JANUARY 5, 1978

WILL THERE BE ENOUGH CHIPS FOR THE AUTO MAKERS?/103

The protection tradeoff: circuit breakers vs fuses/ 163

How to determine the cost of LSI testing/ 171

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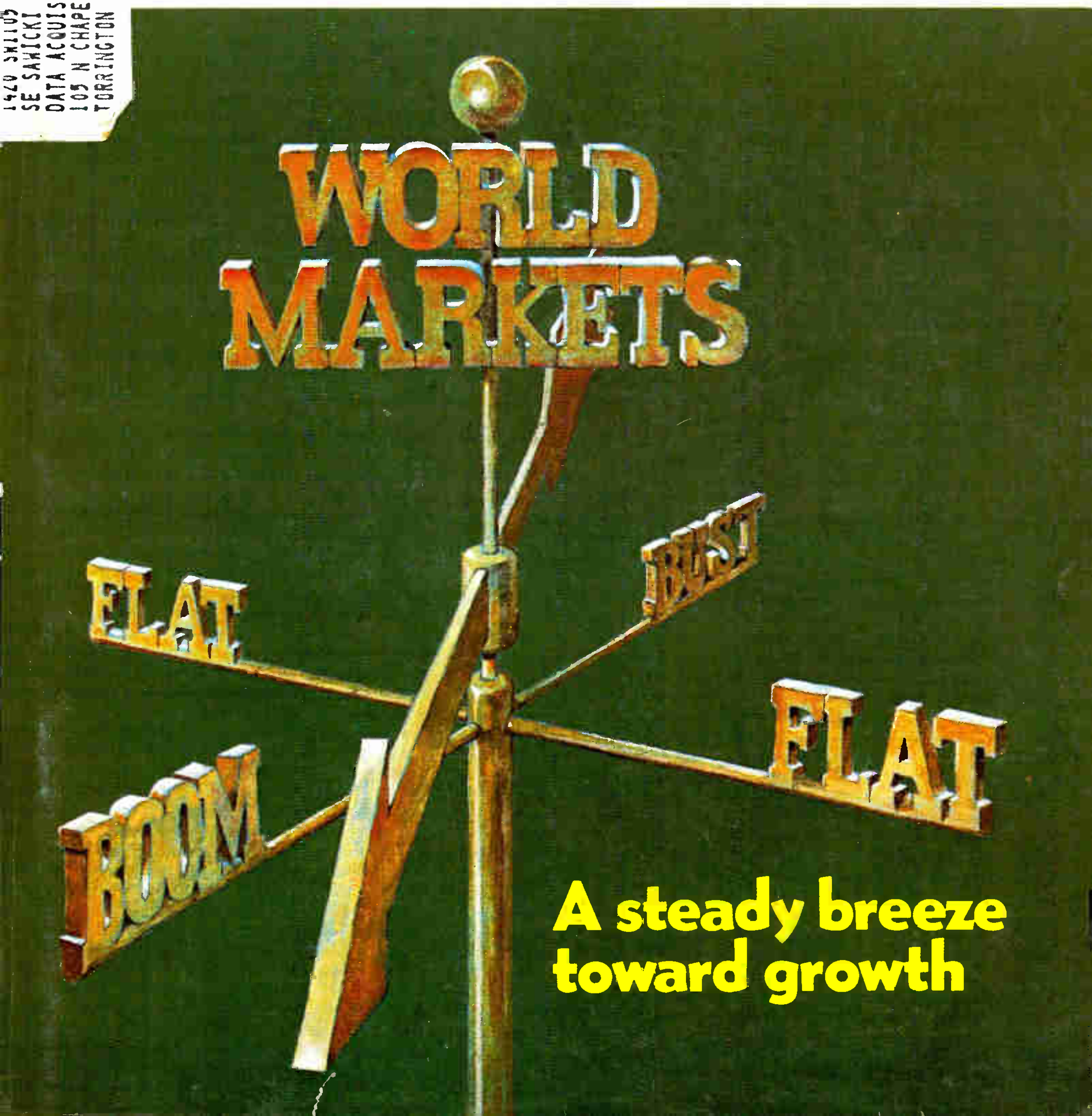

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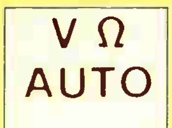

Battery and probe versatility. You can operate this DMM from the line or select rechargeable lead-acid batteries for complete portability. And to extend the 3466A's capabilities, choose from HP's wide selection of probe accessories, including RF, high voltage and Touch-Hold probes.

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097/48

Circle 900 on reader service card

Electronics

The International Magazine of Electronics Technology

Vol. 51, No. 1 • January 5, 1978

Highlights

Cover: Favorable tradewinds to continue, 125

In 1978, the consumption of electronics equipment for the U. S., Europe, and Japan will top $100 billion for the first time. The consensus forecast from *Electronics'* annual survey is for an 11.7% growth.

The U. S. will once again set the pace with a predicted gain of 13% (p. 126). European consumption should rise 9.3%, about the same as last year (p. 138), while Japan expects a slight decline in its growth rate, to 10.4% (p. 143).

Cover by Art Director Fred Sklenar.

ECL boom inspires tester makers, 106

With the use of emitter-coupled logic growing in such applications as mainframes, makers of automated test equipment are launching new gear to handle the subnanosecond ECL devices. One controversy: should the equipment also be capable of testing metal-oxide-semiconductor devices?

Choosing between circuit breakers and fuses, 163

To protect semiconductor devices, circuit breakers may serve as well as fuses. In many applications they may be truly cost-effective, as well as fast enough.

How to figure the cost of LSI chip testing, 171

Testing large-scale integrated devices is expensive—as much as $10 a chip. An analysis of how much it costs to test a chip will tell the product designer if he can afford to use it.

And in the next issue . . .

Taking the mystery out of software design . . . using optical couplers in the linear mode . . . selecting the right analog input/output boards.

Electronics

Publisher's letter

This issue, as you are sure to gather from our cover and the 24-page report starting on page 125, contains our annual effort to quantify what we qualitatively describe the year around—the electronics industries.

While that report gives the big picture, you will discover that other sections of this issue have significant stories homing in on a particular area of interest and giving the kind of details that an overall summary just can't cover.

Take as an example the lead Probing the News article by our New York bureau manager, Bruce LeBoss. It raises the question: will Detroit's needs outpace capacity? Then it goes on to present the opinions of Andrew S. Grove, executive vice president of Intel Corp., who believes the semiconductor industry is way behind schedule if it is to meet what he sees as the automobile makers' needs three or so years down the road.

Significantly, other parties to the problem—including the auto companies and other semiconductor executives—do not share his viewpoint. For a report on what is going on in a segment of the market that will have a bigger and bigger impact on the electronics market—and on the figures we compile—in the years ahead, turn to page 103.

Another example of our continuing coverage follows right on the heels of that article. On page 106, you'll find the story behind the important step-up in the application of emitter-coupled devices, and what that boost means to the makers of semiconductor test equipment.

Written by our Los Angeles bureau manager, Larry Waller, the report credits the sudden spurt in ECL to mainframe computer makers. For tester makers the growing market represents an opportunity, but ECL's speed and noise vulnerability presents a very real challenge.

Massachusetts, once a prime hotbed for nurturing advanced technological innovations and enterprising technological entrepreneurs, has run into trouble. In fact, some governmental policies and priorities may be driving high-technology companies from the state.

On page 112, we present an eye-opening account of the effort by the Massachusetts High Technology Council in helping—some would say forcing—the state to overcome some of its economic problems. Larry Curran, our Boston bureau manager, put together the story. He notes that high on the list of concerns voiced by council members, a majority in electronics, are difficulty in finding enough educated, skilled workers and the state's high personal income taxes, which tend to stifle out-of-state recruitment efforts.

Some council members talk of an antibusiness climate that has been developed over the past couple of decades, and others talk of the need to make legislators aware of the long-term economic implications of the actions they are taking. But all talk of the necessity of turning Massachusetts around.

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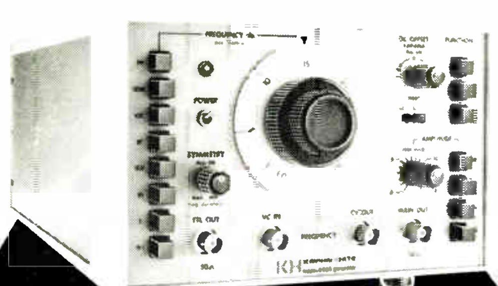
30 MHz



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Readers' comments

Overtaxed

To the Editor: The Executives' Concerns in your Dec. 22 issue erred in a quote attributed to me [p. 87]. The article quoted me as saying, "We did a survey in 1976 that showed that after-tax profits were double what they would have been if we had been in a state like Texas." What I said was that our after-tax profits would have been double if we had been in a state like Texas, instead of Massachusetts.

Like many of my colleagues, I am distressed by the confiscatory nature of the tax structure in Massachusetts, as well as the high cost of labor and energy. Through my activities as chairman of the New England Council of WEMA and Prime Computer's participation in the Massachusetts High Technology Council, we are trying to state our industry's case to the Massachusetts government.

Kenneth G. Fisher
Prime Computer Inc.
Wellesley Hills, Mass.

Trapped?

To the Editor: Timothy Jordan's ring counter is a clever idea ["Ring counter synthesizes sinusoidal waveforms," Aug. 18, p. 115]. However, it seems to have a flaw, but it can be fixed without much trouble.

The circuit will work properly if the leftmost six stages (representing the most significant bits) of the 64-state shift-register network contain any of these numbers: 0, 1, 2, 6, 14, 30, 33, 49, 53, 57, 62, or 63. If the register contains any of the 52 other numbers, it will be trapped in a repeating sequence of states that is not the sequence desired.

The register could contain one of the undesirable numbers by falling into one of those states during power turn-on or could be set into one of them by a transient noise pulse from outside. The cure is simply to reset the register to 0 (or 1) after power turn-on and on the next clock pulse after state 2 (or 0).

Nathan O. Sokal
Lexington, Mass.

News update

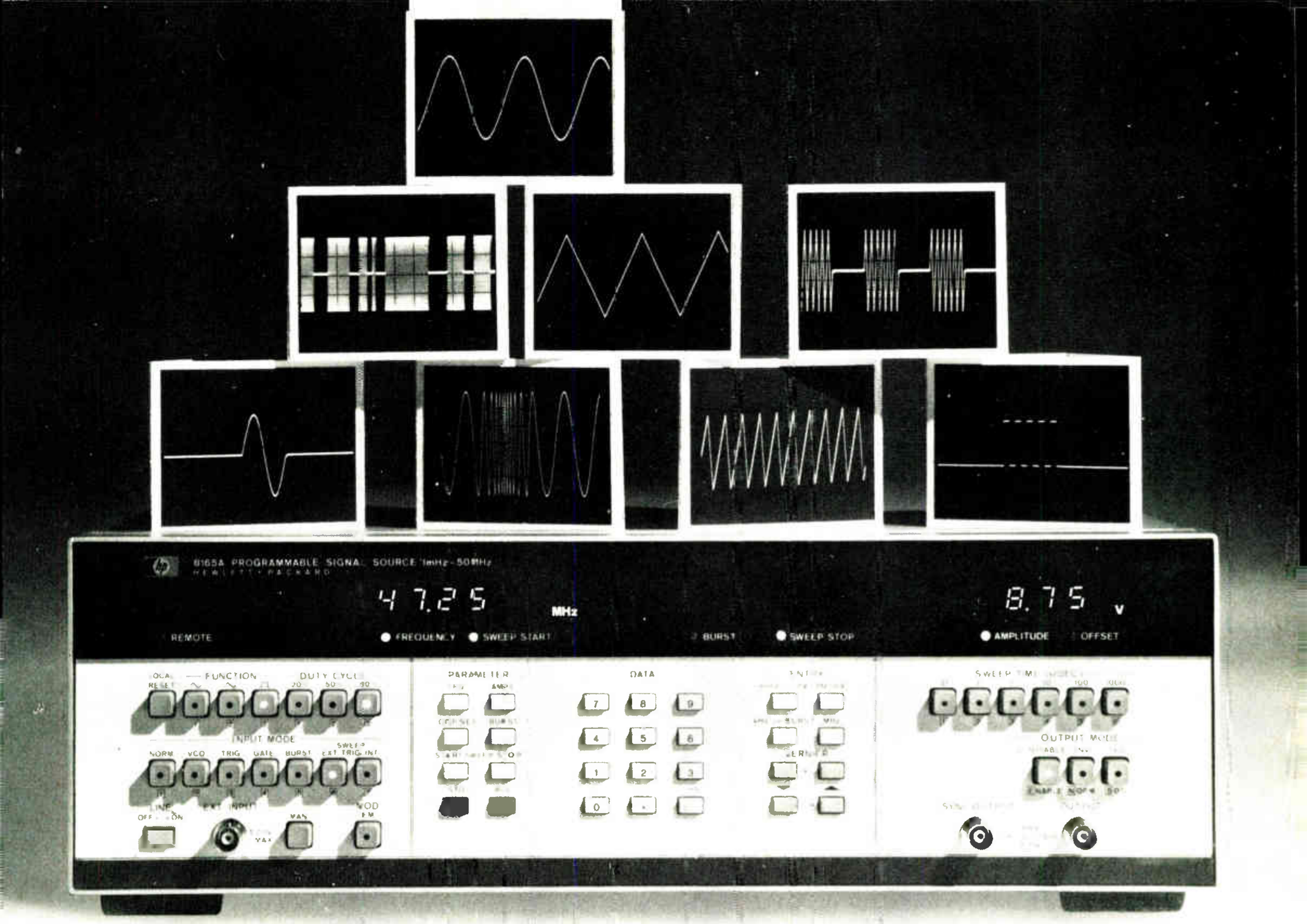
■ The laser gyroscope will soon be introduced in its first practical application—to provide the inertial reference for a Navy weapons control system. To a greater extent than conventional inertial-wheel gyros, the strapdown laser systems promise mechanical simplicity, higher reliability and longer life, plus faster response time [*Electronics*, Aug. 7, 1975, p. 44].

Last month, Sperry Rand Corp.'s Sperry division in Great Neck, N.Y., delivered the first of two prototype systems to the U.S. Navy. The Navy will conduct extensive tests before and after installing the system aboard a ship early this year.

Developed under a $657,000 Navy contract, the new stabilizing unit contains, among its electronics, three single-axis, plug-in-replaceable 15-inch-perimeter laser gyros, three accelerometers, and Sperry's SP1000 digital microcomputer. "If Navy tests prove satisfactory," notes a division spokesman, "this laser gyroscope system will replace the Mark 16 Stabilization Element currently used on nearly 200 ships."

■ The first engineering development model of the U.S. Army's Battery Computer System demonstrated its self-test capabilities and ability to interface with all Government-furnished equipment across radio and wire data links. Developed by United Technologies Corp.'s Norden division in Norwalk, Conn., the system is targeted at fire-control jobs for field artillery [*Electronics*, Oct. 28, 1976, p. 32].

It will use a new microcomputer, built around a standard, commercially available 4-bit microprocessor slice, designed by Marconi Space and Defence Systems Ltd. of England, Norden's teammate on the project. Norden has received the green light to go on to the program's next phase—hardware testing and training. The schedule calls for a production contract no later than February 1979 for 60, 500, or 1,000 units, including 150 for the Marine Corps. **Bruce LeBoss**



Instrument shown with optional sweep mode

Now, quickly program these waveforms...

Using HP's new 8165A, the first programmable signal source with a 0.001 Hz to 50 MHz range.

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Analog and digital waveforms. Sine waves, triangle and square waves up to 50 MHz and pulses or ramps up to 19.99 MHz can be quickly programmed for your testing needs. And there's a DC mode that gives you a 200mA current source. One instrument performing the functions of several gives you a cost-effective way to perform automatic and semiautomatic testing.

External trigger and burst modes. You can either trigger one cycle of a selected waveform using an external signal or in the counted burst mode, generate a specified number of waveforms. The latter eliminates the uncertainties associated with conventional gating.

Sweep control. The standard configuration (VCO) lets you control the master oscillator with an external voltage level. An optional sweep mode ($330**) logarithmically controls the oscillator internally for a programmed time period. And you trigger the sweep either internally or externally.

The 8165A, priced at $6000**, also gives you high accuracy, eliminating the need for time-consuming setup verification with expensive counters and volt meters. Contact your local HP field engineer for complete details.

*HP's implementation of IEEE Standard 488-1975
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"VMOS power FETs, introduced by Siliconix in 1975, have always been better than bipolars—more rugged, more reliable, faster and simpler. Today, we're lowering our prices as we move further along the learning curve, and our economical plastic package brings superior VMOS technology within reach of all designers. At 96¢ apiece,* the new TO-202s will replace bipolars in a broad range of power applications, particularly in interfacing with computers and in telecommunications."

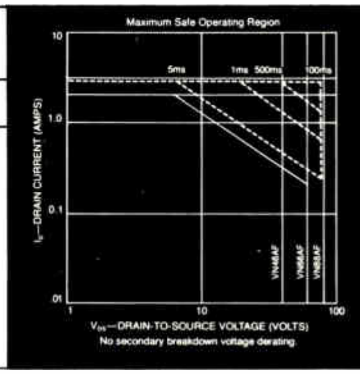
*VN46AF in quantities of 100 – 999

power FET prices time is up."

Siliconix VMOS power FETs in plastic: TO-202 package

Part #	^{BV}DSS	$^{V}DS(on)$ (^{I}D=1 Amp)	Price:1-29	31-99	100-999
VN46AF	40	3.0V	$1.33	$1.12	$0.96
VN66AF	60	3.0V	$1.39	$1.16	$1.00
VN88AF	80	4.0V	$1.54	$1.29	$1.10

All three devices are guaranteed over the temperature range of −55°C to 150°C; their maximum power dissipation is 12.5 watts, and their current rating is 2.0 amperes.



Other VMOS power FETs introduced by Siliconix are also available:

Part #	Package	$^{P}DISS$	^{BV}DSS	$^{V}DS(on)$ (^{I}D=1.0 Amps)
2N6656	TO-3	25W	35	1.8V
2N6657	TO-3	25W	60	3.0V
2N6658	TO-3	25W	90	4.0V
2N6659	TO-39	6.25W	35	1.8V
2N6660	TO-39	6.25W	60	3.0V
2N6661	TO-39	6.25W	90	4.0V

"Until 1975, MOS field-effect transistors (FETs) were restricted to small-signal, low-power applications. To control high currents, designers used bipolar devices. Then Siliconix, using Vertical MOS technology, introduced the VMOS power FET — combining the reliability of FETs with the power of bipolars.

"Today, Siliconix' new plastic TO-202 package means that VMOS power FETs are not only superior to bipolars in performance, but also competitive with them in price. They'll simplify designs and reduce component count in most systems because they eliminate pre-amplifiers, driver transistors, and external protective circuitry required for bipolars. And they can be inserted by machine, a time- and cost-saving advantage in high volume production.

"Anyone who has designed with bipolars knows the failures that can result from thermal runaway, secondary breakdown and current hogging. You don't have to worry about these problems with VMOS power FETs; their positive temperature coefficient eliminates hot-spotting and provides uniform current density, making them fail-safe. Consider how this inherent reliability will reduce your system interruptions and maintenance costs. And VMOS power FETs are faster than bipolars in switching operations — as much as 100 times faster. With all these advantages packed into the low-cost TO-202, you'll be able to eliminate bipolars' problems completely from many system designs.

"The high input impedance of VMOS and its threshold voltage range allow it to interface directly with CMOS, MOS and TTL logic families. And the VMOS power FET is the only interface device with a switching time comparable to that of ECL, so it will interface with a simple level shift — without losing speed. These features make the TO-202s ideal for data processing applications: computer peripherals, micro- and minicomputer systems, and process control equipment. They're also ideal for use in telecommunications: as telephone relay replacements, Touch-Tone muting switches, audio amplifiers, central office systems and analog switches.

"Our new line of VMOS power FETs in plastic may mean the end of the line for bipolars. We want you to discover for yourself how they can improve system design, so use the coupon to send for our detailed brochure. To order parts, contact any of our franchised distributors: Alliance, Century, Components Plus, Future, Hamilton/Avnet, Industrial Components Inc., Pioneer Standard, Pioneer Washington, Quality Components, Semiconductor Specialists, Wilshire, Wyle/Elmar, Wyle/Liberty, or RAE."

Yes, I want to find out for myself how Siliconix put bipolars on the list of endangered species. Please send me your brochure.

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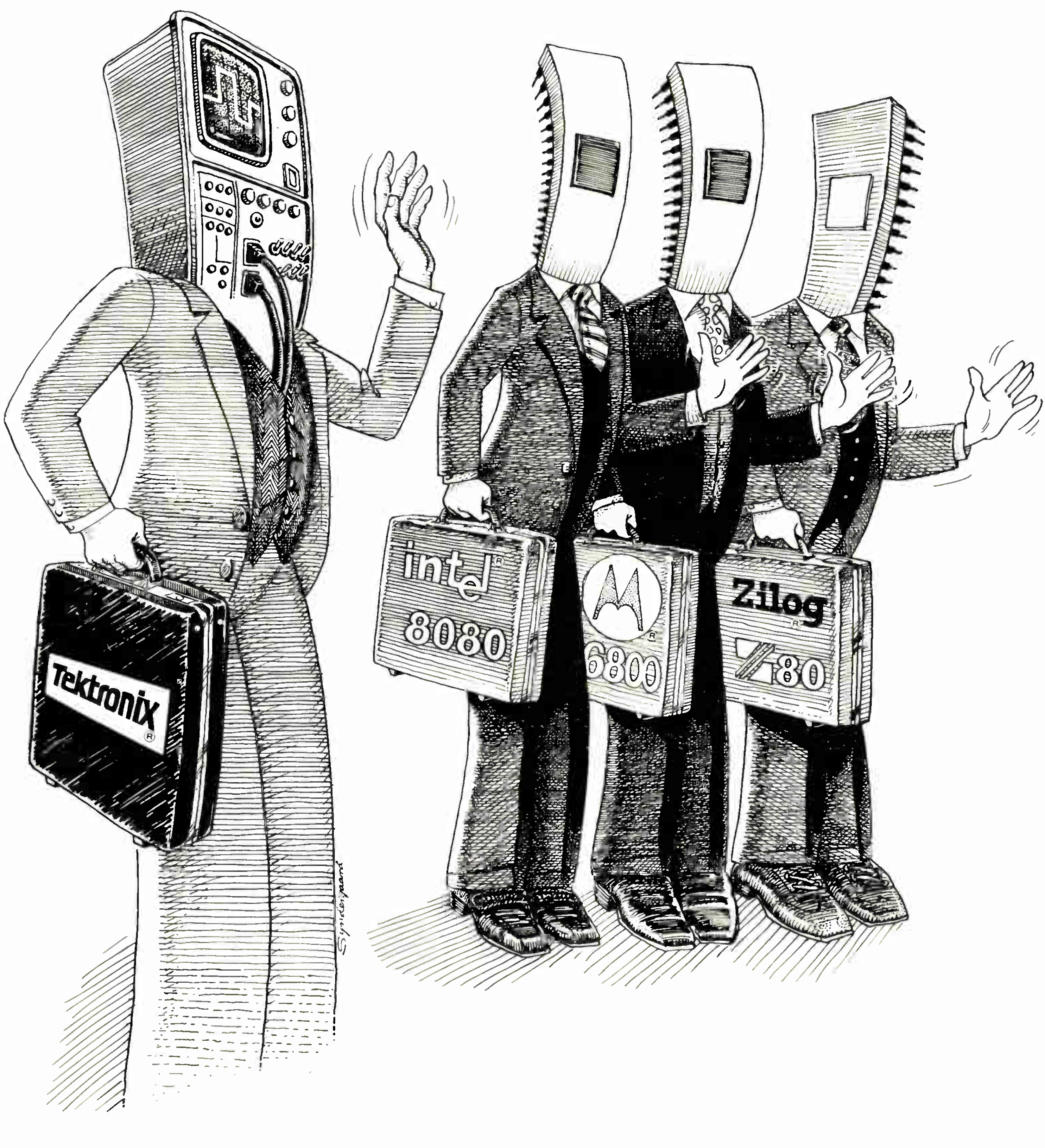

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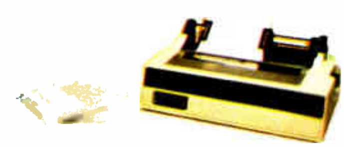

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People

Documation's Cattorini stresses engineering

Joseph Cattorini, newly named vice president for engineering at Documation Inc., is delighted to be working for a company that recognizes how important engineering has been to its success. The Melbourne, Fla., manufacturer of peripheral equipment like high-speed line printers, card readers, cathode-ray-tube displays, and input/output subsystems for mainframe computers, has grown handsomely because of its engineering skills—from $5.5 million in sales in 1973 to more than $30 million for fiscal 1978 ending late this month.

New printer. For example, the company will venture into nonimpact printing for the first time in 1978. "We're free to look at ink-jet or laser technology," he says. "And we're looking at several approaches because I don't think any one will cover the gamut of applications from word processor to high-speed computer printouts."

Generally, Documation comes up with high-performance products first, then fleshes out the line with simpler systems, an approach Cattorini respects. Documation did this, for example, when it found that nobody but IBM was producing reliable, high-speed card readers and line printers. With the "Cadillac" designed, it is easier to come out with lower-performance products, instead of starting at the low end "and trying to sneak up on excellence," says Cattorini, who came to Documation in 1974 and moves up now from director of engineering.

Another major ingredient in his and his company's philosophy is to keep engineering development programs short. "We can complete engineering development three to four times faster than many large companies," Cattorini says, because the company is still small enough not to require the approval of several layers of management before proceeding with a product. In addition, Documation has a fast-reacting model shop that can come up with prototypes quickly. That is because the company makes its own cabinets, has its own circuit-board manufacturing facility, and though still relatively small, has invested some $4 million in highly automated machine tools.

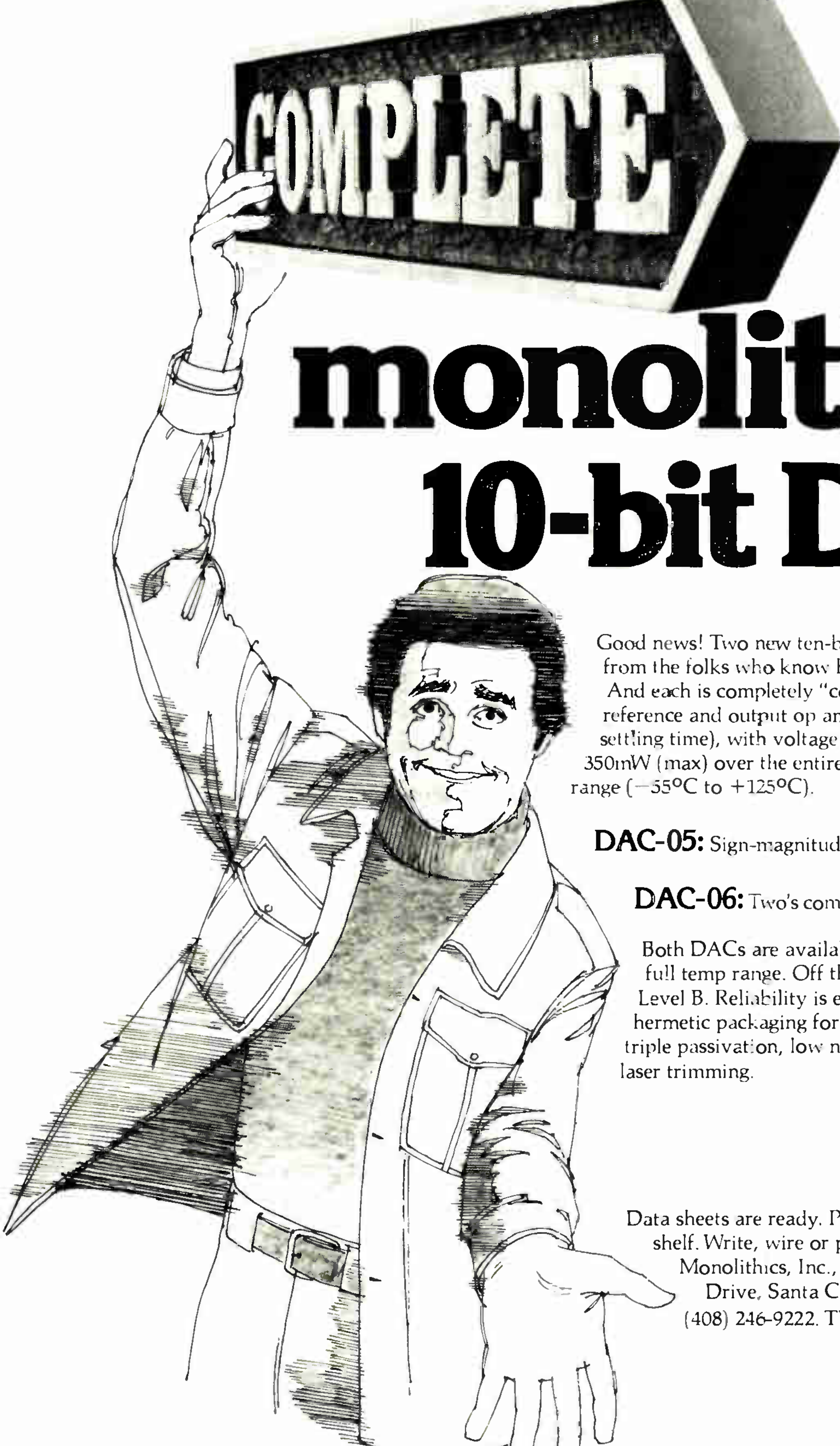
Designer. Corporate planners tell Joseph Cattorini what, not how, to design.

At TRW, communications is all under Campbell's roof

What excites Richard A. Campbell most about now having all of TRW Inc.'s communications efforts under one roof is its huge prospective business—"a pie that is bigger than the parts." By this, Campbell, who on Jan. 1 became vice president and general manager of the newly created TRW Electronics Communications Group, means that the requirements of "the $30 billion computer equipment business and the $30 billion telecommunications business are merging to result in a market that will soon amount to $100 billion."

For the 51-year-old Campbell, "one of the most exciting areas lies in integrated digital switching and multiplexing systems, required by telephone operating companies to meet their heavier loads." He is certain these companies will opt for digital switching and transmission,

PMI announces two



monolithic 10-bit DAC's.

Good news! Two new ten-bit digital-to-analog converters from the folks who know how to make them monolithically. And each is completely "complete." Includes internal reference and output op amp. They are fast (1.5 μsec settling time), with voltage outputs, yet consume only 350mW (max) over the entire military temp range (−55°C to +125°C).

DAC-05: Sign-magnitude coding (sign-plus-ten-bits).

DAC-06: Two's complement coding.

Both DACs are available now specified over the full temp range. Off the shelf to MIL STD-883A Level B. Reliability is enhanced by 100% burn-in, hermetic packaging for all parts, PMI's famous triple passivation, low noise process and no laser trimming.

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People

To come. TRW plans more internal development plus acquisitions, Campbell says.

not by coincidence made by his group's Vidar division, rather than adding conventional telephone gear. "Digital stuff not only saves materials, but its voice quality is better," he says.

Besides Vidar and its digital transmission and switching equipment, in Campbell's group includes the Datacom International division, a data terminal maker, and TRW's Communications System and Service division, which supplies transaction-oriented terminals to financial and retail clients. Based in West Los Angeles, Calif., the group's 1977 sales probably topped $150 million.

In reaching this size in seven years, TRW began without any company-developed products of its own. Instead, it either acquired them or marketed equipment from other companies. "We chose this strategy because getting new products is the easy part," recalls Campbell, who began at TRW Semiconductors in 1954 as an engineering supervisor. "It's building marketing and service that's hard." As he sees it, "products come and go on a four-year cycle, but your people are with you for 25 years." However, TRW recently started producing its own data terminals and other telecommunications gear, and plans more internal developments, while continuing to acquire "new parts that make sense," he says.

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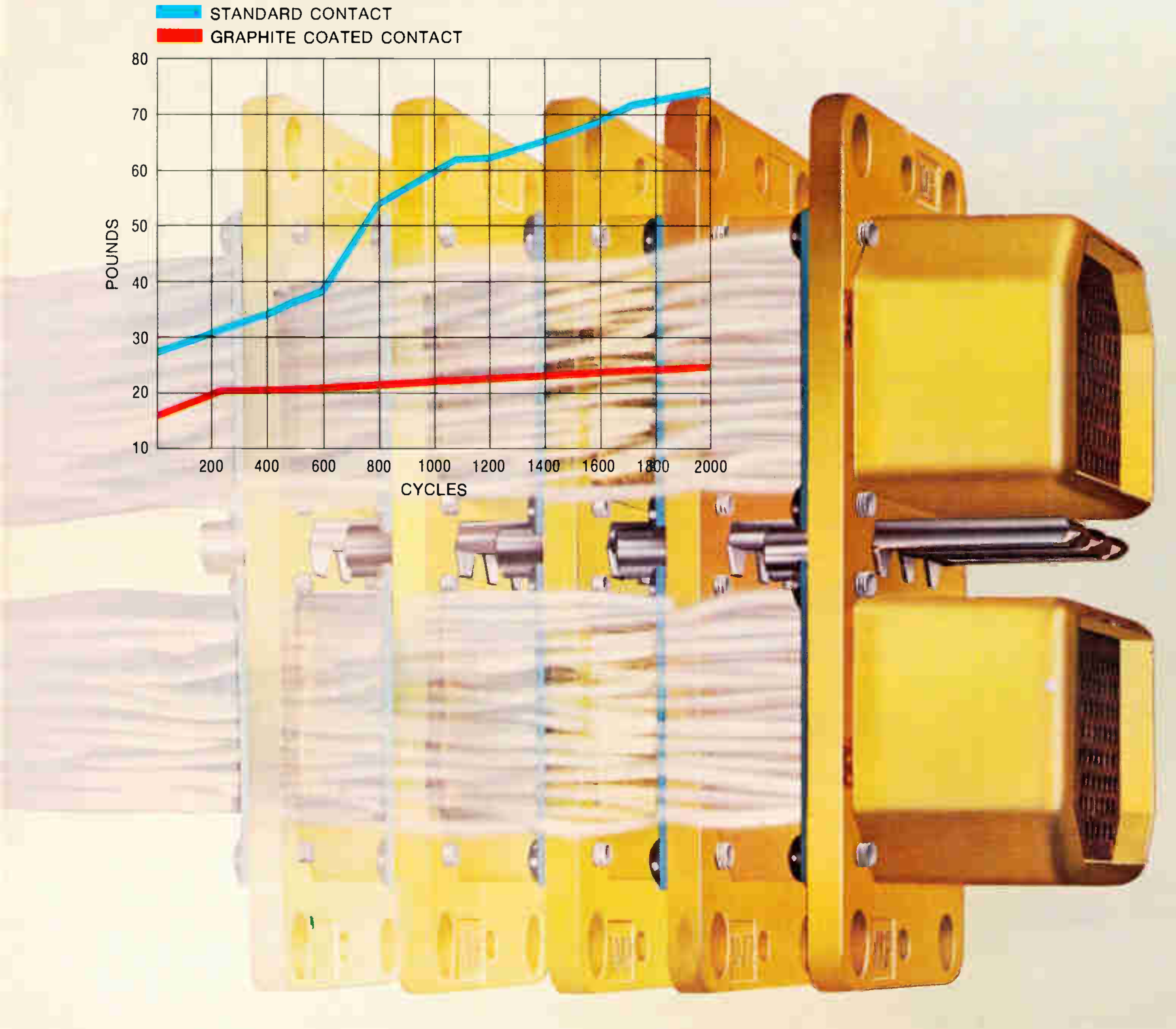
Without compromising performance.



They give you all the advantages of lower insertion force without sacrificing proven contact geometries, or electrical stability. Insertion and extraction forces can be reduced as much as 40% which also results in extended contact life by more than 100% (as the table indicates).

The secret of this outstanding, exclusive improvement lies in the integration of lubricant and plating material, which now can be used on both round or flat contact surfaces. Where used, plating thickness can be cut appreciably with no change in electrical stability. That's why Bonded Lubrication has become one of the industry's most significant and cost effective performance breakthroughs.

And there are many more ways AMP Bonded Lubrication can improve your designs. It facilitates the use of larger pin counts with resulting savings in space, size, weight, materials and assembly time. It reduces servicing and maintenance because there is less damage, wear and replacement of mating contacts. And with it come the advantages of AMP technical assistance . . . first rate engineering help in design, production or prototype planning. Because we want to help you get the most out of your product and ours.

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Why not put all the advantages of the better way, AMP Bonded Lubrication, to work in your products. For technical information just call Customer Service at (717) 564-0100. Or write on your Company Letterhead to AMP Incorporated, Harrisburg, PA 17105. For product information, please circle the reader service number.

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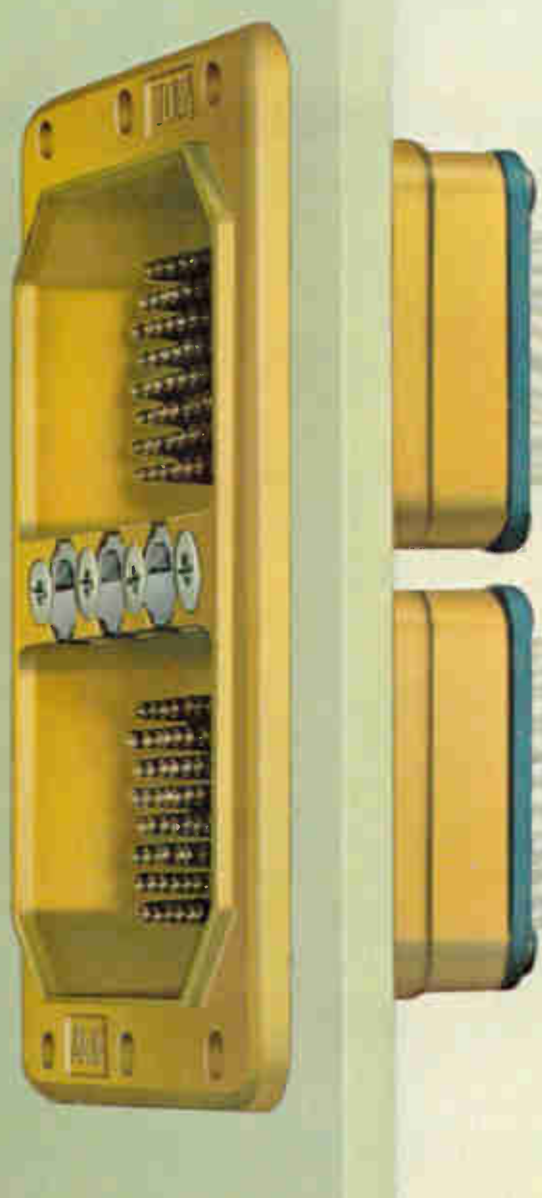

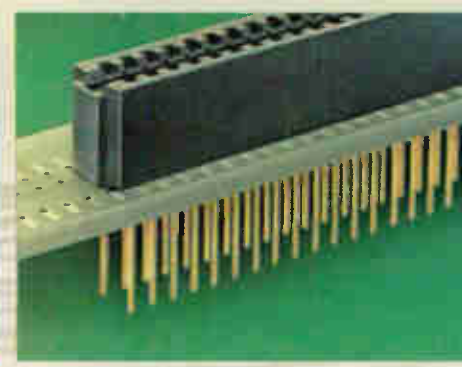

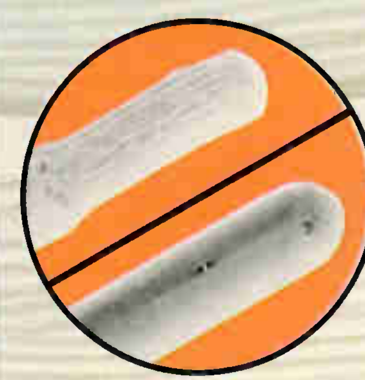

The dramatic difference in wear between Bonded Lubrication and ordinary contacts is shown by these electron images.

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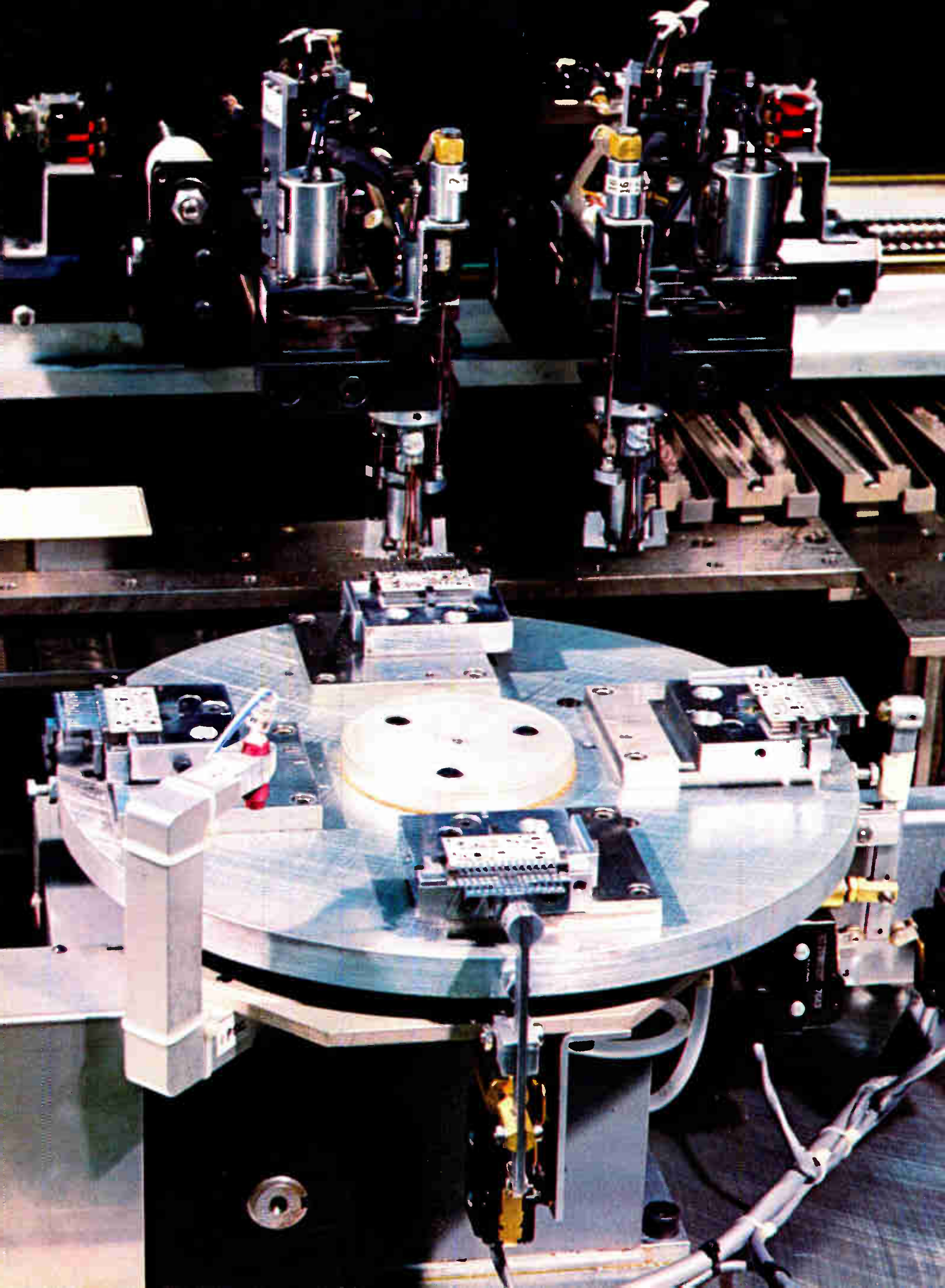
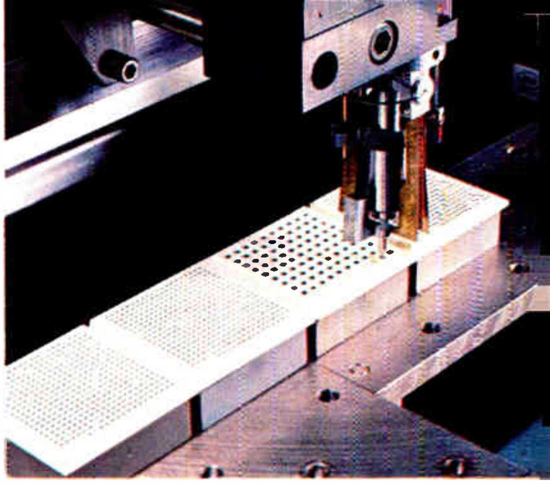
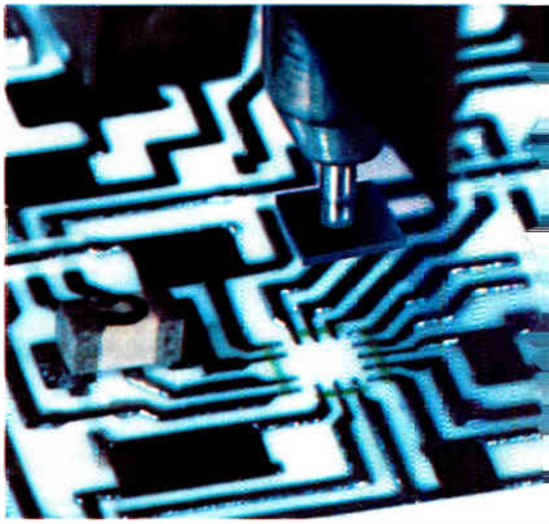
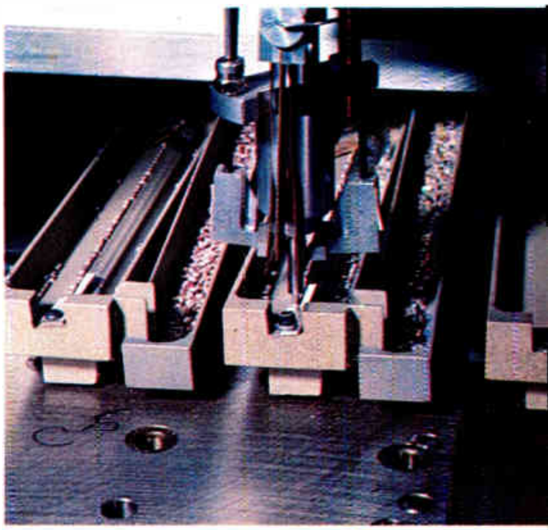
Circle 21 on reader service card









Looking forward from the past 20 years

In the two decades since *Electronics* began preparing a U. S. market forecast, the total value of electronics equipment consumed in the U. S., not allowing for inflation, has nearly quadrupled.

Twenty years ago, equipment sales were estimated at $14 billion, only a 5% increase from the previous year owing to a sluggish general economy. At that time defense spending claimed the largest piece of the pie, accounting for $4.2 billion. In 1978, spending for defense electronics will come to about $16.5 billion and is no longer the front runner.

Today, data-processing equipment claims the biggest chunk of dollars—$24.5 billion of the $65.8 billion U. S. market by the end of the year. In contrast, domestic computer sales in 1958 totaled only $375 million, according to *Electronics*' survey.

Perhaps the most telling trends in the last 20 years have been the spread of electronics to other industries and the development of totally new products spurred by semiconductor technology. As a result, all of the product categories have been expanded or changed over the years to encompass the many new types of equipment available today. For instance, consumer products, worth over $12 billion and the third largest equipment market today, have taken radically new directions into digital applications since the time when the main items were black-and-white television sets, monaural radios, and low-fidelity record players.

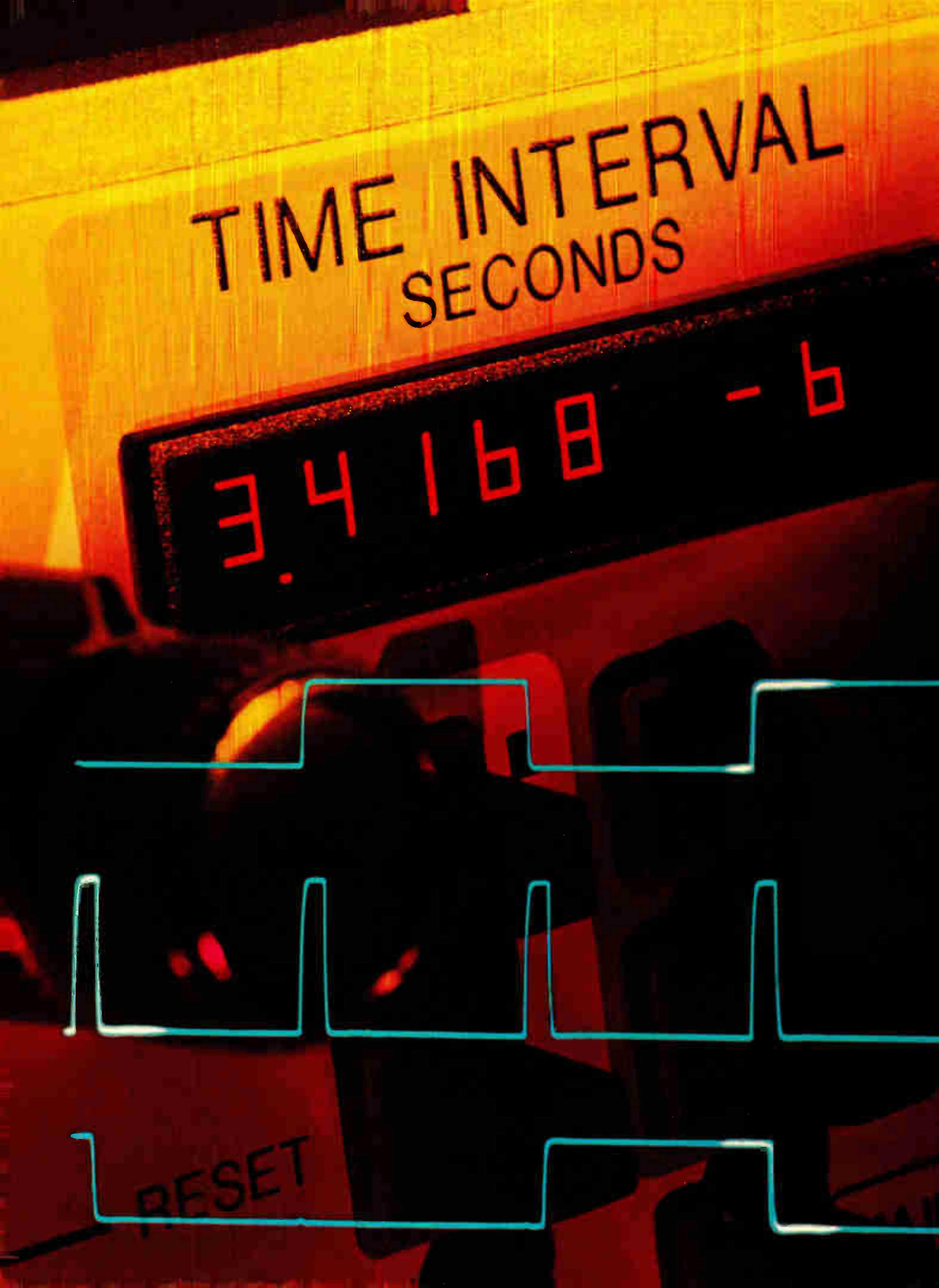
Recognizing similar expansion of the industry overseas, *Electronics* began surveys for Western Europe in 1965 and for Japan in 1970. The prediction for Western Europe's total 1966 electronics equipment consumption was $7.9 billion compared with $26.8 billion expected this year. Then as now, West Germany, France, and Great Britain were the largest markets.

When the survey of Japan's domestic consumption began in 1970, total expenditures for electronic equipment were predicted to hit $8.3 billion in 1971, a little over half of what it is today. At that time the Japanese were worried about maintaining consumer electronics growth after the saturation of color TV and were pushing hand-held calculators, microwave ovens, and video tape recorders—all now vital products worldwide.

In recent years all electronics activities have become increasingly global. Because of their international character, *Electronics* in 1976 started combining the three market reports into a world market forecast. That year total equipment consumption in the three major markets was predicted at $82.8 billion; this year it will top $107 billion.

Over the past 20 years, then, the whole complexion of the electronics industries has changed. The problems, the scares, the success formulas that characterized electronics back in the late 1950s are a far cry from their present counterparts. Yesterday's worries are gone, whether resolved or merely outwaited, and are replaced by the anxieties of 1978.

While the year ahead looks to be a basically good one, no one in the electronics industries can afford not to watch all the economic signs very carefully. The enterprise we call electronics may have mushroomed over the past two decades, surmounting recession, defense-spending cutbacks, and numerous other crises—but individual companies have certainly not all been so fortunate.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RESET

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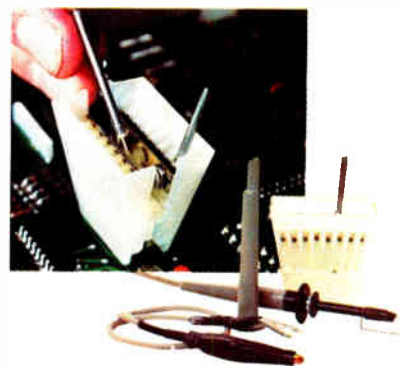

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Value, however, is a lot of things. Such as performance, versatility, and a faster, lower cost way of getting a product to market. For the 4/10, your real savings just begin to start with the sale price. Its large instruction set (including multiply/divide as standard) pays off with exceptional programming versatility, faster development, less memory used. Options include floating-point instructions and double-register shifts.

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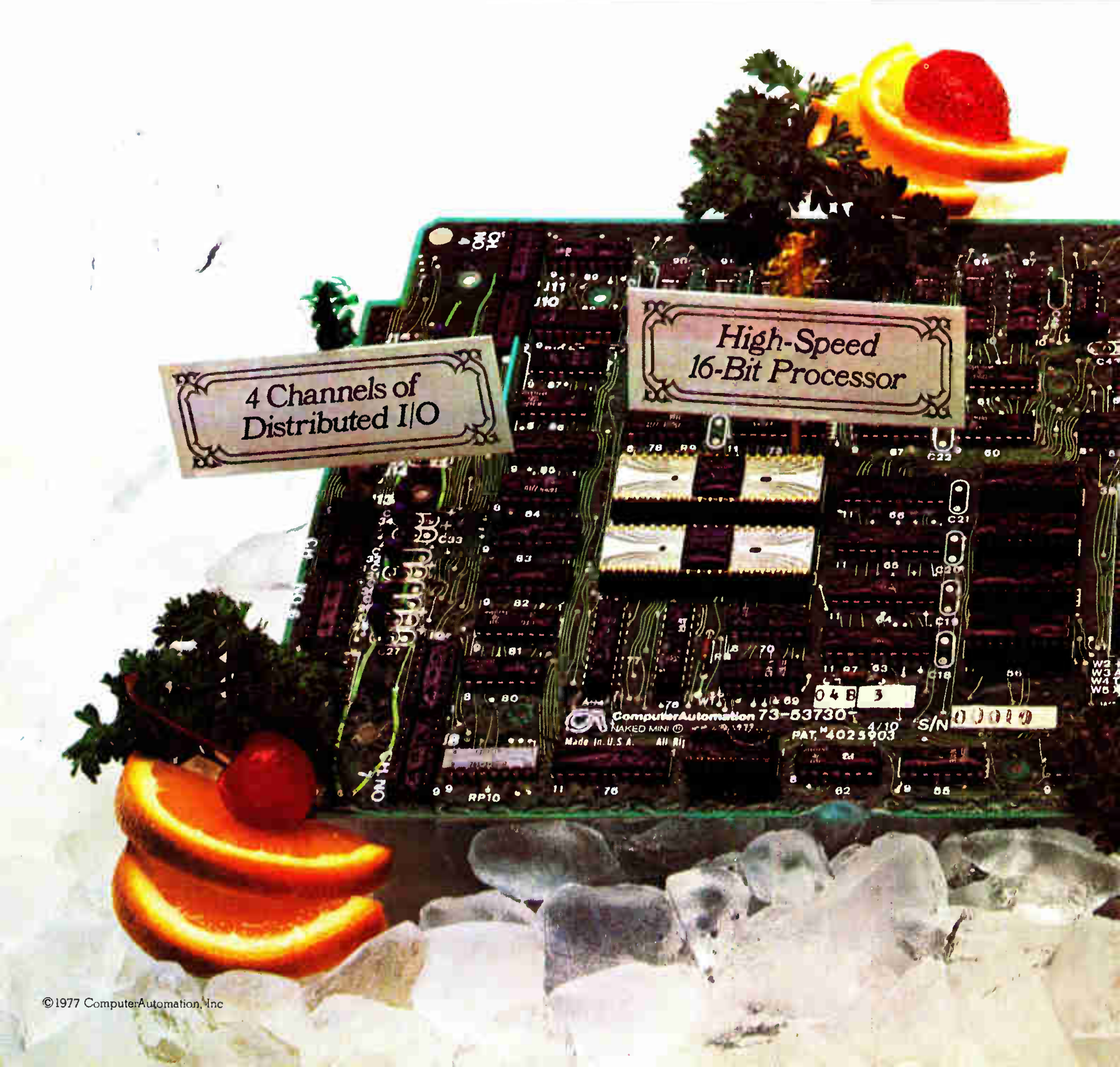


Meetings

Reliability and Maintainability Conference, IEEE, Biltmore Hotel, Los Angeles, Jan. 24 – 26.

Power Engineering Society Winter Meeting, IEEE, Statler Hilton Hotel, New York, Jan. 29 – Feb. 3.

Automated Testing for Electronics Manufacturing Seminar and Exhibit, Circuits Manufacturing Magazine, Los Angeles Airport Marriott Hotel, Los Angeles, Jan. 30 – Feb. 1.

CLEOS—**Conference on Laser and Electro-Optical Systems,** IEEE and OSA, Town and Country Hotel, San Diego, Feb. 7 – 9.

Wincon—Aerospace and Electronic Systems Winter Convention, IEEE, Los Angeles, Feb. 13 – 15.

International Solid State Circuits Conference, IEEE, San Francisco Hilton, San Francisco, Feb. 15 – 17.

Computer Science Conference, ACM, Detroit Plaza Hotel, Detroit, Feb. 21 – 23.

Fifth Energy Technology Conference and Exposition, U. S. Energy Research and Development Administration, Sheraton Park Hotel, Washington, D. C., Feb. 27 – March 1.

Nepcon West and Semiconductor Hybrid Microelectronic Symposium and Exhibits, Industrial and Scientific Conference Management Inc. Anaheim Conference Center, Calif., Feb. 28 – March 2.

Compcon Spring, IEEE, Jack Tar Hotel, San Francisco, Feb. 28 – March 2.

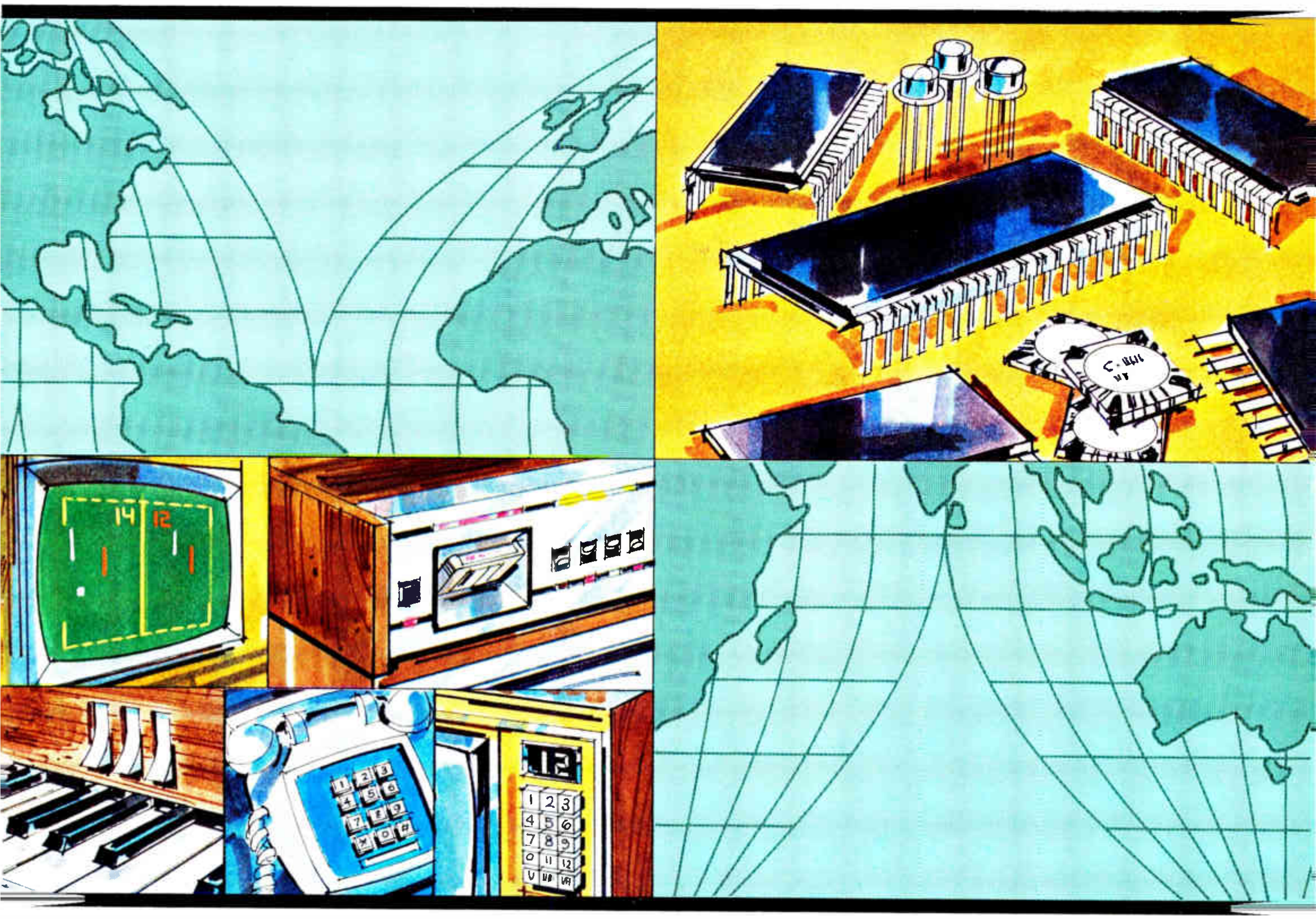
Industrial Applications of Microprocessors, IEEE, Sheraton Hotel, Philadelphia, March 21 – 23.

28th Vehicular Technology Conference, IEEE, Regency Hotel, Denver, Colo., March 22 – 24.

Computer Architecture Symposium, IEEE, Rickey's Hyatt House, Palo Alto, Calif., April 3 – 5.

MICRO ELECTRONICS

1978 Product Guide



GENERAL INSTRUMENT CORPORATION ■ MICROELECTRONICS

DEDICATED TV GAMES

FUNCTION	DESCRIPTION	GAMES	PART NUMBER	LINE STANDARD	PACKAGE	FEATURES
SUPERSTAR	Ten selectable games for one or two players,. with horizontal and vertical paddle motion.	Tennis Hockey Soccer Squash Practice Gridball Basketball Basketball Practice Target I Target II	AY-3-8610	625	28 DIP	Automatic on-screeen scoring. Sound generation (hit, boundary, score). Selectable paddle size (individually selectable for each player). Full two-axis player motion. Color-coding of score and player. Realistic ball service and scoring.
			AY-3-8610-1	525		
SUPERSTAR COLOR CONVERTER	Converts the black & white video outputs of the AY-3-8610-1 to a single color composite video signal.	—	AY-3-8615	525	28 DIP	Colors of the background and paddle outputs are selectively changed directly by the "game select" inputs. Also provides, as an output. a buffered 3.579MHz clock for the game circuit.
BATTLE	A two player "tank battle" game where each player has a completely steerable tank with forward and reverse speed control and a firing button.	Tank Battle	AY-3-8710	625	28 DIP	The on-screen "battlefield" includes anti-tank barricades and exploding mines to retard each tank's progress. Unlimited ammunition to a scoring limit of 16 'hits."
			AY-3-8710-1	525		
NEW CYCLE	A one player game where the player controls the speed of a motorcycle and rider through variations of a three track course.	Stunt Cycle Drag Race Motocross Enduro	AY-3-8760	525 OR 625	28 DIP	Full color display. Selectable NTSC/PAL compatibility. Pro-Am selection for game difficulty factor. Full complement of sounds: cycle engine, bus hit, crash, screech, and good jump.
BALL & PADDLE	Six selectable games for one or two players, with vertical paddle motion.	Tennis Soccer Squash Practice Rifle Game I Rifle Game II	AY-3-8500	625	28 DIP	Automatic on-screen scoring. Sound generation (hit, boundary, score). Selectable paddle size, ball speed, rebound angles.
			AY-3-8500-1	525		
BALL & PADDLE (TWO AXIS)	Six selectable games for one or two players, with horizontal and vertical paddle motion.	Tennis Soccer Squash Practice Rifle Game I Rifle Game II	AY-3-8550	625	28 DIP	All features of the AY-3-8500/8500-1 with the addition of full two-axis player motion, color-coding of score and player, and "hit" and "miss" scoring in Practice game.
			AY-3-8550-1	525		
BALL & PADDLE COLOR CONVERTER	Converts the black & white video outputs of either the AY-3-8500-1 or AY-3-8550-1 to a single color composite video signal.	—	AY-3-8515	525	16 DIP	Colors of the background and paddle outputs are selectively changed directly by the "game select" inputs. Also provides, as an output, a 2.045MHz clock for the game circuit.

PROGRAMMABLE TV GAMES

FUNCTION	DESCRIPTION	GAME FUNCTION	PART NUMBER	PACKAGE	FEATURES
NEW GIMINI ECONOMY "8600" PROGRAMMABLE GAME SET†	With a single AY-3-8615 "Resident Processor" chip in the console, the GIMINI "8600" minimizes system cost. Each game cartridge provides full color with realistic sounds and scoring.	Resident Processor	AY-3-8615	28 DIP	Console-mounted game/color processor.
		Roadrace Cartridge	AY-3-8603-1	28 DIP	Two racing games for one or two players.
		Submarine Cartridge	*AY-3-8505-1	28 DIP	Two sea battle games for one or two players.
		Wipeout Cartridge	*AY-3-8606-1	28 DIP	Four games encompassing combat, strategy, and skill.
		Rifle Cartridge	*AY-3-8607-1	28 DIP	Four target games for one or two players.
		Superstar Cartridge	AY-3-8610-1	28 DIP	Ten ball & paddle/target games.
		Superspace Cartridge	*AY-3-8750-1	28 DIP	Two player space battle game.
		Cycle Cartridge	AY-3-8765	28 DIP	Four motorcycle racing/jumping games.
NEW GIMINI FULL RANGE "8900" PROGRAMMABLE GAME SET††	The "8900" chip set provides the basis for a user-programmed game series for up to eight players and featuring: up to eight user-controlled moving objects, up to 512 characters in ROM or RAM library, up to 240 programmable background locations, movable background field, and display in up to 14 colors plus black and white.	Microprocessor	CP1610	40 DIP	A variant of the GI CP1600 microprocessor, the CP1610 is a 16-bit unit utilizing 8 general purpose registers for fast and efficient processing of all game data.
		TV Interface	AY-3-8900 OR AY-3-8900-1	40 DIP	The "STIC", Standard Television Interface Chip, provides the video signals including sync and blanking and the manipulation and interaction of all graphics data in a non-interlaced pattern for the TV.
		Resident ROM	RO-3-9500 OR RO-3-9501	28 DIP OR 40 DIP	The "graphics" ROM contains 256 8X8 dot matrices for a large variety of game symbols, background/field data, and 64 alpha-numeric characters.
		Cartridge ROM	RO-3-9500 OR RO-3-9501	28 DIP OR 40 DIP	The "program" ROM organized as 2048X10, contains all game "rules", symbol locations, color, velocity and direction data.
		Resident RAM	RA-3-9600	40 DIP	The "working" memory during game operation contains a 352X16 memory plus a 20 word "current line" buffer.
		Sound Generator	AY-3-8910	28 DIP	Provides full software programmability for complex sound effects generation without external timing components.
NEW GIMINI MID RANGE "8950" PROGRAMMABLE GAME SET††	The "8950" chip set provides the basis for a user-programmed game series which does not require moving objects but which offers extensive flexibility in character library and on-screen character positioning.	Microprocessor	CP1610	40 DIP	A variant of the GI CP1600 microprocessor, the CP1610 is a 16-bit unit utilizing 8 general purpose registers for fast and efficient processing of all game data.
		TV Interface/ Resident ROM	AY-3-8950 OR AY-3-8950-1	40 DIP	The "GIC" Graphics Interface Chip, contains a 64 character ROM and all circuitry to generate sync, color burst, blanking and video data.
		Cartridge ROM	RO-3-9500 OR RO-3-9501	28 DIP OR 40 DIP	The "program" ROM organized as 2048X10, contains all game rules and symbol locations.
		Resident RAM	2112A Series	—	The "working" memory during game operation. A total of two 256X4 RAMs are required for a combined 256X8 memory complement.

†All "8600" Programmable Game chips will be available for CCIR compatibility in black and white—check factory for availability dates. * For Future Release

††Game program emulators available for the "8900" and "8950" systems.

MUSIC

FUNCTION	DESCRIPTION	PART NUMBER	MAXIMUM FREQUENCY	POWER SUPPLIES	PACKAGE	FEATURES
MASTER FREQUENCY GENERATOR/ TOP OCTAVE GENERATOR	Generates a complete octave of musical frequencies.	AY-1-0212	1.5 MHz	+12, GND	16 DIP	250kHz minimum frequency.
		AY-1-0212A	2.5 MHz			
		AY-3-0214	4.5MHz	+10 to +16, GND	16 DIP	12 outputs, 50% duty cycle.
		AY-3-0215				13 outputs, 50% duty cycle.
		AY-3-0216				13 outputs, 30% duty cycle.
LATCHING NETWORK	Establishes priority level of 13 latch inputs/outputs.	AY-1-1313	20kHz	GND, -12, -27	40 DIP	Stackable for expanded latching/ priority function.
RHYTHM GENERATOR	Generates 6 rhythms, drives 8 instruments.	AY-5-1315	10kHz	GND, -15	18 DIP	Resets for coupling chords to rhythm. 32 beat pattern. Mask programmable.
CHORD GENERATOR	Produces major, minor, 7th chords, walking bass.	AY-5-1317A	50kHz	GND, -15	40 DIP	Mixed outputs, sustain, top key priority.
PIANO KEYBOARD	Electronically simulates piano operation and sound.	AY-1-1320	—	GND, -10, -27	40 DIP	12 keys per unit, loudness proportional to key press velocity.
FREQUENCY DIVIDERS	4 stage	AY-1-5051	1MHz	GND, -13, -27	10 TO	Arranged 2 + 1 + 1
	5 stage	AY-1-6721/5	1MHz	GND, -13, -27	10 TO	Arranged 3 + 2
	6 stage	AY-1-6721/6	1MHz	GND, -13, -27	12 TO	Arranged 3 + 2 + 1
		AY-1-1006	50kHz	GND, -12, -27	14 DIP	Arranged 3 + 2 + 1
		AY-1-2006	50kHz	GND, -12, -27	14 DIP	Arranged 2 + 2 + 1 + 1
	7 stage	AY-1-5050	1MHz	GND, -13, -27	14 DIP	Arranged 3 + 2 + 1 + 1
		AY-1-1007B	50kHz	GND, -12, -27	14 DIP	Arranged 3 + 2 + 1 + 1, power-on reset.

APPLIANCES

	FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
	CLOCK TIMER	24 hour programmable, repeatable on/off time switch with 4 digit clock.	AY-5-1230	GND, -12 to -18	28 DIP	50Hz input (50 or 60Hz on AY-5-1231). BCD or 7-segment direct fluorescent display drive outputs, zero blanking, 24 hour display (12 or 24 hour on AY-5-1231).
			AY-5-1231		40 DIP	
			AY-5-1232		28 DIP	
			AY-5-1233		28 DIP	
	OVEN/COOKER TIMER	Appliance timer with clock. Full control of "start" time, "stop" time, or "duration".	*AY-5-1250	+9, GND	28 DIP	Three timed outputs, "minute minder" feature, 12/24 hour system, 4 digit display (AY-5-1250) or 14 digit display (AY-5-1251).
			*AY-5-1251		40 DIP	
NEW	MICROWAVE OVEN TIMER	Three mode magnetron control plus minute timer & 4 digit clock.	AY-5-1260	GND, -5, -16	40 DIP	99 minute/99 second oven control and minute timer. Status indicators. Audio output.
	COINBOX CIRCUIT	A memory/credit accumulator for coin-operated equipment.	AY-1-8622	GND, -12, -27	40 DIP	Seven different coin inputs, credit and "bonus" features.
NEW	DIGITAL THERMOMETER	Deep-freeze thermometer circuit (−40°C to 0°C).	*TR 1100	+9, GND	40 DIP	Direct display drive, ±1°C accuracy, power-fail/over-range indication (flashing display).
NEW	VIDEO TAPE RECORDER TIMER	Program "start" time for 2 or 4 hour VTR's.	VTR3300	+7.5 to +15, GND	28 DIP	12 or 24 hour time. Direct drive for 7-segment LEDs.

*For Future Release.

INDUSTRIAL

FUNCTION	DESCRIPTION	PART NUMBER	MAX. COUNT FREQUENCY	POWER SUPPLIES	PACKAGE	FEATURES
3½ DIGIT DVM	DVM logic incorporating dual ramp integration.	AY-5-3507	40kHz	GND, -15	18 DIP	Range to 1999, 7-seg. outputs.
		AY-5-3510			16 DIP	Range to 1999, BCD outputs.
3¾ DIGIT DVM	DVM logic incorporating single ramp intergration.	AY-5-3500	200kHz	GND, -7.5, -15	28 DIP	3 ranges: 999, 1999, 2999. Dual polarity, BCD & 7-seg. outputs.
4¾ DIGIT DVM	DVM logic incorporating dual ramp integration.	AY-3-3550	400kHz	+5, GND	40 DIP	Auto-range, auto-zero, auto-polarity, 7-segment/ BCD outputs, counter mode.
4 DIGIT COUNTER	Counts, stores & decodes four decades to BCD outputs.	AY-5-4057	500kHz	+5, GND, -12	16 DIP	BCD outputs.
4 DIGIT COUNTER/ DISPLAY DRIVER	Counts (up or down), stores & decodes four decades to 7-segment outputs.	AY-5-4007	600kHz	+5, GND, -12	24 DIP	BCD outputs, true/ complement control.
		AY-5-4007A			40 DIP	Includes features of AY-5-4007 & 4007D.
		AY-5-4007D			24 DIP	Serial count output, three carry outputs.
10 BIT D/A CONVERTER	Ladderless D/A converter.	AY-5-5053	SEE DATA SHEET	+5, GND, -12	24 DIP	Employs stochastic techniques.
A/D CONVERTER CONTROL	With AY-5-5053 performs A/D with transmitter facility.	AY-5-5054	SEE DATA SHEET	+5, GND, -12	24 DIP	For use in remote sensing applications.

RADIO

FUNCTION	DESCRIPTION	PART NUMBER	AM/MW/SW IF OFFSET	FM/VHF IF OFFSET	POWER SUPPLIES	PACKAGE	FEATURES
FREQUENCY COUNTER/ DISPLAY	Counts & displays MW, SW, and VHF frequencies.	AY-5-8100	460kHz	10.7MHz	GND, -17	28 DIP	4½ digit display: MW, SW, VHF, 0 to 99 FM channel indication (European standard).
		AY-5-8102	455kHz				
FREQUENCY COUNTER/DISPLAY WITH 4 DIGIT CLOCK	Counts & displays AM/FM frequencies with a 12 hour clock.	AY-3-8110	262.5kHz	10.46 to 10.76 MHz	+10 to +16, GND	28 DIP	Easy time set controls, low power consumption, on-chip intensity control. Clock functions down to +5V.
		AY-3-8112	455kHz				
STEREOMEGA® PHASE-LOCKED LOOP DIGITAL TUNING SYSTEM	Control circuit: accepts inputs to control and program the system.	AY-3-8115	455kHz	10.7MHz	+10 to +16, GND	40 DIP	Tune up, tune down; search stereo only; scanning mode; pre-program 10 favorite stations (5AM/5FM).
	Memory circuit: provides non-volatile storage of station tuning information.	ER 1400	—	—	+12, -24	8 TO	
	Clock circuit: supplements the control circuit to provide time display.	AY-3-8116	—	—	+5 to +16, GND	24 DIP	

*STEREOMEGA is a trademark of General Instrument Corp.

TELEVISION

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
OMEGA® 82 CHANNEL DIGITAL TUNING SYSTEM	Control circuit: accepts keyboard/ remote inputs to control system.	T-1001	+12, GND	40 DIP	Scan mode or search mode may also be selected.
	Display circuit: displays selected channel number.	T-1101	+12, GND	40 DIP	Decodes and drives BCD or LED displays.
	D/A converter circuit: converts output to coarse and fine tune outputs.	MEM 4956	VREF +12, GND	14 DIP	14 bit accuracy for precise varactor tuning.
	Memory circuit: provides non-volatile storage of station tuning information.	ER 1400	+12, -24	8 TO	100 × 14 bit memory
	Optional channel selector interface circuit: permits preset channels.	T-1201	+12, GND	40 DIP	Up to 20 channels; pre-set and/or customer selection.
ECONOMEGA® 16 CHANNEL DIGITAL TUNING SYSTEM	Control circuit: accepts direct/remote inputs to control/program system.	AY-3-8203	+12, GND	40 DIP	16 programs, 14 bit accuracy with coarse and fine tune.
	D/A converter circuit: converts output to coarse and fine tune outputs.	MEM 4956	VREF, +12, GND	14 DIP	14 bit accuracy for precise varactor tuning.
	Memory circuit: provides non-volatile storage of station tuning information.	ER 1400	+12, -24	8 TO	100 × 14 bit memory
CHANNEL/TIME DISPLAY SERIES	Various circuits in series to display channel/time on-screen.	AY-5-8300 SERIES	SEE DATA SHEET	14 DIP 24 DIP	Selection of display position on screen & channel modes (0-15, 0-16, 00-99).
NEW ON-SCREEN TUNING SCALE	Provides an electronic on-screen tuning scale for varactor tuned TV sets.	AY-3-8330 AY-3-8331	+12, GND	16 DIP	4 bands, mask programmable band or channel number display, mask programmable display positions.

*OMEGA & ECONOMEGA are trademarks of General Instrument Corp.

REMOTE CONTROL

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
R/C SYSTEM I	30 Channel Transmitter.	SAA 1024	9V BATTERY	16 DIP	30 ultrasonic control channels, 34-44kHz. Utilizes a 4.4MHz TV crystal for accuracy.
	30 Channel Receivers.	SAA 1025-01 SAA 1025-02	+18, GND	16 DIP	Power on/off output, 16 TV channel selection (& 5 spares), 3 analog outputs (8 functions).
R/C SYSTEM II	23 Channel Transmitters.	AY-5-8410	+15, GND	18 DIP	23 channels, either local control at receiver or remote control
		AY-5-8411	9V BATTERY		
	31/63 Channel Receiver.	AY-5-8420	+15, GND	14 DIP	5 or 6 bit modes, error-detection.
R/C SYSTEM III	30 Channel Transmitter.	AY-5-8450	9V BATTERY	16 DIP	30 ultrasonic control frequencies, interfaces directly with a 5×6 matrix keyboard.
	16 Channel Receivers.	AY-5-8460 AY-5-8461	+12, GND, -6	18 DIP	Interfaces directly with OMEGA 10 digit keyboard inputs plus on/off, recall, 2 analog controls (4 functions).
NEW R/C SYSTEM IV	264 Command IR Transmitter.	*AY-3-8470	9V BATTERY	28 DIP	8 bit PCM system plus 8 PWM analog commands. 4X8 keyboard (32X8 with shifts).
	264 Command IR Receiver.	*AY-3-8475	+ 12, GND	40 DIP	5 bit binary program output, CPU databus interface for 256 digital commands and 8 analog commands.

* For Future Release

SECURITY

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
NEW SMOKE DETECTOR	Complete ionization smoke detector circuitry in a single CMOS LSI.	MEM 4962	9V BATTERY	14 DIP	On-chip input MOSFET and output driver. Low battery warning.
	Circuitry for ionization, photoelectric, or both in a single CMOS LSI.	MEM 4963	9V BATTERY	14 DIP	As above, plus an interconnection capability for common alarm in multiple-unit installations.

MOSFET TRANSISTORS

TYPE	PART NUMBER	$V_{(BR)DSS}$ VOLTS MIN.	$V_{(BR)GSS}$ VOLTS MIN.	I_{DSS} nA TYP.	I_{GSSF} nA TYP.	$V_{GS(th)}$ VOLTS MIN/MAX.	$r_{DS(on)}$ OHMS TYP.	Y_{fs} MHO TYP.	C_{iss} pF TYP.	C_{rss} pF TYP.	CASE
P-CHANNEL ENHANCEMENT MODE	MEM511	−30	−30	−0.5	−0.05	−3/−6	150	2,500	3.5	2.5	TO-72
	MEM511A	−30	−30	−0.5	−0.5	−3/−6	300	2,500	3.5	2.5	TO-72
	MEM511C	−25	−25	−3.0	−0.05	−3/−6	150	2,500	4.0	4.0	TO-72
	MEM517	−30	−25	−0.8	−0.15	−2.5/−5	35	12,000	10.0	10.0	TO-33
	MEM517A	−30	−25	−0.8	−0.15	−2.5/−5	35	12,000	10.0	10.0	TO-5
	MEM517C	−25	−25	−3.5	−0.15	−2.5/−5	35	12,000	10.0	10.0	TO-33
	MEM520	−30	−40	−0.5	−0.03pA	−3/−6	150	2,500	3.0	2.5	TO-72
	MEM520C	−25	−25	−3.0	−0.1pA	−3/−6	150	2,500	3.0	2.5	TO-72
	MEM556	−50	−50	−0.1	−0.1	−3/−6	700	950	0.3	0.3	TO-72
	MEM556C	−45	−45	−0.3	−0.3	−3/−6	700	950	0.4	0.4	TO-72
	MEM560	−35	−35	−1.0	−0.1	−1.5/−3	100	3,500	7.5	1.5	TO-72
	MEM560C	−30	−30	−2.0	−0.2	−1/−3.5	175	3,500	8.0	2.0	TO-72
	MEM561	−30	−50	−1.0	−0.05pA	−1.5/−3	100	3,500	7.5	3.0	TO-72
	MEM561C	−25	−40	−0.5	−0.5pA	−1.5/−3	150	3,500	7.5	3.0	TO-72
	MEM806	−40	−40	−1.0	−0.1pA	−2/−5.5	150	2,800	4.5	1.0	TO-72
	MEM806A	−40	−40	−0.1	−0.05pA	−2/−5.5	150	2,800	4.5	1.0	TO-72
	MEM807	−40	−40	−0.5	−0.1	−2/−5.5	150	2,800	4.5	1.0	TO-72
	MEM807A	−40	−40	−0.05	−0.2	−2/−5.5	150	2,800	4.5	1.0	TO-72
	MEM814	−35	−35	−1.0	−0.1	−1.5/−3	80	3,500	6.0	1.0	TO-72
	MEM816	−30	−30	−5.0	−0.2	−2/−5	150	3,000	6.0	3.5	Plastic
	MEM817	−45	±200	−0.1	−0.05pA	−2.5/−5.5	150	2,000	3.5	1.2	TO-72
	MEM823	−35	±200	−0.1	−0.05pA	−2.5/−5.6	150	2,000	3.5	1.2	TO-18

TYPE	PART NUMBER	$V_{(BR)DSS}$ VOLTS MIN.	I_{GSSF} nA TYP.	$V_{GS(th)}$ VOLTS MIN/MAX.	$r_{DS(on)}$ OHMS TYP.	Y_{fs} MHO TYP.	C_{gs} pF TYP.	C_{rss} pF TYP.	Y_{fs} RATIO TYP.	$\lvert V_{G1S}-V_{G2S}\rvert$ mV TYP.	CASE
DUAL P-CHANNEL ENHANCEMENT MODE	MEM550	−30	−0.1	−3/−6	250	1500	1.1	1.1	0.85	70	TO-77
	MEM550C	−25	−0.2	−3/−6	250	800	2.0	2.0	0.8	100	TO-77
	MEM551	−30	−0.03pA	−3/−6	250	1000	1.1	1.1	0.9	70	TO-77
	MEM551C	−25	−1pA	−3/−6	250	750	1.5	1.5	0.85	70	TO-77
	MEM954	−30	−0.03	−2/−5	100	1000	2.0	1.5	0.95	50	TO-77
	MEM954A	−30	−0.03	−2/−5	100	1000	2.0	1.5	0.95	15	TO-77
	MEM954B	−30	−0.03	−2/−5	100	1000	2.0	1.5	0.95	5	TO-77
	MEM955	−35	−0.02pA	−2/−5	100	1000	2.0	1.5	0.95	50	TO-77
	MEM955A	−35	−0.02pA	−2/−5	100	1000	2.0	1.5	0.95	15	TO-77
	MEM955B	−35	−0.02pA	−2/−5	100	1000	2.0	1.5	0.95	5	TO-77

TYPE	PART NUMBER	BV_{DSS} MIN. VOLTS	$V_{(BR)GSS}$ VOLTS MIN.	I_{DSS} nA TYP.	I_{GSSF} nA TYP.	$I_{D(on)}$ mA TYP.	$V_{GS(th)}$ VOLTS MIN/MAX.	$r_{DS(th)}$ OHMS TYP.	Y_{fs} MHO TYP.	C_{iss} pF TYP.	C_{rss} pF TYP.	CASE
N-CHANNEL ENHANCEMENT MODE	MEM562	20	±30	1	1pA	15	0.5/4	150	2,500	3	0.3	TO-72
	MEM562C	20	±30	2	10pA	15	0.5/4	150	2,000	3	0.5	TO-72
	MEM563	20	±30	1	1pA	40	0.5/4	40	5,000	4	0.3	TO-72
	MEM563C	20	±30	3	10pA	40	0.5/4	50	4,000	4	0.4	TO-72
	MEM711	25	±30	1	0.1	40	0.5/1.5	50	3,000	4.5	0.5	TO-72
	MEM712	25	±30	1	.01	40	0.5/2	50	2,500	4.5	0.5	Plastic
	MEM712A	30	±30	1	.01	40	0.5/2	30	2,500	4.5	0.5	Plastic
	MEM713	20	±30	3	10pA	40	0.5/4	50	4,000	4	0.4	Plastic

TYPE	PART NUMBER	$V_{(BR)DS}$ VOLTS MIN.	$V_{(BR)G1S}$ VOLTS MIN.	$V_{(BR)G2S}$ VOLTS MIN.	I_{DSS} mA TYP.	I_{GSS} nA TYP.	$V_{GS(off)}$ VOLTS MAX.	$r_{DS(on)}$ OHMS TYP.	Y_{fs} MHO TYP.	C_{iss} pF TYP.	C_{rss} pF TYP.	G_{ps} dB TYP.	NF dB TYP.	CASE
N-CHANNEL DEPLETION MODE	MEM554	20	+5/−10	±20	5	.01	−1.5	—	13,000	5	0.02	20	2.8	TO-72
	MEM554C	20	+5/−10	±10	5	.05	−1.5	—	11,000	5	0.02	18	3.5	TO-72
	MEM557	20	±10	—	5	.01	−4	200	10,000	3	0.32	18	2.5	TO-72
	MEM557C	20	±10	—	5	.05	−4	200	8,000	3	0.32	17	3.0	TO-72
	MEM564C	20	±6	±6	5	1.0	−1.5	—	12,000	5	0.02	17	3.5	TO-72
	MEM571C	20	±6	—	4	±10	—	—	—	4	0.32	17	2.5	TO-72
	MEM610	20	±6	±6	10	—	−6	—	17,000	5	0.03	25	4.5	TO-72
	MEM614	20	±6	±6	5	1.0	−1	—	10,000	5	0.02	22	3.5	TO-72
	MEM616	25	±6	±6	10	20	−4	—	18,000	5.4	0.02	18	3.0	TO-72
	MEM617	20	±6	±6	6	20	−4	—	4,400	6	0.02	17	3.0	TO-72
	MEM618	20	±6	±6	10	20	−4	—	14,000	5.1	0.02	30	2.5	TO-72
	MEM619	20	±6	±6	15	20	−4	—	10,000	6	0.02	—	—	TO-72
	MEM630	25	±6	±6	6	20	−4G1/−2G2	—	14,000	6	0.03	—	2.5	Plastic
	MEM631	25	±6	±6	10	20	−4G1/−3G2	—	16,000	6	0.03	—	3.5	Plastic
	MEM632	25	±6	±6	6	20	−4G1/−2G2	—	—	6	0.03	—	—	Plastic
	MEM636	20	±6	±6	15	50	−4	—	16,000	6	0.02	22	3.5	Plastic
	MEM637	20	±6	±6	15	20	−4	—	18,000	6	—	18	—	Plastic
	MEM638	20	±6	±6	15	20	−4	—	14,000	5.1	0.02	30	—	Plastic
	MEM639	20	±6	±6	10	—	−6	—	17,000	5	0.03	25	4.5	Plastic
	MEM655	20	±6	—	4	±10	−4	30	10,000	4	0.32	22	2.5	TO-72
	MEM660	20	+30/−20	—	3	—	−4	30	10,000	4.5	0.30	—	—	TO-72
	MEM667	20	±100	—	3	.05pA	−4	—	2,000	2	0.3	—	—	TO-18
	MEM670	20	±100	—	3	.05pA	−4	—	2,000	2	0.3	—	—	TO-72
	MEM680	25	±6	—	4/30	50	−4	—	18,000	5.4	0.2	21	2.5	TO-72
	MEM681	25	±6	—	2/20	50	−4	—	4,400	6	—	18	—	TO-72
	MEM682	25	±6	—	3/20	50	−4	—	14,000	5.1	0.02	30	—	TO-72
	MEM683	20	±6	±6	15	20	4	—	18,000	4.0	0.02	22	2.2	TO-72

TYPE	PART NUMBER	DESCRIPTION	PEAK-PEAK SIGNAL INPUT RANGE	ON RESISTANCE	TEMP. RANGE	SUFFIX/ PACKAGE
ANALOG SWITCHES	MEM780	4 CHANNEL	20 Volts	30 ohms	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/14 Plastic DIP D/14 Ceramic DIP F/14 Flat Pack
	MEM781	4 CHANNEL	20 Volts	30 ohms	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/14 Plastic DIP D/14 Ceramic DIP F/14 Flat Pack
	MEM851	4 CHANNEL	30 Volts	100 ohms	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/14 Plastic DIP D/14 Ceramic DIP F/14 Flat Pack
	MEM855	6 CHANNEL	25 Volts	350 ohms	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/24 Plastic DIP D/24 Ceramic DIP F/24 Flat Pack
	MEM856	6 CHANNEL	40 Volts	1000 ohms	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/24 Plastic DIP D/24 Ceramic DIP F/24 Flat Pack
	MEM857	8 CHANNEL	25 Volts	150 ohms	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/24 Plastic DIP D/24 Ceramic DIP F/24 Flat Pack
	MEM853	10 CHANNEL	25 Volts	150 ohms	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/14 Plastic DIP D/14 Ceramic DIP F/14 Flat Pack
	MEM4900	4 CHANNEL DRIVER	—	—	−65 to +85 (Plastic Dip) −65 to +125 (Ceramic DIP, Flat Pack)	P/14 Plastic DIP D/14 Ceramic DIP F/14 Flat Pack

Note: Check factory for availability of JEDEC registered 2N and 3N type MOSFETs.

HOME INFORMATION CENTER / HOME COMPUTER

FUNCTION	DESCRIPTION	COMPUTER FUNCTION	PART NUMBER	PACKAGE	FEATURES
"8900" HOME INFORMATION CENTER	The General Instrument "8900" Home Information Center is a powerful system for video display of Game, Educational, Financial, Research and related Home Computer Service Information, under the control of program ROMs, cassette tape or digital data received over the telephone line via modem. Moving objects, realistic sound, alpha-numeric information in color are features of the system.	Microprocessor	CP1610	40 DIP	A variant of the GI CP1600 microprocessor, the CP1610 is a 16-bit unit utilizing 8 general purpose registers for fast and efficient processing of all home information center data.
		TV Interface	AY-3-8900 OR AY-3-8900-1	40 DIP	The "STIC", Standard Television Interface Chip, provides the video signals including sync and blanking and the manipulation and interaction of all graphics data in a non-interlaced pattern for a standard television.
		Resident ROM	RO-3-9500 OR RO-3-9501	28 DIP OR 40 DIP	The "graphics" ROM contains 256 8X8 dot matrices for a large variety of symbols, background/field data, and 64 alpha-numeric characters.
		Cartridge ROM	RO-3-9500 OR RO-3-9501	28 DIP OR 40 DIP	The "program" ROM organized as 2048 X 10, contains all basic program instructions, symbol locations, color, velocity and direction data.
		Resident RAM	RA-3-9600	40 DIP	The "working" memory during home information center operation. Contains a 352X16 memory plus a 20 word "current line" buffer.
		Sound Generator	AY-3-8910	28 DIP	Provides full software programmability for complex sound effects generation without external timing components.
"8950" HOME INFORMATION CENTER	The "8950" system provides many of the features of the "8900" system in a more economcal form where only fixed alpha-numeric and shape data is required.	Microprocessor	CP1610	40 DIP	A variant of the GI CP1600 microprocessor, the CP1610 is a 16-bit unit utilizing 8 general purpose registers for fast and efficient processing of all home information center data.
		TV Interface/ Resident ROM	AY-3-8950 OR AY-3-8950-1	40 DIP	The "GIC", Graphics Interface Chip contains a 64 character ROM and all circuitry to generate sync, color burst, blanking, and video data.
		Cartridge ROM	RO-3-9500 OR RO-3-9501	28 DIP OR 40 DIP	The "program" ROM organized as 2048X10, contains all basic program instructions and symbol locations.
		Resident RAM	2112A Series	—	The "working" memory during home information center operation. A total of two 256X4 RAMs are required for a combined 256X8 memory complement for the minimum system.

SERIES 1600 MICROPROCESSOR

FUNCTION	PART NUMBER	PACKAGE	DESCRIPTION	FEATURES	APPLICATIONS
LSI CIRCUITS					
16 BIT SINGLE CHIP MICRO-PROCESSOR	CP 1600 *CP 1600A CP 1610	40 DIP	The CP 1600 utilizes third generation mini-computer architecture with eight general purpose registers. The 16-bit word enables fast & efficient processing of alpha-numeric or byte oriented data. The 16-bit address capability permits access to 65,536 words in any combination of program memory, data memory, or peripheral devices.	■ 8 program accessible 16-bit general purpose registers. ■ 87 basic instructions. ■ 4 addressing modes. ■ Unlimited interrupt nesting and priority resolution. ■ 16-bit 2's complement arithmetic & logic. ■ Direct memory access (DMA) for high speed data transfer. ■ 64K memory using single address.	The CP 1600 Microprocessor is designed for high speed data processing & real time applications. Typical applications include programmable calculator systems, peripheral controllers, process controllers, intelligent terminals & instruments, data acquisition and digital communications processors, numerical control systems, programmable TV game systems.
DUAL DIGITAL TO ANALOG CONVERTER	DAC 1600	40 DIP	The DAC 1600 contains four registers which can be loaded or read through a 10-bit I/O data port.	■ 10 bit bidirectional data bus. ■ Synchronous/Asynchronous loading. ■ Manual input mode.	The DAC 1600 Digital to Analog Converter has been designed to interface to a process control loop.
INPUT/ OUTPUT BUFFER	IOB 1680	40 DIP	The IOB 1680 is a byte oriented programmable input/output buffer which provides comprehensive interfacing facilities for The CP 1600 microprocessor. Data is transferred to and from the peripheral on 16 bidirectional lines, each of which can be considered to be an input or output	■ Single 16-Bit or Dual 8-Bit Ports for Bidirectional Input/Output. ■ Parity Check Logic on Both Ports. ■ Three Levels of Priority. ■ Automatic Handshake Logic and Signals. ■ Control Register.	The IOB 1680 enables efficient interfacing between a peripheral and the CP 1600 by the use of six 8-bit registers and a 16-bit programmable timer.
18 CHANNEL ANALOG MULTIPLEXER	MUX 1600	28 DIP	The MUX 1600 is a binary addressed 18 channel analog multiplexer. The MUX 1600 includes on-chip address latches and separate address strobe and chip select signals.	■ Connects 1 of 18 analog inputs. ■ Address latch on-chip. ■ 0 to 6 volt input range. ■ Analog output controlled by chip select signal.	The binary address selection of the 18 input channels provides for simplified direct control of analog signals by the CP 1600 microprocessor chip.
HARDWARE					
GIMINI SINGLE CARD MICRO-COMPUTER	*SC1600	12½"X17" PC Board, Ribbon Cable Connectors	The SC1600 GIMINI Single Card Microcomputer provides full 16-bit processing power on a single card. The SC1600 uses the CP1600 microprocessor with all circuitry for a complete operating system.	■ 16K words of RAM. ■ 14K words of PROM sockets. ■ 1K words of EAROM. ■ Up to 16 input and 16 output lines. ■ UAR/T-RS232 Serial I/O channel. ■ Real time clock.	In industrial usage, the SC1600 can serve as the kernel of a modular expandable processing system with other cards added as required. In consumer applications, the SC1600 can serve as the basis for many user-programmable systems such as TV games, home TV terminals, etc.
GIMINI MICRO-COMPUTER SYSTEM	GIMINI	—	The GIMINI utilizes a totally modular design for maximum configurability. The system provides direct addressing to 65K words, unlimited DMA channels, and a multi-line multi-levelnested interrupt system with full priority resolution and self-identifying addresses. All control & timing signals as well as data & address busses are fully buffered.	■ Built around the CP 1600 Microprocessor. ■ Complete microcomputer system. ■ Separate Data, Address and Control Buses. ■ Up to 65K memory space. ■ Unlimited DMA channels. ■ Nested interrupt system with full priority resolution.	To simplify microprocessor hardware and software development, speed the product design cycle & support product prototyping, a microcomputer development system and its associated components are a must. The Series 1600 family fills these requirements with the GIMINI Microcomputer.

*For Future Release

MICROELECTRONICS

SERIES 8000 MICROPROCESSOR

FUNCTION	PART NUMBER	PACKAGE	FEATURES	DESCRIPTION	APPLICATIONS
8 BIT MICRO-PROCESSOR SYSTEM	LP 8000 LP 6000 LP 1030 LP 1010 LP 1000	40 DIP 40 DIP 8 DIP 40 DIP 40 DIP	■ 2 Chip Minimum System (plus clock). ■ 48 Accessible 8 Bit Registers. ■ 48 Basic Instructions. ■ Binary and Decimal Arithmetic. ■ Direct and Indirect Input/ Output Capability. ■ Automatic subroutine nesting on memory devices.	The LP 8000 Logic Processor Unit is a complete 8-bit single chip MOS-LSI Microprocessor. It has a modern computer architecture with forty eight general purpose internal registers. The 8-bit Data highway is supplemented by a 6-bit Address bus to give a 14-bit address capability which permits access to 16,384 words.	The Series 8000 Logic Processor System is designed to perform any digital function using far fewer packages than a TTL or CMOS implementation. Typically a 100 package system can be reduced to a three chip solution of LP 8000 Processor, LP 6000 Program Memory and LP 1030 Clock Generator. Also available: LP 1010 I/O Buffer, LP 1000 Memory Interface.

PIC SERIES MICROCOMPUTER

FUNCTION	PART NUMBER	PACKAGE	FEATURES	DESCRIPTION	APPLICATIONS
LSI CIRCUITS					
8 BIT SINGLE CHIP MICRO-COMPUTER	PIC 1650	40 DIP	■ User Programmable. ■ 32 8-Bit Registers. ■ 512X12-Bit ROM for Program. ■ Arithmetic Logic Unit. ■ 4 Sets of 8 User Defined TTL-compatible Input/Output Lines. ■ Real Time Clock Counter. ■ Self contained Oscillator. ■ Access to RAM Registers inherent in instruction.	The PIC 1650 MOS/LSI circuit array is a byte oriented programmable controller. The array is a complete chip controlled with an internal customer-defined ROM program specifying the overall functional characteristics and operational waveforms on each of the general purpose input/ output lines.	The array can be programed to scan keyboards, drive multiplexed displays, control vending machines, traffic lights, printers and automatic gasoline pumps. Since it contains ROM, RAM, I/O as well as the central processing unit on one device, the PIC 1650 is truly a complete 8-bit microcomputer on one chip.
NEW	PIC 1654	28 DIP	■ All the features of the PIC1650 but with fewer I/O lines (4 in, 8 out, 8 I/O) and registers (24) for low-power (battery/hand-held) applications.		
NEW	PIC 1655	28 DIP	■ All the features of the PIC1650 but with fewer I/O lines (4 in, 8 out, 8 I/O).		
NEW	PIC 1670	40 DIP	■ All the features of the PIC1650 but with double the amount of ROM program memory (1024X12) and more RAM.		
8 BIT SINGLE CHIP DEVELOPMENT MICRO-COMPUTER	PIC 1664	64 DIP	■ PIC 1650 microcomputer without ROM. ■ ROM address and data lines brought out to pins. ■ Can be stopped or single stepped via a HALT pin.	The PIC 1664 circuit is exactly the same as the PIC 1650 except that the ROM portion of the PIC 1650 has been removed. Any external RAM or PROM can be used to aid in the development of a final PIC 1650 configuration.	The PIC 1664 has been designed as a useful tool for engineering development and prototyping and for initial field trial and demonstrations of systems which will utilize the PIC 1650.
HARDWARE					
NEW PIC DEVELOPMENT SYSTEM	DB 1650	8"X8½" PC Board	■ Full debugging capability. ■ In-circuit emulation. ■ Direct TTY interface.	The DB 1650 contains a PIC 1650 preprogrammed with PICBUG, a program which enables loading a PIC 1650 program and executing in either a run or single step mode. PICBUG interacts with a PIC 1664 and a 512X12 bit RAM which emulates the user's PIC 1650. A TTY interface also contained in the DB 1650 allows control and monitoring of the program operation.	The DB 1650 allows the user to test his PIC 1650 application program in the actual environment of his hardware application. True in-circuit emulation is provided via a cabled 40 pin DIP plug which replaces the PIC 1650 in the actual application.
NEW PIC FIELD DEMO SYSTEM	FD 1664	4"X6½" PC Board	■ Contains a PIC 1664 with address line driver circuits. ■ Sockets provided for 512X4 PROM or 512X8 UV EPROM.	The FD 1664 is a printed circuit module containing a PIC 1664 and sockets for external PROMs. Provision is made for either an on-board RC oscillator or an externally supplied clock.	The FD 1664 may be used to demonstrate a PIC 1650's capability in the field before committing to a masked ROM. A ribbon cable is supplied which terminates in a PIC 1650 compatible 40 pin DIP.

*For Future Release

SBA SERIES MICROCOMPUTER

FUNCTION	PART NUMBER	PACKAGE	FEATURES	DESCRIPTION	APPLICATIONS
LSI CIRCUITS					
SINGLE BIT MICRO-COMPUTER/ SEQUENTIAL BOOLEAN ANALYZER	SBA	40 DIP	■ 24 basic instructions including AND, OR, XOR, COMPARE, INVERT. ■ 1023 words of program. ■ 30 programmable inputs, outputs, or multiplexed inputs/ outputs. ■ 16 element stack and 120 element read/write memory.	A simple, low cost single-bit microcomputer, the SBA can directly evaluate a set of Boolean equations. Thirty programmable inputs and outputs as well as memory, make the SBA a true 1-bit microcomputer.	The SBA is suitable for a wide variety of applications requiring timing and control functions, especially in systems requiring a response in milliseconds rather than microseconds: e.g. telecom controllers, industrial timers, consumer games, microprocessor slave processor, etc.
NEW SBA DEVELOPMENT MICRO-COMPUTER	SBA-1	64 DIP	■ SBA microcomputer without memory. ■ ROM data lines brought out to pins.	The SBA-1 circuit is virtually identical to the SBA except that the program memory has been removed. Any external PROM or RAM can be used to aid in the development of a final program configuration.	The SBA-1 is useful for prototyping or debugging systems which use the SBA.
HARDWARE					
NEW SBA FIELD DEMO SYSTEM	SBA-FD	7½"X9" PC Board	■ Contains an SBA-1 circuit with a program counter and sockets for 5 1K PROMs. ■ Demultiplexing circuitry for 30 I/O lines.	The SBA-FD is a printed circuit module which provides external control of contents and I/O assignments using the SBA-1 development microcomputer.	The SBA-FD allows the demonstration of SBA routines before committing to fixed memory and I/O assignments. PROM sockets and DIP switches for I/O assignment allow for quick changes in function.

TELEPHONY

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
5 CHANNEL RELAY DRIVER	Isolates +5V logic and exchange-powered relays.	AY-5-9050	+5, GND (Logic). −48, GND (Exchange)	14 DIP	Each driver is capable of supplying 50 mA.
PUSH BUTTON TELEPHONE DIALLER CIRCUIT	Converts push button input to rotary dial pulses	AY-5-9100	SEE DATA SHEET	18 DIP	Programmable timing, one-call memory. Optional redial and access pause capability (except on AY-5-9118).
		AY-5-9106		18 DIP	
		AY-5-9110		18 DIP	
		AY-5-9118		14 DIP	
		AY-5-9120		18 DIP	
		*AY-5-9150	+2.5 to +5, GND	18 DIP	Low-voltage versions.
		*AY-9-9600	+1.5 to +15, GND	16 DIP	
REPERTORY DIALLER	Stores ten telephone numbers	AY-5-9200	SEE DATA SHEET	16 DIP	Complements AY-5-9100 to enable storage of up to ten 22-digit telephone numbers. Stackable.
COINBOX CIRCUIT	Controls the operation of a standard pay telephone.	AY-5-9300	SEE DATA SHEET	24 DIP	Up to 3 coin denominations recognized, 16 selectable coin ratios.
DUAL TONE MULTI-FREQUENCY GENERATOR	Generates DTMF/tone telephone frequencies.	AY-3-9400	+5, GND	14 DIP	With a low cost ceramic resonator, generates 12 tone pairs
		AY-3-9401	+5, GND	16 DIP	Same as AY-3-9400 but generates 16 tone pairs for data transmission.
		AY-3-9410			
		*AY-9-9086	+1.5 to +15, GND	16 DIP	Low-voltage version.
CLOCK GENERATOR	Generates 2-phase clocks from a single power supply.	AY-5-9500	SEE DATA SHEET	14 DIP	Generates 2-phase clocks for AY-5-9100 & AY-5-9200.
MULTI-FREQUENCY RECEIVER	Detects and converts DTMF/ tone telephone frequencies.	AY-5-9800 SERIES	GND, -8.5, -17	28/40 DIP	Choice of output codes: 4 bit, 1 of 16, 2 of 8, binary, custom programmable.

*For Future Release

HYBRID ACTIVE FILTERS

FUNCTION	PART NUMBER	DESCRIPTION
UNIVERSAL ACTIVE FILTER	ACF 7032C ACF 7092C	The ACF 7032C and the ACF 7092C filters are low cost devices which can be used to generate any filter response. Low pass, Band pass, Band Rejection, High pass, and All pass filter responses are available by means of external connections. The design provides for independent control of Frequency, Q, and Amplifier Gain, and is usable throughout the frequency range of 10Hz to 10kHz.
PCM TRANSMIT LPF	ACF 7170C ACF 7270C	The ACF 7170C/7270C filters have been designed for PCM transmit applications. This 0dB gain filter provides for a minimum 39dB attenuation at 4.6kHz and an in-band ripple specification of plus or minus 0.125dB.
BAND PASS FILTER & FULL WAVE DETECTOR	ACF 7300C ACF 7301C ACF 7302C	The ACF 7300C/7301C/7302C each consist of a full wave detector and a four (4) pole fixed band width band pass filter factory tunable over a center frequency (Fo) range: ACF 7300C - 540Hz to 1980Hz; ACF 7301C - 700Hz to 1700Hz; ACF 7302C - 2280Hz to 3825Hz.
2600Hz BPF	ACF 7310C	The ACF 7310C is a sharply tuned filter designed to detect and pass the 2600Hz signaling frequency. This filter provides for a minimum attenuation of: 30dB plus and minus 200Hz, 50dB plus and minus 500Hz, and 70dB plus and minus 100Hz from the center frequency of 2600Hz.
DTMF TONE DETECTION BPF	ACF 7323C ACF 7363C ACF 7383C	The ACF 7323C/ACF 7363C/ACF 7383C Band Pass Active Filters are factory pre-tuned filters designed specifically for tone receiver applications. These two pole constant Q filters are available in the standard AT&T tone frequencies and in the standard multifrequency steps.
DIAL TONE BAND SUPPRESSION FILTER	*ACF 7401C	The ACF 7401C is a dual tuned band suppression filter which has been designed to reject frequencies of 350Hz and 440Hz, which are present on a telephone line. The unit is totally self contained and requires no external components for proper operation. The filter provides for 0dB insertion loss in the pass band of 697Hz through 1633Hz, the normal DTMF tone frequencies. The filter also provides for 60Hz attenuation for low noise operation.
2600Hz BAND SUPPRESSION FILTER	ACF 7410C	The ACF 7410C is a sharply tuned filter designed to reject the 2600 Hz signaling frequency. This filter provides for a minimum attenuation of 60dB plus and minus 15Hz from the center frequency of 2600Hz.
DTMF BAND SEPARATION FILTER	ACF 7711C	The ACF 7711C is a dual filter which has been designed to provide channel isolation between the low frequency group of the tone (DTMF) frequencies of 941Hz, and the high frequency group of 1209Hz through 1633Hz. This filter provides for a minimum attenuation of 30dB for the adjacent frequencies of 941Hz and 1209Hz, 0dB in the pass bands, and 25dB out-of-band attenuation.

*For Future Release

DATA COMMUNICATIONS

FUNCTION	DESCRIPTION	PART NUMBER	REPLACES (PIN-FOR-PIN)	BAUD RANGE	MAX. FREQ.	TEMP. RANGE	POWER SUPPLIES	PACKAGE	FEATURES
UAR/T®	Complete 5-8 bit serial/ parallel, parallel/serial interface.	AY-3-1015	AMI S1757 SIG 2536 SMC COM2505 TI TMS6011 WD TR1402A WD TR1602A	0 to 30kB	480kHz	0 to 70	+5, GND	40 DIP	1, 1.5, or 2 stop bits
		†AY-6-1013		0 to 22.5kB	360kHz	-55 to +125	+5, GND, −12	40 DIP	1 or 2 stop bits
		AY-5-1013A		0 to 40kB	640kHz	0 to 70			
		AY-3-1014A		0 to 30kB	480kHz	0 to 70	+5 to +14, GND	40 DIP	1, 1.5, or 2 stop bits
P/SAR	Programmable receiver interface.	*AY-8-1472B	WD1472B	0 to 100kB	100kHz	0 to 70	+5, GND, −12	40 DIP	Data conversion to all standard formats.
P/SAT	Programmable transmitter interface.	*AY-8-1482B	WD1482B	0 to 100kB	100kHz	0 to 70	+5, GND, −12	40 DIP	
RANDOM/ SEQUENTIAL ACCESS MULTIPLEXER	Multiplexes 16 analog channels, with on-chip logic control.	AY-5-1016	—	—	2 MHz	0 to 70	+5, GND, −12	40 DIP	
		†AY-6-4016				-55 to +125			

*For Future Release.

†Also available with MIL STD 883 screening (add suffix TX to part number).

®UAR/T is a trademark of General Instrument Corporation.

STATIC RANDOM ACCESS MEMORIES

BITS	MEMORY ORGANIZATION	PART NUMBER	REPLACES (PIN-FOR-PIN)	ACCESS TIME/ CYCLE TIME	POWER SUPPLIES	PACKAGE	FEATURES
1024	256x4	**RA-3-4256**	—	500ns/500ns	+5, GND	24 DIP	Power down mode.
		RA-3-4256A	—	650ns/650ns	+5, GND	24 DIP	Power down mode.
		RA-3-4256B	—	650ns/650ns	+5, GND	22 DIP	

ELECTRICALLY ALTERABLE READ ONLY MEMORIES

BITS	MEMORY ORGANIZATION	PART NUMBER	READ ACCESS	ERASE TIME/MODE	WRITE TIME/MODE	POWER SUPPLIES	PACKAGE	FEATURES
512	32 x 16	**ER2050**	10 μs	100ms/16 bit word	100ms/16 bit word	+5, -28	28 DIP	10 year data storage @ +70°C.
		ER2051	3 μs	50ms/16 bit word	50ms/16 bit word			
1024	256 x 4	**ER1105**	2 μs	100ms/32x4 block	5ms/4 bit word	+12, -12	24 DIP	
1400	100 x 14	**ER1400**	2.8 μs	16ms/14 bit word	16ms/14 bit word	-35	14 DIP	
4096	1024 x 4	**ER2401**	2 μs	100ms/1024x4 block	10ms/4 bit word	±5, -14, -24	24 DIP	
		ER3400	750ns	10ms/4 bit word or 1024x4 block	1ms/4 bit word	+5, -12, -30	22 DIP	
		ER3401	950ns					
8192	2048 x 4	**ER2800**	2.6μs	100ms/2048x4 block	10ms/4 bit word	±5, -14, -24	24 DIP	
		ER2805	1.65μs					

READ ONLY MEMORIES

BITS	MEMORY ORGANIZATION	PART NUMBER	REPLACES (PIN-FOR-PIN)	ACCESS TIME	CLOCKS/ VOLTAGE	POWER SUPPLIES	PACKAGE	FEATURES
2560	512 x 5	**RO-3-2560**	—	450 ns	STATIC	+5, GND	18 DIP	
4096	512 x 8	**RO-3-4096**	—	500 ns	STATIC	+5, GND	22 DIP	
5120	512 x 10	**RO-3-5120**	EA 4000	500 ns	STATIC	+5, GND	24 DIP	
8192	2048 x 4	**RO-5-8192**	AMI S8865	1.2 μs (typ.)	2/TTL	+5, -12	24 DIP	
16384	2048 x 8	**RO-3-8316A**	INTEL 8316A AMI S6831A	850 ns	STATIC	+5, GND	24 DIP	
		RO-3-8316B		450 ns				
		RO-3-9316A	INTEL 8316E AMI S6831B MOT 68317	850 ns	STATIC	+5, GND	24 DIP	Replaces two 2708 or 8708 UV PROMs.
		RO-3-9316B		450 ns				
		RO-3-9316C		350 ns				
	4096 x 4	**RO-3-16384**	AMI S8996	1 μs	STATIC	+5, GND	24 DIP	Address/Chip Select latch
NEW 20480	2048 x 10	**RO-3-9500**	—	—	STATIC	+5, GND	28 DIP	Designed for use with Series 1600 microprocessors.
		RO-3-9501					40 DIP	
32768	4096 x 8	***RO-3-9332C**	—	350 ns	STATIC	+5, GND	24 DIP	

*For Future Release.

Note: All Read Only Memories are mask-programmable.

KEYBOARD ENCODERS/CHARACTER GENERATORS

BITS	MEMORY ORGANIZATION	PART NUMBER	REPLACES (PIN-FOR-PIN)	ACCESS TIME	CLOCKS/ VOLTAGE	POWER SUPPLIES	PACKAGE	FEATURES
2376	88 x 3 x 9 KEYBD. ENCOD.	**AY-5-2376**	SMC KR2376	10-100kHz Scan Rate	1/TTL or INT. OSC	+5, GND, -12	40 DIP	2 key rollover; 88 keys, 3 modes.
3600	90 x 4 x 10 KEYBD. ENCOD.	**AY-5-3600**	SMC KR3600	10-100kHz Scan Rate	1/TTL or INT. OSC.	+5, GND, -12	40 DIP	2/N key rollover, 90 keys, 4 modes.
		AY-5-3600 PRO	—					Preprogrammed with binary codes for PROM application.
2240	64 x 5 x 7 CHAR. GENER.	**RO-5-2240S**	MK 2302 FSC 3257	1 μs (typ.)	1/TTL for Scanning	+5, GND, -12	24 DIP	5x7 char. column output, on-chip scanning.
2560	64 x 8 x 5 CHAR. GENER.	**RO-3-2513**	SIG 2513	450 ns	STATIC	+5, GND	24 DIP	5x7 characters, row output.
5184	64 x 9 x 9 CHAR. GENER.	**RO-5-5184**	—	5 us (typ.)	1/TTL for Scanning	+5, GND, -12	24 DIP	9x9 characters, on-chip left/right scanning.

Note: All Keyboard Encoders and Character Generators are mask-programmable. Standard patterns are available.

STATIC SHIFT REGISTERS - Contact any GI Sales Office for details.

CALCULATORS

FUNCTION	DESCRIPTION	9V LED	9V FLUOR.	9V LED (DIRECT)	15V FLUOR.	15V LED
8 DIGIT BASIC	4 functions and percent key.	C-683	CF-683	C-683D	CF-583	C-583
	4 functions, percent key, one-key or multi-key memory.	C-685	CF-685	C-685D	CF-585	C-585
8 DIGIT ALGEBRA	4 functions, percent key, x^2, $\sqrt{x}$, 1/x, +/–, one-key or multi-key memory, choice of 20 to 29 keys.		CF-687	C-687D	CF-589	C-589
	4 functions, percent key, x^2, $\sqrt{x}$, 1/x, +/–, one-key or multi-key memory, brackets, inch-centimeter conversion, choice of 24 to 30 keys.		CF-689	C-689D	CF-689HV	—
9 DIGIT BASIC	4 functions and percent key.				CF-593	C-593
	4 functions, percent key, one-key memory.				CF-594	C-594
	4 functions, percent key, multi-key memory.				CF-595	C-595
9 DIGIT SCIENTIFIC	Basic 4 functions, scientific notation, sin, cos, tan, arc sin, arc cos, arc tan, memory, square root, pi, natural logs, 1/x, e^x, memory exchange, degrees and radians, exponent range ± 99, choice of 19 to 35 keys.				CF-596	C-596
	All the above plus: 0 to 10^{99} degree trig range, $\log_{10}$, y^x, extended digit accuracy of trancendentals, choice of 21 to 38 keys.				CF-598	C-598
	All the above plus: two levels of parenthesis, x^2, %, +/–, choice of 24 to 41 keys.				CF-599	C-599

FUNCTION	DESCRIPTION	PART NUMBER	PACKAGE	FEATURES
8 DIGIT PRINTING	Basic 4 functions and percent, automatic constant in multiply and divide, repeat add/subtract, decimal select mode, and other features. Interfaces with the Olivetti Pu1100 dot matrix printer. Option for use with thermal printing version of Pu1100.	*C-716	40 DIP	Accumulator and 4 key memory
12 DIGIT PRINTING	Basic 4 functions and percent, automatic constant in multiply and divide, repeat add/subtract, decimal select mode, memory-in-use indicator, rounding options, non-add (#)/date key, and other features. Interfaces with the Shinshu Seiki Model 310 impact printer.	C-717X	40 DIP	Accumulator and Grand Total Memories.
		C-718		Accumulator, item counter, and four-key independent memory.
	Basic 4 functions and percent, automatic constant in multiplying divide, repeat add/subtract, decimal select mode, and other features. Interfaces with the Olivetti Pu1100 dot matrix printer. Option for use with thermal printing version of Pu1100.	*C-724	40 DIP	Accumulator and 4 key memory
PRINTER-DISPLAY INTERFACE	Adds display capability to the C-717X and C-718 printing calculator circuits.	C-719	28 DIP	For both LED and fluorescent displays.
	Adds display capability to the C-716 printing calculator circuit.	*C-720		
	Adds display capability to the C-724 printing calculator circuit.	*C-723		

*For Future Release.

CLOCKS

FUNCTION	DESCRIPTION	PART NUMBER	DISPLAY TYPE	FLASHING SECONDS	ZERO BLANKING	50/60 Hz OPERATION	PACKAGE	FEATURES
4 DIGIT	12/24 hour clock	AY-5-1200A	7-SEGMENT FLUORESCENT		✓	✓	24 DIP	Direct fluorescent display drive.
		AY-5-1202A	7-SEGMENT FLUORESCENT	✓	✓	✓	24 DIP	Direct fluorescent display drive.
		AY-5-1203A	BCD OUTPUTS	✓		✓	24 DIP	See AY-5-8320 TV circuit.
		AY-5-1204A	7-SEGMENT FLUORESCENT	✓		✓	24 DIP	Direct fluorescent display drive.
		AY-5-1224A	BCD OR 7-SEGMENT LED		✓	✓	16 DIP	Zero blanking in 12 hour mode only.
4 DIGIT WITH ALARM	12 hour clock, 24 hour alarm	CK3000	7-SEGMENT PLASMA	✓	✓	✓	40 DIP	Snooze alarm, individual digit drive.
		CK3100	7-SEGMENT LED	✓	✓	✓	40 DIP	Snooze alarm, individual digit drive.
	12/24 hour clock, 24 hour alarm	CK3200	7-SEGMENT PLASMA	✓	✓	✓	28 DIP	Snooze alarm, duplexed digits.
		CK3400	7-SEGMENT LED	✓	✓	✓	28 DIP	Snooze alarm, duplexed digits
4 DIGIT CLOCK RADIO	12/24 hour clock, 24 hour alarm	CK3300	7-SEGMENT LED	✓	✓	✓	28 DIP	Snooze alarm, duplexed digits, sleep-timer, timeswitch, battery standby capability
4 DIGIT AUTOMOBILE CLOCK	12 hour clock	CK3500	7-SEGMENT LED		✓	CRYSTAL INPUT	40 DIP	Operates directly from a 3.58MHz TV crystal. Direct drive of display.
		CK3500F	7-SEGMENT FLUORESCENT					

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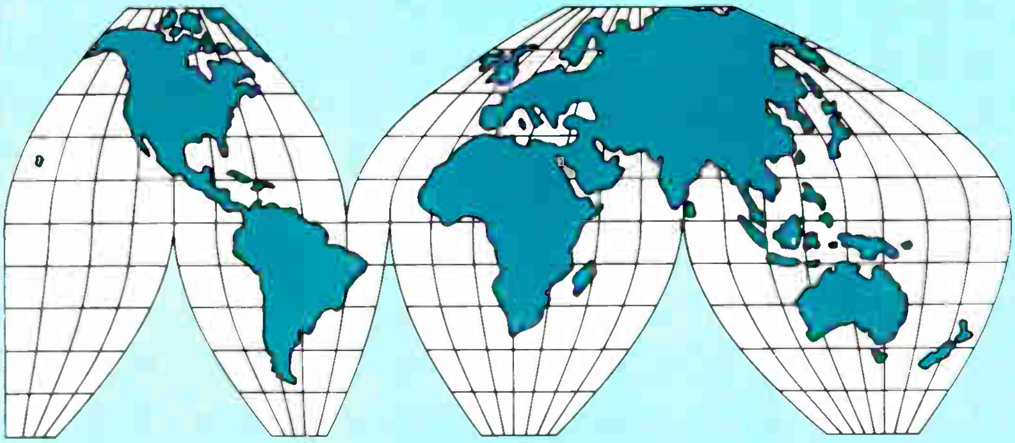

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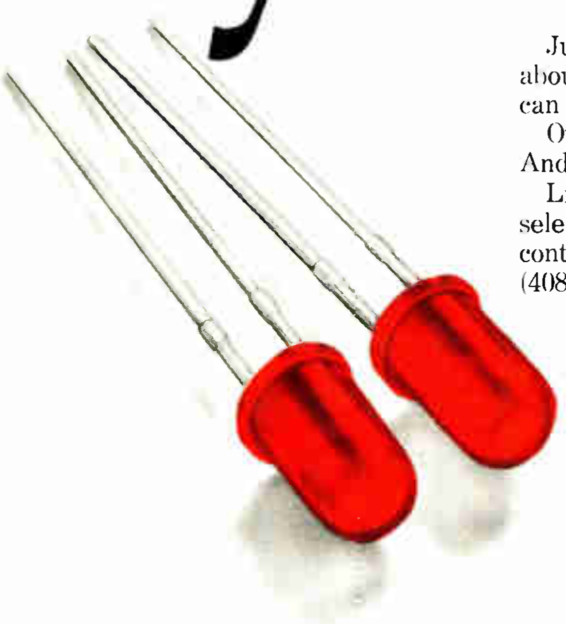


Solid-state relays from Theta-J break $2 floor

Convinced that solid-state relays must compete in price with mechanical units, Theta-J Relays Inc. is breaking the $2 price barrier for the first time with a new series rated at 1.5 A and up to 280 V ac. Edward T. Rodriguez, the company's maverick chairman and technical director, says that in the past year he has identified 25 to 30 customers **who would buy quantities of 150,000 to 300,000 at the right price but at present are often building their own relays.** While the ultralow price is for quantities of 10,000, "we're challenging all these people who make their own to do it cheaper than we can sell them relays," Rodriguez says.

The Bedford, Mass., company's MX-100 line, for operation from 90 to 140 V ac, will sell for $1.99 apiece in lots of 10,000 or more or $3.40 each in hundreds. The MX-200 entry, for 90-to-280-V ac requirements, is priced at $2.49 in 10,000-and-up quantities or $4.00 in hundreds. Both offer optical isolation of 3,750 V ac rms or 5,500 V peak. The relays contain only three components—a light-emitting diode, a cadmium-sulfide detector, and an output triac—and can be assembled into a molded plastic four-pin single in-line package in less than a minute, Rodriguez says. Theta-J has even designed the company logo and part number into half of the snap-together plastic molding, cutting 15 cents from the selling price that would have been added with a separate part-marking step. Deliveries will begin next month.

16-bit micro on a board coming from GI . . .

General Instrument Corp.'s Microelectronics group in Hicksville, N. Y., is putting the final touches on a **single-card microcomputer that provides full 16-bit processing power on a 12.5-by-17-inch printed-circuit board.** To be available by the end of the first quarter, the SC1600 Gimini is built around GI's 16-bit single-chip microprocessor, the CP 1600, and comes with all the circuitry for a complete operating system. On the board, in addition to the CP 1600, are 16,384 words of random-access memory, 14 kilowords of programmable read-only memory, 1 kiloword of electrically alterable ROM, up to 16 input and 16 output lines, a UART RS232 serial I/O channel, and real-time clock.

. . . while I²L chips for phone market are due in spring

Meanwhile, GI's Chandler, Ariz., operation continues to enjoy a measure of success in applying the firm's proprietary integrated-injection-logic process, Giant IV, developed jointly with a research group at the University of Utah in Salt Lake City. The next I²L circuits, to be introduced in late March or early April, **are aimed at the telephone marketplace.** One, the AY-9-9600, is a telephone dialer circuit that converts push-button inputs to rotary dial pulses. The other, AY-9-9086, generates 16 pairs of telephone frequency tones for data transmission. Both are designed for low-voltage (+1.5-to-+15 V) operation, and each comes in a 16-pin dual in-line package.

Transatlantic trials of TDMA techniques are under way

Under way via an Intelsat-4 satellite are transatlantic trials of the time-division multiple-access signal-transmission technique, which boosts traffic capacity of satellites. They are sponsored by the German post office, which in concert with its French counterpart has successfully tested 60-megabit-per-second TDMA transmissions. This month, France, the United Kingdom, Italy, and the U. S. will join the transatlantic trials **with the object of discovering how TDMA techniques work over a large network with a**

number of ground stations spread over both continents. The TDMA equipment comes from a two-country consortium of Standard Elektrik Lorenz AG, AEG-Telefunken, and Siemens AG in West Germany, and Thomson-CSF, CIT-Alcatel, and Société Anonyme de Télécommunications in France. Now in development is TDMA gear for 120-Mb/s transmissions. It will be tried out with Europe's Orbital Test Satellite in 1979.

54% of wristwatches sold in 1985 to be quartz-controlled

By 1985, quartz-controlled units will account for a majority of wristwatch sales around the world, says Mackintosh Ltd. In a study for the West German ministry for research and technology, the consulting firm forecasts the market share will jump 12% in 1976 to 37% in 1980 and 54% in 1985. Moreover, light-emitting diodes will lose almost all of their present 71% dominance of the quartz-watch displays. In 1985, such displays will be 50% liquid crystals and 45% analog. **A similar sharp increase is in store for eletronic clocks, Mackintosh adds.** Their share of the world market will spurt from 6% in 1976 to 53% in 1985. However, digital displays will play an insignificant role in these clocks, says the British firm.

Pain killers to lead sales of electronic care systems

Overall, sales of biomedical electronic patient-care systems will increase at the rate of about 11% a year, according to a recent report by Predicasts Inc., a Cleveland business information and market research firm. Leading the advance will be new devices for pain control. **Transcutaneous electronic nerve stimulators, applied externally with electrodes connected to the skin to block pain messages, are gaining wider use.** Implantable devices, which generate impulses directly in the spinal cord or brain, are newer. Spinal cord stimulators are being used more than brain stimulators. The leading manufacturer of such equipment is Medtronic Inc., Minneapolis, which has been able to transfer much of the technology it uses in cardiac pacemakers, also impulse-generating devices. Medtronics agrees that Predicasts' estimate of a 25.6% growth rate for pain killers is reasonable, noting that it may be conservative.

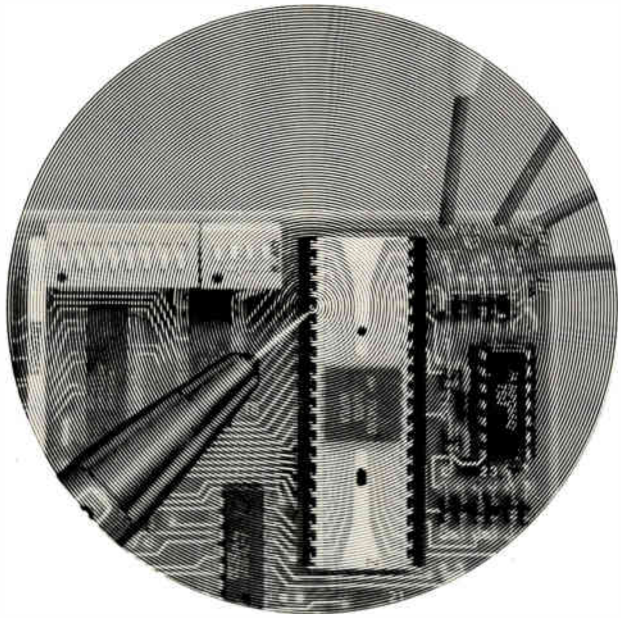
Navy to buy Atlantic radar from Raytheon

Raytheon Co.'s Equipment division, Wayland, Mass., has been chosen over RCA Corp. to provide the Navy with a wide-area active surveillance radar to monitor activity in the Atlantic Weapons Range. Raytheon will engineer and install the L-band unit at Pico del Este, Puerto Rico, under terms of the $13.4 million contract from the Naval Electronic Systems Command. **The radar will probably be a smaller version of the Air Force Cobra Dane phased-array radar** at Shemya Air Force Station in the Aleutian Islands, which collects intelligence data on Soviet missile-development tests. L band is considered to have good visibility through the clutter that can occur when a radar looks down on water from an elevated site like the one in Puerto Rico.

Addenda

The Japanese Ministry of Finance, in its draft of the nation's new budget, has cut funding for the VLSI effort to $36,563,000 from $42,125,000. The Ministry of International Trade and Industry **is working to have the figure restored.** . . . Intel Corp. says its 8080A central processing unit has won approval as a military standard device, **the first microprocessor chip and first LSI part to gain that designation.**

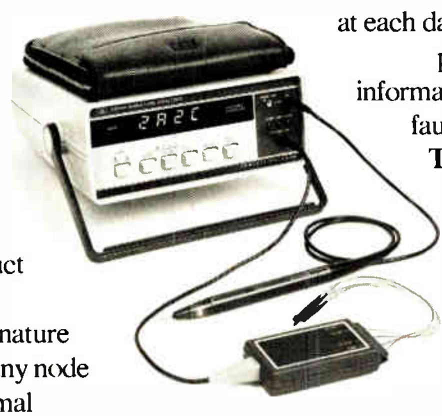
Troubleshoot microprocessor products fast–



right down to the component level.

Here's HP's new Signature Analyzer. It makes it economical to find the faulty component in a microprocessor-based product both in production and in the field. No longer is it necessary to make a large investment in expensive modules or boards for service. And no longer do you have to troubleshoot by conventional and costly hit-and-miss methods. It could even eliminate the need to partition your product for modular service.

The concept is simple. The 5004A Signature Analyzer converts lengthy bit streams at any node in a circuit into short, four-digit, hexadecimal "signatures." Just activate a digital exercise routine in the circuit under test, and compare the bit stream "signature" at each data node with the known good signatures previously written into your manual. This information lets you backtrace right down to the faulty component. Quickly and confidently.



The price is low. Only $990.* To help you design your product with all the advantages of digital signature analysis, we've prepared Application Note 222—"A Designers Guide to Signature Analysis." It's yours for the asking, just contact your nearest HP field sales office, or write.

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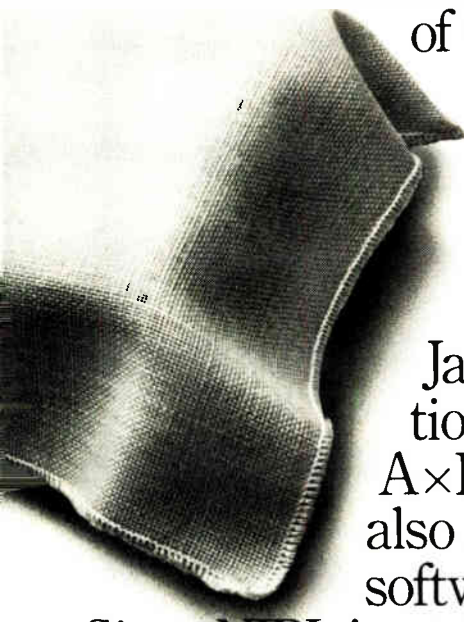

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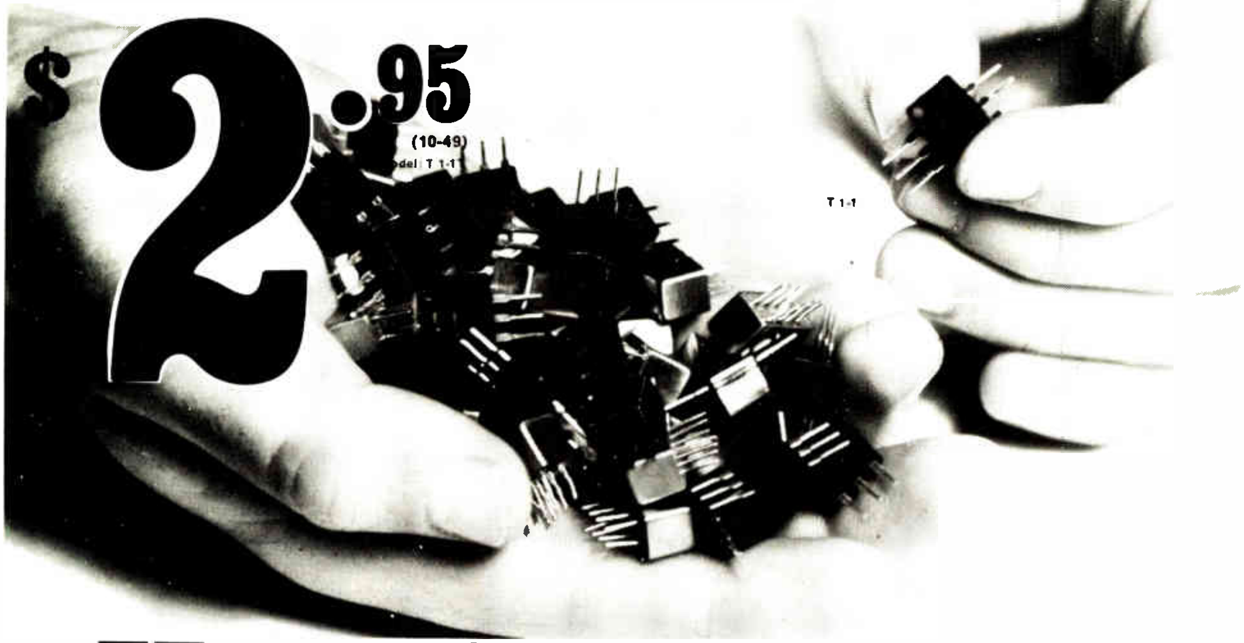

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Freq. Range, MHz	.15-400	.1-300	.01-100	.02-200	.15-200	.3-120
Impedance Ratio	1	1.5	2.5	4	9	16
Max. Insertion Loss	MHz	MHz	MHz	MHz	MHz	MHz
3 dB	.15-400	.1-300	.01-100	02-200	.15-200	.3-120
2 dB	.35-200	.2-150	.02-50	.05-150	.3-150	.7-80
1 dB	2-50	.5-80	.05-20	1-100	2-40	5-20
Price, Model TMO	$4.95	$6.25	$5.95	$5 95	$5 45	$5.95
(10-49) Model T	$2.95	$3.95	$3 95	$3 95	$3 45	$3.95

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Freq. Range, MHz	.015-600	.5-800	.5-600	.15-250	.2-150
Impedance Ratio	2	3	4	8	14
Max. Insertion Loss	MHz	MHz	MHz	MHz	MHz
3 dB	.015-600	5-800	2-600	.15-250	2-150
2 dB	.02-400	2-400	5-500	25-200	5-100
1 dB	.05-200		2-250	2-100	2-50
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Plastic Case	T 1-1T	T 2-1T	T 2.5-6T	T 3-1T	T 4-1	T 5-1T	T 13-1T
Freq. Range, MHz	.05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
Impedance Ratio	1	2	2.5	3	4	5	13
Max. Insertion Loss	MHz	MHz	MHz	MHz	MHz	MHz	MHz
3 dB	.05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
2 dB	.08-150	.1-100	.02-50	.1-200	.35-300	.6-200	.7-80
1 dB	.2-80	.5-50	.05-20	.5-70	2-100	5-100	5-20
Maximum Amplitude Unbalance MHz							
.1 dB	.5-80	1-50	.1-20	1-70	5-100	10-100	5-20
.5 dB	.05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
Maximum Phase Unbalance Degrees MHz							
1°	.5-80	1-50	1-20	1-70	5-100	10-100	5-20
5°	05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
Price (10-49)							
Model TMO	$5.95	$6.25	$6.25	$5.95	$4.95	$6.25	$6.25
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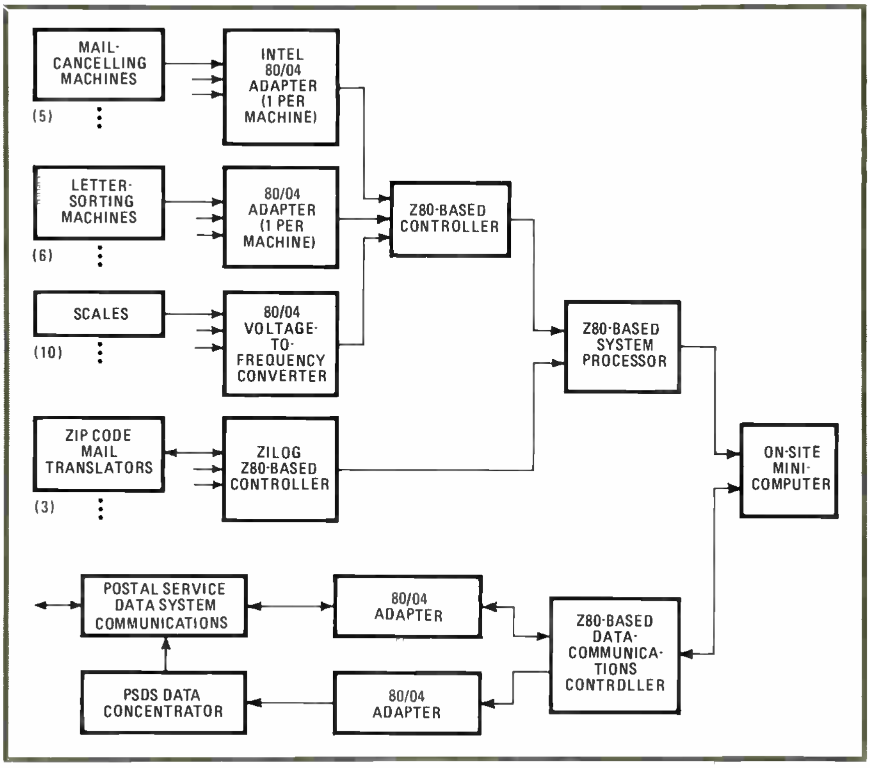
Circle 52 on reader service card

22/Rev/D

Data-gathering system to help a post office smooth its workload

Microcomputer monitors tied into mail-handling equipment develop real-time data for making manpower decisions



Mail call. Monitoring system has low-cost Intel microcomputers as interfaces and high-speed Zilog boards as controllers for gathering data on mail in process. With real-time information, supervisors can do a better job of matching the workers to the workload.

How does a U.S. Postal Service supervisor know when to move personnel from one task to another to match the workload? The answer is that he or she must either rely on off-line analyses, which are done too late, or simply keep a keen eye out for bottlenecks.

But now the Postal Service is experimenting with a better way: a system in which microcomputers monitor and process data acquired from decades-old electromechanical mail-handling machines like letter sorters and postage cancelers. The cost of such an arrangement is low, yet the data is delivered fast enough to do some good.

The pilot installation is in a facility in Sacramento, Calif. Minimal data-collection equipment has been used in the past to monitor machine running times, production rates, and jams. The data was always processed at a central office, mainly for statistical analysis. However, says Fred Jensen, systems analyst at Sacramento, "there's no way to predict how much mail will be in the box."

Two types. The monitoring system, built by Applied Computer Research Co., uses two microcomputer types: Intel Corp.'s single-board SBC 80/04 and Zilog Corp.'s Z80 family. Arthur Rezac, president of the small Brick Town, N.J., systems-design firm that won the Postal Service contract in September, describes the entry into the "virgin territory of the post office" as an arduous one. "We were allowed no modification or rewiring," he explains. All connections are made with high-impedance logic.

Despite the noninvasive connection, the system must still interface with a host of switches, photocells, motors, and solenoids. Many of the signal sources are high-impedance and therefore subject to loading. Also, a mixture of logic levels and signal types is found in each box. "There's some resistor-capacitor-transistor logic and a smattering of transistor-transistor logic, but mostly a lot of high-level ac and dc," Rezac says.

Teamwork. The Intel microcomputer boards, whose programmability allows them to accommodate many types of signals, are the interfaces with the electromechanical equipment, while the Zilog boards are system controllers. "We chose the Intel boards for low cost—under $100 each—and the Zilog parts for their high speed," explains Rezac. The Z80 device with its 4-megahertz clock, is the fastest microcomputer Rezac says he could find for handling the inputs from the many Intel data-gathering boards.

The Z80 microcomputers hook up to an on-site minicomputer—a Data General Corp. Nova that is mainly a system development tool—and also interface with the Postal Source Data System, a nationwide communications link. The PSDS, in existence for more than 10 years, carries the National Time and Attendance System employee information, which includes badge-reader and Social Security data on every worker for personnel and payroll purposes.

According to Jensen, the system will provide supervisors with fresh information for shifting personnel within each facility. Sacramento, with about 2,000 employees, is probably the smallest facility that would get such a system, he adds. But the microcomputer monitors could also really make a difference in Chicago, Los Angeles, or New York, each with more than 10,000 employees. □

The result will be a more efficient postal system. If the system operates as planned, says Jensen, its $200,000 price tag could be amortized within one year, with most of the savings in overtime pay and standby personnel. □

Industrial

Infrared sensor outclasses thermocouples in checking metal fatigue in jet engines

Jet engine manufacturers, always seeking more thrust for their products, must push turbine materials to their limits in tests to determine to what extent metal fatigue will be accelerated. Mainly, the manufacturers have relied on thermocouples mounted in test engine nacelles to monitor turbine blade and disk temperatures; abnormally high temperatures are a good indication of potential failures.

But thermocouples can be difficult to mount, and they cannot be placed close enough to the blades to determine their actual temperatures. That is why Vanzetti Infrared & Computer Systems Inc. came up with a turbine-blade thermal monitoring system that marries fiber-optic, infrared sensing, and signal-processing technologies.

The Canton, Mass., company, low bidder in a competition with Kollsman Instrument Corp., shipped two monitors to the Naval Air Propulsion Center in Trenton, N. J., just last month under a $38,000 contract. The systems will be used to develop thermal profiles of turbine disks and blades as they are rotated and heated in a test setup for 40 to 50 hours. Chyau Shen, senior electronics engineer at the center, says the disks will be induction-heated to between 400°C and 1,200°C, and the blades heated to between 60°C and 1,500°C, in order to simulate actual engine temperatures.

According to Shen, the earlier thermocouple-based system was tricky to install and had to be "babied." He is more comfortable with the noncontact Vanzetti units, which are essentially radiation pyrometers, though he has no test results yet.

Anthony Intrieri, Vanzetti's director of marketing and sales and an engineer as well, explains the system's operation this way. A fiber-optic probe is inserted into the test nacelle or directly into the engine close to the blades. Radiant energy emitted from a preselected sequence of points on the target area of each blade—as many as 56—is collected by the fiber-optic probe and transmitted to a remote infrared detector.

Fast response. The photon detector, usually a single silicon photodiode, "can respond to step input changes in less than 150 nanoseconds," Intrieri says, and is specially shaped spectrally to get the fast response. Vanzetti engineers selected a window between 0.8 and 0.97 micrometer in which to measure the radiant energy, in order to minimize signal attenuation caused by gases in the test chambers, in which the turbines may be rotating as fast as 77,000 revolutions per minute. The detector operates photoconductively, changing resistivity as the rate of photon energy striking it varies. "The detector acts as a current generator, and we convert the current to a voltage," Intrieri explains.

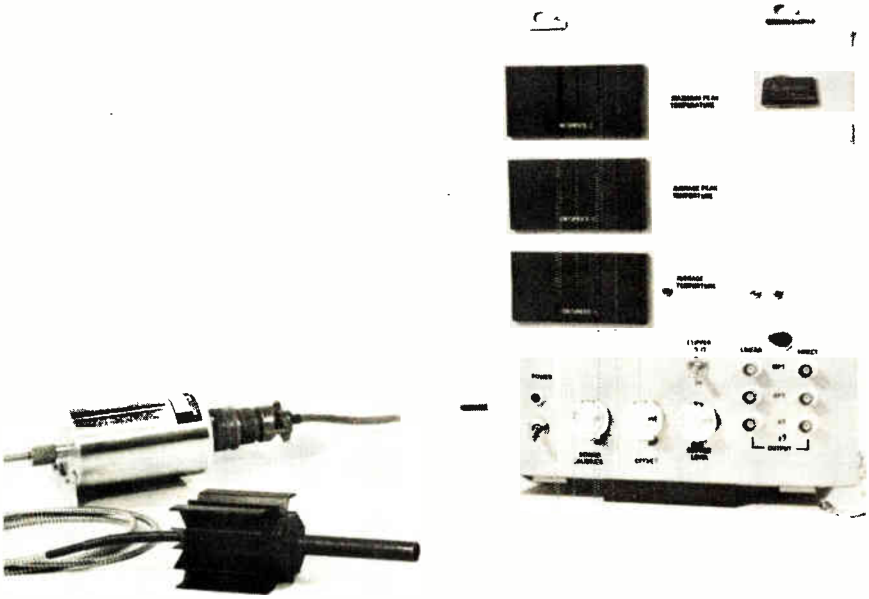
A preamplifier in the detector section boosts the millivolt-level signals to the 0.2-volt range. They then

Better times looming for infrared pioneer

For Ricardo Vanzetti, the last two years represent his company's "emergence from the Red Sea." The founder and president of Vanzetti Infrared & Computer Systems says his company, a pioneer in applying infrared technology to industrial testing, took eight years to make its first profit—a minimal $16,000 on sales of exactly $1 million in the year ended Sept. 30, 1976. But the company really turned the corner in the year ended last Sept. 30. Sales were $1.6 million and profits were $175,000.

Vanzetti, an Italian Resistance leader in World War II, spent eight years with Raytheon Co. verifying the feasibility of using fiber optics and infrared sensing for thermal testing of electronic hardware. But Raytheon, by charter, is not interested in developing test and process-control equipment. So Vanzetti founded his company in 1968. The first two or three years were spent refining equipment, and then came recessions in 1970–71 and 1974–75.

Now the company is in its growth phase, Vanzetti hopes. "We're looking forward to several more years of fat cows," he says, using the biblical analogy about famine and plenty. But he is worried about putting together capital to fund the growth. "In the Resistance, it was easy," he notes, recalling the events after he was parachuted into German-occupied northern Italy by the U. S. Office of Strategic Services in March 1943. "If we needed money, we'd just rob a bank," he says, almost wistfully.



Monitor. Typical turbine-blade monitor includes fiber-optic probe with black heat sink (foreground), an IR detector head, and signal-processing and -display unit (right).

go to a linearizer, which is part of the signal-processing section of the system. The analog signal, which is directly proportional to the temperature at each turbine blade test point, goes through a logarithmic amplifier to start the linearization and is specially conditioned, says Intrieri, to provide temperature measurements to within 1% of reading.

Three output channels. Intrieri is guarded about the specifics of the signal processing, but says the processed signal provides three output channels from three linearizers that can be either digitally displayed on three digital panel meters in the system or brought out to an oscilloscope for analysis. The three outputs are the average integrated temperatures of all blades on a rotor, the average of the maximum peak temperatures of all blades, and the maximum peak temperature of the single hottest blade.

Additionally, in the Navy system, the data can be multiplexed to display the hottest blade by number. With this kind of combination, Intrieri says engine makers or users can determine whether an entire engine or a given blade is running too hot, and can later analyze whether accelerated metal fatigue was induced in the process. □

Microcomputers to vend coffee

Anyone peeking into the innards of a coffee-vending machine has probably been amazed at the myriad of cams and relays needed to bring forth a cup of the hot brew. Basically, the mechanical and electromechanical parts control the step-by-step sequence of events after a customer inserts a coin and makes a selection.

Microcomputers can easily handle just such control tasks, and they will be doing so within the next few months. About then, two manufacturers, Coffee-Mat Corp. and Refreshment Machinery Inc., will start shipping the first microcomputer-controlled machines, capping a trend to solid-state electronics that has been brewing in the vending industry for five years. Both companies had developed controls some time ago that were built from transistor-transistor logic, but they never brought them to market because the controls required too many packages to implement and proved too expensive.

Paying their way. But microprocessors should pay their way from the start: Coffee-Mat's new FD-1072 coffee-vending machine will sell for about $1,400. "That's roughly 20% less than its predecessor, a cost savings directly attributable to the microprocessor," says a marketing official for the Kenilworth, N. J., subsidiary of Flagstaff Corp. Coffee-Mat controls about 40% of the coffee-vending business.

Coffee-Mat's chief engineer, Mahendra Desai, declines to divulge which microprocessor he chose for his design, except to say that it is an 8-bit single-chip microcomputer. However, there are several designed specifically as controllers, with sufficient input/output channels and program memory to put the coffee machine through its paces dispensing various hot drinks.

According to Desai, the microcomputer continually scans the credit switch on the coffee machine's coin changer, looking for the pulse that indicates enough money has been deposited. "When the proper credit is established, the processor scans the selection switches and, when a selection is made, begins the machine's timing cycle," he says. With a master's degree in mechanical engineering, he has picked up the knowledge to direct Coffee-Mat's solid-state design efforts.

The microcomputer, buffers, and drivers are mounted on a single printed-circuit card, "and that board is directly adaptable right now to any machine we make," Desai says. He has also replaced electromechanical relays with solid-state triacs to drive each load: three solenoid valves that control water lines and six to eight small electric motors that turn the auger gears that dispense the machine's ingredients. Conventional coffee machines use relay logic and a timer motor that drives a camshaft. The cams switch solenoids on and off, controlling motors to deliver ingredients in sequence.

Besides a substantial cost savings,

the microcomputer control makes possible a host of new features and options, as well as making a cup of coffee faster. Also, beverages are more consistent from one machine to the next, because the time that hot water and powders are delivered is more precise. Moreover, self-cleaning and self-diagnostic features can be easily added, Desai says, requiring 250 to 300 more bytes of memory, along with a few indicators and switches.

Similar control. Refreshment Machinery Inc. has developed a similar microprocessor control, and the Warminster, Pa., firm will start phasing it into its existing RMI 1400 freeze-dried and RMI 850 loose-grind coffee machines during the first quarter of 1978. Ten test machines were put into the field last month. Most use a control built around Signetics's 8-bit 2650 two-chip processor set, although a few use Rockwell International's 4-bit PPS 4/1 microcomputer. In the works is a third control based on Intel's 8048 8-bit microcomputer, says Naim Salfity, who is RMI's director of research and development.

The real difference in the vending machines is in the way timing is adjusted to change the amount of ingredients mixed in each serving. Coffee-Mat uses a 10-position rotary switch for each powder, while RMI has developed a plug-in service module to vary its 15 different dispensing channels. Both approaches are easier than changing the position of cams on a camshaft.

RMI's service module, which looks like a hand-held calculator with a six-digit light-emitting-diode display, stores timing changes in a small, battery-backed random-access memory, Salfity explains. Instead of a keyboard, the unit has a four-position rotary switch to select beverage, channel number, start and stop settings, and a pair of push buttons to increase or decrease the time that each ingredient is delivered in 0.01-second steps.

Will the new machines and their controls work in the field? Desai, for one, is confident they will. "We've tested the control for a half million cycles without one problem. That's half the 10-year life of a machine in a busy location." □

Microprocessors

Fairchild 9440 starts going to customers

The latest microprocessor to be putting pressure on minicomputers is the 16-bit 9440 from Fairchild Camera and Instrument Corp. [*Electronics,* June 23, p. 113], which this month is beginning to be shipped in quantity.

Powerful. Incorporating the most powerful single-chip central processor on the market today, the bipolar 9440 is being supplied in a $750 kit that includes a complete operating software package. The package executes an instruction set like that of the popular Nova 1200 minicomputer from Data General Corp. With this software plus the cost of putting the kit's components on a circuit board added in, a user can be off and running for less than $1,000 with a computing system that matches the power of general-purpose minicomputers costing many times more. The 9440 achieves its performance—propagation per gate is only 4 nanoseconds—using Fairchild's high-density Isoplanar integrated injection logic.

Range of OEMs. Fairchild is shooting for the 9440's incorporation in a broad range of original equipment. Typical applications might be in test equipment and mass spectrographs, says Thomas A. Longo, vice president and chief technical officer at the company's headquarters in Mountain View, Calif.

Longo, however, emphasizes that Fairchild is not out to fill Nova sockets, but seeks instead to create new markets. So he sees other areas as targets, too. One is telecommunications, especially electronically switched private branch exchanges in large plants or offices where using minicomputers might be a case of overkill. Another is distributed processing, where the explosion of distributed intelligence is opening up increasingly sophisticated applications in intelligent terminals and front-end processing, he says.

Centralized electronic controls for buses and trucks also look bright, because "this kind of microprocessor capability can usefully serve that market," Longo says. Moreover, retail shops "can generate quite a market," he continues, with the kit aimed at the high-level hobbyist, the professional engineer who brings work home, and the small-business owner or professional.

Besides the 9440 chip, which Fairchild now calls the Microflame, the kit consists of 16 transistor-transistor-logic, 4,096-bit dynamic random-access memories (the model 93481), small-scale and medium-scale integrated components for memory control, a set of user manuals, and the Fire 1 software package (Fire stands for Fairchild integrated real-time executive).

The package contains three primary software programs: diagnostics, including a toggle-in-memory test, system exerciser, instruction timer, and memory diagnostics; an interactive entry and debugging program; and a bootstrap and binary ladder. By itself, it has a price of $250 in single quantities.

More software. Other Fire software packages include a $110 text editor, a $50 symbolic debugger, and a $550 basic business language. Downstream, the company plans to add even more punch to the package by offering more software and large-scale integrated support circuits. A floppy-disk operating system and a disk operating system are due in the spring, followed by a Fortran compiler by the end of the year. In hardware, a 16,384-bit dynamic RAM should be out this winter, a memory control with control refresh and direct-memory access capabilities is due out at midyear, and a hardware multiplier and divider should appear in time for next Christmas.

The 9440 has a memory capacity of 32,768 16-bit words that can be any combination of instruction and data. Its input-output ports can serve

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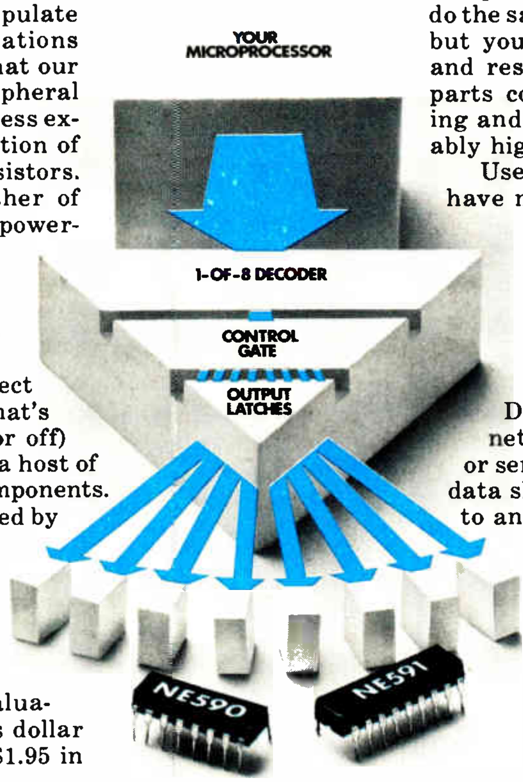

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63 peripheral devices using programmed interrupt-driven or direct-memory-access I/O lines. Fairchild has also priced the microprocessor so that several 9440 devices can be ordered with one software package.□

Communications

Latest telephone industry proposals draw ire of independent manufacturers

Calls on Congress to reject proposals by a task force from the telephone industry to limit telecommunications competition are increasing as legislators reconvene this month to consider rewriting the 1934 Communications Act. Two trade groups representing independent manufacturers of terminal equipment, computer users, and specialized common carriers all attacked a four-part recommendation last month to the House and Senate subcommittees on communications that would restructure the way the national telecommunications network may be used.

The telephone industry's latest proposals vary only slightly from its earlier Consumer Communications Reform Act (the Bell bill). The House group failed to adopt it last year as the basis for new legislation. "The Bell bill would have eliminated competition by a single stroke," argues the opposing Ad Hoc Committee for Competitive Telecommunications, a coalition of manufacturers and specialized carriers. "The new proposals would starve us out of existence," the group says.

The Computer and Communications Industry Association charges the proposals would prevent resellers and packet suppliers of computer services who deal with more than one customer from interconnection with the public network. "What this means in effect is that computer users will no longer have any dial-up capability for specialized services," contends A.G.W. Biddle, who is CCIA president.

Proposals. Four service categories are proposed under the telephone industry's plan. Category I deals with regular local and interstate telephone service, leaving it unchanged and incorporating existing rate averaging that favors sparsely populated areas. Category II would permit interconnection with the public network of specialized carrier networks like that of Washington-based MCI Inc, but this would be done only through switches on the using company's premises. Thus a user away from "home" would be prohibited from accessing a specialized carrier net. Moreover, charges to special network users for access to the public network would be higher.

Category III deals with private nets provided by either regulated carriers or customers themselves. These would not connect with the public switched network but would communicate only with other stations in the private system, provided, the telephone companies say, "they are not essentially duplicative" of existing public network services. Examples of such private networks range all the way from TWX and Telex to tandem tie lines and value-added services like those of packet-data-switching systems.

Category IV embraces competitive terminal equipment and radio common carriers, limiting the latter's access to the public network to areas not served by the public network. It would also limit customer-owned terminals to those registered with the Federal Communications Commission that do not duplicate category I offerings.

Reactions. The telephone industry's self-styled "compromise" was rejected by both ACCT and the CCIA, who labeled it one more effort to set ground rules for the upcoming congressional battle. Opponents of the 23-page plan see category II guaranteeing higher and inequitable charges to specialized private carriers for access to the public network, while categories III and IV are viewed as highly restrictive of terminal equipment competition.

Congressional response to the plan is still muted as House and Senate subcommittees study it and review industry objections. Noting that technological advances are rapidly altering old concepts of telecommunications, Rep. Lionel Van Deerlin, (Dem., Calif.) chairman of the House unit, reflects sympathy with pro-competition forces. He put forward this observation last month: "Just as it is impossible to distinguish between data processing and data communications, it is also impossible to resolve the issue of whether services are old or new, innovative or duplicative. Every ser-

FCC's Fogarty: legislation is premature

At least one Federal Communications Commission member believes the four-part telephone industry task force proposals to Congress for rewriting the 1934 Communications Act are "a solution in search of a problem." Shortly after the revised plan was delivered to Capitol Hill, commissioner Joseph Fogarty urged "caution in reviewing legislative proposals which preempt existing policy or unduly restrict [the FCC's] ability to respond to new telecommunications issues as they arise." Definition of the problem must come first, Fogarty says, adding that "there is no evidence that competition for the past decade has had any adverse effect on local telephone rates, or that we can expect any significant negative impact in the future."

Citing the FCC's proposed look at overall telecommunications competition to determine its "outer limits," Fogarty believes the issues "are ripe now for commission investigation" but not for legislation, "given the lack of a record of relevant data and analysis." A new investigation, he says, could lead to "the largest and most important rule making in the history" of the FCC.

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vice is to some degree like every other service, and to some degree different."

House subcommittee staff members say a proposed revision of the Communications Act should be introduced in Congress in about April, but Van Deerlin indicates that its complexity will probably preclude final House passage before 1979. □

Home computers

Custom ICs improve image of new home computer on ordinary TV set

The man behind one of the industry's most popular microprocessors is also behind an innovative home computer announced just last month. David Chung directed the original F8 microcomputer group while he was at Fairchild Camera and Instrument. Now, as vice president and part owner of the relatively new Umtech Inc. in Sunnyvale, Calif., he has developed a computer that plugs into a color television set's antenna terminal just like any video game.

For the nonexpert. Keyboard is part of new home computer that comes with a library of educational and entertainment programs.

His VideoBrain home computer terminal can put up to 16 colors on the screen and, while retaining the set's characteristic 525-line scan, gets much higher resolution from the TV picture by means of a pair of custom n-channel metal-oxide-semiconductor chips.

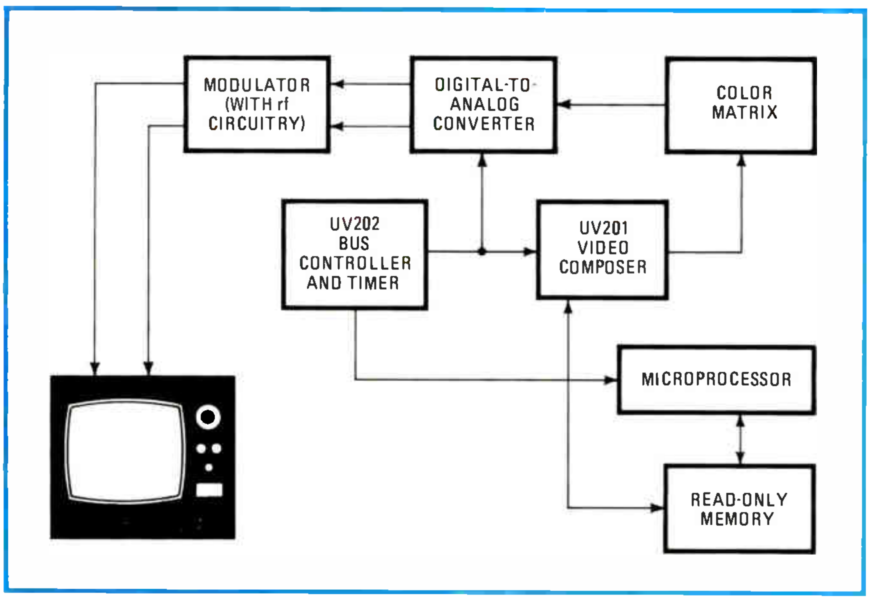
Moreover, the $500 machine, which comes with joysticks for playing video games and a 36-key keyboard for access to the computer, has perhaps the broadest range of plug-in software packages yet available. Included are solid-state cartridges with programs for finance and cash management, stock valuations, and real estate analysis and calculations, as well as for learning mathematics, English, and music. It also has cartridges for a range of video games like pinball and blackjack. (However, the Winter Consumer Electronics Show opening this week in Las Vegas should see other home computer makers introduce new plug-in applications programs for the computer novice uncomfortable with developing programs using a computer language.)

At the show in Las Vegas, Umtech will also be exhibiting the prototype of an add-on interfacing module that will allow the F8-based system to be connected to a range of peripherals: a printer, a telephone (via an acoustic coupler), or an audio cassette deck for data storage.

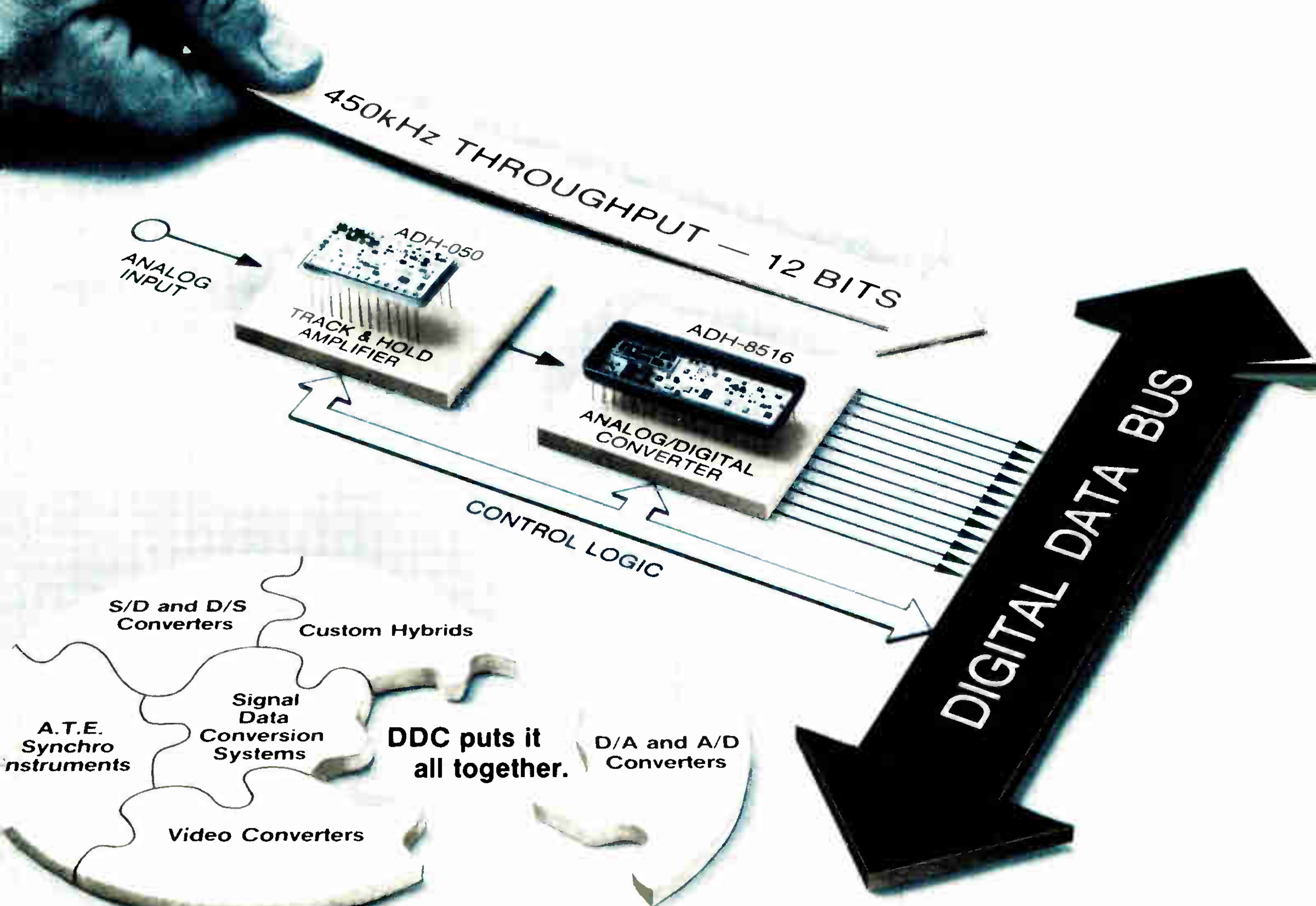
But Chung says, "The display is the most important part of the computer," meaning that its attractiveness helps decide whether a computer novice buys or not. He improves the TV screen's resolution with a timing technique that keeps track of where the electron beam is in its scan and then turns it on to write a point on the screen. Chung has reported on the technique [*Electronics*, Jan. 20, 1977, p. 102] as a way of getting a microprocessor's timing resolution down to a single clock cycle.

Accordingly, Chung is able to divide each line scan into about 180 picture elements, or roughly 100,000 for the entire screen. In comparison, an ordinary TV game might address only some 80 picture elements per line, or about 40,000 total.

For this high performance, Chung uses the two custom chips to operate between the F8 and read-only memory that stores images on one hand, and on the other, TV conversion circuitry composed of the color matrix, digital-to-analog converter, and radio-frequency modulator, shown in the diagram at the left. Chung describes one of the chips, the



Doing the job. Pair of video composer and timer chips developed for VideoBrain handle the image selection and timing chores that boost the resolution of the display obtained on the screen of an ordinary TV set.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UV201 video composer, as "a super counting circuit that pulls stuff out of the read-only memory at the right time."

For each line, the video composer calculates the location of ROM-stored image elements and the proportion of the line to be taken up by background and image information. It pulls the latter out of the memory, adds color and intensity coding, and sends the data to the d-a conversion circuitry. Background data, encoded with color and intensity, goes directly to the converter.

The chip actually looks at two TV lines at a time—with the interleaved scanning fields, it processes one while updating information on the other. The complex chip also contains refresh and update logic, dot and line counters, and command and interrupt registers. The other custom chip, the UV202 timing and controller circuit, directs the microprocessor, the ROM, and the video composer, as well as providing the timing and generating synchronization signals to control the output between the chips and the d-a converter.

Another feature of the VideoBrain is that its architecture has been designed to work with other microprocessors besides the F8. Thus a new and more powerful computer could be designed and brought to market with relative ease. □

News briefs

Terminal equipment registration deadlines extended by FCC

The Federal Communications Commission has extended the "grandfather" eligibility date for terminal equipment not registered with the FCC to be directly connected to the telephone network by 9½ months. The deadline is now Oct. 17, 1978, instead of Jan. 1, 1978 [*Electronics*, Oct. 27, p. 48]. If a type of unregistered equipment is in use before Oct. 17, it may continue to be connected through June 30, 1979, the FCC says, but after that date only registered equipment may be connected. Not covered are private-branch-exchange switches and key systems, for which the FCC's common carrier bureau says rules will be proposed before the end of February. The FCC also noted that the revisions now apply to protective circuitry and couplers that were not specifically addressed in its earlier ruling.

If your atomic clock is slow, you forgot 1977's 'leap second'

Engineers who find their atomic clocks running 1 second slow in the new year clearly missed 1977's "leap second," according to the National Bureau of Standards. The leap second was inserted into Universal Coordinated Time, used to coordinate atomic clocks, at precisely 23:59:60 on Dec. 21, extending the year by 1 second. NBS's Boulder, Colo., laboratory, the official U. S. timekeeper, has made similar adjustments every year since 1972, when 2 leap seconds were inserted. "Leap seconds are needed," NBS explains, "because atomic clocks are more precise than the variable rate at which the earth rotates on its axis." Adjusting clocks to conform to the earth's spin "would defeat their purpose of providing uniform time." Atomic clocks can be checked with NBS time signals broadcast on frequencies of 2.5, 10, and 15 megahertz, or by telephoning (303) 499-7111.

European, Canadian firms win $2.5 billion telecom order

Philips Gloeilampenfabrieken of the Netherlands, L M Ericsson of Sweden and Bell Canada have teamed to win an approximate $2.5 billion contract to expand the Saudi Arabian telephone system. About $900 million worth of computer-controlled switches, cable, network equipment, and telephone instruments will be supplied equally by Philips and Ericsson over a three-year period. Bell Canada will manage the system over a five-year period at a cost of over $500 million. The rest of the $2.5 billion will go for labor, construction, and buildings, among other items. In winning the large telecommunications order, the triumvirate topped three other teams: ITT and United Telecommunications; Western Electric, Plessey, and Cables and Wireless; and Nippon Electric, Hitachi, and Mitsubishi Electric.

Siemens, AMD proceed with joint venture

Advanced Micro Computers will be the name of the new joint venture that West Germany's Siemens AG and Advanced Micro Devices Inc. of Sunnyvale, Calif., said they would form [*Electronics*, Oct. 13, p. 31]. The new company will design, manufacture, and market worldwide microcomputer systems and related products. Siemens will also purchase 400,000 shares of AMD common stock for $18 million, to add to 200,000 shares it bought earlier which will give it an approximately 20% ownership position in AMD. Details of the purchase and the joint venture are expected to be worked out by Feb. 1. Meanwhile, Britain's Ferranti Ltd., a $250 million electronics equipment company, has bought for about $3.3 million tiny Interdesign Inc., also in Sunnyvale, a manufacturer of custom integrated circuits.

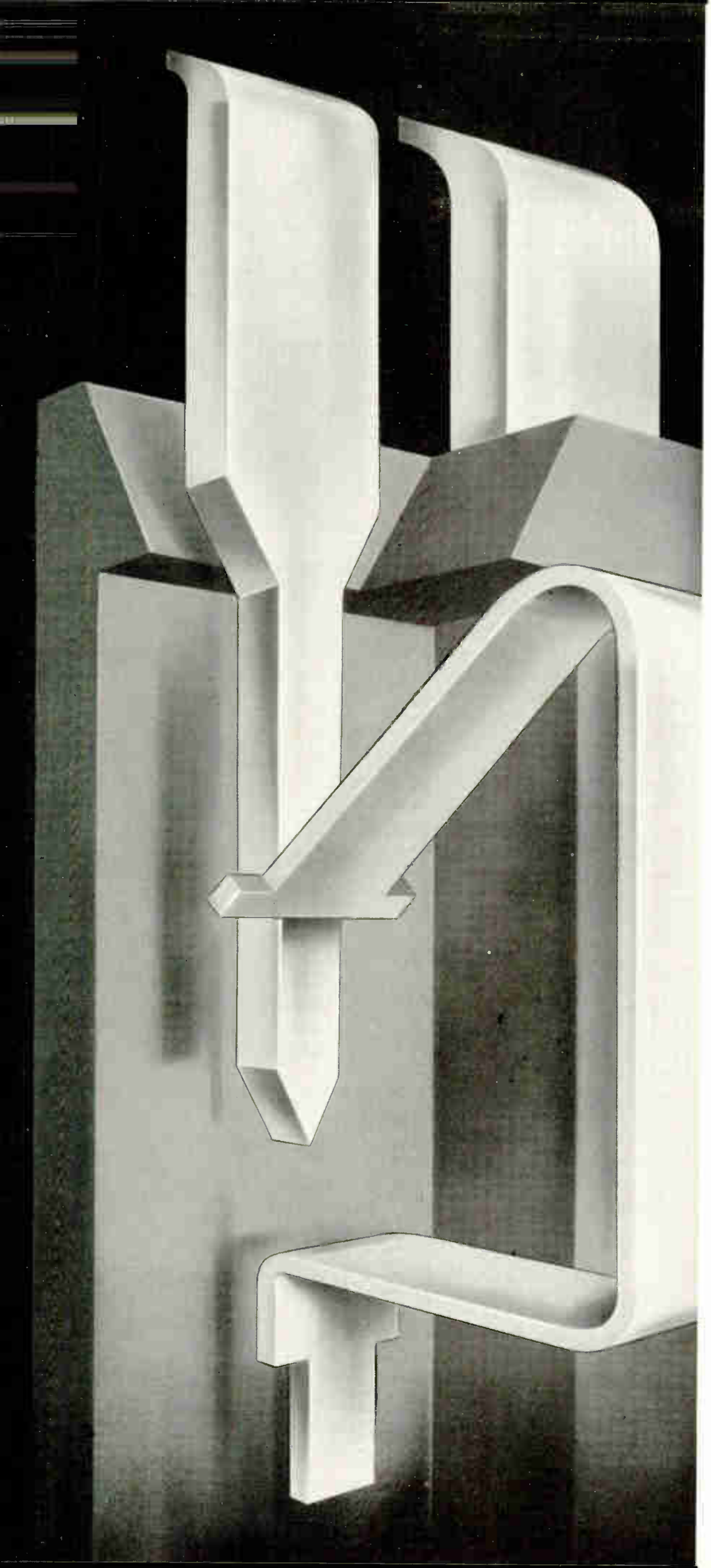
Aerospace

Sales by U. S. will rise 8% in 1978

Despite the U. S. aerospace industries' 8% sales gain to $32.4 billion in 1977 and an expected equivalent rise in 1978 to $34.9 billion, the New Year will mark "a crossroads for the industry," says Aerospace Industries Association president Karl G. Harr. He believes that uncertainty about pending Government rulings on technology and economic issues could lose the U. S. its aerospace leadership.

Profits, as a percentage of sales, reached 4% in 1977, up from 3.5% in 1976, while jobs declined by 5,000 to 893,000. Exports of $7.2 billion for the year declined some $600 million from the 1976 level, with declines in civil aircraft shipment more than offsetting a military exports rise.

American trade and patent policies as well as Federal research and development funding, says Harr, are among the key concerns of AIA members. The aerospace industries' contribution to the U. S. trade



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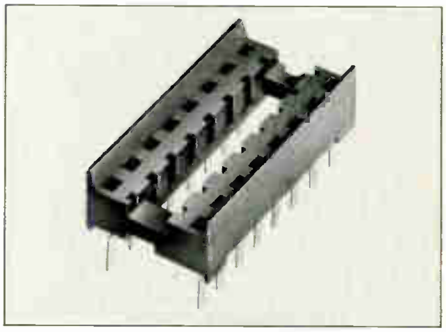

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Circle 63 on reader service card

balance could be threatened if U. S. protectionism caused tariff and non-tariff trade barriers to be raised elsewhere. Changes in national policy that lead to cutbacks in foreign military sales, plus new definitions of what constitutes "strategically critical" technology for export, will also have a major impact on aerospace products and services, he says.

Gains in outlays. Significant gains in military research-and-development outlays will be proposed in the Carter Administration fiscal 1979 budget to go to Congress later this month [*Electronics*, Nov. 24, p. 59]. But debate is bound to arise in Congress this year over proposals by the aerospace and electronics industries that Federal rules be relaxed on corporate use of patents developed with Federal funds.

Typical of the opposition that industry can expect is Adm. Hyman G. Rickover's testimony at year's end before a Senate subcommittee. Rickover wants a uniform Federal policy requiring all Government agencies "by law to retain patent rights, except in exceptional circumstances, to all inventions developed at Government expenses." Charging Federal contractors with "double-talk," Rickover contends that "toward their employees and subcontractors, the companies' practice is that the one who pays for an invention should own it. But in dealing with the Government, they contend that the one who actually made the invention should own it, not the one who paid for it."

Breakout. Military outlays for aerospace products and services rose 17% last year, totaling nearly $16.3 billion and accounting for over half the industries' volume. But the National Aeronautics and Space Administration's 1977 funds of just under $2.6 billion were off nearly 8% from funds in 1976.

Military aircraft buys accounted for $8.16 billion of last year's Department of Defense total, the AIA estimates, with missiles at $2.92 billion. Monies for RDT&E amounted to $1.86 billion for aircraft, $2.66 billion for missiles, and $673 million for astronautics. □

Solid state

IEDM describes tomorrow's devices

More than ever, it seems, upcoming changes in the way the semiconductor industry does things are foreshadowed at the International Electron Devices meeting. Among developments reported at it last month in Washington were ion-implantation methods for improving the performance of microwave field-effect transistors, novel optoelectronic-device designs for use in couplers and fiber-optic communications, and solar cells with high efficiencies.

Unquestionably, the liveliest microwave area now is gallium-arsenide power FETs, as developers push operating levels higher. Hewlett-Packard Co. in Santa Rosa, Calif., for example, has successfully built a fully ion-implanted FET that performs at least as well as devices made with conventional epitaxial processes. Because of their simple, planar structure, these FETs also promise greater reliability, with potential application in GaAs integrated circuits, says HP. With a gain of 5 decibels, researchers have obtained more that 1 watt of output power at 6 gigahertz and a power-added efficiency of 34%.

Ion implantation is also the key to work in low-noise microwave FETs being done by Avantek Inc. of Santa Clara, Calif. The firm is implanting silicon into a GaAs semi-insulating substrate at relatively low energy to obtain a very shallow but steep profile. At 18 GHz, a device having a 300-micrometer gate width holds its noise figure down to 2.5 dB with an associated gain of 7 dB. Avantek's best noise figure for a 150-μm-gate device is 2.75 dB.

Phone switches. Meanwhile, Bell Laboratories is developing a pair of unusual optoelectronic semiconductors. The company's Murray Hill, N. J., facility is working towards a bilateral phototransistor for use in optical couplers for telephone switching applications. Unlike other

phototransistors, which can block voltage and pass current for only one polarity of applied bias, the new device provides useful gain for both polarities. So far, a bilateral gain of 180 with a blocking voltage of ±10 V has been obtained for a 2.1-μm-thick base, one of 3,000 with ±2.6-V blocking voltage for a 0.3-μm-thick base. Bell wants to raise the blocking voltage to 300 V or more, to create a coupler that will switch more than 100 milliamperes with a forward light-emitting-diode current of 10 mA.

In a related development, Bell's Crawford Hill Laboratory in Holmdel, N. J., has come up with an optically switched LED for fiber-optic use as the single interface device between normal digital logic circuits and glass fibers. The LED is a double heterostructure (pnpn) device that is made from indium gallium arsenide phosphide.

An early application, project the people at Bell, could be as the sole optical element in a tap-and-repeater circuit for an optical-fiber data link. The pnpn device could amplify the light pulses, while its simultaneous electrical output would be adequate for driving transistor-transistor logic directly.

Solar cells. As for solar cells, the Jet Propulsion Laboratory of the California Institute of Technology in Pasadena, Calif., has pushed the efficiency of gallium-arsenide metal-oxide-semiconductor cells to 17% with a fabrication technique that lends itself to reproducibility, too. Researchers there attribute their success to a new chemical surface preparation. They form the oxide layer by physical deposition and make an improved antireflecting coating by pulsed-laser evaporation.

In addition, Texas Instruments Inc. in Dallas is building tandem-junction thin-film solar cells that have collecting junctions on both their illuminated and dark sides. Experimental results look good—an open-circuit voltage of 600 millivolts, a short-circuit current of 50 mA per square centimeter, and an efficiency of approximately 18% at a temperature of 25°C. □

Video games

TV games may burn in images, FTC says

"Warning: the Federal Trade Commission has determined that electronic video games may be dangerous to your TV screen." Although the FTC has not ordered this declaration placed on packages and ads, it has concluded that the stationary details of video games—field outline, net, and score—can leave imprints on the face of a TV picture tube. Further, the danger is greater for monochrome than for color sets, the commission says, after studying results of tests by the National Bureau of Standards and other data.

"Reasonable use" of such games, however, should not damage TV screens, the FTC notes. But it warns that prolonged use may cause permanent damage.

Monochrome receivers can be imprinted after 100 to 200 hours of use with bright, high-modulation games, while color sets will not be imprinted until more than 350 hours of use. "Low-modulation games will take even longer before any distinct imprinting will be noticed," the FTC reports, as will those with constantly changing luminance or automatic shut-off features. Similar findings were reported by the Canadian Consumer and Corporate Affairs department in December 1976.

Recommendations. The commission urges that games be shut off when not in use and says consumers should pick games that: (1) have low-modulation signals, (2) use constantly changing brightness levels and colors when left on, and (3) use low-brightness whites or light colors and gray, rather than true black.

The FTC says most reported problems appear due to continuous display of games on dealers' showroom floors, adding that it has received no consumer complaints. Nevertheless, it wants consumers warned that prolonged display of a fixed game pattern is likely to imprint the TV screen. □

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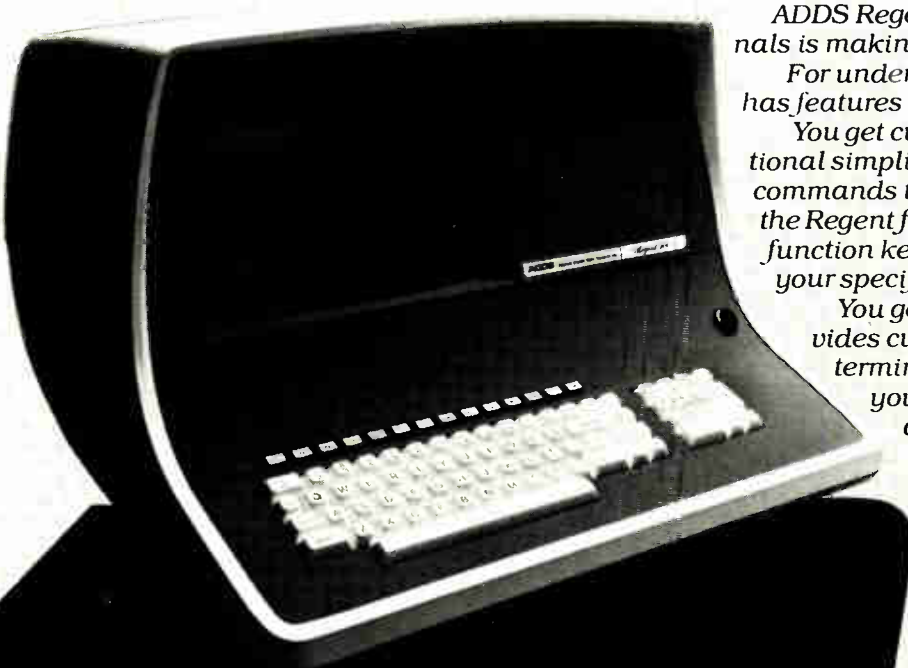

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ADDS Regent family of Smart terminals is making Dumb look dumb.

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Circle 136 on reader service card

TEAC's Done It Again Open Reel Performance in the Cassette Mode

The TEAC R-81 has all the features you look for in a high quality data recorder, but with a big plus: 4 speeds.

Open reel data recorders offer 4-speed selection as a standard feature, but cassette types have been limited to the single speed mode.

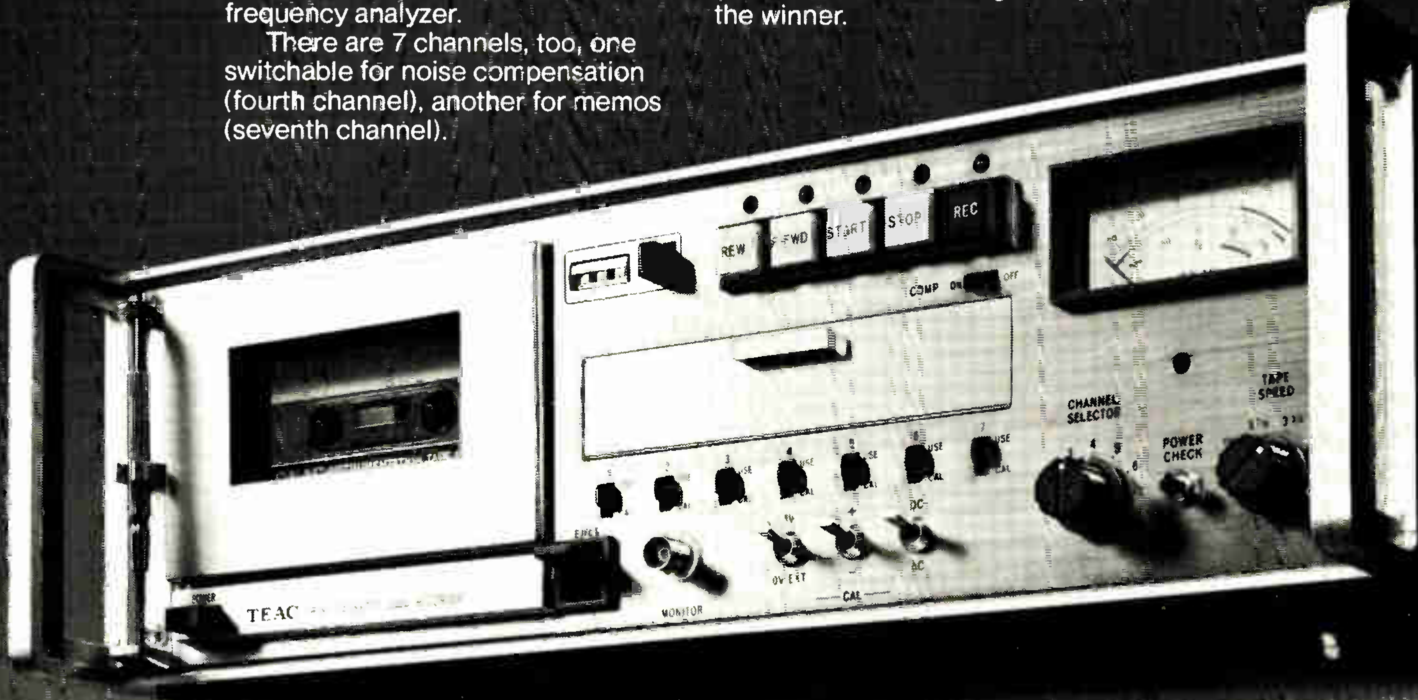
The R-81 changes all that, giving you the convenience and simplicity of a cassette recorder along with all the options of 4-speed variability. High-frequency data can be recorded at high speed and reproduced at low speed—or low-frequency data converted to a higher frequency, for analysis by a general-purpose frequency analyzer.

There are 7 channels, too, one switchable for noise compensation (fourth channel), another for memos (seventh channel).

The R-81 also features the clean, rational styling that TEAC cassette tape decks are famous for. The front-loading configuration, with all the controls on the front panel, is ideally convenient for desk-top use. It also facilitates mounting with other equipment made to professional standards, as does the body size, which meets EIA specifications.

And the R-81 is ready to operate anywhere. In addition to AC (with adapter) and DC power sources, you have the full portable versatility of dry cell battery operation.

TEAC's done it again: advanced the art of data recording. And you're the winner.



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Circle 68 on reader service card

Belar, Motorola perform best in a-m stereo tests . . .

Initial assessments of a-m stereo radio field tests give Belar Electronics Laboratory Inc.'s system the highest marks for overall simplicity, most easily decoded (demodulated) signal, and compatibility with existing monophonic receivers. On the other hand, Motorola Inc.'s entry, called C-QUAM, for compatible quadrature amplitude modulation, **performed best in a high-noise environment—including pickup of skywave transmissions**—but its signal-demodulation approach is highly complex. Magnavox Corp.'s system is less sophisticated than Motorola's, although it uses a similar phase-modulation approach, but more complex than Belar's.

That is the word from engineers reading the 455-page report of field tests just delivered to the Federal Communications Commission by the National A-M Stereophonic Radio Committee [*Electronics*, April 14, 1977, p. 82]. Copies of the study, which contain only test data with no recommendations, are being printed by the Electronic Industries Association and made available for $20 per copy at its Washington headquarters, 2001 Eye St., N. W. The committee is jointly sponsored by the EIA and the National Association of Broadcasters, the National Radio Broadcasters Association, and the IEEE's Broadcast, Cable, and Consumer Electronics Society. They want the FCC to choose a system soon so that auto makers will be able to get a-m stereo into 1979 models.

. . . with IC demodulator seen as key to new market

Despite the fact that many a-m radio broadcasters and receiver makers are eager for the FCC to act on stereo broadcasting this year, commission insiders suspect a decision will not come before the final quarter of the New Year, if then. Whenever a ruling comes to open the estimated $250 million annual wholesale equipment market—80% of it in auto radios—equipment makers say success will hinge on development of a new integrated circuit to make production costs of a-m stereo receivers competitive with fm.

Sources at the FCC and the national a-m committee privately express concern that receiver and studio transmission equipment **makers expressing the greatest interest in test results are from Japan,** suggesting to them that when the new market is opened, U. S. manufacturers might find themselves once more left at the starting gate in the race to get products on dealers' shelves, as they were in the citizens' band radio competition.

SBS wants bids on rf terminals by Feb. 28

Satellite Business Systems wants firm, fixed-price bids by Feb. 28 for design and manufacture of a prototype radio-frequency terminal and 100 production units for its domestic communications satellite system. Award of two parallel contracts is planned for the third quarter. The terminals will include antennas, 5 or 7 meters in diameter, and associated electronics operating at 14 and 12 gigahertz for installation on customers' premises. The revised proposal request came at year's end after **the company rejected earlier responses to an RFP issued last May,** saying it needed "a more cost-effective" terminal program.

The revision, SBS says, contains simplified technical, structural, and point requirements for antennas; quality assurance specifications; and reduced testing and documentation. The RFP calls for deliveries of an engineering model in April 1979, a prototype in the third 1979 quarter, and production units beginning in the first quarter of 1980.

Washington newsletter

UL to supervise U. S. role in new quality system

American participation in the new international components quality-certification system known as IECQ took another step forward with selection of Underwriters Laboratories Inc. as the organization to operate the U. S. National Supervising Inspectorate. The IECQ system, to be chartered by the International Electrotechnical Commission at Geneva this month, **is expected to become operational in about another year.** Its goal is to provide worldwide quality standards for electronic components [*Electronics*, Nov. 10, 1977, p. 50].

GAO urges Congress to scrap Marad ship-shore project

The Commerce Department's Maritime Administration (Marad) system using the Marisat satellite should be dropped **because it duplicates commercial services for ship-to-shore communications** and its computerized management control system has generated little interest among shipowners [*Electronics*, Sept. 16, 1976, p. 60]. That is the judgment of the General Accounting Office in a study for House Government Operations Committee chairman Jack Brooks (D., Tex.).

The Maritime Administration rejects the GAO charge, noting that it uses commercial channels on Communications Satellite Corp.'s Marisat, which became operational in 1976. It calls the GAO's recommendation to scrap the computerized management control system "premature," until completion of a cost-benefit study of the system's value to shipowners. Marad would provide the latter with real-time operational data from ships at sea so that they can monitor costs and alert captains to new cargo opportunities. Initiated in 1970, the program has cost $10.5 billion and is expected to spend $5.3 million more through 1980.

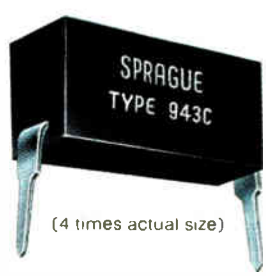
EIA wants data to promote U. S. contracting out

The Electronic Industries Association wants member companies to provide examples of how the Government saved money by contracting work out, rather than performing it in house, **in order to build a data base for lobbying Congress and Federal agencies this year.** The EIA drive for data is part of a new multi-association Committee on Contracting Out organized "to counter congressional and Federal union pressures that have eroded Government policy to rely on the private sector."

Addenda

Among military and aerospace electronics manufacturers **entering the new year with major new Government awards are:** General Dynamics Corp., Pomona, Calif., which got a $50 million initial production contract from the Naval Sea Systems Command for the Phalanx/Close-In Weapons System. The Navy estimates that it will eventually need nearly 450 Phalanx/CIWS packages for ship defense at a projected $1 billion cost. . . . McDonnell Douglas Corp., Long Beach, Calif., topped Boeing Co. of Everett, Wash., in the Air Force competition for a new Advanced Tanker/Cargo Aircraft with a $28 million award to begin production engineering and tooling to build the DC-10-30CF. **About 20 planes could be ordered.** . . . RCA Corp., Camden, N. J., picked up two space shuttle communications awards from NASA worth more than $19 million, including one expected to total **$8.6 million for the shuttle orbiter's package for extravehicular activity and air traffic control.** The second, worth an estimated $10.5 million if NASA is able to buy the maximum of five orbiters, covers the vehicle's closed-circuit TV system, including portable color cameras and color and monochrome monitors.

Imitation is the sincerest form of flattery.



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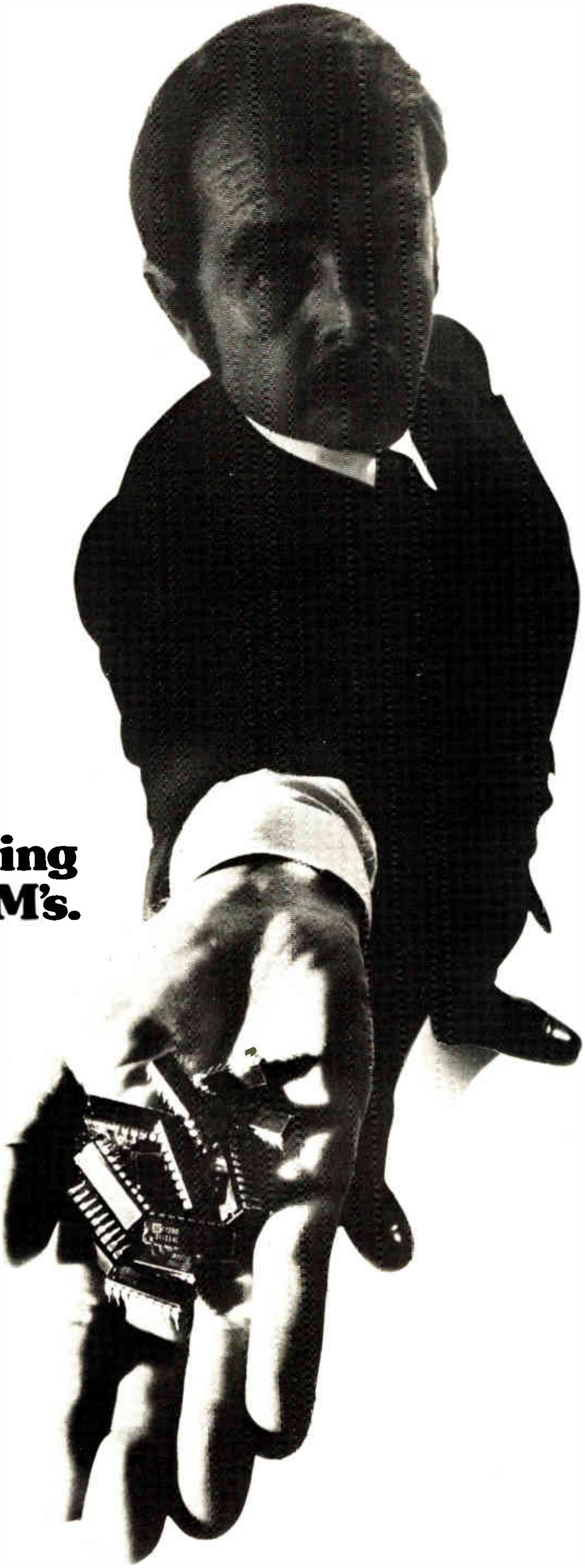

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No refresh circuitry.
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Synertek

Two governments set aid amounts for electronics firms

French firms producing medical and scientific instruments will get nearly $50 million in government aid in the next five years. More than $30 million will be in the form of contracts dependent on achievement of certain growth targets by individual firms, and the rest will come from the health ministry for studies of potential products. **Across the English Channel, $45 million in government aid** will go to the United Kingdom's microcircuit industry for the development of new process techniques and products. Participating companies must chip in roughly the same amount for their research-and-development efforts. Local manufacturing operations of foreign firms probably will be included.

One-chip version due of associative parallel processor . . .

That high-speed associative-memory parallel processor on a breadboard kicking around at Britain's Brunel University is going to pop up in a one-chip version within the next year or so. To be fabricated in Plessey's high-density integrated-injection-logic process, the Micro-APP will incorporate a 16- or 32-byte associative memory and the necessary microprogram control logic **to perform search-modify-write and search-modify-read operations in less than 200 ns.** Brunel's R. M. Lea is confident his design can be stretched to accommodate a complete 64-byte processor. The Micro-APP is intended for text-retrieval, editing, and compression tasks in large word-processing systems, for which microprocessors are neither fast enough nor flexible enough. The United Kingdom's Department of Industry is funding Lea's one-chip development with a $34,000 grant.

. . . while study begins of associative memory occupying a wafer

In another Department of Industry project at the Uxbridge, Middlesex, university, Lea will carry out a computer simulation and evaluation of a large-scale associative memory proposed by computer theorist Ivor Catt. Already the subject of a $51,000 hardware feasibility study at Middlesex Polytechnic, **Catt's proposal is based on the concept of a self-organizing array of serial shift registers diffused onto an undiced wafer.** He believes that use of the wafer rather than diced chips will realize huge savings in assembly and testing, as well as eliminating the problems of chip interconnections. Lea's $34,000 study will be of the system engineering and software problems in a text-compression application.

Philips power amps to up synchrotron's particle energy

Sometime next year the Super Proton Synchrotron of the European Council for Nuclear Research will double the energy level of the atomic particles accelerated for high-energy physics and fusion experiments. **Making possible the jump from 400 to 800 gigaelectronvolts will be four power amplifiers** from Philips' component-producing Elcoma division. For supply and installation of the 500-kw, 200-MHz amplifiers, the Geneva-based research organization will pay $4.5 million. Its Super Proton Synchrotron is in a tunnel 7 km in circumference and is buried at an average depth of 40 m.

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RCA helps you make discoveries in power design.

New devices. New packages. New parameters. All from the Powerhouse, your source for the widest choice in SCRs and Triacs. They offer you the latest ways to improve design, reduce costs and increase performance.

A new way to heat. Solid-state induction heating is now entirely feasible, thanks to our new 40A asymmetrical SCR (ASCR). The RCA S7310 gives you 40 kHz frequency, high voltage and current. Plus high di/dt and dv/dt capability. No need for 50/60 hertz transformers and other bulky parts.

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G4000	50-400	15	3	Gate Turn-off SCR	TO-220
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S5800	100-600	5	50	Fast switching SCR	TO-220
C106	15-600	4.0	0.200	4-amp gen. purp. SCR	TO-202
T2320	50-400	2.5	3-40	Sensitive-gate triac	TO-202
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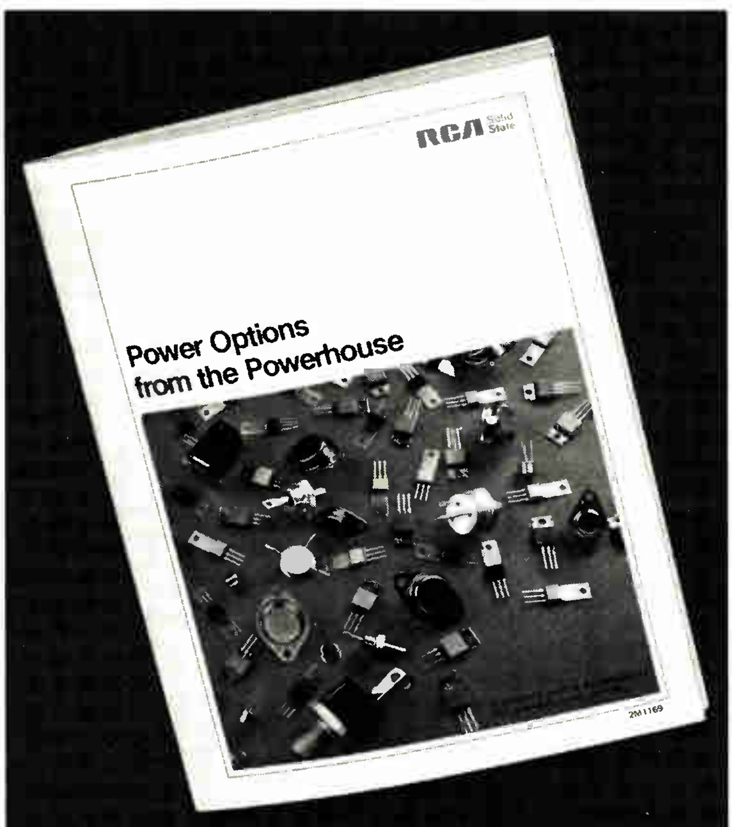
A new source for circuit ideas. "Power Options from the Powerhouse" is a new designer's guide to the selection of optimum RCA solid-state devices for power circuits. It's arranged by application, with over 40 circuits shown. This makes it easy for you to choose the type best suited to the job.

For your free copy, contact RCA Solid State headquarters in Somerville, NJ; Sunbury-on-Thames, Middlesex, England; Quickborn 2085, W. Germany; Ste.-Anne-de-Bellevue, Quebec, Canada; Sao Paulo, Brazil; Tokyo, Japan.



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RCA

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Lab unveils two MOS processes for high-speed communications circuits

In the race to perfect very-large-scale integrated circuits with 2- or 3-micrometer design rules, Japanese researchers are finding more than one horse on which to lay their bets. Two new candidates for achieving the VLSI fine lines are high-speed, low-power metal-oxide-semiconductor techniques that have just been unveiled by the Musashino Electrical Communication Laboratory.

Still highly experimental, the 3-μm techniques have produced memory and logic circuits with subnanosecond speeds and speed-power products of about 100 femtojoules. In addition, both cut the number of processing steps required to produce the finished device.

The new techniques from the lab, which is an arm of the Nippon Telegraph and Telephone Public Corp., join the recently announced advance from Japan's cooperative VLSI laboratory [*Electronics*, Dec. 22, p. 25]. Aiming at 1-to-2-μm design rules in mainframe computers, the VLSI lab has devised a technique for fabricating two closely spaced photoresist walls to protect the intervening region from stray ions during MOS implantation procedures.

Two approaches. One of Musashino's new techniques is a complementary-MOS process that could lead to communications-oriented devices, such as digital filters and digital-to-analog and a-d converters. Central processing units and static memories are also possibilities.

The other process is being called elevated-electrode depletion MOS, based on a similar bipolar process developed at the lab. It would lead to high-speed logic circuits, including microprocessors for on-line data processing and CPUs for control of electronic telephone exchanges.

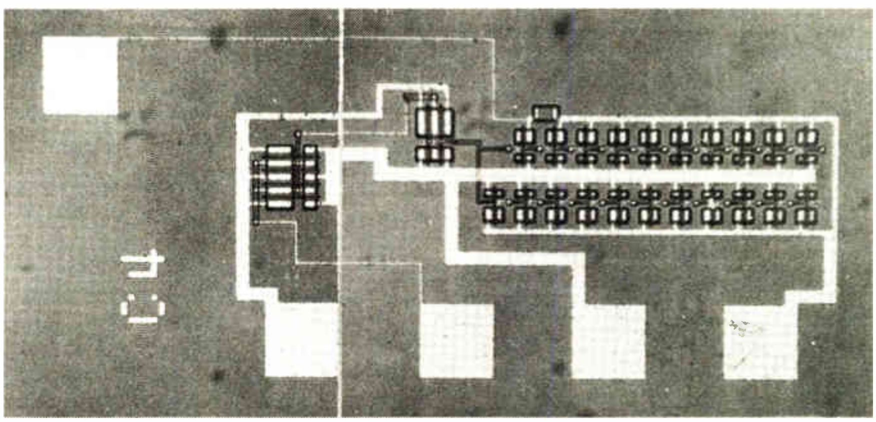
Researchers say that development of practical device technologies will take perhaps two more years. If they are to be used in a new microprocessor family or similar device for which the architecture must also be developed, another year or two must be added on to the developmental timetable.

The C-MOS technique uses the same basic technology as the Musashino lab's experimental 65,536-bit random-access memory [*Electronics*, April 28, 1977, p. 68]—giving 3-μm design rules and 500-angstrom gate oxides. Propagation early in the 21-stage ring oscillator in the photograph is 430 picoseconds per stage. Power consumption during switching is 186 microwatts, giving a speed-power product of 80 fJ.

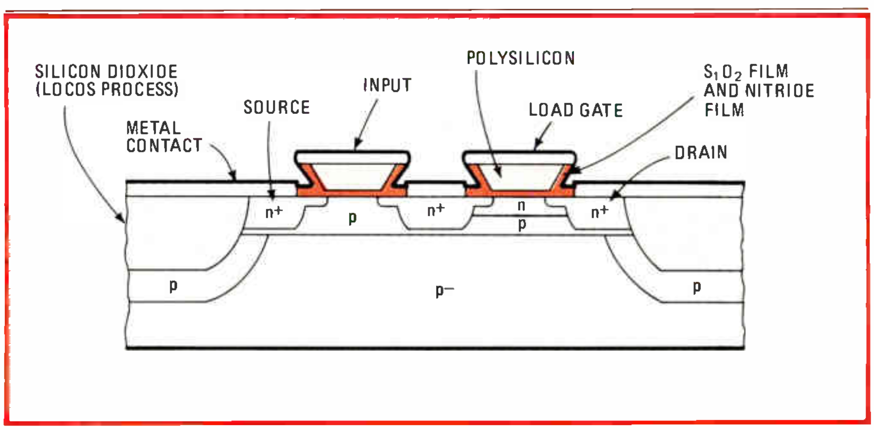
Effective channel length of the 5-volt, totally ion-implanted device is only 1.2 μm. Even with this short channel length, tests have shown that the devices will operate undamaged at 7 V, although power consumption jumps.

Engineers in the C-MOS group of the lab say that breakdown problems are less severe than with n-channel MOS devices, because most of the supply voltage is impressed across the off transistor of the pair. Helping maintain the necessary breakdown voltage is the shallow depth of both source and drain: 0.3 μm.

The devices feature a 2-μm-deep silicon-dioxide isolation region, made with the Philips-developed



Tryout. In this 21-stage developmental ring oscillator, Musashino's new C-MOS process is giving a speed-power product of 80 fJ and a propagation delay of 430 ps per stage



Thin stuff. Diffused arsenic in elevated-electrode devices provides the very shallow source and drain regions with an effective spacing of about 2 micrometers.

process known as Locos (for local oxidation of silicon). The isolation region is deep enough to eliminate the need for channel-stopper diffusion, which saves a process step and allows the region's width to be reduced to about 7 μm. It also greatly reduces stray capacitance between overlying connections and the substrate.

Elevation. The rival elevated-gate technique uses the NTT lab's self-alignment technology developed for the bipolar stepped-electrode transistor [*Electronics*, Jan. 22, 1976, p. 63]. With the SET techniques, researchers have fabricated two versions of a 15-gate ring oscillator with enhancement drivers and depletion loads. Both versions have 3-μm design rules and effective channel lengths of about 2 μm; the chief difference is the load current of the depletion-load transistors.

When operated from a power supply of 2.8 V, the high-speed gate has a propagation delay of 500 ps and a speed-power product of 120 fJ. When operated from a 1.5-V power supply, the low-power gate has a propagation delay of 800 ps and a speed-power product of 30 fJ.

As shown in the drawing, the MOS designs of the SET technology have inverted trapezoidal polysilicon gates rising above the surface of the silicon. These gates provide a self-aligning mask for diffusion and ion implantation, and they permit simultaneous metalization of source, gate, and drain without subsequent etching for separation.

Distancing. The gates' trapezoidal shape—about 3 μm wide at the top and just over 2 μm at the bottom—give lateral separation of the source and gate contacts and of the gate and drain contacts.

The self-aligning technology and the Locos process keep capacitance to about a third that of other designs, thus enhancing high-speed operation. Cell size of practical devices will be about half that of previous designs, so density will be high, say Musashino engineers.

With two promising techniques vying for the fine-line sweepstakes, what course will the Musashino laboratory follow? A spokesman says it is too early to tell. The two groups doing the work do not yet know the tradeoffs that will go into designing practical circuits. Moreover, the similarity in speeds and speed-power products means that at this point it cannot be shown that either technology is superior. In the long run, too, neither may prove totally superior across the board.

While NTT is not officially part of the cooperative VLSI lab, as are the leading semiconductor makers, it has been cooperating with the lab's efforts. At any rate, as Japan pushes for VLSI leadership [*Electronics*, June 9, 1977, p. 99], it may be that the Japanese will not put all their bets on one horse. □

Around the world

Microprocessor controls stereo receiver functions

A TMS1300 microprocessor directs all tuning operations and a number of other functions in a new Barco Cobar Electronics stereophonic receiver. The processor will respond to commands from an infrared remote controller or from buttons on the receiver's face. Among the tuning functions on the $1,400 C3000 from the Kuurne, Belgium, firm are a semiautomatic station-selection mode in which the frequencies for as many as 16 radio stations are stored in a random-access memory. Another is an automatic station-search mode in which the tuner runs up the frequency range in steps of 1 kilohertz on the a-m band and 25 kHz on the fm band, stopping when it reaches a station of sufficient power. When the user touches a button on the IR control unit or the receiver, the search continues until the next station is found.

Besides directing the tuning operations, the TMS1300 keeps tabs on the signals generated by the control buttons, ensuring that all functions are carried out in accordance with the program in its memory. It also keeps track of the instructions fed to the receiver's tuner, amplifier, display, and tape deck, if there is one. A member of the Texas Instruments' TMS1000 4-bit microcontroller family, the 1300 is in the receiver. The buttons' outputs go into an input matrix, from which the processor senses the information.

Dutch phone company plans more stored-program-controlled lines

Last month the Dutch ministry of posts, telegraph, and telephone put its 500,000th stored-program-controlled line into service, and by 1985 it will have some 4 million SPC lines, some two thirds of its total. Major, if not exclusive, supplier will be Philips Telecommunicatie Industrie BV of the Netherlands, providing chiefly the PRX/205 it developed with the PTT. This hardware has a highly modular design, so exchanges can be built as small as 1,000 lines or as large as 20,000 lines. The PRX gear is also doing well in export markets. Latest big score is a 470,000-line order from Saudi Arabia, to be split equally with Sweden's L M Ericsson Co. First-generation units have sealed-reed-relay switching matrixes supervised by a control unit that handles program instructions at an average speed of 4 microseconds.

French PO sees telecopier service as major growth area

The ministry of posts, telephone, and telegraph in France thinks it can rent out around a million home and office facsimile machines during the 1980s. The PTT wants to pay no more than $300 apiece for its telecopiers, for which it has let development contracts worth about $1.4 million each to four French firms [*Electronics*, Dec. 8, p. 53]. While the government and its potential suppliers carefully avoid talk of a full-fledged mail system for fear of union problems, it appears that is what is in the air. The French move is the latest in a series of signals that facsimile units are going to be big business soon. Next year the West German PTT plans to offer a service that will send material over public telephone lines between post-office–approved telecopiers, and the Nippon Telegraph and Telephone Public Corp. plans to offer a home telecopier service in Japan by March 1979 [*Electronics*, Oct. 13, p. 53]. In the U. S., Satellite Business Systems is urging equipment makers to turn out telecopiers that can make use of the wideband satellite network that SBS will be offering by 1981.

INTERSIL

Product Guide

Company Profile

As a vertically integrated multi-technology semiconductor company, Intersil offers OEM manufacturers a broad range of both products and technologies. Products from state-of-the-art semiconductors to add-on and add-in memories. Technologies from bipolar to MOS/LSI utilizing selective oxidation and double poly process techniques.

This broad range of products and technologies is the result of the 1976 merger between Intersil and Advanced Memory Systems, a major manufacturer of IBM compatible memory systems. And today, with annualized sales exceeding $85 million, Intersil is one of the eight largest independent semiconductor companies in the United States, as well as a leading independent supplier of computer memory systems.

Our Semiconductor Division is presently engaged in the development and manufacture of analog, low-power CMOS, digital CMOS/LSI, NMOS/LSI and bipolar/LSI products. The Intersil Systems Division produces price and performance competitive add-on and add-in memory systems for IBM and non-IBM computer applications.

The analog product group, with a wide range of process technologies and an expanding line of data acquisition circuits, is the largest and one of the fastest growing product groups in the Semiconductor Division. This product line has broadened substantially during the past two years through the development and introduction of numerous state-of-the-art devices, including a broad multi-technology line of sensors, amplifiers, filters, multiplexers, sample and hold circuits, and A/D-D/A converters. The recent addition of power amplifiers provides Intersil with a unique "closed loop" capability for data acquisition, conversion, processing and control of industrial operations.

Intersil is also a leader in digital CMOS/LSI technology. Due to expanded market acceptance of Intersil's 6100 family of 12-bit microprocessors, associated support circuits, and the new Intercept family of microprocessor development and floppy disk operating systems,this product line is becoming an increasingly important factor in systems engineering and design. The planned introduction of a second family of microprocessing elements and a series of associated circuits in fiscal 1978 should further expand this fast-growing product group.

In NMOS/LSI Intersil offers a broad range of circuits including 4K static and dynamic RAM's, 16K dynamic RAM's and proprietary 8K RAM's utilized in the production of in-house systems. Also scheduled for introduction later in the year is a new and faster 4K static RAM with a sub-100 nanosecond access time.

In Memory Systems, Intersil's Systems Division produces vertically-integrated lines of add-on memory and an expanding family of subsystems...built principally from memory, microprocessor and data acquisition circuits manufactured by the Semiconductor Division. Intersil's two new classes of memories, the UMS-1 and UMS-2, are IBM compatible and replace up to 10 add-on systems of the previous generation. The Systems Division also develops and produces non-IBM related memory systems and subsystems utilizing both custom and standard circuit board assemblies.

As an important part of both your business and ours, virtually all Intersil products are available to MIL STD-883.

Intersil's full range of circuits, discretes and memory systems is available through an international network of fully stocked Intersil Distributors. Field Sales Offices located in strategic areas throughout the United States and Canada provide a level of product support which is unexcelled in the industry.

As a multi-technology leader in the field of semiconductor products, Intersil offers you a broad range of product and technical assistance. On a worldwide basis. A complete listing of our Field Sales offices and Distributors is included at the end of the guide. When you call them, you'll find that at Intersil, leadership isn't just state-of-the-art...it's state of mind.

IM6100 Microprocessor

The IM6100 is a single address, fixed word length, 12 bit C-MOS microprocessor. The processor emulates the instruction set of Digital Equipment Corporation's PDP-8/E minicomputer. The internal circuitry is completely static and is designed to operate at any speed between DC and the maximum operating frequency. Two pins are available to allow for an external crystal thereby eliminating the need for clock generators and level translators. The crystal can be removed and the processor clocked by an external clock generator. The CPU design is optimized to minimize the number of external components required for interfacing with standard memory and peripheral devices.

Features

DESIGN

- Silicon Gate C-MOS
- Fully Static-0 to 8 MHz
- Single Power Supply
  - IM6100 C:V_{cc} = 5 volts
  - IM6100A:V_{cc} = 10 volts
- Crystal Controlled On Chip Timing
- Low Power Dissipation < 10 mW @ 4 MHz @ 5 volts
- Single Power Supply $4V \leq V_{cc} \leq 11V$
- TTL Compatible at 5 Volts
- Excellent Noise Immunity
- −55°C to +125°C Operation

INTERFACE

- 64 I/O Devices with PDP-8/E Compatible Interface
- Control Panel Request Input
- Switch Register Select Input
- Asynchronous Interface between CPU and memory or I/O.
- Device Controlled Input-Output
- All Control Signals Produced By The CPU
- Power-on Reset

ARCHITECTURAL

- Executes PDP-8/E Instruction Set
- Direct, Indirect, and Autoindexed Memory Addressability
- 12-Bit Memory Accumulator ADD Instruction
  - IM6100A 2.5μsec @ +10 volts/8.0 MHz
  - IM6100 5μsec @ +5 volts/4.0 MHz
  - IM6100C 6μsec @ +5 volts/3.3 MHz
- Input-Output Instruction
  - IM6100A 4.25μsec @ +10 volts/8 MHz
  - IM6100 8.5μsec @ +5 volts/4.0 MHz
  - IM6100C 10.2μsec @ +5 volts/3.3 MHz
- Single-Clock, Single-Instruction Capability
- Direct Memory Access (DMA)
- Interrupt
- Dedicated Control Panel Features

Applications

- Intelligent Computer Terminals
- POS Terminals
- Portable Terminals
- Aerospace/Satellite System
- Automotive Systems
- Remote Data Acquisition Systems
- Process Control
- Instrumentation
- Medical Electronics
- Displays
- Traffic Control
- Navigation

IM6101 CMOS Programmable Interface Element

The IM6101 Programmable Interface Element (PIE) is a low power silicon gate CMOS general purpose peripheral control device which provides addressing, interrupt and control for a variety of peripheral functions such as UARTs, FIFOs, Keyboards, etc. The PIE is designed to eliminate external logic. Data transfers between the Intersil IM6100 CMOS Microprocessor and the IM6101 are via IOT instructions, control lines and DX bus. Data transfers between peripheral devices and the DX bus are controlled by the PIE via 2 read, 2 write, 4 sense and 4 flag functions.

IM6102 CMOS Memory Extension/DMA/Interval Timer/Controller

IM6102 is a multiple function C-MOS peripheral device for the IM6100 microprocessor, providing the capabilities of Memory extension, DMA control, Interval Timing and Interrupt Control. This single power supply device allows the IM6100 to address up to 32K 12-bit words of memory by supplying all the required extended memory control registers and instructions.

The device, with the addition of a crystal connected directly to its pins, will provide programmable real time clock facilities to the user.

A simultaneous DMA controller capable of totally transparent operation is built into the IM6102. The controller transfers DMA data during idle bus periods avoiding the need to "steal cycle". Word count and current address registers may be initialized under program control. The DMA channel can be used to provide refresh timing for dynamic RAM memory array.

IM6102 status information is obtained by polling controller flags when interrupted, or by vectoring.

IM6103 CMOS 20-Bit Data Port

The IM6103 20-Bit Data Port is designed for IM6100 microprocessor applications that require a large number of input-output bits in parallel. The IM6103 eliminates the need for external output latches or tristate input buffers in small microcomputer systems.

IM6402/03 Universal Asynchronous Receiver/Transmitter (UART)

The IM6402 and IM6403 are CMOS/LSI components for interfacing computers or microprocessors to an asynchronous serial data channel. The receiver converts serial start, data, parity and stop bits to parallel data verifying proper code transmission, parity, and stop bits. The transmitter converts parallel data into serial form and automatically adds start, parity, and stop bits. The data word length can be 5, 6, 7 or 8 bits. Parity may be odd or even. Parity checking and generation can be inhibited. The stop bits may be one or two or one and one-half when transmitting 5 bit code.

IM6403 permits the use of an inexpensive external crystal for generating the transmit and receive clocks.

Development Support

1. IM6100 Microprocessor User's Manual

Look over our 134-page data book, "Intersil IM6100 CMOS 12 Bit Microprocessor." It covers in detail the microprocessor, the Intercept Prototyping System, the Intercept Jr. Tutorial System, and includes data sheets on all other members of the IM6100 CMOS family.

2. IM6100 CMOS Family Sampler

This is a fully documented, pre-packaged kit of components for an all-CMOS IM6100 microprocessor system. The 7-part kit includes IM6100, IM6101 PIE, IM6312 12K ROM, IM6403 UART and three IM6561 1K RAMs. $49 each. PC Board, $32.50 each.

3. Intercept Jr. Tutorial System

This complete one-card battery powered operating system includes multi-function keyboard, 8-digit LED display, 256 words of RAM, resident microinterpreter, provisions for modular expansion and instructions for $281. Options...1K x 12 CMOS RAM with battery back-up, 2K x 12 P/ROM, Serial I/O, Audio Cassette Interface and Tutorial Module.

4. Intercept Prototyping System

The Intercept Prototyping System is a complete microprocessor system with 4K words of CMOS memory with on-board battery back-up. It provides an easy means of prototyping the user's systems, developing software, and evaluating the IM6100 family in typical configurations. Price is $2,850. A library of papertape software is also available, including editor, assembler, debugging programs, floating point package, high level language, utility routines and diagnostic programs.

5. Floppy Disk Based Operating System

Intersil's 6970-IFDOS Floppy Disk Operating System provides all the hardware and software necessary for high speed program development, typically decreasing software development time by a factor of 10. Includes all Intercept software. Price $5,100.

CMOS RAM's

Organization	Max Access Time (ns)	No. of Pins	V_{cc} max (V)	I_{cc} Max (μA)	Pkg	Temp Range
4096 x 1						
IM6504/6505	200	18	7.0	0.2 (typ.)	D,J,F	C,I,M
1024 x 1						
IM6508/6518	460	16/18	8.0	100	D,J,F	C,I,M
IM6508-1/6518-1	300	16/18	8.0	10	D,J,F	I,M
IM6508A/6518A	150	16/18	12.0	500	D,J,F	I,M
IM6508A-1/6518A-1	95	16/18	12.0	100	D,J,F	I,M
256 x 4						
IM6551/61	360	18/22	8.0	100	D,J,F	I,M
IM6551A/61A	180	18/22	12.0	500	D,J,F	I,M
256 x 1						
IM6523	800	16	7.0	50	D,J,F	I,M
64 x 12						
IM6512	460	18	8.0	100	D,J,F	C,I,M
IM6512A	150	18	12.0	500	D,J,F	I,M

CMOS EPROMS

Organization	Max Access Time (ns)	No. of Pins	V_{cc} max (V)	I_{cc} max (μA)	Pkg	Temp Range	Remarks
1024 x 4							
IM6603	500	24	8.0	100	D,J	I	TBA 4Q '77
512 x 8							
IM6604	500	24	8.0	100	D,J	I	TBA 4Q '77

CMOS ROM's

Organization	Max Access Time (ns)	No. of Pins	V_{cc} max (V)	I_{cc} max (μA)	Pkg	Temp Range
1024 x 12						
IM6312	400	18	8.0	100	D,J	C,I,M
IM6312A	200	18	12.0	500	D,J	I,M

BIPOLAR PROM's

Organization	Max Access Time (ns)	No. of Pins	Output Type[1]	Pkg[2]	Temp
FPLA					
IM5200 48 Product Terms 14 Inputs, 8 Outputs	100	24	OC	J	C
32 x 8					
IM5600	50	16	OC	D,J,F	C,M
IM5610	50	16	TS	D,J,F	C,M
256 x 4					
IM5603A	60	16	OC	D,J,F	C,M
IM5623	60	16	TS	D,J,F	C,M
512 x 4					
IM5604	70	16	OC	D,J,F	C,M
IM5624	70	16	TS	D,J,F	C,M
512 x 8					
IM5605	70	24	OC	D	C,M
IM5625	70	24	TS	D	C,M

Note 1: OC-Open Collector Output
TS-Tri-State Output

Note 2: D: Ceramic Dual-In-Line
J: Cerdip Dual-In-Line
F: Ceramic Flat Package

Intersil is a major producer of memory components utilizing state of the art N-MOS, C-MOS, and P-MOS technologies.

Intersil has shipped over 20 million MOS and CMOS RAMs in the past eight years, and that number is increasing at a rate of 400 thousand a month.

Dynamic RAMS

Organization	Max Access Time (nS)	Min Read Cycle (nS)	Min Read/Mod Write Cycle (nS)	No. of Pins	Input Levels V_{IL}/V_{IH} (V)	Power Supplies (V)	Max Operating Power (mW)	Standby Power (mW)	Pkg (note 1)	Temp Range (note 2)
16384 x 1										
IM7116-3	200	375	375	16	.8/2.4	+12,±5	550	27	J	C
IM7116-4	250	375	375	16	.8/2.4	+12,±5	550	27	J	C
8192 x 1										
IM7008-10	150	300	370	22	.6/2.4	+12,±5	756	7	J	C
IM7008-11	200	400	520	22	.6/2.4	+12,±5	756	7	J	C
4096 x 1										
IM7027-1	120	250	325	16	.8/2.2	+12,±5	462	27	J	C
MK4027-2	150	320	325	16	.8/2.2	+12,±5	462	27	J	C
MK4027-3	200	375	420	16	.8/2.2	+12,±5	462	27	J	C
MK4027-4	250	375	480	16	.8/2.2	+12,±5	462	27	J	C
2048 x 1										
IM6003-11	350	575	575	22	−71.5	+3,−20	280	110	D,P	C
IM6003-10	460	695	695	22	−71.5	+35,−20	260	110	D,P	C
1024 x 1										
IM6002-11	150	250	N/A	18/22	1.0/19	+7,+20,+23	180	2	D	C

Static RAMS

Organization	Max Access Time (nS)	Min Read Cycle (nS)	No of Pins	Input Levels V_{IL}/V_{IH} (V)	Power Supplies (V)	Max Operating Power (mW)	Pkg (note 1)	Temp Range (note 2)
4096 x 1								
IM7141-2	200	200	18	.8/2.0	+5	370	J	C,M
IM7141-3	300	300	18	.8/2.0	+5	370	J	C,M
IM7141	450	450	18	.8/2.0	+5	370	J	C,M
IM7141L2	200	200	18	.8/2.0	+5	265	J	C
IM7141L3	300	300	18	.8/2.0	+5	265	J	C
IM7141L	450	450	18	.8/2.0	+5	265	J	C
1024 x 4								
2114-2	200	200	18	.8/2.0	+5	525	J	C
2114-3	300	300	18	.8/2.0	+5	525	J	C
2114	450	450	18	.8/2.0	+5	525	J	C
2114L2	200	200	18	.8/2.0	+5	370	J	C,M
2114L3	300	300	18	.8/2.0	+5	370	J	C,M
2114L	450	450	18	.8/2.0	+5	370	J	C,M
IM7114L2	200	200	18	.8/2.0	+5	265	J	C
IM7114L3	300	300	18	.8/2.0	+5	265	J	C
IM7114L	450	450	18	.8/2.0	+5	265	J	C
1024 x 1								
IM7001-12	60	180	22	.8/2.4	+15,+7,−3	525	D,P	C

Note 1: Package Types
D —Ceramic Dual-in-line
J —Cerdip Dual-in-line
P —Plastic Dual-in-line

Note 2: Temperature Ranges
C —Commercial Temperature: 0~70°C
I —Industrial Temperature: −25~+85°C
M—Military Temperature: −55~+125°C

NMOS/PMOS Cross Reference

Intersil	AMD	Fairchild	Intel	Mostek	National	NEC	Signetics	TI
6002								4062
6003					5262			
7027/4027		4027	2104A	4027		µ414		4027
7114/2114	9130*		2114		2114		2614	4045
7116		f 16K	2116	4116		µ416	2630	4070/71
7141	9140*			4104*	5257		2613	4044

*Functional Equivalent

Whatever your memory needs, from a simple off-the-shelf board to a sophisticated custom system, you can count on Intersil for innovative design, quality workmanship and on-time delivery. We would like to build a memory system for you.

Standard Products

The basic module: RAMSTAK

The basic stand-alone core replacement, utilizing NMOS silicon gate dynamic memories. Versatile, flexible, expandable. Built with either 4K 22 pin Intersil 7280 or 8K 22 pin Intersil 7008 (optional) for double density and greater speed at reduced per-bit power dissipation. Depopulation provides smaller capacities. TTL compatibility and a single external refresh signal make it easy to interface with most digital systems.

Specifications

RAM	WORDS	WORD LENGTH	CARD ACCESS	R/M/W CYCLE	R/W CYCLE
RAMSTAK 4K	16K 32K	16 to 20 bits 8 to 10 bits	275ns 275ns	650ns 650ns	500ns 500ns
RAMSTAK 8K	32K 64K	16 to 20 bits 8 to 10 bits	200ns 200ns	500ns 500ns	350ns 350ns

Features

- Independent asynchronous module—requires only external refresh signal.
- ±15V, +5V operation or optional +12V, ±5V.
- Versatile organization options.
- Expandability—stackable up to 8 cards per rack, without external decode.
- Maintainability—sockets for reduced spares requirements.
- Independent byte control—flexible Read/Modify/Write operations (accommodates external ECC).
- Low cost.
- Low power consumption—just 0.1 mW per bit operating, and 0.06 mW/bit standby.

Modular Memory Systems

Complete systems, rack mountable for memories from 32K to 2048K built with 4K 16 pin Intersil 7027 or 16K, 16 pin, 7116 NMOS silicon gate RAMs. Power supplies are included and the unit features an ECC (Error Checking and Correction) option. Versatile, flexible, expandable and reliable.

Specifications

RAM	MAX WORDS	WORD LENGTH	SYSTEM ACCESS	SYSTEM CYCLE
4K	572K	22 bits	240 NS	350 NS
16K	2048K	22 bits	350 NS	425 NS

Features

- Fast access time, as low as 240ns.
- Parity or ECC option.
- Battery backup option.
- Stackable up to 8 modules (or provided in a single chassis).
- Rack mountable.
- Byte write available.
- Integral power supply & fans.
- Customized interface.
- Optional self-check diagnostic.
- Low cost.
- Low power dissipation.
- 4 Megabytes (2048K words up to 22 bits wide).

Benefits

- Universal core replacement.
- Flexible interface and organization
- Expandable.
- Reliable.
- Maintainable.
- High performance.
- Optional capacity.
- Low cost.
- Proven design.

Power Saver Series—CMOS

The Intersil Power Saver Card provides up to 16K bytes of low power CMOS memory on a single 7" x 14" card. Utilizing Intersil's IM6508, 1K x 1, CMOS RAM, the series offers a variety of performance advantages including 300 nanosecond access and CMOS/TTL compatibility which meets the interface requirements of most popular microprocessors.

Features:

- Capacity—to 16K x 8
- Low power operation
- On board batteries for 20 days operation
- Fully static—no refresh required
- Operating temperature range—0-60°C
- MTBF—20,000 hours
- Ideal Microprocessor Interface
- TTL or CMOS Logic Interface
- Single +5V power supply

Custom Products

Custom requirements come easy

Pick your RAMs, the organization you need, your access and cycle times and leave the rest to us. We are specialists in solving RAM memory problems and we have the capacity and the capability to meet your memory requirements quickly, inexpensively and reliably. With more than seven hundred megabytes of installed semiconductor memory behind us (more than any other independent add-on manufacturer), we're in a unique position to sell a broad range of field-proven, demonstrated reliable memory cards and subsystems. We've got the costs down and performance up. With our expertise in testing, our unique production/process flows, and the fact that we burn in all cards and subsystems, there isn't a better qualified source in the industry for your conversion from core to semiconductor memory. We do the engineering and deliver a reliable product at a highly competitive price. You save time and money, and a lot of headaches.

When your memory development program is taking too long, costing too much, or tying up your engineering staff, Intersil solves the problem or offers the solutions.

The translating of analog information into digital signals and vice versa for display, data logging, data transmission and feedback control has become increasingly important as monitoring, digital control and computational techniques are applied to industrial, commercial and military analysis and control applications. Intersil offers the design engineer an extensive array of data conversion products with an outstanding range of performance characteristics for these applications.

Integrating Analog-to-Digital Converters for Display

Maximum Electrical Specification at +25°C unless otherwise noted.

	Single Chip		**Two Chip System**					
Model	**New ICL7106**	**New ICL7107**	**ICL8052/ ICL8053**	**ICL8052A/ ICL8053A**	**ICL8052/ ICL7101**	**ICL8052/ ICL7103**	**ICL8052A/ ICL7103A**	**LD 110/LD 114/ LD 111**
Resolution	± 3½ digit	± 3½ digit	Depends on counter used	Depends on counter used	± 3½ digit	± 3½ digit	± 4½ digit	± 3½ digit
Accuracy								
Nonlinearity	± 1 count	± 1 count	± 0.002%	± 0.002%	± 1 count	± 1 count	± 1 count	± 1 count
Zero Input Reading	± 0.000	+ 0.000	± 0.0000	± 0.0000	± 0.000	± 0.000	± 0.0000	± 0.000
Ratiometric Reading	+ 1.000,	+ 1.000,	+ 1.0000,	+ 1.0000,	+ 1.000,	+ 1.000,	+ 1.0000,	+ 1.000,
(Ratiometric)	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count
Rollover Error	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count
Stability								
Offset vs Temperature	1 μV/°C	1 μV/°C	5 μV/°C	5 μV/°C	5 μV/°C	5 μV/°C	2 μV/°C	—
Gain vs Temperature	5 ppm/°C	5 ppm/°C	15 ppm/°C	5 ppm/°C	15 ppm/°C	15 ppm/°C	5 ppm/°C	—
Conversion Rate	0.1 to 15 conv/sec	0.1 to 15 conv/sec	0.1 to 30 conv/sec	0.1 to 30 conv/sec	0.1 to 30 conv/sec	0.1 to 30 conv/sec	0.1 to 30 conv/sec	0.3 to 12 conv/sec
Analog Input								
Voltage Range	± 200mV to ± 2V	± 200mV to ± 2V	± 2V	± 2V	± 200mV to ± 2V	± 200mV to ± 2V	± 2V	± 2V
Impedance	$10^{12}\Omega$	$10^{12}\Omega$	$10^{9}\Omega$	$10^{9}\Omega$	$10^{9}\Omega$	$10^{9}\Omega$	$10^{9}\Omega$	$10^{9}\Omega$
Leakage Current	2pA	2pA	30pA	10pA	30pA	30pA	10pA	40pA typ
Noise (peak-to-peak)	15μV typ	15μV typ	20μV typ[1]	20μV typ[1]	20μV typ[1]	20μV typ[1]	20μV typ[1]	—
Digital Outputs								
Format	7 segment LCD display	7 segment LED display	Depends on counter used	Depends on counter used	Latched Parallel BCD	Multiplex BCD	Multiplex BCD	Multiplex BCD
Logic Level	AC: 4.5V down from V+	11, Comm Anode DTL/TTL/CMOS	Depends on counter used	Depends on counter used	TTL/CMOS	TTL/CMOS	TTL/CMOS	TTL/CMOS
Power Supply								
Voltage	+ 9V	± 5V	± 15V; +5V	± 15V; +5V	± 15V; +5V	± 15V; +5V	± 15V; +5V	±15; +5V
Current	1.8mA	1.8mA	12mA	12mA	17mA; 25mA	18mA; 30mA	18mA; 30mA	27mA; 24mA
Package	40pin DIP	40pin DIP	(2) 14 pin DIP	(2) 14 pin DIP	16 pin DIP 40 pin DIP	16 pin DIP 24 pin DIP	16 pin DIP 24 pin DIP	(2) 16 pin DIP

[1]Low Noise ICL8052 (typically 2μV peak-to-peak) designated ICL8052LN Available 1st Qtr. 1978

Integrating Analog-to-Digital Converters for Data Acquisition

Model	**New ICL8052/[2] ICL7104-12**	**New ICL8052A/[2] ICL7104-14**	**New ICL8052A/[2] ICL7104-16**	**ICL8052/ ICL7101**	**ICL8052/ ICL7103**	**ICL8052A/ ICL7103A**	**LD111/LD114**	**ICL8052/ ICL8053**
Resolution	± 12 Bit Binary	± 14 Bit Binary	± 16 Bit Binary	± 3½ digit BCD	± 3¼ digit BCD	± 4½ digit BCD	± 3½ digit BCD	up to ±40000 counts
μP Compatible	yes	yes	yes	yes	yes	yes	yes	yes
Output	Programmable: 1. Latched parallel three state Binary 2. Controlled 2-8 bit byte for ICL7104-12/14 3-8 bit byte for ICL7104-16			Latched Parallel BCD	Multiplexed BCD	Multiplexed BCD	Multiplexed BCD	Interface to MOS, TTL, μP
Control Lines	Start/Convert, Busy, Byte Enables, Mode, Load, Send Enable Out of Range			Start/Convert Busy, Out of Range	Start/Convert Busy, Strobe Out of Range Underrange	Start/Convert Busy, Strobe Out of Range Underrange	Continuous Conversion Measure/Zero, Comparator Output, up/down output Latch inhibit, Digit phase, Bit phase, Scan	Auto-zero, Signal Integrate Two Reference, Integrate, and Comparator Output
UART Compatible	yes	yes	yes	no	yes	yes	yes	no

[2]Accuracy of ICL8052/ICL7104 Family same as ICL8052A/ICL8053A

Digital-to-Analog Converters

Maximum Electrical Specification at +25°C unless otherwise noted

	R-2R Ladder Multiplying Type					**Integrating Type**		
Model	**New AD 7530**	**New AD 7520**	**New ICL 7113**	**New AD 7531**	**New AD 7521**	**New ICL 7105-12***	**New ICL 7105-14***	**New ICL 7105-16***
Resolution	10 bit	10 bit	3 digit	12 bit	12 bit	12 bit	14 bit	16 bit
Accuracy	J/K/L	J/K/L	B/A	J/K/L	J/K/L			
Linearity	0.2%/0.1%/0.05%	0.2%/0.1%/0.05%	0.2%/0.05%	0.2%/0.1%/0.05%	0.2%/0.1%/0.05%	0.05%	0.002%	0.001%
Zero Offset	300 nA	200 nA	200 nA	300 nA	200 nA	100 nA typ	100 nA typ	100 nA typ
Full Scale Reading	0.3% typ	0.3% typ	0.3% typ	0.3% typ	0.3%	0.01%	0.003%	0.001%
Stability								
Gain vs. Temperature	10 ppm/°C	10 ppm/°C	10 ppm/°C	10 ppm/°C	10 ppm/°C	5 ppm/°C typ	5 ppm/°C typ	5 ppm/°C typ
Linearity vs. Temperature	2 ppm/°C	2 ppm/°C	2 ppm/°C	2 ppm/°C	2 ppm/°C	1 ppm/°C typ	1 ppm/°C typ	1 ppm/°C typ
Settling Time to ± 0.05% of F.S.	500 ns typ	500 ns typ	500 ns typ	500 ns typ	500 ns typ	TBA	TBA	TBA
Input Code								
Logic Compat- ibility option	DTL/TTL/CMOS Binary Offset Binary	DTL/TTL/CMOS Binary Offset Binary	DTL/TTL/CMOS BCD	DDT/TTL/CMOS Binary Offset Binary	DTL/TTL/CMOS Binary Offset Binary	DTL/TTL/CMOS Double-Buffered Binary	DTL/TTL/CMOS Double-Buffered Binary	DTL/TTL/CMOS Double-Buffered Binary
Power Supply								
Voltage	+5 to +15V	+5 to +15V	+5 to +15V	+5 to +15V	+5 to +15V	±15V to +5V	±15V to +5V	±15V to +5V
Current	2mA	2mA	2mA	2mA	2mA	TBA	TBA	TBA
Package	16 pin DIP	16 pin DIP	18 pin DIP	18 pin DIP	18 pin DIP	40 pin DIP	40 pin DIP	40 pin DIP

*Available 1st Qtr. 1978

TBA—To Be Announced

Multiplexers

The Intersil IH 5060 and IH 5070 are CMOS Monolithic Multiplexers. In data acquisition systems, these devices will switch up to 16 single-ended or 8 differential analog channels, respectively, for digitizing by a single analog-to-digital converter. Channel selection is controlled by a four line binary input in addition to a system enable line.

Maximum Electrical Specification @ −25°C Unless Otherwise Noted

Model	IH 5060	IH 5070
Number of Channels	16 Singled-ended	8 Differential
"ON" resistance	400 Ω	400 Ω
"OFF" Isolation	60 db @ 500 KHz	60 db @ 500 KHz
Switching Time		
"ON"	1.5 μs	1.5 μs
"OFF"	1 μs	1 μs
Overvoltage Protection	± 25V	± 25V
Analog Signal Range	± 15V	± 15V
Break Before-Make Switching	yes	yes
Logic Compatibility	DDL/TTL/CMOS	DTL/TTL/CMOS
Power Supply		
Voltage	± 15V	± 15V
Current	200 μA	200 μA
Package	28 pin DIP	28 pin DIP

Sample and Hold

The sample and hold is predominently used to hold the data constant for successive approximation analog-to-digital converters. The IH 5110 and IH 5111 are complete Sample and Hold circuits, (except for sampling capacitor). The input logic is designed to "Sample" and "Hold" from standard TTL logic levels. The primary difference between the IH 5110 and IH 5111 is input voltage swing, which for IH 5110 is 10V pp and for the IH 5111 is 20V pp.

Maximum Electrical Specification @ 25°C unless otherwise noted.

Model	IH 5110	IH 5111
Vanalog	10V pp	20V pp
Input Impedence	10^8 Ω @ 10Hz	10^8 Ω @ 10Hz
Gain	+ 1	+ 1
Sample Accuracy	0.1%	0.1%
Slew Rate	6V/μs typ	6V/μs typ
Acquisition Time	6 μs; Cs = 0.001 μF 10V step	6 μs; Cs = 0.001 μF 10V step
Output Droop Rate	4mV/sec; Cs = 1 μF	4mV/sec; Cs = 0.1 μF
Aperture Delay	200 ns	200 ns
Charge Injection	5mV pp; Cs = 0.1 μF	5mV; Cs = 0.1 μF
Power Supply		
Voltage	± 15V	± 15V
Current	6 mA	6 mA
Package	16 pin DIP	16 pin DIP

Power Op-Amps

In addition to Intersil's wide variety of operational amplifiers, which can be used for converting current output Digital-to-Analog converters to voltage output, signal simulation, analog filtering or buffering, here are three members in the power field. These power op amps can operate on power supplies up to ± 30V and deliver at least 1 amp (ICH8510), 2 amps (ICH 8520) or 2.7 amps (ICH 8530) output current. Applications for these amplifiers are x-y plotters, D.C. servo motors, power servo loops, digitally programmable power supplies and D.C. actuators.

Maximum electrical specification @ + 25°C unless otherwise noted.

Model	ICH 8510	ICH 8520	ICH 8530
Input Characteristics			
Offset voltage			
at +25°C	± 3mV	± 3mV	± 3mV
−55 to +125°C	± 9mV	± 9mV	± 9mV
Offset current			
at +25°C	100 nA	100 nA	100 nA
−55 to +125°C	200 nA	200 nA	200 nA
Common Mode Range	± 10V	± 10V	± 10V
CMRR	70 dB	70 dB	70 dB
Large Signal Voltage Gain	100 dB	100 dB	100 dB
Frequency Response			
Small Signal Bandwidth	300 kHz typ	300 kHz typ	300 kHz typ
Full Power Bandwidth	10 kHz typ	10 kHz typ	10 kHz typ
Slew Rate	0.5V/μs	0.5V/μs	0.5V/μs
Output Characteristics			
Voltage	± 26V	± 26V	± 25V
Current	1 amp	2 amp	2.7 amp
Protection	Against inductive kickback or short circuits		
Power Supply			
Voltage	± 5V to ± 30V	± 5V to ± 30V	± 5V to ± 30V
Current	40 mA	40 mA	40 mA
Package	8 lead TO−3	8 lead TO−3	8 lead TO−3

Low Voltage References

The ICL8069 is a 1.2V temperature compensated voltage reference. It uses the band-gap principal to achieve excellent stability and low noise at reverse currents down to 50 μA. Applications include analog-to-digital converters, digital-to-analog converters, and voltage regulators. Its low power consumption makes it especially suitable for battery operated equipment.

Maximum electrical specifications at +25°C unless otherwise noted.

MODEL	ICL8069B	ICL8069C
Reverse Voltage	1.23V typ.	1.23V typ.
Reverse Voltage Temp. Coefficient	50ppm/°C	100ppm/°C
Reverse Voltage Change for 50 μA ≤ I_R ≤ 5mA	20mV	20mV
Reverse Dynamic Impedance	2Ω	2Ω
Reverse Current	50 μA to 5 mA	50 μA to 5 mA

Intersil makes a broad range of monolithic linear circuits for most applications including filters, signal amplification and conditioning, data acquisition and conversion, comparators, power amplification and voltage regulators.

Operational Amplifiers—General Purpose

Type	Description	V_{os} (mV)	I_b (nA)	A_{VOL} (V/V)	GxB/W (MHz)	I_{cc} (mA)	T_A (°C)	Packages	Remarks
101A	Gen Purpose, Uncompensated	2.0	75	50,000	0.8*	3.0	−55,+125	J,F,T	
101ALN	Guaranteed Noise 101A	2.0	75	50,000	0.8*	3.0	−55,+125	J,F,T	50nV/√Hz @ 10Hz
107	Gen Purpose, Compensated	2.0	75	50,000	—	3.0	−55,+125	T	
108	Low Level, Uncompensated	2.0	2.0	50,000	1.0*	0.6	−55,+125	J,F,T	
108A	Low offset 108	0.5	2.0	80,000	1.0*	0.6	−55,+125	J,F,T,	
108LN	Guaranteed Noise 108	2.0	2.0	50,000	1.0*	0.6	−55,+125	T	70nV/√Hz @ 10Hz
124	Quad, Compensated	5.0	300	100,000*	1.0*	2.0	−55,+125	J	
148	Quad 741, Compensated	5.0	100	50,000	0.9*	3.6	−55,+125	J,F	
149	148 Compensated for $A_V \geq 5$	5.0	100	50,000	3.0*	3.6	−55,+125	J,F	
207	Low bias, Compensated	2.0	75	50,000	—	3.0	−25,+85	T	
208	Low level, Uncompensated	2.0	2.0	50,000	1.0*	0.6	−25,+85	J,F,T	
208A	Low offset 208	0.5	2.0	80,000	1.0*	0.6	−25,+85	J,F,T	
224	Quad, Compensated	7.0	500	100,000*	1.0*	2.0	−25,+85	J	
248	Quad 741, Compensated	6.0	200	25,000	0.9*	4.5	−25,+85	J	
249	248 Compensated for $A_V \geq 5$	6.0	200	25,000	3.0*	4.5	−25,+85	J	
301A	Gen Purpose, Uncompensated	7.5	250	25,000	0.8*	3.0	0,+70	P,T	
301ALN	Guaranteed noise 301A	7.5	250	25,000	0.8*	3.0	0,+70	P,T	50nV/√Hz @ 10Hz
307	Low bias, Compensated	7.5	250	25,000	—	3.0	0,+70	P,T	
308	Low level, Uncompensated	7.5	7.0	25,000	1.0*	0.8	0,+70	F,J,P,T	
308A	Low offset 308	0.5	7.0	80,000	1.0*	0.8	0,+70	J,T	
308LN	Guaranteed noise 308	7.5	7.0	25,000	1.0*	0.8	0,+70	T	70nV/√Hz @ 10Hz
324	Quad, Compensated	7.0	500	100,000*	1.0*	2.0	0,+70	J,P	
348	Quad 741, Compensated	6.0	200	25,000	0.9*	4.5	0,+70	J,P	
349	348 Compensated for $A_V \geq 5$	6.0	200	25,000	3.0*	4.5	0,+70	J,P	
741	Gen Purpose, Compensated	5.0	500	50,000	1.0*	2.8	−55,+125	T	
741C	Gen Purpose, Compensated	6.0	500	25,000	1.0*	2.8	0,+70	P,T	
741HS	Guaranteed Slew Rate 741	5.0	500	50,000	1.0*	2.8	−55,+125	J,T	Slew Rate 0.7V/µS
741CHS	Guaranteed Slew Rate 741C	6.0	500	25,000	1.0*	2.8	0,+70	P,T	Slew Rate 0.7V/µS
741LN	Guaranteed Noise 741	5.0	500	50,000	1.0*	2.8	−55,+125	J,F,T	50nV/√Hz @ 10Hz
741CLN	Guaranteed Noise 741C	6.0	500	25,000	1.0*	2.8	0,+70	P,T	50nV/√Hz @ 10Hz
8008M	Low bias current, Compensated	5.0	10	20,000	1.0*	2.8	−55,+125	J,T	
8008C	Low bias current, Compensated	6.0	25	20,000	1.0*	2.8	0,+70	J,P,T	

Operational Amplifiers—Low Power Programmable

Type	Description	V_{os} (mV)	I_b (nA)	A_{VOL} (V/V)	GxB/W (MHz)	I_{cc} (µA)	at I_{set} (µA)	at V_s (V)	T_A (°C)	Packages
4250C	Programmable, Compensated	5.0	10	25,000	—	8.0	1	± 1.5	0,+70	T
		6.0	75	25,000		90	10	± 1.5		
8021M	Programmable, Compensated	3.0	20	50,000	0.27	40	30	± 6.0	−55,+125	J,T
8021C	Programmable, Compensated	6.0	30	50,000	0.27	50	30	± 6.0	0,+70	T
8022M	Dual 8021M	3.0	20	50,000	0.27	40	30	± 6.0	−55,+125	J,F
8022C	Dual 8021C	6.0	30	50,000	0.27	50	30	± 6.0	0,+70	J,P
8023M	Triple 8021M	3.0	20	50,000	0.27	40	30	± 6.0	−55,+125	J
8023C	Triple 8021C	6.0	30	50,000	0.27	50	30	± 6.0	0,+70	J,P

Operational Amplifiers—F.E.T. Input

Type	Description	V_{os} (mV)	I_b (pA)	A_{VOL} (V/V)	GxB/W (MHz)	Slew Rate V/S	I_{cc} (mA)	T_A (°C)	Packages	Remarks
LF155	BIFET, Compensated	5	100	50,000	2.5*	5*	4	−55,+125	T	
LF155A	BIFET, Compensated	2	50	50,000	2.5*	3	4	−55,+125	T	
LF156	BIFET, Compensated	5	100	50,000	5*	7.5	7	−55,+125	T	
LF156A	BIFET, Compensated	2	50	50,000	4	10	7	−55,+125	T	
LF157	BIFET, Compensated for $A_V \geq 5$	5	100	50,000	20*	30	7	−55,+125	T	All BIFET amplifiers
LF157A	BIFET, Compensated for $A_V \geq 5$	2	50	50,000	15	40	7	−55,+125	T	offer low noise—
LF255	BIFET, Compensated	5	100	50,000	2.5*	5*	4	−25,+85	T	See data sheets
LF256	BIFET, Compensated	5	100	50,000	5*	7.5	7	−25,+85	T	
LF257	BIFET, Compensated for $A_V \geq 5$	5	100	50,000	20*	30	7	−25,+85	T	
LF355	BIFET, Compensated	10	200	25,000	2.5*	5*	4	0,+70	T,P	
LF355A	BIFET, Compensated	2	50	50,000	2.5*	3	4	0,+70	T,P	
LF356	BIFET, Compensated	10	200	25,000	5*	12*	10	0,+70	T,P	
LF356A	BIFET, Compensated	2	50	50,000	4	10	7	0,+70	T,P	
LF357	BIFET, Compensated for $A_V \geq 5$	10	200	25,000	20*	50*	10	0,+70	T,P	
LF357A	BIFET, Compensated for $A_V \geq 5$	2	50	50,000	15	40	7	0,+70	T,P	
740M	General Purpose	20	200	50,000	3*	6*	5.2	−55,+125	T	
740C	General Purpose	110	2000	20,000	1*	6*	8.0	0,+70	T	
8007M	General Purpose, Compensated	20	20	50,000	1.0*	6*	5.2	−55,+125	T	
8007AM	8007M, Low I_b	30	1.0	20,000	1.0*	2.5	6	−55,+125	T	
8007C	General Purpose, Compensated	50	50	20,000	1.0*	6*	6	0,+70	T	
8007AC	8007C, Low I_b	30	1.0	20,000	1.0*	2.5	6	0,+70	T	
8007M-5	8007M, Low V_{os}, I_b	10	10	50,000	1.0*	3.0	5.2	−55,+125	T	15µV/°C
8007C-4	8007C, Low V_{os}, Offset Null	10	10	50,000	1.0*	3.0	6	0,+70	T	10µV/°C
8007C-5	8007C, Low V_{os}, Offset Null	10	10	50,000	1.0*	3.0	6	0,+70	T	15µV/°C
8043M	Dual 8007M	20	20	50,000	1.0*	6.0*	6	−55,+125	J	
8043C	Dual 8007C	50	50	20,000	1.0*	6.0*	6.8	−55,+125	J,P	
8500	MOSFET Input, Compensated	50	0.1	20,000	0.7*	0.5*	2.7*	−25,+85	T	
8500A	MOSFET Input, Super Low I_b	50	0.01	20,000	0.7*	0.5*	2.7*	−25,+85	T	

Operational Amplifiers—High Speed

Type	Description	V_{os} (mV)	I_b (nA)	A_{VOL} (V/V)	GxB/W (MHz)	Slew Rate V/μS	I_{cc} (mA)	T_A (°C)	Packages
HA2500	High slew rate, Compensated	5.0	200	20,000	12*	25	6.0	−55,+125	F,T,J
HA2502	High slew rate, Compensated	8.0	250	15,000	12*	20	6.0	−55,+125	F,T,J
HA2505	High slew rate, Compensated	8.0	250	15,000	12*	20	6.0	0,+75	F,T
HA2510	High slew rate, Compensated	8.0	200	10,000	12*	50	6.0	−55,+125	F,T
HA2512	High slew rate, Compensated	10.0	250	7,500	12*	40	6.0	−55,+125	F,T
HA2515	High slew rate, Compensated	10.0	250	7,500	12*	40	6.0	0,+75	F,T
HA2520	Compensated for $A_V \geq 3$	8.0	200	10,000	30*	100	6.0	−55,+125	F,T,J
HA2522	Compensated for $A_V \geq 3$	10.0	250	7,500	30*	80	6.0	−55,+125	F,T,J
HA2525	Compensated for $A_V \geq 3$	10.0	250	7,500	30*	80	6.0	0,+75	F,T,J
8017M	High speed, Inverting	5.0	200	25,000	10*	130*	7.0	−55,+125	T,F
8017C	High speed, Inverting	7.0	200	25,000	10*	130*	8.0	0,+70	T,F

Operational Amplifiers—High Impedance

Type	Description	V_{os} (mV)	I_b (nA)	A_{VOL} (V/V)	Slew Rate (V/μS)	I_{cc} (mA)	T_A (°C)	Packages
HA6200	High impedance, Compensated	4.0	10	100,000	4	3.7	−55,+125	F,J,T
HA2602	High impedance, Compensated	5.0	25	80,000	4	4.0	−55,+125	F,J,T
HA2605	High impedance, Compensated	5.0	25	80,000	4	4.0	0,+75	F,J,T
HA2620	2600 Compensated for $A_V \geq 5$	4.0	15	100,000	25	3.7	−55,+125	F,J,T
HA2622	2602 Compensated for $A_V \geq 5$	5.0	25	80,000	20	4.0	−55,+125	F,J,T
HA2625	2605 Compensated for $A_V \geq 5$	5.0	25	80,000	20	4.0	0,+75	F,J,T

Video Amplifiers

Type	Description	Gains (V/V)	Bandwidths (MHz)	E_N (IN) μV (rms)	Output Offset (V)	I_{cc} (mA)	T_A (°C)	Packages
733M	Gain selectable video amp.	400,100,10*	40,90,120*	12	1.5	24	−55,+125	T
733C	Gain selectable video amp.	400,100,10*	40,90,120*	12	1.5	24	0,+70	T

Operational Amplifiers—Military, JAN 38510

Part No.	Industry Type	V_{os} (mV)	$\Delta V_{os}/\Delta t$ (μV/°C)	I_{os} (nA)	$\Delta I_{os}/\Delta t$ (nA/°C)	I_b (nA)	A_{VOL} (V/V)	GxB/W (MHz)	S.R. (V/μS)	T_A (°C)	Packages
JM38510/10101	741	3.0	15	30	0.5	110	50,000	0.43	0.3	−55,+125	T

Voltage Followers

Type	Description	V_{os} (mV)	I_{IN} (nA)	A_V (MIN) (V/V)	3db B/W (MHz)	Slew Rate (V/μS)	Swing (V)	I_{cc} (mA)	T_A (°C)	Packages
102	Voltage Follower	5	10	0.999	—	—	±10	4.0	−55,+125	F,T
110	Voltage Follower	4	3	0.999	—	—	±10	—	−55,+125	D,F,T
202	Voltage Follower	10	15	0.999	—	—	±10	—	−25,+85	T
210	Voltage Follower	4	3	0.999	15*	30*	±10	4.0	−25,+85	D,T
302	Voltage Follower	15	30	0.9985	15*	30*	±10	4.0	0,+70	T
310	Voltage Follower	7.5	7	0.999	15*	30*	±10	—	0,+70	D,P,T

Comparators

Notes: Tpd measured for 100mV step with 5mV overdrive.
I_{cc} measured for V_s = ±15V

Type	Description	V_{os} (V)	I_b (nA)	A_V (V/mV)	Tpd (nS)	I_{cc} (mA)	V_{OL} (V) at	I_{OL} (mA)	T_A (°C)	Packages
111	Precision Comparator	3	100	200*	200*	6	0.4	8	−55,+125	D,F,T
211	Precision Comparator	3	100	200*	200*	6	0.4	8	−25,+85	D,F,T
311	Precision Comparator	7.5	250	200*	200*	7.5	0.4	8	0,+70	D,F,J,P,T
8001M	Low Power Comparator	3	100	15	250*	2	0.5	2	−55,+125	T
8001C	Low Power Comparator	5	250	15	250*	2	0.4	2	0,+70	T
LM139	Quad. Comparator	5	100	200*	1300*	2	0.7	4	−55,−125	D
LM139A	Low Offset 139	2	100	200*	1300*	2	0.4	3	−55,+125	D
LM239	Quad. Comparator	5	250	200*	1300*	2	0.7	4	−25,+85	D
LM239A	Low Offset 239	2	250	200*	1300*	2	0.4	3	−25,+85	D
LM339	Quad. Comparator	5	250	200*	1300*	2	0.7	4	0,+70	D,P
LM339A	Low Offset 339	2	250	200*	1300*	2	0.4	3	0,+70	D,P

Power Amplifiers—Servo & Actuator

Note 1. Specifications apply at ±30V supplies.
2. All units packaged in 8 lead TO3 can.
3. Fully protected against inductive current flow.
4. Externally settable output current limiting.

Type	Description	Output Current (A)	Output Swing (V)	V_{os} (mV)	I_b (nA)	A_{VOL} (V/V)	Slew Rate (V/μS)	Quiescent I_{cc} (mA)	T_A (°C)
IH8510M	Hybrid Power Amp.	1.0	± 26	3.0	250	100,000	0.5	40	−55, +125
IH8510C	Hybrid Power Amp.	1.0	± 26	6.0	500	100,000	0.5	50	−25, +85
IH8520M	Hybrid Power Amp.	2.0	± 26	3.0	250	100,000	0.5	40	−55, +125
IH8520C	Hybrid Power Amp.	2.0	± 26	6.0	500	100,000	0.5	50	−25, +85
IH8530M	Hybrid Power Amp.	2.7	± 25	3.0	250	100,000	0.5	40	−55, +125
IH8530C	Hybrid Power Amp.	2.7	± 25	6.0	500	100,000	0.5	50	−25, +85

Voltage Regulators

Type	Input Voltage (V)		Output Voltage (V)		Input/Output Differential (V)		Load Current (mA)		Load Reg* O-F.L (%)	Line Reg* (%/V)	Avg. Temp Coeff (%/°C)	Pd at 25°C (mW)	T_J (°C)	Packages
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX						
100	8.5	40	2.0	30	3.0	30	3.0	12	0.5	0.2	0.005	500	−55, +150	F,T
105	8.5	50	4.5	40	3.0	30	0	12	0.05	0.06	0.005	500	−55, +150	F,T
300	8.0	30	2.0	20	3.0	20	3.0	12	0.5	0.2	0.03	300	0, +70	T
305	8.0	40	4.5	30	3.0	30	0	12	0.05	0.06	0.03	500	0, +70	T
723	9.5	40	2.0	37	3.0	38	0	50	0.15	0.03	0.015	800	−55, +125	T,J
723C	9.5	40	2.0	37	3.0	38	0	50	0.2	0.03	0.015	660	0, +70	P,T

Special Function Circuits

Type		Accuracy	V_s (V)	T_A (°C)	Packages
SE555	Precision R-C monostable/astable timer/multivibrator,		4.5 to 18	−55, +125	J,T
NE555	triangular plus square wave outputs available		4.5 to 16	0, +70	P,T
SE556	Dual SE555		4.5 to 18	−55, +125	J
NE556	Dual NE555		4.5 to 16	0, +70	P
AM2502	4, 8, and 12 bit Successive		−0.5 to +7.0	−55, −125	J,F,T
	Approximation Registers		−0.5 to +7.0	0, −70	P
AM2503	can be used as Serial to Parallel		−0.5 to +7.0	−55, +125	J,F,T
	counter or ring counters. Contains		−0.5 to −7.0	0, +70	P
AM2504	all storage and control for SAR A to D		−0.5 to +7.0	−55, +125	J,F,T
	convertors		−0.5 to +7.0	0, +70	P
8013AM	Four quadrant multiplier. Output proportional to algebraic products	± 0.5%	± 15	−55, +125	T
8013BM	of two input signals. Features ±0.5% accuracy; internal op-amp	± 1.0%	± 15	−55, +125	T
8013CM	for level shift, division and square root functions; full ±10V	± 2.0%	± 15	−55, +125	T
8013AC	input/output range; 1MHz bandwidth.	± 0.5%	± 15	0, +70	T
8013BC		± 1.0%	± 15	0, +70	T
8013CC		± 2.0%	± 15	0, +70	T
8018	High speed precision current switch		±20V	−55, +125	J
	for use in current summing		±20V	0, +70	P
8019	D to A convertors. Can be purchased		±20V	−55, +125	J
	individually or in matched sets with		±20V	0, +70	P
8020	accuracies of 0.01% (8018), 0.1% (8019), 1.0% (8020)		±20V	−55, +125	J
			±20V	0, +70	P
8038AM	Simultaneous Sine, Square, and Triangle wave outputs T²L	1.5%	± 5 to ±15	−55, +125	J
8038AC	compatible to 28V over frequency range from 0.001 Hz to 1.0 MHz.	1.5%	± 5 to ±15	0, +70	P
8038BM	Low distortion (<1%); high linearity (0.1%); low frequency drift with	3.0%	± 5 to ±15	−55, +125	J
8038BC	temperature (50ppm/°C max.), variable duty cycle (2%-98%).	3.0%	± 5 to ±15	0, +70	P
8038CC	External frequency modulation.	5.0%	± 5 to ±15	0, +70	P
8048BC	Log amp. 1V/decade (Adjustable). 120 db range	± 30mV	± 15	0, +70	J,P
8048CC	with current input. Error referred to output	± 60mV	± 15	0, +70	J,P
8049BC	Antilog amp, adjustable scale factor.	± 10mV	± 15	0, +70	J,P
8049CC	Error referred to input	± 30mV	± 15	0, +70	J,P
8211M	Micropower voltage detector/indicator/voltage regulator/		2 to 30	−55, +125	T
8211C	programmable zener. Contains 1.15V micropower reference		2 to 30	0, −70	P,T
8212M	plus comparator and hysteresis output. Main output		2 to 30	−55, +125	T
8212C	inverting (8212) or non-inverting (8211).		2 to 30	0, −70	P,T
8240	Programmable Timers/Counters using		4V to 18V	−55, +125	J
	external R/C time base set. Programmable		4V to 18V	0, +70	P
8250	from minutes to days. Selectable output		4V to 18V	−55, +125	J
	count 1RC to 255RC (8240), 1RC to		4V to 18V	0, +70	P
8260	99RC (8250), 1RC to 59RC (8260)		4V to 18V	−55, +125	J
	hr. accuracy = ±0.5% typ and low drift =		4V to 18V	0, +70	P
	±100 ppm/°C typ.				

Notes: 1. All parameters are specified at V_s = ±15V and T_A = +25°C unless otherwise noted.
2. All parameters are worst case MIN/MAX limits except for those marked * which are typical.

PACKAGE KEY
D —Solder lid side brazed ceramic dual in line.
F —Ceramic flat pack.
J —Glass frit seal ceramic dual in line.
P —Plastic dual in line.
T —Metal can (TO5 size)

Intersil produces a broad line of discrete devices which includes single and monolithic Dual Field Effect Transistors of both the junction and MOS type, and high performance monolithic dual NPN and PNP bipolar transistors.

All devices are 100% visually pre-cap inspected to Military Standard 750, method 2072. The guaranteed quality assurance level is 5% lot tolerance percent defective.

Switches—Junction FET

Ordering Information Preferred Part Number	Package	$R_{DS(on)}$ max ohm	V_p min/max V	I_{GSS} max pA	B_{VGSS} min V	$I_{D(off)}$ max pA	I_{DSS} min/max mA	t_{sp} max nS	C_{iss} max pf	C_{rss} max pf
N-channel: Generally requires driver circuit to translate the popular logic levels to voltages required to drive the JFET.										
2N4091	TO-18 TO-92	30	−5.0 −10.0	−200	−40	200	30	65	16	5.0
2N4092	TO-18 TO-92	50	−2.0 −7.0	−200	−40	200	15	95	16	5.0
2N4093	TO-18 TO-92	80	−1.0 −5.0	−200	−40	200	8	140	16	5.0
2N4391	TO-18 TO-92	30	−4.0 −10.0	−100	−40	100	50 150	55	14	3.5
2N4392	TO-18 TO-92	60	−2.0 −5.0	−100	−40	100	25 75	75	14	3.5
2N4393	TO-18 TO-92	100	−0.5 −3.0	−100	−40	100	5 30	100	14	3.5
2N4859	TO-18 TO-92	25	−4.0 −10.0	−250	−30	250	50	34	18	8.0
2N4860	TO-18 TO-92	40	−2.0 −6.0	−250	−30	250	20 100	60	18	8.0
2N4861	TO-18 TO-92	60	−0.8 −4.0	−250	−30	250	8 80	120	18	8.0
2N5432	TO-52 TO-92	5	−4.0 −10.0	−200	−25	200	150	41	30	15.0
2N5433	TO-52 TO-92	7	−3.0 −9.0	−200	−25	200	100	41	30	15.0
2N5434	TO-52 TO-92	10	−1.0 −4.0	−200	−25	200	30	41	30	15.0
2N5555	TO-92	150	−10.0	−1 nA	−25	10 nA	15	35	5	1.2
2N5638	TO-92	30	−12.0	−1 nA	−30	1 nA	50	24	10	4.0
2N5639	TO-92	60	−8.0	−1 nA	−30	1 nA	25	54	10	4.0
2N5640	TO-92	100	−6.0	−1 nA	−30	1 nA	5	63	10	4.0
P-channel: Can be used to switch into inverting input of op-amps and needs no driver circuit; can be switched directly from TTL logic.										
2N3993	TO-72	150	4.0 9.5	1.2 nA	25	1.2 nA	−10		16	4.5
2N3994	TO-72	300	1.0 5.5	1.2 nA	25	1.2 nA	−2		16	4.5
2N5114	TO-18 TO-92	75	5.0 10.0	500	30	500	−30 −90	37	25	7.0
2N5115	TO-18 TO-92	100	3.0 6.0	500	30	500	−15 −60	68	25	7.0
2N5116	TO-18 TO-92	150	1.0 4.0	500	30	500	−5 −25	102	25	7.0
IT100	TO-18 TO-92	75	2.0 4.5	200	35	100	−10		35	12.0
IT101	TO-18 TO-92	60	4.0 10.0	200	35	100	−20		35	12.0

Switches and Amplifiers—MOSFET

Ordering Information Preferred Part Number	Package	$V_{GS(TH)}$ * $V_{GS(off)}$ min/max V	B_{VDSS} min V	I_{DSS} max pA	I_{GSS} max pA	G_{FS} min µ mho	$R_{DS(on)}$ max ohm	$I_{D(on)}$ min mA
P-channel Enhancement: Gen. used where max isolation btwn. signal source and logic drive req'd: sw. "On" resistance varies with signal amplitude								
3N161	TO-72	−1.5 −5.0	−25	−10 nA	−100.0	3500		−40 −120 Diode Protected
3N163	TO-72	−2.0 −5.0	−40	−200	−10.0	2000	250	−5 −30
3N172	TO-72	−2.0 −5.0	−40	−400	−10.0	1500	250	−5 −30 Diode Protected
N-channel Enhancement: Can switch positive signals directly from TTL logic; gen. requires driver or translator circuit to switch bipolar signals								
2N4351	TO-72	1.0 5.0	25	10 nA	10.0	1000	300	3
3N169	TO-72	0.5 1.5	25	10 nA	10.0	1000	200	10
3N170	TO-72	1.0 2.0	25	10 nA	10.0	1000	200	10
3N171	TO-72	1.5 3.0	25	10 nA	10.0	1000	200	10

Amplifiers—N-Channel Junction FET

Ordering Information Preferred Part Number	Package	G_{FS} min µmho	I_{DSS} min/max mA	V_p min/max V	I_{GSS} max pA	B_{VGSS} min V	C_{iss} max pf	C_{rss} max pf	e_n max $nV/\sqrt{Hz}$
2N3684	TO-72 TO-92	2000	2.5 7.5	−2.0 −5.0	−100	−50	4	1.2	140 @ 100 Hz
2N3685	TO-72 TO-92	1500	1.0 3.0	−1.0 −3.5	−100	−50	4	1.2	140 @ 100 Hz
2N3686	TO-72 TO-92	1000	0.4 1.2	−0.6 −2.0	−100	−50	4	1.2	140 @ 100 Hz
2N3687	TO-72 TO-92	500	0.1 0.5	−0.3 −1.2	−100	−50	4	1.2	140 @ 100 Hz
2N3822	TO-72 TO-92	3000	2.0 10.0	−6.0	−100	−50	6	3.0	200 @ 10 Hz
2N4117	TO-72 TO-92	70	0.03 0.09	−0.6 −1.8	−10	−40	3	1.5	
2N4117A	TO-72 TO-92	70	0.03 0.09	−0.6 −1.8	−1	−40		1.5	
2N4118	TO-72 TO-92	80	0.08 0.24	−1.0 −3.0	−10	−40	3	1.5	
2N4118A	TO-72 TO-92	80	0.08 0.24	−1.0 −3.0	−1	−40	3	1.5	
2N4119	TO-72 TO-92	100	0.2 0.6	−2.0 −6.0	−10	−40	3	1.5	
2N4119A	TO-72 TO-92	100	0.2 0.6	−2.0 −6.0	−1	−40	3	1.5	
2N4220	TO-72 TO-92	1000	0.5 3.0	−4.0	−100	−30	6	2.0	
2N4221	TO-72 TO-92	2000	2.0 6.0	−6.0	−100	−30	6	2.0	
2N4222	TO-72 TO-92	2500	5.0 15.0	−8.0	−100	−30	6	2.0	
2N4223	TO-72	3000	3.0 18.0	−0.1 −8.0	−250	−30	6	2.0	
2N4224	TO-72	2000	2.0 20.0	−0.1 −0.8	−150	−30	6	2.0	
2N4338	TO-18 TO-92	600	0.2 0.6	−0.3 −1.0	−100	−50	7	3.0	65 @ 1 kHz
2N4339	TO-18 TO-92	800	0.5 1.5	−0.6 −1.8	−100	−50	7	3.0	65 @ 1 kHz
2N4340	TO-18 TO-92	1300	1.2 3.6	−1.0 −3.0	−100	−50	7	3.0	65 @ 1 kHz
2N4341	TO-18 TO-92	2000	3.0 9.0	−2.0 −6.0	−100	−50	7	3.0	65 @ 1 kHz
2N4416	TO-72 TO-92	4500	5.0 15.0	−6.0	−100	−30	4	2.0	
2N4867	TO-72 TO-92	700	0.4 1.2	−0.7 −2.0	−250	−40	25	5.0	10 @ 1 kHz
2N4867A	TO-72 TO-92	700	0.4 1.2	−0.7 −2.0	−250	−40	25	5.0	5 @ 1 kHz
2N4868	TO-72 TO-92	1000	1.0 3.0	−1.0 −3.0	−250	−40	25	5.0	10 @ 1 kHz
2N4868A	TO-72 TO-92	1000	1.0 3.0	−1.0 −3.0	−250	−40	25	5.0	5 @ 1 kHz
2N4869	TO-72 TO-92	1300	2.5 7.5	−1.8 −5.0	−250	−40	25	5.0	10 @ 1 kHz
2N4869A	TO-72 TO-92	1300	2.5 7.5	−1.8 −5.0	−250	−40	25	5.0	5 @ 1 kHz
2N5397	TO-72 TO-92	6000 @ 1 mA	10.0 30.0	−1.0 −6.0	−100	−25	5	1.2	3 dB @ 450 mHz
2N5457	TO-92	1000	1.0 5.0	−0.5 −6.0	1 nA	25	7	3.0	3 dB @ 450 mHz
2N5458	TO-92	1500	2.0 9.0	−1.0 −7.0	1 nA	25	7	3.0	3 dB @ 450 mHz
2N5459	TO-92	2000	4.0 16.0	−2.0 −8.0	−1 nA	−25	7	3.0	3 dB @ 450 mHz
2N5484	TO-92	3000	1.0 5.0	−0.3 −3.0	−1 nA	−25	5	1.0	120 @ 1 kHz
2N5485	TO-92	3500	4.0 10.0	−0.5 −4.0	−1 nA	−25	5	1.0	120 @ 1 kHz
2N5486	TO-92	4000	8.0 20.0	−2.0 −6.0	−1 nA	−25	5	1.0	120 @ 1 kHz
U308	TO-52 TO-92	10,000	12.0 60.0	−1.0 −6.0	−150	−25	7 typ.	4.0 typ.	10 @ 10 Hz typ.
U309	TO-52 TO-92	10,000	12.0 30.0	−1.0 −4.0	−150	−25	7 typ.	4.0 typ.	10 @ 10 Hz typ
U310	TO-52 TO-92	10,000	24.0 60.0	−2.5 −6.0	−150	−25	7 typ.	4.0 typ.	10 @ 10 Hz typ.
UC200	TO-72 TO-92	6000	10.0 30.0	−6.0	−100	−50	7	3.0	70 @ 100 Hz

Amplifiers—P-Channel Junction FET

Ordering Information Preferred Part Number	Package	G_{FS} min µmho	I_{DSS} min/max mA	V_P min/max V	I_{GSS} max nA	B_{VGSS} min V	C_{iss} max pf	C_{rss} max pf	e_n max nV/√Hz
2N2606	TO-18 TO-92	110	−0.1 −0.5	1.0 4.0	1	30	7	2	400 @ 1 kHz
2N2607	TO-18 TO-92	330	−0.3 −1.5	1.0 4.0	3	30	7	2	400 @ 1 kHz
2N2608	TO-18 TO-92	1000	−0.9 −4.5	1.0 4.0	10	30	7	2	180 @ 1 kHz
2N2609	TO-18 TO-92	2500	−2.0 −10.0	1.0 4.0	30	30	7	2	180 @ 1 kHz
2N3329	TO-72	1000 @ −1 mA	−1.0 −3.0	5.0	10	20	7	2	400 @ 1 kHz
2N3330	TO-72	1500 @ −2 mA	−2.0 −6.0	6.0	10	20	7	2	400 @ 1 kHz
2N3331	TO-72	2000 @ −5 mA	−5.0 −15.0	8.0	10	20	7	2	400 @ 1 kHz
2N5265	TO-72	900	−0.5 −1.0	3.0	2	60	7	2	115 @ 100 Hz
2N5266	TO-72	1000	−0.8 −1.6	3.0	2	60	7	2	115 @ 100 Hz
2N5267	TO-72	1500	−1.5 −3.0	6.0	2	60	7	2	115 @ 100 Hz
2N5268	TO-72	2000	−2.5 −5.0	6.0	2	60	7	2	115 @ 100 Hz
2N5269	TO-72	2200	−4.0 −8.0	8.0	2	60	7	2	115 @ 100 Hz
2N5270	TO-72	2500	−7.0 −14.0	8.0	2	60	7	2	115 @ 100 Hz
2N5460	TO-92	1000	−1.0 −5.0	0.75 6.0	5	40	7	2	115 @ 100 Hz
2N5461	TO-92	1500	−2.0 −9.0	1.0 7.5	5	40	7	2	115 @ 100 Hz
2N5462	TO-92	2500	−4.0 −16.0	1.5 9.0	5	40	7	2	115 @ 100 Hz
2N5463	TO-92	1000	−1.0 −5.0	0.75 6.0	5	60	7	2	115 @ 100 Hz
2N5464	TO-92	1500	−2.0 −9.0	1.0 7.5	5	60	7	2	115 @ 100 Hz
2N5465	TO-92	2500	−4.0 −16.0	1.8 9.0	5	60	7	2	115 @ 100 Hz

Differential Amplifiers—Dual Monolithic N-Channel Junction FETS

Ordering Information Preferred Part Number	Package	V_{GS1-2} max mV	ΔV_{GS} max µV/°C	I_G max pA	B_{VGSS} min V	V_P min/max V	g_{fs} min/max µmho	I_{DSS} min/max mA	e_n max nV/√Hz
2N3954	TO-71	5	10	−50	−50	−1.0 −4.5	1 3	0.5 5.0	160 @ 100 Hz
2N3954A	TO-71	5	5	−50	−50	−1.0 −4.5	1 3	0.5 5.0	160 @ 100 Hz
2N3955	TO-71	10	25	−50	−50	−1.0 −4.5	1 3	0.5 5.0	160 @ 100 Hz
2N3955A	TO-71	10	15	−50	−50	−1.0 −4.5	1 3	0.5 5.0	160 @ 100 Hz
2N3956	TO-71	15	50	−50	−50	−1.0 −4.5	1 3	0.5 5.0	160 @ 100 Hz
2N3957	TO-71	20	75	−50	−50	−1.0 −4.5	1 3	0.5 5.0	160 @ 100 Hz
2N3958	TO-71	25	100	−50	−50	−1.0 −4.5	1 3	0.5 5.0	160 @ 100 Hz
2N5196	TO-71	5	5	−15	−50	−0.7 −4.0	700 @ 200 µA	0.7 7.0	20 @ 1 kHz
2N5197	TO-71	5	10	−15	−50	−0.7 −4.0	700 @ 200 µA	0.7 7.0	20 @ 1 kHz
2N5198	TO-71	10	20	−15	−50	−0.7 −4.0	700 @ 200 µA	0.7 7.0	20 @ 1 kHz
2N5199	TO-71	15	40	−15	−50	−0.7 −4.0	700 @ 200 µA	0.7 7.0	20 @ 1 kHz
2N5452	TO-71	5	5	IGSS −100	−50	−1.0 −4.5	1 4	0.5 5.0	20 @ 1 kHz
2N5453	TO-71	10	10	IGSS −100	−50	−1.0 −4.5	1 4	0.5 5.0	20 @ 1 kHz
2N5454	TO-71	15	25	IGSS −100	−50	−1.0 −4.5	1 4	0.5 5.0	20 @ 1 kHz
2N5515	TO-71	5	5	−100	−40	−0.7 −4.0	1 4	0.5 7.5	30 @ 10 Hz
2N5516	TO-71	5	10	−100	−40	−0.7 −4.0	1 4	0.5 7.5	30 @ 10 Hz
2N5517	TO-71	10	20	−100	−40	−0.7 −4.0	1 4	0.5 7.5	30 @ 10 Hz
2N5518	TO-71	15	40	−100	−40	−0.7 −4.0	1 4	0.5 7.5	30 @ 10 Hz
2N5519	TO-71	15	80	−100	−40	−0.7 −4.0	1 4	0.5 7.5	30 @ 10 Hz
2N5520	TO-71	5	5	−100	−40	−0.7 −4.0	1 4	0.5 7.5	15 @ 10 Hz
2N5521	TO-71	5	10	−100	−40	−0.7 −4.0	1 4	0.5 7.5	15 @ 10 Hz
2N5522	TO-71	10	20	−100	−40	−0.7 −4.0	1 4	0.5 7.5	15 @ 10 Hz
2N5523	TO-71	15	40	−100	−40	−0.7 −4.0	1 4	0.5 7.5	15 @ 10 Hz
2N5524	TO-71	15	80	−100	−40	−0.7 −4.0	1 4	0.5 7.5	15 @ 10 Hz
2N5902	TO-99	5	5	−3	−40	−0.6 −4.5	70 250	0.3 0.5	100 @ 1 kHz
2N5903	TO-99	5	10	−3	−40	−0.6 −4.5	70 250	0.03 0.5	100 @ 1 kHz
2N5904	TO-99	10	20	−3	−40	−0.6 −4.5	70 250	0.03 0.5	100 @ 1 kHz
2N5905	TO-99	15	40	−3	−40	−0.6 −4.5	70 250	0.03 0.5	100 @ 1 kHz
2N5906	TO-99	5	5	−1	−40	−0.6 −4.5	70 250	0.03 0.5	100 @ 1 kHz
2N5907	TO-99	5	10	−1	−40	−0.6 −4.5	70 250	0.03 0.5	100 @ 1 kHz
2N5908	TO-99	10	20	−1	−40	−0.6 −4.5	70 250	0.03 0.5	100 @ 1 kHz
2N5909	TO-99	15	40	−1	−40	−0.6 −4.5	70 250	0.03 0.5	100 @ 1 kHz
2N5911	TO-99	10	20	−100	−25	−1.0 −5.0	5/10 @ 5 mA	7.0 40.0	20 @ 10 kHz
2N5912	TO-99	15	40	−100	−25	−1.0 −5.0	5/10 @ 5 mA	7.0 40.0	20 @ 10 kHz
SU2365	TO-71	5	10	−100	−30	−3.5	1/2 @ 200 µA	0.5 10.0	15 @ 1 kHz
SU2365A	TO-71	5	10	−20	−30	−3.5	1/2 @ 200 µA	0.5 10.0	50 @ 1 kHz
SU2366	TO-71	10	10	−100	−30	−3.5	1/2 @ 200 µA	0.5 10.0	15 @ 1 kHz
SU2366A	TO-71	10	10	−20	−30	−3.5	1/2 @ 200 µA	0.5 10.0	50 @ 1 kHz
SU2367	TO-71	10	25	−100	−30	−3.5	1/2 @ 200 µA	0.5 10.0	15 @ 1 kHz
SU2367A	TO-71	10	25	−20	−30	−3.5	1/2 @ 200 µA	0.5 10.0	50 @ 1 kHz
SU2368	TO-71	15	25	−100	−30	−3.5	1/2 @ 200 µA	0.5 10.0	15 @ 1 kHz
SU2368A	TO-71	15	25	−20	−30	−3.5	1/2 @ 200 µA	0.5 10.0	50 @ 1 kHz
U257	TO-99	100	—	−100	−25	−1.0 −5.0	5/10 @ 5 mA	5.0 40.0	30 @ 1 kHz

Differential Amplifiers—Dual Monolithic P-Channel MOSFETS (Enhancement)

Ordering Information Preferred Part Number	Package	$V_{GS(TH)}$ min/max V	B_{VDSS} min/max V	I_{DSS} max pA	I_{GSS} max pA	G_{FS} min µmho	$I_{D(on)}$ min/max mA	$R_{DS(on)}$ max ohm	V_{GS1-2} max mV
3N165	TO-99	−2 −5	−40	−200	−10	1500	−5.0 −30	300	100
3N166	TO-99	−2 −5	−40	−200	−10	1500	−5.0 −30	300	
3N188	TO-99	−2 −5	−40	−200	−200	1500	−5.0 −30	300	100 Zener Protected
3N189	TO-99	−2 −5	−40	−200	−200	1500	−5.0 −30	300	Zener Protected
3N190	TO-99	−2 −5	−40	−200	−200	1500	−5.0 −30	300	
3N191	TO-99	−2 −5	−40	−200	−200	1500	−5.0 −30	300	
MEM550	TO-99	−3 −6	−30	−10 nA	−10 nA	500	−1.5	250	Zener Protected

Differential Amplifiers—Dual Monolithic Bipolar Transistors

Ordering Information: Preferred Part Number	Package	$V_{BE\ 1\text{-}2}$ mV max	ΔV_{BE} μV/°C max	H_{FE} @ $I_C = 10\mu A$ $V_{CE} = 5V$ min	$I_{B\ 1\text{-}2}$ @ $I_C = 10\mu A$ $V_{CE} = 5V$ nA max	LV_{CEO} V min	I_{CBO} nA max	Noise dB max	f_t MHz @ I_C min	C_{obo} pf max	Structure	Type
2N2453	TO-78	3	10	80		30	5	7	150 @ 1 mA	8	Junc. Isol.	NPN
2N2453A	TO-78	3	5	80	.6 μA @ 100 μA	60	5	4	150 @ 1 mA	4	Junc. Isol.	NPN
2N4044	TO-78	3	3	200	5	60	.1	2	200 @ 1 mA	.8	Dielec. Isol.	NPN
2N4045	TO-78	5	10	80	25	45	.1	3	150 @ 1 mA	.8	Dielec. Isol.	NPN
2N4100	TO-78	5	5	150	10	55	.1	3	150 @ 1 mA	.8	Dielec. Isol.	NPN
2N4878	TO-71	3	3	200	5	60	.1	2	200 @ 1 mA	.8	Dielec. Isol.	NPN
2N4879	TO-71	5	5	150	10	55	.1	3	150 @ 1 mA	.8	Dielec. Isol.	NPN
2N4880	TO-71	5	10	80	25	45	.1	3	150 @ 1 mA	.8	Dielec. Isol.	NPN
2N5117	TO-78	3	3	100	10	45	.1	4	100 @ .5 mA	.8	Dielec. Isol.	PNP
2N5118	TO-78	5	5	100	15	45	.1	4	100 @ .5 mA	.8	Dielec. Isol.	PNP
2N5119	TO-78	5	10	50	40	45	.1	4	100 @ .5 mA	.8	Dielec. Isol.	PNP
IT120	TO-78 TO-71	2	5	200	5	45	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	NPN
IT120A	TO-78 TO-71	1	3	200	2.5	60	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	NPN
IT121	TO-78 TO-71	5	10	80	10	45	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	NPN
IT122	TO-78 TO-71	10	20	80	25	45	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	NPN
IT124	TO-78	5	10	1500	.6 A V_{CE} = IV	2	.1	3	100 @ 200 μA	.8	Dielec. Isol.	NPN
IT126	TO-78 TO-71	1	3	200	2.5	60	.1	1 typ.	250 @ 10 mA	4	Dielec. Isol.	NPN
IT127	TO-78 TO-71	2	5	200	5	45	.1	1 typ.	250 @ 10 mA	4	Dielec. Isol.	NPN
IT128	TO-78 TO-71	5	10	100	10	45	.5	1 typ.	250 @ 10 mA	4	Dielec. Isol.	NPN
IT129	TO-78 TO-71	10	20	100	25	45	.5	1 typ.	250 @ 10 mA	4	Dielec. Isol.	NPN
IT130	TO-78 TO-71	2	5	200	5	−45	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	PNP
IT130A	TO-78 TO-71	1	3	200	2.5	−60	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	PNP
IT131	TO-78 TO-71	5	10	80	10	−45	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	PNP
IT132	TO-78 TO-71	10	20	80	25	−45	1	2 typ.	150 @ 1 mA	2	Junc. Isol.	PNP
IT136	TO-78 TO-71	1	3	200	2.5	−60	.1	2 typ.	250 @ 10 mA	4	Dielec. Isol.	PNP
IT137	TO-78 TO-71	2	5	200	5	−45	.1	2 typ.	250 @ 10 mA	4	Dielec. Isol.	PNP
IT138	TO-78 TO-71	5	10	100	10	−45	.5	2 typ.	250 @ 10 mA	4	Dielec. Isol.	PNP
IT139	TO-78 TO-71	10	20	100	25	−45	.5	2 typ.	250 @ 10 mA	4	Dielec. Isol.	PNP

Specialty Items

ID-100 ID-101	This product is a back to back diode combination used to protect P-channel MOSFET duals (non-diode protected). Their chief characteristic is < 1 pa leakage when voltage across them is less than 5 mV. If voltage across diodes is adjusted to 0V ±0.1 mV, leakage is less than 0.01 pa.

VARAFET

Intersil has pioneered the VARAFET—a new concept in junction FET technology. Designed to replace the 2N4091 and 2N4391 families, the Varafet replaces the usual interfacing components thus saving the designer board space and costs.

Type	$R_{DS\ (on)}$ Ω max	V_p V max	$I_{s\ (off)}$ pA max	I_{DSS} mA min	t_{on} ns max	t_{off} ns max	Package 4 FETS/Pkg	V_{analog} V_{pp} min	V_{inject} V_{pp} max
IT401	30	7.5	200	45 min	50	150	16 Pin Dip	15	10
IT401A	50	5	200	35 min	50	150	16 Pin Dip	20	10

Intersil manufactures a comprehensive line of analog switches with an outstanding range of performance characteristics.
Intersil is experienced in specifying its reliable, high quality FETs as analog switches. Our J-FET, PMOS and CMOS switches are ideally suited for optimizing a variety of switching functions in future designs or upgrading present ones.

Analog Switches with Driver

Electrical Characteristics @ +25°C—Military Temperature Devices

Type	No. of Channels	Intersil Device No.	Switch Technology	$R_{DS(on)}$ Ohms max(1)	$I_{D\,(off)}$ nA max	t_{on} μS max	t_{off} μS max	Logic Input: Logic Level	Logic Input: Input Typ(2)	Power Consumption Watts
SPST	1	2110A	N-JFET	30	1.0	0.7	0.7	High Level	hi	Data not available
		IH5001	N-JFET	30	5.0	0.5	1.0	DTL, TTL, RTL	lo	175m
		IH5002	N-JFET	50	5.0	0.5	1.0	DTL, TTL, RTL	lo	175m
		IH5021	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5022	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5023	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5024	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5037	P-JFET	100	0.5	0.2	0.2	TTL High Level	lo	
		IH5038	P-JFET	150	0.5	0.2	0.2	TTL High Level	lo	
		IH5040	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, CMOS, PMOS	hi	350μW
	2	DG111	PMOS FET	450	−1.0	0.3	1.0	DTL, TTL, RTL	lo	330mW
		DG112	PMOS FET	450	−1.0	0.3	1.0	DTL, TTL, RTL	lo	300m
		DG133A	N-JFET	30	1.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		DG134A	N-JFET	80	1.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		DG141A	N-JFET	10	10.0	0.5	1.25	DTL, TTL, RTL	hi	175m
		DG151A	N-JFET	15	10.0	0.5	1.25	DTL, TTL, RTL	hi	175m
		DG152A	N-JFET	50	2.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		DG180	N-JFET	10	10.0	0.3	0.25	DTL, TTL, RTL	lo	150m
		DG181	N-JFET	30	1.0	0.15	0.13	DTL, TTL, RTL	lo	150m
		DG182	N-JFET	75	1.0	0.25	0.13	DTL, TTL, RTL	lo	150m
		DG433A	N-JFET	35	5.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		DG434A	N-JFET	80	5.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		DG441A	N-JFET	15	15.0	0.75	1.25	DTL, TTL, RTL	hi	175m
		DG451A	N-JFET	20	15.0	0.75	1.25	DTL, TTL, RTL	hi	175m
		DG452A	N-JFET	100	5.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		IH181	Vara FET	30	0.1	0.25	0.13	DTL, TTL, RTL, CMOS, TTL High Level	lo	350μW
		IH182	Vara FET	75	0.1	0.25	0.13	DTL, TTL, RTL, CMOS, TTL High Level	lo	350μW
		IH200	CMOS	75	1.0	1.0	0.5	DTL, TTL, RTL, CMOS, TTL High Level	lo	350μW
		IH5003	N-JFET	30	1.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		IH5004	N-JFET	50	1.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		IH5005	N-JFET	10	10.0	1.0	2.5	DTL, TTL, RTL	hi	175m
		IH5006	N-JFET	30	1.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		IH5007	N-JFET	80	1.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		IH5017	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5018	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5019	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5020	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5033	P-JFET	100	0.5	0.2	0.2	TTL High Level	lo	
		IH5034	P-JFET	150	0.5	0.2	0.2	TTL High Level	lo	
		IH5035	P-JFET	100	0.5	0.2	0.2	TTL High Level	lo	
		IH5036	P-JFET	150	0.5	0.2	0.2	TTL High Level	lo	
		IH5041	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, CMOS, PMOS	hi	350μW
		IH5048	CMOS	35	1.0	0.25	0.15	DTL, TTL, RTL, CMOS, PMOS	hi	350μW
	3	IH5013	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5014	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5015	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5016	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5029	P-JFET	100	0.5	0.2	0.2	TTL High Level	lo	
		IH5030	P-JFET	150	0.5	0.2	0.2	TTL High Level	lo	
		IH5031	P-JFET	100	0.5	0.2	0.2	TTL High Level	lo	
		IH5032	P-JFET	150	0.5	0.2	0.2	TTL High Level	lo	
	4	DG116	P-MOSFET	450	−4.0	0.3	1.0	DTL, TTL, RTL	lo	600mW
		DG118	P-MOSFET	450	−4.0	0.3	1.0	DTL, TTL, RTL	lo	660mW
		IH201	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, CMOS	lo	350μW
		IH202	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, CMOS	hi	350μW
		IH5009	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5010	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5011	P-JFET	100	0.2	0.5	0.5	TTL High Level	lo	
		IH5012	P-JFET	150	0.2	0.5	0.5	TTL Low Level	lo	
		IH5025	P-JFET	100	0.5	0.2	0.2	TTL High Level	lo	
		IH5026	P-JFET	150	0.5	0.2	0.2	TTL High Level	lo	
		IH5027	P-JFET	100	0.5	0.2	0.2	TTL High Level	lo	
		IH5028	P-JFET	150	0.5	0.2	0.2	TTL High Level	lo	
	5	DG123	P-MOSFET	450	−4.0	0.3	1.0	DTL, TTL, RTL	lo	750mW
		DG125	P-MOSFET	450	−4.0	0.3	1.0	DTL, TTL, RTL	lo	825mW
SPDT	1	DG143A	N-JFET	80	1.0	0.4	0.8	DTL, TTL, RTL	(3)	175m
		DG144A	N-JFET	30	1.0	0.4	0.8	DTL, TTL, RTL	(3)	175m
		DG146A	N-JFET	10	10.0	0.5	1.25	DTL, TTL, RTL	(3)	175m
		DG161A	N-JFET	15	10.0	0.5	1.25	DTL, TTL, RTL	(3)	175m
		DG162A	N-JFET	50	2.0	0.4	0.8	DTL, TTL, RTL	(3)	175m
		DG186	N-JFET	10	10.0	0.3	0.25	DTL, TTL, RTL	(3)	80m
		DG187	N-JFET	30	0.1	0.15	0.13	DTL, TTL, RTL	(3)	80m
		DG188	N-JFET	75	0.1	0.25	0.13	DTL, TTL, RTL	(3)	80m
		DG443A	N-JFET	80	5.0	0.5	1.0	DTL, TTL, RTL	(3)	175m
		DG444A	N-JFET	35	5.0	0.5	1.0	DTL, TTL, RTL	(3)	175m
		DG446A	N-JFET	15	15.0	0.75	1.25	DTL, TTL, RTL	(3)	175m
		DG461A	N-JFET	20	15.0	0.75	1.25	DTL, TTL, RTL	(3)	175m
		DG462A	N-JFET	100	5.0	0.5	1.0	DTL, TTL, RTL	(3)	175m
		IH187	Vara FET	30	0.1	0.25	0.13	DTL, TTL, RTL, CMOS, PMOS, TTL High Level	(3)	350μW
		IH188	Vara FET	75	0.1	0.25	0.13	DTL, TTL, RTL, CMOS, PMOS, TTL High Level	(3)	350μW
		IH5042	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, PMOS, CMOS	(3)	350μW
		IH5050	CMOS	35	1.0	0.25	0.15	DTL, TTL, RTL, PMOS, CMOS	(3)	350μW
	2	DG189	N-JFET	10	10.0	0.3	0.25	DTL, TTL, RTL	(3)	150m
		DG190	N-JFET	30	1.0	0.15	0.13	DTL, TTL, RTL	(3)	150m
		DG191	N-JFET	75	1.0	0.25	0.13	DTL, TTL, RTL	(3)	150m
		IH5043	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, PMOS, CMOS	(3)	350μW
		IH5051	CMOS	35	1.0	0.25	0.15	DTL, TTL, RTL, PMOS, CMOS	(3)	350μW

Type	No. of Channels	Intersil Device No.	Switch Technology	$R_{DS(on)}$ Ohms max(1)	$I_{D(off)}$ nA max	t_{on} µS max	t_{off} µS max	Logic Input: Logic Level	Logic Input: Input Typ(2)	Power Consumption Watts
SPDT	2	IH190	CMOS	30	0.1	0.25	0.13	TTL, CMOS, PMOS, TTL High Level	(3)	350µW
		IH191	CMOS	75	0.1	0.25	0.13	TTL, CMOS, PMOS, TTL High Level	(3)	350µW
DPST	1	IH5044	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, CMOS, PMOS	hi	350µW
	2	DG126A	N-JFET	80	1.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		DG129A	N-JFET	30	1.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		DG140A	N-JFET	10	10.0	0.5	1.25	DTL, TTL, RTL	hi	175m
		DG153A	N-JFET	15	10.0	0.5	1.25	DTL, TTL, RTL	hi	175m
		DG154A	N-JFET	50	2.0	0.3	0.8	DTL, TTL, RTL	hi	175m
		DG183	N-JFET	10	10.0	0.3	0.25	DTL, TTL, RTL	hi	150m
		DG184	N-JFET	30	1.0	0.15	0.13	DTL, TTL, RTL	hi	150m
		DG185	N-JFET	75	1.0	0.25	0.13	DTL, TTL, RTL	hi	150m
		DG426A	N-JFET	80	5.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		DG429A	N-JFET	35	5.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		DG440la	N-JFET	15	15.0	0.75	1.25	DTL, TTL, RTL	hi	175m
		DG453A	N-JFET	20	15.0	0.75	1.25	DTL, TTL, RTL	hi	175m
		DG454A	N-JFET	100	5.0	0.5	1.0	DTL, TTL, RTL	hi	175m
		IH184	Vara FET	30	0.1	0.25	0.13	DTL, TTL, RTL, CMOS, PMOS	hi	350µW
		IH185	Vara FET	75	0.1	0.25	0.13	DTL, TTL, RTL, CMOS, PMOS	lo	350µW
		IH5045	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, PMOS, CMOS	lo	350µW
		IH5049	CMOS	35	1.0	0.25	0.15	DTL, TTL, RTL, PMOS, CMOS	lo	350µW
	3	DG120	P-MOS FET	450	−3.0	0.3	2.0	DTL, TTL, RTL	lo	150mW
		DG121	P-MOS FET	450	−3.0	0.3	2.0	DTL, TTL, RTL	lo	165mW
DPDT	1	DG139A	N-JFET	30	1.0	0.4	0.8	DTL, TTL, RTL	(3)	175m
		DG142A	N-JFET	80	1.0	0.4	0.8	DTL, TTL, RTL	(3)	175m
		DG145A	N-JFET	10	10.0	0.5	1.25	DTL, TTL, RTL	(3)	175m
		DG163A	N-JFET	15	10.0	0.5	1.25	DTL, TTL, RTL	(3)	175m
		DG164A	N-JFET	50	2.0	0.4	0.8	DTL, TTL, RTL	(3)	175m
		DG439A	N-JFET	35	5.0	0.5	1.0	DTL, TTL, RTL	(3)	175m
		DG442A	N-JFET	80	5.0	0.5	1.0	DTL, TTL, RTL	(3)	175m
		DG445A	N-JFET	15	15.0	0.75	1.25	DTL, TTLQ, RTL	(3)	175m
		DG463A	N-JFET	20	15.0	0.75	1.25	DTL, TTL, RTL	(3)	175m
		DG464A	N-JFET	100	5.0	0.5	1.0	DTL, TTL, RTL	(3)	175m
		IH5046	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, CMOS, PMOS	(3)	350µW
4PST	1	IH5047	CMOS	75	1.0	0.5	0.25	DTL, TTL, RTL, CMOS, PMOS	hi	350µW
MUX	1 of 16	IH5060	CMOS	400	10.0	1.5	1.0	DTL, TTL, RTLV, CMOS	hi	5mW
	2 of 16	IH5070	CMOS	400	5.0	1.5	1.0	DTL, TTL, RTL, CMOS	hi	5mW

Multi-Channel FET Switches

Electrical Characteristics @ +25°C—Military Temperature Devices

Type	No. of Channels	Intersil Device No.	Switch Technology	$R_{DS(on)}$ ohms max (4)	$R_{DS(on)}$ ohms max(1)	$I_{D(off)}$ na max	t_{on} ns max*	t_{off} ns max*	Logic Input: Logic Level	Logic Input: type (4)
SPST	3	MM-455	P-MOS	200	600	0.2	50	50	P-MOS	lo
		MM-555	P-MOS	200	600	20.0	50	50	P-MOS	lo
	4	G-124	P-MOS	100	450	2.0	100	100	P-MOS	hi
		G-125	N-JFET	500	500	0.05	30	50	−5V PMOS	hi
		G-126	N-JFET	250	250	0.05	30	50	−10V PMOS	hi
		G-127	N-JFET	90	90	0.1	30	50	−5V PMOS	hi
		G-128	N-JFET	45	45	0.1	30	50	−10V PMOS	hi
		G-129	N-JFET	500	500	0.05	30	50	−5V PMOS	hi
		G-130	N-JFET	250	250	0.05	30	50	−10V PMOS	hi
		G-131	N-JFET	90	90	0.1	30	50	−5V PMOS	hi
		G-132	N-JFET	45	45	0.1	30	50	−10V PMOS	hi
		G-1330	N-JFET	20	20	0.5	30	50	−5V PMOS	hi
		G-1340	N-JFET	10	10	0.5	30	50	−10V PMOS	hi
		G-1350	N-JFET	20	20	0.5	30	50	−5V PMOS	hi
		G-1360	N-JFET	10	10	0.5	30	50	−10V PMOS	hi
		MM-451	P-MOS	200	600	0.2	50	50	P-MOS	lo
		MM-452	P-MOS	200	600	0.2	50	50	P-MOS	lo
		MM-551	P-MOS	200	600	20.0	50	50	P-MOS	lo
		MM-552	P-MOS	200	600	20.0	50	50	P-MOS	lo
	5	G-116	P-MOS	100	450	−2.5	100	100	P-MOS	lo
		G-117	P-MOS	100	450	−0.5	100	100	P-MOS	lo
	6	G-115	P-MOS	100	450	−10.0	100	100	P-MOS	lo
		G-118	P-MOS	100	450	−3.0	100	100	P-MOS	lo
Diff	2	G-123	P-MOS	125	500	−10.0	100	100	P-MOS	lo
		MM-450	P-MOS	200	600	0.2	50	50	P-MOS	lo
		MM-550	P-MOS	200	600	20.0	50	50	P-MOS	lo
SPST	3	G-119	P-MOS	100	450	−1.5	100	100	P-MOS	lo

*These times are dependent on the driver used.

Drivers for FET Switches

Electrical Characteristics @ +25°C—Military Temperature Devices

No. of Channels	Intersil Device No.	V_{OUT} Positive volts	V_{OUT} Negative volts	"ON" ns max	"OFF" ns max	I_{in} Lo mA (Max)	I_{in} Hi µA (Max)	Logic Input Level	Power Consumption (mW)
2	D112	+9.9	−19.2	250	1500	0.7	1.0	TTL	200m
	D113	+9.9	−19.2	250	1500	1.0	1.0	TTL	200m
	D120	+9.9	−19.2	250	600	0.7	1.0	TTL	200m
	D121	+9.9	−19.2	250	600	1.0	1.0	TTL	200m
4	D129	V_{cc}	−19.3	250	1000	−0.2	0.25	TTL/DTL	100m
6	D123	V_{cc}	−19.7	250	600	1.0	1.0	TTL/DTL	125m
	D125	V_{cc}	−19.7	250	600	0.7	1.0	TTL	300m

1. Switch Resistance under worst case analog voltage.
2. Positive logic lo ("O") or hi ("I") voltage at driver input necessary to turn switch on.
3. Logic "O" or "I" can be arbitrarily assigned for double-throw switches.
4. Switch resistance under best case analog voltage.

Intersil manufactures a variety of sophisticated standardized watch and clock chips. Because these devices have been standardized, pricing is low and predictable.

Any of our standard devices can be customized to fit any timing requirement.

Watches and Clocks

Part Number	Circuit Description	Power	Crystal Frequency
ICM1115A/ ICM1115B	Quartz clock circuit, bipolar stepper motor application with simple alarm	(1) 1.5-volt cell	4.194MHz
ICM1424A/ ICM1424B	5-function LCD wristwatch circuit. Features: hrs, min, sec, month, date, 3½ digit display. 1424 B has rapid advance on setting	(1) 1.5-volt cell	32-768kHz
ICM1424M	Same electrical characteristics as ICM1424A and B but with mirror image configuration.	(1) 1.5-volt cell	32-768kHz
ICM7038A	Quartz clock circuit with alarm, synchronous motor	(2) 1.5-volt cells	2 to 10MHz
ICM7038B	Quartz clock circuit with alarm, synchronous motor	(1) 1.5-volt cell	2 to 10MHz
ICM7045	Complete 4-function stop watch/24-hr. clock on single microcircuit chip with direct drive for LEDs on chip	(3) 1.2-volt cells	6.5536MHz
ICM7045A	Complete 4-function industrial stopwatch precision decade timer to count seconds, minutes or hours by selection of suitable oscillator frequencies	(3) 1.2-volt cells	Seconds 1.31072MHz Minutes 2.184533MHz Hours 3.640889MHz
ICM7049A	Quartz clock circuit, unipolar stepper motor application with complex alarm	(1) 1.5-volt cell	4-1943MHz
ICM7050	Quartz clock circuit, bipolar stepper motor application with complex alarm	(1) 1.5-volt cell	4-1943MHz
ICM7051A	Quartz automobile clock circuit for synchronous motor	(1) 12.0-volt cell	4-1943MHz
ICM7051B	Quartz automobile clock circuit for bipolar stepper motor	(1) 12.0-volt cell	4-1943MHz
ICM7200A (ICM7203A 24-hr. type)	One chip LED wristwatch circuit with direct drive for LEDs on chip. Features: hrs, min, sec, day and date	(2) 1.5-volt cells	32-768kHz
ICM7202A (ICM7204A 24-hr. type)	One chip LED wristwatch circuit with direct drive for LEDs on chip. Features: hrs, min, sec, date	(2) 1.5-volt cells	32-768kHz
ICM7205	Split and Taylor time stopwatch circuit with direct drive for LEDs on chip	(3) 1.2-volt cells	3.2768MHz
ICM7210/ ICM7210A	4-digit 6-function alpha-numeric LCD wristwatch circuit. Features: hrs, min, day, date, month, sec	(1) 1.5-volt cell	32-768kHz
ICM7210M	Same electrical characteristics as ICM7210 but with mirror image	(1) 1.5-volt cell	32-768kHz
ICM7214/ ICM7214A	5- and 6-function alpha-numeric LED readout wristwatch circuits with english, french, german and italian languages versions and perpetual calendar. Features: hrs, min, sec, day, date, month	(2) 1.5-volt cells	32-768kHz
ICM7215	Complete 4-function stopwatch including "time-out" function. Direct drive for LED on chip	(3) 1.2-volt cells	32-768kHz
ICM7220	6-digit and 6-function LCD wristwatch circuit, alphanumeric with options such as dual time zone, alarm, chronograph or 12 or 24 hours	(1) 1.5-volt cell	32-768kHz
ICM7221	4-digit 6-function LCD watch circuit with alarm—can be used for clock circuits	(1) 1.5-volt cell	32-768kHz
ICM7222	Same as ICM7220		

Note: Most of the above devices are available in packaged form as well as die form.

Industrial Counting and Timing Microcircuit

Part Number	Circuit Description	Package	Crystal Frequency	Output
ICM7045A	Complete industrial stopwatch precision decade timer to count seconds, minutes or hours by selection of suitable oscillator frequencies	28 pin DIP	Seconds-1.31MHz Minutes-2.18MHz Hours-3.64MHz	7 digit common Cathode LED drive. Displays up to 240,000 secs 2,400 mins 24 hrs
ICM7201	Low battery voltage indicator	TO-72	Not applicable	Lights LED at voltage below 2.9V
ICM7206	Touch tone encoder Requires one contact per key	16 pin DIP	3.57954MHz	2 of 8 sine wave for tone dialing
ICM7206A	Touch tone encoder Requires 2 contacts per key with common line connected to the positive supply	16 pin DIP	3.57954MHz	2 of 8 sine wave for tone dialing
ICM7206B	Touch tone encoder Common line connected to the negative supply and oscillator is enabled when key is depressed	16 pin DIP	3.57954MHz	2 of 8 sine wave for tone dialing
ICM7207 ICM7207A	Frequency counter timebase. Includes .01, 0.1, or 1 second count window plus store, reset and MUX	14 pin DIP	6.5536MHz 5.24288MHz	Crystal frequency, ÷ 2^{13}, ÷ 2^{17}, ÷ 10 (2^{17}) divider stage
ICM7208	7 digit unit counter. With the addition of ICM7207 the circuit becomes a complete timer-frequency counter	28 pin DIP		LED display direct drive
ICM7209	High frequency clock generator for 5-volt systems	8 pin DIP	to 10MHz	Crystal frequency, ÷ 2^3 divider stage
ICM7213	Oscillator, divider and wave-shaping circuit	14 pin DIP	1 to 6MHz	Crystal frequency, ÷ 2^{22} frequency, one-second and one-minute pulses
ICM7216	8 digit self contained universal counter with option for frequency counting only	28 pin Cerdip or plastic	10MHz	8 digit common anode or common cathode LED direct drive
ICM7226	8 digit full function universal counter which can function as a frequency counter, period counter, frequency ratio counter, time interval counter or as a totalizing counter	40 pin ceramic DIP or plastic	10MHz	8 digit common anode or common cathode LED direct drive
ICM7217	4 digit, synchronous, presettable up/down counter with an onboard presettable register continuously compared to the counter for hard wire control application	28 pin Cerdip or plastic		Seven segment common anode or common cathode direct LED drive
ICM7227	4 digit, synchronous, presettable up/down counter with an onboard presettable register continuously compared to the counter for microprocessor control applications	28 pin Cerdip or plastic		Seven segment common anode or common cathode direct LED drive
ICM7218	Universal LED driver system with 8x8 memory, optional BCD to seven segment decoder to direct drive common anode or cathode 8 digit LED displays for hard wired or microprocessor systems	28 pin Cerdip or plastic 40 pin Ceramic or plastic		Seven segment plus decimal point common anode or common cathode direct LED drive

Commitment

Intersil is a major supplier of Military/Hi Rel components. Our broad range of products and history of supplying reliable components, have allowed us to participate in a very large number of major programs. We dedicate the time and effort required to support the user with Program Management. This specialized service provides baseline control, milestone schedules, critical event reporting, and coordinated engineering level data exchanges.

Intersil is totally committed to supporting this important business segment.

Semiconductor Manufacturing and Process Control

Strict process control inspections after each manufacturing operation are necessary to achieve high yields, as well as produce a product with high quality and reliability. At Intersil reliability is built into the product by utilizing only the most modern ultra clean manufacturing facilities, by staffing with the most experienced and well trained personnel available for processing, and by quality monitors of the critical manufacturing steps.

Product Assurance and Quality Control

The Intersil Product Assurance and Quality Control Groups continuously monitor all operations from incoming raw material to shipment of finished product. Intersil's Product Assurance Manual (PA 4000, available on request), is a statement of the policies which insure Intersil's continuing commitment to high quality and reliability standards. This document is based on MIL-Q-9858A, NHB5300.4 (1C), and MIL-I-45208A. A further extension of Intersil's commitment to quality products is the utilization of the companies two in-house scanning electron microscopes (SEM), which are used both as a lot acceptance tool and an in-process monitor on all product lines.

100% Environmental and Electrical Lot Screening

The purpose of this screen is to assure a high level of quality and reliability within a lot of semiconductor devices. Intersil offers a wide range of Hi Rel flow alternatives. This fact allows a user to select an Intersil standard flow or create, through the use of a drawing, a custom made screening program to exactly fit his individual needs. Intersil Product Engineering and Quality Groups often assist the user with the development of this documentation.

Quality Conformance and Qualification

The reliability of a semiconductor device can be established after its exposure to extended time and environmental stress. Intersil maintains ongoing reliability evaluations per MIL-STD-883 Method 5005, Class B, Groups B, C, and D. Mean life evaluation data is obtained by selecting random samples of product on a periodic basis and subjecting them to operating life tests which are performed at accelerated conditions to speed up potential failure mechanisms. Failure analysis is routinely performed on all confirmed rejects to assure that results are pertinent and provide timely corrective action. Summary life test data accumulated on Intersil devices is available on request.

Benefits of Hi Rel Screening

- Increased system reliability
- Reduced system down time
- Reduced in house and field repair costs
- Reduced customer dissatisfaction
- Reduce inspection costs
- User screening programs not necessary

Screening/Conformance Programs

- MIL-M-38510 (1) "JAN"
- MIL-S-19500 (1) "JANTX"
- Intersil screening programs per MIL-STD-883 (See table below)
- Customer custom drawing requirements.

(1) On QPL listed devices only.

Intersil 883 Screening Programs

REQUIREMENT	METHOD 5004 CLASS S	CLASS B	CLASS C	METHOD 5008 HYBRID
1. Internal Visual (Precap)	2010A	2010B	2010B	2017
2. Stabilization Bake	X	X	X	X
3. Temp Cycle and/or Thermal Shock	X	X	X	X
4. Constant Acceleration	X	X	X	X
5 Particle Impact Noise Detection	X	—	—	—
6. Seal (Fine & Gross)	OPT	X	X	X
7. Serialization	X	—	—	—
8. Interim Electrical	X	—	—	—
9. Burn-In	240HR	160HR	—	160HR
10. Interim Electrical	X	—	—	—
11. Reverse Bias Burn-In	72HR	—	—	—
12. Interim Electrical	X	X	—	X
13. Seal (Fine & Gross)	X	—	—	—
14. Final Electrical	X	X	X	X
15. Radiographic	X	—	—	—
16. External Visual	X	X	X	X

Intersil Generic Data Quality Conformance Program

Group A— Group A inspection is performed on each sublot or inspection lot and consists of electrical parameter tests.

Group B— Group B inspection is performed on each inspection lot, for each package type and lead finish. Group B consists of mechanical and environmental tests.

Group C— Group C inspection is performed periodically at 3 month intervals. Group C consists of die-related tests.

Group D— Group D inspection is performed periodically at 6 month intervals for each package type. Group D consists of package-related test.

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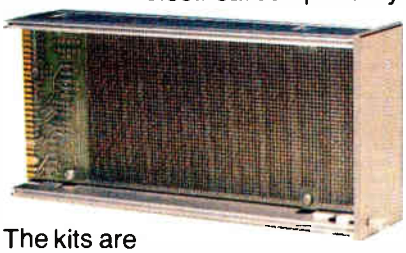

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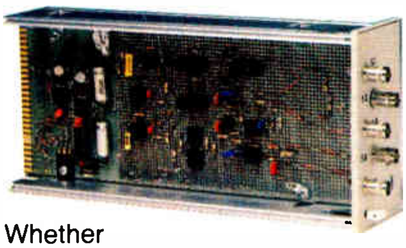

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Will Detroit's needs outpace capacity?

Intel's Grove paints gloomy picture for semiconductor industry, though car makers and rival chip makers are not convinced.

by Bruce LeBoss, New York bureau manager

Not so long ago, semiconductor manufacturers were asking: "Who's going to use all those functions we can put on microcomputer-type chips?" But with large-volume applications for these devices rapidly surfacing in telecommunications, appliance, and automobile markets, among others, at least one industry official now asks: "Who's going to make all those functions?"

The question, posed by Andrew S. Grove, executive vice president at Intel Corp. in Santa Clara, Calif., might cause Detroit's auto makers to shift gears; they see microcomputers and associated circuits as a primary means of meeting mandated fuel-economy and emission standards that go into effect as early as 1980. Grove envisions the auto industry perhaps becoming as major an outlet for microcomputer products as are the data-processing companies. But he believes the semiconductor industry is badly behind schedule in building up capacity to meet the auto makers' microcomputer requirements for the 1980–81 timeframe. In fact, he predicts a catastrophic breakdown in supply.

Not so. That's what Motorola's Colin Crook says to contention that semiconductor makers may not be able to meet autos' needs.

Though Grove's alarming forecast is rejected by both car makers and his competitors, he bases it on several factors that he says they are either unaware of or disbelieve. First, he estimates that in the early 1980s, over 30 million automobiles will be produced annually with three microcomputers or microcomputer-like chips in each car. "That's 100 million microcomputer-type chips per year," he says, "and that's a lot."

He predicts this will cause the same kind of design, production, reliability, and delivery troubles as happened when the semiconductor industry geared up to make 4,096-bit random-access memories. "The only difference is that the auto industry's burps have more decibels associated with them," he adds. Still, he believes a successful supply and technical relationship will eventually be worked out, albeit very painfully for both sides.

The figures. Grove's 100-million-part estimate factors in the mandated conversion for U.S. cars and the assumption that foreign cars will follow two years after. To meet that need, over and above the growth of the semiconductor industry's basic businesses, Grove notes, will require essentially 10 fully utilized wafer-fabrication plants. Each must produce about 10,000 3-inch-wafer starts per week, or a total of 5 million annually. A transition to 4-in. wafers would not significantly reduce the number of starts.

Then, it takes at best about 18 months to construct such a plant and another 18 months to bring it to full capacity. "And I could easily add another year to the total," Grove remarks. Add this time to the long lead times needed to produce these devices in large volume and ship them, and he concludes that the semiconductor industry should have started four plants in the middle of 1977, should start four more in the latter part of 1978, and finally two more in 1979.

So why did the semiconductor industry fail to start four such dedicated plants six months ago? The reason is cost, says Grove. At $25 million each, all 10 plants would cost $250 million, not counting the additional $5 million to $10 million needed per plant for test and assembly equipment. But in 1975–76, the whole U.S. semiconductor industry spent $450 million on all capital investments.

The new need cannot be met by short-changing other customers, either. As the Intel vice president puts

Worried. Nevertheless, Intel's Andrew S. Grove maintains that industry would need 10 new plants just to supply Detroit.

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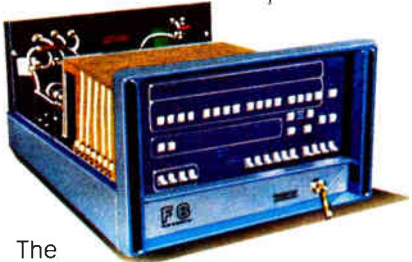

The Formulator family is designed to allow easy, efficient software development and real time hardware simulation of F8 or F3870 based systems. It is supported by a complete line of functional modules including memory, I/O and simulation cards that plug directly into the Formulator cardframe.

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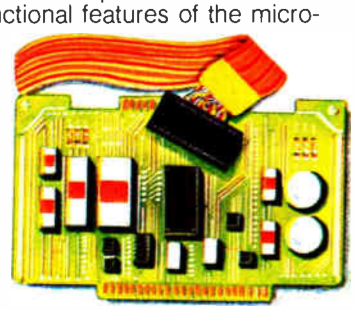

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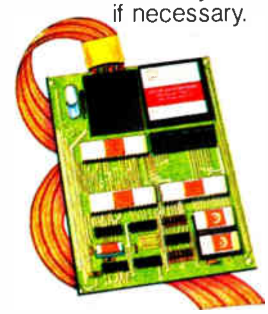

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The software consists of an operating system, utility programs and diagnostic routines; a monitor, text editor, assembler and debug package. It includes linking loader and relocating assembler and will operate in interactive or batch mode. The result is an easy to use, reliable, fast and extremely efficient capability for microprocessor based system development.

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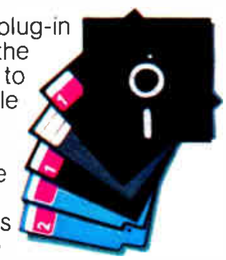

An inexpensive plug-in module interfaces the Formulator with up to four plug-compatible ICOM Floppy Disc Drives, providing over one megabyte of storage. If you prefer other Floppies an application note provides the information necessary to modify Drivers for your system.

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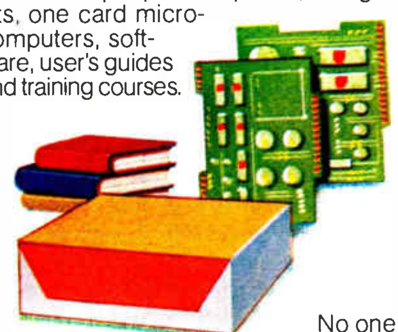

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it, "We can't shut down the data-processing industry in order to supply the auto industry."

Nor is it a simple matter of converting unused capacity, even assuming there is any. Even to take 4-k memory capacity and convert it for 16-k microcomputer devices "is like standing on your head and trying to swallow—it's not the simplest operation," Grove points out. "But to take capacity that's for transistor-transistor-logic production and convert it for 16-k devices is very difficult."

The Intel official does not believe the auto makers will fill much of their requirements themselves, unless they choose to go out and buy a large semiconductor company. Though each of the Big Three auto producers has an electronics-producing arm, they lack advanced semiconductor capability. "Now they may be thinking of building this up, but if I prognosticate 36 months' start-up for ourselves, it's a reasonable assumption that it's going to take them significantly longer to do so, at their speed, and with their start-up problems." Grove says.

His conclusion: getting the auto industry into the electronic age is going to be "a long, laborious and problem-ridden process, something between lovemaking and a wrestling match, and it's going to go on for years and years." As for meeting the auto maker's 1980–81 needs, he says, "I don't know where those devices will come from." Does that suggest the auto companies might not make their mandated targets? "I have fears of that sort."

Others unafraid. The auto companies do not share those fears. Although the exact configuration and quantities needed are still uncertain, according to Don Atwood, general manager of General Motors Corp.'s Delco Electronics division in Kokomo, Ind., the semiconductor industry is seen as having enough capacity for all General Motors and perhaps the entire auto industry's needs. Delco plans to act as a second source to Motorola's Integrated Circuit division in Austin, Texas, in the production of 6800 microprocessor parts for GM vehicles. "We will be subcontracting for a significant portion of devices to firms such as Texas Instruments, Intel, and others." Atwood says. What's more, Delco is expanding its own semiconductor operations "with a view to increasing our capability for metal-oxide-semiconductor-type circuits, including microcomputers."

Chrysler Corp. and Ford Motor Co. spokesmen seem equally confident. Chrysler's Huntsville, Ala., division is already working with several electronics suppliers and, says a company spokesman in Detroit, "they seem to be moving ahead with us and at this point to be in position to handle our needs into the early 1980s."

Similarly, a spokesman for Ford's Electrical and Electronics division near Ann Arbor, Mich., notes that the buyers there "don't see [lack of capacity] as a problem. There's no reason for it; there's enough lead time."

Progress to the rescue. Also, there are several technical reasons why the semiconductor industry should have no problem in meeting the auto makers' requirement, claims Colin Crook, group operations manager for microcomputers at Motorola's IC division in Austin, Texas. "First, we are going to be using 4-in. wafers in high-volume manufacturing," he says. Secondly, "we will be using 4-micrometer technology, which will be just as easy to use then as 6-μm technology is now. Thus, we expect the industry could supply 100 million microcomputer parts annually with about 20,000 4-in. wafer starts per week, or 1 million starts per year."

The key to this overall wafer productivity, says Motorola's microcomputer manager, is getting high probe yields on 3- and 4-in. wafers. "Microcomputer dice sizes for the auto industry are going to be very small, about 150 mils on a side. We are very happy with the dice sizes we've got to support the auto industry, and if others don't have comparable sizes, they still have ample time to come up with them for high-volume manufacturing."

He points out that if it took 5 million wafer starts per year to generate 100 million microcomputer chips, as Grove suggests, "that means getting only 20 finished goods per wafer start." Rather, Crook continues, "you will have to be generating 50 to 100 finished goods per wafer start to be viable." □

Who's selling what to Detroit

While electronic controls are expected to perform numerous functions in the automobiles of the future, most of the attention and dollars are going toward the development of engine controls. Principal applications include: electronic spark advance (ESA) or ignition timing, electronic fuel metering, and exhaust-gas recirculation (EGR). Here's what is being supplied to the Big Three auto makers:

- General Motors. Rockwell International is supplying 10-bit microprocessors for the Misar ESA system that is going into the 1977 Oldsmobile Toronado. Motorola's Integrated Circuits division and GM's own Delco Electronics division will build microprocessor-based engine controls, starting with the 1980 model cars. Both Intel and Texas Instruments are expected to supply chips for the systems Delco will build.
- Ford. Toshiba Ltd., Essex International, Ford's own Electrical and Electronics division are supplying the combined ignition timing and EGR system for 1978 cars, with the Ford division getting its parts from TI and Intel. Motorola and the division will provide the combined ignition timing/EGR/fuel-management system for 1980 cars, with chips supplied by TI and Intel to the Ford division. Meanwhile, Motorola's Automotive Products division and the Ford division are supplying carburetor controls for 1978 cars.
- Chrysler. RCA's Solid State division is supplying an analog ESA system for 400-cubic-inch engines in 1978 cars, and a digital microprocessor-based ESA system for 1978 V-8s and four-cylinder subcompacts. RCA also is competing with TI to supply Chrysler's Huntsville division with chips for a combined ESA-and-fuel-metering system for 1980 autos.

Instrumentation

Tester makers look to big ECL year

Device sales in 1977 rise 50% as mainframe makers rush to replace TTL with subnanosecond-speed of faster logic

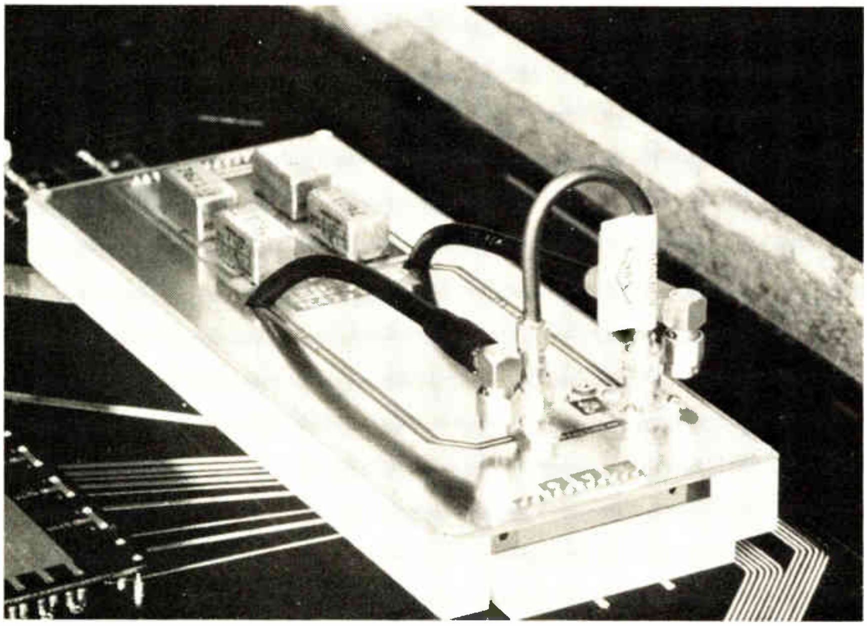
by Larry Waller, Los Angeles bureau manager

For manufacturers of automated semiconductor testers, 1978 dawns as the year when sharply stepped-up use of emitter-coupled-logic devices presents them with a major opportunity.

Spurring demand are mainframe computer producers, most of whom plan next-generation machines in which transistor-transistor logic will be replaced by speedier ECL devices working at nanosecond rates or faster. Already announcing ECL-based mainframes are Honeywell Information Systems Inc., Burroughs Corp., NCR Corp., and Sperry Univac. Also confirming ECL expansion are 1977 device sales, which jumped 50% to $61.5 million, up from $40.6 million in 1976.

Among the first with a device tester is Teradyne Inc.'s Semiconductor Test division in Chatsworth, Calif. Teradyne calls its dedicated S357 pulse parametric subsystem, "the first automatic production tester offering a subnanosecond capability." An add-on to the $125,000 J325 digital integrated-circuit test system, it sells for $215,000 and is the firm's most expensive unit.

Right behind Teradyne is Macrodata Inc., which has promised its new 501E tester, also an add-on, in the first quarter. Macrodata, located in nearby Woodland Hills, Calif., is pricing its package so that, when combined with the large 501 unit, it will cost about $350,000. Although the testing characteristics of the competing units are much the same, Macrodata plans a capability for checking out non-ECL microprocessors and even low-power Schottky TTL devices in some machines.



Test section. Rf matrix of Teradyne's S357 ECL test system. ActuaLLy a pulse parametric subsystem for Teradyne's J325 IC digitaL tester, the S357 sells for $215,000.

Virtually neck and neck with Macrodata is Tektronix Inc., Beaverton, Ore., which "definitely is planning to provide a solution to ECL testing," according to James Fischer, general manager of the Semiconductor Test Systems division. First units will be ready in February, he says, and two are sold. The Tektronix model 1805 takes 64-pin packages in addition to handling closely related current-mode logic. Also, "it measures propagation delays down to 100 picoseconds with a sampling technique, and 350-ps delays as a single shot," Fischer says. Tektronix' price, however, is higher than its rivals': $400,000 to $450,000 as a stand-alone, or $200,000 to $250,000 as an add-on option to the S-3260 IC tester.

Fairchild will weigh in at this month's Internepcon/Japan and International Microelectronics Exhibition in Tokyo with an ECL option for its Century device testers. The time measurement module will sell for $70,000 to $100,000; it will be able to test fast 10,000 and 100,000 series parts, says Gene G. Griggs, product marketing manager at Fairchild Camera and Instrument Corp.'s Instrumentation and Systems Groups in Mountain View, Calif.

The challenge of testing ECL devices derives not only from their speed, but from sensitivity down to 400 millivolts, making them vulnerable to noise transients. Metal-oxide-semiconductor devices, by contrast, have voltage swings up to 15 volts. "The testing crunch comes in measuring the subnanosecond propagation delay, or response time, of the individual device," explains Wayne

D. Ponik, Teradyne's product manager for logic testing, who directs the ECL development.

Teradyne's tester will measure speed down to 700 ps, with a 10-ps resolution over a 0-to-20-ns range, Ponik claims. Also, fully programmable pulse sources have 1-mv resolution from 200 mv to 2 v.

At Macrodata, "we're building an ECL tester targeted at less than 400 ps," says Richard C. McCaskill, manager of application services.

Teradyne's Ponik does not agree that an ECL tester will work as well for MOS devices. "We considered that, too, but in the real semiconductor world you can't do all things equally well. You have to make tradeoffs," he says.

Boards. Along with ECL testing, computer makers need a board-level capability to check for defective connections, poor assembly, and even bad logic parts that somehow slip through. Two board-tester firms are offering this, although they are taking different approaches. Computer Automation Inc.'s Industrial Products division in Irvine, Calif., shows buyers of its Capable family of board testers how to program for ECL. Fluke/Trendar Corp., Mountain View, Calif., has an $18,000 interface option that converts its 3040 logic tester into an ECL board tester.

The Fluke board tester has a proprietary "dynamically active control-sensing circuit" that converts its standard TTL testing to ECL levels. This circuit can tell if a board pin is receiving or sending a pulse and switch the interface accordingly at the right speed, according to Don Allen, vice president of marketing. The interface has 30 cards with 16 circuits per card.

Although Computer Automation supplies its ECL programming as part of the universal tester price, and Fluke charges $18,000 for its interface, total tester prices are comparable: in the $100,000 range.

At GenRad Inc. in Concord Mass., Arthur Boudreault, marketing manager of the component test product line, agrees that the mainframe houses will turn to board-level testing. But he won't say if GenRad is also going to bring out an ECL device tester. □

Electronics abroad

French economy has a chill

Inflation, negative balance of payments, high unemployment could hold growth to 3.25%, as election also casts a pall

by Andrew Lloyd, McGraw-Hill World News

The ailing French economy has not yet been consigned to the ward for the "sick men of Europe"—but it risks turning up there next year. Among the symptoms: inflation barely below double digits, a negative balance of payments, and dangerously high unemployment.

Worse still, the prognosis for 1978 is at best uncertain and will not be known for sure until after the national assembly elections in March. Although the French government is still forecasting a 4.3% growth in gross domestic product in 1978, up from 3.1% last year, economists at the Organization for Economic Cooperation and Development say 3.25% is a better figure. They also maintain that inflation will run more than a full point higher than the official French forecast of 7.6% for 1978. Further, the OECD warns that unemployment will rise appreciably unless the government makes drastic changes in its employment policy.

Everybody's predictions could be off the mark if the somewhat shaky coalition of the Socialists and Communists wins the election. Forecasts of what would happen then vary according to the politics of the forecaster. Most electronics executives hope the establishment parties win and the status stays quo. But the election is a toss-up and there is concern over the outcome, particularly at a number of candidates for nationalization—ITT subsidiaries, the Thomson-Brandt Group, and the Compagnie Générale d'Electricité.

Meanwhile, there are markets to cope with in France. *Electronics'* annual survey shows that firms are estimating a 10.3% overall increase in 1978, to just over $7 billion for equipment and components. For equipment alone the rise in sight is 10.3%, which would carry the market to $5.7 billion. In components growth, the increase is pegged at 10.4% and the total market at $1.35 billion.

Mixed picture. Assuming that little changes after the elections, the forecast for the consumer sector is $1.928 billion with black-and-white TV set sales dropping from $144 million to $129 million. Sales of color sets will reach $722 million from $660 million in 1977. The electronic watch and clock market will rise by almost 70% to $51 million, with still-illegal citizens' band transceivers up 11% to $10.3 million.

Some markets should be pretty stable whatever the election results. Defense and communications equipment suppliers, for example, can count on already approved public credits. The postal and telecommunications agency's massive program to get its long-neglected telephone network into the second half of the 20th century is in full swing. Spending for electronic and semielectronic switching in 1978 is set at $164.9 million—up 66.6% from last year, which was 37.1% more than the figure for 1976.

The next year should see the start of France's facsimile transmission program. Four French firms have recently won a contract to develop a $200-to-$300 two-minute telecopier. Each will develop a prototype; then one or more will be selected to build 120,000 a year. This first giant step toward electronic mail also could give French firms a leg up in export markets.

The military-equipment suppliers

FRENCH ELECTRONICS MARKETS FORECAST
(IN MILLIONS OF DOLLARS)

	1976	1977	1978
Total assembled equipment	4,682	5,176	5,712
Consumer electronics	1,622	1,776	1,928
Communications equipment	1,228	1,365	1,527
Computers and related hardware	1,321	1,499	1,680
Industrial electronics	178	187	200
Medical electronics	147	159	165
Test and measurement equipment	136	146	153
Power supplies	50	55	59
Total components	1,104	1,225	1,351
Passives	650	719	796
Semiconductors	251	285	321
Tubes	203	221	234

Note: Estimates in this chart are the consensus estimates of consumption of electronic equipment obtained from a survey made by *Electronics* magazine in September and October 1977. Domestic hardware is valued at factory sales prices and imports at landed costs. Exchange rate: $1 equals 4.85 francs.

sum up the outlook for 1978 as better than in the past few years, but not great. Recently, the defense budget has remained stagnant in real-money terms. This year, the budget should carry a 10% to 15% rise in defense electronics equipment purchases. Adding to the general air of assurance in this sector, Thomson-CSF's senior vice president, Edouard Guigonis, says that his company's order backlog is still running high and is equivalent to more than a year's sales.

Computers up. Along with the military and communications markets, computers and related equipment are expected to do well—but not quite so well in 1978 as in 1977. Growth this year is put at 12.1% compared to 13.4% in 1977. The total market is estimated at $1.68 billion.

The fortunes of France's CII-Honeywell Bull, though still far from asured, are at least good enough for the company to say it has met its initial targets. More surprisingly, the sales of the near-IBM-compatible Iris 80 series, the original product of CII, have soared beyond expectations, giving the company a headache as well as fattened coffers. The enlargement of the Iris customer base means the company will have to take even greater care of them when it comes up with a successor model, which it is hoped will bring the CII and Honeywell lines together.

On the components side, integrated-circuit sales will continue their rise—18% in 1977 to 18.4% in 1978 for estimated sales of just over $150 million this year. IC makers are set to get a $125 million boost over the next four years through a government aid plan to get French firms firmly established in the custom chip markets. But some industry executives are skeptical about the plan. Thomson-CSF, for one, is going ahead with negotiations to team up with an American semiconductor partner.

Thomson's rival, CIT-Alcatel, is aiming to build up its design expertise. Director-general manager Georges Pébereau says the company is conducting "important negotiations" for a possible special relationship with a supplier—"maybe Philips," he hints. □

Companies

Zilog: high flyer is first of its kind

First company dedicated to building microcomputers as systems has grown to $10 million in sales, expects $30 million in 1978

by William F. Arnold, San Francisco bureau manager

Neither a semiconductor nor a computer company, Zilog Corp. is both: the first firm devoted to the manufacture of microcomputers. With venture capital provided by Exxon Corp., Zilog has blazed a trail since it burst on the scene two years ago with its Z80 microprocessor. It is a trail that could serve as a path for similar future companies.

The Zilog formula is simple in concept—control both the silicon and the system: that is, build chip families and supply the software for them. So, the $10 million company has leaped forward with a family of software-compatible peripheral and memory chips to work with the Z80. Soon it plans to further challenge companies like Intel Corp. by offering new microcomputers and other new parts to bracket the powerful Z80 microprocessor.

Can Zilog keep trying to outdo Intel, not to mention Texas Instruments, Motorola, Fairchild, National, and other entrenched competitors? "Next year, we will clearly out-Intel Intel," declares Ralph K. Ungermann, executive vice president. "Our advantage is that we're a microcomputer company, dedicated to being the No. 1 microcomputer company."

What may distinguish Zilog is that, having set its sights on the flourishing microcomputer business, it is emphasizing software and systems in developing its growing product line. Thus, Ungermann says, the software-compatible parts up and down the line will be able to talk with each other.

Ungermann expects about a 300% improvement in sales to $30 million this year, and he has three arguments for a continued steep growth curve. One is the very large microcomputer market itself. "Two is that the Z80 is recognized around the world as the highest-performance computer," he says, and three is the Exxon financing. "We're a very well-financed company," he says.

Goal. Executive vice president Ungermann says Zilog will out-Intel Intel in 1978.

Looking ahead. For the far future, says president Faggin, SOS is the technology.

Although Zilog does not expect to triple sales again in 1979, "we're not going to pause at $30 million to $40 million by any means," Ungermann asserts. "Our strategy is to participate in the high end of the market. As we grow, we will change to a high-volume market." This means more new products. When the Z8 and Z8000 come out, "of course we'll make it as easy as possible to put large memories into microcomputer systems," and Zilog plans to integrate all products into systems, subsystems, and boards this year.

Technologically speaking, Zilog sees n-channel processes as "the workhorse of MOS technology; the arsenal, if you want" into the 1980s, in terms of performance and volume, according to Faggin. "We guess by then we'll find some limitations as with any technology," he surmises, mentioning the speed-power product and power dissipation. Until then, like Intel and Mostek Corp., "we'll keep it the basic concept in MOS technology by scaling. Silicon on sapphire looks like it will be the technology of the future—not the immediate future but in the long term," Faggin declares.

Timing governs much of Zilog's strategy. The Z80 came out two years after Intel's 8080 but "that didn't harm us," Ungermann says, because the design-in phase for microcomputers is long: about five years. Thus, "our approach with the Z80 was to come out with a processor that was far more powerful than the competition."

Also helping market penetration was Zilog's choice of second sources. Mostek Corp. is a strong partner, one reason for the success of the Z80, Ungermann says. □

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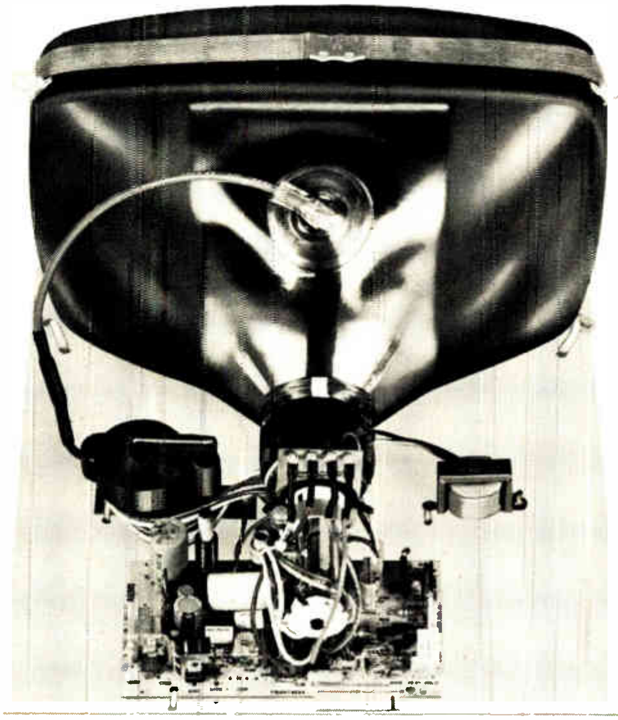

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Government

Massachusetts firms strive for change

New high-technology council, including 20 electronics companies, seeks to make it easier to find qualified people and to cut taxes

by Lawrence Curran, Boston bureau manager

The Commonwealth of Massachusetts, with its proud record of attracting innovative high-technology companies, is driving them and their jobs out of the state. That's the message that will be hammered home by the recently formed Massachusetts High Technology Council in a major effort to reverse the trend [*Electronics*, Nov. 24, 1977, p. 35].

Of the council's original 37 members, more than 20 are electronics companies. All agree that there are two major parts to the problem. The first, according to a council position paper, "is that [we] cannot find enough people in Massachusetts with the right education and skills to meet [our] rapidly expanding needs." High personal taxes in a commonwealth often referred to as "Taxachusetts" is the second, putting member companies at a disadvantage when they try to recruit electronics engineers, programmers, and technicians from other states.

Ray Stata, chairman and president of Analog Devices Inc., is president of the council. He says the organization will complement, not compete with, such other organizations as Wema, which is becoming a national organization to get member-company issues aired in Washington.

The council wants its voice heard in the state legislature, and Massachusetts educational and financial institutions. The long-term goals include making the legislature aware of the impact on high-technology companies of pending legislation, to make it clear to educational institutions that council members face an expanding need for highly skilled engineers and technicians, and to make the personal tax burden "no greater than that of the 17 manufacturing states with which we compete for people," Stata says. That tax, in fiscal 1976, come to $903 per capita, or 22.4% higher than the other 17 states' average of $738. The overall U. S. average is $731, with only New York and California ranking above Massachusetts.

And Massachusetts companies are not alone. Electronics executives in the other high-tax states, especially California, are also making remarks about needing relief even as they locate new plants out of state [*Electronics*, Dec. 22, 1977, p. 81].

On the education front, Stata says he has talked to officials at the Massachusetts Institute of Technology and Northeastern University, and learned that the number of engineering school graduates has remained essentially unchanged for 10 years. "That's a significant problem," Stata observes, "and probably a nationwide problem. We think we can do things to change that. We've got to change the image of high-technology careers through such things as high-school career fairs."

Persevere. Stata cautions council members, who by charter must be the highest officer of the business unit located in the state, against expecting "overwhelming accomplishments in the near term. We have to adopt a 5- to 10-year perspective, stick at it, and gradually the environment will get better."

But some of the moving forces

Change makers. Among electronics chiefs on council: from left, Unitrode's Berman, Data General's deCastro, Prime's Fisher.


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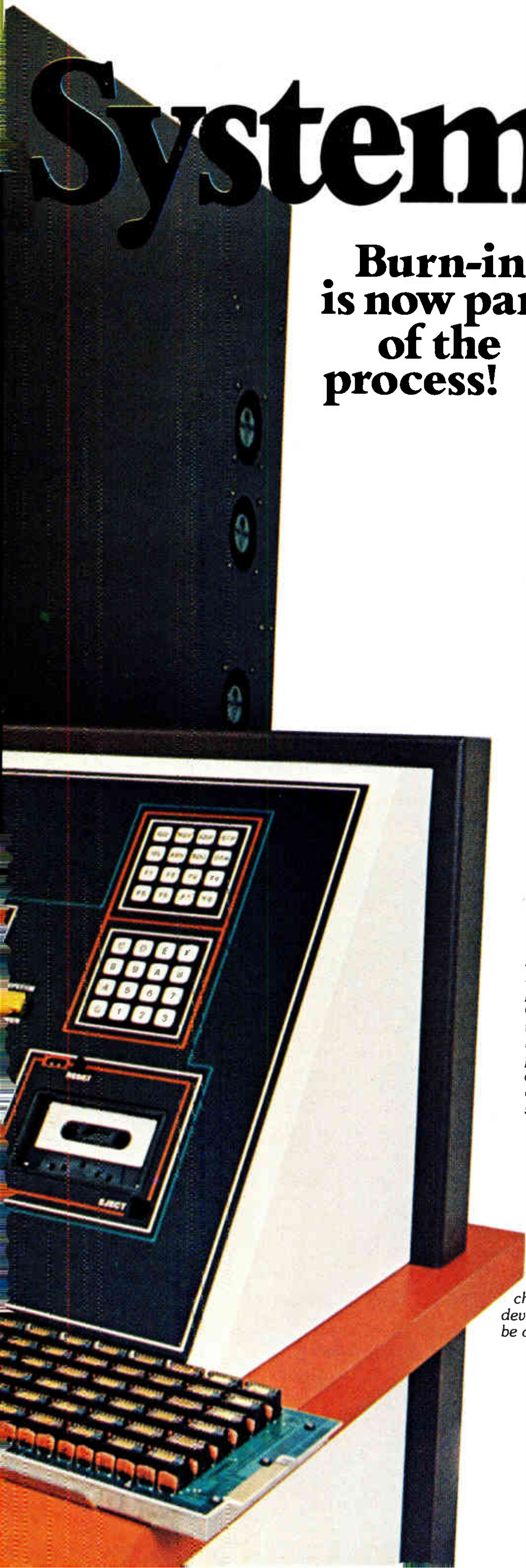

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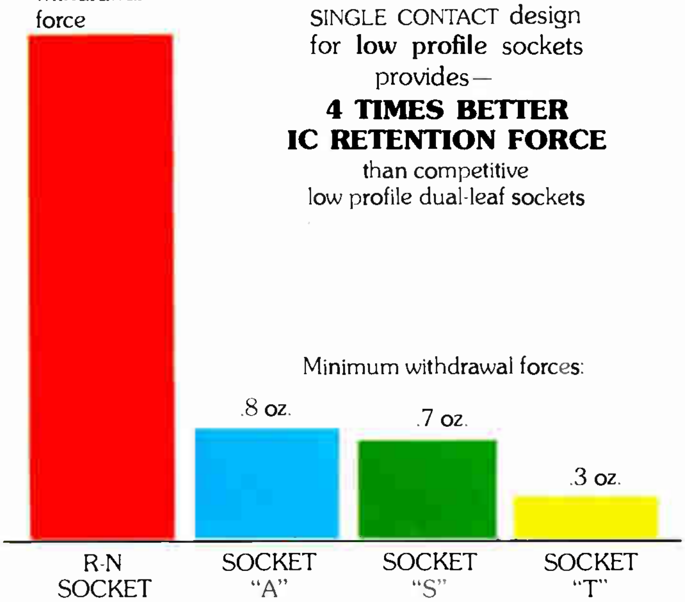

* In "Fat-Skinny test," withdrawal forces are measured using the smallest size (.008") lead **after** insertion of **largest** size (.012") lead.

Representative NORMAL FORCE Test Scores for 10 R-N ICL low profile sockets

TEST SOCKET	NORMAL FORCE *
1	410 grams
2	465 grams
3	480 grams
4	465 grams
5	395 grams
6	425 grams
7	465 grams
8	395 grams
9	410 grams
10	425 grams

AVERAGE – 430 grams

This force is 4 to 5 times greater than average dual contact socket NORMAL FORCE

* NORMAL FORCE means force perpendicular or at right angles to IC lead. The single ICL contact exerts this kind of force against the IC lead when inserted into the socket.

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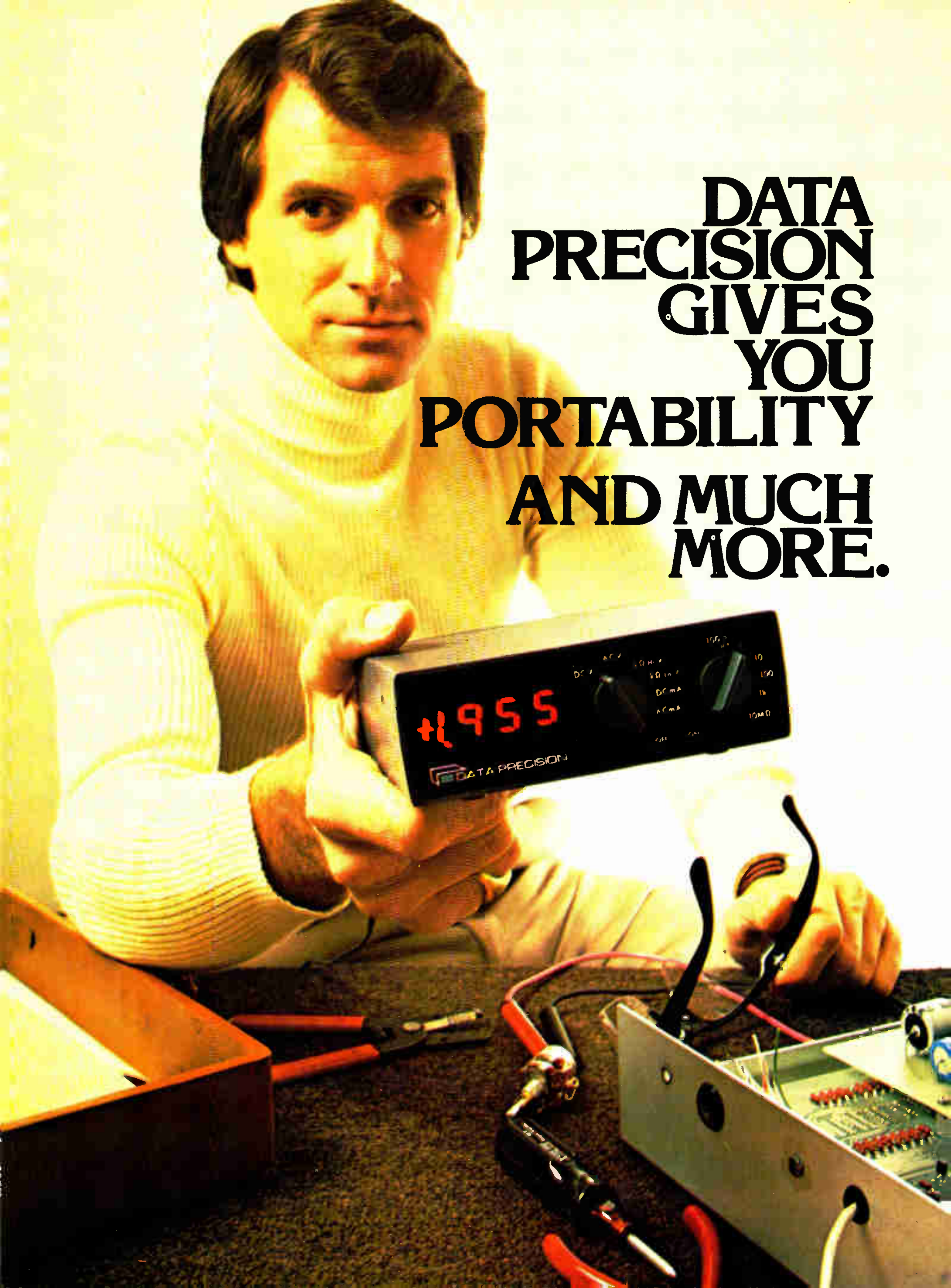
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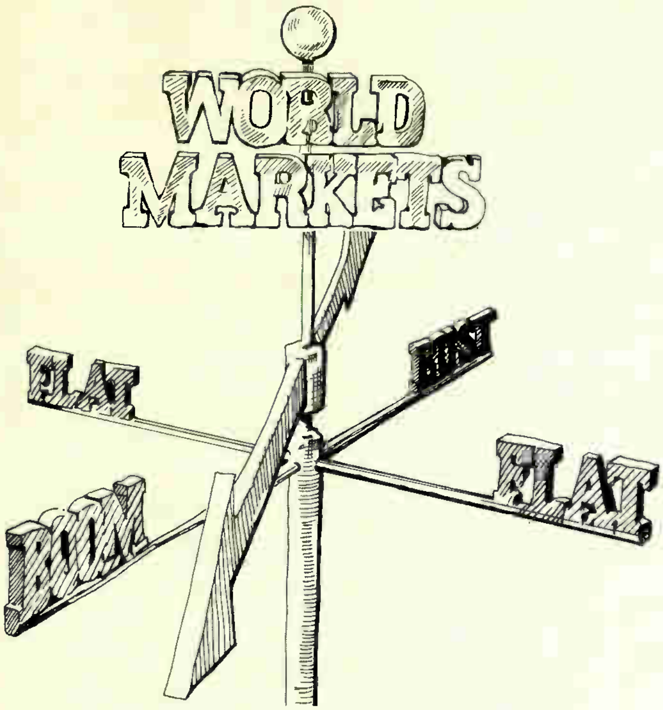


Worldwide equipment sales to top $100 billion

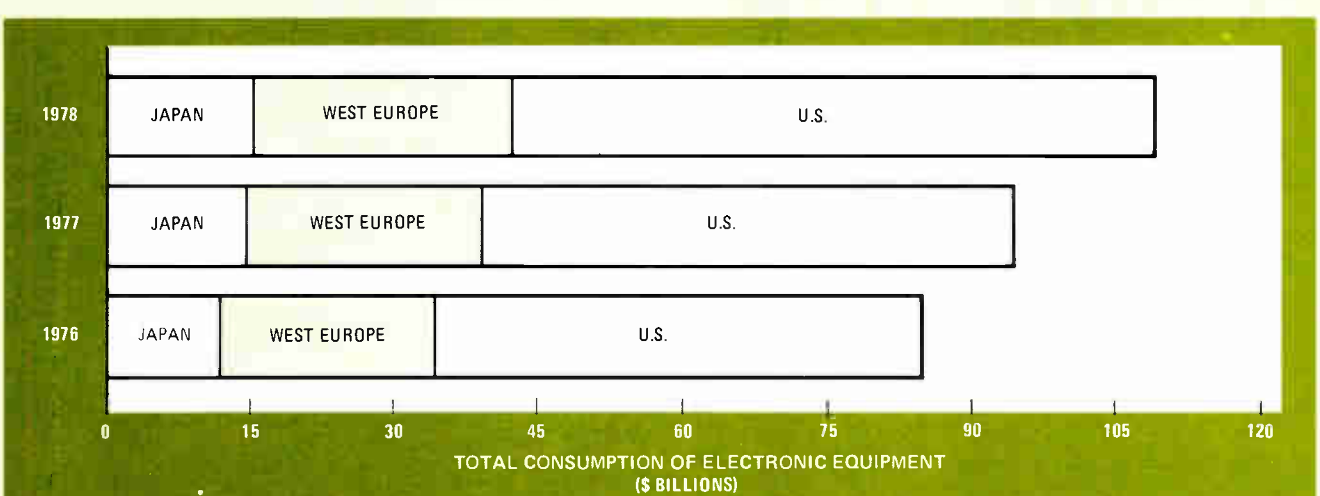
☐ Steady growth, rather than boom or bust, appears to be in the winds for the world's electronic industries. This year, the combined electronics equipment consumption of the United States, Western Europe, and Japan will for the first time pass $100 billion and hit over $107 billion. Derived from surveys conducted by *Electronics*, the figure represents an 11.7% growth for these major markets.

Once again consumption of electronics equipment in the United States is leading the way with a better-than-13% gain for 1978. Equipment consumption in Western Europe should register a 9.3% rise, about even with the 9.4% growth rate of 1977. Japan, meanwhile, expects a slight decline in growth rate this year from 11% to 10.4%. The combined consumption in the three markets last year came to more than $96.7 billion for a 12% increase over the previous year, according to *Electronics'* survey.

Nevertheless, each of the major market areas has economic problems. A continuing one is the impact of energy costs. Also, all the countries involved are grappling with difficulties due to trade imbalances, in particular, the impact of Japanese exports on the U. S. and Europe or, to look at it from the other side, the impact of an overseas cutback in demand on the export-dependent Japanese producers. The arguments over tariffs and quotas involve not only steel, textiles, and automobiles, but television sets, microprocessors, and computers as well.

As for worldwide developments, the major one is the application of microprocessors to a whole range of products. The U. S., with a total microprocessor market this year of $250 million, has enjoyed a lead both in technology and in applications. But others are closing the gap ($55.9 million in Europe and $77 million in Japan), making microprocessor uses an arena for international competition.

Aside from these overall challenges, the U. S., West Europe, and Japan face individual uncertainties. For the U. S., the $65.8 billion in total equipment consump-



Steady as she goes. Total consumption of electronics equipment in the United States, Western Europe, and Japan should increase this year past $107 billion for a growth of not quite 12% overall. Consumption in the United States should again lead in growth rate with a 13% gain.

tion predicted for 1978 is premised on solid increases in data-processing equipment propelled by microcomputers, in consumer products paced by good TV and video cassette recorder sales, and in Federal electronics mobilized by defense spending. The uncertainties include what actions the Federal government will take affecting energy costs, tax reform of capital investment credits, import protection, and funding for R&D. These actions could be especially important to sales of test and measuring instruments as well as industrial electronic controls.

In Europe, West Germany, France, and the United Kingdom still lead in dollar value—$8.73, $5.71, and $3.9 billion respectively—of the $26.8 billion total electronics equipment predicted for this year. But there are differing ups and downs within categories from country to country.

In color television, for example, the sales pace has slowed in West Germany and dropped in Scandinavia, while sales are good in France and just starting to take off in Italy and Spain. Total consumer electronics consumption in Western Europe, up 7% last year, is not expected to grow over 6% this year to $9.2 billion.

While the vanguard consumer products are dawdling, both computer and communications equipment in Europe should move up nicely. In fact, aided by government projects in various countries, the $7.95 billion total for computers and related equipment will mean a growth of 13% in 1978. Communications will probably move up to $5.7 billion this year.

On the whole, the rise in equipment sales this year will be the same as last year. It won't be much to cheer about, but will be better than the confusing general economy of these countries.

Japan probably faces the most trying period. The domestic economy, after a difficult recovery from the oil crisis recession of 1974–75, turned sour again last year. During this time the electronics industries rebounded, because of their strategy of exporting their way out of trouble. But now this approach is being questioned, and Japan's electronics producers are coming to grips with the need to lessen their dependence on exports and stimulate demand at home. Of course, Japan will probably always need an export market to keep its production wheels turning. But its importance will diminish if the entire nation—government and industry—decides to restructure its economy.

Meanwhile, other countries in Asia are gathering the wherewithal to take over the export role that Japan is partly vacating. Today, Taiwan and South Korea are becoming technically sophisticated manufacturers in their own right.

U.S. MARKETS

☐ The way the wind is blowing, the signs point to a good year for the electronic equipment markets in the United States, although some products may experience a change in direction by the fourth quarter. Total growth this year should be slightly over 13%, reaching to $65.9 billion, according to the annual *Electronics* forecast. Since growth last year was almost 14%, to $58 billion, the industry appears to be on an even, though unspectacular, course for now.

All the major equipment product categories are aiming upward, with especially good years expected for data processing ($24.6 billion), consumer ($12.3 billion), and yes, Federal electronics equipment ($18.2 billion). The communications sector took a dip last year primarily because of the collapse of the citizens' band transceiver market. But even with moribund CB sales this year, total communications equipment consumption of $3.6 billion will be back on the plus side.

As usual, the electronics industries will outpace the general economy this year, though the worries besetting business enterprises generally are also troubling electronics producers. McGraw-Hill Publications Co.'s Economics department predicts the real Gross National Product will grow about 4.2% this year, compared to 4.8% gain last year and the much better 6% growth rate of 1976. Industrial production is forecast to rise to a bit less than 5% in 1978, which compared with gains of nearly 6% in 1977 and more than 10% in 1976. Real capital investment will rise only 3% in 1978.

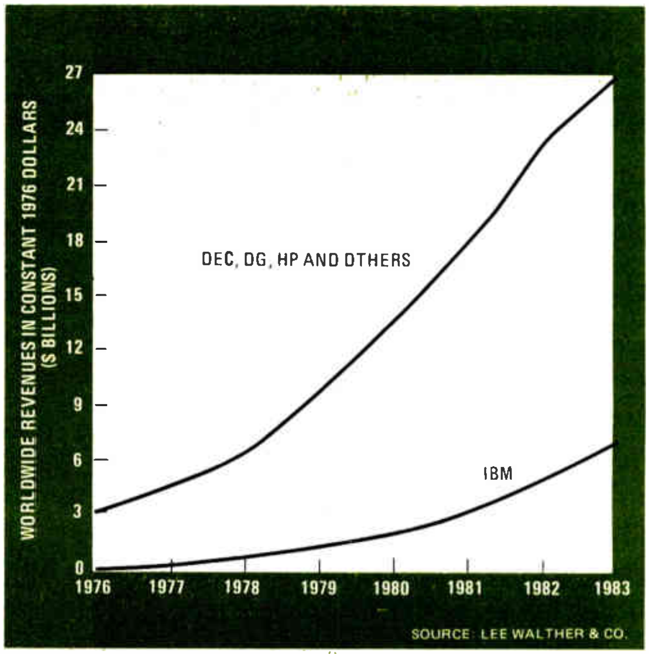
The problems confronting the economy are: inflation, pegged at 6% per year; unemployment, still hovering around 7%; balance of payment deficits; and energy.

How these economic factors will affect the electronics markets remains to be seen. For now, at any rate, there is an air of cautious optimism down the line in the components and semiconductor sectors, which usually set the tone for the equipment producers later. Semiconductors are expected to gain by a modest 10% this year to $3.6 billion, whereas components should slow to an 8.7% growth to $6.7 billion.

A bright outlook all round

The close of 1977 left many manufacturers in the data-processing industry pleased with a year of unexcelled growth—as high as 50% in the youthful, microcomputer-related areas. And this year even the grandaddy mainframes will manage a spurt, despite a slower overall market rate of expansion, as deliveries of 1977 orders boost their annual factory sales by 12% instead of the previous 9%. The total market in all computers and related equipment should rise to $24.6 billion from 1977's $21 billion.

Peripheral equipment is one area that is being heavily fueled by microcomputers. Fast becoming as much a commodity as smaller integrated circuits, the powerful little processors will help this year's factory sales of memory systems rise 14% to $585 million, low-speed printers rise 31% to $422 million, and terminals grow 22% to $1.4 billion.



Minicomputer futures. The minicomputer market will continue to flourish, and although IBM Corp. currently has only a small market share, many industry observers predict that the company will manage to grab a 14.5% share in 1980 and 25.4% by 1983.

Terminals prosper

Printing and display terminals are doing particularly well. For one thing, users of mainframe computers are subscribing more to multi-user, interactive processing approaches, rather than batching up jobs, and are therefore spreading more work stations around than ever. But giving the printer/displays an even bigger boost is the increasing popularity of the distributed processing networks that hook up many minicomputers.

This trend of course aids minicomputer sales, too. Although not as ebullient as the microcomputer-system market, minicomputer shipments this year should reach about $3.7 billion. Under attack from below by high-performance microcomputers, minicomputer makers are retaliating with low-end minicomputer- and microcomputer-board products and are also marketing what are essentially interactive mainframe products costing upwards of $1 million. Diversification of this nature is only to be expected in the face of heightened competition from IBM Corp., since in the eyes of many market observers its Series/1 minicomputer will grab 17% of minicomputer sales that could approach $18 billion worldwide by 1981 (see figure).

Mainframe activity

IBM is also being far from idle about its mainframe computers. Its recently introduced 3031, 3032, and 3033 processors already have orders extending out several years, and it has made across-the-board purchase and lease price cuts. As the company is well aware, the mainframe market is in a state of change despite the heavy shipping that will be happening this year. The increased plug-compatible competition, compounded by a looming Japanese threat, has IBM boosting its marketing force and encouraging outright sale of computers over rental or lease.

As befits their junior status, small-business systems will enjoy a better year than ever. Another microcomputer beneficiary, they will garner 20% to 30% more factory sales dollars. Systems for inventory maintenance and transaction accounting are just reaching into what research firm The Yankee Group of Cambridge, Mass., predicts will be a market of $2.2 billion in small retail businesses alone (those with less than $500,000 annual sales and more than 10 employees).

Electronic funds transfer will open up new markets within the next several years, pending Government legislation over banking regulations and security issues. In the meantime, point-of-sale terminals will exhibit growth of 14% to $691 million, while other transaction-related processing systems such as optical character readers, magnetic-card readers, and electronic data security systems will sell steadily until the regulations for electronic funds transfer are finally clarified.

New office jobs

Accelerating the approach of the all-electronic office are word-processing systems. The market should rise 35% this year to $950 million and promises to explode by 1981. Comprising processors, memory subsystems, printers, and other terminals, such systems look like they should be yet another shot in the arm for peripherals. In particular, there should be a growing demand for miniature flexible-disk drives, sales of which will rise 25% to $10 million.

1978 has a hard act to follow

Last year was so good, consumer electronics producers hope their unexpected luck will last them well into the New Year. It may be the second half before they start doubting if they can repeat 1977's glorious 17% leap in market dollars.

As the industry gathered in Las Vegas this week for the Winter Consumer Electronics Show, the odds for 1978 looked favorable—an 11.1% rise to $12.3 billion. The television companies are betting on consumer video tape recorders made in Japan, though cut-throat pricing is already causing jitters. Video games, the other high roller in the TV market, are also scoring well and should hold up again this year if component shortages do not cause more delays. And, not to forget the biggest draw of them all, color television should stand pat, but with a pretty good hand.

Even digital watches, which had a shake-out last year, and hand-held calculators, which are essentially a three-company competition, should come up with a decent year. Microwave ranges continue to roll, although the Japanese have now introduced the programmable feature and will erode the present American lead. Most segments of the audio market, from the expensive high-fidelity components to tape players and a-m–fm radios, should come out ahead again this year.

For all this optimism, no one expects 1978 to be easy. Even the early takeoff of home video tape recorders has its dark side. Last year, it is generally agreed, 170,000 VTRs were sold, mostly in the final four months as the Japanese makers began landing their own models and those manufactured under U. S. labels.

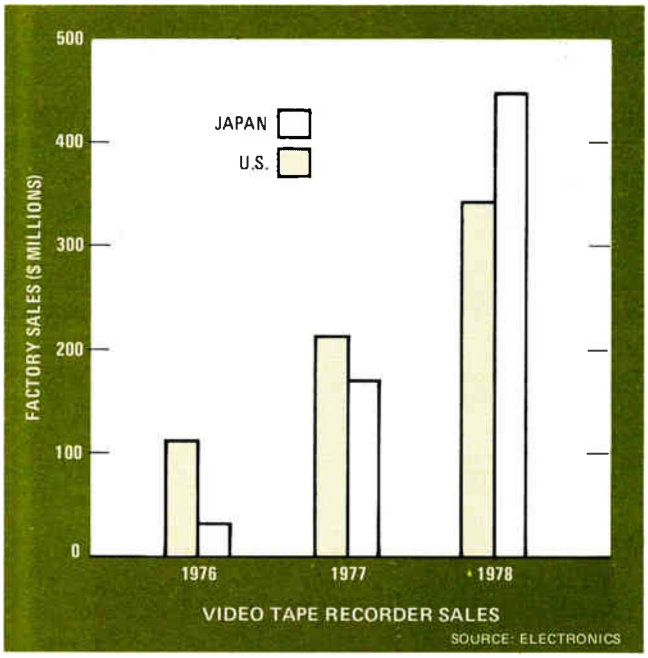
This year 500,000 to 750,000 units could bring in $450 million—provided that Japanese production gets up to speed and sales resistance erodes faster than prices. Their early units, of course, almost sold themselves to the gadget buyers who sop up all the latest novelties, but now the industry has to get out and start selling.

All things considered, though, growth this year should be 10% or more compared to 1977. Last year's 17% gain was even a few pegs above the 14.5% predicted by *Electronics* a year ago, thanks mainly to the record-setting months of TV sales in the second half.

Color TV boosts its ratings

While all eyes were anxiously on the VTR's reception, color TV jumped up and surprised everyone. Instead of the 8.5 million units in dealer sales predicted, the industry moved close to 9 million units and could sell up to 9.5 million this year. In dollars it translates into $3.25 billion for 1978, a 17% gain over 1977, according to the *Electronics* consensus. This year dollar value will be flat—only a 1% gain, manufacturers report.

American producers were successful in getting a quota on Japanese imports, and it had an immediate effect. The Japanese share of the U. S. color TV market fell to below 40% in portable and table models, down from 46.8% in 1976. But the low-price slack is already being taken up by producers in Taiwan, as expected.



VTR picking up speed. Although sales of video tape recorders in Japan have been ahead of those in the United States till now, the American market will really get rolling this year, passing the total in Japan and reaching almost half a billion dollars.

Unexpectedly, though, a foreign incursion in low-end video games failed to materialize to any great extent last year, in part because the perennially long lead time in game chips slowed down the plants in Hong Kong, Korea, and Taiwan. Sales of around 6 million units are estimated for last year, 500,000 to 600,000 programmable types and the rest dedicated. This year the estimate is for 1 million to 1.5 million programmables and 8 million to 9 million dedicated games. Coming up fast too are non-video games and electronically controlled toys, which could add another 3 million to 5 million units to this market category.

Outside entertainment, consumer electronics products in 1978 will be a mixed bag. According to the *Electronics* survey, electronic watches, both digital and analog, should gain 11% this year, reaching $395 million as the market settles into a liquid-crystal-display era. Hand-held calculators are like radios in having no apparent saturation point—their dollar value this year should ease upward to $657 million. Having zoomed past the 2-million-unit mark last year, microwave ranges should settle in this year at about 2.75 million units or $1.07 billion, passing the $1.050 billion anticipated for combined sales of gas and electric ranges. The big sellers will continue to be the microprocessor-based programmable models.

Earth terminals fly, CB slumps

For some makers of communications gear, 1977 was definitely a year to drink to. But poor sales of citizens' band radios depressed 1977's totals, which were down 5.6% from 1976, and seem likely to drag down 1978's totals too. However, exclusive of CB, consumption of communications equipment last year was up 20% over 1976 and this year will be up 15% over 1977.

The market in satellite earth terminals for cable television should double in 1978, and later small earth terminals will get a boost when the SBS satellite network becomes operational. Although this and other all-digital land networks will cut into the modem market, they will act as a catalyst for the high-speed facsimile market. And this year fiber-optics consumption should jump from $10 million to about $25 million, on its way to a $1 billion market a decade from now. Even land-mobile radio continued to grow at a steady 10%, with much of that growth in replacement equipment and new portable units for police and others involved in public safety.

CB shakeout

The drop in CB radio sales last year was due in part to the continued availability of 23-channel sets, which were sold off at a discount, and consumers' reluctance to purchase costlier 40-channel sets. Altogether, *Electronics* estimates only 10 million sets or so were sold in 1977 at an average factory price of less than $40. And although some industry sources see annual sales of 10 million to 12 million sets continuing through 1981, *Electronics* expects only 6 million CB sets to be sold this year at a $55 factory price tag. Why the decline? For one thing, CB is no longer all that fashionable. For another, high-noise urban areas are frustrating the growing number of people attempting to use CB radios there—a problem that will get still worse in 1979 when the sun-spot cycle is at its peak.

Even so, users seem to want CB to evolve into a workable, personal-communications link. As this trend gains momentum, the Federal Communications Commission will feel pressure to provide spectrum in the 800-megahertz region, something it has been considering. That could bring a whole new class of CB radios on the market by 1981. At an average factory selling price of about $150, about 7 million sets could chalk up a market in excess of $1 billion.

Bright future

Another relative newcomer, fiber optics, is moving into telephone communications, interconnections to computers, industrial process-control systems, and head-end and distribution trunking for cable television, as well as master antenna TV systems inside apartment buildings and the like. However, any company wishing to cash in on this potentially lucrative marketplace (see table) will have to set up an organization capable of providing all the needed components for a complete fiber-optic system, at least until users become sophisticated enough to abandon one-stop shopping.

U.S. MARKET FOR FIBER OPTICS
(IN MILLIONS OF DOLLARS)

Year	Cable	Sources	Detectors	Connectors	Total
1977	7	0.78	1	2.2	11
1978	16	2	2	6	26
1979	38	4	3	8	53
1980	93	9	8	7	117
1981	133	11	11	7	162
1982	203	15	16	9	243
1983	352	37	27	13	429
1984	545	42	38	16	641
1985	668	52	49	21	790
1986	824	63	62	20	969
1987	1024	74	80	22	1200

SOURCE: INTERNATIONAL RESOURCE DEVELOPMENT INC.

Last year the Mutual Radio Broadcasting System, the country's largest radio network, petitioned the FCC for permission to become the first one to be connected by satellites rather than land lines. The petition included the request to be allowed to erect small receive-only terminals without first having to file with the FCC. If approved, it might well encourage other nets like UPI and Musak to put up terminals, too, and the U. S. market in small earth terminals could grow rapidly. Right now the demand for satellite ground stations comes mostly from overseas, and manufacturers are waiting for the Satellite Business Systems, the joint IBM-Comsat-Aetna venture, to create substantial domestic business.

The all-digital SBS system, on one hand, would help the earth terminal and high-speed digital facsimile markets, but, on the other hand, could hurt the modem market. Meantime, though, modem consumption should remain stable with 5.6% growth this year, with low-speed modems losing ground to high-speed types as technological advances permit higher-speed transmission using voice-grade lines.

High-speed facsimile

As for fast facsimile machines, the entry of new companies into the field will probably lower their price—a development made all the more likely by the French post office's recently announced plan to buy a million 1-minute digital faxes from anyone capable of building them at a cost under $300 each. This will undoubtedly increase their attraction, especially once they can be linked with low-cost, large-bandwidth transmission services such as those now available or coming on line over Bell's data network, private packet-switching nets, and the SBS network.

All areas doing well

Having drawn almost straight As in 1977, industrial electronics this year could even improve on that excellent grade average. An outstanding 1977 saw U. S. consumption increase 14.22% over 1976, and manufacturers of industrial electronic equipment are looking forward to a solid 16% increase this year.

Making the prospect less than inevitable, though, and maybe even reversible, are the classic economic threats to growth in this area: inflation, a declining U. S. economic growth rate, rising interest rates that limit the investment capital available for expansion, and shortages of raw materials. The energy shortage and rising environmental concern, on the other hand, could turn out to be positive factors.

In this context, what kind of showing can be expected from the three important segments in the industrial control market—process control, numerical control of machine tools, and energy management? In 1977, consumption of electronic equipment for process control—inspection systems, thickness gages, process controllers and indicators, sequence controllers and process-control computers—reached $585.2 million, according to the *Electronics* survey. During the same 12 months, the total for electronic equipment for numerical controls climbed to $97.6 million, compared to $77.9 million for the previous year. The relatively new but important energy-management electronics field became a $35.1 million industry in 1977.

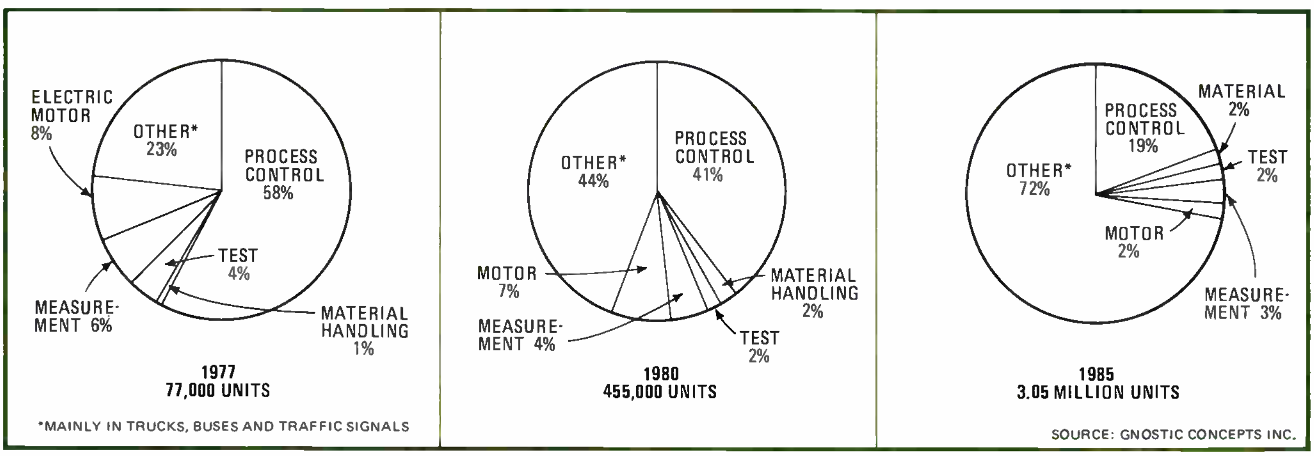
Process-control electronics will score the lowest grade this year. Its customers, particularly in the chemical, petrochemical, and petroleum-refining industries, as well as in the presently depressed steel industry, will not be increasing their overall spending on capital equipment very much in 1978. The McGraw-Hill Economics Department labels the 7% to 8% real growth in 1977 investment "a disappointment," and this year the outlook is for a still more disappointing 3% increase. However, spending for modernization, energy conservation, increased process efficiency, and conversion to alternate fuels should help boost total consumption of electronic process-control systems by at least 10%. Total dollar value this year should be $674.1 million for this segment of the market.

By contrast, total 1978 consumption of numerically controlled equipment could rise 25% or more over 1977, prophesy the manufacturers of such equipment after 1977's 25% improvement on 1976. As an indication of how well their sales have been running, General Electric Co.'s Industrial Controls division in Waynesboro, Va., had a record year in 1977 for numerically controlled electronic systems. For all manufacturers the consensus is a 1978 total of $131.2 million.

Prospects for further growth to 1980 seem good. A surge of machine-tool orders in the 1976 to 1977 period is still mainly unfilled, and many of these still-to-be-delivered machines will be numerically controlled, creating a larger base for replacement sales in later years. As the field expands, microprocessor-run systems will gradually garner most of it, with the remainder going to minicomputer numerical control. By the 1980s, hardwired and direct computer control should no longer be important factors.

Top marks to energy management

Another field with an excellent potential is energy management. Markets for this type of equipment are growing in process control, power generation, and even in the home. A 31% growth in 1977 could snowball to an even larger growth of 52% in 1978. The *Electronics* survey pegs it at $53.5 million. By the 1980s, factory sales of energy-management systems to U. S. users will exceed $122 million. And as in numerical control, microprocessor control will be the fastest-growing segment of the energy-management market.



Under control. Microcomputers in industrial equipment will increase from 77,000 units in 1977 to 3.05 million units in 1985. One of the largest growth areas is the application of these units to truck and bus engine controls, a market segment that will almost double by 1980.

Profiting from change

Life and soul of the party in the instrument sector last year were the microprocessor design and troubleshooting systems, which accounted for about half of 1977's nearly 15% sales growth. And, U. S. consumption of all instruments in the New Year looks to be almost as lively, growing a little more than 12% to $2.65 billion, even though the most swinging products—microprocessor development systems and logic analyzers—will be quieting down a little.

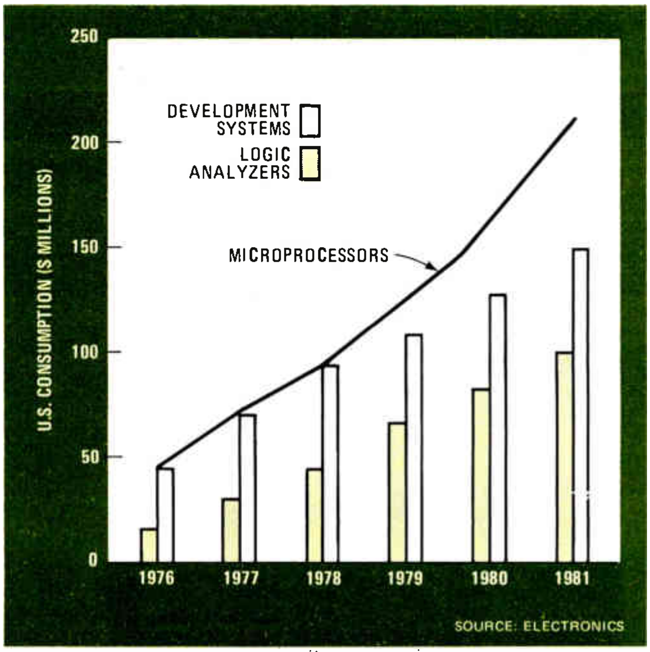
Even so, logic analyzers, of both logic state and logic timing, will continue to pace the test instruments market. With an anticipated growth rate this year in excess of 40%, they could be heading for about $100 million by 1981. Makers of logic analyzers are still attempting to fill the demand from designers, yet are also eyeing the large market for field-service equipment, as are many other instrument makers. Though board swapping will probably remain the commonest repair technique at the customer's site, manufacturers are looking into more complex test equipment for the U. S.'s 15,000 or so service personnel at regional depots.

Microprocessor development systems, once the sole preserve of microprocessor manufacturers who wished to encourage use of their own devices, are now becoming standard multi-device instruments. This area is expanding at about the same rate as the logic analyzer field and is already above the $70 million level annually.

Also participating in the microprocessor-based equipment boom is automatic test equipment, aimed at both manufacturers and users of microprocessors. As the number of high-volume users increases, there will be more demand for test equipment needed at incoming inspection, since the costs of finding a failure on a board are quite high. At the same time, board testers are growing, although prices continue to come down as more large-scale integrated circuits are used within the equipment itself. Testers of components (including integrated circuits) and boards together should earn their makers $192 million in 1978, about 10% above 1977's $175 billion. However, the market is much more volatile than the 10% growth figure indicates. A new generation of low-cost testers for LSI circuits is coming to market, costing less than half the $150,000-plus for which established computer-controlled testers now sell.

Few areas are as active as digital multimeters, yet the market dollars are growing at about a modest 11% rate. The cause is a steady decline in prices of new 4½-digit and more especially 3½-digit instruments, many of which are taking aim at the less-than-$100 market.

Up to now, that has been the bastion of analog multimeters. These, although they probably will never disappear from the scene, are declining by about $1 million a year and could fall to the $15 million mark in 1981, whereas 3½-digit DMMs should rack up more than twice that in sales in that year.



Up and up. Consumption of microprocessor support instruments at present relates more to number of microprocessor applications than to overall device sales. But when large-volume use in cars, for example, begins in 1979, the device market will leap ahead.

Electronic counters and timers will exhibit trends similar to the multimeter field, with steadily declining prices as more use is made of LSI chips.

For a mature product, oscilloscopes continue to do respectably well. They will exhibit their steady 10% growth rate again in 1978, reaching about $210 million, although some industry observers see a pent-up demand that could boost sales if the Government should move on tax credits for capital investments. Spectrum analyzers are doing much better: a good 1977 will be followed by a 20% growth in 1978 to $96 million as new units using microprocessors for computation and control begin to make themselves felt in the marketplace.

Medical gear to recover

In medical equipment, there was a decline in consumption of diagnostic equipment in 1977—from $628 million in 1976 to $607 million. What happened was that tomographic X-ray scanners cut into the consumption of conventional X-ray equipment, which fell from $300 million to $230 million. This nearly 25% decline more than offset the modest sales increases in other diagnostic equipment categories. Still, the medical market should get back on track in 1978, as some potential users of tomographic equipment decide for it and others settle for conventional X-ray gear. Then the first market should improve by about 30% to $160 million, and the second recover to about $280 million.

Chips surge ahead

A mixture of caution and optimism prevails in the semiconductor industry. The caution stems from the comparatively modest increase in U. S. semiconductor consumption in 1977. *Electronics'* survey, taken early in the fourth quarter, indicates that the year closed with consumption at $3.25 billion, a growth of 12%. But some industry sources suggest a somewhat higher rate, more like 14%. In either case, 1977 will exhibit rather less than the 22% growth rate predicted for it at the beginning of last year. And that slower growth will continue in 1978—on the order of 10%, according to the consensus.

But the optimism is there, too, for most of the drag is due to discrete devices, a relatively mature segment of the industry, while excellent performances are being turned in by the high-technology products in the area of large-scale integration. Furthermore, suppliers report that there is no double ordering, and the industry's book-to-bill ratio, a useful near-term market indicator, stands solidly above unity, compared to the 0.95 ratio widely experienced during the summer's doldrums.

Last year, demand for most discrete product lines increased by a mere 2%, *Electronics* estimates. This drag is expected to continue throughout the decade, as ever more discretes are eliminated by functions integrated onto chips.

As for integrated circuits, they grew by a solid 16% to reach $2.2 billion, or 61% of total semiconductor consumption. In addition, last year's consumption of metal-oxide-semiconductor chips grew by almost 30% and will grow by another 30% this year. Thus, companies that made the move to high-technology MOS product lines in the early and mid-1970s will undoubtedly perform well above the industry average.

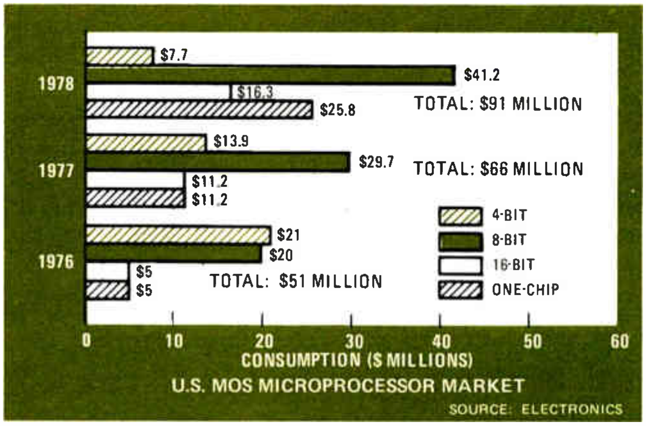
It's more and more a MOS world

Indeed, consumption of microcomputer products, which are primarily MOS types, grew by almost 60% last year to $189 million and will reach $250 million this year. Here, the byte-oriented multichip families (including processors, memories, and peripherals) are seeing the most action, accounting for over $125 million, or almost two thirds of the microcomputer chips bought and used in the U. S. in 1977.

Meanwhile, a move is beginning toward 16-bit microcomputer designs for higher throughput and more data storage. Sales of 16-bit central processing units, which totaled $11.2 million last year, should grow to over $16 million this year and reach $80 million by 1981.

One-chip microcomputers are also in sharp demand, especially the new 8-bit devices intended for mid-range peripheral designs as well as for such potentially huge markets as automobile engine controls. Sales of one-chip types doubled last year, reaching $8 million, and will grow a further 70% this year.

Just as strong are semiconductor memories, which chalked up $632 million in factory sales last year, almost 30% over 1976. Another 30% increase is expected this year. Indeed, as 16-bit designs grow more popular and memory accounts for an increasingly larger proportion of the system, memory sales should remain very strong. By 1981 they could exceed $1.1 billion, almost 30% of the total semiconductor consumption.



Small stuff makes the big time. In 1977, 8-bit devices made up about half of all microcomputer CPU sales. This year, sales of 16-bit CPUs and one-chip microcomputers should also accelerate as users extend system performance both upward and downward.

RAMS flourish

All memory product lines are prospering, especially random-access memories. They grew to almost $350 million last year and will reach nearly $410 million this year as mainframe and minicomputer makers begin to manufacture their new lines of memory-rich computer families. By 1981, the RAM market alone will total $615 million, or almost one half of the total memory consumption. Meanwhile, 1978 is the year users will start turning to 16,384-bit dynamic RAMs as manufacturers move them onto production lines in place of older 4,096-bit parts. Thanks to the boom in microcomputer-based designs, static RAMs are also in strong demand and will reach $174 million by the end of the year.

In linear integrated circuits, U. S. consumption rose nearly 8% in 1977 to $410.3 million and should climb to $452.7 million in 1978, a solid growth of more than 10%. Data conversion, which remains one of the hottest of linear areas, is expected to grow 26% in 1978 to $33.8 million. Moreover, prospects for the near future are brighter still, in particular for microprocessor-compatible data converters, and consumption should easily double in the next three years.

Another up-and-coming area, interface circuits, should reach $60 million this year, an increase of nearly 19% over 1977. Growth for more mature market segments, like operational amplifiers, will be more modest—between 5% and 10%.

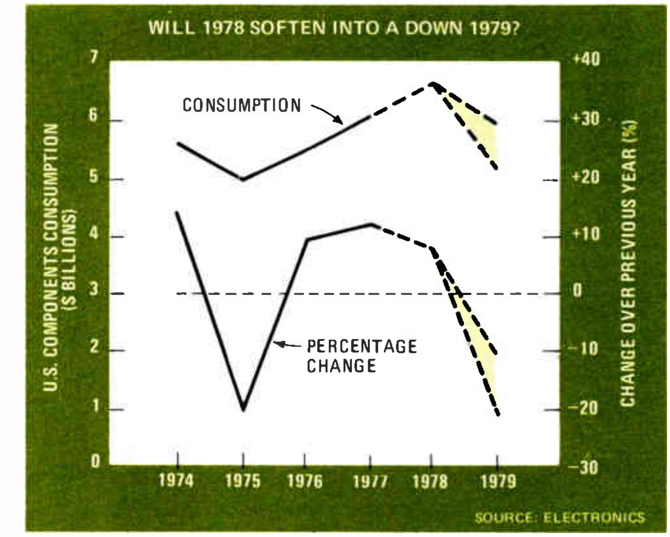
COMPONENTS

A peak experience

The surprisingly bravura performance of the components market last year looks like it will be sustained well into this year, although the tempo is expected to slow somewhat and most makers are uncertain what to expect as a finale. In 1977, U. S. consumption hit $6.16 billion, up 11.9% over 1976. In 1978, it should rise again, by 8.7% to $6.7 billion. All the current business signs point to the New Year being the best ever for components, despite a possible downturn in the second half.

Lead times are beginning to stretch out in certain high-growth sectors—in particular, deliveries for thick-film resistor networks are extending out from two to three months. However, for the most part, components makers are keeping in step with increasing demand, operating at nearly full production capacity now and planning for some expansion in the coming year. Manufacturers and customers alike are proceeding with caution, both careful to avoid inventory buildup.

Thus far, this caution is paying off. But should the market soften within the second half, consumption for 1979 will in all likelihood return to somewhere around its 1974 level (see graph).



Looking ahead. This year should be the best ever for components, with U. S. consumption climbing to an all-time peak of $6.7 billion. However, if the market softens, as it might possibly do after midyear, 1979 could be down appreciably—by as much as 10% to 20%.

To assure that this survey reflects the marketplace's response to new technologies, *Electronics* substantially changed many components listings this year, bringing the grand totals up by hundreds of millions of dollars for each year. Connectors, switches, and transducers now include extra categories, as do both crystals and passive filters. Hybrid and modular components are being gathered under the components banner, rather than under semiconductors. Yet another new category is interconnection systems, which are being grouped with printed circuits, along with one more important new area, flexible circuits. Moreover, the wire-and-cable grouping now includes fiber-optic cable.

FEDERAL

DOD to spend more than expected

President Jimmy Carter's projected 10% increase in military electronics outlays gainsays his promise as a candidate to cut defense spending. But it reflects the influence of Defense Secretary Harold Brown, who persuaded him to boost calendar 1978's military budget to $16.5 billion in order to counter the Soviet Union's superior manpower in Europe with upgraded intelligence, warning, and weapons systems.

Procurement of military electronics alone will climb nearly 12.5% to $7.9 billion, with avionics and related ground systems reflecting the biggest increase—up to 17% to $2.2 billion from 1977—as major buys continue for Air Force and Navy aircraft. Buys of missiles and space hardware, up 10% to $2.5 billion, indicate the high priority being assigned to programs like cruise missiles as well as space reconnaissance satellites.

The budget for military research, development, test and engineering will post a lesser boost of 10% to $5.44 billion. This increase is due to pressure from Brown and the Joint Chiefs of Staff to develop a new class of "killer satellites" carrying high-energy lasers; they would counterbalance Soviet spacecraft that destroy other satellites by crashing into them.

Other major elements in the military RDT&E increase include: White House concern with the declining trend in American high-technology R&D [*Electronics*, Nov. 24, p. 50]; recognition that DOD is the most efficient mechanism for getting R&D money quickly into the economy; and increasing concern with unemployment generally and high-technology joblessness in particular. However, new money accounts less for the overall increase than Brown's determination to shift more R&D work into the hands of industry. Naval shipboard electronics will climb to nearly $1.4 billion, with that 15% boost representing the second largest increase after electronics for aircraft of all types. □

U.S. MARKETS FORECAST 1978

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

COMPONENTS

(millions of dollars)	1976	1977	1978	1981
COMPONENTS, TOTAL	**5,500.1**	**6,155.6**	**6,690.1**	**7,897**
Resistors, total	**391.6**	**445.8**	**453.3**	**491**
Fixed, total	166.4	189.5	189.8	199
Composition	46.8	50.1	44.7	35
Deposited-carbon	16.9	20.2	21.0	28
Metal-film	55.1	66.4	70.1	79
Wirewound	47.6	52.8	54.0	58
Variable, total	151.4	164.6	157.1	179
Potentiometers, wirewound	25.4	27.2	26.2	26
Potentiometers, nonwirewound	68.3	73.4	68.3	80
Trimmers, wirewound	19.2	20.0	19.1	19
Trimmers, nonwirewound	38.5	44.0	43.5	54
Thermistors	25.2	32.8	39.1	41
Resistive networks, total	48.6	58.9	67.3	73
Thin-film	4.5	5.0	6.2	7
Thick-film	44.1	53.9	61.1	76
Capacitors, total	**606.1**	**724.2**	**779.1**	**834**
Paper	65.2	80.7	82.6	91
Film	75.6	87.5	93.5	100
Electrolytic, total	245.5	284.8	316.3	333
Aluminum	110.9	133.2	153.1	157
Tantalum	134.6	151.6	163.2	176
Mica	23.2	30.4	35.2	33
Glass and vitreous enamel	4.7	5.0	5.1	4
Ceramic, except chips	154.0	192.7	200.0	220
Variable	16.5	17.5	18.5	20
Chip	21.4	25.6	27.9	33
Relays, total	**434.0**	**475.9**	**514.2**	**590**
General-purpose	90.1	99.4	109.4	130
Telephone-type	23.8	25.5	27.3	35

(millions of dollars)	1976	1977	1978	1981
Crystal-can	39.1	43.3	47.4	52
High-sensitivity	23.3	25.9	28.4	37
Rf	71.2	78.9	86.4	90
Reed	30.7	34.5	38.6	45
Stepping and impulse	5.0	4.5	4.0	3
Time-delay	18.0	21.8	23.5	28
Solid-state	14.8	20.1	24.2	34
Other	118.0	122.0	125.0	135
Switches, total	**307.2**	**336.0**	**360.6**	**429**
Small-movement snap-action	56.1	58.1	60.2	64
Lighted	60.1	62.3	65.4	85
Push-button	25.0	27.0	29.2	34
Toggle	16.8	17.8	18.9	23
Slide	16.2	18.3	18.9	23
Rotary	34.1	35.9	37.0	40
Coaxial	11.0	11.6	10.3	8
Thumbwheel	17.8	20.0	22.4	25
Dual in-line	20.0	25.0	30.0	40
Keyboard, single-key	5.7	6.6	7.5	9
Keyboard, assemblies	37.8	45.2	51.0	65
Solid-state, including Hall-effect	6.6	8.2	9.8	16
Magnetic, total	**356.9**	**370.2**	**385.4**	**416**
Computer memory cores	25.2	24.3	24.2	16
Transformers, chokes, except TV	254.6	269.3	285.1	325
Laminated	164.5	173.7	183.8	208
Toroidal	55.2	58.6	62.1	72
Pulse transformers	34.9	37.0	39.2	45
TV components	59.3	59.8	60.4	61
Rf coils	17.8	16.8	15.7	14
Electron tubes, total	**1,057.1**	**1,121.0**	**1,191.3**	**1,217**
Receiving	131.0	121.2	112.7	68
Power and special-purpose, total	356.7	366.8	375.8	409
High-vacuum	61.9	59.4	58.4	56
Gas and vapor	15.7	15.7	15.4	16
Klystrons	41.8	42.1	42.9	45
Magnetrons	50.2	52.3	53.9	64
TWTs, including backward-wave	91.6	96.2	101.3	115
Light-sensing	13.6	14.4	15.2	17
Image-sensing, including TV camera and image-intensifier	31.2	33.0	34.9	42
Storage	15.8	14.6	13.8	9
Cathode-ray, except TV	34.9	39.1	40.0	45
TV picture, black-and-white	28.8	26.1	23.5	15
TV picture, color	540.6	606.9	679.3	725
Microwave hardware, total	**94.8**	**107.6**	**123.0**	**153**
Mixers	9.8	10.1	11.2	13
Detectors	4.1	4.6	5.1	6
Amplifiers	14.8	20.1	25.7	35
Passive components, total	31.7	35.0	38.1	43

(millions of dollars)	1976	1977	1978	1981
SEMICONDUCTORS, TOTAL	**2,904.7**	**3,253.3**	**3,578.6**	**5,140**
Discrete semiconductors	**886.5**	**904.2**	**895.2**	**949**
Diodes	323.2	328.7	316.7	322
Signal	36.6	39.0	38.5	35
Rectifier	163.2	163.5	158.9	161
Arrays	20.7	16.9	14.3	14
Zener, total	65.0	70.3	66.0	68
Voltage regulator	48.6	52.7	49.8	50
Reference	16.4	17.6	16.2	18
Special-purpose, total	37.7	39.0	39.0	44
Microwave, total	28.2	30.0	30.3	35
Varactor (less than 1 GHz)	7.9	7.8	7.7	8
Tunnel	1.6	1.2	1.0	1
Transistors, total	457.5	449.8	446.7	470
Bipolar, total	418.9	411.1	406.7	426
Small-signal (less than 1 W)	150.2	142.0	127.0	107
Power (1 W or more)	202.2	200.3	207.5	246
Duals and arrays	20.7	19.7	18.2	14
Rf and microwave	45.8	49.1	54.0	59
Field-effect, total	38.7	38.7	40.0	44
Junction, total	24.6	23.6	24.4	27
Small-signal	24.6	23.5	24.0	26
Power	—	0.1	0.4	1
MOS, total	14.1	15.1	15.6	17
Small-signal	14.1	15.0	15.2	16
Power	—	0.1	0.4	1
Thyristors	84.7	105.7	110.6	134
Protection devices, including varistors	21.1	20.0	21.2	23

(millions of dollars)	1976	1977	1978	1981
Integrated circuits, total	**1,909.2**	**2,223.7**	**2,536.2**	**3,989**
Standard logic families, total	677.0	775.2	864.1	1,146
RTL	5.6	4.5	3.8	3
DTL	39.0	32.0	27.2	25
TTL	393.7	400.0	409.6	455
Schottky TTL, total	66.6	103.5	143.1	221
Standard	27.7	36.0	37.7	46
Low power	38.9	67.5	105.4	175
I^2L	11.3	19.0	28.6	70
ECL	40.6	61.5	67.7	93
C-MOS	120.2	154.7	184.1	280
Microprocessor families, total	113.7	188.5	249.9	717
CPUs, total	55.0	74.0	104.7	322
MOS, total	51.0	66.0	91.0	272
4-bit	21.0	13.9	7.7	5
8-bit	20.0	29.7	41.2	87
16-bit	5.0	11.2	16.3	80
1-chip	5.0	11.2	25.8	100
Bipolar, total	4.0	8.0	13.7	50
Bit-slice	2.5	6.0	10.3	35
Full CPU	1.5	2.0	3.4	15
ROMs	20.9	34.9	42.3	100
RAMs	14.9	35.1	43.0	107
I/O interface chips	14.0	23.5	30.0	98
LSI peripheral chips	8.9	21.0	29.9	91
Dedicated LSI logic	72.0	54.1	56.0	87
Memories, total	509.2	632.4	742.6	1,156
Random-access, total	277.7	348.7	409.1	615
Dynamic, total	163.3	197.7	235.5	327

(millions of dollars)	1976	1977	1978	1981
Waveguide	7.1	8.2	9.0	8
Coaxial and strip-line	24.6	26.8	29.1	34
Switches, total	9.0	9.9	11.6	15
Waveguide	3.1	3.4	3.9	6
Coaxial and strip-line	5.9	6.5	7.7	9
Ferrite devices, total	21.3	23.5	26.2	33
Isolators	6.1	6.5	7.4	7
Circulators	10.1	10.8	11.9	14
YIG devices	5.1	6.2	6.9	10
Power limiters	4.1	4.4	5.1	7
Readout devices, total	**116.4**	**151.8**	**185.7**	**246**
Discrete, total	37.0	44.3	47.5	46
Gas-discharge	3.6	3.2	2.6	2
Incandescent	3.6	4.2	4.6	7
Fluorescent	1.6	1.7	1.8	2
Light-emitting-diode	28.2	35.2	38.5	35
Multidigit, total	79.4	107.5	138.2	200
Gas-discharge	23.1	29.7	42.5	73
Segmented	3.4	4.6	7.2	12
Dot-matrix	19.7	25.0	35.3	61
Incandescent	1.1	1.0	0.9	0
Fluorescent	2.4	3.2	3.7	4
Electroluminescent	1.9	2.3	3.1	4
Light-emitting-diode	36.0	41.2	47.0	59
Liquid-crystal	14.9	30.1	41.0	60
Transducers, total	**174.2**	**202.1**	**242.9**	**351**
Pressure	106.5	120.6	139.5	217
Temperature	5.0	7.0	8.0	15
Motion, linear	20.0	24.7	30.0	35.
Motion, angular	10.0	15.0	28.0	35
Torque	20.1	20.6	21.1	23
Vibration	12.6	14.2	16.3	126
Crystals, total	**110.5**	**106.5**	**106.2**	**112**
Discrete crystals, total	55.5	50.5	49.2	55
Communications	18.0	20.0	21.0	23
Color TV	1.5	2.0	2.2	3
Watches	30.0	20.0	15.0	15
Digital-logic clocks	2.0	4.0	6.0	8
Filters	4.0	4.5	5.0	6
Assemblies, incl. mounts and ovens	55.0	56.0	57.0	57
Passive filters and networks, total	**149.5**	**155.4**	**160.7**	**180**
LC filters	41.4	41.8	42.4	45
Electromechanical filters, total	41.8	44.2	45.9	56
Crystal	33.8	34.7	34.9	42
Ceramic	6.0	7.0	8.0	10
Other	2.0	2.5	3.0	4
Rfi and emi filters	44.1	45.2	46.2	50
RC networks	10.2	11.2	12.2	16
Delay lines	12.0	13.0	14.0	15

(millions of dollars)	1976	1977	1978	1981
Hybrid and modular components, total	**234.5**	**269.2**	**315.5**	**464**
Operational amplifiers	19.2	22.0	25.3	30
Instrumentation amplifiers	5.3	6.0	6.9	10
Isolation amplifiers	2.7	3.7	4.6	8
Data conversion, total	49.1	57.3	69.0	97
D-a converters	23.8	26.5	30.0	40
A-d converters	19.1	22.7	29.2	40
Multiplexers	2.4	3.4	3.9	4
Sample-and-holds	3.6	4.1	4.7	8
Converter subsystems	0.2	0.6	1.2	5
Functional circuits	12.2	13.8	15.8	20
Signal sources, incl. oscillators	1.5	2.0	2.3	3
Active filters	5.8	7.0	8.6	13
Miscellaneous custom functions	138.7	157.4	183.0	283
Connectors, total	**622.1**	**723.6**	**797.0**	**1,045**
Coaxial, total	65.0	68.7	74.7	89
Standard size	49.1	50.3	52.9	60
Miniature	15.9	18.4	21.8	29
Cylindrical, total	161.8	184.5	199.6	23.9
Standard	51.4	55.2	55.9	61
Miniature	66.9	77.2	83.2	93
Subminiature	43.5	52.1	60.5	85
Rack-and-panel	160.5	187.6	204.9	256
Fused	11.4	11.3	12.5	15
Printed-circuit	116.3	142.3	156.2	200
Card-insertion	76.3	87.6	100.2	135
Two-piece, metal-to-metal	40.0	54.7	56.0	65
Flat-cable	44.0	59.1	75.4	150
Fiber-optic	0.6	0.9	1.6	6
Flexible-circuit	0.2	0.8	1.5	4
Special-purpose	62.3	68.4	70.6	85
Printed circuits and interconnection systems, total	**493.5**	**577.7**	**660.5**	**879**
Printed circuits, total	358.4	407.7	432.0	506
Rigid boards, total	316.4	356.7	376.0	426
Single-sided	50.2	60.0	64.0	72
Double-sided	176.0	198.0	209.0	222
Multilayer	90.2	98.7	103.0	132
Flexible circuits	42.0	51.0	56.0	80
Interconnections, total	131.1	165.0	222.5	363
Sockets and socket panels for DIPs	75.0	95.0	135.0	240
Backplanes	56.1	70.0	87.5	123
Prototyping boards	4.0	5.0	6.0	10
Wire and cable, total	**351.7**	**388.6**	**414.7**	**490**
Coaxial cable	55.1	61.2	67.9	84
Flat cable	105.0	126.0	135.0	152
Hook-up wire	89.2	96.6	104.3	113
Multiconductor, shielded	65.1	64.0	63.0	69
Multiconductor, unshielded	36.8	36.8	37.0	42
Fiber-optic cable	0.5	4.0	7.5	30

p-MOS	29.1	18.5	8.1	1
n-MOS, total	133.7	177.2	221.7	314
1-k	14.2	17.2	20.1	29
4-k	114.4	125.0	115.7	85
16-k	5.1	35.0	85.9	200
Bipolar	0.5	2.0	5.7	12
Static, total	114.4	151.0	173.6	288
Bipolar	40.9	52.0	55.3	65
n-MOS	61.3	80.5	90.6	178
C-MOS	12.2	18.5	27.7	45
Read-only, total	197.1	243.0	282.4	431
Mask type, total	78.6	92.0	101.1	153
Bipolar	11.2	12.0	11.4	16
MOS	67.4	80.0	89.7	137
Programmable type	77.6	91.0	100.2	152
Alterable type, total	40.9	60.0	81.1	126
Ultraviolet	37.1	55.0	72.5	110
Electrical (EAROM)	3.8	5.0	8.6	16
CCDs	2.7	6.3	16.2	54
Magnetic-bubble devices	—	4.9	7.7	30
Shift registers	31.7	29.5	27.2	26
Linear ICs, total	380.3	410.3	452.7	672
Analog switches	33.2	33.1	34.2	45
Operational amplifiers	97.7	102.0	107.8	142
Instrumentation amplifiers	1.4	2.0	2.7	6
Comparators	16.1	17.0	18.1	24
Voltage regulators	31.1	33.5	36.3	62
Timers	36.3	36.1	39.4	56
Other	4.0	5.6	7.1	22

Data conversion, total	21.9	26.8	33.8	73
D-a converters	9.3	11.5	14.6	31
A-d converters	4.7	7.5	9.4	26
Multiplexers	4.4	4.4	5.1	8
Sample-and-holds	3.5	3.4	3.7	4
Interface	45.5	50.5	60.0	96
Communications	29.9	35.9	39.7	60
Entertainment	63.2	67.8	73.6	87
Consumer product ICs, total	157.0	163.2	170.9	211
Calculator chips, total	68.5	62.2	57.3	57
Personal	44.4	41.0	37.2	39
Scientific	11.0	12.1	11.4	12
Multichip	8.7	6.1	5.8	4
Other	4.4	3.0	2.9	2
Watch chips	46.6	46.5	44.4	61
Game chips	20.6	31.0	42.5	56
Other	21.3	23.5	26.7	38
Optoelectronic devices, total	**109.0**	**125.4**	**147.2**	**203**
Photovoltaic (solar) cells	8.5	8.6	10.5	12
Photoconductive cells	4.4	6.2	7.4	9
Light-emitting diodes	43.5	50.5	58.5	80
Laser diodes	0.2	0.5	1.5	5
Photodiodes, incl. arrays	5.5	5.0	7.1	10
Phototransistors, incl. arrays	14.1	13.8	16.2	20
Optically coupled isolators	26.8	35.0	40.0	60
Silicon targets	6.0	5.8	6.0	7

INDUSTRIAL AND COMMERCIAL MARKETS

(millions of dollars)	1976	1977	1978	1981
INDUSTRIAL AND COMMERCIAL, TOTAL	**26,136.0**	**30,317.0**	**35,357.0**	**50,651**
Test, measuring, and analytical instruments, total	**2,060.3**	**2,364.7**	**2,653.8**	**3,494**
Test and measuring equipment, total	**1,648.3**	**1,894.7**	**2,133.8**	**2,848**
Analog voltmeters, ammeters, multimeters	19.0	18.0	17.0	15
Digital multimeters, total	63.0	70.0	76.0	86
3½-digit and below	23.0	27.0	30.0	34
4½-digit and above	40.0	43.0	46.0	52
Panel meters, total	97.0	108.0	115.0	133
Analog	75.0	82.0	87.0	100
Digital	22.0	26.0	28.0	33
Counters, time and frequency	47.0	52.0	56.0	70
Microprocessor-development systems	45.0	70.0	93.0	150
Logic analyzers	16.0	30.0	43.0	100
Oscilloscopes, total	180.0	190.0	210.0	235
Non-plug-in	110.0	114.0	126.0	143
Plug-in main-frame only	45.0	47.5	54.6	59
Accessories and plug-ins	25.0	28.5	29.4	33
Spectrum analyzers	70.0	80.0	96.0	110
Frequency synthesizers	35.0	40.0	45.0	68
Function generators	20.0	22.0	24.0	30
Signal generators	40.0	46.0	48.0	60
Sweep generators	32.0	36.0	40.0	51
Pulse generators	11.0	13.0	15.0	19
Oscillators	11.0	12.0	12.0	13
Waveform analyzers, distortion meters	32.0	35.0	39.0	45
Power meters, below microwave frequencies	3.0	3.5	4.0	5
Calibrators and standards, active and passive	18.0	19.5	22.0	27
Noise-measuring equipment,	4.0	5.0	5.0	8
Temperature-measuring instruments	16.0	19.0	22.0	26
Phase measuring equipment	21.0	23.0	25.0	32
Field-intensity meters and test receivers	6.0	7.0	8.0	10
Antenna pattern measuring equipment	5.0	5.0	5.0	6
Amplifiers, total	60.0	65.0	70.0	80
Impedance bridges	12.0	13.0	13.0	14
Recorders and plotters, total	178.0	196.0	210.0	229
Strip- and circular-chart	100.0	110.0	117.0	120
X-Y	16.0	18.0	20.0	25
Magnetic-tape	62.0	68.0	73.0	84
IC testers	73.0	83.0	85.0	90
Component testers	20.0	23.0	26.0	29
Pc-board testers, total	57.0	69.0	81.0	105
Bare-board	7.0	9.0	11.0	15
Completed assemblies	50.0	60.0	70.0	90
Microwave impedance-measuring equipment	16.0	18.0	20.0	26
Microwave-power-measuring equipment	6.0	7.0	7.0	9
Microwave wavemeters	1.0	1.2	1.2	1
Microwave modulators	1.3	1.5	1.6	2
Automotive diagnostic equipment	235.0	265.0	295.0	390
Communications test equipment	180.0	230.0	283.0	550
Radiation-detection and -monitoring, total	18.0	19.0	21.0	24
Analytical instruments, total	**412.0**	**470.0**	**520.0**	**646**
Chromatographs, total	73.0	96.0	116.0	152
Gas	50.0	66.0	78.0	100
Liquid	23.0	30.0	38.0	52
Spectrophotometers, total	125.0	142.0	158.0	194
Infrared	25.0	30.0	33.0	38
Ultraviolet-visible	31.0	34.0	37.0	48
Atomic absorption	29.0	33.0	36.0	46
Other	40.0	45.0	52.0	62
Mass spectrometers	26.0	28.0	31.0	46
Nuclear magnetic-resonance spectrometers	17.0	18.0	18.0	20
Electron microscopes	17.0	20.0	22.0	26
pH meters and ion-selective electrodes	25.0	29.0	31.0	36
Spectrofluometers	12.0	13.0	14.0	18
X-ray analysis	39.0	42.0	45.0	58
Other	78.0	82.0	85.0	96
Power supplies, total	**460.0**	**533.0**	**582.0**	**842**
Encapsulated	15.0	17.0	20.0	25
Modular	222.0	260.0	280.0	420
Open-frame and card	98.0	112.0	120.0	170
Lab and bench	30.0	34.0	36.0	47
Programmable and system	20.0	22.0	24.0	30
Industrial heavy-duty	75.0	88.0	102.0	150
Automotive electronics, total	**228.0**	**300.2**	**399.3**	**1,061**
Voltage regulators	31.0	25.2	25.0	29
Emission-control systems	54.0	72.0	100.0	240
Electronic ignition systems	82.0	112.0	150.0	270
Fuel-injection systems	12.0	14.0	20.0	40
Fuel-metering systems	6.0	12.0	12.3	200
Safety systems, total	43.0	65.0	92.0	282
Anti-skid controls (truck and car)	39.0	60.0	86.0	200
Air-bag sensors and controls	4.0	5.0	6.0	82

(millions of dollars)	1976	1977	1978	1981
Data-processing systems, peripherals, and office equipment, total	**17,284.3**	**20,911.3**	**24,636.0**	**35,489**
System shipments, total	6,227.0	7,766.0	9,531.0	15,310
Desktop computers	77.0	106.0	151.0	340
Small (less than $100,000)	1,800.0	2,650.0	3,660.0	7,800
Medium (up to $1 million)	2,050.0	2,510.0	2,930.0	4,000
Large (greater than $1 million)	2,300.0	2,500.0	2,790.0	3,170
Micros and minis, total	561.0	928.1	1,048.3	1,863
OEM microcomputers	118.3	352.8	461.0	945
OEM minicomputers	442.7	575.3	587.3	918
Memory systems, total	452.3	514.0	584.9	748
Add-on systems	267.3	297.7	338.3	444
Core	117.3	110.2	104.0	92
Semiconductor	150.0	187.5	234.3	352
OEM systems	185.0	216.3	246.6	304
Core	129.0	148.0	155.0	150
Semiconductor	56.0	68.0	91.0	150
Magnetic-bubble	–	0.3	0.6	4
Data-storage devices, total	2,096.0	2,368.4	2,607.5	3,203
Rigid-disk, total	1,522.0	1,704.6	1,858.0	2,340
Fixed	307.0	334.5	354.7	398
Removable	1,215.0	1,370.1	1,503.3	1,942
Flexible-disk, total	35.0	68.0	91.5	128
8 inch	35.0	60.0	81.5	110
5¼ inch	–	8.0	10.0	18
Magnetic drum	45.5	42.0	38.5	35
Reel-type magnetic-tape	470.0	520.3	574.1	621
Cassette magnetic-tape	16.0	20.0	24.0	27
Cartridge magnetic-tape	7.5	13.5	21.4	53
Input/output peripherals, total	1,489.0	1,793.7	2,166.3	2,821
Card-read/punch	120.0	119.0	112.0	100
High-speed line printers	79.5	91.8	104.2	118
Medium-speed printers	720.0	900.0	1,096.9	1,260
Low-speed serial printers	266.5	322.6	422.0	605
Large nonimpact printers	60.0	73.5	89.5	177
Computer output microfilm	110.0	140.5	170.0	315
Optical character readers	35.2	39.5	52.9	89
Magnetic-ink character readers	23.5	21.5	20.4	17
Electromechanical plotters	41.5	48.7	57.4	86
Digitizers	9.8	11.6	13.0	18
Paper-tape devices	23.0	25.0	28.0	37
Key entry, total	229.5	224.8	215.2	205
Key punch	85.0	77.5	68.3	63
Key-to-tape	4.5	4.3	3.9	1
Key-to-disk	65.5	65.0	59.5	42
Keyboard-to-cassette/cartridge	74.5	78.0	83.5	99
Data terminals, total	927.9	1,159.2	1,416.3	1,778
Printing terminals	90.0	100.0	112.0	140
CRT terminals, total	687.6	846.0	1,026.0	1247
Intelligent	304.0	360.0	432.0	554
Other	383.6	486.0	594.0	693
Graphics terminals, total	127.3	189.4	253.7	354
Storage and refresh	117.5	170.0	215.0	273
Raster-scan	9.8	19.4	38.7	81
Remote-batch terminals	23.0	23.8	24.6	38
Source data-collection equipment, total	966.6	1,240.1	1,431.5	2,189
Point-of-sale systems, total	480.9	607.7	691.1	1,054
Electronic cash registers/terminals	425.0	535.5	604.0	882
Credit-authorization terminals	35.5	46.7	56.5	111
Electronic scales	20.4	25.5	30.6	61
Banking systems, total	81.2	161.1	187.0	247
Automated terminals, cash dispensers	35.7	39.1	58.0	102
Teller terminals	45.5	122.0	129.0	145
Industrial systems, total	64.5	70.1	88.0	134
Other specialized terminal	340.0	401.2	465.4	754
Office equipment, total	4,335.0	4,917.0	5,635.0	7,373
Non-consumer calculators, total	100.0	120.0	140.0	220
Word-processing	500.0	700.0	950.0	1,300
Dictation	194.0	228.0	267.0	355
Copying	1,650.0	1,760.0	1,918.0	2,200
Facsimile	23.0	30.0	42.0	140
Electronic typesetting	185.0	218.0	294.0	685
Accounting/bookkeeping	1,133.0	1,236.0	1,339.0	1,648
Printing/duplication	550.0	625.0	685.0	825
Lasers and equipment, total	**65.5**	**78.0**	**89.5**	**139**
Gas lasers	22.0	27.0	32.0	60
Semiconductor lasers	4.0	5.0	6.0	9
Other (ruby, neodymium-doped, etc.)	21.0	22.0	23.0	28
Laser power supplies	12.0	17.0	20.0	28
Modulators	5.5	7.0	8.5	14

(millions of dollars)	1976	1977	1978	1981
Communications equipment, total	**3,459.9**	**3,278.4**	**3,662.8**	**5,244**
Radio, total	1,923.0	1,334.0	1,400.2	2,400
Aviation mobile, including ground support	40.0	44.0	48.0	55
Marine mobile (ship and shore stations)	40.0	44.0	48.0	56
Land mobile (mobile and base stations)	600.0	660.0	725.0	960
Amateur	14.0	16.0	19.2	25
Citizens' band	1,054.0	375.0	330.0	1,000
Microwave (complete system, incl. antennas)	115.0	115.0	130.0	160
Broadcast	40.0	45.0	50.0	59
Satellite earth stations	20.0	35.0	50.0	85
Navigation systems	140.0	148.0	155.0	170
Telemetry (industrial only)	32.0	36.0	40.0	50
Voice switching system, total	316.0	359.0	400.0	445
Central office	310.0	341.0	376.0	405
PABX, total	6.0	18.0	24.0	40
Laser communications systems	11.0	12.0	13.2	16
Fiber-optic communications systems	1.0	10.0	25.0	170
Telephone-answering machines	40.0	45.0	50.0	66
Pocket pagers	60.0	72.0	86.0	130
Video recording units (non-consumer)	35.0	35.0	36.0	44
Data-communications equipment, total	604.0	892.0	1,084.0	1,302
Modems, total	160.0	180.0	190.0	220
Multiplexers	67.0	80.0	95.0	120
Programmable concentrators	40.0	51.0	66.0	72
Front-end communications processors	215.0	450.0	600.0	720
Message-switching systems	122.0	131.0	133.0	170
Facsimile terminals	80.0	96.0	113.0	160
Television equipment	217.9	239.4	260.4	291
Broadcast equipment, total	105.4	114.2	122.6	132
Transmitters	13.5	14.5	15.8	18
Antennas	11.9	12.1	14.3	20
Cameras	42.0	47.0	48.5	43
Auxiliary equipment	38.0	40.6	44.0	50
CATV, total	77.0	87.5	97.0	112
Studio and head-end	10.0	10.5	11.0	14
Distribution	22.0	27.0	33.0	40
Transmission lines and fittings	25.0	26.0	28.0	29
Converters	20.0	24.0	25.0	29
CCTV, total	35.5	37.7	40.8	48
Cameras	28.0	30.0	32.0	38
Monitors	7.5	7.7	8.8	10
Industrial electronic equipment, total	**1,521.3**	**1,738.4**	**2,015.8**	**2,674**
Motor controls (speed, torque),	219.0	238.0	257.0	345
Numerical controls, total	77.9	97.6	131.2	189
Hard-wired	40.0	38.0	36.0	12
Direct	1.7	3.8	5.2	9
Computer-controlled	24.0	36.0	50.0	63
Microprocessor-controlled	12.2	19.8	40.0	105
Inspection systems, total	39.4	43.0	47.1	59
Ultrasonic	12.7	13.5	14.5	16
X-ray	21.2	23.3	25.7	33
Infrared	4.0	4.5	5.0	7
Ultraviolet	1.5	1.7	1.9	3
Thickness gages and controls, total	84.8	95.1	106.8	143
Photoelectric	62.0	69.9	79.0	107
Radiation-based	22.8	25.2	27.8	36
Data-acquisition systems, total	425.0	508.0	604.0	802
Continuous process	160.0	187.0	219.0	310
Discrete process	265.0	321.0	385.0	492
Process controllers	60.8	68.5	77.7	92
Process recorders and indicators	72.0	77.5	83.0	99
Sequence controllers, total	60.0	78.0	113.5	161
Programmable	40.0	60.0	97.5	145
Hard-wired	20.0	18.0	16.0	16
Ultrasonic cleaning	10.0	11.0	12.0	14
Pollution-monitoring equipment, total	187.8	200.6	214.6	256
Air	109.7	117.4	125.6	150
Water	78.1	83.2	89.0	106
Induction and dielectric heating and sealing	41.9	40.4	42.9	52
Welding controls	19.0	22.5	26.5	40
Process-control computer systems, total	202.0	223.1	246.0	302
Digital	161.7	177.9	195.6	237
Analog	40.3	45.2	50.4	65
Energy-management equipment, total	21.7	35.1	53.5	122
Microprocessor-based	6.9	10.2	14.8	41
Minicomputer systems	5.0	10.0	17.5	30
Centralized	9.8	14.9	21.2	51

(millions of dollars)	1976	1977	1978	1981
Medical equipment, total	**1,057.0**	**1,113.0**	**1,317.8**	**1,708**
Diagnostic, total	511.5	475.0	556.0	720
Tomographic X-ray	100.0	120.0	160.0	200
Other X-ray	300.0	230.0	280.0	375
Electroencephalographs	12.0	13.0	14.0	17
Electrocardiographs	30.0	36.0	38.0	45
Ultrasonic scanners	35.0	50.0	54.0	68
Automated blood analyzers	80.0	82.0	84.0	93
Scintillation cameras and counters	56.0	60.0	64.0	75
Audiometers	15.0	16.0	17.0	22
Patient-monitoring systems	116.5	132.0	155.0	175
Prosthetic, total	320.0	387.0	480.0	642
Hearing aids	120.0	127.0	135.0	157
Pacemakers	200.0	260.0	345.0	485
Therapeutic, total	78.0	84.0	88.0	115
X-ray	39.0	39.0	36.0	48
Diathermy, shortwave and microwave	8.0	9.0	10.0	12
Ultrasonic generators	10.0	11.0	12.0	15
Defibrillators	21.0	25.0	30.0	40
Surgical support, total	31.0	35.0	38.8	56
Blood-flow meters	8.5	9.0	10.0	12
Blood-pressure monitors	14.5	17.0	17.8	25
Biomedical lasers	8.0	9.0	11.0	18

(millions of dollars)	1976	1977	1978	1981
FEDERAL ELECTRONICS, TOTAL	**15,659**	**16,638**	**18,210**	**20,754**
Defense, total	**14,049**	**14,963**	**16,487**	**18,868**
Procurement, total	6,783	7,051	7,932	9,721
Communications and intelligence	1,185	1,205	1,317	1,682
Aircraft, related ground equipment	1,810	1,890	2,212	2,569
Missiles and space systems	2,265	2,310	2,541	3,213
Mobile and ordnance	403	436	471	568
Ship and conversions	1,120	1,210	1,391	1,689
Research, development, test, and engineering	4,416	4,945	5,440	5,759
Operations and maintenance	2,850	2,967	3,115	3,388
NASA, total	**795**	**810**	**818**	**845**
Transportation, total	**380**	**405**	**421**	**512**
FAA procurement	235	240	247	320
FAA research and development	89	100	111	118
Highway and transit systems	56	65	63	74
Health, Education, and Welfare, total	**375**	**387**	**397**	**421**
Education systems	105	107	111	118
Health-care electronics	270	280	286	303
Department of Energy, total	**60**	**73**	**87**	**108**

CONSUMER ELECTRONICS

(millions of dollars)	1976	1977	1978	1981
CONSUMER ELECTRONICS, TOTAL*	**9,425.2**	**11,067.8**	**12,319.9**	**15,767**
Television receivers, total	**3,232.8**	**3,697.6**	**3,735.6**	**4,125**
Black-and-white	480.6	484.0	485.0	483
Color	2,752.2	3,213.6	3,250.6	3,642
Consumer audio equipment, total	**3,649.9**	**4,230.8**	**4,600.0**	**5,488**
Radios, total	770.0	978.0	1,095.2	1,236
Table, clock, and portable radios, total	435.0	620.0	712.0	772
A-m only	135.0	158.0	158.0	80
A-m/fm	300.0	462.0	554.0	692
Automobile radios	335.0	358.0	383.2	464
Phonographs and radio-phonographs, total	290.0	293.5	278.8	237
Tape recorders and players, total	804.9	863.3	922.0	1,049
Automobile players	220.0	253.0	278.3	320
Cassette and cartridge player/recorders	185.4	203.9	224.5	270
Reel-to-reel players/recorders	51.5	46.4	41.2	29
Tape player/radio combination	348.0	360.0	378.0	430
Hi-fi audio components	1,600.0	1,900.0	2,100.0	2,750
Hi-fi audio consoles	185.0	196.0	204.0	217
Other consumer electronics products, total	**2,542.5**	**3,139.4**	**3,984.3**	**6,153**
Antennas, TV, and radio	200.0	170.0	175.0	220
Home video players/recorders	20.3	174.0	450.0	1,300
Video projectors	4.0	60.0	66.0	80
Electronic organs, other instruments	288.4	331.7	381.1	473
Intrusion alarms, fire monitors	154.5	162.0	168.5	195
Electronic assembly kits	71.4	76.5	81.6	106
Microwave ovens	548.0	796.0	1,070.0	1,840
Smoke detectors	41.6	46.9	52.9	83
Electronic games	195.0	280.0	435.0	490
Calculators, hand-held, total	675.0	653.0	657.0	783
Electronic watches	318.0	352.0	395.0	496
Digital clocks	26.3	37.3	52.2	89

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

EUROPEAN MARKETS

☐ More and more, the people who run the governments and businesses in Western Europe resemble players in a game whose rules change while play is in progress. The old game plans simply do not make for winning scores any longer, and efforts to work out successful tactics on the field most often end up as frustrating false starts.

Under the old rules, economies rose and fell in discernible cycles, always ending up at a higher level of activity. Governments and businesses then learned how to brake the descents and accelerate the ascents into and out of the troughs in the cycles. It helped, too, that in Western Europe some countries would be on an up tick while others were on a down tick; for the latter, the chance for exports to fast-expanding economies took some of the sting out of the slower business at home. Above all, there was always a return to solid growth for the output of goods and services, and solid growth solves everybody's economic problems.

The rules began changing soon after the oil-producing countries quintupled their prices for crude five years ago. In large measure, the strong growth rates that prevailed through the late 1960s and early 1970s—they averaged about 5.5% for Western Europe overall—were fired by cheap oil. And with expensive oil came the decline, as country after country went into recession, usually with a dangerous mix of unemployment and inflation.

Since then, no country has been able to get back to its old growth rate and stay there. Nor does it seem at all likely for any country in Western Europe this year. Because inflation can flare so easily, governments no longer dare channel a lot of money into their economies in order to reflate them, as they would have under the old rules.

Chancellor Helmut Schmidt's coalition government has put together a mild reflation program. But even so, West Germany, whose economy sets the pace for neighboring Belgium and the Netherlands, cannot count on much more than 3% real growth for its Gross National Product. France figures to do only a little better than that; but all predictions about France have to be hedged against the strong possibility that the Socialists and Communists will oust the establishment parties in the legislative election in March and, for starters, hype consumer spending. North Sea oil will make for better business in Britain, but not enough better to boost growth above 3%. Italy, as always, is unpredictable; the country's persistent inflation and its precarious political position seem to rule out any significant growth. The same goes for Spain. The Scandinavian countries will not flourish this year either.

Overall, then, the real growth in Western Europe this year should run in the neighborhood of 3%. A lot of economists would not be surprised if the number turned out closer to 2%.

But what is true for business overall rarely is true for the electronics industries. Although sales of electronics hardware are not bounding upward as they would in good times, high technology seems able so far to spawn new markets for itself—desk calculators, digital watches, and the new breeds of small computers come immediately to mind—when established ones slow down, and thus keep growing at a faster pace than the economy as a whole. After its annual survey of 11 countries last fall, *Electronics* estimates this year's equipment markets will add up to $26.80 billion. That is a gain of 11% over the estimated $24.53 billion for 1977 and 19.5% above the $22.43 billion logged in 1976. These market estimates were calculated in current money and therefore make the gains look better than they would if they were discounted for inflation (see chart, p. ?).

As for components markets, they will total $7.34 billion in 1978, the survey suggests. That works out to a 9.1% gain for the year—if the forecasts are right. To no one's surprise, integrated circuits is the segment that will gain the most ground.

And there are few surprises in the equipment charts. Saturation has slowed some major color television markets, and that translates into a mediocre year for the consumer electronics sector, which leads the list for size. Close behind come computers, and they figure to get even closer with a strong rise in 1978. Communications, third on the equipment list, will move up strongly, too. The very touchy economic situation has stifled capital investment, so not much can happen in industrial electronics. But test and measurement gear, long a lethargic category, showed signs of stirring last year and should continue to improve this year.

As always, a chart marked "West Europe" belies an important reality—that what is involved is a group of national markets. The largest, of course, is West Germany. Equipment markets there will this year total $8.73 billion according to the *Electronics* survey. France comes next with a forecast of $5.71 billion, followed by the UK with $3.90 billion. Italy comes in at $2.47 billion, and the Benelux countries at just over $2 billion. Spain, at $1.33 billion, and Sweden, at $1.03 billion, are fairly close. Finally there are Switzerland at $0.64 billion, Denmark at just over half a billion dollars, and Norway slightly under a half billion dollars.

CONSUMER

Color TV to pace modest entertainment rise

Like the cast of a soap opera that has managed to stay on the air over several seasons, the entertainment electronics business in Western Europe has lost a lot of its zing. Color television, long in the leading role, cannot keep the ratings climbing as it once did. Promising newcomers like video tape recorders and video games still have just bit parts. Hi-fi hardware, fortunately, continues to belt out the theme song loud and clear.

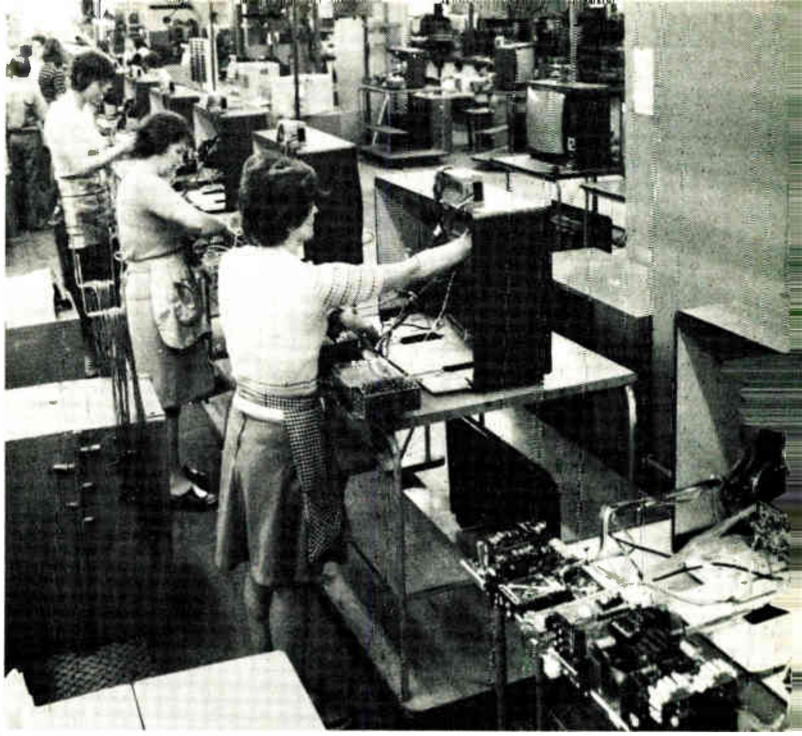
That still leaves entertainment at the top of the list of markets, all the same. *Electronics'* annual survey puts the 1977 market at $8.682 billion, up from $8.100 billion the previous year, a 7% rise. For the year ahead, the survey forecasts consumer electronics markets of $9.243 billion, a gain of only 6%. The main reason: a slowdown in sales of color sets.

The forecast for Western Europe puts sales of color sets last year at $4.190 billion, up 11% over the 1976 figure of $3.789 billion. For the year ahead, the estimate comes to $4.526 billion, up only 8%. Because the survey values markets at current factory prices, these gains look better than they really are, since they include price rises. A clearer idea comes from the charts that log sales by units. One worked up last fall at Philips Gloeilampenfabrieken in the Netherlands, largest of Europe's set-making outfits, predicted a total of 8.5 million sets for 1977 in Western Europe, up about 7% over 1976.

Whether in dollars or in units, the figures summarize a variety of national market prospects—from soaring in Spain and Italy to sagging in Scandinavia. The dominant West German market comes closer to sagging than soaring. More optimistic than most, Wieland A. Liebler, head of market research at Saba-Werke GmbH, sees a rise of 6% for the year ahead, to 2.76 million sets. But at Hamburg-based Philips GmbH, market researchers foresee a 2% growth to 2.35 million sets.

High or low, these forecasts do not point to a big color year in West Germany, where the saturation level has passed 50%. The same can be said for the neighboring Benelux countries, where the markets are flat. In the United Kingdom, too, the market is stagnant at around 1.65 million units. In Scandinavia the growth has topped out. Swedes, for example, bought some 400,000 color sets in 1976. Last year they took home only 330,000, and this year they will take even fewer—310,000. The market should stabilize at around 300,000 sets annually, starting in 1979.

Look south, and prospects look better. French consumers dawdled during the early 1970s while their neighbors in West Germany and the United Kingdom were flocking to showrooms to buy color sets. So it was 1976 before French set makers got past the 1-million-set level. Last year sales ran some 1.2 million sets and this year could go to 1.4 million and more. "The rise for consumer electronics could be 20% or so if the Left wins the elections in March," says Jacques Lorre, assistant director of the group that follows leading-edge industries for the Bureau d'Informations et de Prévisions Economiques, a highly regarded quasi-governmental French economics research organization.



Still in the pink. Although color television sales in West Germany will taper off this year, set makers will still be busy, as can be seen at Telefunken's TV plant near Hanover. Total color TV sales for Western Europe will be $4.5 billion, a 7% gain over 1977.

In Italy, euphoria bloomed in the color TV market during 1976 as consumers decided to spend their disposable income rather than see it diminished by inflation. Color TV sales doubled to some 500,000 sets during the year. The figures so excited set makers that they churned out far more receivers than the market could handle during the first half of 1977 and had to cut back sharply on both their output and their prices. If they get their inventory in hand, Italian set makers should do all right in 1978, relatively speaking.

In Spain as in Italy, inflation and a very low penetration rate ballooned color TV sales last year to some 300,000 sets. The inflationary expectations that turn even low-level wage earners into buyers of staggeringly priced color sets (the tickets are in the neighborhood of $2,000) still persist, and the market should run strong again this year. "Spain is special because about 50% of current owners of color sets are working-class people," maintains José Maria Gorria, a marketing executive at Philips Iberia.

In the next few years, the markets that are flaring now will cool down as they, too, become saturated like those in Scandinavia, Great Britain, and West Germany. So far, it looks as if set makers throughout Western Europe will have to learn to tune in on low-growth national markets, heavily laced with replacements. Video tape recorders, to be sure, are beginning to chalk up some modest sales, and video disk players will turn up soon. But it will be a long time, if ever, before they can compensate for the slower color TV sales. Scant succor can come from a second-set market in small-screen color portables and from hi-fi equipment, now a billion-dollar business second only to color TV on the consumer electronics charts. That's because the Japanese have moved in on the native suppliers.

COMPUTERS

Continual growth foreseen across the board

No matter what may be going on in the economy, computer makers somehow keep finding customers. That is obvious to anyone who matches up the figures for computer sales over the past few years with those that government economists have been promulgating for the Gross National Product. So it is not terribly surprising to learn that, despite the dismal general outlook, people in the computer business generally see a pretty good year ahead, albeit not the gaudy growth of the early 1970s.

For 1978, *Electronics'* survey forecasts sales of $7.955 billion for computers and related electronic data-processing equipment, a comfortable 13% above the estimate for 1977—$7.050 billion. That's not bad, even when the growth is discounted for price rises.

A closer look at the survey figures shows where the growth is coming from—mainly minicomputers, small systems, and terminals. Indeed, in most countries, the market seems to be splitting into two segments—very big and very small.

A big reason for the fast growth at the low end is the low cost of distributed-processing hardware. "With hardware costs going down about 30% a year, users can increase their power without adding to their mainframe," explains Heinz Blasser, computer systems manager for Hewlett-Packard in Western Europe. At the same time, cheaper computer power has brought a whole new army of customers—small-business men—within range of the computer makers' sales platoons.

Sales of terminals to big companies and government agencies are also on the rise. The banks in Britain, for example, will install between 6,000 and 7,000 on-line terminals over the next two years, estimate the computer-market experts of the Department of Trade and Industry. Swedish tax authorities are moving ahead on a nationwide net that eventually could have 100,000 dumb terminals. In France, post offices throughout the country are getting teller terminals for the postal banking system. In the Netherlands and in Italy, the transport ministries are automating their automobile-license operations with terminal-heavy systems.

These and dozens of other systems with batches of terminals—mostly intelligent—will keep sales of terminals throughout Western Europe moving ahead by some 20% this year, according to *Electronics'* survey. Some countries will far outstrip the average. Marketing men at Saab-Univac, for example, see a 60% rise in the offing for Sweden. There is no doubt that all this business in terminals will "reinforce the demand for large mainframes," says John Hartley, a marketing executive at ICL, the British computer heavyweight.

Although the growth pattern has much the same outline in the different countries of Western Europe, there is a spread in growth rates and a vast spread in market size. West Germany, far and away the largest computer market, was the laggard in growth last year, plodding ahead 8.5% to reach $2.456 billion. But a lot of German EDP users who have been putting off upgrading their systems from year to year, waiting for an upturn in the economy, can no longer wait.

France and the United Kingdom both scored good rises last year and figure to repeat them this year. The figures: a 12% rise to $1.68 billion in France and a 13% rise to $1.097 billion in the UK. CII-Honeywell Bull, surely, expects to have a strong year. At year-end, Jean-Pierre Brulé, who heads the company, made it known that CII-HB plans to hire 500 people during 1978, after a couple of years of a "no hire" regime.

Italy, though, tops the rankings for growth in computers and related equipment, with a forecast 15% rise to $793 million. And the Italian market still has high potential, says Mario Speranza, head of market research and analysis for Honeywell Information Systems Italia. Spending for data processing amounts to only about 1.5% of the GNP in Italy, he points out, a whole percentage point or more below countries like West Germany, France, and the UK. Speranza sees EDP running strong until the mid-1980s in Italy. "Computer demand seems to evolve independently of GNP and inflation because the market is so young," he adds.

COMMUNICATIONS

Prospects not so good for telecommunications

Time was when West European producers of telecommunications equipment, most of whom have to scramble in tough world markets for most of their business, could find some compensating comfort in stable home markets. Those days are gone. The long, slow spell for business in general brought an end to rising year-in and year-out outlays for equipment by the government-run communications networks in most countries. To compound the discomfort, the advent of integrated-circuit hardware distorted traditional market patterns.

So communications equipment makers have had to learn to work in markets that move down as well as up. This year, the three largest countries will show the best gains in their communications markets; elsewhere, Norway excepted, prospects are poor for 1978. Overall, the charts predict an 11% gain this year. If the prediction holds, West European communications equipment suppliers will share a $5.742 billion market, up from an estimated $5.167 billion in 1977.

In West Germany, a solid rise is in sight. After holding the line on spending for two years, the post office plans to open its coffers this year and invest slightly more than $3 billion in new plant. That is 11% higher than spending for 1977 and ensures a good year. Together with what other federal agencies and private users will spend, the market for communications gear should move up 12.3% this year to $1.504 billion.

The West German market also figures to run strong for electronics telecommunications gear for a while. The EWS electronic switching system has started to become a market factor, points out Manfred Beinder, chief economist for ITT subsidiary Standard Elektrik Lorenz AG. Siemens AG, SEL, and two smaller suppliers have EWS in production and the post office plans a long-term changeover from conventional switching to electronic switching that probably will last beyond the year 2000. Another long-term big-ticket item is the EDS electronic data switching system. The post office will shell out more than $570 million through the early 1980s to equip itself with EDS systems.

The French telecommunications administration rates as a big spender, too. In its drive to build its phone network up to 20 million lines by 1982, it budgeted $4.8 billion for the program last year. It has another $5.3 billion allocated for 1978, which the agency calls the key year for electronic switching. Most of the money goes for putting in lines, but there is a hefty allocation for equipment, too. *Electronics'* survey, for example, shows $268 million for carrier equipment, now on the wane, and $165 million for electronic and semielectronic switching equipment, just starting to wax. Sharp rises for deliveries of electronic switching equipment are certain over the next few years. Fully 40% of the exchanges the agency plans to order this year for later delivery will be all-electronic time-division hardware.

CIT Alcatel, the telecommunications company of the CGE group, stands to benefit most from the heavy shift to time-division switching. However, Thomson-CSF, the largest producer in France of "professional" equipment like radars and telecommunications, will do all right with the conventional switching gear produced by Le Matériel Téléphonique, the former ITT subsidiary it now controls.

And Thomson-CSF presumably will benefit from the boost of some 15% in defense spending that the government has set for 1978 after two years of holding outlays at the same franc level, meaning that the real spending was on the decline. Exactly where the added money will go has not yet been worked out, but some will surely find its way into the coffers of defense electronics makers. Though a welcome upturn, it has to be weighed against the fact that exports account for more than half the business at Thomson-CSF.

In the UK, sales of communications equipment will move up 14% to $1.166 billion, according to the survey. Because the survey omits electromechanical exchanges, the charts do not show the plight of telecommunications companies, which have been hard hit by the whopping cut the British Post Office made in its switching program when it found out in the course of last year that it had 20% excess in capacity.

Significantly, the program for the TXE-4 semielectronic exchange came out of the cuts virtually intact. Over the next five years, 750 of them are planned at a cost of $1.26 billion. The British Post Office has let development contracts, worth $36 million, for its System X all-digital transmission and switching network.

UK defense electronics makers have a troublesome home market. Military spending has been cut to the bone. But luckily, British arms makers are still doing well in export markets, and so the charts show comfortable rises for things like radars and radio-communications hardware destined for overseas customers.

TEST AND MEASUREMENT

Instrument sales looking up after recent flat years

Instrument makers became inured to flattish markets in the mid-1970s, but find themselves doing considerably better at the moment. To be sure, the levels of growth in the various markets are far from lusty. But they did manage last year to move up almost 10% to $634 million overall, according to *Electronics'* survey. The forecast for the year ahead is another rise in the vicinity of 10%. As David Baldwin, instruments marketing manager in Europe for Hewlett-Packard, puts it, "We are in a controlled comeback from the recession."

There are a lot of positive signals that indicate the comeback. Timing of the market cycle points to another 12 months or so of good business in the opinion of Henk Bodt, deputy manager of Philips' test and measurement department. Bodt also notes that the time it takes to close orders has been shortening, even though orders have been getting bigger.

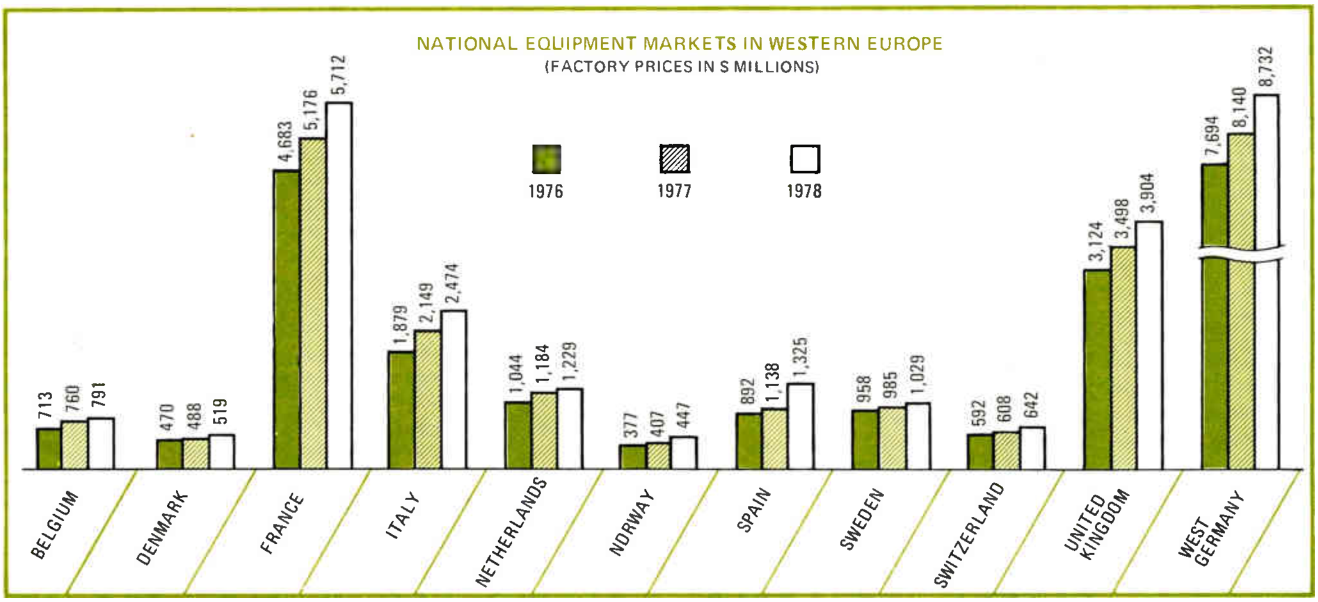
One burgeoning class of instruments is data-domain hardware. HP's Baldwin sees it growing four or five times faster than the overall average in Western Europe. "It's such a multifaceted market that we reeducated our sales force and put a big effort in seminars to educate customers," he says.

Another upwardly mobile category is automatic test equipment. Here, Philips' Bodt expects "an enormous increase in data-logging—because people need sampling for quality control." Both ATE and data-logging gear these days usually come blessed with some kind of microcomputer to supervise and speed up operations. Bodt thinks the test and measurement market is on its way to splitting into two segments—low-cost "throw-away" instruments, and sophisticated microprocessor-based instruments—systems if you will.

COMPONENTS

Following two good years, makers see leveling off

West European components suppliers can expect some cooling down in their markets. In 1977, the parts people logged their second good year in a row. Components sales, according to *Electronics'* survey, scored an increase



of 11.4% to reach a total of $6.737 billion.

As for 1978, "it's going to be a fair year, nothing more," predicts Philippe Rietzler, head of market research for Sprague Europe. Much the same assessment comes from Alfred Prommer, a Siemens vice president who is also president of the European Component Manufacturers' Association. "Rather temperate" is how Prommer puts it.

The chart says it with figures; it forecasts components sales of $7.34 billion for the 11 countries surveyed, and that works out to a rise of only 9% over 1977—in current money, yet. Passives and electromechanical components remain the largest market segment at $3.756 billion, but semiconductors are growing faster and should get past $2 billion this year.

In one respect, 1977 was a landmark year for semiconductor suppliers in Europe. For the first time, the survey logged higher markets for integrated circuits—$885 million—than for discretes—$855 million. "An interesting fact," remarks one West German industry official, "but no particular cause for joy."

IC markets will really pull away this year. They are tagged to move up above $1 billion, while discretes will make it barely past $0.9 billion. Memories and microprocessors will do the most for the rise in ICs, something like 18%. "It's going to be the first big year for microprocessors in Europe," maintains Brussels-based Tom Lawrence, European marketing manager for Intel Corp. "They're going into consumer products, telecommunications, big computers, small computers. Except in autos, where the U. S. is way ahead, the market here is developing about the same way as in the States."

The zoom for ICs does not mean that West European semiconductor makers will have an easy time of it this year. Prices are under pressure. "We're still being crucified by U. S. suppliers," laments David Benda, head of the economics and market research department at Mullard Ltd., the main components-producing company for the Philips group in the UK.

What's more, there are even more marketing problems ahead. For example, Nippon Electric Co. has started making heavy shipments of 4,096-bit random-access memories from its plant in Ireland, and competitors say the Japanese firm has picked up a lot of business at mainframe computer makers. □

More microprocessors. The pervasiveness of microprocessors is exemplified in this traffic light control. A Siemens technician programs a processor installed in a roadside cabinet for a timing sequence that better suits the intersection's traffic conditions.

JAPANESE MARKETS

☐ Like the lovely princess in a No play who turns out to be a demon, Japan's electronics markets are undergoing a transformation from the beautiful recovery of 1976 through early 1977 into a fearsome set of problems. Flat demand in key sectors of the domestic front and restriction of favorite export markets are aspects of more fundamental economic woes—including slow growth of the Gross National Product, inflation, unemployment, and dependence on imports for raw materials and energy. To make matters worse, all of these problems are likely to increase as a result of external pressures on Japan's balance of trade.

Just as a No play may end in a way that leaves the audience hanging, the end of 1977 left the electronics industries hanging. So to break the demon's spell, they may this year begin basic, long-term changes in new product development, international marketing strategies, and technological directions.

As for the general economic outlook, financial observers constantly refer to "restructuring" the Japanese economy. By this they mean that Japan can no longer follow its practice of exporting itself out of a recession and must make the necessary adjustments within its own economy to strike a balance among employment, demand, inflation, and a more expensive currency. The latter is being catapulted upward by the rapid growth of trade surpluses, and unemployment, which was virtually nil for more than a decade in Japan, is also a new factor, reaching over 2% in mid-1977.

As a result, the government has had to take an increasingly active part in stimulating the domestic economy. Last September it announced yet another recovery program, boosted public works spending, and lowered interest rates. In late November there was even a cabinet shuffle designed to bear down on economic problems. Proposals that followed include a 15-month budget to get the economy moving—an economy-stimulating supplemental budget providing a head start during January through March, followed by a similar 12-month budget for fiscal 1978 starting April 1. Tariffs on selected imports, including computers, will be reduced.

Despite these proposals, the outlook for the electronics industries, with certain exceptions, is rather gloomy. According to *Electronics'* survey, total equipment consumption this year should be $15.4 billion, compared with just under $14 billion last year (see graph). Consumption of components (semiconductors, passive, and electromechanical devices, and tubes) is predicted to reach $6.6 billion.

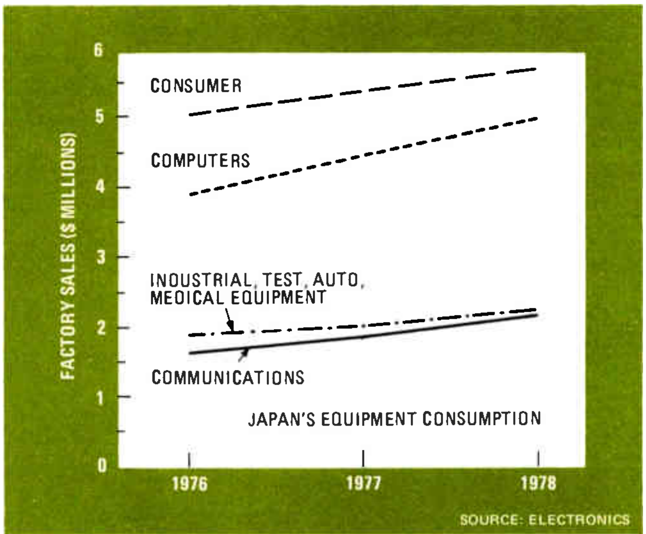
CONSUMER

High-end features make up for flat sales volume

Giving up their recession-minded preoccupation with low-priced, economy-designed products, Japan's consumer electronics producers last year brought out a raft of new models loaded with features designed to up the ante in sales. The idea was to make up in yen value what the domestic market lacks in unit sales.

They almost carried it off. In TV, both color and monochrome, in high-fidelity audio, tape recorders, radios, watches, and calculators, and even in microwave ranges, the accent was on new features, and with these features, a larger yen return. The strategy worked sufficiently to get 1977 up to a growth of approximately 8%, a figure the consumer companies find unsatisfactory.

Now the Japanese face a new year with prospects not unlike those of last year, which means they will have to do something clever again in 1978. Fortunately, the



Note: The value of the yen has been changing regularly. Dollar values for this chart were computed at 250 yen = $1.

Japan's flatlands. In contrast with its steep growth rate in previous years, Japanese electronics equipment consumption was relatively flat last year. Only the computer section shows an appreciable gain for 1977, but not up to its past performances.

arrival of home video cassette machines as real consumer products will help the cause.

Consumer video tape recorders will most certainly help exports, which might otherwise be a shambles. Besides the quotas put on TV sets and the near-death of citizens' band transceivers for the important U. S. market, the rising value of the yen relative to the American dollar is sabotaging Japanese price competitiveness and opening the way for lower-priced items from Korea and Taiwan. The value of the yen has gone up something like 20% or more in the last year, and although the Japanese have announced price increases in the U. S. to compensate, there is no way that they can hike price tags a full 20% in one step and remain competitive. They will have to continue increasing prices a little at a time.

There are problems domestically, too. For color TVs, household saturation is now past 95% and unit sales leveled at 5.7 million units last year, with about the same number projected for this year. Higher-priced features such as electronic tuners have kept the yen value from declining, as *Electronics'* consumption table indicates.

Now, the TV makers are promoting 20-in. televisions with touch-type electronic tuners and remote control to boost the average value of sets sold. Matsushita Electric Industrial Co. has even made a play to move 26-in. consoles with the introduction at the end of last year of a model priced at ¥298,000 ($1,192), which puts it close to the 22-in. set's price of ¥260,000 ($1,040).

High-fidelity stereo equipment, which has consistently been a growth performer, also has run into trouble. Last year the youth market that usually supports audio sales took its money elsewhere and the hi-fi business slumped in value by 4%, according to *Electronics'* survey. This year producers expect a slight recovery, reaching $870 million, but on the whole, stereo, like TV, consumption is flat, with the possible exception of tape decks.

The fledgling consumer video cassette market, however, has rapid growth ahead, after its small beginnings. It is generally agreed that the domestic market bought 250,000 to 300,000 units last year and should account for 400,000 to 500,000 units this year—600,000 units would be the absolute maximum. The reason is that the market is snapping up all that are made.

By contrast, the microwave range market has been only simmering at a little over 1 million units a year since 1974. Consumption this year will probably be the same, with 1.1 million to 1.2 million units sold. The microprocessor-based programmable ranges have had very little impact domestically. Instead, the Japanese makers hope to heat up sales with new combination units: tabletop models that have both microwave and conventional electric cooking in the same oven cavity.

The calculator market is similar to the U. S.'s—not too exciting, but rewarding enough to those few still in the competition. The long-term price declines are over.

The great VTR hope. All the major manufacturers of consumer video cassette equipment have lined up with either Sony's Beta Format or Japan Victor's Video Home System. The Sanyo two-hour Beta Format unit above was the early price leader.

COMPONENTS

IC processors, memories set pace; discretes drift

The semiconductor market reflected the overall confusion in 1977. Television manufacturers, expecting to continue exporting, built up inventories; citizens' band radio manufacturers, on the other hand, lived off inventory. But the decline in CB and leveling in TV sales compared with the previous year kept demand for discretes almost flat, while demand for linear integrated circuits picked up sharply, pushing them far out in front. Solid growth for linear ICs should continue this year, with a gain of over 12% indicated by *Electronics'* market survey, compared with a growth of 6% for discretes.

Among the leaders in last year's 8% growth for all ICs were memories and microprocessors. This year IC consumption is expected to jump 23%, and memory chips should forge ahead of calculator chips for the first time—microprocessor chips may do the same in 1979. The leading product is still 4,096-bit dynamic random-access memories, with 1,024-bit units second. But 16,384-bit dynamic RAMs are coming up fast and will become less expensive per bit later this year. The first 64-k dynamic RAMs are not expected until next year.

In statics, demand is said to exceed supply for 4-k RAMs for use with microprocessor sets. The nonvolatile 1-k static RAM developed by Tokyo Shibaura Electric Co. (Toshiba) should be designed into a number of applications, because the company has finally succeeded in producing the control IC that simplifies the memory plane. In fact, Mitsubishi Electric Industrial Co. in Japan and General Instrument Corp. in the United States say they will second-source the device.

Finally, the supply of 8,192-bit programmable read-only memories is plentiful. Prices for PROMs, consequently, are very soft.

As for microprocessors, applications are proliferating. Initially, commercial applications, including cash registers, office copiers, vending machines, and facsimile terminals, had been large users; but this year, consumer product applications should pull out in front.

Four-bit microprocessors lead the pack, with Japanese-made custom one-chippers becoming increasingly dominant over the standard units from American or Japanese sources. In 8-bit systems the lion's share is enjoyed by the 8080A, with second-generation custom devices like the 8045 and 8085 coming along. In addition, Motorola Semiconductor reports that sales in Japan of the MC6800 tripled last year, but still did not grow as fast as the total market. Demand for 16-bit units is satisfactory from minicomputer manufacturers, but less so from other users, who are still developing software.

Though not as glamorous, demand for low-power Schottky transistor-transistor logic is increasing nicely; for complementary metal oxide semiconductors, it is growing at a more moderate rate; and for standard TTL, it is holding its own. Although still not large on an absolute basis, demand for current-mode logic is growing rapidly because of the steep increase in sales of very large computers, including Amdahl machines exported to the U. S.

Demand for discretes used in television sets is declining both because fewer sets are being made and because the trend is for four or five large linear ICs to replace more of the active devices in the set. Electronic tuning in TVs, though, is helping hold up discrete demand by requiring more varactor diodes. An attractive new market for discretes is video tape recorders, which at present use up to 150 transistors each.

COMPUTERS

Competition gets rough for replacement-based market

In the two years since Japan threw open its computer market to all makers, the Japanese mainframe companies have come to appreciate the true strength of their American competitors, particularly IBM Corp. It has been a rough time, despite the competitive weapons—joint efforts, research and development for new machines—that Japan's government helped the main domestic firms forge in anticipation of liberalization.

While the Japanese companies this year will be in a good position to compete, the struggle for this $5 billion market will continue. Indeed, they received something of a shock last year when a survey of computer-user satisfaction conducted annually by the Industrial Efficiency Junior College ranked a Japanese company first on only 1 of 10 factors.

Hitachi Ltd. got a first for maintenance and service, while IBM came in first in 5 of the 10 categories. Burroughs in 3, and NCR in 1. Fujitsu Ltd., Japan's leading computer firm, got 3 second-place mentions. But on the whole, the domestic firms did not fare well.

Up and down the product lines, the battle continues to be fierce for what has tended to be a replacement market with strong brand loyalty. But distributed processing promises to be a new source of sales in the next couple of years. This trend should have the greatest impact on consumption of terminals, which until now have been sold mainly as part of large on-line systems. The 16% growth anticipated for data terminals will outpace the 11% gain predicted for data-processing mainframe systems as a whole (see chart, p. 147).

In mainframes, there was action at both ends. IBM is offering more competition with the introduction of its 3033 system to replace the System 370/168. Significantly, the 3033 is now being manufactured in Japan, whereas IBM did not build 370/168s in Japan.

At the other end, in minicomputers, manufacturers expect almost 17% growth this year, reaching $234 million, according to *Electronics'* survey. While the larger systems are more or less rolling with the replacement market, the minis have had more flexibility in seeking out new customers.

COMMUNICATIONS

Future depends on new phone company services

Communications have turned into a whole new ball game as the leading domestic customer, Nippon Telegraph and Telephone Public Corp., celebrated its 25th anniversary in 1977. NTT has finally cleared away the backlog of customers waiting for service installation and also has most of its basic plant in place. From now on, the telephone company will have to develop new sources of business if its consumption is to increase more than a natural 2% a year.

Since NTT can no longer offer its suppliers a rapidly growing market, many are turning to overseas markets—especially less developed countries—to continue their growth. The other bright spot is the United States, whose markets have been opened up somewhat by recent Federal Communications Commission rulings encouraging competition with the Bell System.

Nevertheless, purchases by NTT last year climbed back to 1975 levels, recovering from their decline during 1976. Consumption of electronic exchanges continues to grow by 20% to 30% a year, but crossbar sales are falling by 10%, with crossover in deliveries predicted for next year. This year semiconductor memories will replace core memories in new units, bringing prices down to the level of crossbars. Next year sealed multicontact matrix switches will replace miniature crossbar switches as a speech path [*Electronics*, Nov. 10, p. 56], bringing down prices still further.

DDX-50 digital data exchanges to go into service in 1979 in five cities will be the start of Japan's digital data network. The following year should see the emergence of experimental time-division exchanges for speech.

This year a 20% growth in facsimile terminals is forecast, with the biggest market for 2- and 3-minute machines using CCITT's abbreviated-protocol transmission format. NTT will offer machines for this service for the first time next year, and small-scale domestic users of Telex may switch to them. NTT will also offer small, inexpensive machines for home use, so that industry sources expect the facsimile market to increase dramatically in four or five years.

Field tests this year of a 20-kilometer fiber-optic system mark a start for this market, but significant business is probably still five years away. Closer to today, a digital paging system operating in the 250-megahertz band started last year should help equipment sales by expanding the business band, as frequency allocations in the 150-MHz band for conventional tone pagers are now saturated.

INDUSTRIAL

Modest growth continues

Industrial controls gained a moderate 10% last year, but the outlook for this year is a lower 8%. Process controls, the largest market segment, grew approximately 8% last year and will do about the same this year, reflecting the comparative slump that Japan's major industries are experiencing.

Demand for process controls is about half for new installations and about half for replacements—with many of the new installations going into nontraditional markets, including food, fine chemicals, and pharmaceuticals. Other new installations are going into turnkey plants that are destined for export.

Replacements lean heavily toward installations that save energy, raw materials, or labor. According to a Ministry of International Trade and Industry official, Japan can acquire enough additional energy for up to 6% growth in the Gross National Product, but must save energy to attain anything higher. Therefore, the energy-saving equipment market has good potential.

Capital investment in the steel industry, one of the few to continue growing after the oil crisis, has come to an end. However, refineries and petrochemical plants, which have made no purchases in four or five years, are starting to buy replacements for obsolete controls in order to save energy and raw materials or to change their product mix. Also buying replacements to achieve energy and raw materials savings is the paper industry.

Yokogawa Electric Co. says that since introduction of its Centum microprocessor-based process control system in 1975, it has sold 100 installations, with the average installation having 40 to 50 loops, the largest 150 loops, and the smallest 20. Yamatake-Honeywell Co. claims to have sold a total of 1,300 loops of the TCDS 2000 developed jointly with Honeywell Inc. and announced at the end of 1975.

INSTRUMENTS

Microprocessors chip in

Test equipment sales rose less than 10% last year and promise to approach 12% this year. Manufacturers consider themselves lucky to have done as well as they did last year, because many traditional customers including entertainment electronics and citizens' band transceiver makers cut back on purchases sharply. Many sales were made in new fields as electronics continued proliferating throughout Japanese industry.

Greatly increased use of microprocessors in electronic cash registers and point-of-sale terminals, in copying machines, and in facsimile equipment provided these new markets. Also helping was increased use of instrumentation in automobile and steel plants. Purchases of instruments by manufacturers of automobile components indicate they are developing microprocessor-based engine controls and other systems for eventual installation in cars. Production of cars using such systems will probably fuel a large increase in test equipment purchases for production and service.

On the other hand, falling prices held down sales increases for many instruments in which unit quantities are growing. In particular, increased use of large-scale integration brought down prices for such products as counters and digital multimeters. Some observers say there may be a trend toward combining instruments, such as adding a counter to a DMM, which merely requires another LSI device and an inexpensive crystal. As for oscilloscope, demand grows for 250-megahertz units, but most sales are for low-priced scopes like Matsushita's new two-channel portable unit.

DEFENSE AND SPACE

Security funding boosted

A MIG-25 that disappeared from both ground-based radar screens and those in F-4 fighters before landing on Japan's northernmost island of Hokkaido in September 1976 will probably clinch a deal for the Japan Defense Agency to start acquiring the 123 F-15 fighters and 45 P-3 antisubmarine patrol planes it desires.

This year's budget request includes 29 F-15s, whose radar has superior look-down capabilities, 10 P-3Cs, and 19 F-1s—a Mach 1.6 ground-support version of a Japanese-developed supersonic trainer. Initial American planes will be complete, followed by knocked-down versions, and then by partial kits, with the remaining parts fabricated in Japan. The total 1978 request for 154 aircraft for three defense forces (air, maritime, and ground) is over $544 million.

Delivery by Mitsubishi Electric Corp. of 3-d radar by the end of March will bring to seven the number installed on Japan's 28 radar sites. The next one, for delivery by the end of March 1979, is an improved system from Nippon Electric Co. Mitsubishi might get an order for a portable unit, but that is less lucrative because of the smaller quantities involved.

A big project that started in 1977 is a five-year plan to install a 960-channel, 8-gigahertz microwave system on Japan's four main islands. Equipment purchases include $12.8 million last year and a request for $14 million this year. Also requested for 1978 is $13.6 million for ground communications replacements.

The National Space Development Agency's fiscal 1977 budget of $32 million is 84% of Japan's total space allotment and will probably be increased another 10% to 15% for fiscal 1978. Its geostationary meteorological satellite Sunflower was orbited from the United States in July and followed by an experimental communications satellite in December. The third satellite in the series to be orbited from the United States will be an experimental broadcast satellite scheduled for February or March. It will pave the way for broadcasts to homes. □

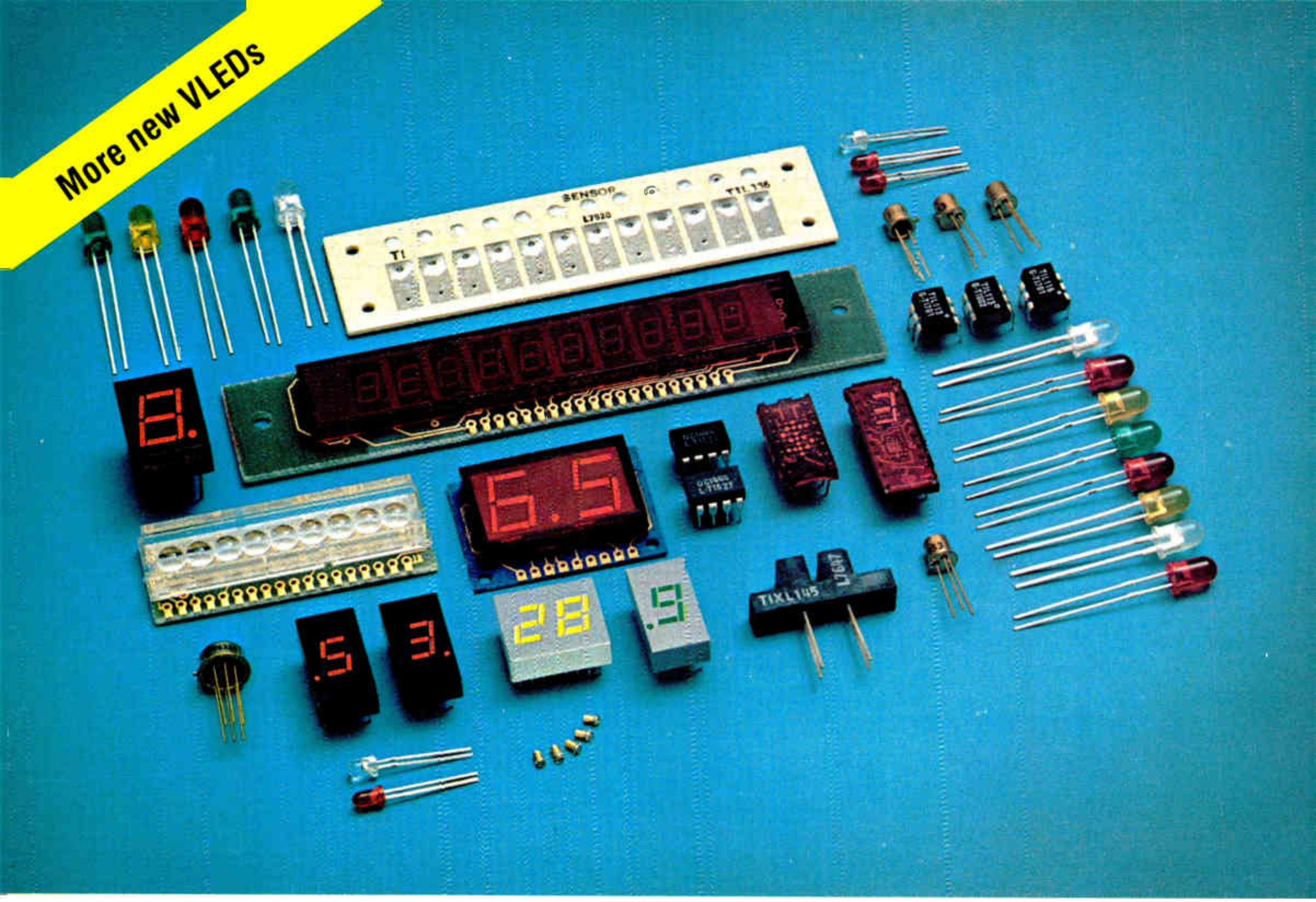
JAPAN/EUROPE MARKETS FORECAST 1978

	JAPAN 1976	JAPAN 1977	JAPAN 1978	WEST EUROPE 1976	WEST EUROPE 1977	WEST EUROPE 1978
COMPONENTS, TOTAL (millions of dollars)	**5,681.4**	**6,035.7**	**6,574.8**	**6,047.5**	**6,737.6**	**7,340.3**
PASSIVE AND ELECTROMECHANICAL	**2,985.5**	**3,197.1**	**3,369.7**	**3,142.7**	**3,447.9**	**3,755.7**
Capacitors, fixed	673.4	712.5	745.3	679.4	750.1	821.0
Capacitors, variable	61.2	63.8	91.6	49.9	54.4	58.3
Connectors, plugs, and sockets	110.8	119.1	129.4	402.8	444.3	481.3
Filters, networks, and delay lines	---	---	---	63.9	69.2	75.2
Loudspeakers (OEM type)	190.3	226.0	257.1	132.8	136.4	143.5
Microphones (OEM type)	58.3	58.6	61.4	36.8	40.4	43.2
Microwave components	46.4	46.4	46.4	0.3	0.5	0.6
Potentiometers, composition	185.0	205.7	193.3	152.1	162.9	171.6
Potentiometers, wirewound	12.9	13.6	14.2	52.5	58.1	61.6
Printed circuit boards	291.3	335.6	367.3	372.2	422.3	474.2
Quartz crystals (including mounts and ovens)	152.5	154.4	164.1	69.2	76.4	85.6
Relays (for communications and electronics)	189.4	214.3	229.5	286.4	301.3	327.8
Resistors, fixed (including wirewound)	196.7	203.4	208.3	236.8	251.3	261.3
Resistors, nonlinear	---	---	---	31.8	34.5	39.6
Servos, synchros, and resolvers	20.0	21.7	21.6	38.8	43.0	47.9
Switches (for communications and electronics)	182.8	198.2	211.8	183.1	207.6	231.8
Transducers (pressure, strain, temperature, etc.)	6.4	7.2	8.4	---	---	---
Transformers, chokes, coils, TV yokes, and flybacks)	608.1	616.6	620.0	353.9	395.2	431.2
SEMICONDUCTORS, DISCRETE, TOTAL	**836.8**	**895.0**	**946.0**	**772.6**	**854.7**	**905.5**
Microwave diodes, all types (above 1 GHz)	8.1	9.0	10.8	13.5	15.1	17.4
Rectifiers and rectifier assemblies	168.2	183.8	186.9	146.8	164.2	177.0
Signal diodes (rated less than 100 mA, including arrays)	97.4	107.5	114.8	70.6	77.5	82.9
Thyristors (SCRs, four-layer diodes, etc.)	44.8	52.5	61.4	76.8	86.1	91.0
Transistors, bipolar power (more than 1-W dissipation)	172.5	182.6	187.5	143.3	162.6	176.9
Transistors, bipolar small signal (including duals)	282.7	284.2	270.2	246.2	262.4	267.2
Transistors, field-effect (power and small-signal)	27.7	31.6	57.3	14.2	16.6	18.8
Tuner varactor diodes	13.6	21.4	27.8	22.7	25.5	26.4
Zener diodes	21.8	22.4	29.3	38.5	44.7	47.9
SEMICONDUCTORS, INTEGRATED CIRCUITS, TOTAL	**862.0**	**927.5**	**1,145.3**	**719.8**	**884.9**	**1,051.1**
Hybrid ICs all types	74.5	79.1	87.9	64.3	77.3	89.6
Linear ICs (except op amps)	197.3	216.8	243.1	179.6	205.3	224.5
Op amps (monolithic only)	22.3	23.4	29.9	36.2	42.1	48.5
Logic circuits, bipolar	148.3	158.3	173.7	182.4	207.7	226.9
Logic circuits, MOS and C-MOS	86.0	99.8	119	102.3	134.2	168.9
Memory circuits, bipolar	19.3	23.8	29.9	26.8	38.4	45.0
Memory circuits, CCD	0.7	1.4	2.7	---	---	---
Memory circuits, magnetic-bubble	0.2	0.5	1.6	---	---	---
Memory circuits, MOS and C-MOS (except microprocessors)	89.3	123.0	146.4	76.5	103.6	133.9
Microprocessors (includes CPU, memory, and I/O chips)	36.7	52.4	77.0	20.5	34.5	55.9
Calculator chip sets	128.5	123.0	127.0	6.4	8.0	8.6
Watch and clock chip sets	36.5	43.1	43.8	13.5	24.7	30.8
Other special-purpose circuits	45.3	54.9	63.3	11.3	14.1	18.5
SEMICONDUCTORS, OPTOELECTRONIC, TOTAL	**168.0**	**186.5**	**215.7**	**71.2**	**87.9**	**103.2**
Circuit elements (photoconductive cells, photodiodes, etc.)	17.9	18.2	21.6	22.1	26.8	31.1
Discrete light-emitting diodes	30.0	34.9	43.1	18.6	23.6	27.1
Readouts	120.1	132.0	149.0	29.5	35.8	42.1
Photovoltaic (solar) cells	---	1.4	2.0	1.0	1.7	2.9
TUBES, TOTAL	**829.1**	**829.6**	**898.1**	**1,346.8**	**1,463.8**	**1,532.8**
Cathode-ray tubes (except for TV)	5.6	6.3	7.5	33.4	39.5	44.3
Camera tubes and image intensifiers	23.3	27.7	31.2	58.0	65.4	75.6
Photomultiplier tubes	9.4	9.4	9.8	---	---	---
Power tubes (below 1 GHz), vacuum, total	20.4	20.4	20.8	64.4	71.4	77.3
Power tubes (below 1 GHz), gas or vapor	4.1	4.0	3.8	25.2	27.9	30.1
Microwave tubes, total	54.5	56.3	59.9	94.0	104.9	115.3
Cooker magnetrons	41.5	43.4	47.0	---	---	---
Receiving tubes	7.4	6.7	5.7	63.5	55.7	50.1
TV picture tubes, black and white	51.1	53.9	54.3	90.0	81.4	79.8
TV picture tubes, color	653.3	644.9	705.1	918.3	1,017.6	1,060.3
EQUIPMENT, TOTAL (millions of dollars)	**12,617.5**	**13,978.4**	**15,438.9**	**22,426.8**	**24,533.3**	**26,804.4**
CONSUMER, TOTAL	**5,047.4**	**5,449.3**	**5,824.2**	**8,100.0**	**8,682.4**	**9,242.8**
Audio tape recorders and players	708.5	778.6	825.3	543.8	551.4	565.7
Citizens' band transceivers	6.7	6.5	8.7	97.2	120.4	125.9
Electronic ranges (microwave ovens)	281.4	286.8	293.3	---	---	---
Hi-fi equipment	769.8	736.9	870.3	890.6	1,016.6	1,126.5
Musical instruments (organs, electric guitars, etc.)	148.0	172.0	180.0	---	---	---
Phonographs and phono radio combinations	170.4	122.3	114.9	374.7	383.6	390.3
Pocket calculators (four-function, personal)	182.7	174.7	181.3	359.4	273.3	262.4
Radios (including car radios)	194.5	157.9	221.7	847.6	889.6	913.4
Radio/recorder combinations	386.6	388.8	407.9	440.7	482.2	515.0
TV sets, black and white	92.3	101.3	117.0	674.7	652.2	636.4
TV sets, color	1,763.0	1,992.0	1,848.4	3,789.4	4,190.1	4,525.5
Video games	2.1	12.8	28.4	23.8	37.3	53.2
Video tape machines (consumer)	107.1	208.9	342.5	33.9	51.5	72.8
Watches and clocks, electronic	234.3	309.8	384.5	24.2	34.2	55.7

EQUIPMENT, continued	JAPAN 1976	JAPAN 1977	JAPAN 1978	WEST EUROPE 1976	WEST EUROPE 1977	WEST EUROPE 1978
COMMUNICATIONS, TOTAL	**1,685.3**	**1,864.2**	**2,164.2**	**4,650.0**	**5,167.0**	**5,742.0**
Broadcast	59.8	62.7	69.3	154.4	160.4	181.6
Cable TV	10.0	10.9	11.0	29.9	33.4	36.4
Closed-circuit TV	31.3	35.0	39.3	127.3	143.8	159.5
Data communications	76.0	78.0	80.0	103.2	116.9	132.2
Facsimile terminals	70.1	91.9	110.0	---	---	---
Intercoms and systems	30.1	35.1	39.3	119.8	129.2	138.0
Laser communications	1.2	2.0	3.2	---	---	---
Microwave relay	126.1	138.0	149.3	245.4	266.1	300.6
Navigation aids, except radar	150.7	169.8	190.0	369.3	397.9	431.6
Optical fiber communication	0.1	0.2	0.4	---	---	---
Paging (public and private)	32.0	34.0	37.0	23.4	26.2	31.3
Radar (airborne, ground, and marine)	86.2	94.1	103.4	689.9	771.1	846.3
Radio communications, except broadcast	400.1	424.8	586.1	833.7	926.7	1,017.0
Telephone switching, PABX[1]	82.0	94.0	100.0	514.7	572.8	633.8
Telephone switching, public[1]	165.7	201.9	223.2	431.4	635.0	851.8
Telephone and telegraph carrier	33.5	37.3	41.2	976.7	948.8	937.5
Video recorders and players (non-consumer)	330.4	354.5	381.5	30.9	38.7	44.4
COMPUTERS AND RELATED EQUIPMENT, TOTAL	**3,945.0**	**4,486.4**	**5,044.0**	**6,330.7**	**7,050.1**	**7,954.5**
Data processing systems, total[2]	2,312.1	2,554.8	2,838.7	3,981.9	4,347.8	4,888.0
Microcomputers (basic chassis value less than $1,500)	22.9	48.1	61.0	15.6	22.2	26.7
Mini (system value less than $50,000)	158.1	200.1	234.0	---	---	---
Small (up to $420,000)	366.6	380.2	422.7	---	---	---
Medium (up to $1,680,000)	588.5	628.4	690.6	---	---	---
Large (up to $3,360,000)	731.2	796.1	900.4	---	---	---
Giant (more than $3,360,000)	444.8	501.9	530.0	---	---	---
Add-on memories	74.0	84.6	95.8	53.9	59.5	64.3
Data acquisition	105.7	128.4	144.5	131.2	134.1	141.8
Data entry/output	150.7	173.9	200.7	745.4	827.3	918.7
Data storage	384.0	427.2	482.1	---	---	—
Data terminals	394.5	459.5	534.2	396.4	490.7	587.9
Electronic office equipment	464.0	586.0	664.0	905.7	1,035.2	1,167.7
Billing and accounting machines	68.0	70.0	72.0	---	---	---
Calculators, office type	56.0	60.0	64.0	---	---	---
Calculators, scientific type	32.0	36.0	48.0	---	---	---
Copying machines	308.0	420.0	480.0	---	---	---
Point-of-sale	60.0	72.0	84.0	116.2	155.5	186.1
INDUSTRIAL, TOTAL	**1,011.0**	**1,115.7**	**1,201.4**	**1,542.1**	**1,646.2**	**1,740.3**
Industrial X-ray inspection and gauging	---	---	---	47.5	50.0	53.2
Machine tool controls	73.2	76.0	85.3	99.3	105.9	113.1
Motor controls	140.0	150.0	160.0	66.9	67.2	69.5
Photoelectric controls	---	---	---	36.9	38.6	40.8
Pollution monitoring	100.0	130.7	133.3	29.8	27.5	29.0
Process-control systems	622.4	670.8	726.3	1,174.4	1,267.3	1,342.0
Ultrasonic cleaning and inspection	75.4	88.2	96.5	26.2	27.0	27.6
Welding (with electronic controls)	---	---	---	61.1	62.7	65.1
MEDICAL, TOTAL	**322.3**	**373.0**	**424.1**	**988.5**	**1,096.4**	**1,155.6**
Diagnostic equipment, except X-ray	75.4	90.6	108.1	202.9	223.5	240.4
Patient-monitoring	22.8	25.5	30.0	90.5	102.0	110.5
Prosthetic	16.0	17.2	18.0	87.6	93.2	97.6
Surgical support	8.0	8.8	10.0	---	---	---
Therapeutic, except X-ray	8.1	9.4	10.0	49.2	55.0	58.0
X-ray equipment, diagnostic and therapeutic	192.0	221.5	248.0	558.3	622.7	649.1
POWER SUPPLIES, TOTAL	**124.8**	**135.6**	**149.4**	**238.0**	**256.8**	**271.7**
Bench and lab	28.0	31.0	35.8	24.6	25.8	27.4
Industrial heavy-duty	16.4	16.2	17.2	75.6	83.2	90.5
OEM and modular	80.4	88.4	96.4	137.8	147.8	153.8
TEST AND MEASUREMENT, TOTAL	**420.8**	**460.5**	**511.1**	**577.5**	**634.4**	**697.5**
Amplifiers, lab type	7.0	7.9	9.8	9.6	10.1	10.4
Analog voltmeters, ammeters, and multimeters	18.1	19.8	21.4	28.4	29.9	31.8
Analytic instruments, research or clinical	190.0	207.1	227.5	---	---	---
Automatic test equipment (IC, component, and board)	15.0	20.2	20.5	50.7	57.5	66.8
Calibrators and standards, active and passive	10.7	8.9	9.4	14.6	15.1	15.6
Counters and timers	13.0	13.2	16.1	35.8	38.6	41.8
Digital logic analyzers	2.0	2.4	3.2	11.5	14.4	17.4
Digital multimeters	8.8	11.5	12.9	41.4	45.8	50.4
Microwave test instruments	9.8	10.0	11.0	49.9	54.3	61.4
Oscillators	9.6	12.4	15.4	18.5	19.3	20.6
Oscillators and accessories	41.7	44.0	48.3	105.3	118.1	129.6
Panel meters	37.2	37.8	45.1	28.1	30.4	31.8
Phase measuring equipment	2.6	2.7	2.9	0.9	1.0	1.1
Power meters	4.2	4.7	5.2	1.7	2.0	2.4
Recorders	17.0	19.8	21.3	99.4	105.6	114.4
Signal generators, analog	18.2	19.6	21.1	36.0	39.2	41.7
Signal generators, synthesizer	5.9	5.9	6.0	16.3	18.8	21.7
Spectrum analyzers (audio to 1 GHz)	10.0	12.0	14.0	29.4	34.3	38.6
AUTOMOTIVE, TOTAL	**60.9**	**93.7**	**120.5**	—	—	—

[1]Electronic or semielectronic. [2]Includes stand-alone minicomputers but not computers that are integral parts of process-control and similar systems. ---No estimate available.

Figures in this chart are based on inputs obtained from an 11-country survey made by *Electronics* in September and October 1977. They show consensus estimates for consumption of components, valued at factory prices, used to produce equipment for both domestic and export markets and for consumption of electronic equipment, with domestic hardware valued at factory sales price and imports at landed cost.



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Discrete VLEDs.
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NEW VISIBLE LIGHT EMITTING DIODES

Device	Source Color	Lens Color	Package Outline	Typical Brightness @ 20 mA	100-Piece Price
TIL216-1	Red	Red	T-1	1.0 mcd	.28
TIL216-2	Red	Red	T-1	4.0 mcd	.37
TIL228-1	Red	Red	T-1¾	3.0 mcd	.32
TIL228-2	Red	Red	T-1¾	7.5 mcd	.41
TIL228-3	Red	Red	T-1¾	18.0 mcd	.74
TIL212-1	Yellow	Yellow	T-1	1.0 mcd	.28
TIL212-2	Yellow	Yellow	T-1	4.0 mcd	.37
TIL224-1	Yellow	Yellow	T-1¾	3.0 mcd	.32
TIL224-2	Yellow	Yellow	T-1¾	7.5 mcd	.41
TIL224-3	Yellow	Yellow	T-1¾	18.0 mcd	.74
TIL232-1	Green	Green	T-1	0.8 mcd	.28
TIL232-2	Green	Green	T-1	1.5 mcd	.37
TIL234-1	Green	Green	T-1¾	1.0 mcd	.32
TIL234-2	Green	Green	T-1¾	2.5 mcd	.41
TIL234-3	Green	Green	T-1¾	6.5 mcd	.74

Low-Cost Displays

Device	Character Height & Color	Type Characters	Connection	100-Piece Price
TIL312	.3"—Red	7 Segment—r&lhd	Common Anode	1.36
TIL313	.3"—Red	7 Segment—rhd	Common Cathode	1.36
TIL327	.3"—Red	±1—lhd	Common Anode	1.36
TIL314	.3"—Green	7 Segment—r&lhd	Common Anode	2.85
TIL315	.3"—Green	7 Segment—rhd	Common Cathode	2.85
TIL328	.3"—Green	±1—lhd	Common Anode	2.85
TIL316	.3"—Amber	7 Segment—r&lhd	Common Anode	2.85
TIL317	.3"—Amber	7 Segment—rhd	Common Cathode	2.85
TIL329	.3"—Amber	±1—lhd	Common Anode	2.85
TIL321	.5"—Red	7Segment—r&lhd	Common Anode	1.47
TIL322	.5"—Red	7 Segment—rhd	Common Cathode	1.47
TIL330	.5"—Red	±1—lhd	Common Anode	1.47

High-Performance Displays

Device	Type Characters	Character Height	Package	100-Piece Price
TIL302-304	7 Segment	.27"	Standard	4.85
TIL305	5x7 Dot Matrix Alphanumeric	.30"	Standard	4.58
TIL306-309	7 Segment with Logic	.27"	Standard	9.15
TIL311	4x7 Hexadecimal with Logic	.27"	Standard	9.40
4N41 (TIL501)	7 Segment	.27"	Hermetic	47.37
TIL505	5x7 Hexadecimal with Logic	.27"	Hermetic	66.03
TIL506	7 Segment with Logic	.30"	Hermetic	57.41
TIL507	5x7 Alphanumeric with Logic	.30"	Hermetic	69.72
TIL560	3-Character 5x7 Alphanumeric with Logic	.50"	Hermetic	254.26

Seven-Segment Display Sticks

Device	No. of Digits	Character Height & Color	Feature	100-Piece Price
TIL361	2	.50"—Red	PCB—Edge Conn.	4.05
TIL364	4	.50"—Red	12-hr Clock	5.92
TIL370	4	.50"—Red	24-hr Clock	6.15
TIL804	12	.27"—Red	PCB—Edge Conn.	11.65
TIL807	2	.30"—Red	CA—Plug-in Pkg	2.88
TIL808	2	.30"—Red	CC—Plug-in Pkg	2.88
TIL809	2	.30"—Amber	CA—Plug-in Pkg	4.35
TIL810	2	.30"—Amber	CC—Plug-in Pkg	4.35

Opto-Coupled Isolators

Isolator Family	Part Numbers	Isolation Voltage	Package	100-Piece Price
P-DIP	TIL111—TIL119	Up to 2.5 KV	6-Pin DIP	from $0.74
Dual	MCT6 & MCT66	Up to 1.5 KV	8-Pin DIP	from 1.69
JAN, TX, TXV	4N22—4N24	1.0 KV	TO-5 MC	from 5.19
Hi-Rel	TIL120, TIL121	1.0 KV	TO-72 MC	from 3.75
UL Listed	TIL153—TIL157	3.5 KV	6-Pin DIP	from 0.93
Hi-Voltage	TIL124—TIL128	5.0 KV	6-Pin DIP	from 0.99

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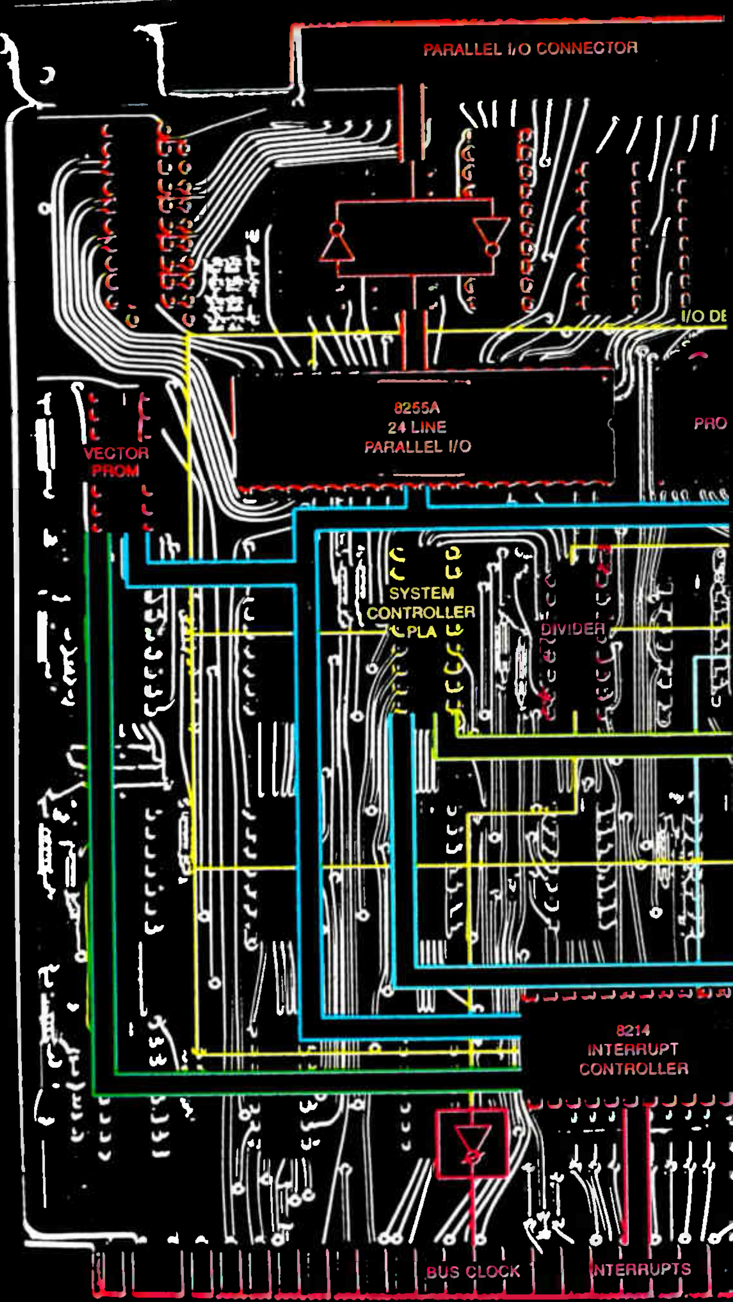
Parallel ins and outs. Two programmable ports offer 48 lines of parallel I/O. Inverted and upright signals can be generated and sensed. All of our I/O lines are buffered inbound and outbound for safety and reliability.



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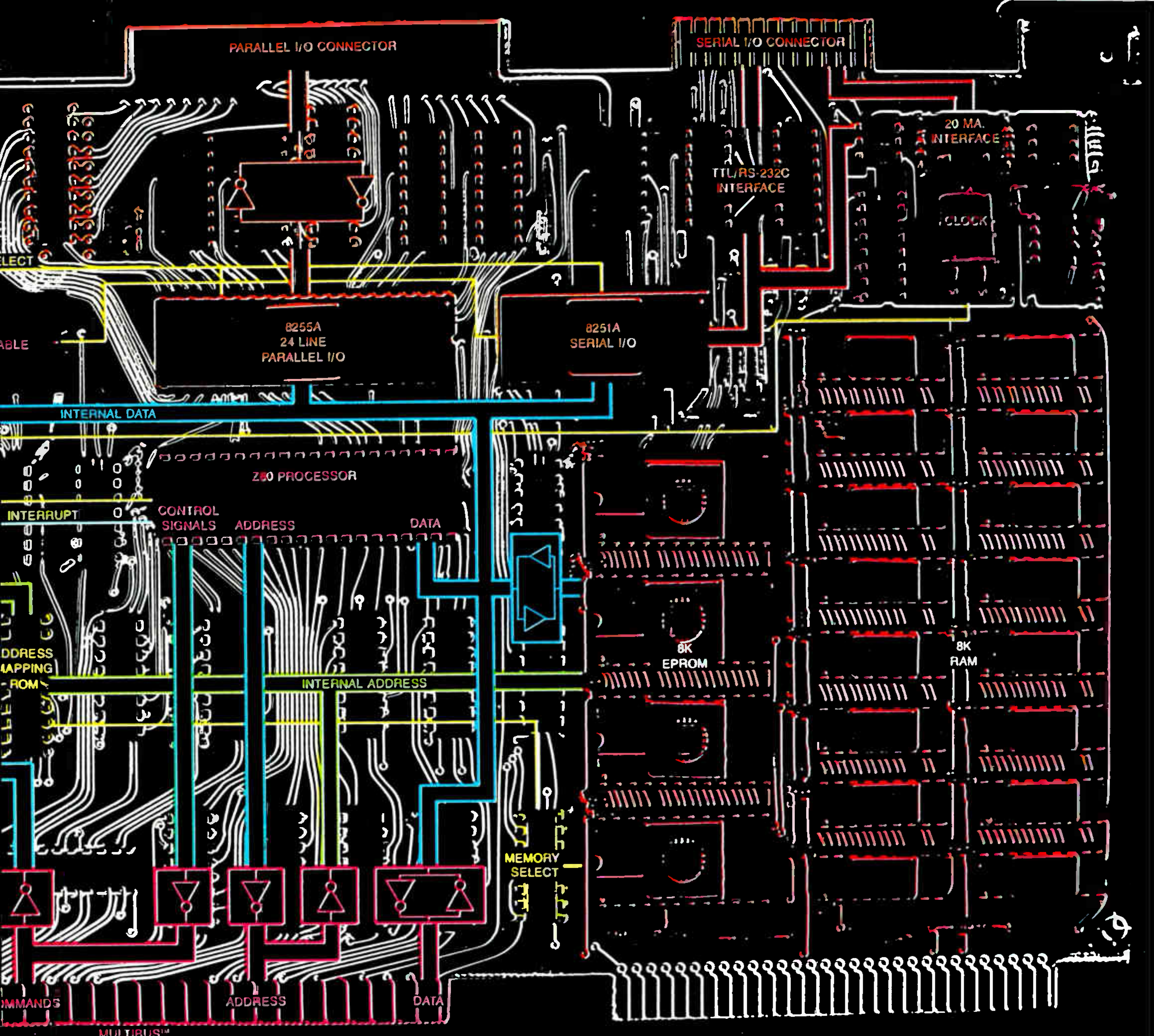

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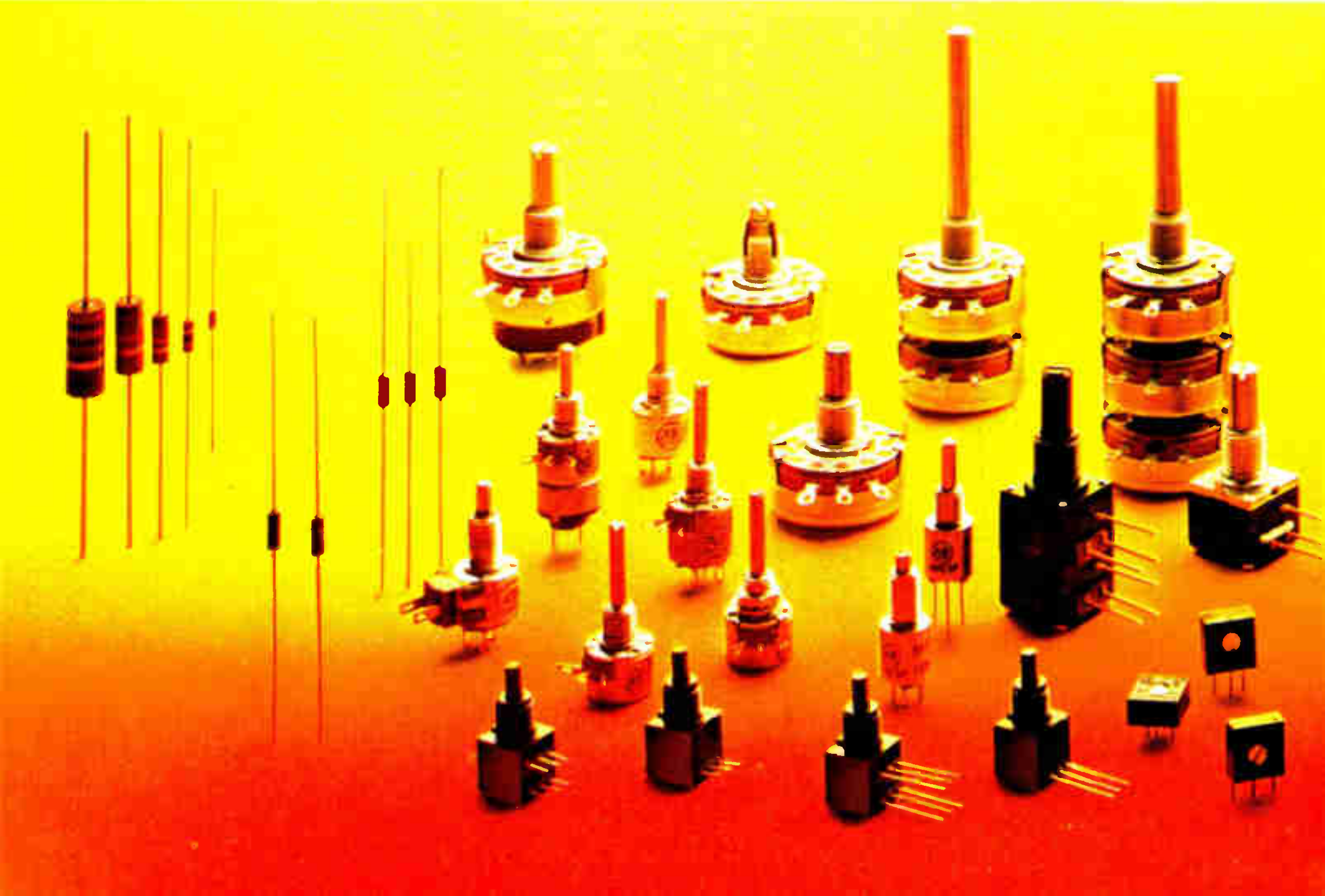
Circle 153 on reader service card



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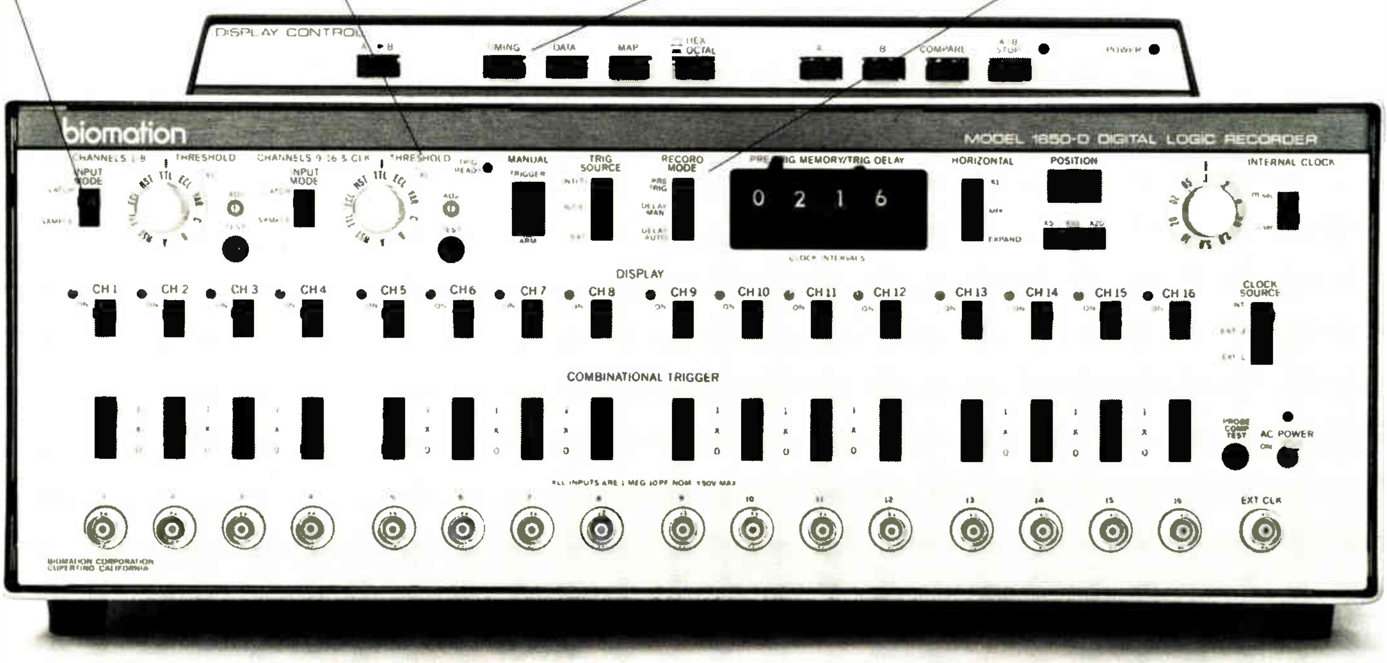


PROM converts weather data for wind-chill index display

by Vernon R. Clark
Applied Automation Inc., Bartlesville, Okla.

A programmable read-only memory and four arithmetic/logic units can convert air-temperature and wind-speed data in real time into wind-chill temperature, which is displayed on a direct numerical readout.

The wind-chill equation adopted by the National Weather Service is:

$$H = (100w^{1/2} + 10.45 - w)(33 - T_a)$$

where H is the heat loss in kilogram-calories per square meters per hour, w is the wind speed in meters per second, and T_a is the actual air temperature in °C. A modified form of this equation is the basis for the well-known wind-chill temperature chart issued by the service. In this circuit, the PROM is programmed so that, in combination with the arithmetic/logic units, it will generate output values identical to those in the chart for a wide range of air temperatures and wind speeds.

Basically, the circuit determines from the incoming data the apparent temperature change (T_c) caused by the wind. Then, it adds or subtracts T_c from T_a to find the equivalent temperature (T_e).

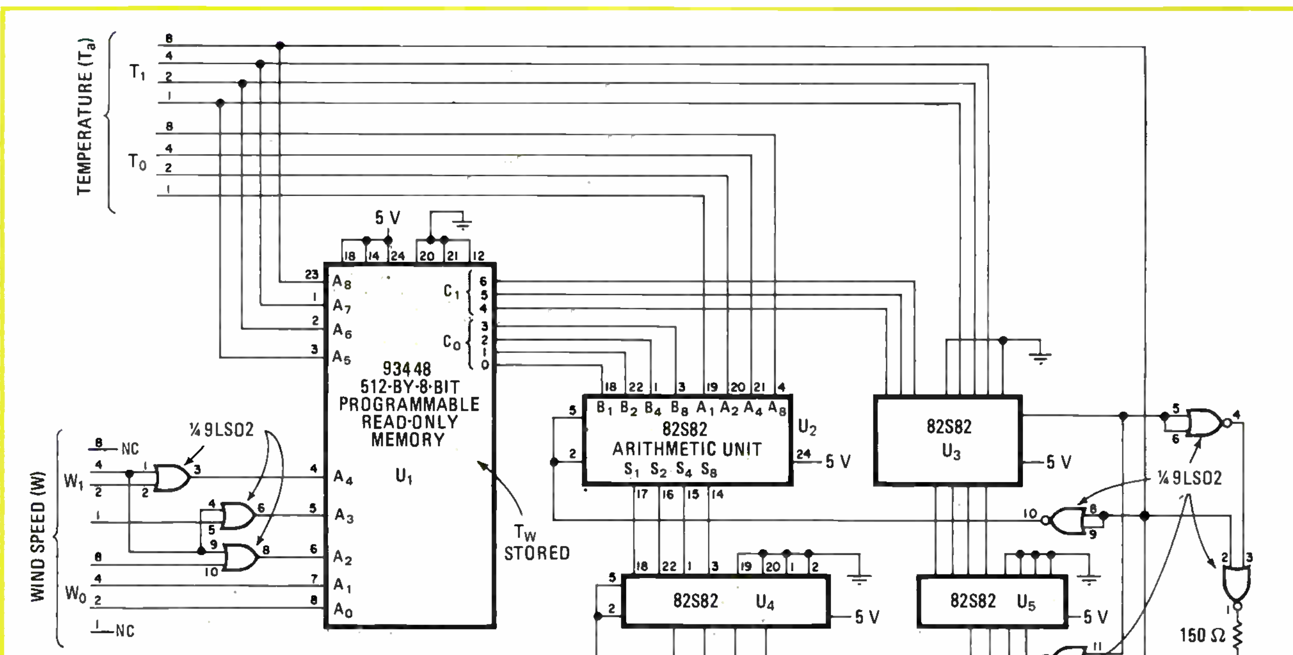
The T_c values are programmed into the PROM for all combinations of air temperature and wind speed over the range:

$$-60F \leq T_a \leq 50F \text{ (10 increments)}$$
$$0 \leq w \leq 46 \text{ miles per hour (2 mph increments).}$$

The circuit must relate each T_a and w to each T_c to find the equivalent temperature.

As shown in the figure, each T_c may be accessed by introducing air-temperature and wind data, in binary-coded-decimal form, to the PROM (U_1) address lines. The actual values of T_c programmed in the PROM are shown in the table.

The value of T_c appearing at the output, for a given T_a and w, is introduced to two ALUs, U_2 and U_3. Also driving U_2 and U_3 is the T_a data. The ALUs compute the magnitude and sign of T_e by adding T_a and T_c. U_4 and U_5 perform a 10's complement operation in order to drive the 7300 displays properly. The operation of all four ALUs is summarized in the figure.



OPERATION	IC2 AND IC3	IC4 AND IC5
$+T_a-T_w=+T_e$	SUBTRACTS	ADDS
$+T_a-T_w=-T_e$	SUBTRACTS	SUBTRACTS
$-T_a-T_w=-T_e$	ADDS	ADDS

Cold solution. Circuit determines and displays wind-chill temperature (T_e). Air temperature (T_a) and wind-speed data (w) address PROM lines to access apparent temperature change (T_c) brought about by given w at T_a. Arithmetic/logic units U_2 and U_3 add T_a and T_c to find T_e. U_4 and U_5 perform a 10's complement operation for the digital display units, for which they serve as an interface.

PROM CONTENTS – WIND-CHILL INDICATOR

LOC		LOC		LOC		LOC		LOC	
0000R	0002	0070R	2628	00E0R	0000	0150R	4750	01C0R	0004
0002R	0409	0072R	3030	00E2R	0000	0152R	5355	01C2R	0714
0004R	1500	0074R	3100	00E4R	0000	0154R	5700	01C4R	2500
0006R	0000	0076R	0000	00E6R	0000	0156R	0000	01C6R	0000
0008R	2125	0078R	3233	00E8R	0000	0158R	5960	01C8R	3543
000AR	2933	007AR	3434	00EAR	0000	015AR	6162	01CAR	5055
000CR	3700	007CR	3637	00ECR	0000	015CR	6365	01CCR	6000
000ER	0000	007ER	3738	00EER	0000	015ER	6667	01CER	0000
0010R	3941	0080R	0001	00F0R	0000	0160R	0003	01D0R	6468
0012R	4344	0082R	0205	00F2R	0000	0162R	0511	01D2R	7275
0014R	4600	0084R	0900	00F4R	0000	0164R	2000	01D4R	7800
0016R	0000	0086R	0000	00F6R	0000	0166R	0000	01D6R	0000
0018R	4849	0088R	1215	00F8R	0000	0168R	2834	01D8R	8082
001AR	5051	008AR	1719	00FAR	0000	016AR	4044	01DAR	8485
001CR	5354	008CR	2100	00FCR	0000	016CR	4800	01DCR	8890
001ER	5556	008ER	0000	00FER	0000	016ER	0000	01DER	9294
0020R	0002	0090R	2223	0100R	0002	0170R	5255	01E0R	0000
0022R	0407	0092R	2425	0102R	0409	0172R	5759	01E2R	0000
0024R	1300	0094R	2600	0104R	1500	0174R	6200	01E4R	0000
0026R	0000	0096R	0000	0106R	0000	0176R	0000	01E6R	0000
0028R	1923	0098R	2728	0108R	2125	0178R	6466	01E8R	0000
002AR	2730	009AR	2929	010AR	2933	017AR	6768	01EAR	0000
002CR	3300	009CR	3031	010CR	3700	017CR	7071	01ECR	0000
002ER	0000	009ER	3132	010ER	0000	017ER	7273	01EER	0000
0030R	3537	00A0R	0000	0110R	3941	0180R	0004	01F0R	0000
0032R	3840	00A2R	0203	0112R	4344	0182R	0612	01F2R	0000
0034R	4200	00A4R	0700	0114R	4600	0184R	2200	01F4R	0000
0036R	0000	00A6R	0000	0116R	0000	0186R	0000	01F6R	0000
0038R	4343	00A8R	1012	0118R	4849	0188R	3036	01F8R	0000
003AR	4445	00AAR	1415	011AR	5051	018AR	4247	01FAR	0000
003CR	4749	00ACR	1700	011CR	5354	018CR	5200	01FCR	0000
003ER	5051	00AER	0000	011ER	5556	018ER	0000	01FER	0000
0040R	0002	00B0R	1818	0120R	0002	0190R	5660	0200R	
0042R	0407	00B2R	1920	0122R	0409	0192R	6365		
0044R	1200	00B4R	2100	0124R	1700	0194R	6700		
0046R	0000	0086R	0000	0126R	0000	0196R	0000		
0048R	1620	00B8R	2222	0128R	2329	0198R	6971		
004AR	2426	00BAR	2323	012AR	3337	019AR	7374		
004CR	2800	00BCR	2425	012CR	4100	019CR	7677		
004ER	0000	00BER	2526	012ER	0000	019ER	7879		
0050R	3032	00C0R	0000	0130R	4346	01A0R	0004		
0052R	3436	00C2R	0000	0132R	4850	01A2R	0613		
0054R	3700	00C4R	0000	0134R	5200	01A4R	2300		
0056R	0000	00C6R	0000	0136R	0000	01A6R	0000		
0058R	3839	00C8R	0000	0138R	5354	01A8R	3340		
005AR	4040	00CAR	0000	013AR	5657	01AAR	4652		
005CR	4142	00CCR	0000	013CR	5960	01ACR	5600		
005ER	4243	00CER	0000	013ER	6162	01AER	0000		
0060R	0002	00D0R	0000	0140R	0002	01B0R	6064		
0062R	0306	00D2R	0000	0142R	0510	01B2R	6770		
0064R	1000	00D4R	0000	0144R	1800	01B4R	7300		
0066R	0000	00D6R	0000	0146R	0000	01B6R	0000		
0068R	1418	00D8R	0000	0148R	2632	01B8R	7577		
006AR	2022	00DAR	0000	014AR	3640	01BAR	7980		
006CR	2400	00DCR	0000	014CR	4400	01BCR	8283		
006ER	0000	00DER	0000	014ER	0000	01BER	8485		

Wind speed frequently varies over a wide range in a short time. This may cause rapid flickering of the display and make it hard to determine the average wind-chill temperature. One answer to this problem is to sample the input data periodically. Another is to use average-value sensor circuits for smoothing the data. ☐

RAM and d-a converter form complex-waveform generator

by William A. Palm and G. A. Williamson
Magnetic Peripherals Inc., Minneapolis, Minn.

☐ A random-access memory and digital-to-analog converter are at the heart of a programmable waveform generator that will produce almost any wave, however complex, at low frequency. It is only necessary to determine the digital equivalent of the desired wave and store that in a 256-word-by-8-bit RAM, for later transformation into an analog output voltage by the d-a converter.

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Photograph of Andromeda Galaxy, courtesy of Lick Observatory. Photograph has been reversed for composition.

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is only 7.8 kilohertz, being limited by the RAM's access speed and the number of locations; but more often than not, a complex wave is required only in very-low-speed applications. If higher speed is desired, the use of emitter-coupled-logic RAMs will increase the repetition rate to nearly 400 kHz, on the assumption that a high-frequency clock is available.

As shown in the figure, binary-coded-decimal thumbwheel switches $S_1 - S_3$ are used to address one of 256 RAM locations, and S_4 and S_5 select one of 256 waveform amplitudes (over the range 0 – 255 in base 2). Thus each location can be stored with an amplitude that can be resolved to 1 bit in 256.

When each location of the RAM is stepped (at a maximum rate equal to the system clock frequency divided by the number of locations), its output at any given instant is in essence converted to one point in a 256-by-256 matrix. The RAM is formed by two 256-word-by-4-bit Fairchild 3538 devices.

Four 74184 BCD-to-binary counters, two 9316 4-bit counters, a 75107 line receiver, and several gates and switches make up the binary address counter. The 75107 allows flexibility in choice of the clock that addresses the RAM—almost any driving signal will do, whether a sine wave, ramp, pulse, or square wave. The address counter either may be single-stepped manually to the desired location (needed when loading the RAM) or cycled continuously when the desired waveform is generated.

Two momentary-contact switches perform the actual address-loading and data-writing operations, and the address at any given time is displayed by eight light-emitting diodes. The maximum clock frequency permitted is limited to 2 megahertz by the slow response of the RAM, and therefore the repetition rate of the output waveform is 2 MHz/256 = 7.8 kHz.

Storing 256 numbers is a tedious task, especially if it must be done often. In cases where a given waveform is needed frequently, consideration should be given to storing it permanently in a nonvolatile read-only memory. The ROM could be substituted for the RAM in this circuit.

When cycled, the output of each RAM location is converted into a current by the MC1408 d-a converter. This is then transformed into an analog voltage by the 741 operational amplifier. □

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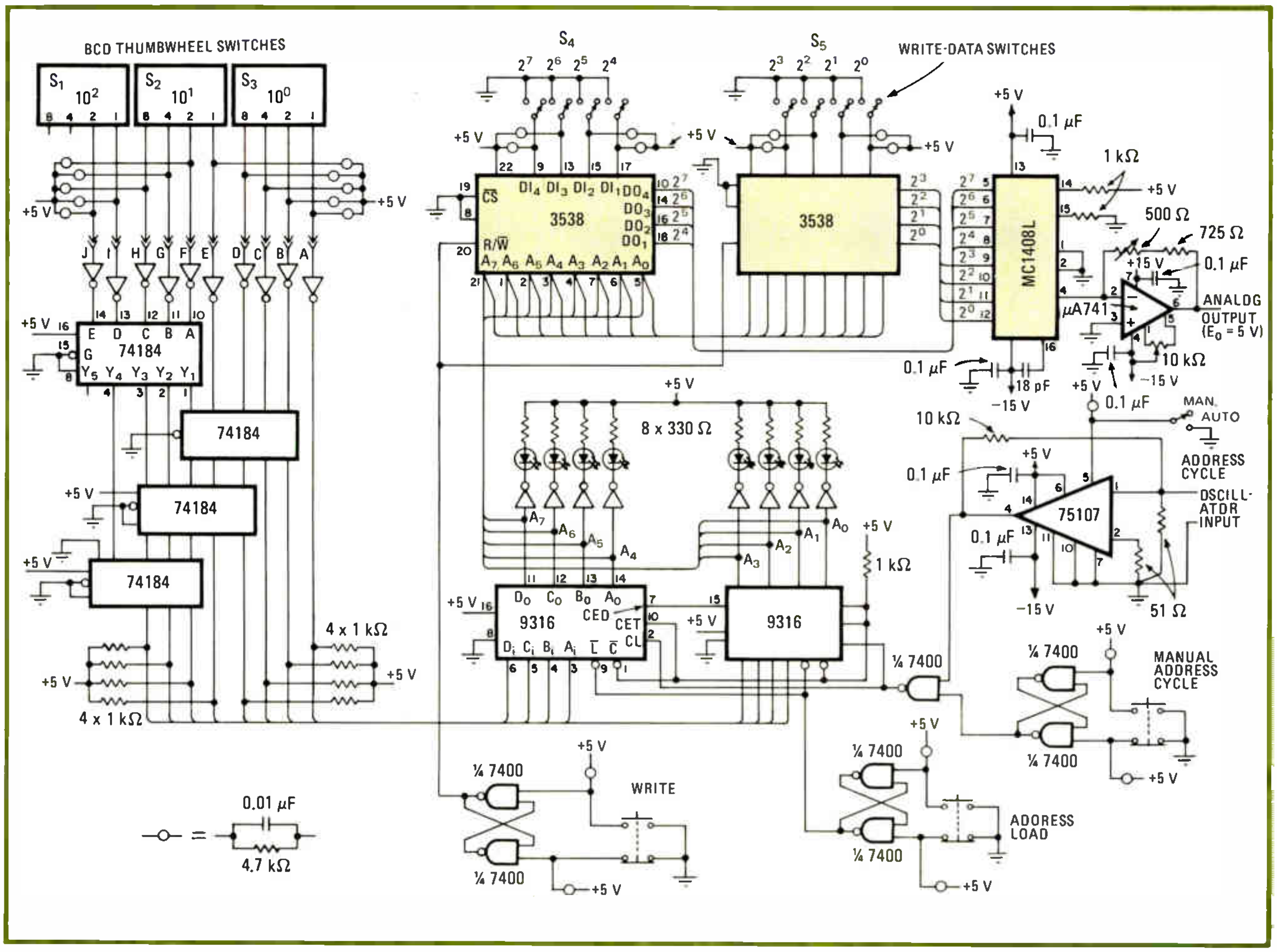

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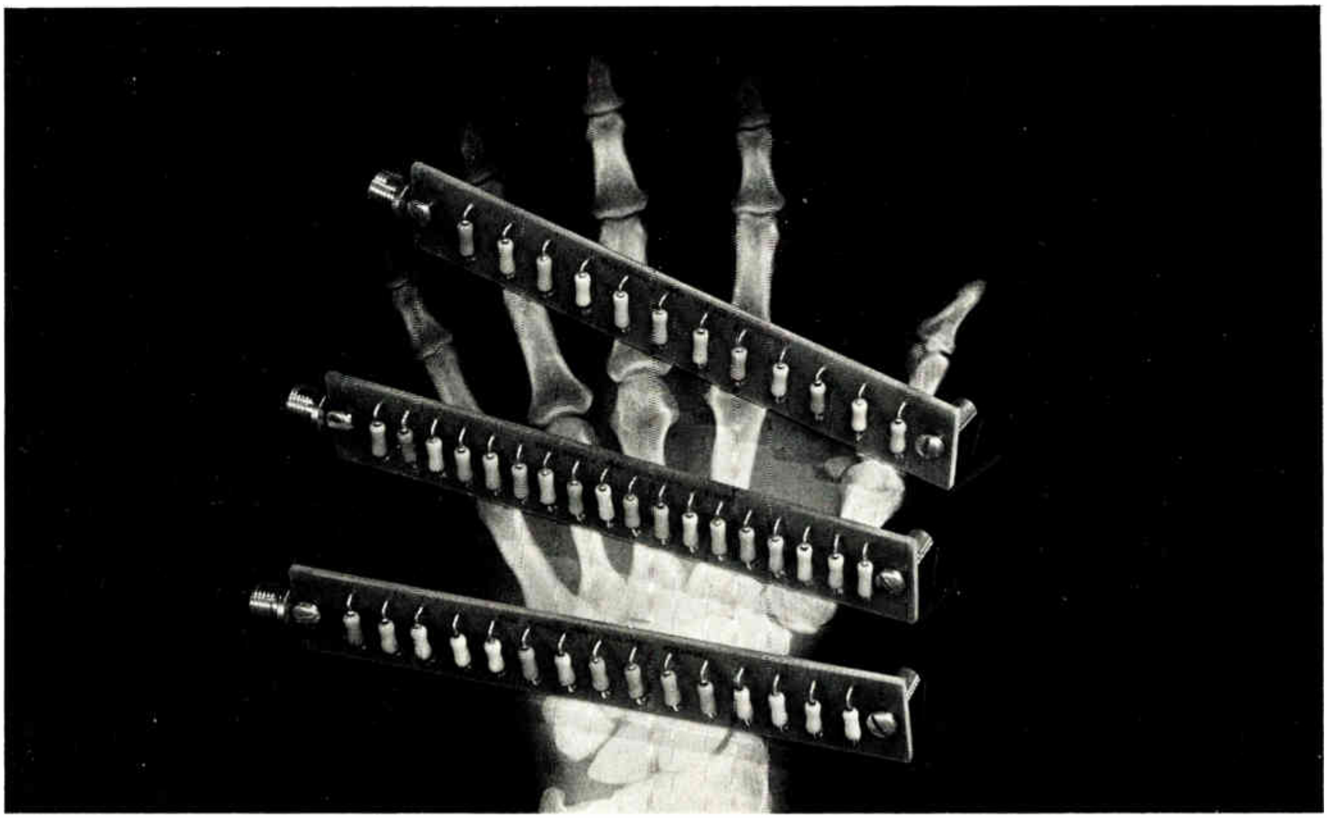

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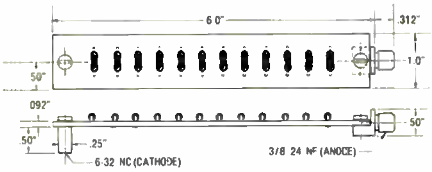

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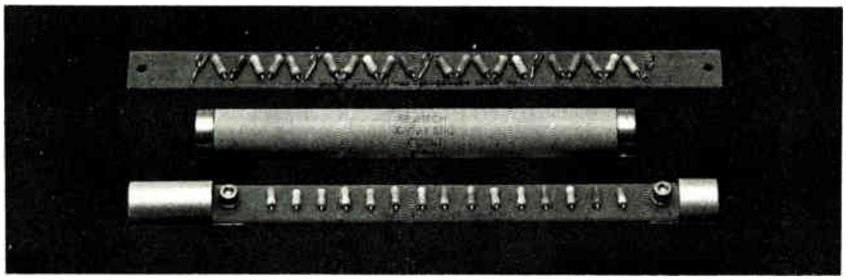

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Protecting semiconductor devices: circuit breakers vs fuses

Fuses are faster and cheaper, but circuit breakers may be fast enough and cost-effective, and they offer several advantages over fuses

by Patrick M. Craney, *Potter & Brumfield Division, AMF Inc., Princeton, Ind.*

☐ Ask a design engineer to protect a silicon controlled rectifier, triac, power diode, or solid-state relay, and more than likely he will immediately think of a fuse. That response, however, may not always be the right one. In many applications, especially in circuits using 48 volts or less, where the fault current is not apt to exceed their maximum interrupting-current capacity, magnetic-hydraulic circuit breakers may be truly cost-effective as well as fast enough—they may take as little as 2 milliseconds to open.

In the long run, circuit breakers often prove less expensive than fuses. For one thing, their inherent ability to provide a visual indication of the breaker condition saves time and effort in locating the circuit at fault, minimizing expensive equipment downtime. For another, even though fuses usually cost less than circuit breakers—say, $4 compared with $7—blown ones have to be replaced, and $20 worth of fuses can be used in just one troubleshooting procedure.

Magnetic-hydraulic circuit breakers can also limit di/dt transients—an important feature in protecting semiconductor switches—which fuses do only by opening. In addition, some models offer simultaneous polyphase operation, and others can control the current in one circuit by sensing the current in another.

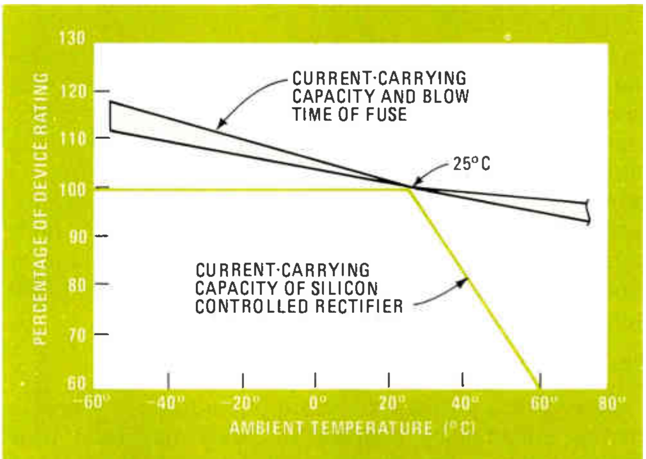
Finally, the belief that circuit breakers are dangerous because they can be held closed manually against an overload is generally not true. Most circuit breakers are designed so that the breaker will remain open when there is an overload or fault, even if the toggle is manually held in the on position. (This "trip-free" feature is specified in the manufacturers' literature; if a breaker lacks it, that fact is usually noted on the data sheet.)

Three choices

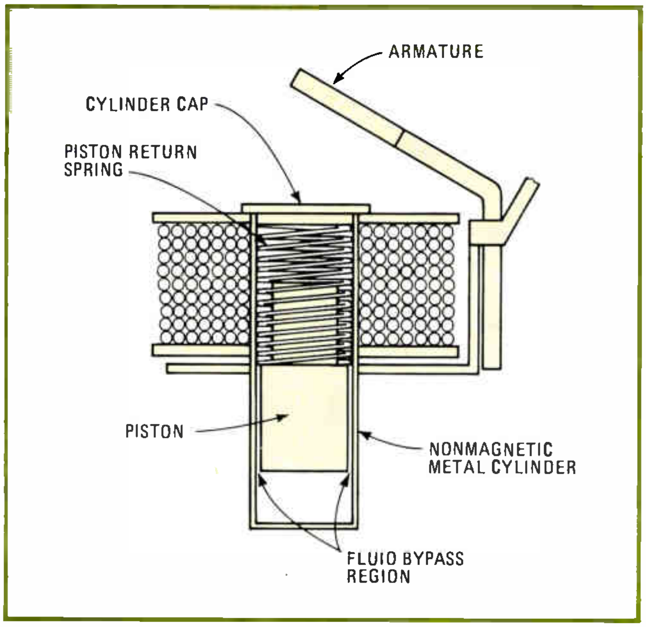
Current-limiting fuses and thermal as well as magnetic-hydraulic circuit breakers are often used to protect in-circuit electronic components. Of the breaker types, the magnetic-hydraulic is faster acting and therefore better suited to protect a semiconductor. A thermal breaker, however, is less expensive and may be sufficient for circuits in which the semiconductor switch is considered expendable (see "Thermal circuit breakers," p. 165). Also, the design of magnetic-hydraulic breakers is such that they are sensitive to current, not temperature. The performance of fuses and thermal breakers, on

COMPARING CIRCUIT PROTECTORS

	Current-limiting fuse	Circuit breakers	
		Thermal	Magnetic-hydraulic
Initial price range	$1 – $6	$2 – $10	$4 – $10
Reusable	no	yes	yes
Maximum interrupt capacity	200,000 A	3,000 A	2,000 A
Visual indication	no	yes	yes
Usable as switch	no	yes	yes
Temperature-sensitive	yes	yes	no
Position-sensitive	no	no	should not be mounted upside-down
Multiphase control	no	yes	yes
Ampere rating checkable by testing	no	yes	yes
I^2T protection	excellent	none	poor to fair
di/dt protection	none	none	fair to excellent
Failure from fatigue	yes	no	no
Replacement stock required	yes	no	no
dc resistance	insignificant	<0.5 Ω	0.004 – 300 Ω
Vibration-sensitive	no	<25 g at 10 – 55 Hz	>50 g at 10 – 55 Hz



1. Temperature-dependent. If the fuse rating is chosen to protect a silicon controlled rectifier, triac, or power diode at 25°C, the circuit will not be adequately protected at lower temperatures and will be overprotected at higher temperatures.



2. Magnetic-hydraulic breakers. Both instantaneous-trip and time-delay circuit breakers trip mechanically when heavy overloads create sufficient magnetic flux in the breaker coil. Instantaneous-trip types have no fluid in the cylinder and open in 2 to 11 milliseconds.

the other hand, is definitely affected by temperature. The table compares the characteristics of current-limiting fuses and both types of circuit breakers.

None of the foregoing means that fuses should not be considered as protection for semiconductors. On the contrary, there are applications where a fuse is desirable. (Indeed, because of their use with semiconductor devices, they are sometimes referred to as "semiconductor fuses.") It may be helpful to discuss fuses first, before giving the details of magnetic-hydraulic-breaker operation and use.

Current-limiting fuses are used in circuits where the potential fault current is greater than the nonrepetitive surge on-state current (I_{TSM}) rating of the semiconductor switch or the interrupting-current capacity of the breaker, or where a circuit-clearing time of 1 millisecond or less is required.

The current-limiting fuse is a tubular device containing a fusible link surrounded with tightly packed silica sand. When there is an overcurrent, the link melts, creating a void that the sand immediately fills, absorbing and extinguishing the arc—usually fast enough to prevent damage to the semiconductor junction. Current-limiting fuses are thereby capable of interrupting fault currents of tens of thousands of amperes, whereas most circuit breakers can interrupt a maximum of only 2,000 amperes without being damaged.

Temperature sensitivity

Since fuses, unlike magnetic-hydraulic circuit breakers, are affected by temperature, they may be a poor choice for semiconductor protection. Usually, the current-handling capability of semiconductors, as well as fuses, is specified at 25°C. The curves in Fig. 1 show that a silicon controlled rectifier's current rating is constant from −55°C to +25°C, at which temperature it derates linearly. However, the current rating and circuit-clearing, or blow, time of a current-limiting fuse vary with temperature over the same range, and this fact must be accounted for in the design.

For example, a fuse rated at 10 A will carry 10 A at 25°C and may open in 1 ms on a 1,000% overload. However, at −40°C, both the current rating and the time it takes the fuse to blow may increase by 17% of the 25°C rating. Thus, at the lower temperature, the fuse may actually carry as much as 11.7 A and at a 1,000% overcurrent may take 1.17 ms before blowing. In contrast, at 60°C, it may carry only 9.5 A and may blow at 0.95 ms. Therefore the fuse may take too long to blow at lower temperatures, while at higher temperatures it may blow prematurely.

Since the fuse's link is not visible, voltage or resistance measurements are necessary to determine its condition. Should the measurement require a service technician, the equipmment will remain inoperative until he arrives.

On the other hand, if a circuit breaker trips to the off position, anyone can quickly spot it and reset it. If, however, the breaker should continue to trip and a technician is called, his work is simplified because he does not have to troubleshoot fuses, unscrew or unsolder them, and install new ones. Moreover, with a circuit breaker, there is no chance of running out of the correct fuse and having to use one of the wrong rating simply to get the equipment back in operation.

Magnetic-hydraulic breaker operation

In a magnetic-hydraulic circuit breaker, the current flowing through the windings of a coil creates a flux, thus attracting an armature to the cylinder cap and thereby snapping open the breaker's contacts. As shown in Fig. 2, the breaker's coil is wound around a hollow cylinder that houses a piston. On heavy overloads and fault currents, sufficient flux is generated to quickly snap open the contacts.

On relatively weak overcurrents, however, the flux generated is in itself insufficient to attract the armature, but is enough to attract the piston resting in the bottom of the cylinder and pull it upward. As the piston moves up, it adds to the permeability of the magnetic circuit, causing an increase in flux density and thereby increasing attraction on the armature. The time it takes the piston to travel to the top of the cylinder is determined in part by the viscosity of a silicon fluid in the sealed cylinder. Should the overcurrent be removed before the piston nears the top of the cylinder, the breaker will not trip and a return spring will push the piston back to the bottom.

Such breakers, termed "time-delay," are typically used with circuits where brief, small overcurrents are expected, especially on start-up—with motors and lamps, for example. They exhibit interrupting-time (trip or circuit-clearing) characteristics like those shown in Fig. 3a, which charts the time delay as a function of the overcurrent, given as a percentage of the breaker's rating. The smaller the overcurrent, the longer it takes the breaker to open.

The non-time-delay version, often called "instantaneous-trip," contains no silicon fluid in the cylinder. It is

Thermal circuit breakers

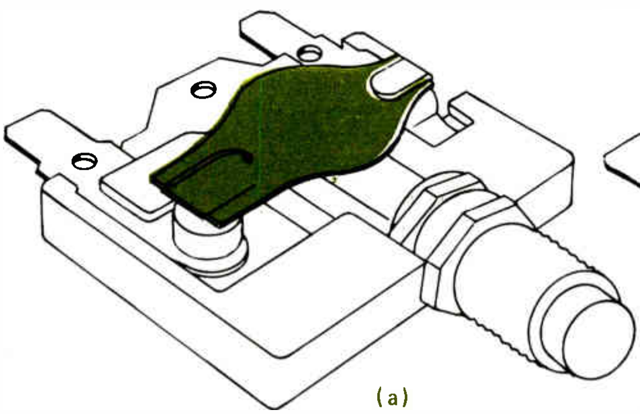
A thermal breaker, like a fuse, is a strictly heat-sensitive device. Its operation is based on the opening of a bimetallic blade through which load current flows, releasing a latch and causing the contact to snap open. Because of their slow response, thermal breakers are generally used to protect wiring from overheating and subsequent insulation deterioration, and not to protect semiconductor devices. But some thermal breakers, like all the magnetic-hydraulic types, may be used as power switches, thus saving the expense of a separate switch.

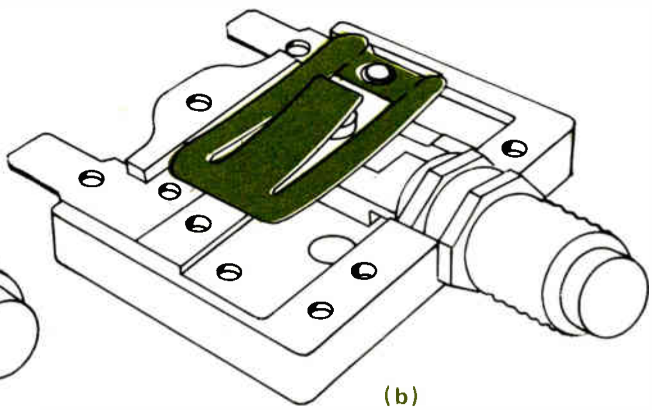
The thermal breakers that cannot be used as power switches are usually the least expensive type, those that have a recessed reset button that cannot be manually pulled out to the off position. They have no latching mechanism, since the bimetallic blade serves as the movable contact arm.

There are two kinds of thermal circuit breakers, depending on the kind of blade structure used. In the first kind (a), as overcurrent heat increases, the bimetallic blade bends upward, causing the pressure between the contact surfaces to decrease, until the blade finally snaps open and separates the contacts. As contact pressure decreases, considerable heat rise due to overcurrent results, which can lead to early failure—even contact welding.

The second kind (b) has a "positive-pressure" blade designed so that, as overcurrent heat increases, contact pressure also increases. When the critical point is reached, the blade snaps open instantly and the arc is extinguished.

Thermal circuit breakers, like their magnetic-hydraulic counterparts, offer definite circuit resistance that helps limit circuit fault current.


(a)


(b)

designed so that even on small overcurrents it will clear a circuit in from 2 to 11 milliseconds—often fast enough for use with semiconductor switches.

Circuit-breaker manufacturers do not pinpoint the actual clearing time of a breaker. Rather, they specify a window of values within which all breakers of that model will open a circuit. Therefore, in determining whether or not to use such a breaker, it is best to assume the worst-case clearing time of 11 ms, even though the actual time may be much less.

The trip characteristics of an instantaneous-trip breaker are shown in Fig. 3b. The curves show that the breaker will carry 100% of its rating, but will trip somewhere between 101% and 125% at about 50 or 60 hertz over an operating temperature range of −40°C to +85°C. Note that the clearing time is the same for overcurrents from a relatively low 400% of breaker rating to 1,200%. In fact, although it is not shown, the clearing time for breakers remains constant to the breaker's maximum interrupt capacity.

Resistance helps

Depending on the ampere-turns of the breaker coil and the rate of rise of the fault current, the impedance of the coil can limit fault current until the breaker opens the circuit. In some cases, the calculated impedance may be enough to save the expense of adding a saturable reactor to the circuit simply to limit fault di/dt. Without such di/dt limitation, the semiconductor switch may be destroyed on severe fault currents or overcurrents.

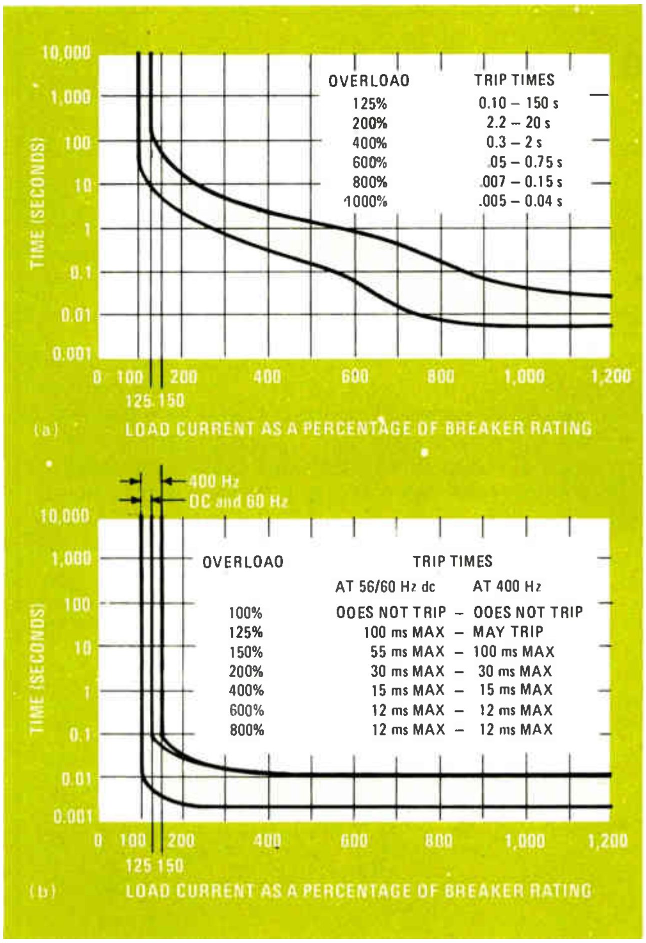
As shown in Fig. 4, the lower the current rating of the breaker, the greater its dc resistance; and the higher the frequency, the greater its impedance. For example, the dc resistance and impedance of a 1-A breaker is approximately 1.1 ohm at 60 Hz, but almost twice that at 400 Hz. Likewise, a 10-A breaker has about 14 milliohms of resistance at dc and at 60 Hz and an impedance of about 23 mΩ at 400 Hz. In fact, coil impedance for a steeply rising fault current may be very high. However, the value must be determined empirically, because no circuit-breaker manufacturer has so far published such data for his products.

Finding the fault current

To determine whether to use a fuse, an instantaneous-trip circuit breaker, or a combination of the two, consider the following:

- Worst-care, root-mean-square, and peak value of the potential circuit fault current.
- Single and perhaps even subcycle surge-current ratings of the semiconductor switch.
- Circuit-clearing time required before component or circuit damage occurs.

Calculating the potential rms and peak circuit fault



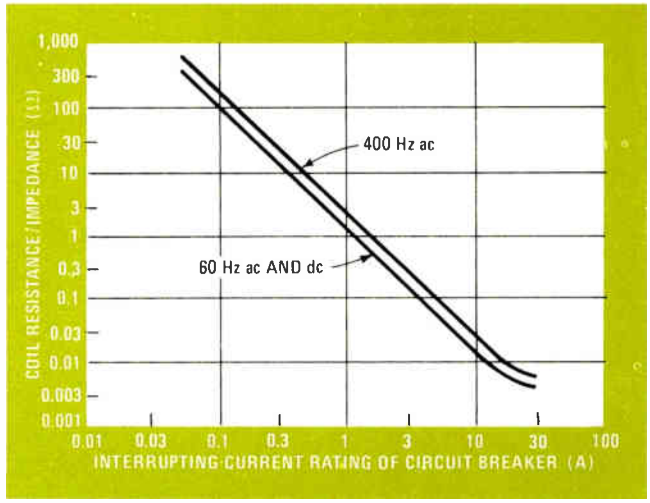
3. Matching breaker to application. Curve (a) typifies response of time-delay circuit breakers designed to handle higher-than-normal load current without opening prematurely. Instantaneous-trip breakers (b) are used in circuits that cannot tolerate overcurrents.

current is simply a matter of dividing the circuit voltage by the total of all resistances or impedances in the circuit. In so doing, consider the resistance of the circuit breaker. Even though the decision has not yet been made to use one, its resistance may significantly limit circuit fault current.

Also, the resistance of the wiring and terminal points should not be neglected. A 50-foot run of two-wire no. 12 AWG copper (100 ft total) has 0.162 Ω of resistance at 25°C—enough to limit the fault current in a 48-V circuit to about 300 A, even though the transformer can deliver considerably more. To determine actual circuit resistance, it is best to use either a milliohmmeter or a Wheatstone bridge.

Such measurements will not yield the impedance of the semiconductor itself under fault current conditions. This value must be approximated from curves, such as the one shown in Fig. 5 for an SC260 triac. First, however, the approximate circuit fault current must be known, which can be determined using only the dc circuit resistance.

If, for example, calculations indicate a fault current of 300 A, then the impedance of the semiconductor can be approximated by determining the resultant voltage drop across it. The 115°C junction-temperature curve in



4. Estimating resistance. Resistance and impedance ratings of magnetic-hydraulic circuit breakers with current-interrupting ratings of from 0.050 to 30 A allow designers to estimate how much coil and contact resistance the breaker will introduce into the circuit.

Fig. 4 shows that a 300-A current causes a 3.5-V drop across the device. Based on the E/I relationship of these values, the semiconductor may thus be considered to represent an impedance of 11.7 mΩ in this case.

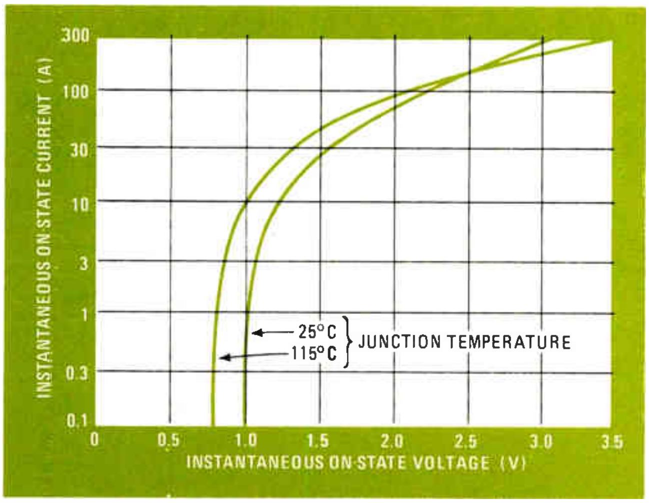
If the calculated fault current based solely on the dc resistance of the circuit, including the resistance of the breaker, is greater than the maximum current shown on the curves given for the semiconductor, chances are that the semiconductor junction will be damaged as a result of overcurrent heating. For this case, a circuit breaker will not adequately protect the semiconductor. (Obviously, though, without the breaker resistance in the circuit, potential fault current would be even greater.) But even the fastest fuse may not adequately protect the semiconductor, and therefore the only solution may be to choose a semiconductor with greater surge-current-handling capability, in which case the circuit breaker would prove adequate.

Keep in mind that, because of the impedance of the semiconductor, the actual fault current will be less than that calculated for the dc resistance only. However, the calculated semiconductor impedance will also be less, simply because the fault current is not as great.

Figure 6 shows a circuit in which a 25-A triac controls a 24-V, 5-A load and a 5-A circuit breaker protects both triac and load. Circuit resistances are calculated from manufacturers' data, and triac impedance from the curves in Fig. 5:

transformer secondary at 25°C	0.055 Ω
circuit breakers at 25°C	0.050 Ω
10 ft of no. 14 AWG copper wire at 25°C	0.026 Ω
SC260	0.012 Ω
approximate circuit impedance	0.143 Ω

The impedance of the transformer secondary may be considerably higher than its dc resistance on steeply rising fault currents; however, for this example, these instances will not be considered. If such impedance values are required, they can be obtained from the transformer manufacturer.



5. Rough cut. Graph of maximum on-state voltage versus on-state current of a commonly used triac, the SC260, gives the designer an idea of the impedance. The fault current must be known, and the voltage across the semiconductor at this current measured.

The approximate fault current for the circuit at 25°C is:

$$I_{rms} \approx (24\ \mathrm{V}/0.143\ \Omega) = 167.8\ \mathrm{A}$$

$$I_{peak} \approx 167.8 \times 1.414 = 237.3\ \mathrm{A}$$

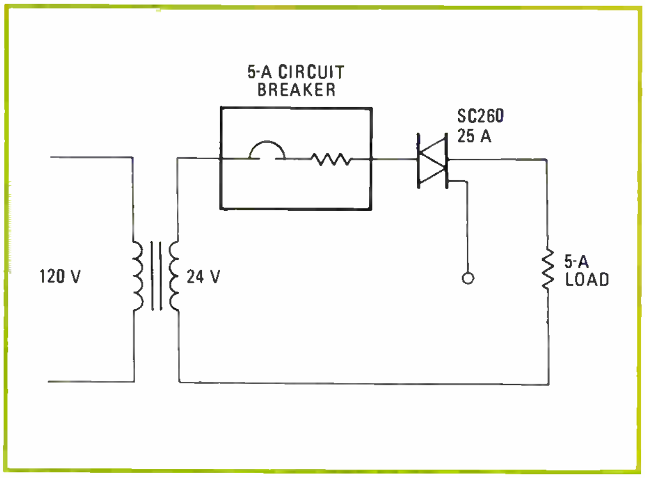
Naturally, many circuits operate at temperatures higher than the 25°C design center of many components. In such cases, component resistances are even greater, and fault current proportionately lower.

To determine if the triac can withstand a peak current of 237.3 A, the I_{TSM} rating must be checked. The manufacturers' data on the SC260 shows an I_{TSM} rating of 250 A, or an rms current of 176.8 A, for 16.6 ms. The interruping-time curve of the breaker (Fig. 3b) shows that the breaker will open the circuit fast enough (2 to 11 ms) to protect the triac.

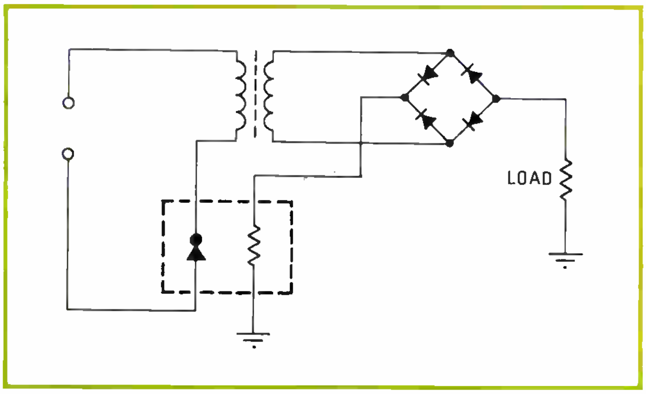
To use the curve, first determine what percentage of breaker rating the fault current represents. For the example given, the breaker has a rating of 5 A and a 167.8-A rms overcurrent represents a 3,356% overload. Even though the curve in Fig. 3b is not plotted beyond the 1,200% overload point, it does not change out to the breaker's 2,000-A interrupt capacity, as mentioned earlier. Thus circuit-clearing time for a 3,356% overload remains between 2 and 11 ms.

In circuits where a breaker cannot provide worst-case fault-current protection for the semiconductor switch, a fuse can be used as backup protection. If, for example, there is no transformer secondary to help limit fault current and 120 V is applied directly to the semiconductor, the peak current will come close to the interrupt capacity of the breaker. Manufacturers' data shows that a fuse can protect the thyristor from the peak current of nearly 2,000 A, but the rating of the fuse should match that of the thyristor, not the rating of the load. Otherwise, the fuse could blow on start-up and other surge currents.

When deciding whether to use a fuse, a breaker, or a combination of the two, the designer may find that circuit-protection costs are prohibitive. In some cases, he may consider the thyristor expendable and simply use an inexpensive thermal circuit breaker to protect the load and wiring.



6. Dual protection. Shown is a typical circuit in which a magnetic-hydraulic circuit breaker protects both solid-state switch and load.



7. Relay-trip circuit. By sensing the dc load current in the secondary winding of the transformer and opening the primary side when an overcurrent exists, the breaker not only protects the load, but ensures that the transformer does not remain unloaded.

Additional circuit breaker advantages

Besides being reusable on repeated overcurrents, circuit breakers can of course serve as on-off switches. Furthermore, some models of both magnetic-hydraulic and thermal breakers offer other features not obtainable with fuses. The most notable is the ability of a multipole breaker to open all legs of a polyphase line when an overcurrent is sensed in any one of the lines. Circuit breakers are available ganged to 10 poles or more so that all poles will open almost simultaneously if any of the individual breakers detect an overcurrent.

An auxiliary single-pole, double-throw snap-action switch incorporated in some models makes possible another desirable feature. The switch is mechanically connected to, but electrically isolated from, the breaker contacts, enabling the breaker to control auxiliary circuits or panelboard lamps that indicate circuit condition. In addition, magnetic-hydraulic circuit breakers come in versions that enable the breaker to open one circuit when it senses an overcurrent (Fig. 7). □

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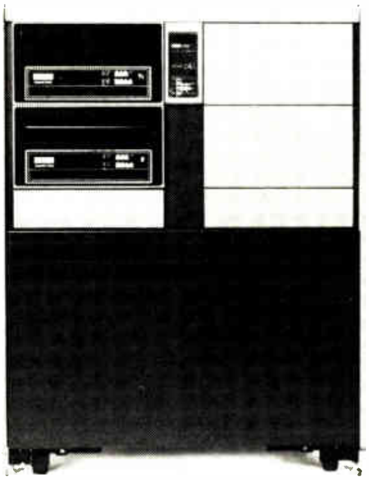

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Circle 169 on reader service card

AND HERE'S WHAT'S IN IT FOR THE OEM.

Calculating the cost of testing LSI chips

Anyone planning to design with large-scale integrated circuits must remember to factor in the cost of testing them

by Christos Chrones, *DCA Reliability Laboratory, Sunnyvale, Calif.*

☐ Before making the leap into large-scale integration, a product designer should look realistically at the cost of LSI testing. It can easily skyrocket to as much as $10 a chip, since LSI test systems are expensive to buy and even more expensive to run. To make an intelligent design decision, therefore, the engineer needs to know the facts about LSI testing and test equipment and how the two contribute to per-unit testing cost.

An LSI test system is a large capital investment, running initially to maybe several hundred thousand dollars. The block diagram highlights the major architectural features of such a tester, one capable of checking all sorts of LSI devices, from microprocessors and memories to random logic functions. Yet its price of approximately $350,000 works out at only a fraction of its total operating cost, when all the overhead factors and labor costs are considered. Of that $350,000, only about half goes on computer hardware—the system's central processing unit, associated memory, and peripherals. The rest goes on hardware for test and measurement instrumentation.

In fact, though, program development is the basic—and often the biggest—expense of LSI testing, even running around $1 million in the lifetime of the system. It is, however, an absolute necessity, since LSI devices are not supplied with functional test specifications, let alone test programs. The truth table, most common in the data sheets of small-scale and medium-scale integrated circuits, simply does not exist for LSI devices.

Essential elements of the test system

Among the computer peripherals needed to develop an adequate test program are at least one and more usually two video terminals, a disk memory offering quick access to several million bytes of data, and a magnetic-tape unit for bulk data storage. Additionally, a line printer is a must, not only for program development but also to log failures or produce a statistical summary of the test results—both essential operations in LSI testing. Two video terminals are needed for developing test programs or logging data while simultaneously testing the LSI components, thus providing both foreground (testing)

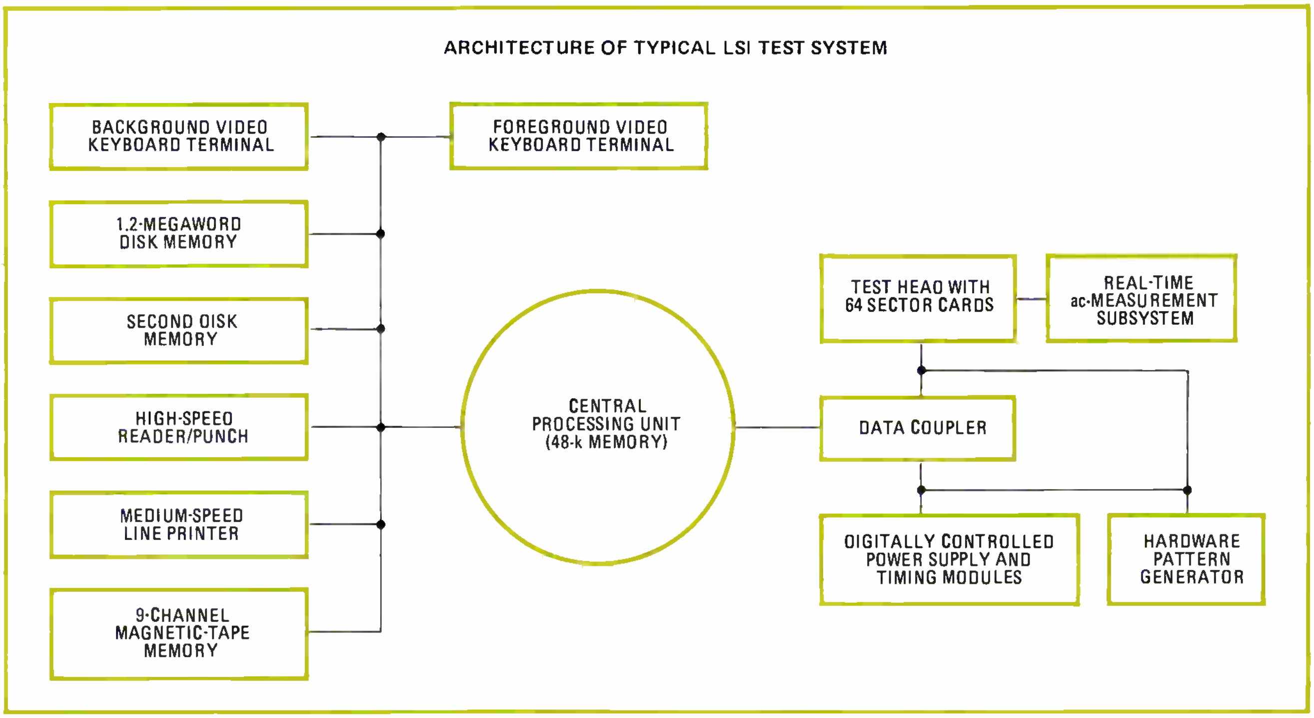


TABLE 1: MONTHLY COSTS FOR $350,000 LSI TESTER

Item	Cost ($)	Percent of total cost (%)
Principal and interest	4,500	36.6
Operating costs	1,300	10.5
• insurance		
• property tax		
• floor space		
• electricity		
• chemicals		
• air conditioning		
• paper/supplies		
Maintenance, spares	1,500	12.2
Software support	2,500	20.3
Hardware jigs/fixtures	500	4.1
Technological improvements	2,000	16.3
Total	12,300	100.0

and background (program development) capability. Only if program development is either nonexistent or performed elsewhere is it possible to eliminate such time-sharing of the computer and to make do with just one video terminal.

The test and measurement hardware is needed to perform dc and ac parametric tests, as well as functional tests, at rates up to 20 megahertz. At the heart of this instrumentation is the test head containing perhaps scores of sector cards, one or more for each pin of the device under test. Each card is a small, high-speed LSI tester in itself, and it is through this delicate set of pin electronics that signals to the device under test.

The test head, however, does offer some economic tradeoffs. For example, heads containing as many as 64 sector cards are necessary for devices having large numbers of pins, say 40, as is the case for complex parts, like microprocessors. If only memories are to be tested, then a simpler, less expensive system will be adequate—a 24-pin system, for instance, is nearly $40,000 less than a 40-pin one. When testing only memories, it is also possible to reduce the complexity and cost of the computer hardware.

To keep productivity high, the system must have a pattern generator, which is a high-speed processor dedicated to generating algorithmic patterns. Using software, rather than hardware, to execute these patterns would increase overhead, taxing the computer, as well as slowing the test time with data interruptions and ultimately raising the cost to test.

Another function that may be performed in either hardware or software is real-time ac measurement—which, however, can often be eliminated since the real-time measurement of propagation delay, transition time, and so on is not always needed. The hardware for these dynamic (ac parametric) tests is relatively expensive, though, and may be replaced by iterative techniques using digital successive-approximation methods.

Even though the quarter-of-a-million-dollars-or-more

TABLE 2: ESTIMATING PER-UNIT TEST COST

Original cost of equipment	$350,000	
Depreciation	5 years	
Monthly costs: ■ depreciation ■ occupancy ■ maintenance ■ supplies ■ software support	$12,300	
Total available hours per month (based on ≈ 4.3 weeks per month)	720 h/mo	
Shift utilization factors (shift hours over total available hours): ■ 1 shift = 40 h/wk = 172 h/mo ■ 2 shifts = 80 h/wk = 344 h/mo ■ 3 shifts = 120 h/wk = 516 h/mo	F_1 = 0.239 F_2 = 0.478 F_3 = 0.717	
Productivity factor (up-time over total time): Differences due to: ■ downtime ■ idle time ■ maintenance/repair	F_P = 0.75	
Hourly equipment cost based on productive time (add $15/h for operator):	Equipment	+Operator
■ 1 shift = $F_1 \times F_P \times$ 720 h/mo = 129 useful h/mo ■ 2 shifts = $F_2 \times F_P \times$ 720 h/mo = 258 useful h/mo ■ 3 shifts = $F_3 \times F_P \times$ 720 h/mo = 387 useful h/mo	$95.35 $47.67 $31.78	$110.35 $ 62.67 $ 46.78
Test rate (units/h): ■ T_T = test time in seconds ■ T_H = handling time in seconds	$\frac{3{,}600 \text{ s/h}}{T_T + T_H}$ = units/h	
Unit cost (hourly cost divided by test rate):	$/unit	

price tag of an LSI test system seems high, it in fact amounts to only about one third of the actual cost of operating the equipment. For example, with a $350,000 system, the monthly cost of LSI operations exceeds $12,000, a figure that about triples the monthly payment for the system itself.

Table 1 itemizes all the factors associated with the LSI tester and its overhead, indicating the approximate cost of each item and what percentage it contributes to the total. Software support covers only the operating software of the system and not the cost of writing LSI test programs. For the most part, technological improvement takes into account the cost of updating hardware by installing, for example, new pin cards, options to enhance testing of new devices, automatic handlers, and temperature testing fixtures.

The bottom line: cost per unit

Once the total monthly operating cost has been estimated, the next step is to determine the per-unit cost to test an LSI device. To do this, the total hourly cost of running the equipment and employing an operator must be known, as well as the test rate of the system. Dividing the first figure by the second figure yields the per-unit test cost.

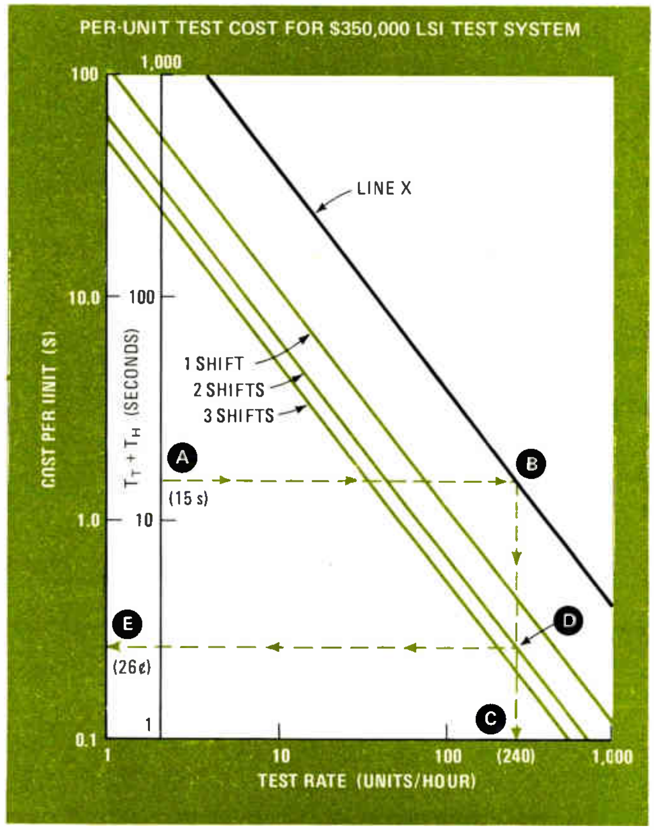
As shown in Table 2, the computation must reflect both the number of shifts being used (utilization factor) and the actual time the system is operating (productivity factor). For example, for a two-shift operation (344 hours per month) and a 75% productivity factor (giving only 258 useful hours per month), the hourly equipment cost (monthly cost divided by useful hours per month) works out to $47.67 for the $350,000 system. When this figure is added to the operator's cost of $15 per hour, the result is a total hourly equipment cost of $62.67. Such an amount is typical for most LSI test systems, which generally have an all-inclusive operating cost ranging from $60 to $80 per hour.

Test rate depends on the LSI device

To determine a system's test rate, estimate or measure its test and handling times for the specific application. For instance, volume testing of 4,096-bit random-access memories with the $350,000 system typically requires 7 seconds of test time and 8 seconds of handling time, making the test rate come to 240 units per hour. Dividing the hourly cost of $62.67 by this rate yields a per-unit test cost of about 26 cents. In contrast, worst-case pattern testing of a 16-k RAM would take approximately 7 minutes running up the test cost to a whopping $7 a unit, even with a two-shift operation.

Since these computations are fairly straightforward, the nomograph given here may be used to assess approximate per-unit testing cost quickly. It shows the test cost per unit as a function of the system test rate for one-, or two-, and three-shift operations. It covers per-unit test costs ranging from 10 cents to $100.

To use the nomograph, draw a horizontal line from the point (A) representing the sum of the test and handling times to line X, and then draw a vertical line from this point (B) to the horizontal axis. The point (C) on the axis corresponds to the test rate of the system. Now



select the appropriate shift factor and draw another horizontal line from this point (D) across to the point (E) corresponding to the cost per unit. In this example, the 15-second test and handling times give a test rate of 240 units per hour, and the cost per unit is 26 cents for a two-shift operation.

The $350,000 test system on which this nomograph is based can characterize as well as test any LSI device currently on the market. In short, it is a truly general-purpose LSI tester. On the other hand, less expensive, dedicated equipment, costing anywhere from $30,000 on up to $200,000, is also available for efficient testing of specific devices.

Needless to say, the key difference between the two is a matter of flexibility. The general-purpose tester offers software program development, whereas programming is done by hardware in the dedicated system, with test patterns stored in read-only memories and timing and supply levels set by hardwired performance boards. As a result, to program a dedicated system for a certain microprocessor might cost only about $3,000, but programming costs for 100 different LSI devices could conceivably run up to $300,000, which approaches the price of a general-purpose tester.

Besides being capable of testing a wide variety of LSI components, the general-purpose system may be used for production as well as engineering evaluation testing. In contrast, dedicated equipment is really intended for cost-effective production testing of a single type of device at a time. Assuming that the volume can justify the purchase of a dedicated system, the cost of memory testing may thus be reduced by a factor of five, although there is generally less of a reduction for most other LSI devices.□

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Circle 175 on reader service card

Digital thermometer circumvents drift

by Henry Wurzburg and Mike Hadley
Motorola Semiconductor Products Inc., Phoenix, Ariz.

A direct-reading thermometer that measures temperature digitally can be built from a diode sensor and an analog-to-digital converter, without any buffers or operational amplifiers. The temperature-drift errors associated with amplifiers are therefore eliminated, so that, unlike its analog counterpart, the circuit remains calibrated over a wide temperature range—from −199° to 199° in either the Fahrenheit or Celsius scales. The circuit resolution of 0.1° is primarily limited by the 3½-digit a-d converter.

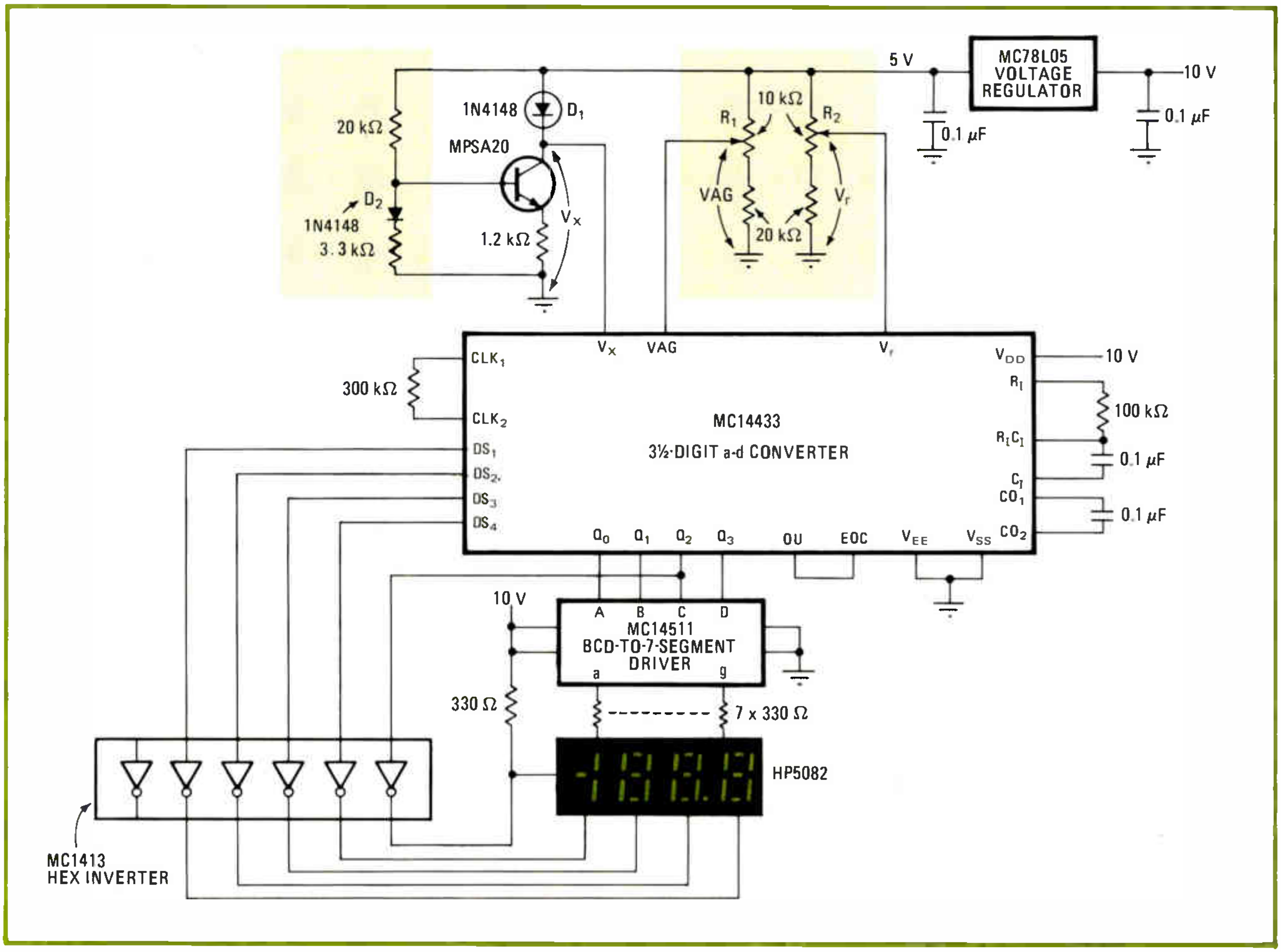
The figure shows the MC14133 converter chip changing the output voltage of D_1, a 1N4148 silicon temperature sensor, into a binary-coded-decimal number. The auto-zero and auto-polarity features of the chip ensure that its operation is virtually unaffected by temperature changes. More important, its high-impedance differential input circuit, with its wide, 200-millivolt-to-2-volt range of full-scale input voltages, allows the chip to be directly connected to the diode sensor, despite the latter's low output voltage, so that there is no need for intervening buffers or amplifiers that would amplify temperature-offset errors.

The MPSA20 transistor and associated network supply a suitable operating bias to D_1. The effect of temperature on the bias network, and thus output current, is extremely low.

Output count of the converter (see figure) is:

$$C = [(V_x - VAG)/(V_r - VAG)] \times 2{,}000$$

This number is displayed by the HP5082 displays with the aid of the MC14511 BCD-to-seven-segment decoder



Digital thermometer. Circuit is accurate over wide temperature range because no operational amplifiers are used. Op amps, normally needed to amplify sensor voltage, also amplify temperature-offset errors, and so are replaced by a-d converters. Converter has high input impedance, wide dynamic range, and can interface to sensor.

drivers and one MC1413 hexadecimal inverter.

To calibrate the circuit, the sensor temperature should be kept at 0°C or 0°F while R_1 is adjusted until the display reads 0. The sensor is then brought to a temperature of 199° (or to a lower temperature if decreased accuracy is acceptable), and R_2 is adjusted until the display matches the sensor temperature. V_r must be greater than VAG during all phases of the calibration in order for the converter to function properly.

Using a standard diode sensor limits the error of the system to no greater than 1.0°. However, diode sensors with an error of less than 0.6°C are available from Motorola on a special-order basis. □

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

Calculator notes

SR-52 scales data for accurate drawing

by Charles S. Gaylord
American Telephone and Telegraph Co., Kansas City, Mo.

Determining the dimensions required to draw any object to scale on a given size of paper can be a major headache. This SR-52 program eliminates the mental gymnastics by finding the scale factor and then converts the object lengths (expressed in feet, inches, and divisions thereof) to the number of incremental inches required for accurate drawing or plotting.

The all-important scale factor is found once the largest dimension of the object to be drawn (P) and the available drawing space (Q) are specified. The scale factor is, or course, equal to Q/P. The resolution with which the object will be measured and the figure or lines drawn must also be expressed in divisions of an inch and supplied to the program. Actual scaling starts when the object's dimensions of interest are specified.

For instance, assume there is a figure with a maximum dimension of 4 feet, 5⅞ inches, which when drawn is to cover 22 inches on paper. Assume the fractional dimensions of the figure are to be expressed in eighths of an inch, and lines on the drawing are resolvable within a 20th of an inch.

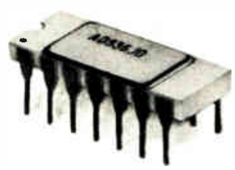
After keying in the program and then the information shown in the table, the scale factor is found and the resolution-measuring data supplied is stored in order to perform the scaling operation.

Suppose that some feature on the figure is 3 ft, 3⅜ in. from an established point, and the scaled distance from the corresponding point on the drawing is desired. After keying in 3 ft, 3⅜ in. as shown, the program determines that this scaled dimension will be 16.02 in. This actually indicates that the feature is 16²⁄₂₀ in. from the point: note the readout is expressed in incremental inches, not decimal inches. If the A′ key is pressed, 16.02 in. will be expressed in decimal form. The scale factor may be retrieved by pressing B′.

To change the resolution with which the object is measured or drawn, it is necessary to return to step 2 of the instruction set (see the program listing). This is done by pressing CLR E. The entire data-entering procedure for

SAMPLE SPECIFICATION AND CALCULATION FOR SCALING PROGRAM

Enter	Press	Display	Comments
8	E	8	*object resolution: 1/8 in.*
20	E	20	*drawing resolution: 1/20 in.*
4	A	48	*object's maximum dimension: 4 ft 5 7/8 in.*
5	B	53	
7	C	53.875	
	E	53.875	
22	B	22	*width of paper: 22 in.*
	E	0.4083526682	*scale factor*
3	A	36	*feature on object 3 ft 3 3/8 in. from established (reference) point*
3	B	39	
3	C	39.375	
	D	16.02	*feature should be 16 2/20 in. from corresponding point on drawing*



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For specs and samples call Doug Grant at (617) 935-5565. Analog Devices, P.O. Box 280, Norwood, MA 02062.

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the scale-factor operation must then be repeated.

If the instructions are not followed in the order specified in this program the display will flash. Pressing CLR E, or just E (depending on the actual location of the program), will clear the display and return the program to step 2 in the instruction set. ☐

SR-52 OBJECT-SCALING PROGRAM

LOCATIONS	CODES	KEYS	COMMENTS
000 – 004	50 02 19 41 88	'st flg 2 'D' GTO '2'	
005 – 009	46 19 42 00 06	'LBL 'D' STO 06	
010 – 014	60 00 10 50 00	'if flg 0 'E' 'st flg 0	
015 – 018	00 42 00 01	0 STO 01	
019 – 024	46 10 43 00 06 56	'LBL 'E' RCL 06 'rtn	
025 – 028	46 97 10 55	'LBL 'O' 'E' ÷	
029 – 032	43 00 04 54	RCL 04)	
033 – 037	46 87 44 00 01	'LBL '1' SUM 01	
038 – 042	43 00 01 46 88	RCL 01 'LBL '2'	
043 – 045	22 57 81	INV 'fix HLT	
046 – 050	46 11 65 01 02	'LBL A X 12	process input dimension: feet
051 – 055	46 12 54 24 19	LBL B) CE 'D'	process input dimension: inches
056 – 061	41 87 46 13 54 24	GTO '1 LBL C) CE	process input dimension: fraction of inches
062 – 065	19 75 01 54	'D' – 1)	
066 – 070	80 97 10 41 87	'if pos 'O' 'E' GTO '1'	
071 – 076	46 14 22 60 00 67	LBL D INV 'if flg 0 '7'	initiate conversion
077 – 080	22 60 02 67	INV 'if flg 2 '7'	
081 – 086	43 00 01 42 00 00	RCL 01 STO 00	
087 – 091	65 43 00 05 54	X RCL 05)	
092 – 096	42 00 06 57 00	STO 06 'fix 0	
097 – 101	75 93 05 54 37	– .5) 'D.MS	
102 – 105	22 44 00 06	INV SUM 06	
106 – 109	48 00 06 65	'EXC 06 X	
110 – 114	43 00 03 54 37	RCL 03) 'D.MS	
115 – 118	42 00 02 75	STO 02 –	
119 – 122	43 00 03 54	RCL 03)	
123 – 127	90 89 43 00 02	'if zro '3' RCL 02	
128 – 130	65 93 00	X .0	
131 – 136	46 89 01 85 10 54	LBL '3' 1 + 'E')	
137 – 139	22 50 00	INV 'st flg 0	
140 – 142	57 02 81	'fix 2 HLT	display value
143 – 146	46 15 54 24	LBL E) CE	specify object and drawing maximum dimension and resolution; also determine scale factor.
147 – 151	60 02 79 90 67	'if flg 2 '6' 'if zro '7'	
152 – 156	60 01 77 50 01	'if flg 1 '4' 'st flg 1	
157 – 159	42 00 00	STO 00	
160 – 163	04 48 00 00	4 'EXC 00	
164 – 169	46 77 36 42 00 00	'LBL '4' 'IND STO 00	
170 – 172	58 78 55	'dsz '5' ÷	
173 – 176	43 00 02 54	RCL 02)	
177 – 180	42 00 05 86	STO 05 'rset	go to location 000
181 – 185	46 78 22 50 00	'LBL '5' INV 'st flg 0	
186 – 187	41 88	GTO '2'	
188 – 190	46 17 24	'LBL 'B' CE	scale factor
191 – 195	43 00 05 41 88	RCL 05 GTO '2'	
196 – 200	46 79 22 90 67	'LBL '6' INV 'if zro '7'	
201 – 205	22 50 02 41 88	INV 'st flg 2 GTO '2'	
206 – 209	46 67 51 69	LBL '7' SBR '9'	
210 – 212	22 50 00	INV 'st flg 0	
213 – 214	46 16	'LBL 'A'	decimal equivalent of fractional inches
215 – 220	43 00 00 57 03 81	RCL 00 'fix 3 HLT	display value

INSTRUCTIONS

1. Key in program
2. Specify resolution, in divisions-per-inch, with which object will be measured:

   (P), E
3. Specify resolution, in divisions-per-inch, with which lines or figures are to be drawn on artwork:

   (Q), E
4. Specify largest dimension of object (P′) and maximum dimension of artwork (Q′) permitted, in feet, inches, and divisions:

   (P'_{FT}), A, (P'_{IN}), B, (P'_{DIV}), C, E

   (Q'_{FT}), A, (Q'_{IN}), B, (Q'_{DIV}), C
5. Determine the scale factor from previous step:

   press E
6. Specify the actual length of any object or line to be drawn, in feet, inches, and divisions:

   (P''_{FT}), A, (P''_{IN}), B, (P''_{DIV}), C
7. Find corresponding length of object or line on artwork or graph:

   (Q″), D

   Repeat steps 6 and 7 as desired.
8. To change (P) or (Q), return to step 2 by pressing CLR E; repeat entire procedure

Engineer's newsletter

Using an op amp to convert square waves into triangular ones

The 741 op amp's slew rate (SR) is limited to 0.5 $V/\mu s$—a limitation that can be used to turn the device into a simple square-to-triangular-wave converter, points out Noel Boutin, an engineer in the Applied Sciences department of the University of Sherbrooke in Quebec, Canada. **Of course, the output signal must never exceed the input signal in amplitude.**

Boutin's design is a noninverting, unity-gain follower circuit. When its input signal is a square wave of amplitude $\pm V_i$ and frequency $1/T$, then the output signal's amplitude V_o rises and falls at a rate such that $2V_o = SR \times T/2$. Note that there is a minimum frequency below which the amplifier no longer operates as a square-to-triangular-wave converter. This is $f_{min} > SR/4V$. Thus at a given slew rate, the higher the value of V, the lower f may be.

The same slew-rate limitation can be used to convert a sine wave into a triangular wave. Also, adds Boutin, a trapezoidal output can be generated by a square wave that has an input frequency below f_{min} for a given slew rate and amplitude.

How not to bridge gaps on pc boards

When metallic growth or conductive contaminants bridge the conductors on a printed-circuit board, you get problems ranging from current leakage in the microampere range right on up to dead shorts. Solutions are discussed in depth in a new report from the Institute of Printed Circuits. Entitled "How to Avoid Metallic Growth Problems in Electronic Hardware," it lists and discusses **the steps to take to inhibit or reduce electromigration and other forms of dendritic growth.** Copies of report IPC-TR-476 can be obtained for $5 from the institute at 1717 Howard St., Evanston, Ill. 60202.

Tapes teach digital troubleshooting in two days

Could you use the equivalent of a two-day live seminar on digital troubleshooting at your own company? A Hewlett-Packard video tape program is designed to teach those who have never been involved in the area before.

The course consists of 14 video tapes, a 180-page textbook, lab work book, and study guide. Topics discussed in the tapes begin with an introduction to digital electronics and the binary system, the basics of transistors and ICs, logic gates and symbols, and the various digital IC families. Then they get into how to **troubleshoot digital ICs, flip-flops, counters, shift registers, combinational logic circuits, display devices, and memories.**

The package costs $3,600. For further details, write to the Inquiries Manager, Hewlett-Packard Co., 1607 Page Mill Rd., Palo Alto, Calif. 94304.

Understanding strain gages

Are you about to apply semiconductor strain gages for the first time? A 20-page bulletin from Kulite Semiconductor Products will set you off on the right track. The bulletin supplies **a detailed description of piezoresistance in semiconductors,** strain gage characteristics, and circuits for strain gage measurement. Application notes and considerations for gage selection are also offered.

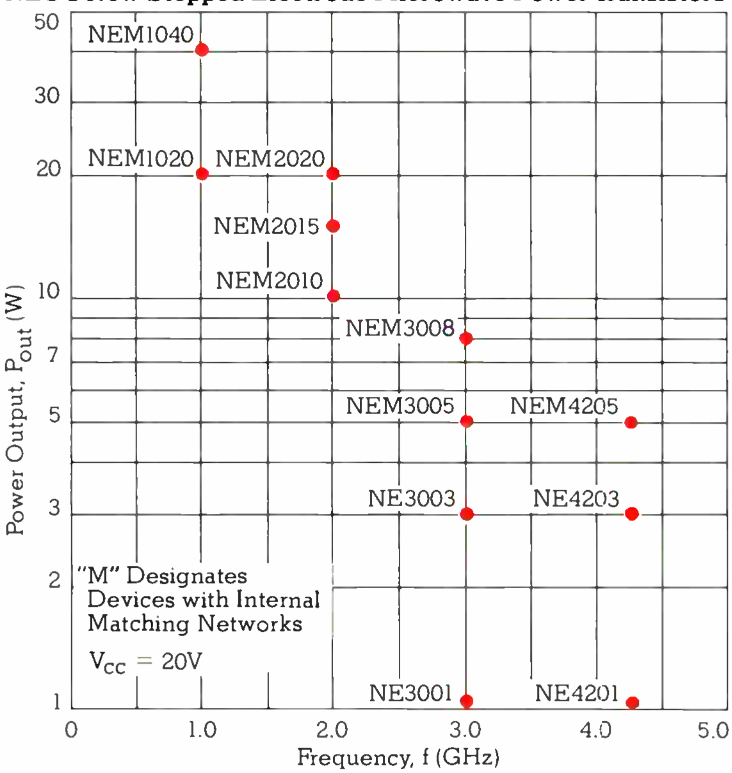
For a copy of this booklet, contact Ron Moores, Kulite Semiconductor Products Inc., 1039 Hoyt Ave., Ridgefield, N. J. 07657. **Jerry Lyman**

From 40 Watts at 1.0 GHz to 5 Watts at 4.2 GHz

NEC's New Power Bipolar Transistor Series. That's right. While everyone else is trying to accomplish it, NEC has done it.

A recent development program at the Nippon Telephone Telegraph Public Corporation (NTT) in Japan and NEC has revolutionized the power bipolar transistor industry. It's not just an "improvement" or a fancy variation of an already acknowledged second-generation device, it's a whole new technology called SET—Stepped Electrode Transistor.*

NEC's New Stepped Electrode Microwave Power Transistors



The SET structure realizes a virtual "zero gap" between the base junction and emitter metallization. New structure, new fabrication process, new reliability . . . a new era.

Now NEC can offer you four complete lines of SET bipolars for applications from 1.0 GHz to that all-important 3.7 to 4.2 GHz communications band. Applications run the gamut from mobile radios to satellites.

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*patent pending

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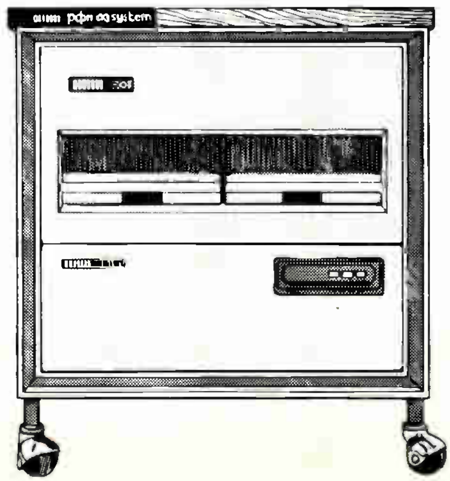

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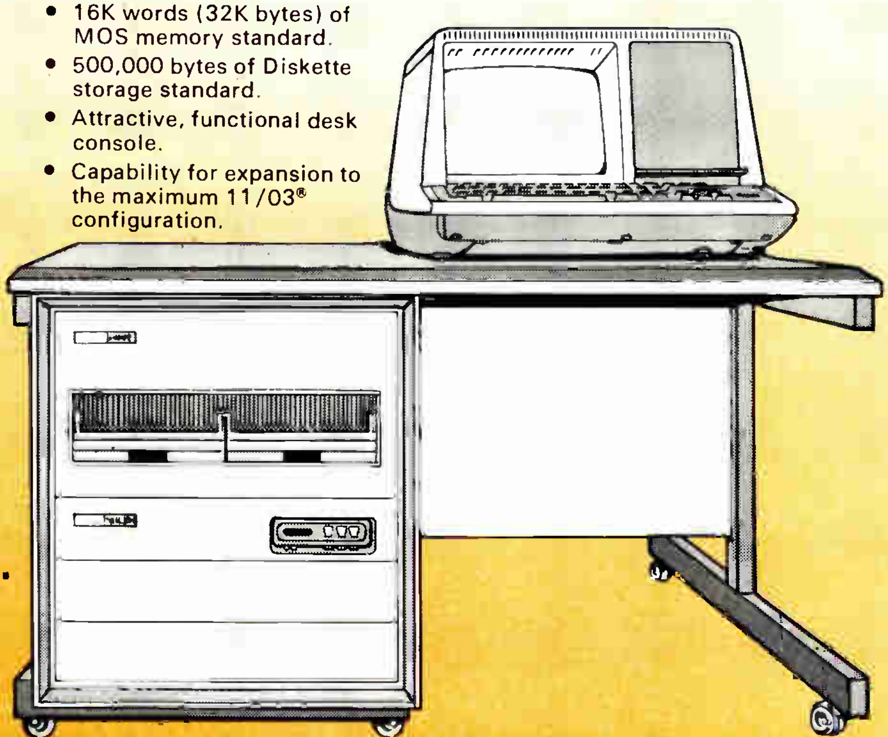

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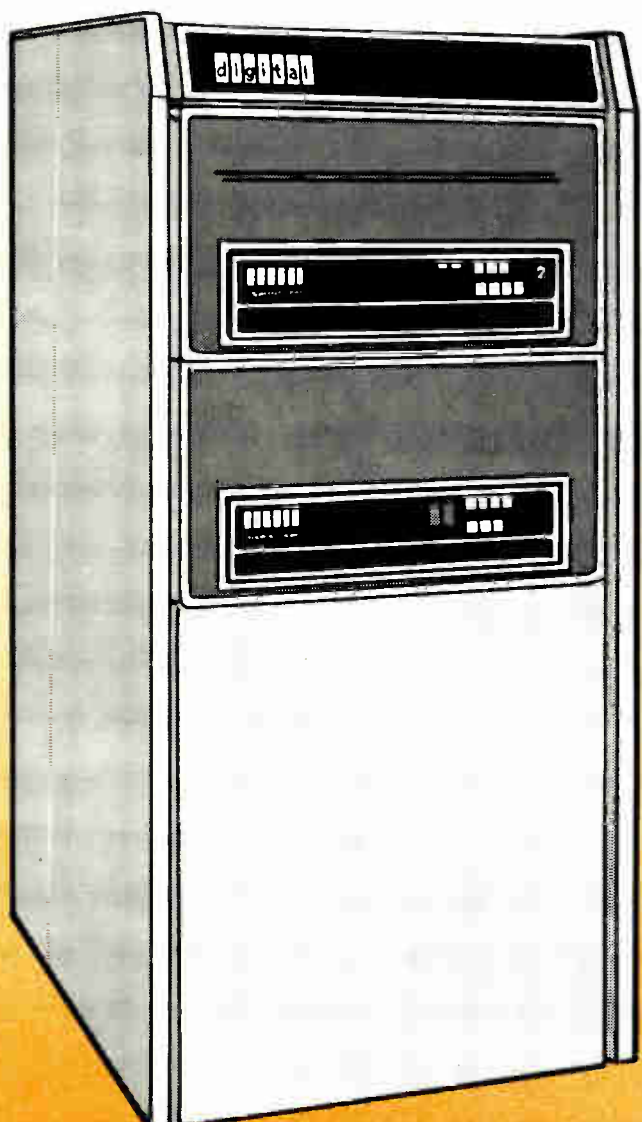

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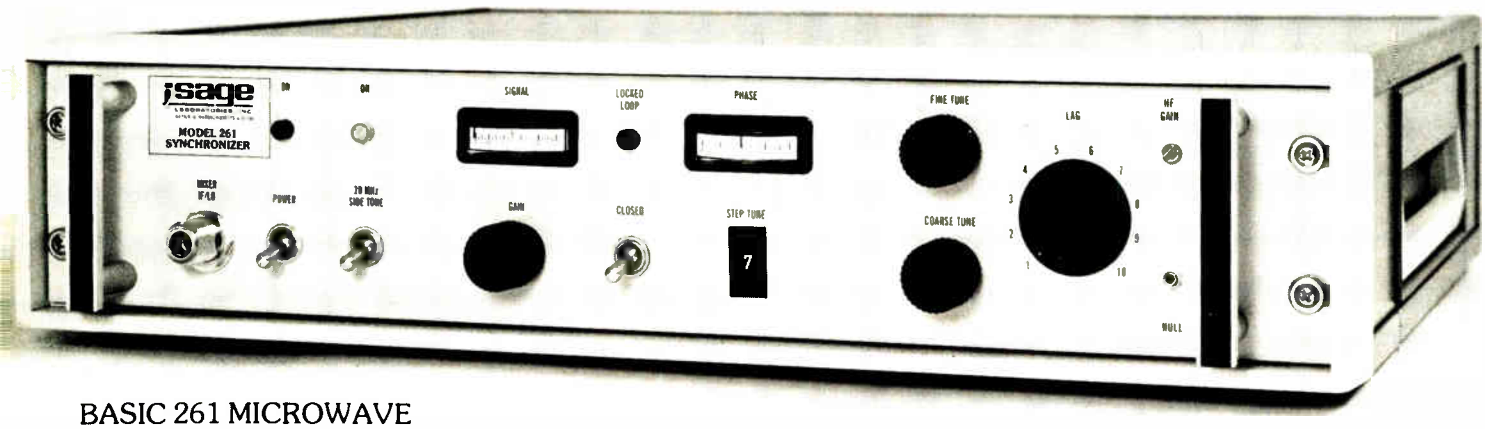

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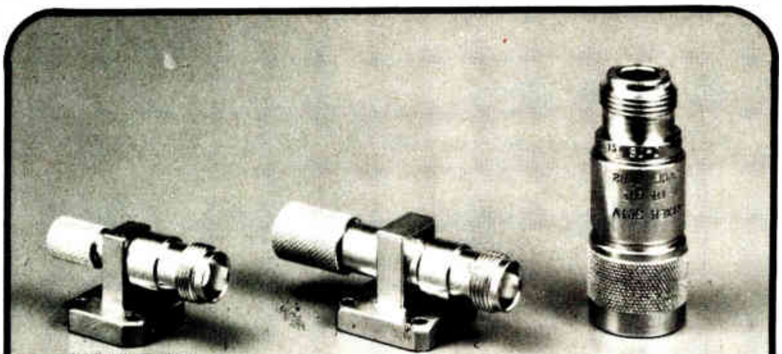

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The key feature of the 261 is the fact that it derives all frequencies from a single built-in oven controlled quartz crystal oscillator. Thus, there is none of the "settling down" drift normally associated with the changing of crystals. The combination of this voltage-tuned crystal oscillator (VCXO) and a built-in digital synthesizer, used in conjunction with the various 261 mixers, provides continuous coverage from 1-40 GHz. Primary standard stability can be achieved by locking the 261 VCXO to an external synthesizer or standard tuned near 1, 2, 5, or 10 MHz. A monitor output near 10 MHz enables you to count the fundamental 261 synthesizer frequency, and to compute the exact locked frequency.

The basic 261, complete with the 261A mixer, sells for $3800. The 261B mixer option costs $250. The 261C mixer sells for $200. All units are stocked.

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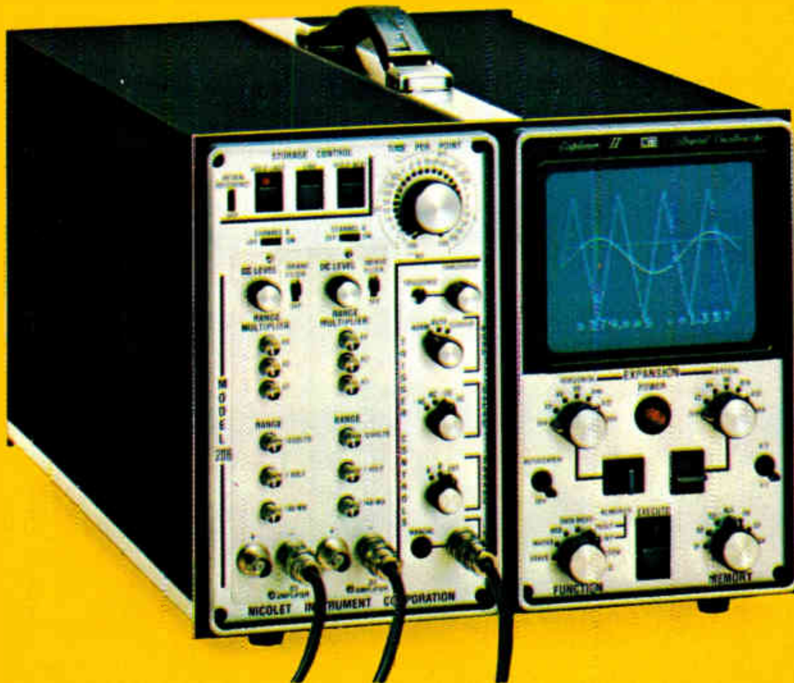


The General Purpose EXPLORER II

New digital oscilloscope for low-frequency, high precision signal measurement.

EXPLORER II is an oscilloscope in every sense of the word—for use in the same way as other oscilloscopes. It has the same sweep controls, trigger controls and amplifier controls.

What makes it different is its precision and enormously improved waveform storage capability. EXPLORER II is a digital oscilloscope. Because of this and careful human engineering, a dozen old operating problems have just disappeared.

Great Storage: Storage occurs at the touch of a button. The captured waveform has the same quality as live waveforms — amazing quality. There is no trace fading or blooming. If you wish, you can tuck the waveform away, out of sight, for later recall and continue to use the oscilloscope for other things in the meantime. Storage at the touch of a button means more than saving operating steps. It means no blank screen before storage.

Automatic Persistence: The EXPLORER always displays the last signal waveform until the next signal occurs, even when signals occur only rarely. There are no adjustments or mode switching.

CRT Independence: No longer is accuracy dependent on the cathode-ray tube. True voltage and time numerics for any selected point end that problem. The numbers can show differences in both times and voltages, for two selected waveform points. Accuracies and resolution are an order of magnitude greater.

Write-through Storage: At the touch of a switch, **both** live and stored waveforms are shown superimposed. This is far better than split-screen storage, which shows a stored waveform in one area of the screen and live waveforms in another. Write-through storage allows you to see changes as small as 0.025% while they are happening!

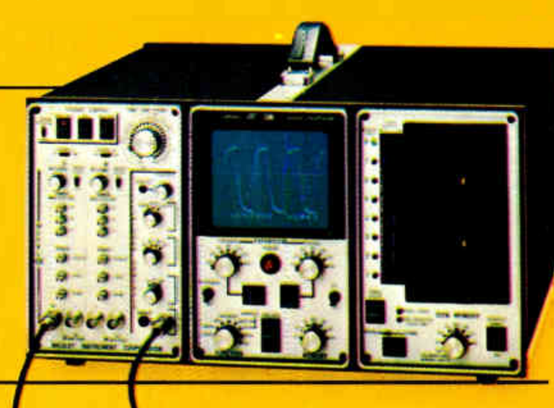
Dual Beam: EXPLORERS with two-channel plug-ins are "dual beam". Both signals are accepted together. There is no need for alternate sweeps or chopped sweeps.

Cursor Triggering: It used to be that all you could see on a 'scope was the result of an event. With EXPLORER you can see what caused an event to happen. Move the vertical marker line to any desired position. In the cursor trigger mode, this will be time zero, the time the sweep trigger occurs. The trace shows you what happened before and after the trigger.

Easy Operation: It's as difficult to describe the "feel" of EXPLORER II as it is to describe the feel of a great sports car to someone who has only driven "soft" passenger cars. But once you've had an hour or two of familiarization and used this new digital 'scope you'll know. You'll never want to go back to anything else.

EXPLORER III

Identical to EXPLORER II, this unit incorporates an added module that contains a magnetic disk memory and a digital input/output port. To document waveforms for future reference, the diskette preserves the accuracy and resolution of the original. There is no compromise as with a photo document. For computation, the digital I/O allows interface to computers and calculators, also IEEE 488 interface.



See It Demonstrated. ***To really appreciate either of these new 'scopes you have to see them in action. For complete details, including descriptive brochures, send the reader service card or call Jim Bartosch at 608/271-3333.***

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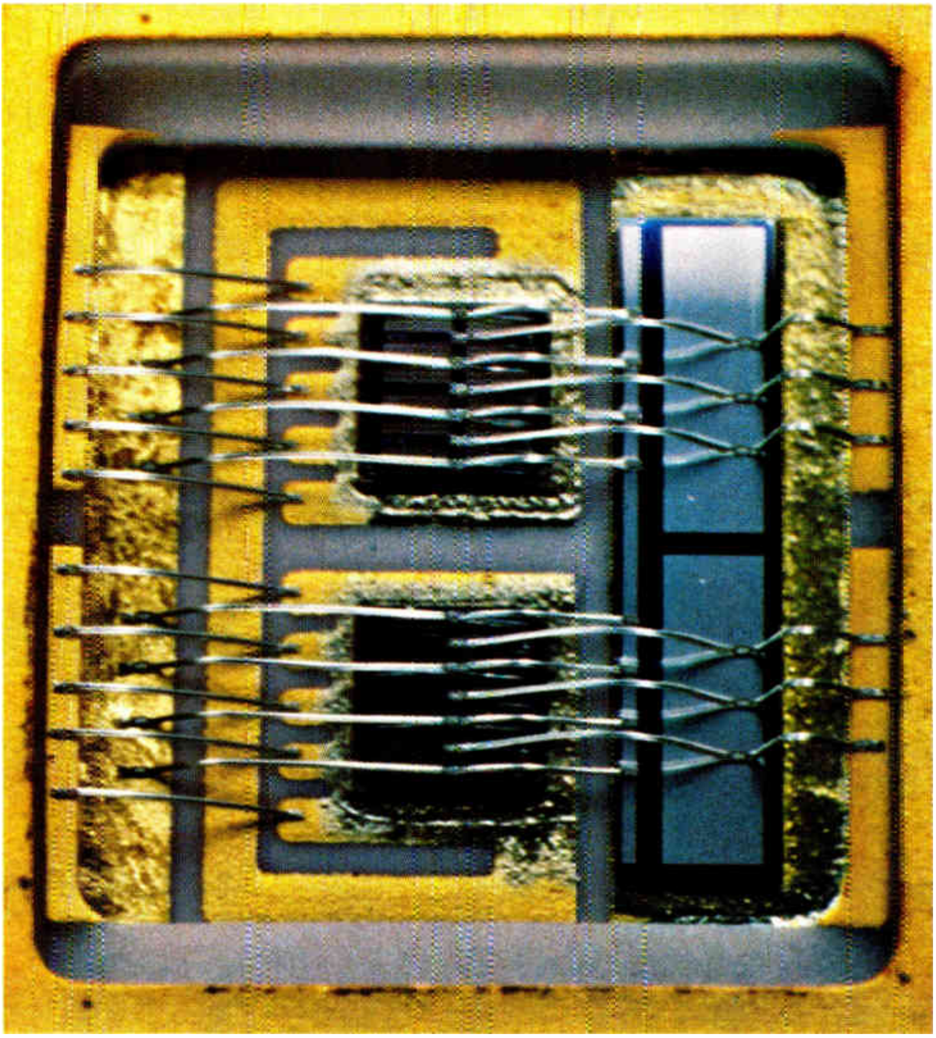
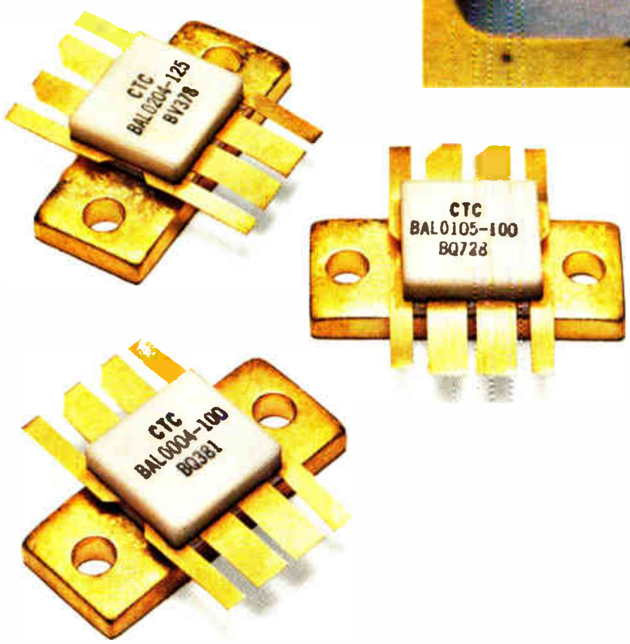
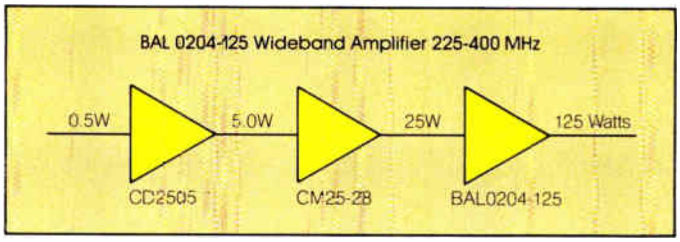


Nobody gets the power out like we do. From HF to microwave. Because nobody else has the Balanced Transistor, a new concept in high power RF and microwave transistor design. The Balanced Transistor, designed and developed by CTC, opens new horizons in amplifier design for land mobile, military and microwave.

In circuit designs which pushed existing technology too far; where power out or available bandwidth were constraints, where the circuit was possible but a bear, where impedances were far too low; the Balanced Transistor means more than practical feasibility. It's consistent, reliable, easy to use, and delivers outstanding performance.

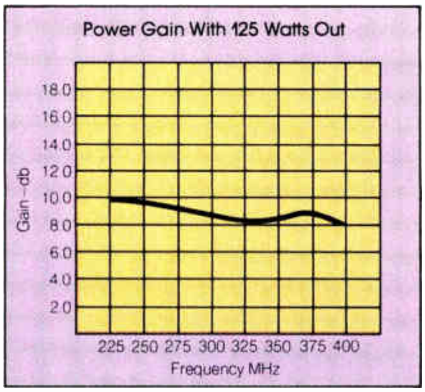
Our design is unique. By arranging two chips in series instead of the traditional parallel design, input and output impedances are increased by a factor of four over conventional bipolars of the same size chip.

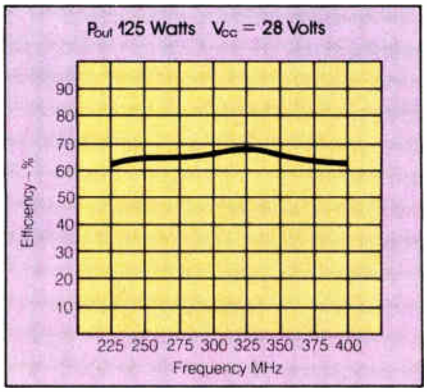




Using the BAL0204-125, this lineup will provide 125 watts CW power across the frequency range of 225-400MHz with 0.5 watts of drive.

balanced transistors.





Typical efficiency and gain at 125 watts power out with the low Q, high output impedance of the input *and output* matched BAL0204-125.

The Balanced Transistor for the first time allows octave and multi-octave bandwidths with as much as 100+ watts of CW power.

The outstanding consistency and reliability of the Balanced Transistor are a direct result of the fact that it has fewer internal parts and is easier to assemble. It also accommodates output matching circuitry with far less complexity than conventional transistors. The result is vastly increased efficiency and far greater power.

Whole new avenues are opened for the circuit designer, using a wide variety of proven balanced (push-pull) circuit techniques. The unique RF ground inside the package offers several advantageous bias options. For us, it's easy to manufacture. For the circuit designer, it's new potential with ease of use and outstanding performance. In operation, it's performance and reliability never before possible.

Simplicity, consistency, performance and reliability—hallmarks of the Balanced Transistor and CTC Like most good things, it didn't just happen. We made it happen. From design through operation, CTC employed many technologies to introduce another series of highest quality transistors to its product line, including non-organic hermetically sealed packages. We have all the

technologies and capabilities on an unequalled level. That's why we're number one. Total Technology from CTC.

For complete information on our Balanced Transistors and how we make it happen at CTC, write for information on our Balanced Transistor product line and our new brochure, "Capability in Power. The Thrust of Total Technology in RF through Microwave." Communications Transistor Corporation, a wholly owned subsidiary of Varian Associates, 301 Industrial Way, San Carlos, California 94070. (415) 592-9390.

CTC the power in RF and microwave

varian

Logic unit monitors IEEE-488 buses

Display formatter for Tektronix logic analyzer displays messages in IEEE-488 mnemonics; it also decodes and displays all 128 ASCII characters

by Bruce LeBoss, New York bureau manager

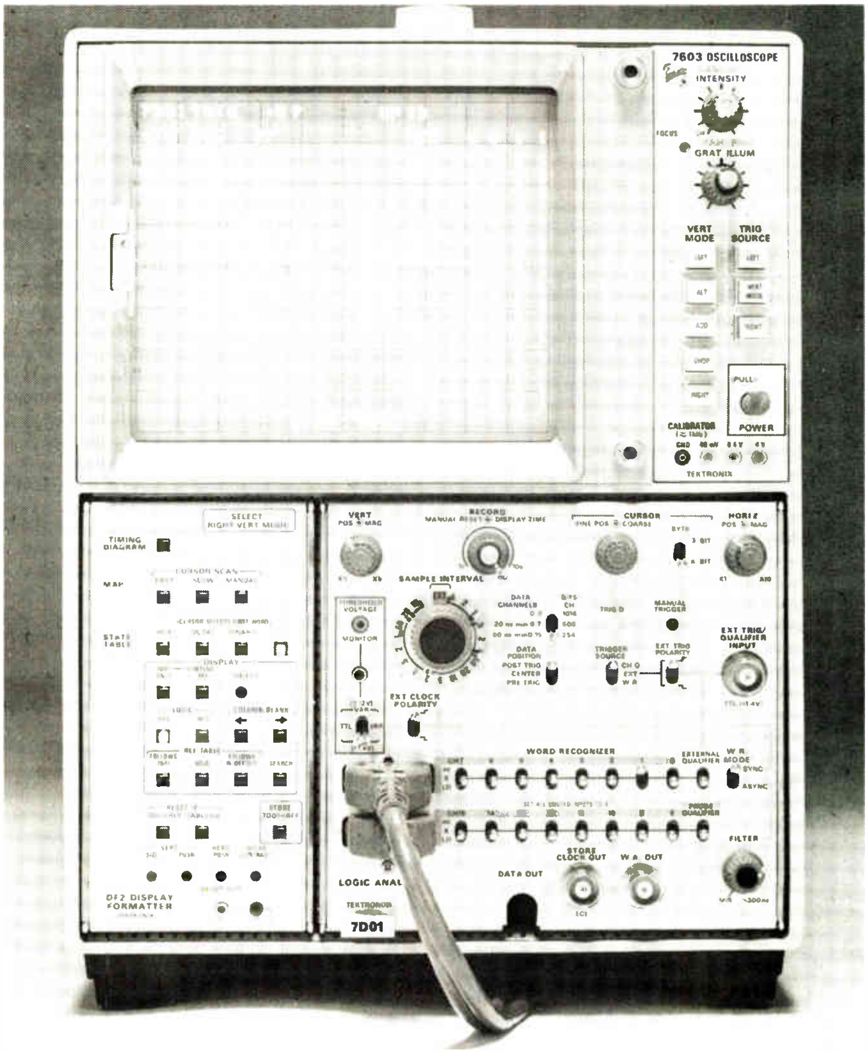
Programmable instruments designed to work with the IEEE-488 bus are all supposed to work together. But unless they are supplied by a single manufacturer, it may take some tedious systems engineering to ensure compatibility. To simplify that task, Tektronix has developed a logic analyzer display formatter that monitors, in sequence, the activity that occurs on standard data buses connecting programmable instruments.

The new DF2 display formatter, available in four weeks, is a $1,945 plug-in module for Tektronix' 7D01 logic analyzer, itself a plug-in that converts any of the firm's 7000-Series laboratory oscilloscopes into a 16-channel logic analysis system. Like its DF1 predecessor, selling for $1,395, the DF2 provides timing diagram, state table (in binary, octal and hexadecimal), and mapping displays of data. "But the $550 premium for the DF2 buys the user two very important additional features," says David Parmley, product planner for logic analyzers.

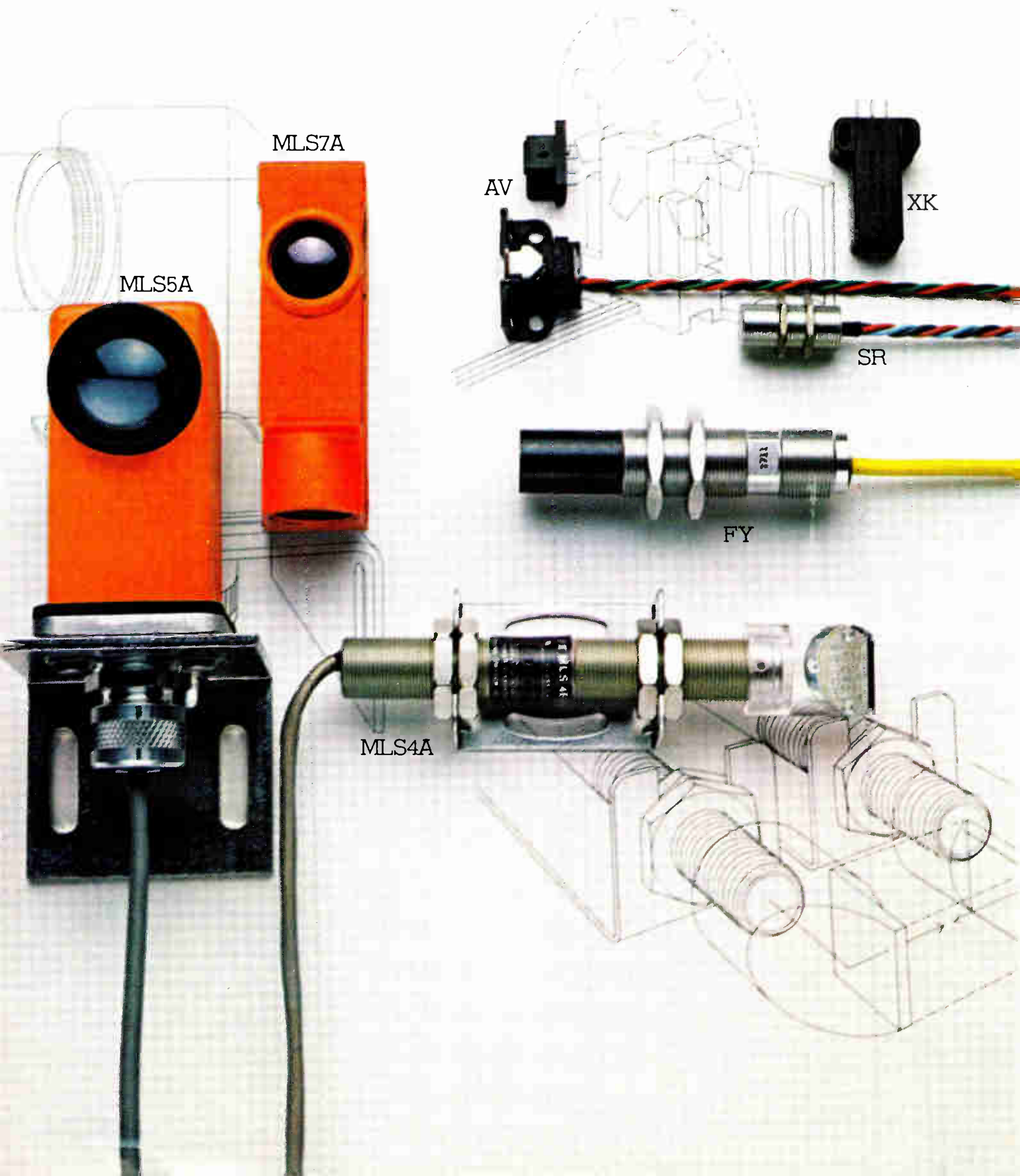
First, "the DF2 displays bus control and device-dependent messages in mnemonics familiar to IEEE-488 bus users," Parmley notes. In one of its two modes, information is acquired synchronously and up to 18 instructions are displayed at one time. As the data is scrolled, all of up to 256 instructions stored in the 7D01 are then disassembled and displayed in mnemonic format. The states of four bus management lines and eight data lines are displayed, as can be four additional lines of user-definable data to provide circuit information. In the other mode, the same arrangement of lines is displayed as a timing diagram.

Perhaps equally important, the DF2 provides ASCII decoding of all 128 control characters. This is significant, Parmley says, because the abundant supply of components that encode, decode, translate and print ASCII data have led to its widespread use in a variety of computer and peripheral system designs. Thus, he continues, "the designers of these products can now use the DF2 to interpret and display data in the familiar ASCII format without the need for elaborate conversions and extrapolations."

Tektronix Inc., P. O. Box 500, Beaverton, Ore., 97077. Phone (503) 644-0161 [338]



About the only No Touch Controls we don't make you haven't asked for. Yet.



Subassemblies

Unit converts digital signals for CRT display

Called a graphics translator, the model 1350A is a subsystem intended to convert the outputs of digital systems into a form suitable for display on a fast, high-resolution cathode-ray-tube display. The unit takes information from the IEEE-488 interface bus or (optionally) from an EIA RS-232C interface bus and stores it in an internal 2,048-word random-access memory.

Each word in the RAM can be a vector coordinate or a character. The translator contains a character generator that can produce upper- and lower-case ASCII characters in four sizes. An optional read-only memory provides 512 user-definable vectors for graticules and special characters.

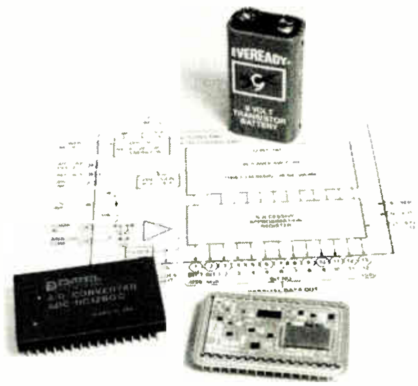
For enhanced flexibility, the memory of the graphics translator can be divided into 32 independent files. These files, which can be used to drive separate displays, can be of different size, are addressable, are selectively eraseable, and can be flashed to highlight important display information.

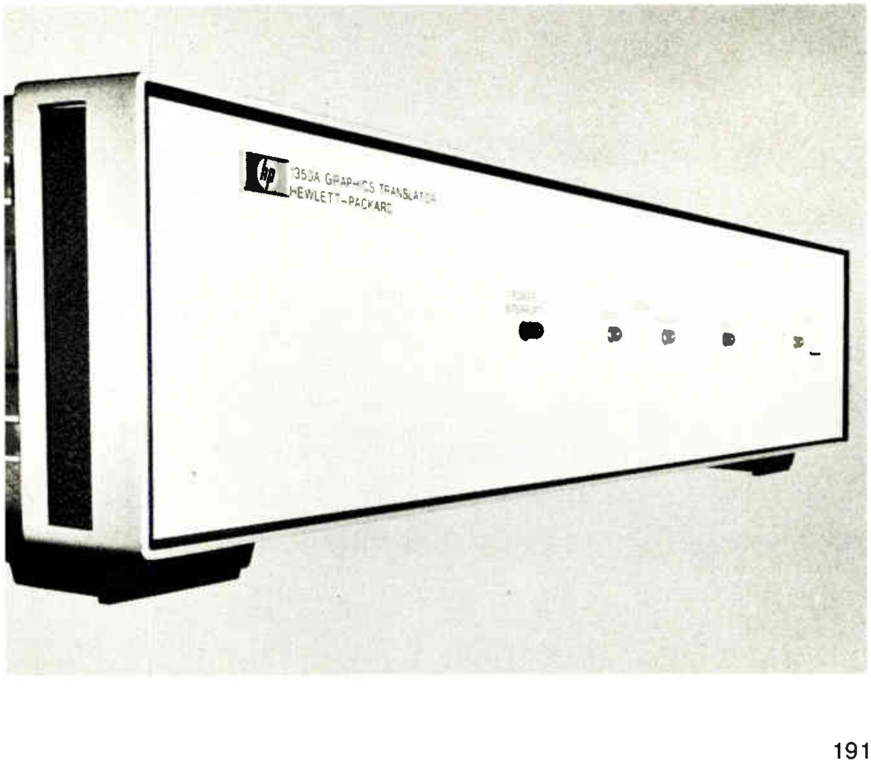
The 1350A is recommended for use with directed-beam displays with bandwidths of at least 2 MHz to take advantage of its ability to generate vectors very quickly. It sells for $3,450 and has a delivery time of eight weeks.

Inquiries Manager, Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [381]

12-bit C-MOS a-d converter needs single supply voltage

A low-power hybrid analog-to-digital converter for portable and remote instrumentation applications can operate from a single 9- or 12-v battery. The ADC-HC12B uses complementary metal-oxide-semiconductor circuitry to keep its power





consumption down to a maximum of 120 mw. In the standby mode—when it is not actually making a conversion—the unit draws only 10 μA of supply current.

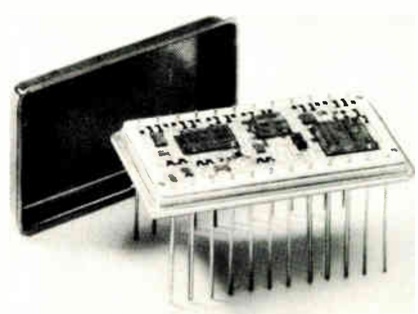
The converter comprises an input amplifier with protection diodes, 12 C-MOS switches, a C-MOS successive-approximation register, a clock circuit, a precision zener-based reference source, an energy-storage circuit, and a laser-trimmed thin-film R-2R resistor ladder network. All of this fits into a package with dimensions of 1.1 by 1.7 by 0.25 inch.

The tight tracking characteristics of the ladder network (1 part per million/°C typical) give the converter guaranteed monotonicity over its entire temperature range. Versions with three ranges (0°C to 70°C, −25°C to 85°C, and −55°C to 125°C) and two case styles are available. Prices range from $129 for a plastic-packaged unit that operates from 0°C to 70°C to $219 for a wide-range converter in a hermetic case. Deliveries are from stock to four weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Eugene L. Murphy at (617) 828-8000, Ext. 141 [383]

Multiplying d-a converter resolves 14 bits

Linear to within 0.0125% of full scale and featuring a settling time of less than 20 μs, the DAC-U-12 is a multiplying digital-to-analog converter with a resolution of 14 bits. The four-quadrant unit is intended for use in XY displays and plotters, character and stroke generators, graphics displays, and programmed pulse generators. If desired, the

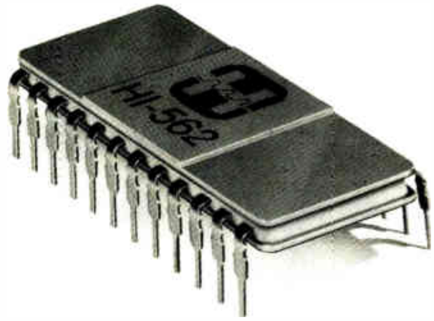


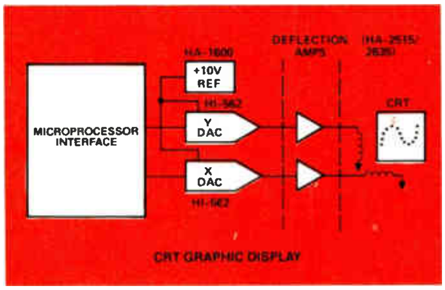
converter will provide its 14-bit resolution over a two-quadrant range.

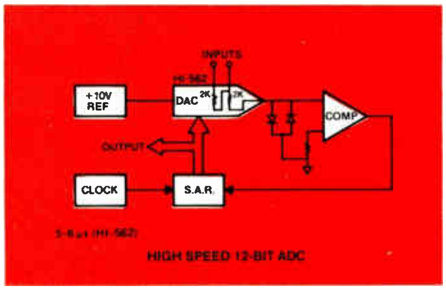
For less demanding applications, a similar unit, the DAC-U-11 is available. It differs from the -12 in that its maximum nonlinearity is 0.025% of full scale. Both devices will provide full accuracy with reference-voltage frequencies from dc to 400 Hz, both have a full-power bandwidth of 100 kHz, and both are offered in two temperature ranges—0°C to 70°C and −55°C to 125°C. Small-quantity prices for units in the DAC-U family start at $245. De-

Another Industry Breakthrough!

Introducing...The Harris HI-562 D/A Converter.







If you've been looking for the right D/A converter to match your brightest design ideas, you can stop looking... it's here... the new Harris HI-562.

The HI-562 is the first monolithic D/A to combine high speed performance and true 12-bit accuracy on the same chip—attained through the utilization of the most advanced laser resistor trimming techniques in the industry. Consider these features:

- Fast Settling: 200 ns to ±1/2 LSB
- Excellent Linearity: ±1/4 LSB
- Low Gain Drift: ±2 ppm/°C
- Fully monotonic over temperature

At only $29 (100-up), the Harris HI-562 is the cost-effective answer to your most demanding data conversion design problems. So if you are into A/D converters, CRT graphic displays, process control systems, precision instruments, data acquisition systems, communication terminals... to mention a few... the Harris HI-562 can provide you with the performance, economy, accuracy and design versatility you won't find in any other D/A converter.

Available in a 24-pin DIP, the 562 operates on +5V and −15V supply voltages and a +10V reference.

Check out this new dimension in data conversion. Contact your nearby Harris Semiconductor distributor for evaluation devices. For full details, call the Harris Hot Line, or write: **Harris Semiconductor Products Division, P.O. Box 883, Melbourne, Florida 32901.**

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Circle 193 on reader service card

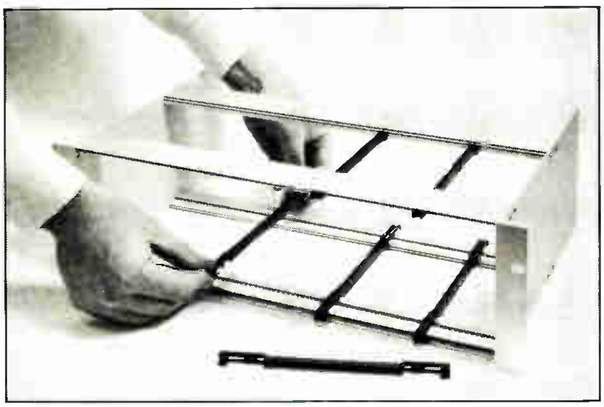
"BET YOU CAN'T BEAT THE SYSTEM!"

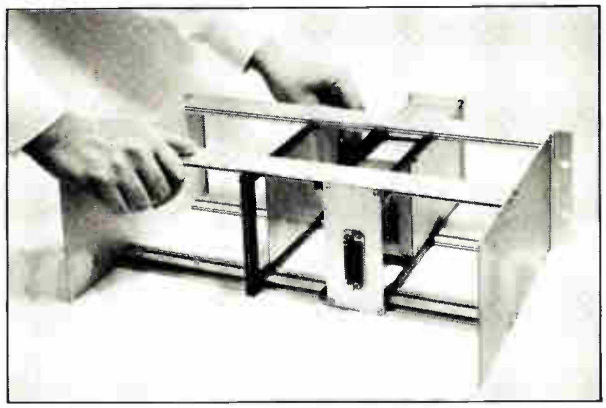
Bud's Modular Electronic Packaging System gives you options. Options to use circuit boards; to use full-enclosed modules, to use all of one, or a combination of both to develop an electronic package for a variety of applications. Equally important, the Bud System gives you the flexibility to alter your original circuit board/module arrangement for subsequent applications. The options are yours.

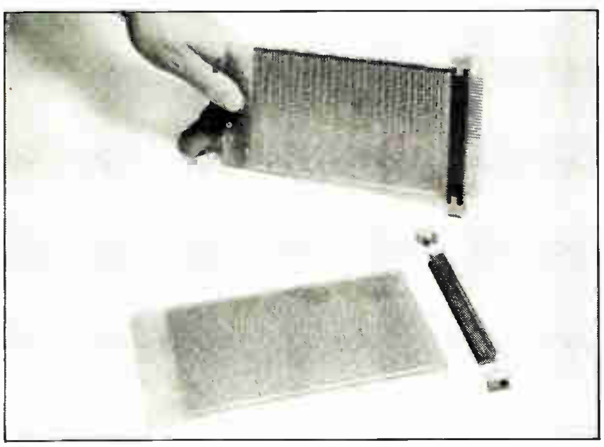
AND HERE ARE FOUR REASONS WHY:

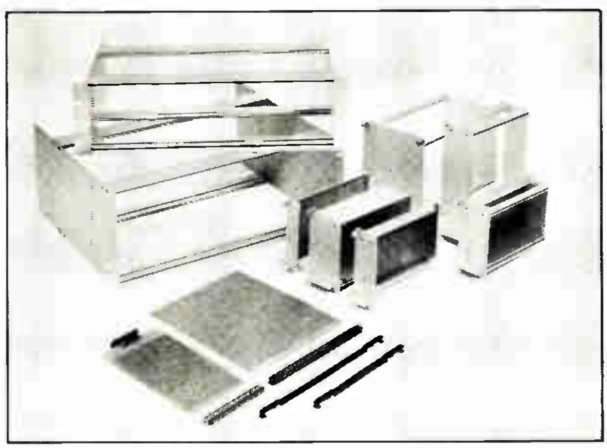
1 Movable Snap-in Guides. One reason for the System's flexibility are full-length, impact-resistant guides. You can move them, snap them in and out -- adjust them to a basic pitch of 0.2" to accommodate circuit boards and modules -- without dismanteling the System's outer frame. The System will house up to 42 circuit boards; however, even when densely packed, maximum ventilation is assured.

2 Perfect Alignment Between Connector and Circuit Board. The System's distortion-free guides offer packaging flexibility, and also provide the means for positive alignment. All edge connectors, plus panel-type connectors mounted to socket-mounting panels are securely attached at the rear of the guides. Insert circuit boards into the System and they slip directly into the edge connectors. Slide in larger modules and they make perfect contact with the panel-type connectors.









3 Board Profiling is Eliminated. A uniquely designed end foot, easily attached at the end of each guide, not only "leads" circuit boards into edge connectors, but also positions edge connectors so they will accept the full height of the boards. This eliminates board profiling and, in turn, results in maximum contact. Keep in mind the Bud System is designed to utilize a wide universe of circuit boards and edge connectors to give you maximum flexibility.

4 A Choice of Components. Regardless of what type electronic package is required for your present or future applications, Bud has the components to develop that package: eight sub-racks (outer frames), 20 sub-units (enclosed modules), six printed board units, eight circuit boards, plus single and double row edge connectors. All are fabricated to exacting tolerances. All are easily assembled. All are in stock -- immediately available.

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BUD

BUD INDUSTRIES, INC.
4605 East 355th Street
Willoughby, Ohio 44094

Circle 194 on reader service card

livery is from stock to four weeks.

ILC Data Device Corp., Airport International Plaza, Bohemia, N.Y. 11716. Phone (516) 567-5600 [385]

Op amp has 150-MHz unity-gain frequency

Offering a typical unity-gain frequency of 150 MHz, the model 9932 op amp has a minimum unity-gain slewing rate of 600 V/μs.

With its fully differential input, the amplifier exhibits a minimum common-mode rejection ratio of 50 dB at 1 kHz, dropping only to 45 dB minimum at 1 MHz. It is thus well suited for noninverting applications, and will find wide use in video, pulse, ultrasonic, medical and radar equipment, and in high-speed analog function-generator circuits.

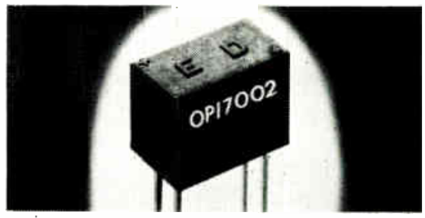
Other key specifications of the model 9932, which is electrically similar to the National Semiconductor model LH0032, are a typical output of $\pm$10 volts at $\pm$50 mA, a typical input bias current of 100 pA, and a maximum settling time to within 0.1% of 100 nanoseconds.

Price of the model 9932, which is housed in a standard 16-pin dual in-line package, ranges from $55 each for one to two units and $49.50 for three to nine units, to $44.50 each for 10 to 29 units. Delivery is from stock.

Optical Electronics Inc., P.O. Box 11140, Tucson, Ariz. 85734. Phone (602) 624-8358 [386]

Optoisolators provide more than 6,000 V of isolation

The OPI 7000 series of optically coupled isolators features input-to-output steady-state isolation-voltage ratings of more than 6,000 V in free air and more than 10,000 V when encapsulated. They consist of a high-efficiency infrared-emitting diode coupled to either a silicon phototransistor or a photodarlington in a molded plastic package. Current transfer ratios range from 20% to



100% for the phototransistor versions (OPI 7002 and OPI 7010) and from 200% to 400% for the photodarlington models (OPI 7320 and OPI 7340). In thousands, prices range from $1 to $1.15.

Optron Inc., 1201 Tappan Circle, Carrollton, Texas 75006. Phone (214) 242-6571 [384]

40-W dc-dc converter has efficiency of 80%

Two encapsulated dc-to-dc converter modules that can deliver 8 amperes at 5 V dc have efficiencies of 80%, which allows them to be housed in small cases with no danger of excessive temperature rise. The modules have dimensions of 3.5 by 2.5 by 2.0 inches, feature more than 60 dB of immunity to input-line transients, and will operate normally despite input-voltage variations of up to 200%.

The converters differ in their input-voltage ranges. The model CW12-5S8000 operates from 9 to 18 V dc, while the CW24-5S8000 works from 18 to 32 V dc. Both have fold-back overload protection and both will not generate potentially damaging overshoots during turn-on, turn-off, or as a result of abrupt load changes. They are thus well suited for powering microprocessors, microcomputers, and solid-state memories.

Identical except for input rating, the supplies have line/load regulation of 0.5%/1% and no more than 13 mV rms of output ripple and noise. Both will deliver full output from -25°C to 60°C. In hundreds, the 12-V unit sells for $98 and the 24-V converter goes for $96. Availability is from stock to two weeks.

Semiconductor Circuits Inc., 306 River St., Haverhill, Mass. 01830. Phone Ted Brewster at (617) 373-9104 [387]

Sol-20. First it was THE SMALL COMPUTER. Now, it's THE SMALL COMPUTER SYSTEM.

A year ago, we introduced the Sol-20. It wasn't the first small computer. It was the first complete small computer with everything needed to get it up and on the air as it came from the factory. The keyboard, interfaces, extra memory, factory backup, and service notes were all there.

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We originally designed the Sol-20 as the heart of a complete computer system. So now to solve the problems of science, engineering, education, business management and control and manufacturing, we offer fixed price Sol systems in either kit or fully tested and assembled form. We offer language flexibility, Extended BASIC, Assembler, PILOT* and FORTRAN.* We offer Helios II/PTDOS, an extraordinarily capable disk operating system. And remember, though we call these small or personal computer systems, they have more power per dollar than anything ever offered. They provide performance fully comparable and often superior to mini-computer systems costing tens of thousands of dollars more.

What you get. What it costs.

Typical systems include Sol System I priced at $1600 in kit form, $2095 fully assembled and tested. Included are a Sol-20/8 with SOLOS personality module storing essential system software, an 8192 word memory, a 12" TV/video monitor, and a cassette recorder with BASIC tape.

Sol System II has the same equipment with a larger capacity 16,384 word memory. It sells for $1825 in kit form; $2250 fully assembled.

For even more demanding tasks, Sol System III features Sol-20/16 with SOLOS, 32,768 words of memory, the video monitor and the dual drive Helios II Disk Memory System with the PTDOS disk operating system and Extended DISK BASIC Diskette. Price, $5750 fully assembled and tested.

More information.

For the most recent literature and a demonstration, see your dealer listed below. Or if more convenient, contact us directly. Please address Processor Technology Corporation, Box J, 7100 Johnson Industrial Drive, Pleasanton, CA 94566. Phone (415) 829-2600.

*Available soon.

Processor Technology

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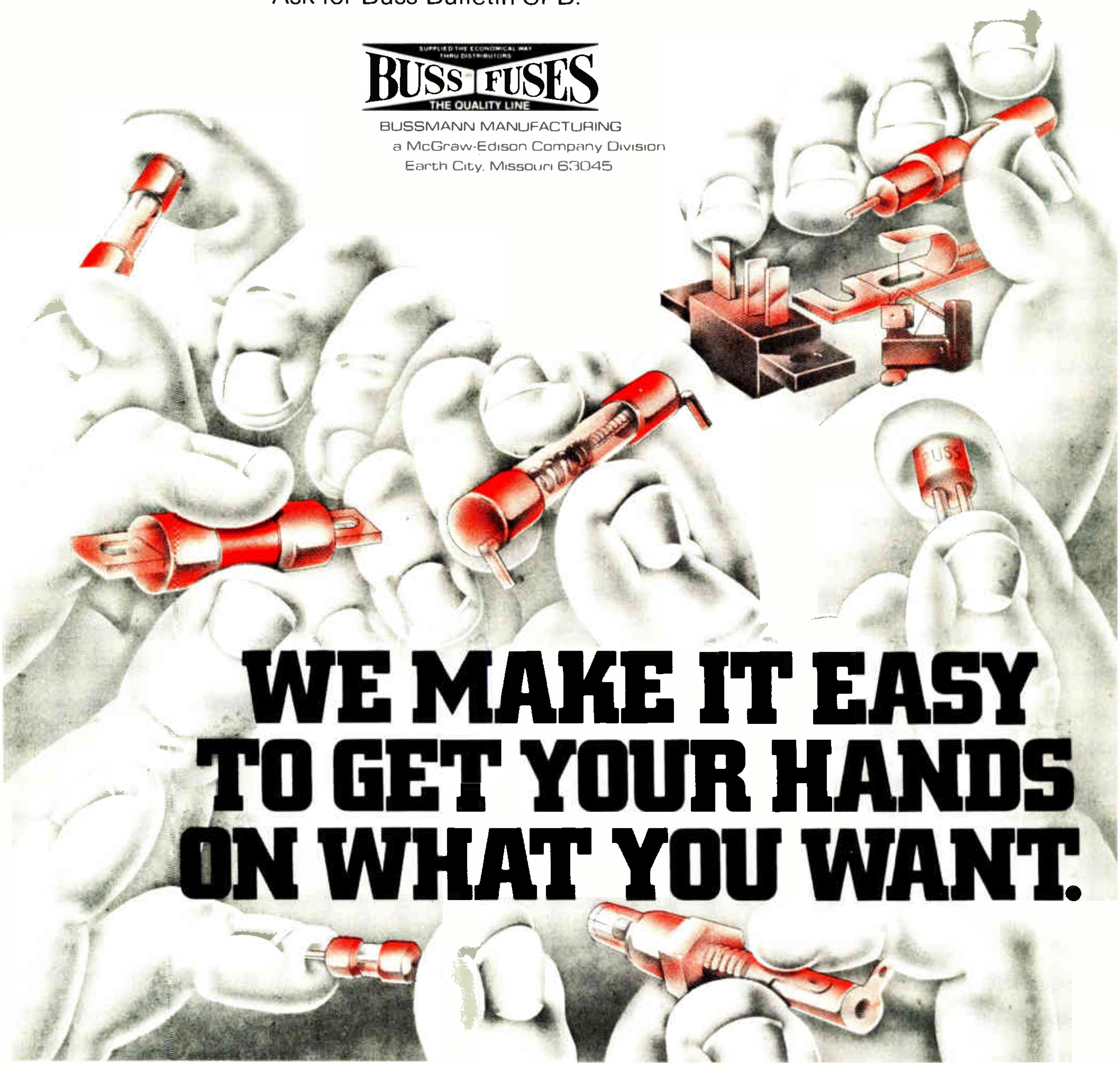


Instruments

Forgiving DMM sells for $169

3½-digit meter withstands 1,000 V on voltage ranges, 500 V on resistance

Less than two months ago, Data Precision Corp. introduced a 3½-digit multimeter, the model 1750, for users who wanted everything [*Electronics*, Nov. 24, 1977, p. 144]. The company has followed through quickly with its model 1350, an independently designed instrument that has fewer bells and whistles but is probably more forgiving to unsophisticated users.

The 1350 does not short-change users on accuracy and functions. It has the same basic dc accuracy (within 0.1%) as the 1750, which sells for $279, but its price is only $169 because it is aimed at a different market. Harold Goldberg, Data Precision president, emphasizes that the 1350 is for those "who may not be widely experienced in the world of digital multimeters."

The 1350 measures dc volts from ± 100 millivolts full scale to 1,200 v and ac volts from 100 mv full scale to a full 1,000 v rms. It measures resistance from both high (2.3-v) and low (300-mv) excitations from 200 Ω full scale to 20 MΩ, and both dc and ac current from 200 μA full scale to 2 A.

This workhorse instrument, as Goldberg describes it, is also designed for extreme protection. It can withstand ± 1,200 v dc on any dc voltage range continuously without loss of calibration and survive a 6,000-v spike on any voltage input for 500 nanoseconds without damage. Further, any resistance range will take 500 v rms ac or dc continuously with no calibration loss.

The $169 price, which Goldberg says is about normal for instruments having ±0.25% accuracy includes test leads, a spare fuse, a one-year warranty, an operator's and maintenance manual, and certificate of conformance tracing its accuracy to NBS standards. Delivery is from stock.

Data Precision Corp., Audubon Road, Wakefield, Mass. 01880. Phone Robert Scheinfein at (617) 246-1600 [351]

4½-digit multimeter connects to IEEE bus

A systems-oriented 4½-digit multimeter, the model 7344A, includes an interface for the IEEE-488 bus as a

Patented Ballistic™ head.

standard feature. The 20,000-count autoranging DMM measures dc voltage, true-rms ac voltage, and resistance. It has five dc-voltage ranges, from 200-mv full scale to 1,000 v. Maximum dc error is 0.02% of reading + 0.01% of full scale for six months. This excellent long-term-accuracy specification is particularly important in a systems-oriented meter, since it means reduced downtime for the entire system due to calibration.

The instrument's true-rms converter is a dc-coupled device that can handle almost any kind of waveshape. Crest factor is four at full scale, and frequency response extends out to 20 kHz.

In its resistance-measuring mode, the 7344A offers six ranges with a maximum of 20 megohms full scale. All resistance ranges are protected against input voltages up to 350 v rms. The DMM sells for $945 and has a delivery time of 30 days.

Systron-Donner Corp., Instrument Division, 10 Systron Dr., Concord, Calif. 94518. Phone Dave Dunham at (415) 676-5000 [353]

Directional wattmeters work at ultrasonic frequencies

Capable of measuring up to 200 w, two insertion power meters are particularly useful for setting up and matching ultrasonic transducers. The instruments can measure forward and reverse power at the flick of a switch, and they need no tuning over their bandwidths of 35 kHz to 15 MHz (model PM1001) and 5 kHz to 5 MHz (PM1002). Maximum reading error is 5% of full scale for sine waves. Nominal input and output impedances are 50 ohms. The meters measure 7.5 by 5.0 by 3.5 inches and weigh 3 pounds. They sell

for $350. Delivery time is 30 days.

Amplifier Research, 160 School House Rd., Souderton, Pa. 18964. [354]

3-MHz function generator sells for only $245

The model 1000 function generator covers the frequency range from 0.2 Hz to 3 MHz and sells for only $245. The instrument produces sine, square, and triangular waveforms with amplitudes adjustable from 5 millivolts peak to peak to 20 V p-p. Distortion typically will not exceed 0.25%. The frequency setting of the model 1000 can be determined by front-panel controls or by an external voltage. In addition, the unit generates a dc output voltage proportional to its frequency setting. For application to transistor-transistor-logic circuits, the generator has a TTL-compatible output with rise and fall times of 15 nanoseconds.

Krohn-Hite Corp., Avon Industrial Park/Bodwell Street, Avon, Mass. 02322 [356]

Sweep function generator runs on ac or batteries

The model 117 sweep function generator is a 200-kHz instrument that can be powered by the ac line or by an internal rechargeable battery that allows it to operate for 8 hours. This truly portable generator pro-

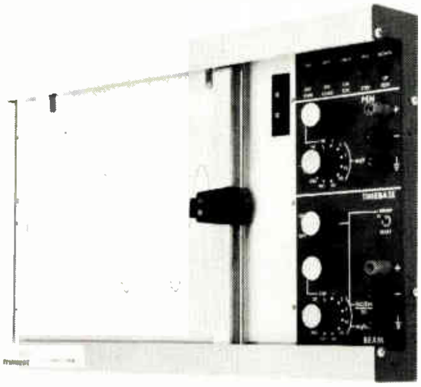
duces sine, square, triangle, ramp, and pulse outputs, with the main output variable up to 15 v peak to peak into an open circuit and 7.5 v p-p into 600 ohms. Both linear and logarithmic sweeps are provided. Supplied complete with battery and charger, the model 117 sells for only $250. Delivery time is two weeks.

Exact Electronics Inc., 455 S. E. 2nd Ave., Hillsboro, Ore. 97123. Phone (503) 648-6661 [355]

X-Y recorders use capacitance transducers

Instead of employing a slidewire or potentiomenter as a position-feedback element in their latest series of X-Y recorders, engineers at Houston Instrument used the company's patented capacitance transducer. As a result, units in the 100 series of Omnigraphic recorders are claimed to have lifetimes several orders of magnitude greater than those of other X-Y recorders. Prices for the modular units begin at $895 for a bare-bones instrument and go up to $1,275 for a full-blown machine.

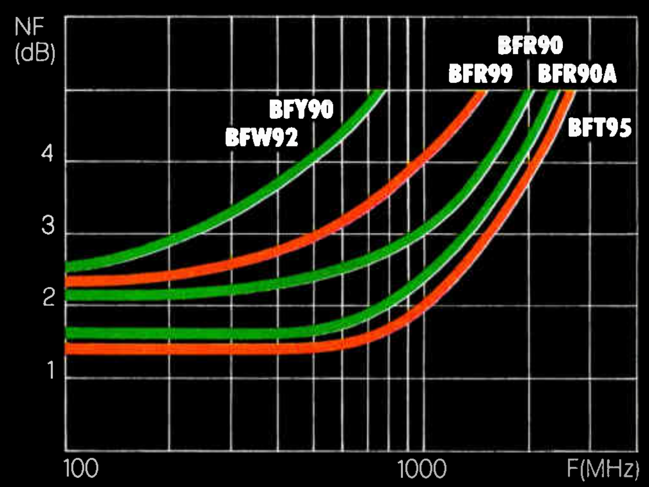
Houston Instrument Division of Bausch & Lomb, One Houston Square, Austin, Texas 78753. Phone (512) 837-2820 [357]



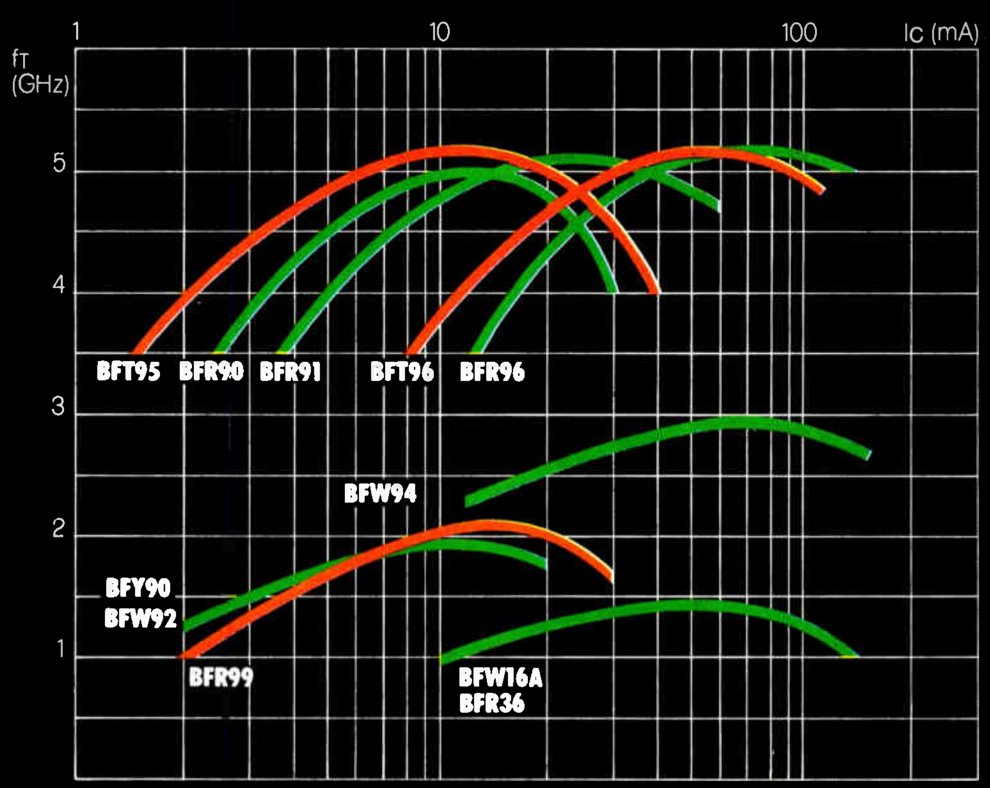
SGS-ATES RF COMPLEMENTARY PAIRS

SGS-ATES experience in RF silicon technology enables electronic circuit designers to employ optimally matched complementary NPN/PNP devices, reducing the number of inductors and transformers in the RF amplifier stage and allowing advanced solutions in UHF and microwave applications; crossmodulation and second order intermodulation products are minimized to meet the requirements of today's CATV/MATV systems.

PNP	NPN	Applications	Package
BFR99	BFY90	Low noise VHF-UHF wide band amplifier	TO 72
BFT95	BFR90 BFR90A BFR91	Low noise wide band amplifier up to 1.5 GHz	T plastic
BFT96	BFR96	Driver or output stage for wide band amp. up to 1.5 GHz	



The chart shows that the SGS-ATES range of complementary RF transistors can cover all MATV CATV and telecommunications applications.



PNP

NPN

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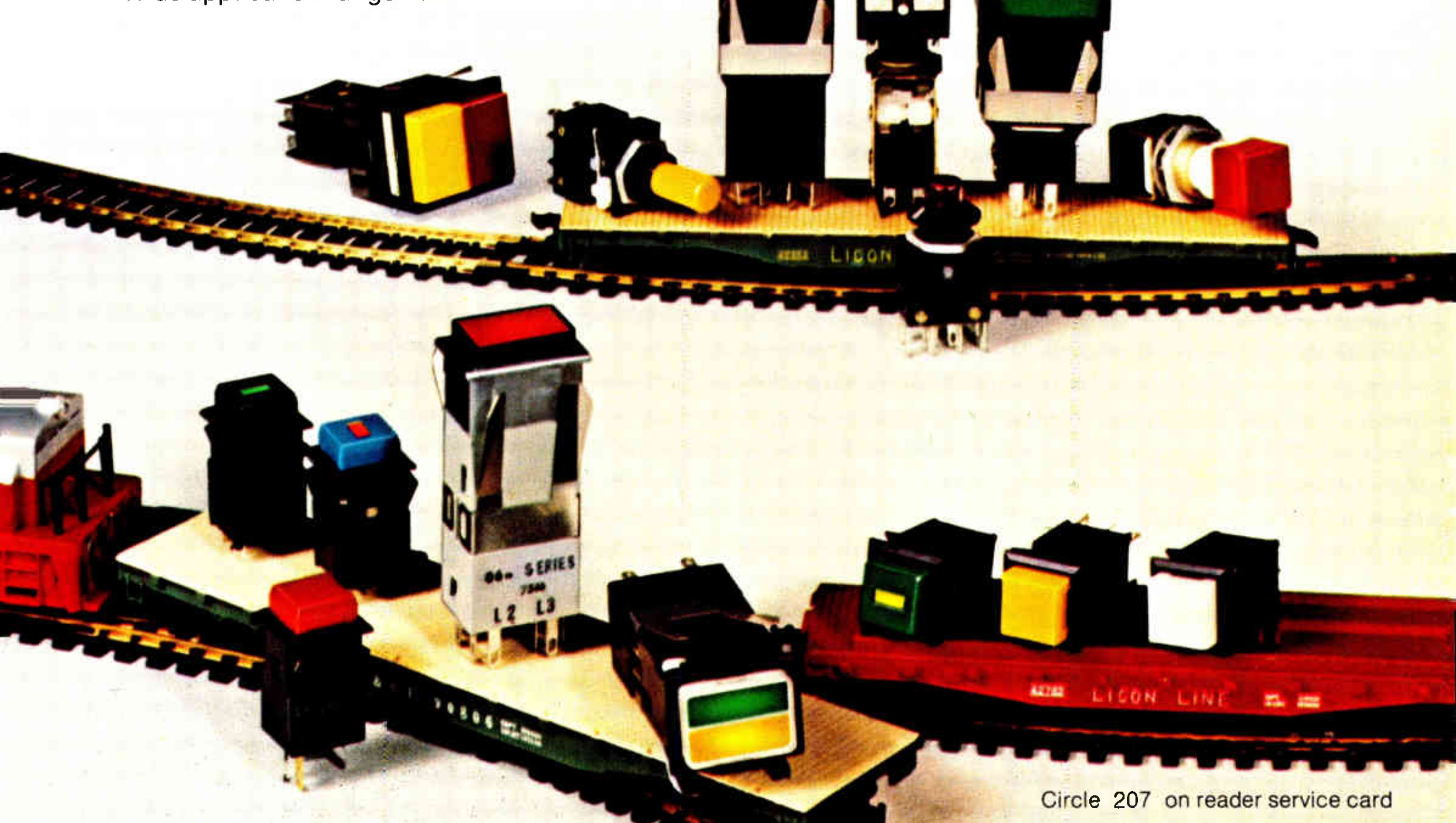

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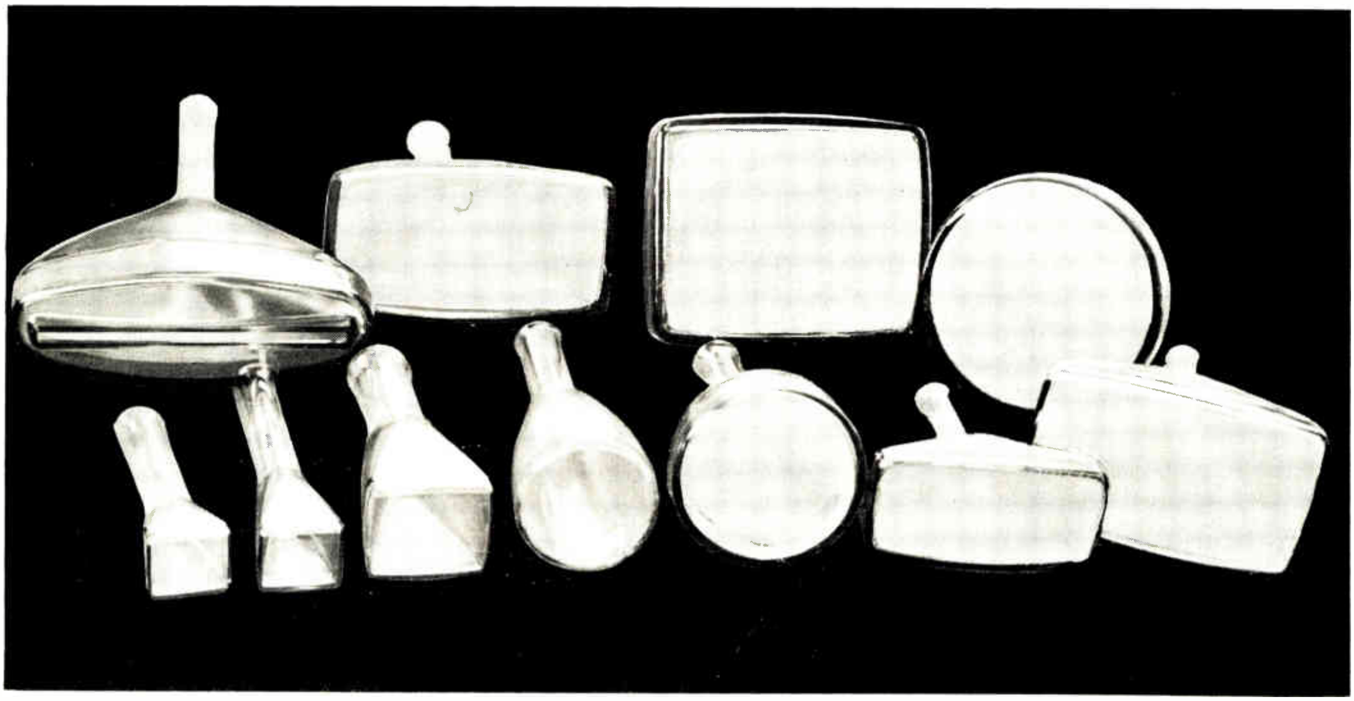

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Collector Cut-off Current	I_{CBO}	0.1	1.0	0.1	0.1	0.1	0.1	μA
Emitter Cut-off Current	I_{EBO}	0.1	1.0	0.1	0.1	0.1	0.1	μA
DC Forward Current Gain	h_{FE}	70	80	80	100	80	80	
Gain Bandwidth Product	f_T	4.5	8.5	8.0	6.0	3.0	4.0	GHz
Collector to Base Capacitance	C_{CB}	0.6	0.6	0.3	0.3	.55	0.9	pF
Insertion Power Gain	$\|S_{21e}\|^2$	6.5	9.0	4.0	9.0	16.0	10.2	dB
Noise Figure	NF	2.7	2.3	3.5	2.7	2.1	4.2	dB
Maximum Available Power Gain	MAG	12.0	13.0	8.0	12.0	18.0	12.0	dB
Frequency for NF, MAG and $\|S_{21e}\|^2$ Measurement	f	2.0	2.0	4.0	2.0	0.5	1.0	GHz
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Data handling

I/O boards ready for LSI-11/2

Data Translation develops seven subsystems for new microcomputer

It is less than two months since Digital Equipment Corp. unveiled the LSI-11/2 [*Electronics*, Nov. 24, 1977, p. 50], but Data Translation Inc. already has a family of analog input/output subsystems in the works for DEC's second-generation microcomputer. The fast-reacting company's DT2760 series of seven boards includes four analog boards (available off the shelf or within 60 days), and three digital boards (scheduled to start delivery in March).

Data Translation officials have been aware for some time that the half-size LSI-11 was coming from DEC, but president Fred Molinari says that, in addition, his company was able to react quickly because it has standardized on the data-acquisition module: the same one will fit any of the wide variety of microcomputer analog I/O subsystems that the firm offers. Paul Severino, vice president for engineering, says that the isolated digital I/O board in the series is the first such subsystem he is aware of for the LSI-11 family. He notes, too, that the DT2760 series will function with the original LSI-11, as well as with the new version.

One of the boards, the DT2762, is a high-level data-acquisition subsystem offering 16 channels single-ended or eight differential channels, accommodating signals from 0 to 10 volts and ±10 V. It has a differential amplifier, sample-and-hold amplifier, a 12-bit analog-to-digital converter, a dc-dc converter allowing all components to use the +5-V microcomputer bus power, and a standard interface that is compatible with DEC software and offers both programmed I/O and interrupt operation. The price is $695 for one, or $495 in quantities of 50 or more.

The low-level data-acquisition subsystem, the DT2764, handles signals from 10 millivolts to 10 V, and has the same features as the 2762. It also has a gain-selectable instrumentation amplifier. The unit price is $795 ($595 for 50 or more).

The two analog output subsystems are designated the DT2766 and DT2767. Both are four-channel d-a converter subsystems that also offer four digital outputs. The only functional difference between them is that the 2766 has 12-bit resolution and the 2767 offers 8-bit resolution. The prices are $695 ($495 for 50 or more) and $495 ($295 in quantity), respectively, and both can be delivered off the shelf.

Severino is especially enthusiastic about the DT2768—the isolated digital I/O subsystem. He has added an event counter to the board that should make it attractive for lab and industrial users who neither need nor want to pay several hundred dollars for a real-time clock board. The DT2768 provides 300-V optical isolation for 16 digital inputs and 16 digital outputs. "A lot of people in the digital world want isolation," Severino says, "because there are a lot of 110-V signals running around in factories that could cause them real problems." Data Translation will also offer an optional signal-conditioning strip with this subsystem that will allow the microcomputer to drive standard 110-V line voltage. The strip contains isolated solid-state relays. The DT2768 is priced at $695 singly ($495 for 50 or more).

The remaining boards are the DT2769 real-time clock subsystem and the DT2770 IEEE interface board. The clock/counter subsystem is fully programmable, provides a means for determining time intervals or counting events, and can be used to interrupt the central processing unit at predetermined time intervals. It will sell for $575 ($375 in quantity). The DT2770 offers a complete interface from the microcomputer bus to the IEEE standard 488 instru-

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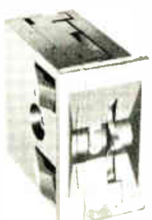

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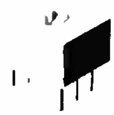

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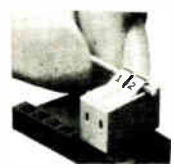

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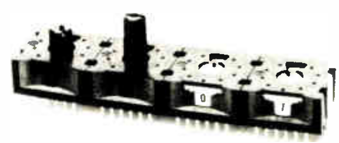

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Data Translation Inc., 4 Strathmore Rd., Natick, Mass. 01760. [361]

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The series CRI computer-recorder interface is essentially a high-speed analog-to-digital converter with memory. With its standard digitizing rate of 20 MHz and its memory capacity of 1.44 million words, the 7-bit unit accepts analog input data from any wide-band receiver or tape recorder and delivers a lower-rate digital data stream to any computer, minicomputer, or digital tape transport or disk. The CRI will interface with any 8-bit or 16-bit computer.

American Electronic Laboratories Inc., M/S 1122, P. O. Box 552, Lansdale, Pa. 19446 [366]

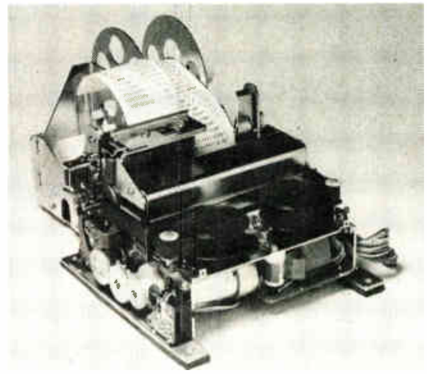
Dot-matrix impact unit prints 120 characters/second

Designed for use in both minicomputer and microcomputer systems, the Integral Impact is a dot-matrix impact printer that can bang out up to 120 characters per second. The unit, which can print up to 132 characters per line, can also operate in an enhanced mode in which it produces double-width characters. Other standard features include RS-232 and current-loop serial interfaces and selectable character and line sizes. In small quantities, the Integral Impact sells for $745.

Integral Data Systems Inc., 5 Bridge St., Watertown, Mass. 02172 [367]

Impact printer has head life of 100 million characters

Series 500 printers are 40-column, dot-matrix devices whose printing heads have a guaranteed continuous-duty life of 100 million characters



and whose entire mechanism has an MCBF (mean cycles before failure) rating of 5 million lines. The printers, which are manufactured in Japan by Shinshu-Seiki, are intended for use in point-of-sale terminals, recording instrumentation, and similar equipment. Printing speed is 2.5 lines per second, size is 175 by 146.5 by 112.5 mm, and weight is 2.5 kg. Samples sell for $210 each.

C. Itoh Electronics Inc., 280 Park Ave., New York, N. Y. 10017. Phone Floyd Makstein or Hans Weck at (212) 682-0420 [363]

Cassette tape drive stores 2.88 megabits

A modular, self-contained cassette tape drive that provides up to 2.88 megabits of storage uses industry-standard cassette tape with biphase level recording. The drive, which is intended for use with Epic Data's 1647 series of fixed data collection terminals, plugs into the terminals and allows them to store data without any auxiliary equipment.

Standard speeds include reading and writing at 10 inches per second, fast-forward movement and rewinding at 80 in./s, and search speeds

from 40 to 80 in./s. Bit density is 800 bits per inch, yielding a data transfer rate of 8,000 b/s. The drive has a mean time between failures of 15,000 hours, excluding the head. Large-quantity prices begin at $1,485. Delivery time is six to eight weeks.

Epic Data Corp., 6350 LBJ Freeway, Dallas, Texas 75240. Phone (214) 387-3121 [364]

5.25-inch floppy disk stores a megabyte

An inexpensive 5.25-inch floppy-disk system combines high reliability with a storage capacity in excess of 1 megabyte.

The MetaFloppy 1054 Mod II comprises four drives in a dual/dual configuration, a controller, a power supply, a chassis, an enclosure, cabling, and a Basic software package. The 1054 will plug into any 8080-based or Z80-based microcomputer using an S-100 bus, according to the company that designed the system. The floppy disk will store up to 1,260,000 bytes.

Among the standard features that enhance the reliability of the 1054 are its all-steel head-positioning system, a disk-insertion interlock, and file-protect circuitry.

Key operating specifications include a track-to-track access time of approximately 30 milliseconds and a maximum data-transfer rate of 250 kilobytes per second.

In singles, the system sells for $3,220. Delivery time is presently running 45 days.

Micropolis Corp., 7959 Deering Ave., Canoga Park, Calif. 91304. Phone (213) 703-1121 [365]

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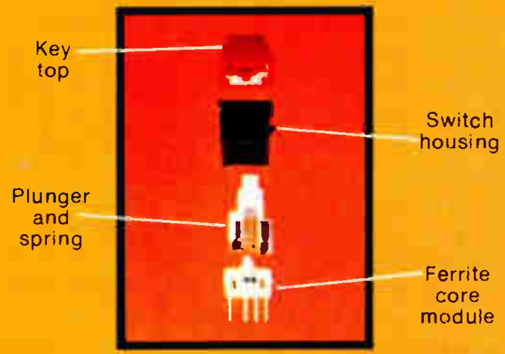

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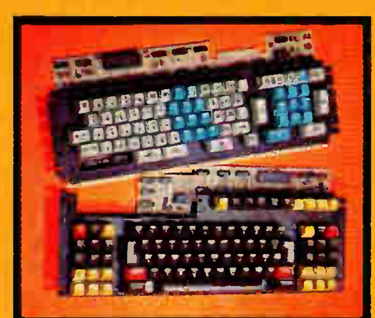

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C-1000 the first TV camera designed for computer interface.

NOTES TO THE SYSTEMS ENGINEER

Ordinary TV cameras are designed to produce a picture on a monitor, not interface with a computer. Proper timing pulses are not available and their shape is inappropriate for computer use. The clock is usually a tuned circuit or a low frequency crystal. While fully adequate for viewing, the precision of these circuits becomes a limiting factor in a computer camera system. The pulses occur infrequently and at periods during the scan format that is wasteful of computer time.

The C1000 system was designed to have a basic clock of 25.39 MH_Z with its half frequency accessible to the computer using TTL logic. All sweeps, blanking and unblanking information are controlled by this computer accessible signal. The basic signal and a number of other timing signals are available and can be brought out by use of the M998 I/O buffer, M999 I/O interface, or a user designed buffer. The customer can build his own interface, or buffer, thus saving considerable money.

All of the digital lines are clock controlled to avoid jitter and to insure maximum precision and reproducibility. The video output from the C1000 is fully usable with standard TV monitors thus no function is lost by making the system computer compatible as is the case with some computerized video systems manufactured by others.

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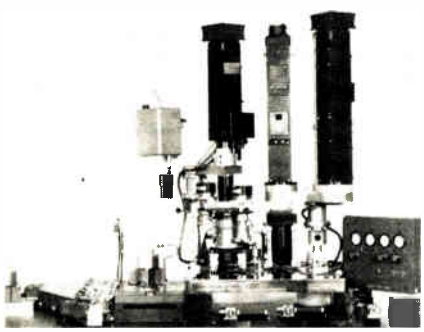
Circle 221 on reader service card

Packaging & production

Masking system speeds repeated patternmaking

A photomasking system called Mask-Maker Criss-Cross has two work stations, enabling the operator to optimize his use of a pattern generator and a step-and-repeat camera by automatically transferring work back and forth between the two stations while the system is operating under laser control. For image repetition, the system uses a single camera with automatic focus control and three interchangeable Zeiss lenses. For pattern generation, it uses a single computer-controlled aperture camera with automatic focus and two Zeiss lenses.

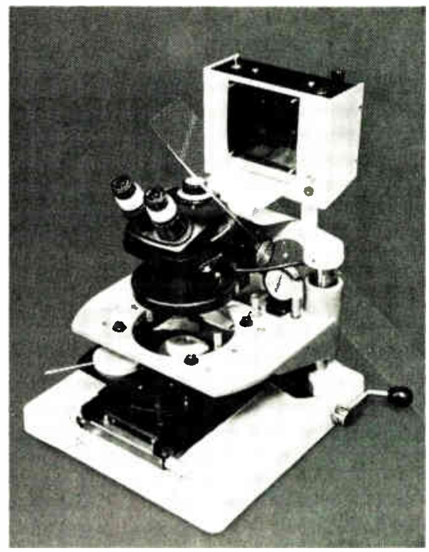


The flexible Criss-Cross costs less than either two conventional single-capability systems or an electron-beam mask-making system. Adding the Criss-Cross capability to the electromask combination pattern generator and image repeater increases throughput when reticles must be generated that contain a high percentage of repetitive patterns. Reticles for devices such as random-access memories and read-only memories, bubble memories, and the like, can be produced in ¹⁄₁₀ to ¹⁄₂₀ of the time required by the standard, variable-aperture pattern generator.

Electromask Inc., 6109 DeSoto Ave., Woodland Hills, Calif. 91364. Phone (213) 884-5050 [393]

Probing station will reduce card alignment time

A new probing station reduces the time it takes to adjust the plane of probe cards and align them. It also minimizes alignment errors. The model 430 has two separate chucks that pivot and lock under the probe card for plane adjustment or alignment. It is possible to integrally mount on top of the station a new model 432 light box, on which is a



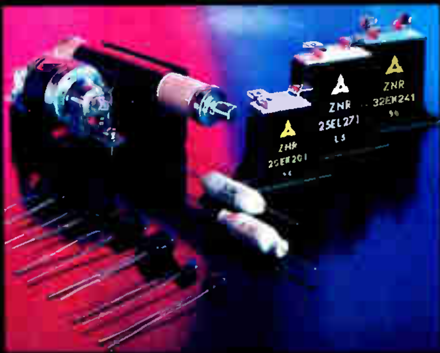
circular pattern of LEDs covered by a Mylar overlay. Any probe-card pattern may be coded on this card-compatible overlay to speed identification of probe points. Time-and-motion studies show that the model 430 reduces card-handling time as much as 30% per card.

Rucker & Kolls, 1305 Terra Bella Ave., Mountain View, Calif. 94042. Phone Gary Spray at (415) 969-2369 [394]

Lightweight heat sinks are efficient and easy to mount

The slanted vane fins on a series of heat sinks dissipate more heat by making air flow in many different directions. The lightweight aluminum heat sinks have at least as high a thermal efficiency as more costly

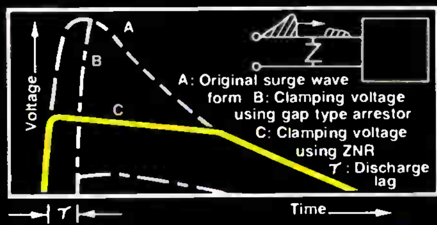
Panasonic ZNR transient/surge absorbers go where others fear to tread.



Panasonic ZNRs provide a reliable, economical approach to the problem of protecting AC and DC circuits against repeated high voltage transients (positive or negative) and surges such as those produced by lightning, switching and noise spikes.

Just one of our ZNRs can replace the pair of back-to-back Zeners you may now be using in your circuit. And they're an excellent alternative to Varistors, RC circuits and spark gaps, too.

ZNRs are ideal for ground fault interrupter circuits, input line transient protection, microwave ovens, TVs, video displays, and just about any AC or DC circuit that is vulnerable to current surges and spikes.



Fast response time.

Panasonic ZNRs are zinc-oxide non-linear resistors whose ohmic value changes in less than 50 nsec when subjected to impulse surges. This eliminates the discharge lag inherent in gap-type arrestors.

Available from stock.

AC circuits ranging from 14V to 1000V, and DC circuits from 18V through 1465V, can be protected with Panasonic ZNRs. All line transient ZNRs are U.L. listed. For complete details, samples and prices, write or call Panasonic Electronic Components, One Panasonic Way, Secaucus, N.J. 07094. (201) 348-7282.

Circle 223 on reader service card

Berg Minisert Sockets display "high reliability" on Tektronix Oscilloscopes

The Berg Minisert™ is a miniature, low-profile P.C. socket which allows .400"-tight board-to-board spacing. The Minisert provides positive, functional reliability over repeated insertion/withdrawal cycling; its elastomeric seal keeps out contaminants.

Tektronix likes the repeated pluggability the Minisert socket affords in using transistors, LED's, lamps, IC's and other components. Tektronix has found it can rely on Berg Electronics . . . to supply the product and the application machines that precisely meet its interconnection needs.

Berg is experienced. We read interconnection needs like Tektronix reads waveforms. We have the products, the background and the back-up to do the job. Your job. Let's work on it, together. Berg Electronics, Division, E. I. du Pont de Nemours & Co., New Cumberland, Pa. 17070—Phone (717) 938-6711.

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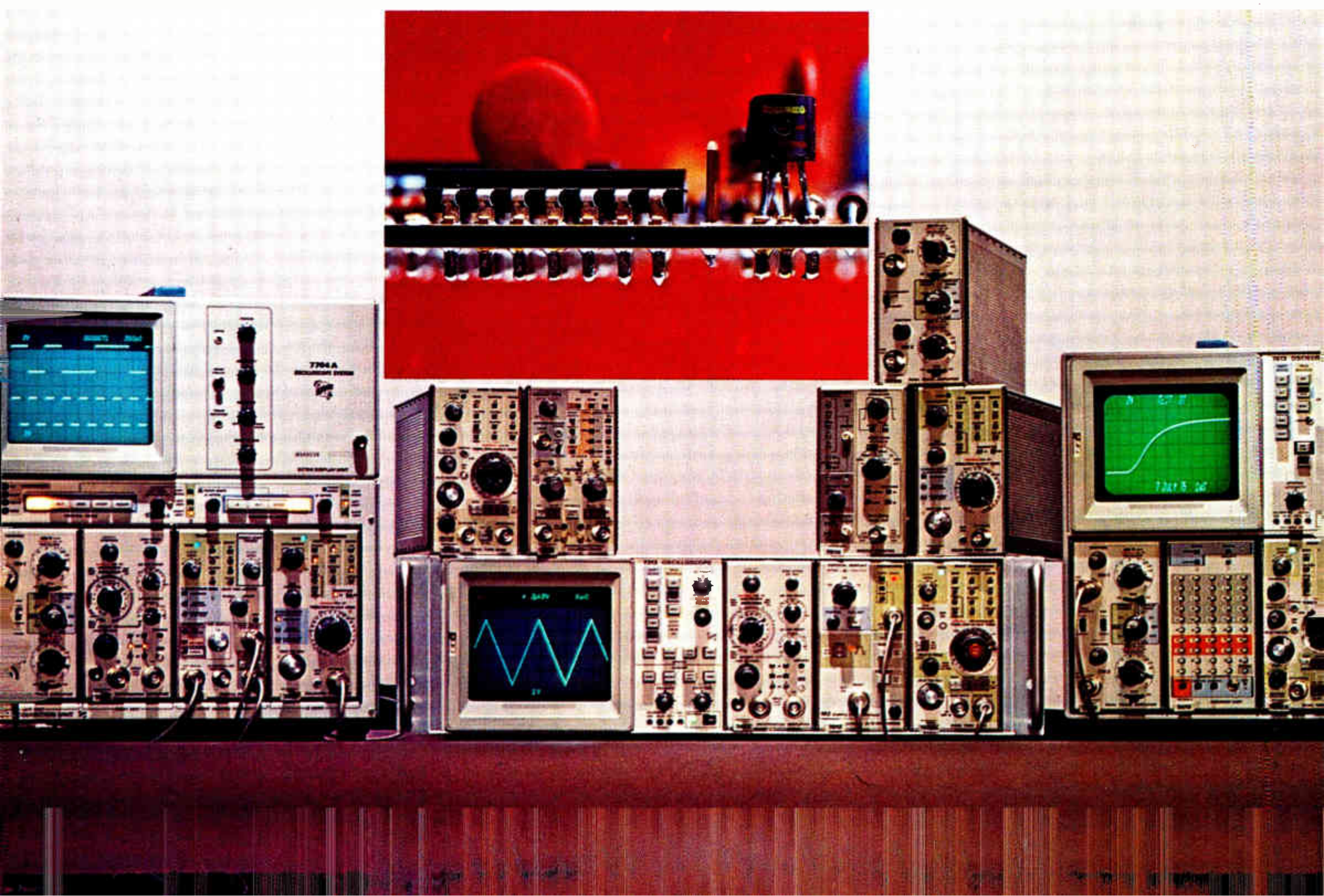


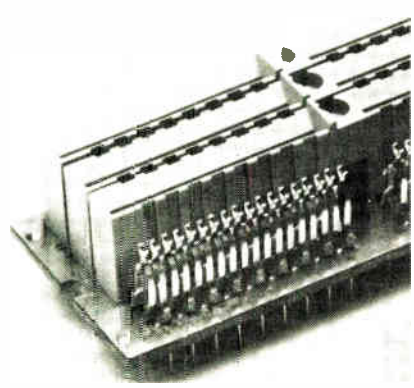
impact-extruded and cast heat sinks. They accommodate plastic power packs and can be easily mounted on printed-circuit boards.

The new heat sinks are available in four models, four different finishes, and two mounting patterns.

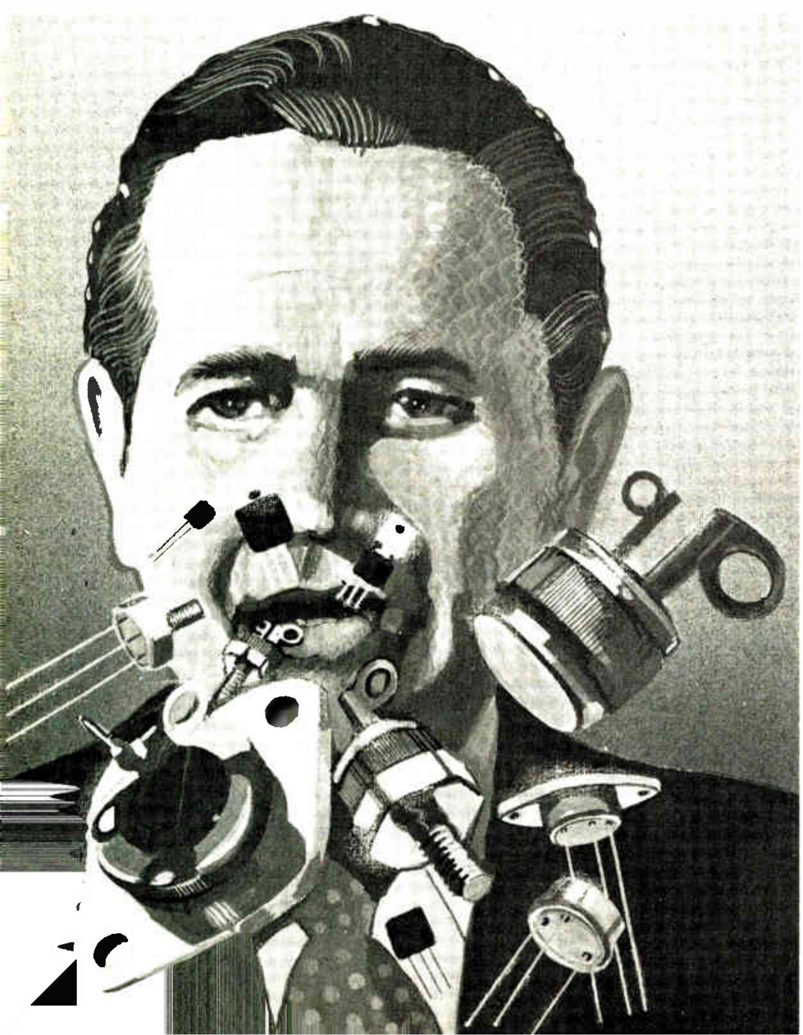
Vemaline Products Co., 487 Jefferson Blvd., Warwick, R. I. 02886. Phone (401) 739-7310 [395]

Press-fit back panels form gas-tight interface

Press-fit PDP back-panel systems utilize the patented EDGE-PAC back-panel concept in which solid pin contacts are press-fitted into printed-circuit boards to form a gas-tight interface. The contacts are on a 0.125-by-0.125-inch staggered grid and are housed in a molded insulator of thermoplastic polyester. The pc board is made from FR-4 per MIL-P-13949 specifications, and the phosphor-bronze contacts have 50 microinches of gold over nickel in the engagement area. The system



Circle 85 on reader service card



eliminates the need for wire terminations, soldering, and bussing. Insulators have a high-impact strength.
Elfab Corp., P. O. Box 34555, Dallas, Texas 75234. Phone (214) 350-6734 [398].

IC tester measures thermal resistance in 7 seconds

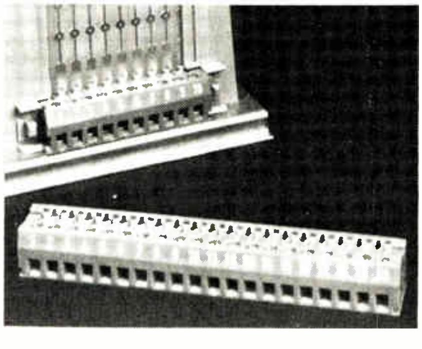
The Theta 400 thermal resistance tester measures the thermal resistance of integrated circuits in just 7 seconds. Using the junction voltage of the forward-biased-substrate isolation diode as the temperature-sensitive-parameter, the instrument applies a repetitive pulse of up to 15 V and 0.5 A that heats the device under test. When a change in isolation-junction voltage occurs, the tester automatically divides this delta by the applied heating power of a direct, full-scale reading of 199.9°C per watt. Unit price of the Theta 400 is $5,600.
Sage Enterprises Inc., 1080 Linda Vista Ave., Mountain View, Calif. 94043. Phone B. Siegal at (415) 969-5111 [399]

High retention bus strips fit 0.080-inch-thick back panels

A high-retention bus strip can be inserted by hand or press into any standard 0.080-inch-thick back panel. Once in place in the panel, the strip exhibits retention characteristics in excess of 2.5 lb per pin. Each pin has a specially formed section designed to lock into a standard insulation sleeve by interference fit and by cold flow of insulation material into a recessed area on two sides of the pin. The strips are available in pin spacing patterns of 0.100 in. and 0.125 in. or multiples thereof.
Bussco Engineering Inc., 119 Standard St., El Segundo, Calif. 90245. Phone (213) 322-6580 [400]

Compact edge connectors for pc boards have 2 to 20 poles

A line of compact edge connectors for 1.4-to-1.8-mm-thick printed-circuit boards have 2 to 20 poles each and come with or without solder lugs. Pressure versions will accommodate up to 16-gage wire.



The connectors are molded of fiberglass, and the bottom cover is ultrasonically sealed.

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EXACT'S MODEL 508 5 MHz FUNCTION GENERATOR GIVES YOU BOTH.

1. Revolutionary start/stop frequency dials provide a dual dial mode for ten-turn type resolution of linear frequencies. DIAL and LOG, modes-illuminated by LED's when selected, allow continuous outer dial control of frequency, 3 decades (1000:1) in LIN and 5 decades (100,000:1) in LOG. For example: 1 Hz to 100 KHz.

2. The 508 uses a high performance 30 V P-P output amplifier and delivers up to 15 Volts P-P into a 50 Ohm load with pulse and square wave rise and fall times of less than 25 nanoseconds. Positive and negative pulse, sine, square, and triangle, as well as the ramp generator signal are all available at the main output.

3. Main generator modes include Run, Gate, Trigger, Internal Pulse and Burst, Linear and Logarithmic Sweep. Eleven frequency ranges provide an overall dynamic frequency range of 0.0001 Hz to 5 MHz. Frequencies within a selected range can be controlled with the Start Frequency Dials, with an external voltage applied to the VCF input, or with the ramp generator in the sweep mode. Frequency sweep limits are set by the start/stop frequency dials.

4. The Ramp generator operates over a range of 10 microseconds to 100 seconds. Operating modes include Start Freq./Stop Freq. selection, Run, Gate and Trigger. In addition to sweeping the main generator frequency, the ramp internally triggers and gates the main generator for pulse and burst modes.

Add such features as: variable start/stop phase, variable symmetry, variable DC offset, fixed attenuation to 60 dB in 10 dB additive steps – plus 20 dB variable. If you want all this performance in one instrument, then specify Exact's Model 508.

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TWX 910-460-8811

Silver-plated, phosphor-bronze contact springs are spaced 5 mm apart. The units can be secured with end clamps or, if the pc board is large, with guide brackets.

Electrovert Inc., 86 Hartford Ave., Mt. Vernon, N. Y. 10553. Phone (914) 664-6090 [397]

Socket with built-in resistors works with any LED voltage

A universal LED panel light socket with a built-in resistor and plug allows a light-emitting diode to operate off a wide range of voltages. The model PS200 series of LED sockets also provide a low-cost method for replacing LEDs. The sockets accept all T1-3/4 discrete LEDs. Voltages can be selected from 3.6 to 28 v dc. The price, for quantities of 100 to 999, is $1.15 each. Delivery is from stock to about four weeks.

Data Display Products, 303 N. Oak St., Inglewood, Calif. 90301. Phone (213) 677-6166 [396]

Wire-wrapping panel is compatible with SBC-80/10

The model 2-8010 wire-wrapping panel, which has been designed for compatibility with Intel's SBC-80/10 microcomputer, features 62 rows of 52 contacts. Plated-through holes on a 0.1-by-0.1-inch pattern allow the mounting of any standard with from 8 to 40 pins. Three 50-pin connector holes are available for input/output connections at the top of the board, and the standard 80/10 edge connector interface is located at the bottom. The panel contains two ground planes and 10 independent power buses to ease the intermixing of analog and digital components with differing power requirements. It measures 6.75 by 12 inches. The model 2-8010 sells for $92.50 in small quantities. Delivery time is two weeks.

Hybricon Corp., 410 Great Rd. (Rt. 119), Littleton, Mass. 01460. Phone (617) 486-3174 [410]

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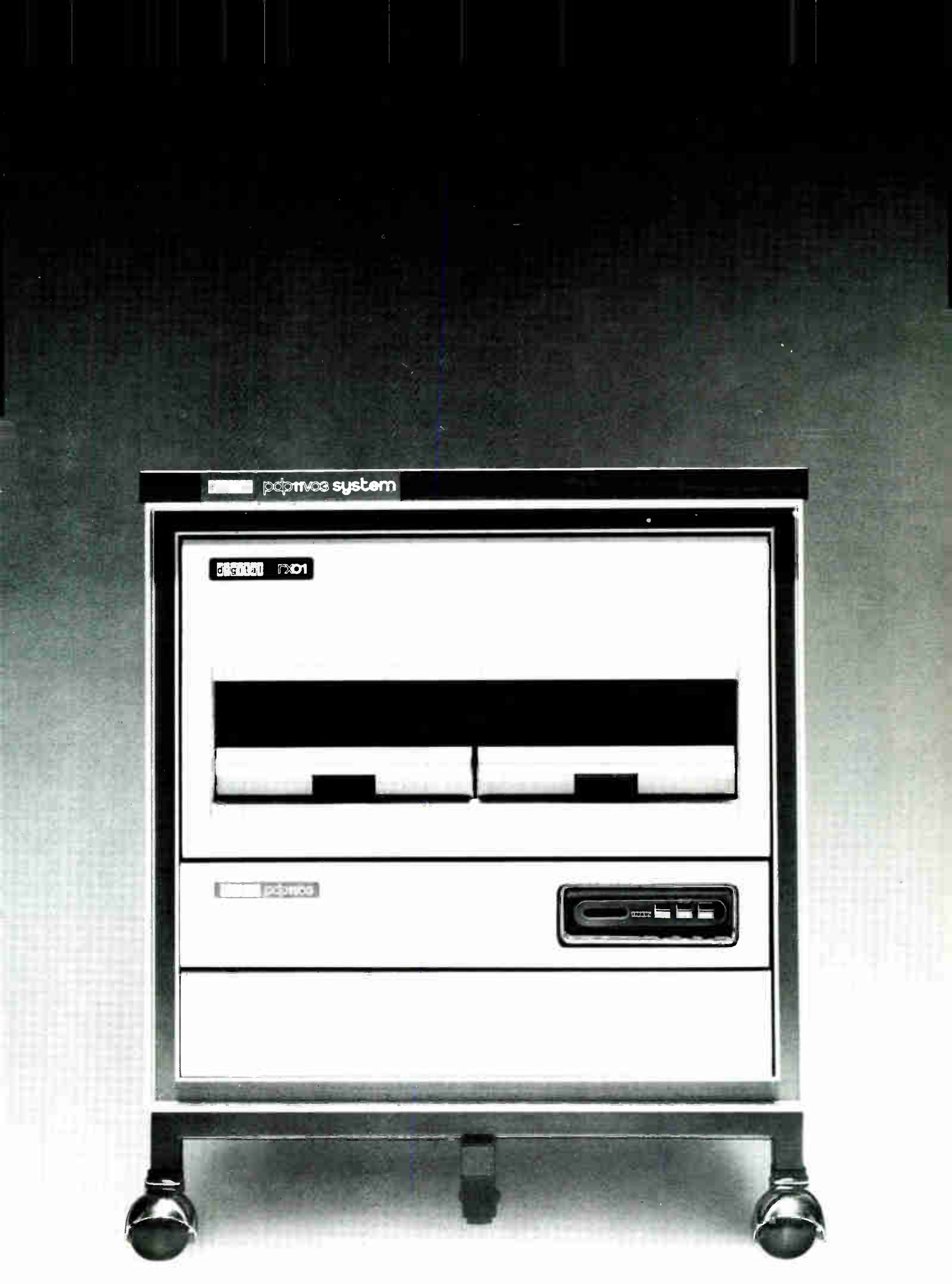
PDP 11/03-L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There are more cards coming. In fact, we would like to build something especially for you. We'll tell you all about it when you write for details on our present line. Write now. Able Computer Technology, Inc., 1616 South Lyon Street, Santa Ana, California. (714) 547-6236. TWX 910-595-1729.

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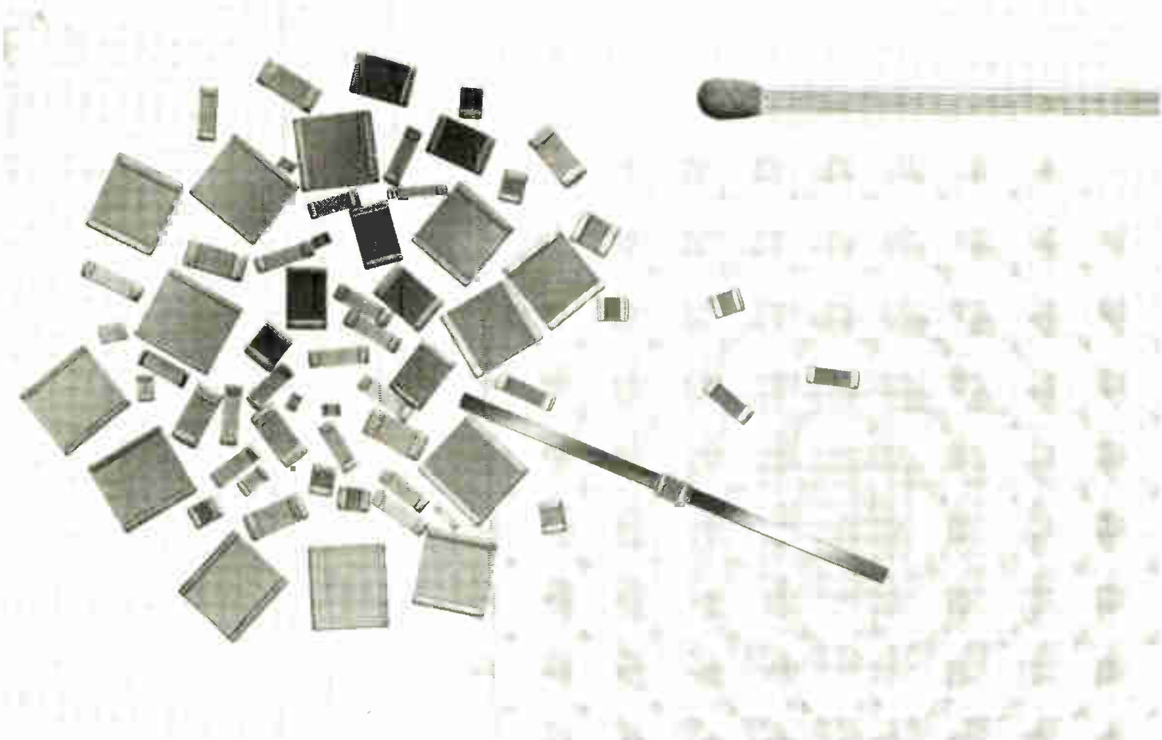
Circle 235 on reader service card

Ceramic Chip Capacitors



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Our ceramic chip capacitors are known as "The Best" the world over.

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But mostly because our entire business is based on providing "The Best" capacitors available.

Our customers are exacting — that's why they put our chips in heart pacemakers, medical monitoring equipment, safety devices and telecommunications products.

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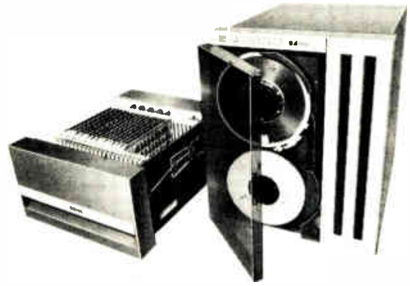

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This means that for the first time, mini-computers can offer the high performance features of much larger computers.

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Components

SIP rivals DIP in less space

Single in-line multiturn cermet trimmer from Bourns can be inserted by machine

Now that trimming potentiometers in dual in-line packages are gaining a solid foothold in new circuits against conventional rectangular units, Bourns Inc. is already looking ahead to the next improvement in automatically insertable packages. The company has come up with a multiturn cermet trimmer in a single in-line package with performance and machine-insertable characteristics comparable to those in DIPs, though it occupies only about a quarter of the board space.

"Decision innovations are mostly in miniaturization, or scaling down the cermet resistive elements into one half the area without sacrificing any critical performance," says Robert M. Todd, trimmer product manager of the Riverside, Calif. firm. The biggest challenges were a drive mechanism that ensures stability under all operating conditions, and fabricating resistive terminations, he says.

Although designers themselves were quick to replace rectangular trimmers with DIP units, Bourns believes the lag into production, resulted from manufacturers being slow to purchase automatic-insertion production machines—now costing $55,000 to $60,000 each. However, the firm expects its SIP unit to be accepted for new designs faster than DIPs were, especially since machine-insertion rates now average 1,800 components per hour.

Particularly designed for high-density printed-circuit boards, the Model 20 trimmer features 0.100-inch pin spacing and a profile only 0.190 in. off the board. Not only does the unit save as much as 75% of board space over a DIP, but it uses 50% of that required by a comparable ¾-in. rectangular unit, says Todd. Physical dimensions of the model 20 are 0.785 in. long by 0.079 in. wide by 0.190 in. high. A 20-millimeter length is planned to agree with metric conversion, he says.

In performance, the Model 20 has a power rating of 0.75 watt at 25°C; 0.50 w at 70°C. It is offered in 18 standard resistance values ranging from 10 ohms to 5 megohms. Resistance tolerance is ±10% standard, with closer tolerances available.

Other key specifications include effective mechanical adjustment of 15 turns, ±3; ±0.05% adjustability for voltage-divider operation and ±1% in the rheostat mode. The temperature coefficient is ±100 ppm/°C, and load life is rated at 1,000 hours. The cermet resistive element assures continuous resolution with continuity maintained for full mechanical range, Todd says.

Pricing philosophy on the new SIP trimmer "is to charge a slight premium for space savings," points out Gordon Bourns, applications engineer for the component. Accordingly, it sells for 75 cents in 1,000–4,999 quantities, against a comparable 60 cents for the standard Bourns 3–4-in. rectangular trimmer and $2.25 for the company's model 3099 DIP trimmer. For a 100-minimum sampling quantity, the firm is charging 91 cents.

Bourns Inc., Trimpot Products division, 1200 Columbia Ave., Riverside, Calif. 92507. (714) 781-5363.

LCD has 5-by-7 dot matrix plus four annunciators

The PI 5135 liquid-crystal display includes a 5-by-7 dot matrix, plus four annunciators that can be turned on or off independently. The viewing area of the matrix is 0.9 by 0.6 in., and the four annunciators are each 0.2 by 0.2 in. This versatile device can be used as part of point-of-sale, or on-line terminals, or wherever a message display is required. It has a reflective background and an oper-

TI MOS 4K DYNAMIC RAM LINE SUMMARY

Device Type	No. of Pins	Maximum Access Time	Minimum Cycle Time	Clock Input	Power Supplies
4027-15	16	150ns	320ns	TTL	±5, +12V
4027-20	16	200ns	375ns	TTL	±5, +12V
4027-25	16	250ns	375ns	TTL	±5, +12V
4050	18	300ns	470ns	12V	−5, +12V
4050-1	18	250ns	430ns	12V	−5, +12V
4050-2	18	200ns	400ns	12V	−5, +12V
4051	18	300ns	470ns	TTL	−5, +12V
4051-1	18	250ns	430ns	TTL	−5, +12V
4060	22	300ns	470ns	12V	±5, +12V
4060-1	22	250ns	430ns	12V	±5, +12V
4060-2	22	200ns	400ns	12V	±5, +12V

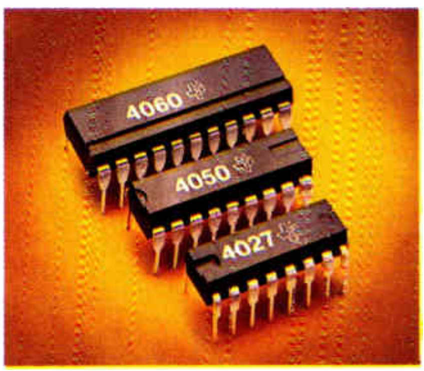
Biggest choice in 4K dynamic RAMs: Eleven from Texas Instruments. Off-the-shelf in all popular pin-outs.

Make it easy on yourself. Tap the broadest choice of immediately available 4K dynamic RAMs. At the major source. Texas Instruments.

Choose from 11 different device types. Including new, high-performance TMS 4027s in space-saving 16-pin packages. Other choices come in the efficient, easy-to-use 18-pin configuration. Or the 22-pin standard. All in either plastic or ceramic.

Ready-to-go stocks

Nobody matches the availability from TI distributors on all 11 types. Because TI is the largest shipper of 4K RAMs. Ever since TI got things going by combining a single transistor cell with the N-channel silicon gate fabrication process four years ago.



Proven performance

This production expertise combines with design advances and process refinements to produce 4K dynamic RAMs of leadership reliability and performance. The new 4027s, for instance, offer access times down to 150 ns.

Low prices

Volume production also helps TI hold costs down to give you the best price/performance ratio. Example: the 100-piece price on the TMS 4027-15 is $6.66 in plastic DIP.

All TI 4K dynamic RAMs come in the 0°C to 70°C industrial temperature range. Most in the −55°C to +85°C range. JAN versions, too.

For speedy delivery of high performance, low cost 4K dynamic RAMs, call your TI distributor listed at left.

TEXAS INSTRUMENTS
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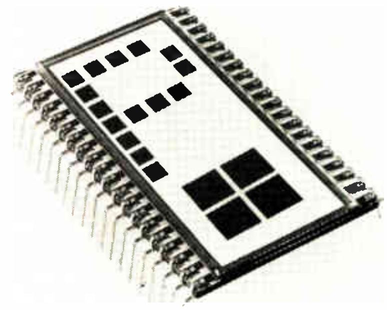


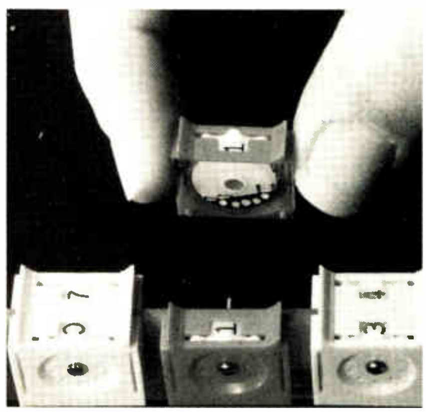
ating voltage of 3.0 v. In lots of 1,000, it sells for $6.25 each.

Perkins Inc., 127 E. Alton Ave., Santa Ana, Calif. 92707. Phone (714) 556-2912 [343]

Thumbwheel switch simplifies installation

A new concept in thumbwheel switches has been applied to a complete line of miniature switches to simplify installation while also reducing weight and size. The idea is that the switch manufacturer supplies hardware for only the switch rotor and housing. The stator is supplied in the form of artwork that the customer uses to define the actual stator on a printed-circuit-board master.

After etching, the boards are drilled at points indicated by etched



locator marks. The drilled holes are then used for mounting the switches to the boards. The technique not only reduces materials and manufacturing costs, it also eliminates the need for electrical connections to the

stator portion off the switch.

The factory-assembled housing is molded from a thermoplastic acetal resin with a concealment flange and stabilizers for secure panel and pc-board mounting. Current ratings are 1.5 A (nonswitching) and 0.125 A (switching). Minimum dielectric withstand voltage is 500 V dc.

AMP Inc., Harrisburg, Pa. 17105. Phone (717) 564-0100 [344]

Shaft encoder can sense 72 shaft angles

A programmable rotary logic switch can be used as a shaft-angle encoder. It senses 60 shaft angles if a detent is used and 72 shaft angles if no detent is used. The contacts of the units can switch a resistive load of 0.125 A at 115 V ac with an operating torque of 14 to 24 inch-ounces. It has a minimum dielectric strength of 500 V ac with a minimum standard

contact life of 500,000 cyles of 360°. The pc terminals are on 0.1-in. centers with spacing of 0.2 in. between the rows.

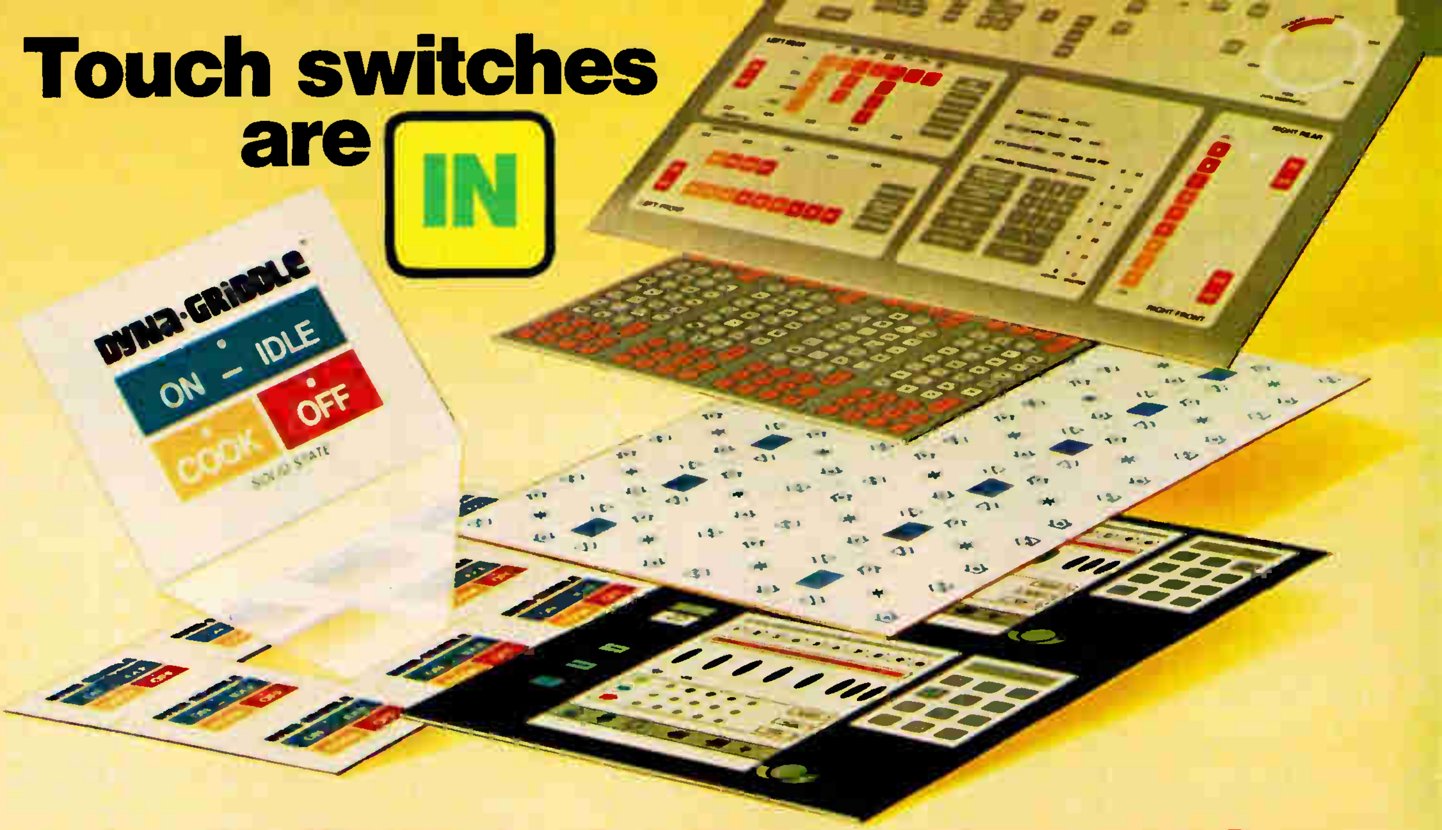
The switch can be used in applications for television games, test instrumentation, TV shaft encoders, telecommunications, and other electronic assemblies.

Standard Grigsby Inc., 920 Rathbone Ave., Aurora, Ill. 60507 [345]

Fireproof resistors can handle 50 watts

Designed for general-purpose use, three additions to the PW series of wirewound fixed resistors have ratings of 30, 40, and 50 W. The resistors are wound on fiberglass cores, filled with fireproof inorganic mate-

Touch switches are IN



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MONOPANELS are batch-processed as 11" X 17" master panels only .075" thick, each containing up to 700 switches. Every Monopanel is a complete, 100% pre-tested subassembly containing switches, front panel and graphics.

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The basic MONOPANEL switch has been operated for sixty million switching cycles without mechanical or electrical failure. And MONOPANEL has been tested and proven against 22 separate mechanical, electrical and environmental standards.

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- Operating current: 100 mA max.
- Contact resistance: 0.2 ohms typical.

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Circle 245 on reader service card

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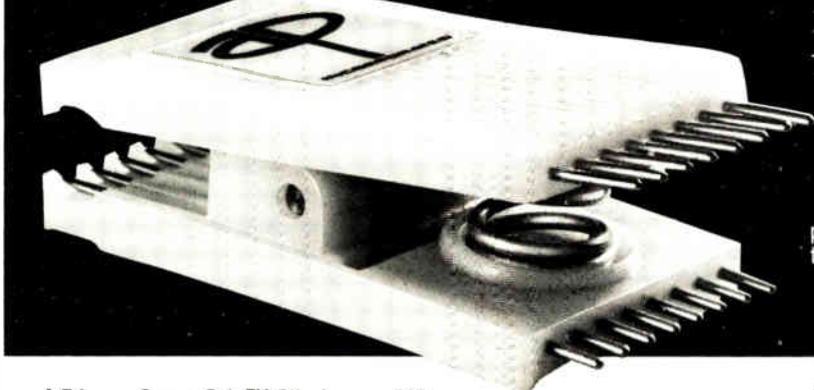

Troubleshooting DIP ICs can be a pain in the probe if you can't get at their pins. But you can make the job faster and easier with Super-Grip™ IC Test Clips from AP. AP Test Clips are precision engineered to assure reliability. Our "contact comb" design prevents shorting while our superior gold-plated phosphor bronze terminals make contact. And this gutsy little spring clip is perfect as an IC puller, too. So use it for its connections or use it for its pull.

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MODEL	ROW-TO-ROW DIMENSION	PART NUMBER	PRICE
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TC-16	.3 in.	923700	$ 4.75
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TC-18	.3 in.	923703	$10.00
TC-20	.3 in.	923704	$11.55
TC-22	.4 in.	923705	$11.55
TC-24	.5/.6 in.	923714	$13.85
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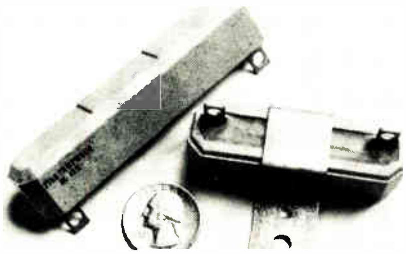


rial, and sealed in steatite ceramic cases. All three resistors are equipped with standard 0.25-in. spade-lug terminals. The standard resistance ranges are from 0.5 to 1,200 Ω for the PW-30, 0.65 to 1,500 Ω for the PW-40, and 0.8 to 1,800 Ω for the PW-50E. Tolerances ±5% and ±10% are available. Dimensions are 2.55 in. long by 0.75 in. square for the PW-30, 3.00 by 0.75 in. for the PW-40, and 3.625 in. by 0.75 in. for the PW-50E.

In large quantities, the PW-30 for 33¢ to 40¢ each, the PW-40 for 36¢ to 43¢ each, and the PW-50E sells for 43¢ to 51¢ each.

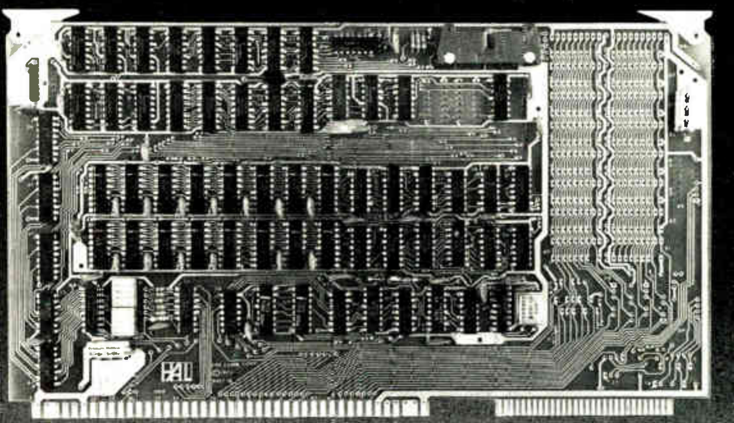
TRW/IRC Resistors, P. O. Box 393, Boone, N. C. 28607. Phone Wink Winkleman at (704) 264-8861 [346]

TOPICS

Components

The Amphenol North America Division of Bunker Ramo Corp., Oak Brook, Ill., has announced that its Blue Ribbon 26 Series rack-and-panel connectors are now available with Underwriters Laboratories yellow-card recognition. . . . **Allen-Bradley Co., Milwaukee, Wis.,** is offering a low-level switch for its Mod Pot line of panel potentiometers. The switch is tested at current levels as low as 15 mA and open-circuit voltages as low as 5 V. . . . **Opcoa Division, IDS Inc.,** is second-sourcing a broad line of light-emitting diodes made by Monsanto, Litronix, Hewlett-Packard, and Texas Instruments. Among the units are red, green, yellow, and deep orange lamps of the OPL series; these are T-1 size units. Other lamps, in the LST series, are available with three different viewing angles.

Add VIDEO to your SBC/BLC System...



The HAL VDB-8024 Video Display Board provides video output in 24 lines of 80 characters each for users of SBC or BLC microcomputer systems. 2K bytes of RAM relocatable by DIP switches, support the display. Special functions include Flash, Bright, Reverse, or Hidden fields of characters, as well as margin bar indicators. Suggested support software is provided in the documentation.

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- ☐ Communications/Terminal Modules
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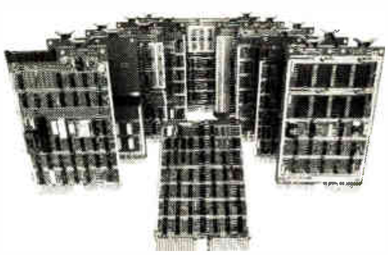

- ☐ MDB Backplane/Card Guide Assembly (8 Quad slots)
  Rack mount chassis 5¼" front panel.
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  System monitoring unit provides front panel switch addressing, power on/off sequencing; line frequency clock.
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MDB also supplies interface modules for DEC PDP*-11 Data General NOVA* and Interdata minicomputers.

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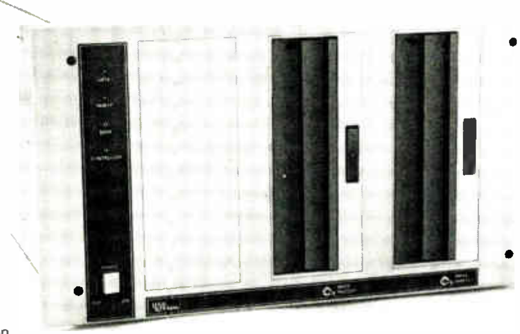

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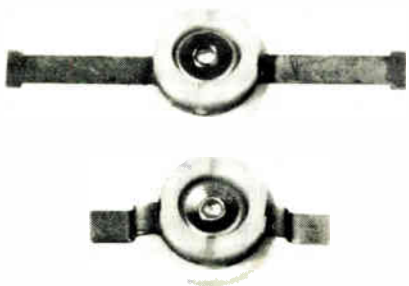
Microwaves

Disk capacitors can replace tubular trimmers

A series of disk-type variable ceramic capacitors for use in microwave applications employs a split-stator design to achieve self-resonant frequencies of about 2 GHz at maximum capacitance. The units are claimed to be equivalent to conventional tubular trimming capacitors, but to sell for much less.

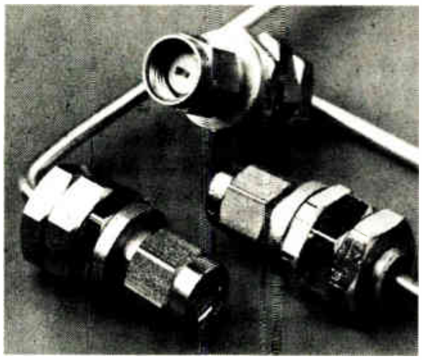


Because of their low cost they are expected to be attractive to manufacturers of land-mobile radios, hand-held communications equipment, pocket pagers, and other equipment now employing tubular microwave trimmers.

Electronic Components Division, Panasonic, One Panasonic Way, Secaucus, N. J. 07094. Phone Steve Belcak at (201) 348-7270 [401]

Phase-adjustable connectors have 18° range at 18 GHz

Two phase-adjustable SMA connectors for 0.085-inch and 0.141-in. semi-rigid coaxial cable offer an 18° phase-adjustment range at 18 GHz. The subminiature connectors have a phase-adjustment nut that alters the length of the connector when it is rotated, thereby changing the electrical length of the cable assembly and, hence, its phase. To prevent unwanted phase changes, a locking system is provided on both sides of the nut. The nut can be released and readjusted at any time.



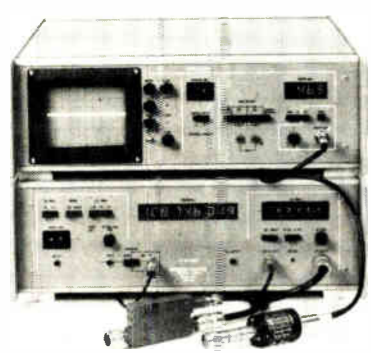
Major applications of the 901 series connectors are in phased-array radars, ILS landing systems, microwave test equipment, and any other gear in which phase matching is critical and space is at a premium. The connector for 0.085-in.-diameter cable is 1.06 in. long when completely closed and 1.19 in. when extended. Corresponding dimensions for the 0.141-in.-diameter cable connector are 0.940 in. and 1.065 in.

Both connectors will withstand 500 mating and unmating cycles without deterioration, have a nominal impedance of 50 ohms, and are rated for operation up to 600 V rms. Operating temperature range is −65°C to 125°C.

Amphenol RF Operations, Bunker Ramo Corp., 33 East Franklin St., Danbury, Conn. 06810. Phone Jerry Nagy at (203) 743-9272 [403]

Two portable instruments test microwave repeaters

Although it consists of only two portable instruments weighing 35 pounds each, Scientific-Atlanta's model 4655 microwave repeater ana-

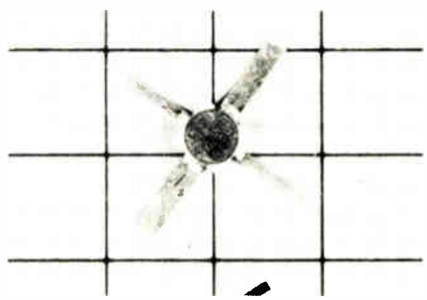


lyzer can perform all routine testing and maintenance procedures required by 4-, 6-, and 11-GHz message radio systems. The analyzer comprises intermediate-frequency and radio-frequency synthesizers, a frequency counter, a cathode-ray-tube display, and a combination digital voltmeter and power meter. Direct-reading displays and microprocessor-based controls make the analyzer easy to operate. Because the test set is tailored specifically for testing repeater stations, it greatly reduces the time needed to perform a complete check-out. The 4655 has a price of $19,985 and a delivery time of 16 weeks.

Scientific-Atlanta Inc., 3845 Pleasantdale Rd., Atlanta, Ga. 30340. Phone Meade Sutterfield at (404) 449-2000 [404]

Low-noise GaAs FET delivers 25 mW at 8 GHz

When tuned for maximum output power at 5 dBm input, the linear (1-dB compression) output of the HFET-1101 is typically 35 mW at



4 GHz and 25 mW at 8 GHz. The gallium-arsenide field-effect transistor is a low-noise device, which makes it a good second-stage or output-stage device for radar and communications equipment operating in the frequency range from 2 to 12 GHz. Housed in the rugged HPAC-100A package, the HFET-1101 sells for $125 in quantities of one to nine and $110 each in lots of 10 through 24. Delivery is from stock.

Inquiries Manager, Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 93404 [405]

INTRODUCING DELCO ELECTRONICS' MONOLITHIC OPERATIONAL AMPLIFIER

If you're now using discrete power output transistors, we've got an alternative that gives you design versatility.

It's the DA-101—Delco's Monolithic Operational Amplifier—with all the circuitry you need in one compact package.

The Monolithic Operational Amplifier (MOA) has two separate gain and power stages contained in a modified dual-in-line package.

The DA-101 operates from a 10- to 16-volt DC supply and can be used in an audio bridge configuration with floating speaker output, or as two separate amplifier-speaker systems.

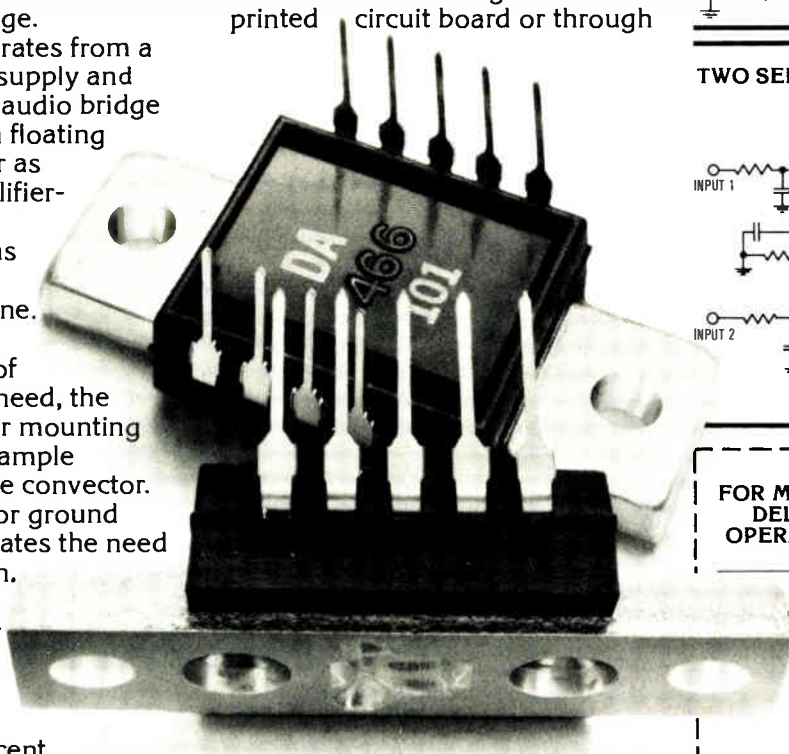
The MOA means weight savings in more ways than one. Besides reducing the total number of components you need, the MOA has a copper mounting surface to assure ample heat transfer to the convector. The tab negative or ground connection eliminates the need for mica insulation.

In fact, the design of one power megaphone showed a components weight savings of 65 percent.

Our new MOA means added design application flexibility, too. In automotive and home entertainment systems, two-way communication systems, power megaphones, motor controls, various H switch applications, and more.

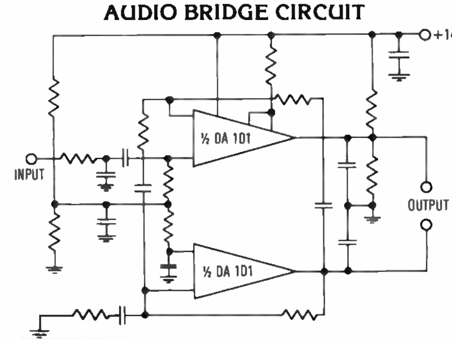
Another advantage of our Monolithic Operational Amplifier is its durability. It has integral protective circuitry for not only overvoltage, but temperature, current conditions and shorted outputs as well.

And it can be mounted by either direct soldering to a printed circuit board or through the use of a suitable socket.

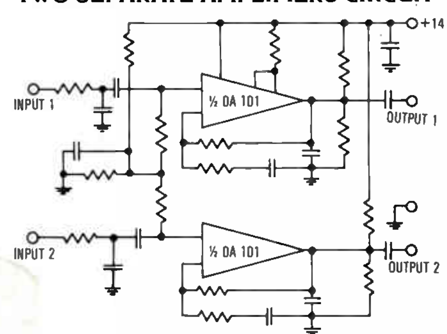


For more information, return the coupon on the right, contact an authorized Delco distributor, or call your nearest Delco sales office: **Kokomo, Ind. (317) 459-1271; Charlotte, N.C. (704) 527-4444; or Van Nuys, Cal. (213) 988-7550.**

AUDIO BRIDGE CIRCUIT



TWO SEPARATE AMPLIFIERS CIRCUIT



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V_{CC} = 14V dc	
I_{idle}, P_{out} = 0W	40mA
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Power Out @ 5% Distortion	
4Ω Bridge	6W
4Ω Non-bridge	3.5W

THERMAL CHARACTERISTICS

Thermal Resistance, $R\theta_{JC}$ (Typical)	4° C/W

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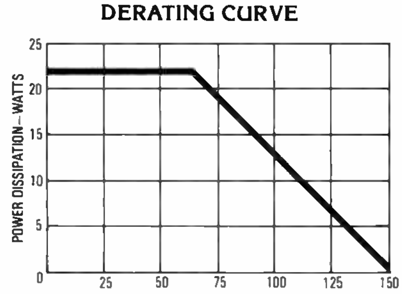

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Semiconductors

65-k ROM has typical access time of 450 ns

Using an advanced, self-aligning metal-gate MOS process, National Semiconductor Corp. has developed a 65,536-bit read-only memory with a typical access time of 450 nanoseconds. The n-channel metal-oxide-semiconductor device, designated the MM5235, requires a single 5-volt supply and pulls less than 130 milliamperes. The power consumed by the 28-pin memory is therefore less than 700 milliwatts.

Unlike most 4-k, 8-k, and 16-k MOS ROMs, which use self-aligning silicon-gate processing techniques, the new Maxi-ROM uses a triple ion-implant metal-gate process. According to Suman Patel, design engineering manager, the metal-gate process offers several inherent interconnect advantages. "Silicon-gate n-MOS is an advantage in random-access memories," he concedes, "but not in ROMs."

At present, the MM5235 sells for $32 each in lots of 250 pieces. In large quantities, the price is expected to drop to about $16, according to Fred Wickersham, manager of MOS/LSI memory products.

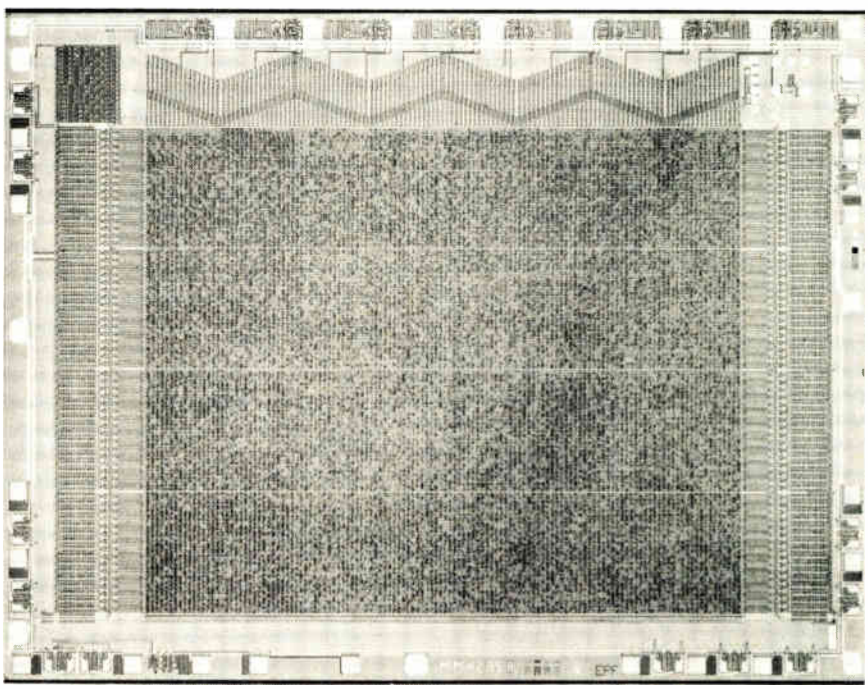
The 65-k ROM is only the first in a family of high-density devices National is working on using the new process. Coming soon are a faster 65-k ROM and a 32-k ROM. Further off are ROMs with capacities of 131 and 262 kilobits, Wickersham says.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone Fred Wickersham at (408) 737-5402 [411]

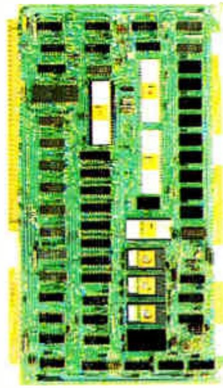
8-bit d-a converter drifts only 10 ppm/°C

A monolithic 8-bit digital-to-analog converter with a maximum nonlinearity of 0.1% has a full-scale current drift of just 10 parts per million/°C. The current-output device is intended for use in fast a-d converters, variable-gain amplifiers, waveform generators, three-digit binary-coded-decimal converters, and programmable power supplies. The unit has a typical power dissipation of 33 mw when used with ±5-v supplies and 135 mw in ±15-v systems. Its maximum differential nonlinearity is 0.19%.

In hundreds, the NE5009N, which comes in a 16-pin plastic dual



WITH WAFERTRAC YOUR OPERATOR COMES IN THE DEAL. PACKED INSIDE.



And that's not the half of it. WAFERTRAC's microprocessor board which mounts an 8-bit CPU, memory and interface capability not only oversees equipment operation like pacing wafers through scrub, photoresist coat, bake and develop, it's got a lot of other talents as well.

WAFERTRAC performs lot surveillance, identifies lost and broken wafers and sounds the alarm when vital process parameters such as spin speed, oven temperature or dispense duration falls out of spec.

There's more. WAFERTRAC™ talks to your programmer and your supervisory computer, as well as every spinner, bake oven, indexer and buffer in the Wafertrac System. So it's a first class bookkeeper, monitoring yields, throughput and other vital production data.

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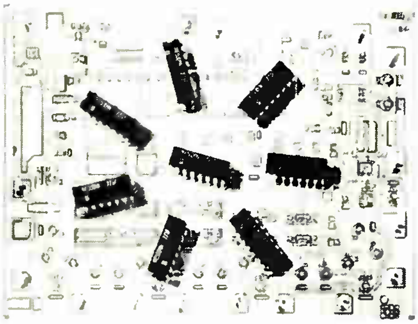


in-line package, sells for $4.75. In the same quantities, the SE5009, in a ceramic DIP, goes for $9.50.

Signetics, P.O. Box 9052, 811 East Arques Ave., Sunnyvale, Calif. 94086. Phone (408) 739-7700 [413]

10-volt reference is within 5 mV at 25°C

The AD581L is a monolithic voltage reference source with a maximum room-temperature (25°C) error of 5 millivolts. Its temperature coefficient is specified at 5 parts per million/°C over the range from 0°C to 70°C so that the guaranteed maximum total error is 7.25 mV over the specified temperature range.

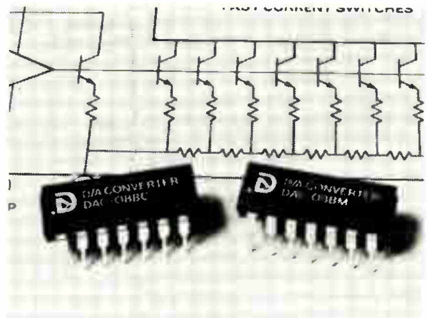
The laser-trimmed device is regulated to within 3 mV for supply-voltage variations from 15 to 30 V (1 mV for variations from 13 to 15 V) and drifts no more than 25 ppm/1,000 hours on a noncumulative basis. A load change from 0 to 5 mA will cause a voltage change of no more than 2.5 mV. Noise in the range from 0.1 to 10 Hz is less than 50 μV peak to peak. The AD481L sells for $11.95 in hundreds.

Two lower-precision versions of the AD581 are also available: the AD581J, which is priced at $2.85 each in hundreds, has a maximum 25°C error of 30 mV and a maximum tempco of 30 ppm/°C; the AD581K, at $5.95 has corresponding numbers of 10 mV and 15 ppm/°C. All units are available from stock.

Analog Devices Semiconductor, 829 Woburn St., Wilmington, Mass. 01887. Phone Jeff Riskin at (617) 935-5565 [414]

8-bit d-a converters settle within 85 ns

Linear to within half a least significant bit, two monolithic digital-to-analog converters are claimed to



have settling times of 85 nanoseconds. The model DAC-08BC comes in a 16-pin plastic dual in-line package and operates from 0°C to 70°C. The model DAC-08BM is housed in a 16-pin ceramic DIP and works from −55°C to 125°C. Both units require an external current reference. Prices are $8 for the DAC-08BC and $12 for the -08BM. Availability is from stock.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Eugene L. Murphy at (617) 828-8000 [416]

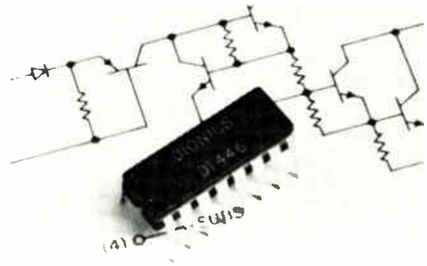
Sample-and-hold unit provides 12-bit performance

Contained in a TO-99 package, the SHC298 is a monolithic sample-and-hold device of sufficient precision to be used in 12-bit systems. The unit, which requires the use of an external holding capacitor, has a gain error of less than 0.005%, a gain drift of less than 4 parts per million/°C, and a full-power bandwidth of 125 kHz with a 1,000-pF holding capacitor. Its input resistance is greater than 10^{10} ohms and its acquisition time is less than 10 μs. If a 1-μF holding capacitor is used, the droop rate is a low 5 mV per minute. The SHC298 sells for $7.95 in small quantities; in hundreds, it goes for $5.75.

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85734. [417]

Dual 80-V driver handles 300-milliampere peaks

A universal dual high-voltage power driver package operates at voltages as high as 80 V and peak currents as high as 300 mA. The DI-446 is a dielectrically isolated monolithic device with a built-in transient-



suppressing diode (drive inductive loads). In lots of 10,000 pieces, the DI-446 sells for $1.38.

Dionics Inc., 65 Rushmore St., Westbury, N. Y. 11590. Phone Manny Sussman at (516) 997-7474 [418]

1,200-V molded triacs have 900-A surge ratings

A series of molded power triacs for operation to 1,200 V contains units

New products

with continuous-current ratings of 50 A rms (400 A surge) and 100 A rms (900 A surge).

The molded triac assemblies incorporate a metal base plate that offers isolation to 2,000 V rms as a heat-transfer medium. Both T50AC and T100AC triacs are available with voltage ratings of 400, 600, 800, and 1,000 V as well as 1,200 V. Junction operating temperature range is −25°C to 125°C.

Prices depend upon voltage rating and current rating. A representative price is $15.48 for the model T50AC40, a 50-A/400-V unit, in hundreds. In the same quantity, the T100AC120 (100 A/1,200 V) sells for $80.28.

International Rectifier, Semiconductor Division, 233 Kansas St., El Segundo, Calif. 90245. Phone (213) 322-3331 [419]

TOPICS

Semiconductors

Texas Instruments Inc., Dallas, is second-sourcing the MC3446 quadruple bus transceiver IC for IEEE-488 applications. In lots of 100 or more pieces, the plastic-packaged version sells for $2.12 and the ceramic for $2.61. . . . **National Semiconductor Corp., Santa Clara, Calif.,** is producing a one-chip digital voltmeter with a resolution of 3,999 counts. An extended-range version of the company's ADD3501, the new ADD3701 needs only a display, an external voltage reference, and a digit driver to form a complete DVM.

Tired of Reruns?

Fluke counters with a new series in the 5 Hz-520 MHz/time slot.

If you're paying over $345 for a counter and getting frequency only, tune in on our new 1900-series of priced-right multicounters.

Five different models offer both time *and* frequency, with award-worthy performance and features; the ratings are terrific!

New Time and Frequency.

Last year's hit, the model 1900A, set the stage for this new series of multicounters by offering frequency, period, period average and totalize *standard* in one great counter.

Now all models in the series offer comparable features and value, with autoranging and autoreset as well.

Most models feature a trigger level control and battery option for reliable field use or line-cord-free bench operation. All typically have a 15 mV sensitivity (guaranteed on most!), plus a 0.5 ppm/month time base for long-term stability.

1900A

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From this shared base of solid performance features, we've built a series of counters with one model just right for your needs.

The new **1912A**, with a 520 MHz range and an extensive package of standard features, offers more capability for $620* than you're likely to find anywhere. For 250 MHz measurement perfection, the **1911A** multicounter is a best-buy for only $495.*

1925A

For lower frequency (125 MHz) applications, specify the **1910A** for $395.* The **1900A**, years ahead in value, has been reduced to $345* for even more cost-effective 80 MHz measurement.

For rugged environment applications in the 125 MHz area, you'll want the **1925A** with its RFI shielding and dust-resistant steel case. $750.* (For only $225* more, a special prescaler option extends the 1925A's range to 520 MHz.)

Tune In and Count.

Call (800) 426-0361, toll free, for the location of the closest office or for complete technical literature. Then stop in for the great family picture, and review the extensive option list for better TCXOs, data outputs, and more. John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043.

*U.S. price only.

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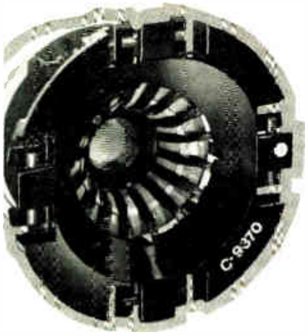
For Literature circle 100
For Demonstration circle 259



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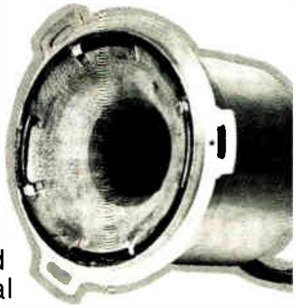
Military



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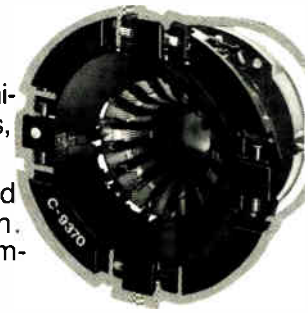

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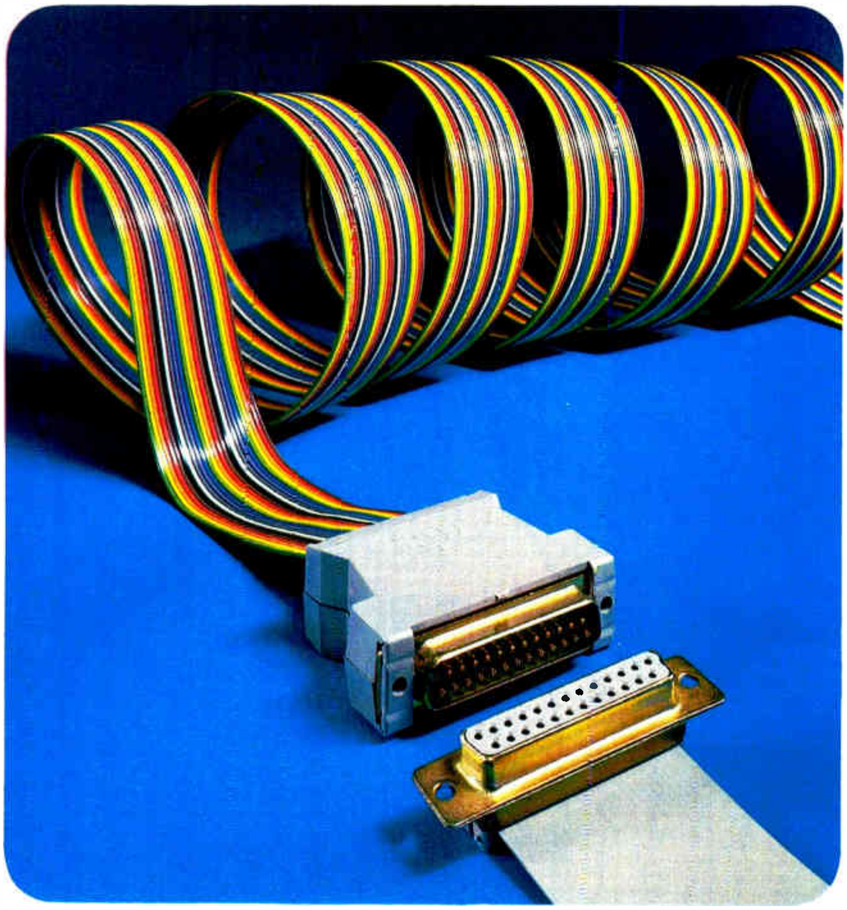

Now Scotchflex brand DELTA Connectors bring the proved labor-savings of 3M's mass termination system to subminiature connections. DELTA series components include pin and socket connectors, junction shells, 25-conductor flat cable and strain relief clips. These system assemblies interface directly with all other industry standard "D" series subminiature connectors. They're also compatible with all connectors in our complete Scotchflex line.

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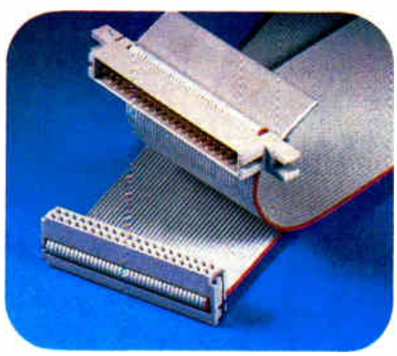

A family of Scotchflex male plug connectors is now available in sizes from 10 to 50 contacts to mate with Scotchflex socket connectors for T-tap or mid-span connections or rack and panel applications.

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

Our broad line of Scotchflex socket connectors includes a variety of 12 different sizes and center spacings to fit standard wrap panels and custom configurations. Also offered are Scotchflex card-edge connectors in sizes for 20 to 50 conductors.

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For more information on Scotchflex products call 612-733-3350.

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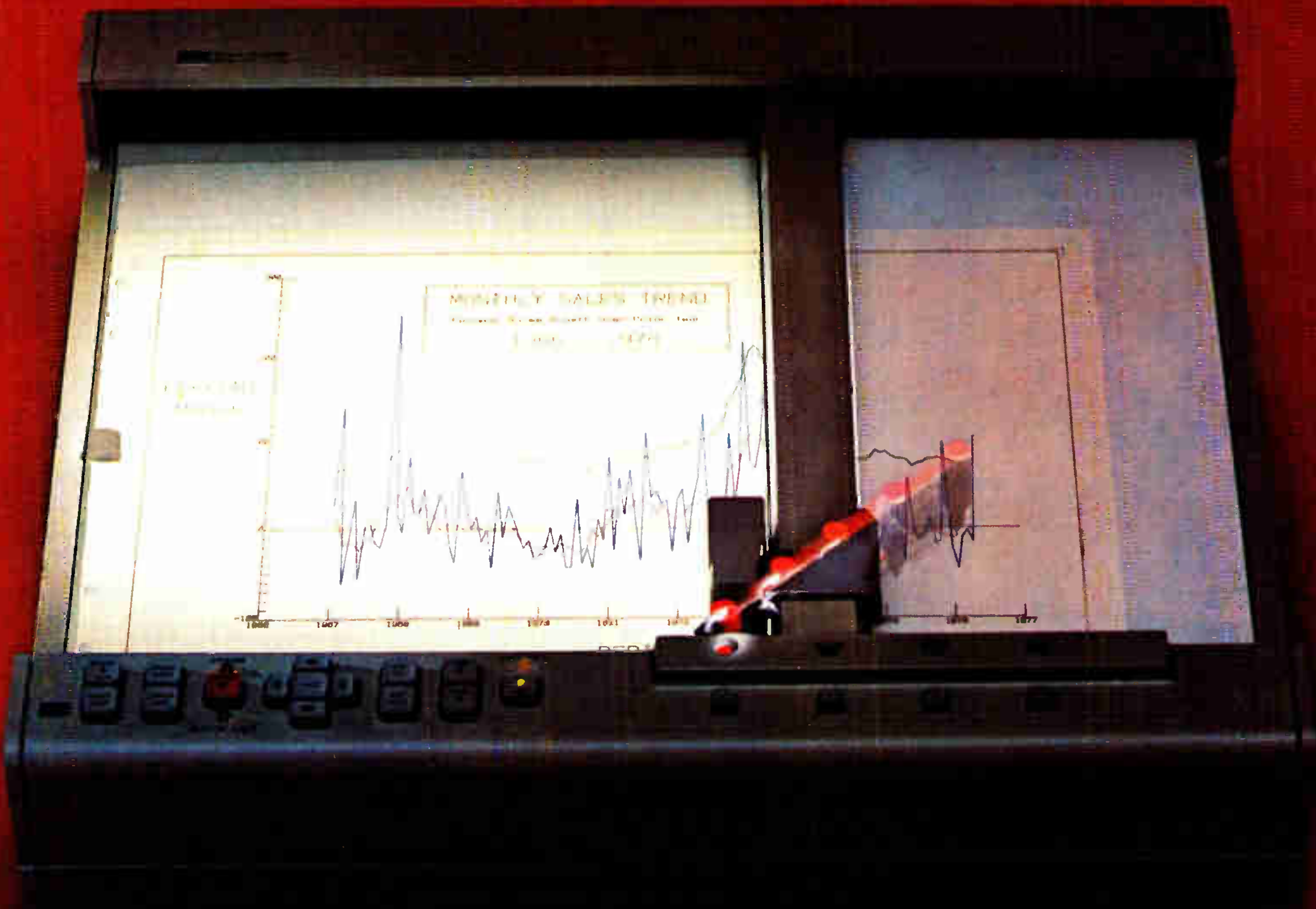


Industrial

Pencil programs 10-channel sequencer

A control sequencer called the UP-Timer (for universal programmable timer) allows users to program arbitrary on/off sequences on 10 independent channels by means of pencil marks on standard IBM cards. Unlike cam-controlled sequencers, the UP-Timer can thus be programmed and reprogrammed quickly and easily.

Loading a program is simple. The four-position front-panel control switch is placed in the program position, the reset button is pushed, a marked IBM card is placed in the front-panel slide tray, and the tray is pushed into the machine.

This loads the program into a solid-state random-access memory, which serves as the working program store. The card need not be used and handled every time the cycle is run—only when it is initially loaded.

Although the 10 timing tracks on the programming card are each divided into 100 divisions, the timing marks do not have to correspond exactly with the divisions—that is, the divisions are for reference only. Programming marks can be thin lines occupying a fraction of a division or large blocks occupying many divisions with partially filled divisions at the ends.

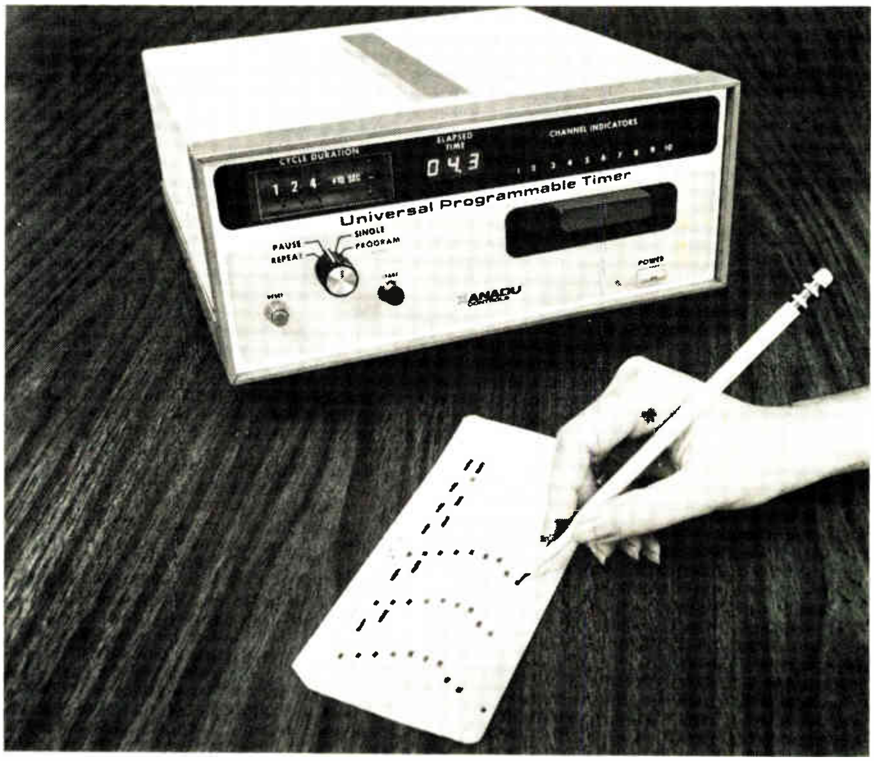
The full length of the timing tracks corresponds to the duration of a machine cycle. This can be adjusted by thumbwheel switches to anywhere from 10 milliseconds to 100 hours. The cycle duration is settable to three significant figures and is controlled by a quartz-crystal time base. The time base can be considered error-free, with the system performance limited only by the resolution of the programming card—0.2%.

On the output end, the sequencer offers a choice of four devices: reed relays rated for 0.5 A at 100 V, a dc solid-state relay rated for 400 mA at 50 V or 100 mA at 250 V with an operating time of 5 μs, an ac-dc SSR that can switch 75 mA at 50 V in 5 μs, and an ac SSR rated for 0.5 A at 140 or 280 V.

Special features on the UP-Timer include a two-digit display of position in the cycle (elapsed time) and an indicator lamp for each channel that glows when the channel is active. Together, these displays allow for easy checking of a program. They allow the user to delect a convenient cycle time, typically 100 seconds, and observe the displays for visual verification that the program is working properly. Debugging is simplicity itself; all it requires is a pencil with an eraser.

Thanks to a built-in rechargeable battery, stored programs are not lost when the sequencer is shut off for brief periods. They are erased only when they are replaced by new ones.

UP-Timer pricing depends upon the number of channels and the type of output relay. A four-channel unit with solid-state relays sells for $1,066; a full 10-channel solid-state sequencer is priced at $1,588. Reed relays can drop the price about $180 for the 10-channel unit and proportionally less on smaller ones. Small quantities are available

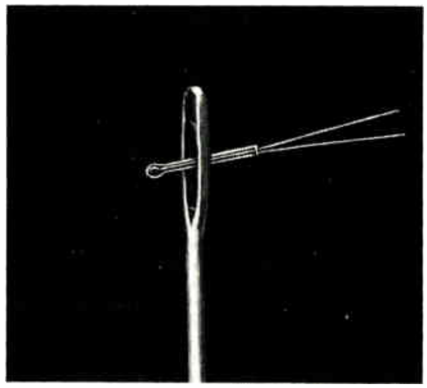


from stock; large orders require from 30 to 60 days.

Xanadu Controls, Division of Valcor Engineering Corp., 45 Fadem Rd., Springfield, N. J. 07081. Phone Peter G. Mesniaeff at (201) 467-8100 [371]

Tiny thermistor probe provides fast response

A glass thermistor probe that is slightly more than ¼ inch long offers an extremely fast time response, making it well suited to dynamic temperature measurements in liquids and gases. The probe consists of a miniature thermistor bead sealed in the tip of a shock-resistant, thin-wall glass tube, with corrosion-



resistant platinum-iridium leads. Its time constant is about 25 milliseconds in moving water. Standard probes are available in nominal resistances of 500 ohms to 300,000 ohms and they can be used at temperatures up to 300°C.

Fenwal Electronics, 63 Fountain St., Framingham, Mass. 01701 [373]

High-pressure transducers cover many applications

Three bonded strain-gage transducers for high-pressure measurements combine light weight, high performance, wide operating temperature range, and miniature size. All three have aerospace applications, as in rocket-motor combustion, and are also suitable for testing hydraulic

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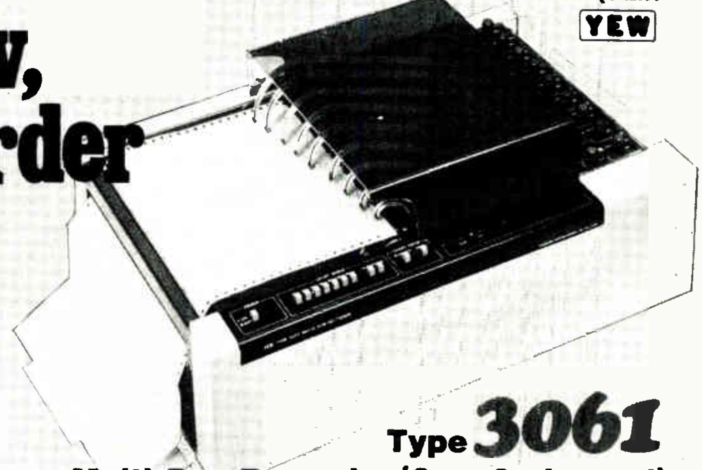
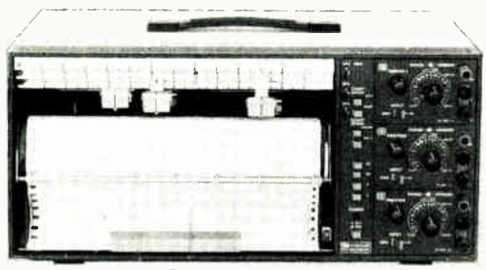
A Full Line of New, Top-Quality Recorder from YEW

1 to 9 channels, vertical and flatbed types

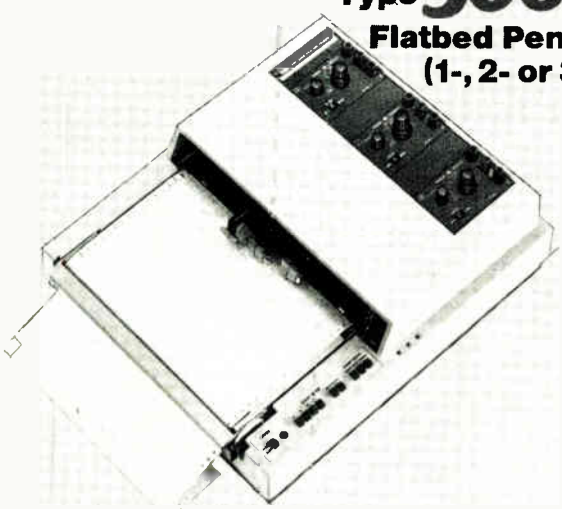


Type 3061
Multi-Pen Recorder (6- or 9-channel)



Type 3056 Vertical Pen Recorder (1-, 2- or 3-channel)

Type 3066
Flatbed Pen Recorder (1-, 2- or 3-channel)



Few competing instruments can match the 250mm recording width, 800mm/s pen speed, and 140dB CMRR of our new recorders. Some can match their 5μV/cm sensitivity (calibrated ranges from 5μV/cm to 5V/cm, with vernier) and offer digitally-controlled chart speeds. There's even one that can match their ±0.25% accuracy. But no others can give you their reliability and ease of use in addition to such specifications.

High performance and reliability:

- Conductive plastic potentiometer offers infinite resolution, minimizes maintenance.
- Overrange-protected pen drives.
- Wear-free brushless DC servo motor (Type 3056).
- Fully modular construction based on a motherboard—minimizes point-to-point wiring, for reliability and ease of maintenance.

Ease of use:

- The world's easiest-to-load chart recorders—just release the catch, slide out the chart bed, drop a Z-fold or roll chart into the tray, pull the end of the chart up over the drive sprockets and slide back the bed. (U.S Patent No.3,946,406)
- High-quality disposable pens—replace in seconds with no mess. Types 3056 and 3066 use felt-tipped pens, 3061 uses pen-tip/capillary/tank refill modules.

Portability:

- Durable, yet compact and lightweight recorders. The largest, the 9-pen Type 3061, weighs only 26kg and measures less than 38×57×28cm. Types 3056, 3066 are half the weight, half the volume.

A full line of X-Y recorders is also available. Contact your YEW representative today for complete information.
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Circle 265 on reader service card

booster pumps. Model 2201 is designed also for testing feed water lines in large nuclear boilers. Its pressure range is from 0 to 150 lb/in.² through 0 to 20,000 lb/in.², and it can operate in temperatures from −100 °F to +300°F. Model 2205, a miniature type, can be used in heavy-hydrogen research and in testing gas turbines. It covers pressure ranges from 0 to 5,000 lb/in.² through 0 to 30,000 lb/in.²

Teledyne Taber, 455 Bryant St., North Tonawanda, N. Y. 14120 [374]

Fiber-optic scanner tolerates shock and vibration

A coaxial fiber-optic scanner with a sensing tip that operates at 100°C is also suited for operation in conditions of severe shock and vibration. Designated the Enviro-Skan, the scanner consists of a glass fiber-optic cable and a separate scanner body containing a light source and phototransistor. The 36-inch cable permits the scanner body to be located at a safe distance from the sensing environment. The cable's small tip and high degree of flexibility permit mounting in limited-access areas. The reflective scanner can be converted to a through-beam type by removing the single branched cable from the scanner body and inserting two cables in its place.

Skan-A-Matic Corp., Rt. 5 West, Elbridge, N. Y. 13060 [377]

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Then scan this list of topics . . .

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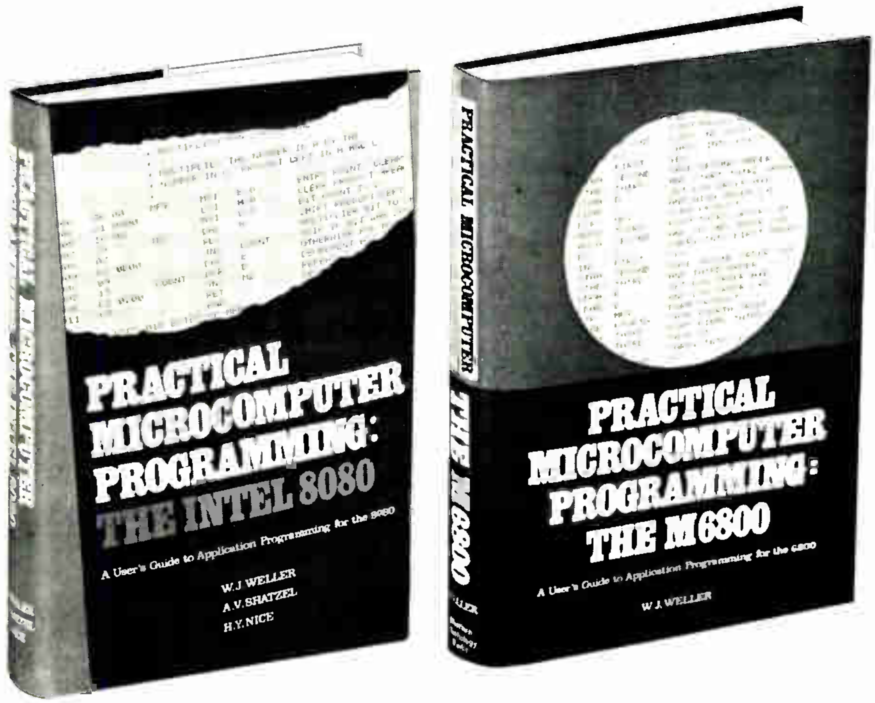
- carry and overflow
- multiple precision arithmetic
- loops
- shifting
- software multiplication and division
- number scaling
- floating point arithmetic
- stack pointer usage
- subroutines
- table and array handling
- number base conversions
- BCD arithmetic
- trigonometry
- random number generation
- programming of the 6820 PIA
- programmed input/output
- control of complex peripherals
- programming with interrupts
- a software time of day clock
- multiple interval timers in software
- data transmission under interrupt control
- polling
- debugging techniques
- patching a binary program
- full source listing of a debug program . . .



Every one of these topics and many, many more are discussed in the **Practical Microcomputer Programming** books. In chapter after chapter and scores of formal program examples, the basic skills of assembly language programming are developed step by step. The examples are real and have been tested and proven. They run, and more important, they teach. If you're tired of generalities, reproductions of manufacturers data sheets and books with examples that don't run, then there is only *one* place to go, the **Practical Microcomputer Programming** series from Northern Technology Books. At $21.95 each they are the best bargain in programming information available anywhere.

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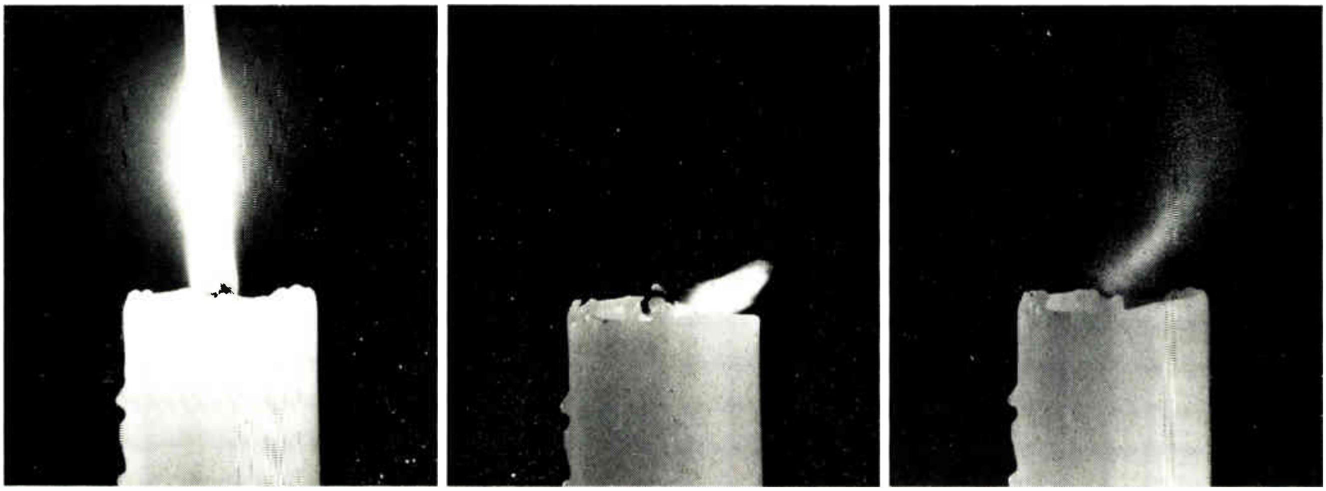
Don't let unreliable contacts snuff out your design.



Some illuminating facts from Scanbe about avoiding "little" power failures due to IC sockets.

It doesn't take a major power failure to snuff out your equipment. One unreliable contact in a faulty socket can kill your product as easily as a gentle breeze extinguishes a flame.

Compare the cost of reliability against the price of failure.

All IC sockets are **not** alike. Talk to your marketing department, your production manager, or your service group. The price your company pays for one faulty contact – in parts, service and customer satisfaction – can wipe out that fraction-of-a-cent cost savings on your last purchase.

US-2 – the low profile socket that's not a "me too" product.

It's the first significant breakthrough in IC socket reliability in the last ten years. Its design is so unique it's patented, and independent laboratory tests prove it meets or exceeds every applicable EIA requirement.

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No customer has ever rejected a US-2. Period. That's the kind of reliability you can depend on; and the level of performance your product should never be without.

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Most IC sockets look alike. Scanbe asks you to take a closer look at US-2 and see for yourself. Its patented design concepts totally eliminate solder wicking and flux entrapment, and assure the highest possible contact holding pressure.

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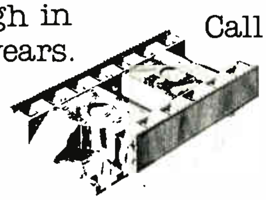

United States Patent 4,033,656
July 5, 1977

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Literature only circle 105
Immediate Application circle 268

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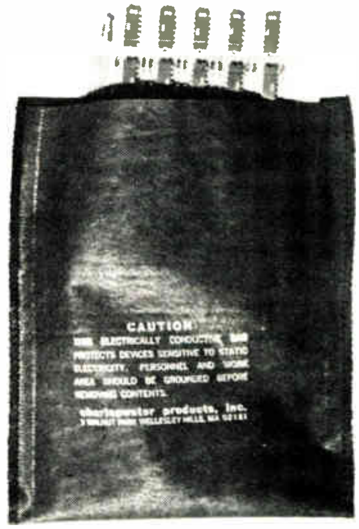
Engelhard Industries, Thick Film Department, 1 West Central Ave., East Newark, N. J. 07029. Phone (201) 589-5000 [476]

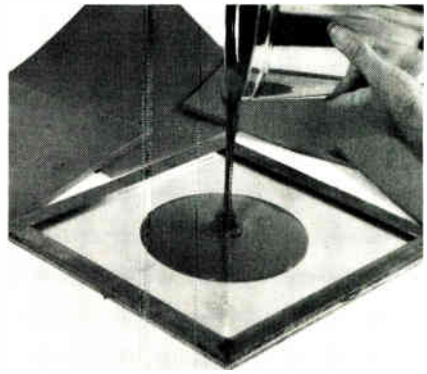
Electrically conductive bags shield devices from static electricity. The heavy-duty nylon bags have a tear strength over 3,000 g/mm and a tensile strength in excess of 7,500 lb/in.^{2} psi. In addition, they are 5 mm thick and have a surface resis-



tivity of less than 30 kΩ per square. They range in size from 5 by 8 inches to 10 by 18 in.; custom sizes may also be ordered. In lots of 100 or more, the bags sell for $21.50 each.

Charleswater Products Inc., 3 Walnut Park, Wellesley, Mass. 02181. [477]

A high-loss rubber dielectric is useful as either a termination or attenuator in a transmission line. This silicone material, Eccosorb LS-D, will lower the Q of a cavity and will suppress surface currents, thus reducing the reflectivity of objects. It is also



useful as a high-loss gasket or seal. A sheet 12 by 12 by ¼ inches sells for $104.50. It is also available in 5-lb containers at $27.50 per pound.

Microwave Products Division, Emerson and Cuming Inc., Canton, Mass. 02021. Phone (617) 828-3300 [478]

Usable from −70°C to 200°C, silicone fiber-glass sleeving is functional at up to 315° for short periods under emergency conditions. This rubber-coated material is more dense, homogeneous, continuous, and concentric than other types of sleeving. Its strength makes it resistant to moisture, corona, ozone, radiation, compression set, fungus, and most chemicals. It is also immune to solvents, weathering, flexure fatigue, and heat degradation. It comes in no. 24 AWG and ranges up to an inside diameter of ⅝ inch. The T-117E sleeving is available in 10 nonfading colors but can be obtained in other colors on special order.

Brand-Rex Co., Willimantic, Conn. 06226. Phone Frank Barnes at (203) 423-7771 [479]

A polyester tape designed for fast, one-step stripping and plating of connector tabs will eliminate the problems of creep and adhesive transfer. The transparent tape is easy to apply, conforms readily to circuit traces, and provides an extra-fine line of demarcation. The high-strength material has minimal stretch, conforms without shrinkage, and does not tear when removed. It can be applied by hand or with automatic taping equipment.

Chemelex Division, RBP Corp., 150 South 118th St., Milwaukee, Wis. 53214. [480]

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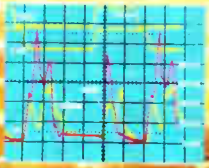

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2104A	350 ns	500 ns	30 mA

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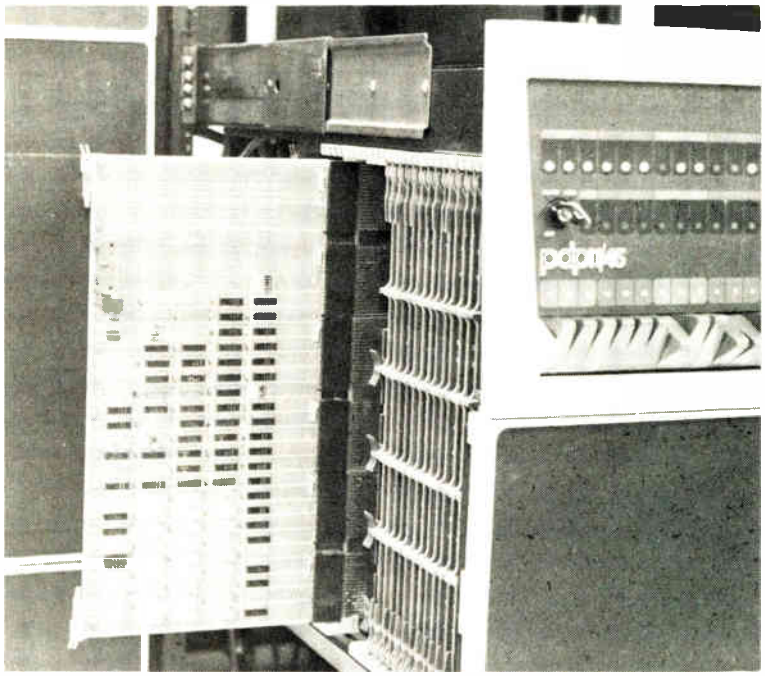

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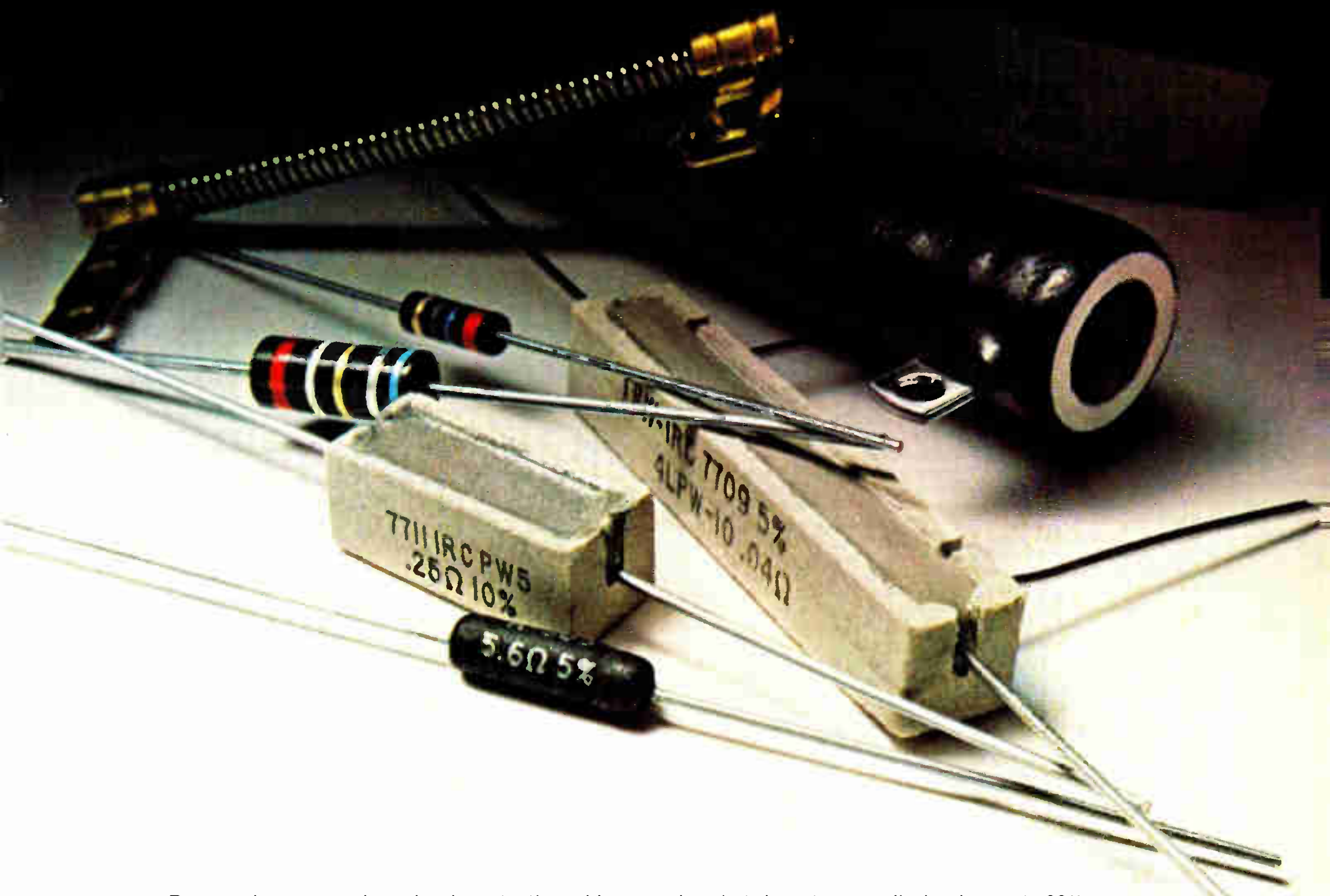

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New literature

Test sockets and carriers. The versatility of test sockets and carriers for integrated and hybrid circuits, medium-scale and large-scale integrated rectifiers, and other semiconductor devices is discussed in a 12-page catalog. These products are designed for production, quality control, environmental, and reliability test applications. Textool Products Inc., 1410 W. Pioneer Dr., Irving, Texas 75061. Circle reader service number 421.

Transducers. Three two-page illustrated bulletins describe miniature, wide-temperature-range, and lightweight high-pressure transducers.

Specifications and options for each transducer are also listed. Teledyne Taber, 455 Bryant St., N. Tonawanda, N. Y. 14120 [422]

Frequency synthesizers. A six-page catalog highlights the advantages of direct over indirect frequency synthesis. It explains how direct digital synthesis can resolve from 0.001 hertz up to and including 2 megahertz and eliminate switching transients while providing absolute phase continuity and high spectral purity. Detailed specifications on the 5100 and 5110 programmable frequency synthesizers, which employ this technique, are included, as well as remote programming information for each type of synthesizer. Rock-

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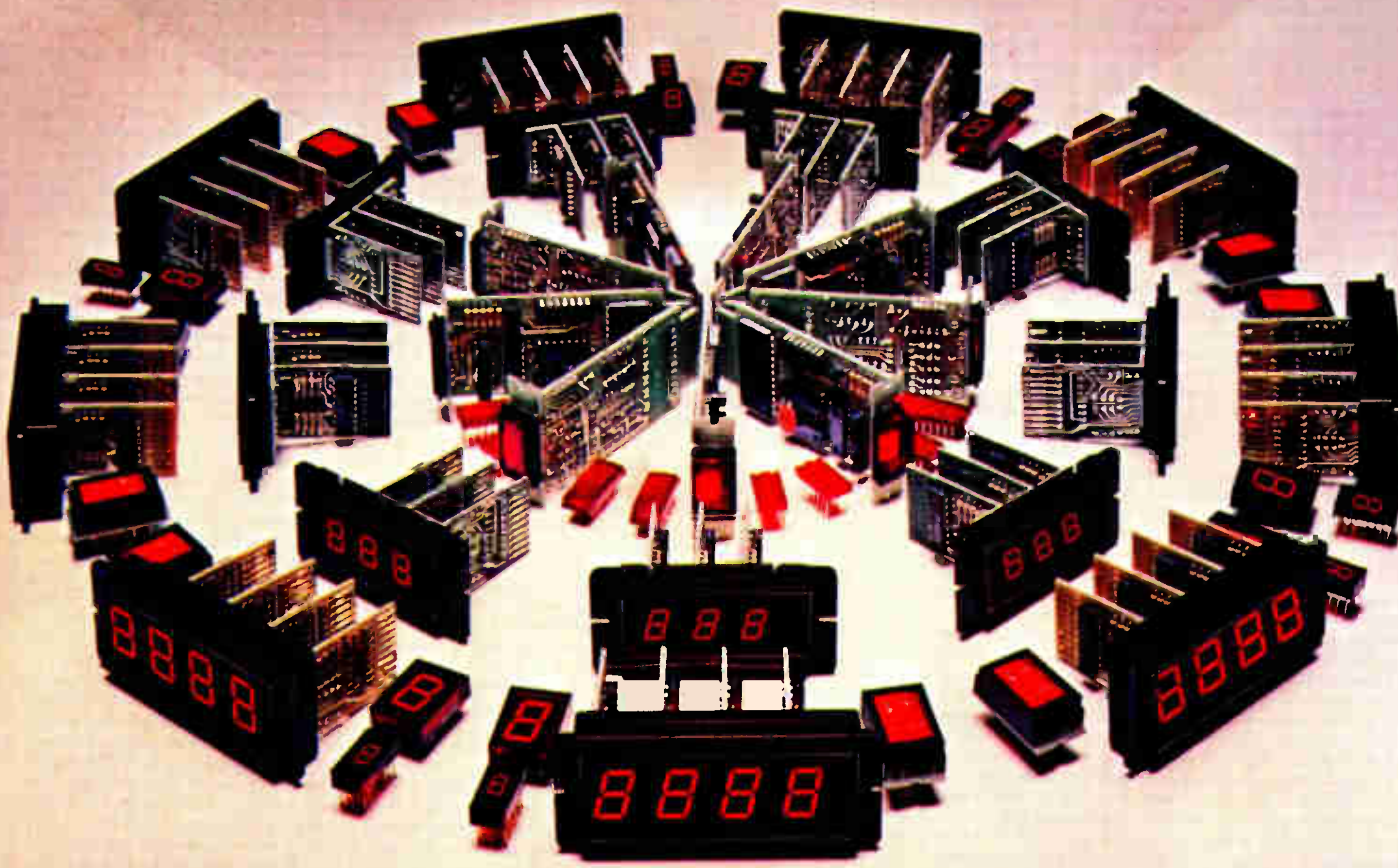

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New literature

land Systems Corp., 230 W. Nyack Rd., West Nyack, N.Y. 10994 [423]

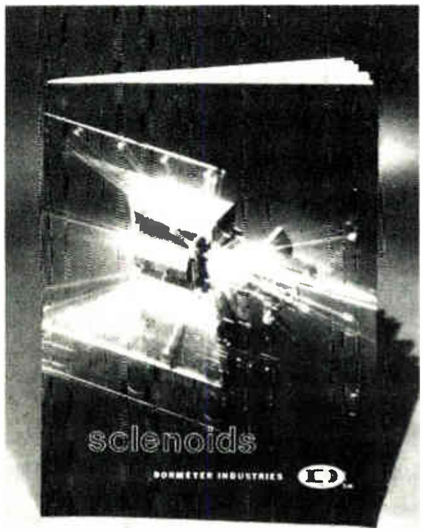
Solderless terminals. Design information, conversion tables, and technical data are given for solderless terminals in a 24-page catalog. They include insulated and noninsulated barrel styles of ring, spade, block

spade, flanged-block spade, snap-spade tongue, and quick-disconnect terminals. Temperature and measurement tables are provided for easy conversion needs. SPC Technology, P.O. Box 66175, Chicago, Ill. 60666 [424]

Linear and data acquisition. "Linear and Data Acquisition Products," a 343-page book, provides detailed specifications, performance curves, and circuit diagrams for a variety of circuits. Included are operational amplifiers, complementary-metal-oxide-semiconductor analog switches and multiplexers, digital-to-analog converters, line drivers, receivers, and communications devices. Designers will be interested in the comprehensive 118-page application section. The copies may be obtained at $2.95 each. Harris Semiconductor, P.O. Box 883, Melbourne, Fla. 32901

Solenoids. Information on box-frame, tubular, laminated, C-frame, and custom-designed solenoids for ac

New literature

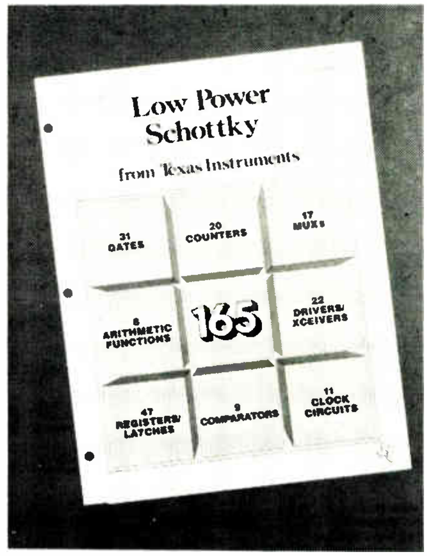


or dc commercial applications is presented in a 60-page catalog. Electrical and mechanical specifications are given for each solenoid series along with dimensional drawings. Dormeyer Industries, a Division of A. F. Dormeyer Manufacturing Co., 3418 N. Milwaukee Ave., Chicago, Ill. 60641 [426]

Ribbon connectors. "Ribbon Connectors Catalog No. C-36" describes ribbon termination equipment as well as ribbon connectors, with particular emphasis on the Superribbon system. A discussion of its operation supplements the dimensional and technical descriptions. The part numbers have been separated from these descriptions and assembled into a two-page spread to make it easy to compare the system elements. TRW Cinch Connectors, Manager, Marketing Communications, 1501 Morse Ave., Elk Grove Village, Ill. 60007 [427]

Electronic fund transfers. The Payments System Planning division of the American Bankers Association has prepared an eight-page summary of a 389-page report, "EFT in the United States, Policy Recommendations and the Public Interest." The summary covers the role of consumers, issues concerning providers, technology, and the Government in relation to electronic fund transfers. Payments Systems Planning Division, American Bankers Association, 1120 Connecticut Ave., N. W., Washington, D. C. 20036 [428]

TTL circuits. A six-page folder describes 165 low-power Schottky transistor-transistor-logic circuits. Operating-life test data at 125°C and 150°C is given, along with the number of failures and the equivalent number of hours at 55°C.



Included is a review of the product-enhancement program, which provides information on higher-reliability circuits. Texas Instruments Inc., Inquiry Answering Service, P. O. Box 5012, M/S 308, Dallas, Texas [429]

Power converters. A 32-page catalog gives specifications and price information on more than 1,000 power converters, including dc-dc converters, miniature hybrid converters, and ac-dc single- and triple-phase converters. Additional devices include ac-dc regulated power supplies, multiple output models, and the 100 series. Tecnetics Inc., 1625 Range St., P. O. Box 910, Boulder, Colo. 80306 [431]

Slide-selector guide. A color-coded, slide-detector guide discusses more than two dozen ball-bearing chassis and drawer slides in terms of load rating, overall dimensions, configuration, material, and finish. Addi-

tional data includes dimensional drawings, special slide designs, and check and vibration control components. Grant Hardware Co., a division of Buldex Inc., 7 Hoover Ave., Haverstraw, N. Y. 10927 [430]

Transistors. Specifications for a line of low-cost transistors that includes metal-can, epoxy, and TO-5 transistors are available from Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. 91343 [432]

Microprocessor information. Technical information for programmers on read-only memories, microprocessor-system analyzers, 4- and 8-bit microprocessor cards, and support equipment is given in a 48-page catalog. The publication discusses the features of each item and gives the price. A personality-module selection guide for the PROMs and a microprocessor-card-compatibility table is also included. Particular emphasis is placed on the CRS-81 and CRS-82 rack systems, with schematics supplied for memory address space and port assignments. A list of electrically compatible support cards and associated software is included, along with the names of the vendor and the contact person. Pro-Log Corp., 2411 Garden Rd., Monterey, Calif. 93940 [433]

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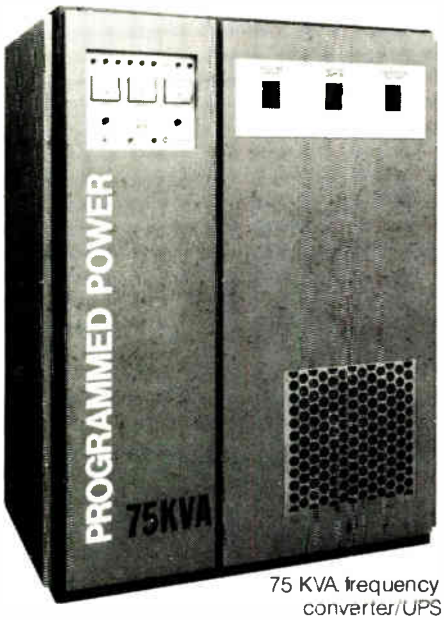

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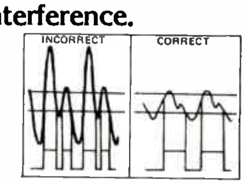

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