systems.

	FABRI-TEK		EMM		DATA PRODUCTS		DATARAM	
MODEL	696	698	Micro 3000 D.D.	Micro 3000 Q.D.	Store 1680		DR-103	DR-103
MEMORY SIZE	16K	32K	16K	32K	16K	32K	16K	32K
CYCLE TIME	650	650	650	850	650		650	750
ACCESS TIME	250	250	270	300	280		265	300
PHYSICAL SIZE	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0		11.5x13.7 x1.0	11.5x13.7 x1.0
COMPATIBILITY 16K TO 32K	YES		NO		NO		NO	

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	Tom Fitzgerald	Bruce Richardson	Al Yarnell	Wally Harrison Don deVries	John French	Jack Graham

9830A's data-storage cassette. Earlier, Infotek developed a semiconductor-memory system that expanded the calculator's storage capacity.

"The most important thing about the F-30 floppy disk is that it emulates the 9830A cassette system, so that no changes in existing software are required," says Stanley Kurzet, director of marketing at Infotek. The floppy disk (middle section in photo) stores 305,000 bytes, which he says is equivalent to the capacity of seven HP cassettes. According to Kurzet, the floppy disk's inherent filing speed is 50 times faster than that of the cassette drive. For transferring data into or from the scientific calculator, he adds, the speed improvement is approximately 3½ times that of the current HP mass memory system—five seconds compared with 18 seconds to store a 10,000-word array.

The Infotek F-30 uses the Signetics model 2650 8-bit microprocessor for control and the Pertec Corp. model 500 disk drive. The floppy disk is 4 inches high and fits between the calculator and printer, or it can be used at a remote location.

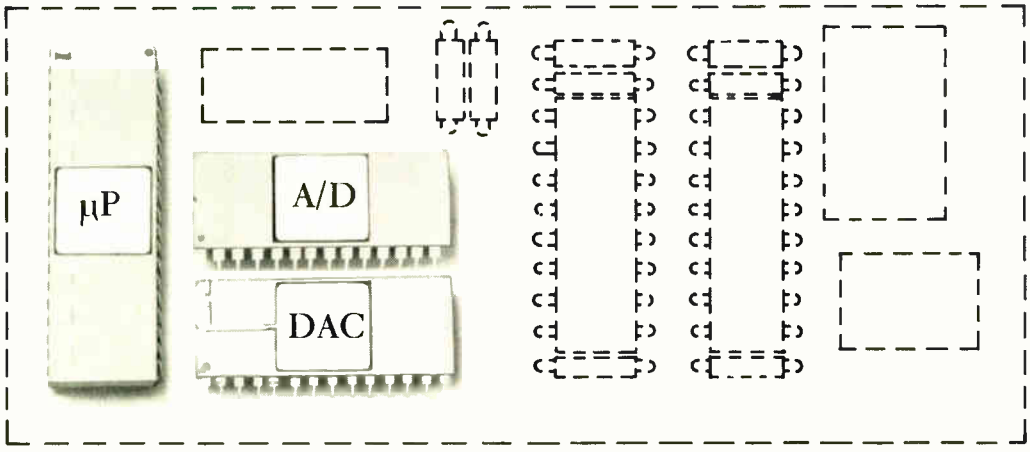
Price is $3,895 and delivery time is 10 weeks.

Infotek Systems Inc., 733 E. Edna Pl., Covina, Calif. 91723. Phone (213) 966-7431 [363]

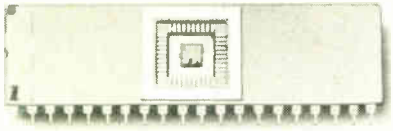
Video RAM provides CRT display of 512 characters

A video random-access memory that acts an interface between a mi-

A lot of microprocessor users wish their analog interface problems would go away.



We made them disappear.



With our monolithic CMOS converters.

10- and 13-bit A/D converters with tri-state output logic that gets you directly onto the microprocessor data bus. And our 10-bit D/A converter with double-buffered inputs direct from the microprocessor. And each communicates in two bytes: the 8 LSB's, and the remaining MSB's.

Our AD7550, industry's newest and most accurate monolithic CMOS A/D converter, uses a patented (Analog Devices U.S. Patent No. 3872466) "quad slope" conversion technique to provide 13-bit accuracy, 1 ppm/°C offset and gain drifts, and has its own amplifier, comparator, clock and digital logic.

Our AD7570 is a monolithic CMOS 10-bit successive approximation A/D converter with ratiometric operation and only 20mW of dissipation. Parallel and serial outputs with 20µs conversion time provide excellent application flexibility.

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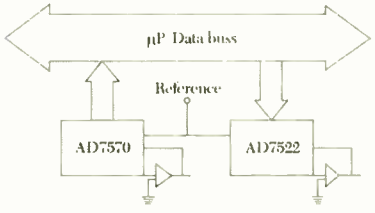
These I/O peripherals, the AD7550, AD7570 and AD7522 data converters are your only real solutions for interfacing a microprocessor to the analog world.

And these are just three of a complete line of more than 20 IC converters that make a lot of your conversion problems disappear. For more information, write Analog Devices, the real company in precision measurement and control.



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Analog Devices, Inc., Norwood, Massachusetts 02062

East Coast: (617) 329-4700, Midwest: (312) 894-3300, West Coast: (213) 595-1783, Texas: (214) 231-5094. Belgium: 03 38 27 07, Denmark: 97 95 99, England: 01/94 10 46 6, France: 686-77 60, Germany: 089/53 03 19, Japan: 03/26 36 82 6, Netherlands: 076-122555 and representatives around the world.

Circle 154 on reader service card

crocomputer and a cathode-ray-tube alphanumeric display is organized as 512 8-bit words. On the input side, the device—designated the MTX-1632—is directly connected to bus-organized systems and looks like a 512-by-8 RAM. The output is a video signal that directly drives a television monitor to provide a 16-by-32 field of 512 ASCII characters. The video RAM offers a flicker-free display and requires only a single 5-volt power supply. It can drive up to 25 TV monitors and offers character blink and an access time of less than 650 nanoseconds.

Matrox Electronic Systems, P.O. Box 56, Ahuntsic Stn., Montreal, Que., Canada H3L 3N5. Phone Lorne Trottier at (514) 481-6838 [364]

Adapter permits DEC users to convert to LSI-11

Without redesigning controllers already in use on the Digital Equipment Corp. PDP-11 line, users can now convert to the LSI-11 and the PDP-11/03 by means of an adapter. The unit, developed by Able Computer Technology, is called the model 10001 Univerter. It is offered as an option that converts the LSI-11 bus to a Unibus structure and permits full bidirectional communication between the two. A pseudo-status register returns control to the user over all four Unibus interrupt levels, and an extended memory map provides a virtual-memory scheme that extends addressing to 512,000 words. The Univerter offers significant speed advantages when both memory and direct-memory-access devices are placed on the Unibus side of the adapter. The

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ELECTRON TUBE MFG. EQUIPMENT

Following is a partial list of Machinery & Equipment now on sale at the plant

SEALING & EXHAUST MACHINES

(37) RCA 16-Head Sealing and Exhaust Machines with Induction Furnaces, Vacuum Pumps, Rectifiers, RF Generators, Filament Lighting and Control Panels, Motor Drives and Electrics. These Machines Are Interchangeable to Produce Many Types of Miniature or Power Tubes.

TUBE TESTING EQUIPMENT

RCA Computerized Conveyor Type Tube X-Ray Testing Machine, Complete with Drives, Controls, Electrics and Digital Readout Consoles.
(4) RCA Automatic Conveyor Type Tube Testing Machines. Tests Gm, Shorts, Gas, Plate Current, Emission, and Opens. Complete with Electronic Detecting Equipment. Machines Designed to test 2100 Tubes Per Hour.
(140) RCA Semi Universal Twin Triode Tube Test Consoles. Tests for Shorts, Gas, and Plate Current. Complete with Instrumentation and Controls.

TUBE AGING EQUIPMENT

(2) RCA Fully Automatic Rotary Tube Aging Machines, Capacity 1120 Tubes Per Hour at an 18 Minute Aging Cycle. Machines Complete with Control Consoles, Motor Drives and Electrics.
Approx. 250 Tube Aging Racks, Complete with Timers and Controls. Equipped for Interchangeable Socket Sizes. Racks are equipped with Either Right or Left Hand Controls.
(18) Power Equipment Co. Rectifiers — Voltage In 220/60, Voltage Out 50-150V DC @ 40 Amps.
(50) Asst. Test Consoles and Stations.

FURNACES

(2) Hydrogen Furnaces, Conveyor Type, Complete with Transformers, Electrics, Instrumentation, Drives and Controls.
Electric Furnace Co. Conveyorized Brazing Furnace, 75 KW - 220 Volts with Blowers, Pumps, Controls and Electrics.

FINE WIRE EQUIPMENT

(4) Vaughn Ring Blox 16 Die Cold Wire Drawing Machines, Type GF2, with Motor Drives and Adjustable Speed Controls.
(3) Multi Wire Fine Wire Cold Drawing Machines.
(7) Waterbury Farrel and Bradford Wire Rolling Machines.
(4) Meteor Type ME301 Wire Spooling Machines with AC Motor Drives and Controls.
(2) Barth Cleveland Wire Coil Winders w/AC Motor Drives & Controls.
(11) Asst. Double and Single Helical Coil Winding Machines.
(2) Balloffet Die Polishing Machines with Controls and Electrics.

FINE WIRE ANNEALING/DRAWING EQUIPT.

(100) Bench Model Hot Fine Wire Drawing Units, with Controls and Electrics.
(20) Hydrogen Fine Wire Annealing Units with Electrics and Spooling Devices.
(8) Hoskins Bench Model Electric Fine Wire Annealing Furnaces with Controls.
(8) Fine Wire Coating Machines with Hydrogen Furnaces, Automatic Spooling Equipment, Drives and Controls.

WIRE TESTING EQUIPMENT

Instron Tensile Testing Machine, Model 1130, with Digital Readout and Controls.
(2) Instron Universal Floor Model Testing Machines, Model TTC, with Chart Recorders.
(2) Instron Table Model Tensile Testers, Model TM, with Console Recorders.

GRID EQUIPMENT

(28) RCA Automatic Grid Winding Machines with Automatic Traying, Motor Drives and Controls.
(17) Sylvania Automatic Grid Winding Machines with Automatic Traying, Motor Drives and Controls.
(84) RCA Universal Semi Automatic Grid Lathes with AC Motor Drives and Controls.
(10) RCA Automatic Frame Grid Machines w/Motor Drives & Controls.
(13) RCA Automatic Grid Welding Machines with Feeders, Variable Speed Motor Drives and Controls.

TUBE EQUIPMENT

(2) RCA Tube Glass Cutting and Anode Sealing Machine Production Lines with Automatic Feed and Discharge, Complete with Drives, Controls and Electrics.
(6) 48-Head Bulb Cutting Tubulating Machines with Auto Hopper Feeders, Discharge Conveyors, Motor Drives and Controls.
(17) Rotary 24-Head Glass Stem Machines with Hopper Feeds. Motor Drives and Controls.
(100) RCA Automatic Stem Trimming and Forming Machines with Motor Drives and Controls.
(8) Rotary Multi Head Stem Trimming & Forming Machines with Drives and Controls.
(2) Metal Tube Exhaust Machines, 16 Head Capacity, with Vacuum Pumps, Motor Drives and Controls.
(8) Rotary Flat Press Stem Machines with Motor Drives and Controls.
(3) Tube Bulb Punch Out Machines with AC Motor Drives & Controls.
(12) Automatic Spade Winding Machines with Poly Auto Pac Units, Motor Drives and Controls.
(12) Asst. Spade Winding Machines with AC Motor Drives & Controls.
(4) RCA 42 Tube Capacity Tube Spot Knockers, for High Voltage Tubes, Complete with Power Supplies and Electrics.
(2) Rotary Tube Cementing Base Machines w/Motor Drives & Controls.
(8) Rotary Tube Base Soldering Machines with Index Tables, Motor Drives and Controls.
(3) Cathode Semi Automatic Coating Machines, Conveyor Type, with Spray Heads, Pressure Spray Tanks, and Related Equipment.

TWEEZER TYPE WELDERS

(300) Bench Model Tweezer Type Production Welders with Power Supplies, and Electrics: Taylor Windfield, Westinghouse and RCA.

TUBE SEAL WELDERS

(3) National Tube Seal Welders: (1) 400 KVA, (2) 75 KVA, with Rotary Indexing Tables, Welding Controls and Electrics.

MISC. EQUIPMENT

Drever Oxide Strip Carbonizing System (8" Strips) with 4-Station Spooler, Transformers and Electrics.
De Vilbiss Automatic Conveyorized Tube Spraying Line with Bake Oven, Spray Equipt., & Exhaust.
Precious Metal Plating Lines with Related Equipt. and Machinery.

DEGREASERS

Blakeslee Continuous Conveyor Type Solvent Vapor Degreaser, Model THLLUL, with Pumps, 12 x 21 x 7 Conveyor Baskets, Drives and Controls. S/N 17866.
(10) Asst. Type Degreasing Tanks w/Related Equipt. & Accessories.

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Machinery and Equipment to Manufacture Tungsten Wire — Includes 600 Ton Hydraulic Powdered Metal Press, Complete Tungsten Slug Treating System, Annealing Furnaces, Wire Drawing and Swaging Machines, Wire Drawing Tables, and Miscellaneous Support Equipt.

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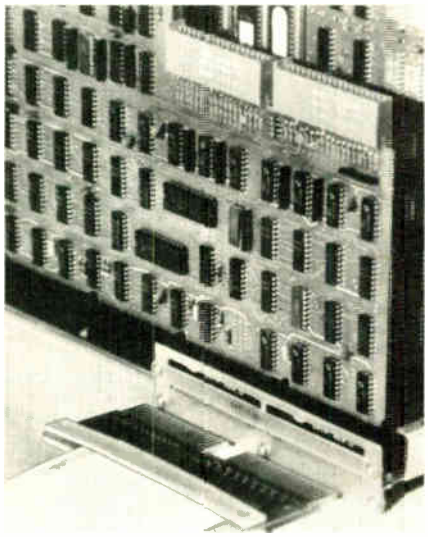


faster "handshake" allows the bus to be released quickly and frees the processor or other devices to make effective use of an increased bandwidth over the basic LSI-11 bus. As a result, low-cost, low-speed controllers can be used without taking speed away from devices that need it. The Univerter is a standard quad-width board that can be installed into an LSI-11 card cage or into the PDP-11/03. It is available from stock at prices as low as $480 when bought in quantity.

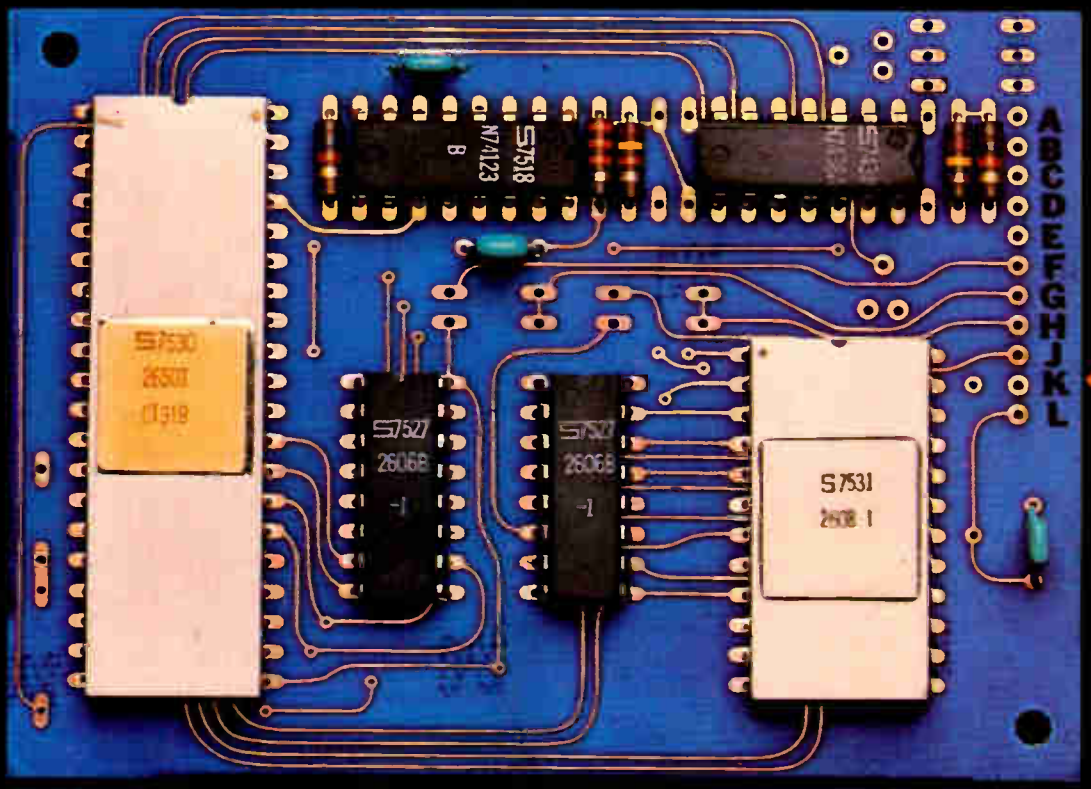
Able Computer Technology, 1538-E East Chestnut St., Santa Ana, Calif. 92705. Phone (714) 547-6236 [365]

Compact unit added to line of rugged computers

Designed for applications where size and weight are particularly important, the model 1650 is the most compact computer to date in Rolm Corp.'s line of severe-environment machines. The 1650 incorporates advances in microprocessing techniques, along with a new double-density core memory, to achieve small package size, the company says. The central processing unit, up to 32,000 words of core memory, and a dc power supply are housed in a rugged chassis measuring 5 by 7¾ by 12½ inches.

Rolm Corp., 18922 Forge Dr., Cupertino, Calif. 95014 [366]

The easiest-to-use microprocessor



(Photograph approximately 2x actual size.)

The single-chip 2650 is easiest-to-buy, too. Now only $21.50 (100-up).

Full support of customer and product is the key to ease of development with the 2650. Applications engineers in the U.S. and abroad are at your beck and call at every stage. Software for almost anyone's requirements and machines. Development hardware is versatile and inexpensive. All circuits are multi-sourced.

Flow Chart: How to travel safely and quickly from spec sheet to your μC.

1. Applications Engineers — in the field now, more coming. Specific assistance to you is available around the USA, and in Belgium, Holland, Germany, France, Sweden, Britain, Italy, etc.

2. Multi-sourced 2650 — available in any quantity from Signetics, at the unprecedented low price of $21.50. Also available from AMS and Philips, and from Signetics' authorized distributors.

3. Development Software — includes the PL μS, an extremely efficient High Level Language (compiler) that reduces programming effort and cuts development time. ANSI standard Fortran IV executes on most machines without alteration. 2650AS1000/1100 Assembler and 2650SM1000/1100 Simulator are available in both 32- and 16-bit, on GE and NCSS time-sharing.

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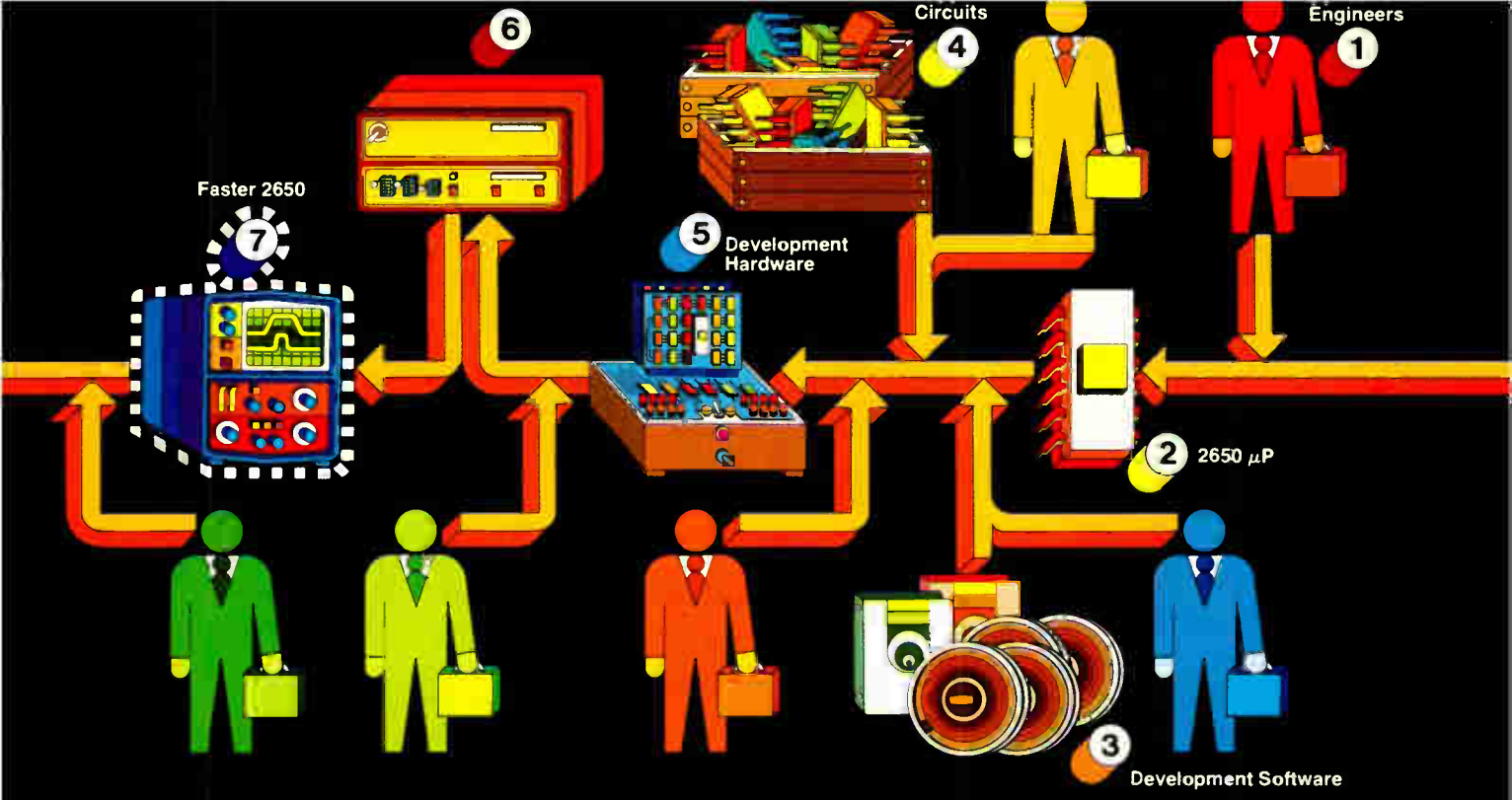

makes the easiest-to-develop microcomputer.

5 Development Hardware — Design/develop/prototype with a variety of cost/capability levels of hardware support. Including prototyping cards and kits, smart typewriter demo card, 4k-byte RAM card, and more. Applications help if you need it.

6 TWIN With Floppy Disks — "crashproofs" your system checkout. With DOS, Resident Assembler, and Text Editor. You develop programs and circuits together in an actual system environment with TWICE (*T*est*W*are *I*n *C*ircuit *E*mulator). PROM programming, too.

7 Over 30% Faster 2650 — By the time you've proven out your μC, you'll have available a faster 2650 if you want it. Uses the same software. For still higher speeds, call Signetics Bipolar Microprocessor Marketing about our 2650 emulator using 3000 series μP.

You go from gleam-in-your-eye to proven prototype in less time for less cost, and the μC you develop is easier and cheaper to produce in quantity, when you start with the 2650. Start now by mailing the coupon.

Attach this to your letterhead for fast response.

☐ Send me complete 2650 short form catalog.
☐ Have a Field Applications Engineer call me for appointment.
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My application is _____

Name _____ Title _____

Telephone _____ Mail Stop _____

THINK **Signetics μP**
a subsidiary of U.S. Philips Corporation
811 E. Arques Ave., Sunnyvale, Ca. 94086

Circle 159 on reader service card

New products/materials

Thin-wall Teflon tubing is heat-shrinkable and impervious to virtually all solvents and chemicals. Other characteristics include a temperature range of −420°F to 500°F and zero water absorption. The inside diameter and wall thickness are said to be completely uniform.

Walls are as thin as 0.001 inch with an internal diameter of 0.002 in. and larger. The tubing is also available with an internal diameter as small as 0.001 in., and this type comes with a wall thickness of 0.007 in. or greater (the average diameter of a human hair is 0.003 in.). When applied over miniature solid and stranded wires, the tubing will not flake or dust off.

Zeus Industrial Products, 101 Foot of Thompson St., Raritan, N.J. 08869. Phone (201) 526-0800 [476]

A thick-film sealing glass paste, called Silica-Seal 1141, is used for screen-printing applications in the manufacture of liquid-crystal displays. The paste is screen-printed on one or both glass plates.

It can also be used as resistor overglaze and, in this application, very small changes in resistance occur as a result of the low encapsulation temperature required for hermeticity. While usually packaged in shatter-proof plastic jars, Silica-Seal 1141 can be shipped in reusable plastic syringes for clean-room applications or for added convenience of the user.

Thick Film Systems Inc., 324 Palm Ave., Santa Barbara, Calif. 93101. Phone (805) 963-7757 [477]

Polyvinyl-chloride tape is said to combine the advantages of a heatless shrinkable tape and a new chemical tape-bonding technique. Adhesives have been eliminated and replaced by a permanent chemical self-bonding process that produces a virtually homogeneous environmental seal after cure. Rated at −35°C to 105°C, the PVC tape provides insulation protection at 600 volts per mil and can also be used in most conventional tape applications.

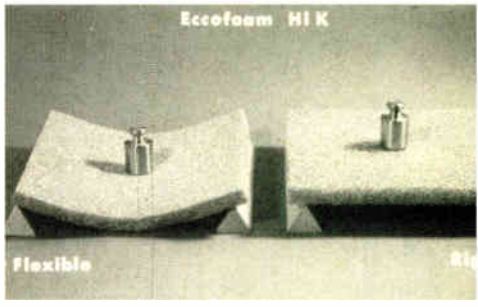
Insulation Systems Inc., 2698 Marine Way, Mountain View, Calif. 94043. Phone (415) 964-1459 [479]

Used in coatings for electronic applications, a chemical compound called Sartomer SR-383 is said to exhibit good thermal stability, can improve heat resistance and flame retardancy, and can be used to help slow down curing speed. SR-383, which is diallyl chlorendate, is soluble in most organic solvents but is insoluble in water.

Sartomer Co., Bolmar and Nield Sts., West Chester, Pa. 19380. Phone Charles Demos at (215) 692-8400 [480]

Low-density artificial-dielectric foam sheet comes in two types, Eccofoam HiK Flexible, which will readily conform to complex contours and can be cut with shears; and Eccofoam HiK Rigid, which is easily machined. Density of both is about 5 pounds per cubic feet and both can be cemented to themselves, to each other, or to other materials. Standard sheet size is 12 by 12 inches (30.5 by 30.5 cm), and thickness is 0.5 in. (1.27 cm). Dielectric-constant values range from 1.1 to 6.0. Price is $41 per sheet for 10 or more.

Emerson & Cuming Inc., Dielectric Materials Division, Canton, Mass. 02021 [478]



New literature

Flake thermistors. A detailed technical catalog from Victory Engineering Corp., Victory Rd., Springfield, N. J. 07081, presents data on the firm's three basic types of thick-film flake thermistors. Included in Product Bulletin VM 2056 are drawings, plus resistance-temperature and voltage-current characteristics, data on frequency response and specific detectivity, and a discussion of infrared fundamentals. Circle 422 on reader service card.

Broadband amplifiers. A wide variety of transistor amplifiers that cover various portions of the frequency range from 100 kilohertz to 18 gigahertz is described in a catalog put out by Amplica Inc., 780 Lakefield Rd., Westlake Village, Calif. 91361. Among the amplifiers are multi-octave low-noise units, medium-power linear devices, high-power class-C assemblies, and high-power linear amplifiers. [423]

Optoelectronics. A 192-page optoelectronics manual contains information on emitters, detectors, couplers, optoelectronic theory and system design, reliability measurements, symbols, terms, and specifications. Copies can be obtained by sending $3 plus applicable tax to GE Semiconductor, Electronics Park, Bldg. 7-49, Syracuse, N. Y. 13201.

High-voltage supplies. Power supplies with outputs from 1,000 to 50,000 volts are covered in a catalog put out by Bertan Associates Inc., 180 Miller Pl., Hicksville, N. Y. 11801. Applications for the supplies include nuclear instrumentation, photomultiplier tubes, cathode-ray tubes, X-ray systems, and electron microscopes. [425]

Plastics. A comprehensive plastics catalog from Ain Plastics, 160 South MacQuesten Pkwy., Mount Vernon, N.Y. 10550, includes nine pages of technical data in addition to information on sizes, shapes, and prices. [426]

Interchangeable thermistors. Curve-matched Unicurve thermistor catalog L-6A describes a line of low-cost interchangeable thermistors that are matched to within 0.2°C over their various operating ranges. New to the line are low-resistance units with resistances of 100, 300, 500, and 1,000 ohms at 25°C. Copies of bulletin L-6A are available from Fenwal Electronics, 63 Fountain St., Framingham, Mass. 01701 [427]

Wire and cable. A 14-page condensed catalog of wire, cable, braiding, power cords, shielding, and tubing is offered by Weico Wire & Cable Inc., 215 Central Ave., Farmingdale, N.Y. 11735 [428]

Metal seals. A wide range of Airpax glass-to-metal and ceramic-to-metal seals is described in the company's short-form catalog 4002. Included are relay headers; TO-8, TO-5, and TO-46 headers; optical windows; frame packages and dual in-lines for hybrids, and actuators for electromechanical relays. The catalog may be obtained by writing to Hermetic Seal Department, Airpax Electronics, Cambridge Division, Woods Rd., Cambridge, Md. 21613 [429]

Static control. Systems solutions to problems of static control in electronics industries are described in a brochure from 3M Company's Nuclear Products department. The brochure describes steps in electronics production processes and shows how 3M Safeguard Systems can be combined to provide protection from static-charge buildup. The brochure is available from 3M Company, Dept. Nu6-4, P.O. Box 33600, St. Paul, Minn. 55133 [430]

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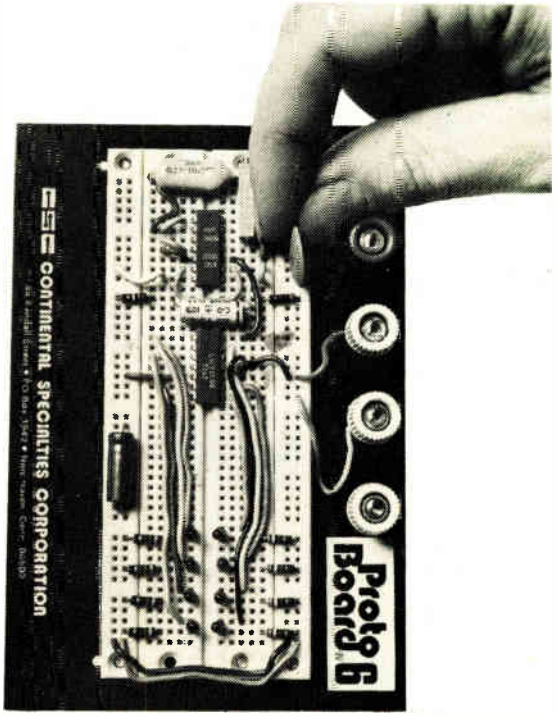

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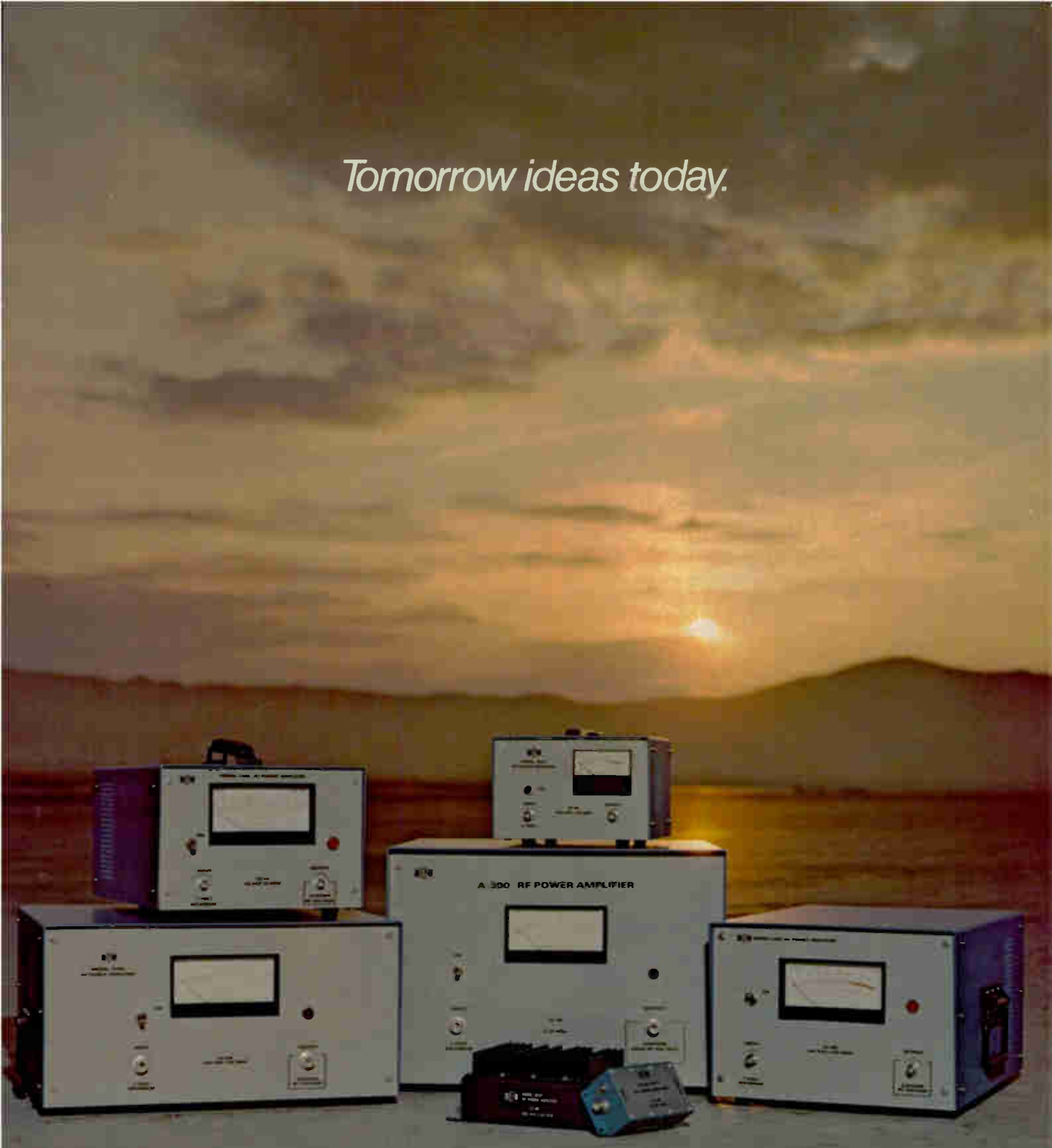

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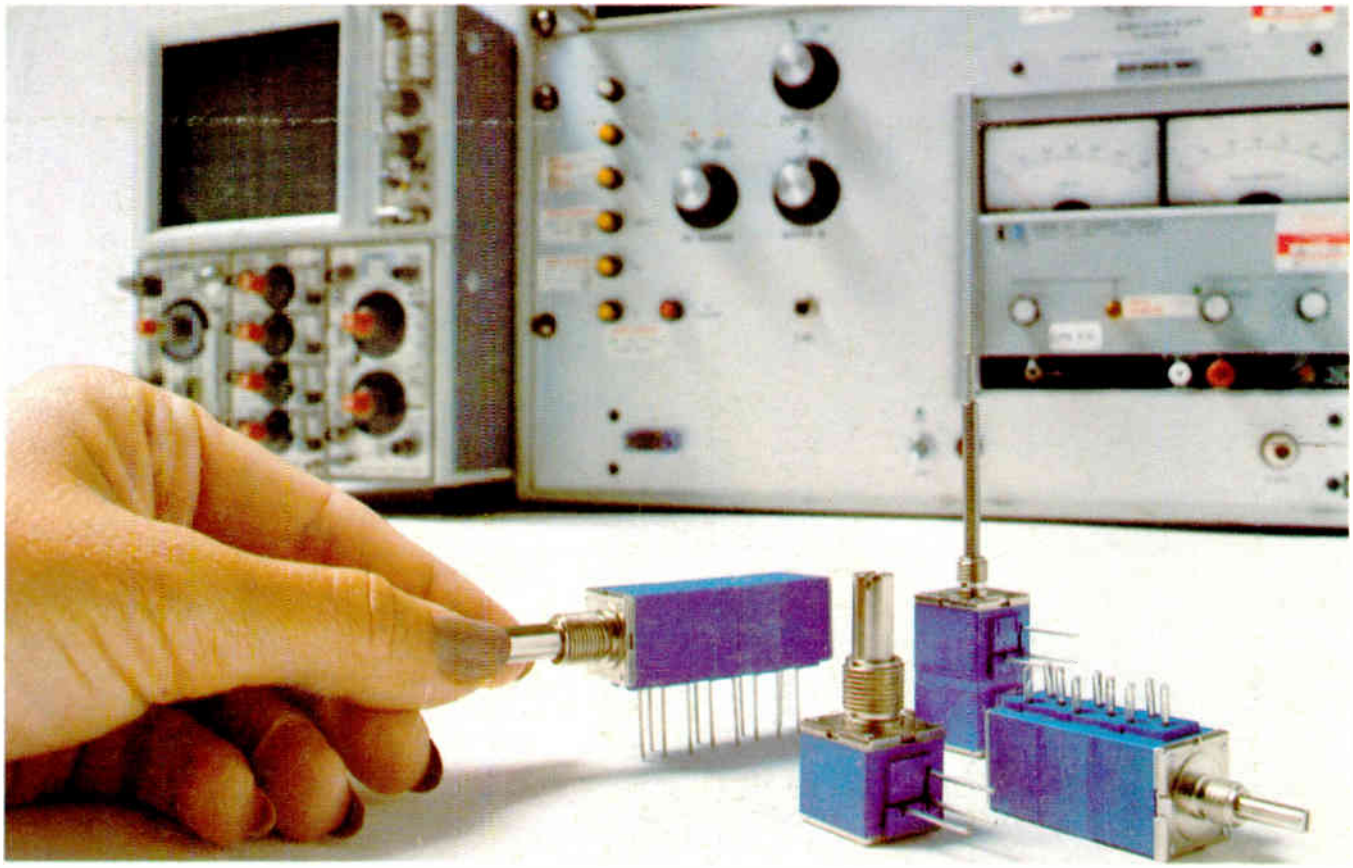

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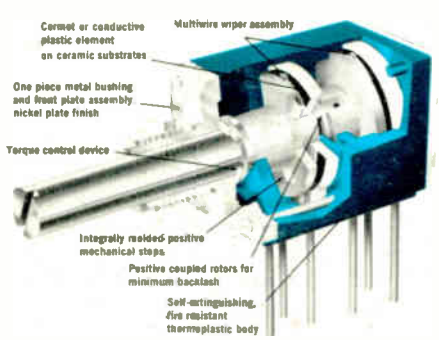

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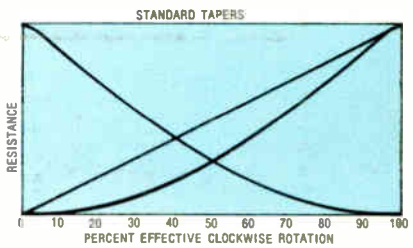

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