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43 Compatibility squabbles mar ECL family harmony
85 European equipment and components market forecast chart
97 A big new memory system designed around 4,096-bit RAM chips

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Consumer spending boosts Europe's markets

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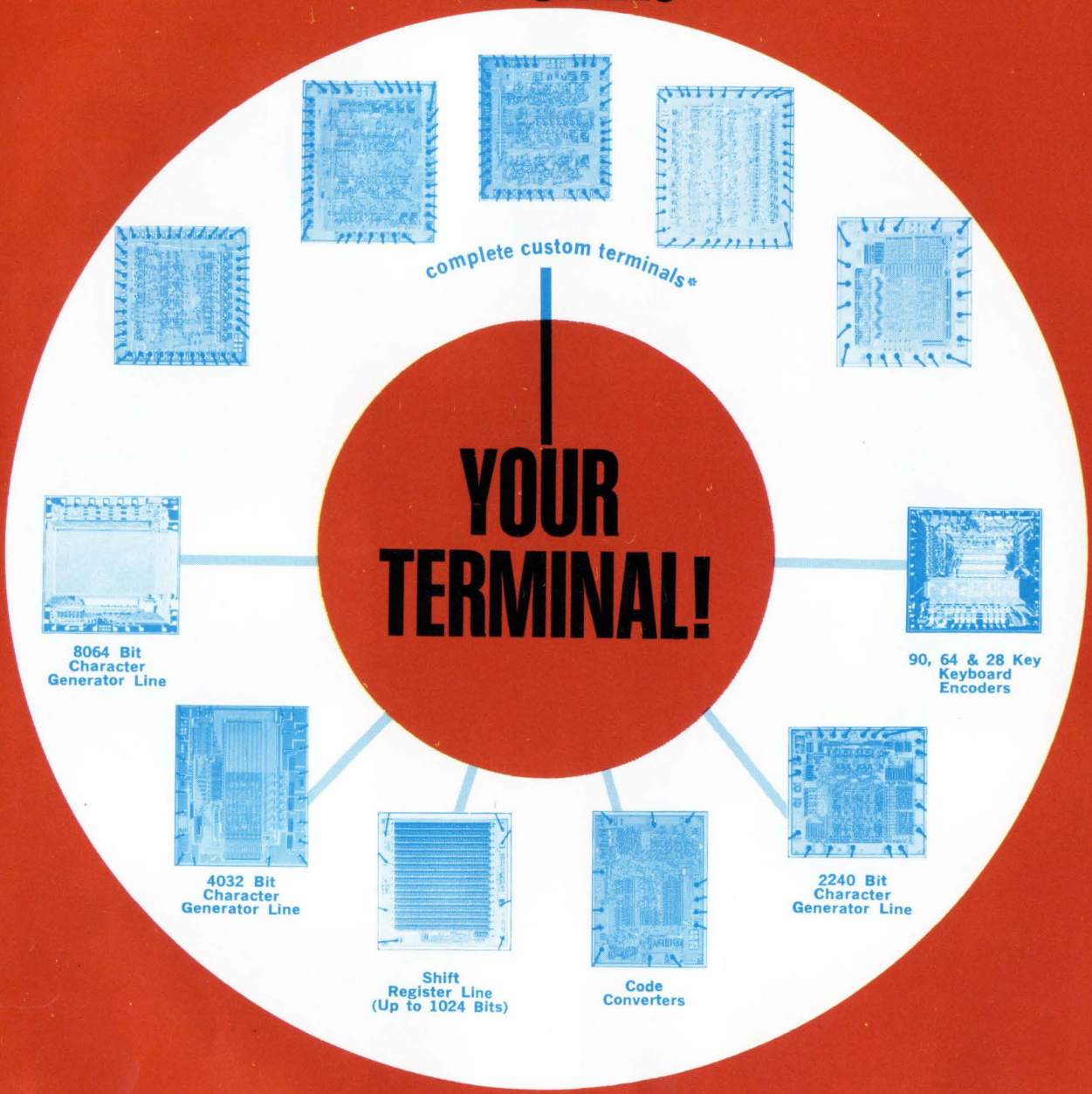

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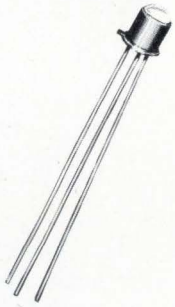


L14A SERIES

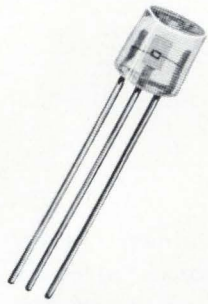
- hermetic phototransistor
- 3 μsec turn on, turn off

L14F SERIES

- hermetic photodarlington
- high sensitivity

L1V SERIES

- hermetic "SCS"



L14D SERIES

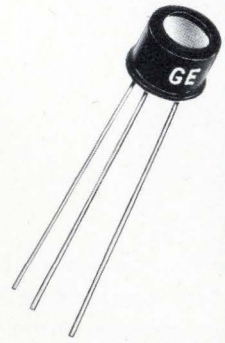
- photodarlington configuration
- high sensitivity

L14E SERIES

- phototransistor
- typical 3 μsec turn on

L14T SERIES

- PNPN photo switch



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Electronics
The International Magazine of Electronics Technology
Vol. 45, No. 26 • December 18, 1972

29 **Electronics Review**

INDUSTRIAL ELECTRONICS: Simulation replaces hardware, 29
MEMORIES: Bell builds fast p-MOS RAM, 29
MEMORIES: Mostek does away with cell contacts, 30
MEMORIES: Charge coupling used in memories, 31
OPTOELECTRONICS: Doppler radar is super bird-watcher, 31
SOLID STATE: Ion implantation comes to op amps, 32
SOLID STATE: Interdigitation for high power, 32
SPACE ELECTRONICS: SEP looks into the moon, 34
SPACE ELECTRONICS: NASA plans a heavyweight, 34
CONTRACTS: Army laying down design-to-cost law, 36
GOVERNMENT ELECTRONICS: Coast Guard wants improved Loran, 36
COMPANIES: Hittinger promoted at RCA, 38
MEETINGS: FJCC finds core makers happy, 38
NEWS BRIEFS: 40

43 **Probing the News**

SOLID STATE: Makers debate ECL compatibility, 43
INTERNATIONAL: Israel pushes electronics exports, 45

53 **Electronics International**

FRANCE: Symphonie launching plans are out of tune, 53
ITALY: Selenia cruises with ship radar, computer, 53

65 **Special report: European Markets**

West Germany, 66
United Kingdom, 68
France, 71
Italy, 73
The Netherlands, 75
Sweden, 76
Spain, 78
Belgium, 79
Switzerland, 80
Austria, 81
Denmark, 82
Norway, 83
Finland, 83
Market Forecast Chart, 85

97 **Technical Articles**

COMPUTERS: New 4,096-bit MOS chip is heart of fast memory, 97
DESIGNER'S CASEBOOK: Auto tachometer squelches point bounce, 106
Agc threshold detector provides fast rf slewing, 107
Phase comparator for servo loops, 108
ENGINEER'S NOTEBOOK: Estimating substrate area and density, 111
Make your own small switches for pc boards, 112
Building timing circuits for noisy environments, 112

117 **New Products**

IN THE SPOTLIGHT: Word generator is fast and flexible, 117
SUBASSEMBLIES: Frequency standard uses rubidium cell, 121
INSTRUMENTS: Generator runs off cell 10 hours, 126
DATA HANDLING: Printer sells for under $500, 131
SEMICONDUCTORS: Monolithic d-a converter resolves 8 bits, 133
MATERIALS: 140

Departments

Publisher's letter, 4
Readers comment, 6
40 years ago, 12
People, 14
Meetings, 20
Electronics newsletter, 25
Washington newsletter, 49
Washington commentary, 50
International newsletter, 55
Engineer's newsletter, 114
New literature, 139

Highlights

Israel exports military electronics, 45
Under pressure to provide sophisticated military equipment to her army, Israel's electronics industries now find they are attracting military customers from abroad, particularly for their communications gear. Some consumer and industrial items are also being exported.

What the rest of the West is up to, 65
Electronics' survey of 12 European nations reveals a good 1972 wherever color TV is booming, with the same again expected for 1973. With some variation from country to country, telecommunications and components are also big, but computers are slow and industrial equipment slower.

Chart of European markets, 85
This nation-by-nation tabulation of market data gives detailed information about a wide range of product categories.

Memory system exploits 4-kilobit chip, 97
A 262-kilobyte memory system mounts on a standard 10½-by-8-inch rack and achieves a full cycle time of 600 nanoseconds. Responsible for this capacity, size and performance is a design centered on a new 4,096-bit n-channel MOS chip.

And in the next issue . . .
Electronics' 15th annual forecast of the U.S. electronics markets . . . better cryptography for greater data security.

The cover
Banknotes and coins come from the 12 countries surveyed for the European market report.

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Publisher's letter

For eight years now, our late–December issue has brought our readers around the world a Christmas card of sorts—our colorful fold-out chart packed with data about equipment and components markets in Western Europe for the year ahead (see p. 85). This year, as always, we've reworked the categories slightly to keep up with technological changes in the markets. And, this year, there's a new country in the charts—Finland.

Adding categories and countries, of course, adds to the time our reporting team has to spend to do the job. Team leader Arthur Erikson, our Paris-based International Managing Editor, logged more than 24 hours in the air—and considerably more than that in airport waiting time—criss-crossing Western Europe from Madrid to Helsinki to interview marketing experts for our consensus forecasts.

"Our contributors include some of the sharpest market researchers in Europe," says Erikson. This honor roll, though, will never be compiled, much less printed. All inputs for the charts are confidential.

On the other hand, its no secret that Erikson's efforts are backed up by *Electronics'* own field men and correspondents for McGraw-Hill's World News Service. If we put bylines to the stories that go with the market charts they would read John Gosch (West Germany), Michael Payne (United Kingdom), Michael Johnson (France), Andrew Heath (Italy), Robert Skole (Sweden), Dominic Curcio (Spain), James Smith (Belgium), Laura Pilarski (Switzerland), John Gosch (Austria), John Heaslip (Denmark), and Martin Schultz (Finland).

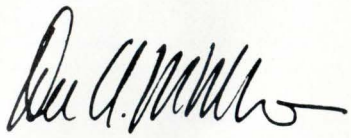
Trend-spotting is one of our most challenging and satisfying jobs. And one of the best vantage points for our trend-spotters is the International Electron Devices Meeting, held this month in Washington.

As usual, there was news there in abundance. You'll find a fistful of items from the meeting—gathered by Laurence Altman, our Solid State Editor, and Sam Weber, Executive Editor—in the Electronics Review section and the Electronics Newsletter.

And, the meeting bristled with trends. Says Altman: "Only 18 months ago, ion implantion was still considered something for the laboratory in most companies. Now, though, its impact is being felt all across the semiconductor industry. What's more, better than 75% of the semiconductor papers at the meeting homed in on implantation."

"It looks, too," he says, "as if this year marks the end of a cycle. Companies have been optimizing old technologies; now they are gearing up to get the new technologies into products."

And, says Weber: "Solid state processing techniques have become so pervasive that they are even being used in vacuum-tube work—especially in the display area. For example, techniques developed for IC arrays are solving the problem of blooming in silicon-target image tubes. And, the writing speed of CRTs is being upped by similar techniques."



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BKF 5–5	5.0 ±10%	0–5
BKF 12–1.4	12.0 ±10%	0–1.4
BKF 12–2.4	12.0 ±10%	0–2.4
BKF 15–1.2	15.0 ±10%	0–1.2
BKF 15–2	15.0 ±10%	0–2
BKF 24–0.8	24.0 ±10%	0–0.8
BKF 24–1.2	24.0 ±10%	0–1.2
BKF 28–0.6	28.0 ±10%	0–0.6
BKF 28–1	28.0 ±10%	0–1

GROUP II

MODEL	VOLTS	AMPS
BKF 5–11	5.0 ±5%	0–11
BKF 8–10	8.0 ±5%	0–10
BKF 12–7	12.0 ±5%	0–7
BKF 15–6	15.0 ±5%	0–6
BKF 24–4	24.0 ±5%	0–4
BKF 28–4	28.0 ±5%	0–4
BKF 36–3	36.0 ±5%	0–3
BKF 48–2.5	48.0 ±5%	0–2.5

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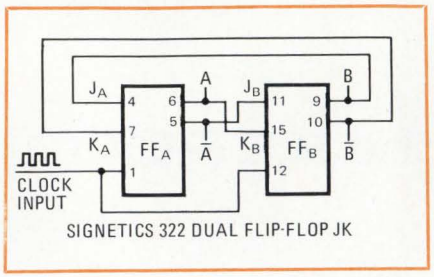
Readers comment

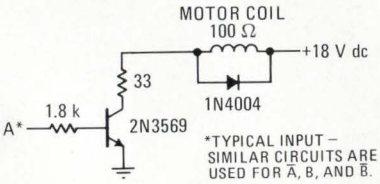
A simple stepper solution

To the editor: I had a problem similar to that described and solved by Michael Doering in his Designer's casebook, "Logic circuit converts synchronous motor to stepper," [*Electronics*, Sept. 25, p.108]. My solution, with a four-phase A. W. Haydon stepper motor, was simpler, but it required a double-pull, double-throw switch:



SIGNETICS 322 DUAL FLIP-FLOP JK

The outputs A, $\bar{A}$, B and $\bar{B}$ give the required logic for the four phases. In the case of the A. W. Haydon motor, a single transistor 2N3569 was used to drive each phase, as shown below:



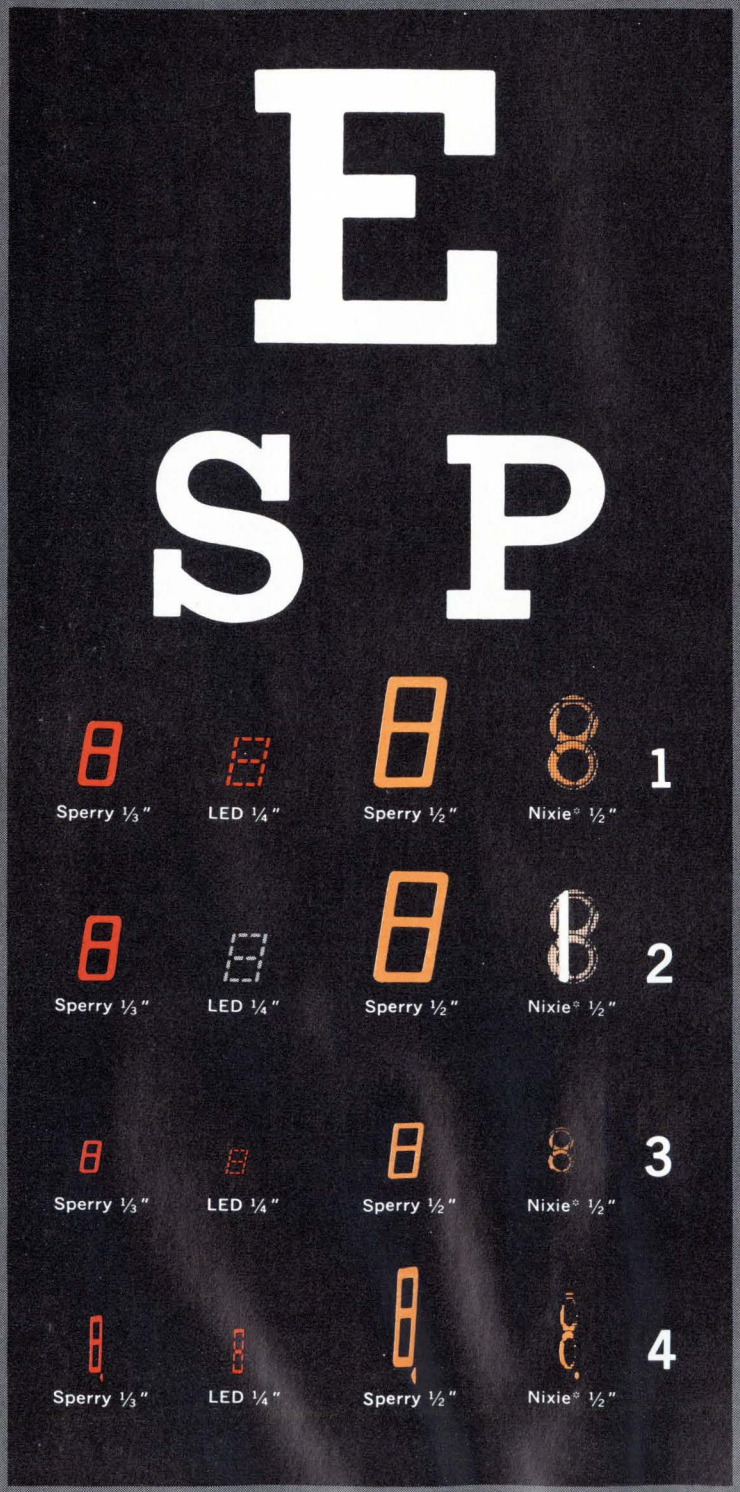
By interchanging A and $\bar{A}$ through a dpdt switch, motor direction is reversed.

Note that the following modes are used in the flip-flop:

t_n		t_{n+1}
J	K	Q
0	1	0
1	0	1

Joel Schwartz
President
Bio-Optical Devices Inc.
White Plains, N. Y.

The Sperry eye test for display equipment buyers



The above is a printed interpretation of the appearance of the more popular displays. You are encouraged to make the same comparison with actual devices.

The old saying "what you see is what you get" certainly applies to the purchase of equipment incorporating displays — panel meters, DVM's, multimeters, counters, instruments, calculators and other equipment. If you can't clearly and easily read the information being displayed then you're not getting full product value. And, you're obviously not getting equipment supplied with advanced Sperry planar displays†.

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1. **Do the displays appear as uniformly bright, continuous characters with no irritating gaps or filaments and screens to reduce readability?**
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2. **Do the displays remain bright and clearly legible with no glare or appreciable fading even under direct sunlight conditions?**
   ☐ **YES** ☐ **NO**
3. **Can you quickly, easily and accurately read the displays from 20 to 40 feet away?**
   ☐ **YES** ☐ **NO**
4. **When the unit is positioned within a 130° viewing angle, can you still clearly read the displayed characters?**
   ☐ **YES** ☐ **NO**

If you answered YES to all four questions, you already have your eyes on equipment featuring preferred Sperry displays.

If you answered NO to any of the questions, you owe it to yourself to take a comparison look at products equipped with superior Sperry displays.

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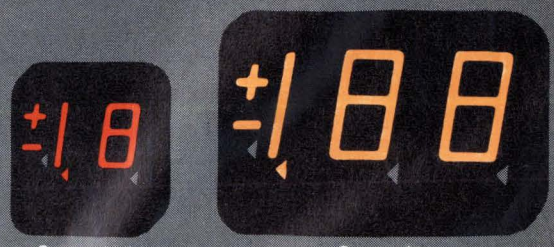

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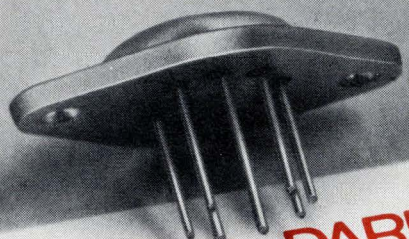

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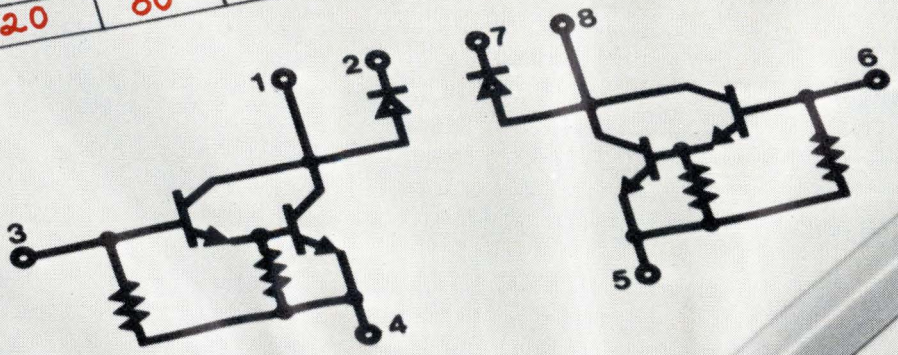
PIC500	30	100	2000	1.5	0.55	2.0	TO-3 (8-pin)	$10.00
PIC501	20	100	1000	2.0	0.65	3.6		6.50
PIC502	20	80	750	2.0	0.65	3.6		4.90



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	Peak I_C A	Type	Package	V_{CER} V	h_{FE}	$V_{CE(sat)}$ V	t_{on} ns	Price (100-999)
NPN	5	U2T301 U2T401	TO-33 TO-66	60	1000 @2A	1.5 @2A	300	$1.25 1.50
		U2T305 U2T405	TO-33 TO-66	150	1000 @2A	2.5 @2A	400	1.80 2.10
	10	U2T101 U2T201	TO-33 TO-66	80	2000 @5A	1.5 @5A	400	2.25 2.55
		U2T105 U2T205	TO-33 TO-66	150	1000 @5A	2.5 @5A	500	2.85 3.15
	20	U2T501 U2T601	TO-66 TO-3	80	2000 @10A	1.5 @10A	400	4.30 4.30
		U2T505 U2T605	TO-66 TO-3	150	1000 @10A	2.5 @10A	500	5.40 5.40
PNP	5	U2T351 U2T451	TO-33 TO-66	60	1000 @2A	2.0 @2A	250	1.50 1.80
		U2T355 U2T455	TO-33 TO-66	120	1000 @2A	2.5 @2A	300	2.16 2.52
	10	U2T151 U2T251	TO-33 TO-66	80	2000 @5A	2.5 @5A	300	2.70 3.06
		U2T155 U2T255	TO-33 TO-66	120	1000 @5A	3.0 @5A	400	3.44 3.78
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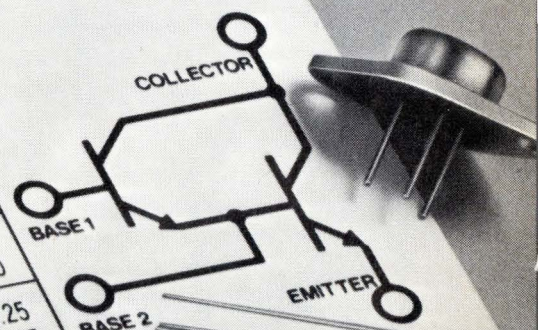

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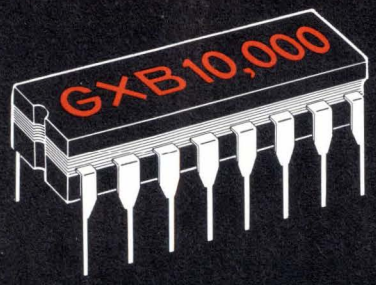
ECL



European production of ECL 10,000 has started

First in the field is Philips with a pin-for-pin compatible family. Twenty devices are currently available, more are coming throughout 1973. Including a 256-bit RAM and 1024-bit PROM.

As well as being the first and only European produced ECL range, Philips GX family has other advantages.

Small, but significant, is the convenient type numbering. Philips GXB 10102 is equivalent to the ECL 10102, for example. And although they are compatible, Philips GXB 10,000 does not suffer from spurious oscillations. A special network is built into every logic input to ensure that the real part of the input impedance stays positive.

The table shows you what's available (we're already delivering) plus what's coming through 1973.

For price, delivery, technical and quality control information contact:

Philips Industries,
Electronic Components and Materials Division,
Eindhoven - The Netherlands.

In USA contact: Amperex Electronic Corporation, 230 Duffy Avenue, Hicksville, N.Y. 11802.

GXB 10101	Quad OR/NOR Gate with Strobe
GXB 10102	Quad NOR Gate
GXB 10105	Triple 2-3-2 OR/NOR Gate
GXB 10106	Triple 4-3-3 NOR Gate
GXB 10107	Triple Exclusive OR/NOR Gate
GXB 10109	Dual 4-5 OR/NOR Gate
GXB 10110	Dual 3-Input/3-Output OR Gate
GXB 10111	Dual 3-Input/3-Output NOR Gate
GXB 10115	Quad Line Receiver
GXB 10117	Dual 2-Wide O-A/O-A-I Gate
GXB 10118	Dual 2-Wide OR-AND Gate
GXB 10119	4-Wide OR-AND Gate
GXB 10121	4-Wide O-A/O-A-I Gate
*GXB 10124	Quad TTL to ECL Translator
*GXB 10125	Quad ECL to TTL Translator
GXB 10130	Dual D Latch
GXB 10131	Dual D Master-Slave Flip-Flop
*GXB 10132	Dual Multiplexer with Latch
*GXB 10133	Quad Latch with Output Enable
*GXB 10136	Universal Up/Down Binary Counter
GXB 10160	12-Bit Parity Generator/Checker
GXB 10161	Binary 1 of 8 LOW Decoder
GXB 10162	Binary 1 of 8 HIGH Decoder
GXB 10164	8 Line Multiplexer
*GXB 10173	Quad Multiplexer with Latch
*GXB 10174	Dual 4-1 Multiplexer
*GXB 10175	Quint Latch
*GXB 10179	Look Ahead Carry Block
*GXB 10181	4-Bit Arithmetic Logic Unit
*GXB 10149	1024-Bit PROM (256 x 4)
*GXB 95410	256-Bit RAM (256 x 1)

* To be introduced through 1973.

PHILIPS

Electronic Components and Materials


PHILIPS

40 years ago

From the pages of Electronics, December 1932

According to G.R. Stanbury of the Wool Industries Research Association, visual methods of wool comparison, although popular among practical men, are unreliable; for instance, a black yarn on a white background always appears to be much more uneven than a white yarn of similar quality on a black background.

For accurate work a photo-electric method has now been developed. A shadow cast by a short length of yarn affects the amount of light falling on a photoelectric cell and the resulting current is measured and recorded with the aid of a Lindemann electrometer. A constant-speed induction motor, through a 400-to-1 gear, drives both the rollers which draw the yarn across the slit placed before the cell, and also the recording camera. The results obtained agree quite well with those obtained by weighing yarn samples.

At the Business Show held in New York City this fall, the Royal Typewriter Company exhibited one of its automatic electric typewriters which continuously printed the same message. Ordinarily this machine was not in motion, but if a visitor came into the booth and reached for one of a pile of circulars on the table alongside the typewriter, the machine immediately began pounding away, being controlled by a photocell, the beam of which was interrupted by the visitor's hand reaching for the circular.

In one of the plants of the International Paper Company it became important to find some way of counting the logs being ground up into pulp while the logs were on their way to the paper machine.

After trying various methods a photoelectric cell was resorted to with entire success, the logs being automatically counted as they flash by, carried by a rushing stream of water moving at high speed. A projector lamp throws a beam of light across the log raceway, and each log that sweeps by intercepts the beam and operates the counter.

AVX

bullish about ceramic capacitors

The ceramic capacitor market is bullish. AVX Ceramics, subsidiary of Aerovox Corporation, turns bullish to meet industry's demands.

AVX Ceramics recognizing design, quality assurance and production as keys to satisfying the market needs, beefs up operations to meet any and all demands.

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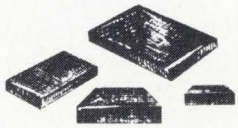
AVX Ceramics' capabilities are unlimited. A wide product line includes Ceralam multilayer ceramic capacitors in chips, molded and dipped radial, molded axial as well as ceramic discs, tubular feed thrus, voltage multipliers and ceramic filters.

When our new manufacturing facility opens in six months, AVX will further enhance its position as the leading manufacturer of ceramic capacitors through continuation of an outstanding line of quality products, increased production and assured on-time delivery.



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Type ULA

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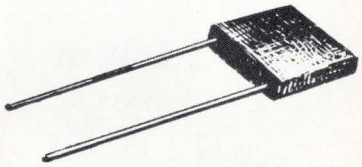
CERALAM RADIALS
Type CK05 — CK06 and
CKR05 — CKR06
Established Reliability



10 PF to 1 MFD range in tolerances of ±10% and ±20%. Dissipation factor 2.5% maximum. Working voltages of 50, 100 or 200 VDC.

CERALAM AXIALS
Type CK12 through CK16 and CKR11 through CKR16 Established Reliability

10 PF to 3.3 MFD in tolerances of ±10% and ±20%. Dissipation factor 2.5% maximum. Working voltages 50 or 100 VDC.

For complete information, write AVX Ceramics Corporation, P. O. Box 867, Myrtle Beach, South Carolina 29577.
(803) 448-3191.

AVX
CERAMICS CORPORATION
Braintree, Massachusetts

People

NRMEC'S Beale set for telecommunications

Beale: NR's man for telecommunications.

With a nice-sized piece of the calculator and business-machine MOS business in its pocket, North American Rockwell Microelectronics Co. is setting its sights on telecommunications. And the man in charge is H. A. (Andy) Beale, most recently manager of advanced systems at the Research and Technology division in NR's electronics group in Anaheim, Calif. Beale's function as director of telecommunications development will include analyzing prospects for NRMEC's existing products, and recommending areas for future effort.

Beale, 39, has a head start in this area. NRMEC is already delivering complete 4,800-bit-per-second adaptive modem assemblies to an OEM customer, is making sets of MOS chips for American Data Systems to put in modems, and is producing lower-speed modem chips for other manufacturers. The company has also developed a push-button-phone generator circuit ("We've had some good nibbles from telephone suppliers"), and has a microcomputer set called the parallel-processing system that appears useful in PABX and other telecommunications switching uses.

Beale says that NRMEC will continue to make both MOS chips and such value-added equipment as the modem board. However, he evinces no interest in marketing to end-users and expects to stick to the OEM role. A good reason may be that some of the products seem likely to disappear as separate entities. Says Beale: "The tendency is to integrate modems into equipment, rather than use stand-alones." For example, in low-speed one-chip modems, NRMEC emphasizes systems.

A part of Beale's work will involve tying together efforts in telecommunications in various parts of NR's Electronics group. His background seems well-suited for that; at the R&T division, he worked with graphic systems, and earlier he supervised design of the original Sharp calculator, as well as point-of-sale terminal equipment. The Autonetics division—another part of the group—is active in military telecommunications, and R&T has devoted considerable effort to simulation of communications systems.

Beale has worked at NR's Electronics group and its predecessors since he received his MSEE from Stanford in 1956, but he obviously relishes the new area he's in: "We expect to have considerable '73 growth in the telecommunications area."

Caffiaux heads EIA response to Defense economy drive

When Jean Caffiaux departs his Washington office at the Electronic Industries Association at the end of the day, he usually heads for a suburban Maryland-bound bus marked "Leisure World." But, as staff vice president of EIA's Government Products division, Caffiaux more often than not totes a heavy attaché case that suggests his after-office activities are not all leisure. For example, Caffiaux's latest effort involves pulling together an EIA task force to determine what industry can contribute to the Defense Department's design-to-cost goals [*Electronics,* Aug. 28, p. 25].

"We are well under way," says the lean 47-year-old manager, "on a program that will come up with some definite hard recommendations to DOD on the reduction of data" required of contractors and customers alike in the military procurement system.

From that effort, as well as more than a dozen other analyses of military contract cost escalators, Caffiaux figures that EIA's membership may be able to come up with as many as a half-dozen responses to

The AN2532 got to be the largest selling digital panel meter in the world with Nixies. Now it's also available with a big, bright, up-front Sperry planar display. You can read it from wider viewing angles and you can see it plainly from 25 feet. Makes any front panel look more attractive.

But we didn't compromise any of the 2532's best-selling features, like accuracy 0.05%, stability of 50 ppm/°C, floating bipolar differential inputs, 1000 megohms input impedance, BCD outputs, low power requirements. And reliability – few other meters can survive our QC routine.

The AN2532 is still under $100 in quantity and still backed by technical assistance in the Analogic tradition. Start by asking for complete technical information – we'll include our 28-page booklet on the theory and applications of DPMs and our A/D-D/A Reference Guide. Analogic Corporation, Wakefield, Mass., (617) 246-0300, manufacturers of the largest line of DPMs in the world.

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West, 303-744-3301, 505-523-0601, 602-946-4215, 505-296-8303, 714-540-7160, 408-374-5220, 206-762-7664, 503-646-6064, 503-646-3416
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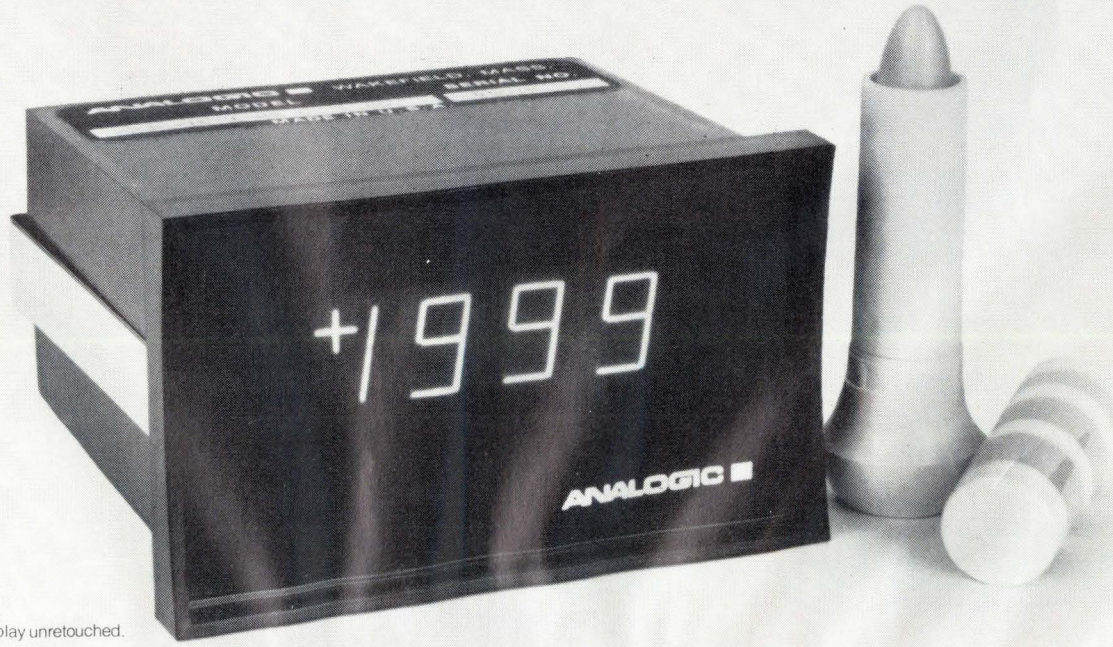

Display unretouched.

Circle 15 on reader service card

the Director of Defense Research and Engineering's drive to cut weapons-system costs. Says DDR&E's Jack Ganzler of the EIA effort, "give us one good idea and we'll be happy."

But Caffiaux, a determined optimist, suspects that EIA has more than one. "We're going to explore the concept of getting industry involved in DOD systems decisions at earlier stages, before the contracts are let, without the limiting factor of hardware exclusions," he explains. "And there are the questions of standardization, greater use of standard modules, and the whole area of using 'warranties' for systems" similar to those offered on commercial and industrial-product lines.

Changes. Caffiaux's latest effort reflects a significant change in EIA's role since he joined the association 19 years ago as a staff engineer. Then based in New York, "we had offices looking out on an air shaft," he recalls, "and it was filled with pigeons. It seemed certain that they would fly in and take over the conference room." Most of the effort of the small overworked and overextended staff was devoted to trying to write standards and assigning type numbers and standards to tubes and semiconductors.

Son of a New York City policeman, Caffiaux grew up in Bayside, Queens. It was on Long Island that he entered the electronics industry, working seven years for Sylvania Electric Products Co. there while taking his BSEE nights under the G.I. Bill at the polytechnic institute of Brooklyn.

It was at Sylvania that he met his wife Joann, the boss's secretary, and, he recalls, "the only girl in the operation" with half-a-hundred engineers. Now the father of two girls and a boy, ranging in age from 19 to 14, Caffiaux lives in Silver Spring, Md., where he indulges his interests in reading, much of it in the area of government and social growth, as well as the more active hobbies as "hunting, fishing, skeet-shooting, and anything that involves camping and the outdoors generally." He is also teaching himself to play the slide trombone.

For the really tough applications, OEM's like Magnavox choose HP.

We all know what collisions at sea can mean to a company's reputation. That's why Magnavox sought reliability above all else in choosing the HP 2100A minicomputer for its all-weather, worldwide Satellite Navigation System. It brings added safety and economy to the operation of large ocean-going vessels. Including the new deep-draft supertankers which must navigate through narrow channels.

In fact, reliability is one of the major reasons why OEM's are using Hewlett-Packard's line of thoroughly modern minis for their systems. But reliability is not enough. Magnavox, like any OEM, also must be competitive in their market place. Hewlett-Packard's 2100A solved their need. Competitive? Just try us!

And modular. So compact and rugged that entire Magnavox systems can be transferred from one vessel to another. Adaptable, too. Commercial transports, oil tankers, passenger ships, exploration vessels for the Navy and Coast Guard. Virtually every large ship plying the waterways of the world can use this system to pinpoint instantly its position anywhere in the world. Night or day.

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Circle 17 on reader service card

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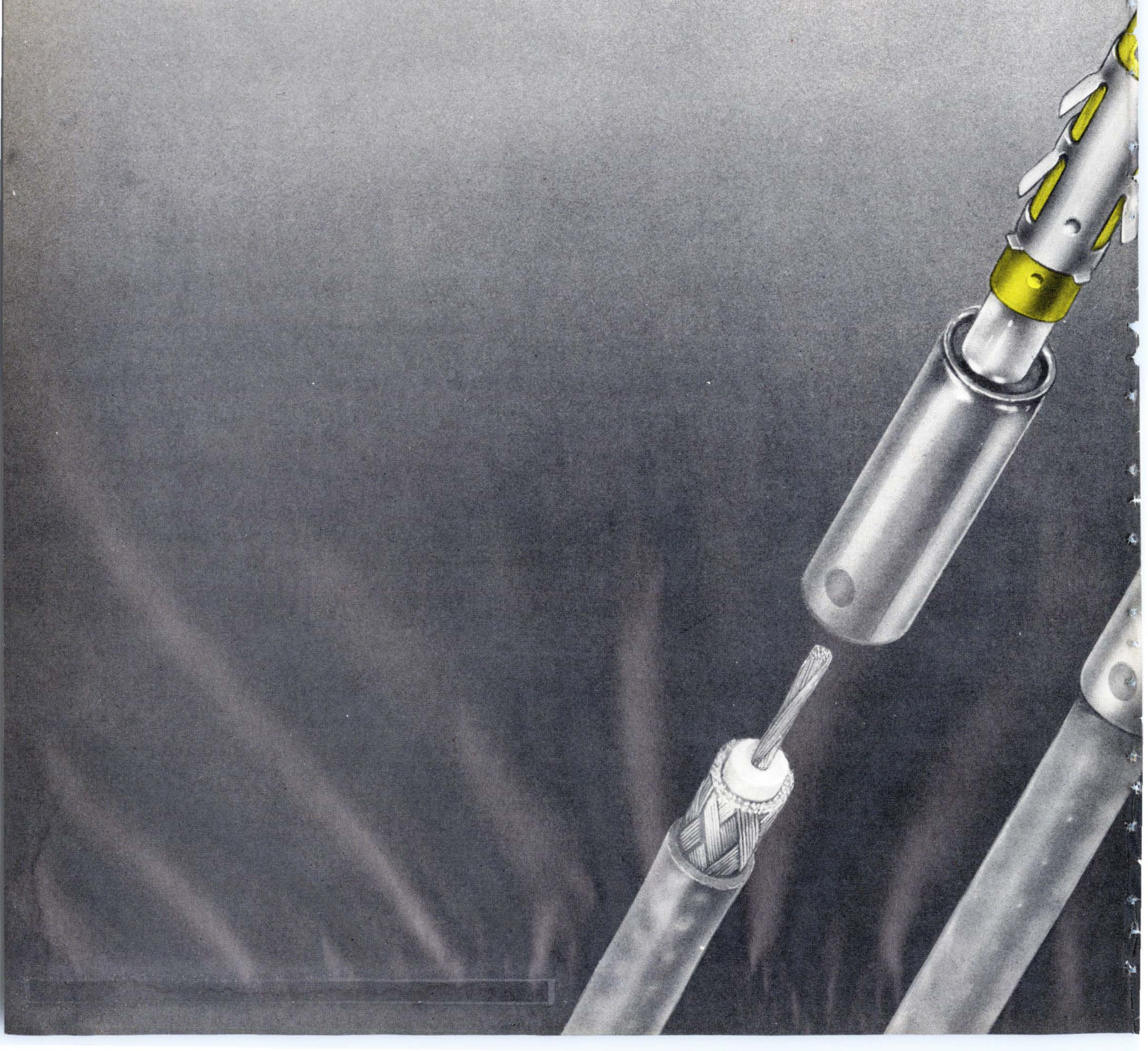
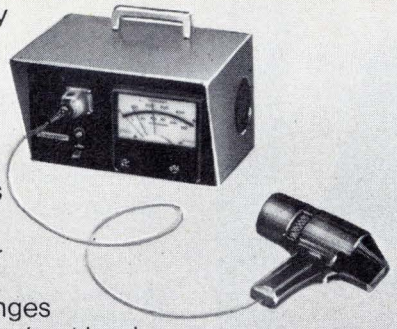
Just four simple steps are required. Insert the coax or twisted pair. Crimp the inner conductor. Crimp the outer conductor. Heat to reflow the solder.



You can expect fewer rejects and more reliable connections because quality control is improved along the line. There are tiny inspection holes to permit a visual check before each crimp is made. A Burndy exclusive is the small black dot that appears when the soldering is completed. It's a heat-sensitive paint on the outer ferrule that changes color to indicate proper heat has been applied for sufficient time.



A range of Burndy tooling is available to let you match your job needs and production rates precisely. For high production, our bench mount CATS machine can crimp and reflow solder up to 240 contacts an hour. If you want a portable system that works in limited access areas, use our MINI-CATS machine (pictured left).

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Circle 19 on reader service card

Meetings

Business and Equipment Exposition: NRMA, New York Hilton, New York, Jan. 7–10.

Aerospace Sciences Meeting: AIAA, Sheraton-Park, Washington, Jan. 10–12.

International Solid State Circuits Conference: IEEE, Marriott, Philadelphia, Feb. 14–16.

Aerospace and Electronic Systems (Wincon): IEEE, Sheraton-U. of Pa., Philadelphia, Feb. 13–15.

IEEE International Convention (Intercon): IEEE, Coliseum and New York Hilton, March 26–29.

Southwestern IEEE Conference and Exhibition (Swieeeco): IEEE, Houston, Texas, April 4–6.

International Symposium on Circuit Theory: IEEE, Four Seasons Sheraton, Toronto, Canada, April 9–11.

International Magnetics Conference (Intermag): IEEE, Washington Hilton Hotel, Washington, D.C., April 24–27.

Carnahan Conference on Electronic Crime Countermeasures: IEEE, U. of Kentucky, Carnahan House, U. of Kentucky, Lexington, Ky., April 25–27.

Electron Device Techniques Conference: IEEE, United Engineering Center, New York, May 1–2.

Naecon: IEEE, Sheraton, Dayton, Ohio, May 14–16.

International Symposium: SID, Statler-Hilton, New York, May 15–17.

Measurement and Test Instrument Conference: IEEE, Skyline Hotel, Ottawa, Ont., Canada, May 15–17.

Conference on Laser Engineering and Applications: IEEE, OSA, Hilton, Washington, D.C., May 30–June 1.

National Computer Conference and Exposition: Afips, New York Coliseum, New York City, June 4-8.

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SIGNETICS ROM SELECTION GUIDE

BIT DENSITY	ORGANIZATION	POWER SUPPLIES	MAX. ACCESS TIME (NS)	COST/BIT (100-999)	TYPE
8,192	2,048 x 4	+5, −12V	700	0.20¢	2580N
5,184	64 x 9 x 9	+5, −12V	750	0.31¢	2526N
4,096	512 x 8	+5, −12V	750	0.39¢	2530N
3,072	64 x 5 x 7	+5, −5, −12V	600	0.29¢	2516N
2,560	64 x 7 x 5	+5, −5, −12V	600	0.35¢	2513N
2,048	256 x 8 512 x 4	+5, −12V	950	0.47¢	2461Y
2,048	256 x 8 512 x 4	+12, −12V	750	0.47¢	2430Y
1,024	256 x 4 128 x 8	+5, −12V	950	0.94¢	2451Y
1,024	256 x 4 128 x 8	+12, −12V	750	0.94¢	2420Y
1,024	256 x 4	+5, −12V	950	0.88¢	2441I
1,024	256 x 4	+12, −12V	750	0.88¢	2410I

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The modular, *plug-in architecture* that lets you design your own keyboard. The choice of *memories* that lets you pick the capacity you need today—with room to grow for tomorrow. The extensive line of Series 9800 *Peripherals* that lets you handle data in the form best for your operation. And the *instrument interface* that lets you plug in test instruments for real-time data acquisition.

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That's the idea. Here's the payoff. On the left is a typical equation solved with the HP Alpha Printer. On the right, the same equation solved without alpha.

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SOLUTION TO
QUADRATIC
EQUATION
OF THE FORM
  2
AX +BX+C=0

ENTER A=
          1.000*
ENTER B=
          1.000*
ENTER C=
          1.000*


COMPLEX ROOTS
REAL PART=
         -0.500
IMAGINARY PART=
          0.866
```

```
          1.000*

          1.000*

          1.000*


         -0.500
         -0.866

         -0.500
          0.866
```

The benefits? Instant verification of your program and input data. Positive identification of each portion of your solution. And the confidence that you can send data to your colleagues and have them understand it.

Moreover, with these easy-to-comprehend user instructions, your assistants can confidently and reliably operate a 9800 Calculator with no computer training whatsoever.

Series 9800 users in science, engineering, medicine, and business have been telling us this silent, built-in "mini-typewriter" is the greatest boon to problem solving since the invention of the electronic calculator. (Note: If you need the formatting versatility of a full-fledged typewriter, we offer one of those. Also with complete Alphanumerics.)

This Printer is but one example of the technology that's enabled us to offer the widest and most exciting line of computing alternatives in the scientific community. Today, our line starts with the dynamic Model 35 Calculator—a shirt-pocket size electronic, super slide rule. Goes to our Series 9800 Programmable Calculators. To our 2100 Minicomputer family. On through to our System 3000, a multi-lingual, multi-programming computer.

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092/6

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For information on the HP-35, circle reader service no. **219**

Bendix puts an end to the bends.

You know the bends. That's when connector pins are bent or damaged during mating by misaligned plug and receptacle.

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You get five-key polarization, too. And that makes mismating a thing of the past.

Another key feature: Bendix 100% scoop-proof SJT connectors conform to the mounting dimensions of low silhouette (JT) series II MIL-C-38999 connectors. They're available in lightweight shell sizes from 8 to 24 with from 3 to 128 crimp type contacts accommodating wire gauges from 12 to 28.

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The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

Circle 24 on reader service card

Electronics newsletter

AMI, Motorola jointly developing 4,096-bit RAM

A cooperative effort to develop a 4,096-bit MOS random-access memory is believed to be in the works between Motorola Semiconductor and American Microsystems Inc. The device, said to have reached the prototype stage, is an n-channel, silicon-gate read/write memory intended for medium-speed applications. **Tests of the first devices reportedly indicate that they will hit a target access time of 200 nanoseconds. Standby power is 1 microwatt per bit.**

One semiconductor marketing executive says, "To be a factor in the RAM market, you need a second source, but the AMI-Motorola deal is unique in that they've worked together in developing the part from the beginning."

Raytheon wants to buy MOS setup

Raytheon Corp. is on the acquisition trail. The company, which for the lack of a better investment has been buying its own stock on the open market, has set aside $75 million for acquisitions. **Part of this has been funneled to Raytheon Semiconductor in Mountain View, Calif., for the acquisition of an MOS facility.** The company several years ago let go of its small MOS effort, but now it wants to buy back in—this time with a going facility so that Raytheon can participate immediately in the MOS-memory business.

Meanwhile, in bipolar memories, Raytheon Semiconductor **still has not delivered any of the 1,024-bit V-ate RAMs, it announced a year ago.** The latest effort to get things going has included diversion of a half-million dollars from development of ECL and Schottky TTL—to the V-ate project. The schedule now calls for a thousand or so parts to be shipped by the end of the first quarter of 1973.

IBM puts n-channel, Schottky on one chip

The goal of building memories with infinite speed and packing density at infinitesimal power consumption may have been brought a step closer by researchers at IBM's Watson Research Center, Yorktown Heights, N.Y. They have combined standard n-channel MOS processing and Schottky-barrier diodes on a single chip. **The result: a 2,048-bit random-access memory with access time of 30 nanoseconds and cycle time of 120 ns.** Chip size is 190 by 135 mils. The memory, which uses high-barrier Schottky diodes as bit drivers and low-barrier (reverse-biased) diodes as loads, had an average cell standby power of 200 nanowatts, which works out to a mere 200 millowatts per chip.

Russians want to buy U.S. ATC equipment

Russian interest in U.S. equipment to upgrade Soviet air-traffic control systems and navigation aids is sparking a U.S. Government-industry plan to assess and meet that market. **In closed Dec. 12 and 13 meetings, the FAA briefed industry on the Soviet civil-air system.** Tops on Russia's shopping list are terminal area ATC systems, followed by ATC simulation, ATC training aids, and landing systems. One company puts the potential market at $1 billion.

VA awards pay

The Veterans Administration has awarded disability compensation to a Korean war veteran for cataracts allegedly caused by microwave radi-

ation. **The action marks the first time any Federal agency has recognized any injury directly related to microwave radiation.**

The veteran, Arthur Kay of New York City, was declared 20% disabled. "I'm going to appeal to the New York office for at least 60%," says Kay. In addition, he says he plans to appeal again to the Board of Veterans Appeals in Washington for other disabilities.

Video disk for commercial use

While competitors like RCA and Philips are rushing to get a video disk ready for the consumers, **Arvin Systems Inc., Dayton, Ohio, claims that its new magnetic video disk recorder already has a $1 million backlog in the educational/industrial market.** Priced at $4,000, the system uses a flexible disk mounted in a $25 Discassette that is inserted into the player in much the same way as an audio tape cassette.

IEEE may open show floor to sales activity

Exhibitors at the IEEE show in New York next March very likely will be able to make sales and close deals on the exhibit floor, **if the Internal Revenue Service approves the institute's application for a new tax status.** The application was dictated by the recent members' vote to amend the institute's constitution.

Autonetics works on inertial nav for Trident sub

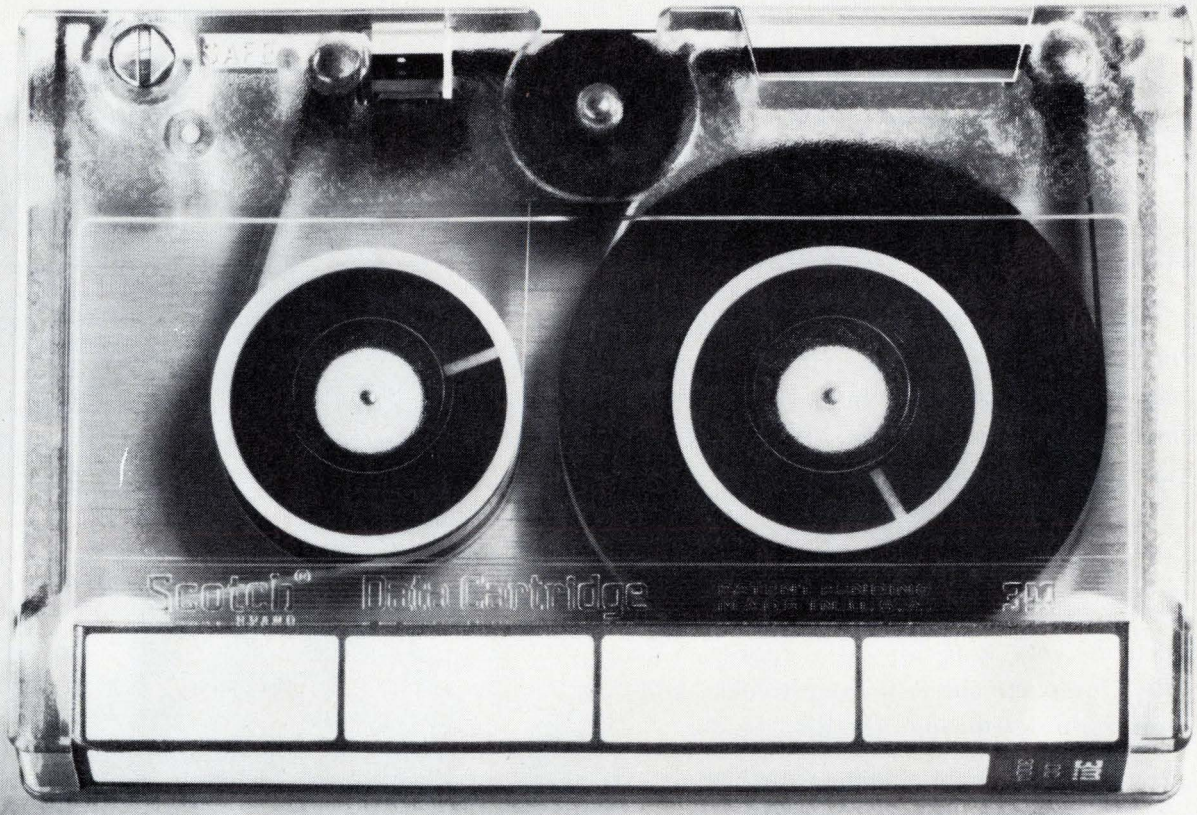
The Autonetics division of North American Rockwell Corp. is hard at work on inertial navigation systems for the upcoming Trident class of missile-firing submarines. **Sea trials of an advanced-development model of an Autonetics inertial unit that uses electrostatic gyros will begin in January or February** aboard the USS Compass Island, a Navy test ship. Both Autonetics and Honeywell Inc. in St. Petersburg, Fla., have Navy funds to develop electrostatic gyros and run the sea trials.

An Autonetics source says that, to avoid detection, the new inertial units in the Trident subs will have to be able to run for weeks without any updating. Autonetics also supplied the Ships Inertial Navigation System (SINS), which runs for days without updating, aboard today's Polaris and Poseidon subs. A source says the initial **Trident boats could carry either the new inertial units with strapdown electrostatic gyros or an updated version** of the SINS for the Polaris/Poseidon boats. Autonetics is updating its SINS units, which use conventional gimbeled gyros, to be ready for either eventuality.

Addenda

Intersil Inc. of Cupertino, Calif., which introduced a $1-per-switch analog gate six months ago, is about to introduce a new 12-product line of the devices. But this time they'll be C-MOS devices. . . . Data General Corp. is making its own cores for computer memories. . . . The tight supply situation in light-emitting-diode displays **should be helped by the entry of a new firm,** Epidyne Corp. of El Segundo, Calif., into the GaAsP field. . . . The Defense Department's drive to have contractors **design to cost** [*Electronics*, Aug. 28, p. 25] **and then hold them to it in future business** reportedly was a significant element in the Pentagon's refusal to permit cost overruns on the F-14. A court fight seems certain now that the contractor, Grumman, refuses to deliver 48 more to the Navy at an estimated price of $570.1 million.

This tape cartridge may be new to you.



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In fact, the cartridge tested out so well and was so easy to use that manufacturers are announcing complete low cost digital storage systems built around it. And others are building drives just for it.

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She began phoning Fighton and offering our services. They're not a huge company. In fact, they're minority-owned and managed, and fairly young. At first they seemed a little skeptical about GE's direct interest in them.

But Kathy kept at it. Finally she convinced them to give us a try. Our delivery schedules looked good. Prices were fine. Best of all, we seemed sincere.

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Test system's computer simulation replaces hardware

RCA Equate, built for Army, does away with racks of sweepers, oscillators, other gear, permits 100% testing

If design engineers can use computers to simulate electronic equipment, why can't test engineers substitute computer simulation for test equipment? They can. This is the approach taken by the RCA Aerospace Systems division, Burlington, Mass., in developing the Equate comprehensive test system.

Its name an acronym for electronic quality-assurance test equipment, Equate could not only potentially do more than such other automatic test systems as Vast or RCA's own Sate or Dimate systems, but it also is smaller, faster, and much less expensive.

Substitution of computer hardware and software—mostly software—for expensive analog and digital test gear sets Equate apart from prior automated test systems. Instead of merely controlling the system, Equate's Data General Nova 800 minicomputer also helps compile test programs, generates all test stimuli up to 1 megahertz, and analyzes all results. And because Equate operates under software control, it can be tailored rapidly to the needs of nearly any type of electronic test. Because it substitutes software for test hardware, IC counters, shift registers, and d-a converters, Equate can replace racks of conventional and costly pulse, word, and function generators, sweepers, oscillators, amplifiers, and more.

For example, fast Fourier computation can make unnecessary such costly instruments as multimeters, distortion analyzers, demodulators, and spectrum analyzers. Indeed, RCA engineers even claim to have improved on the performance of most of these devices.

Equate grew out of the Army's need for more thorough testing of electronic gear. Until now, nearly everything the Army has bought, from battlefield-radar systems to walkie-talkies, has been sample-tested—say, a few units per hundred—and it's been necessary to limit even those tests to a few parameters. There was a need for a comprehensive, flexible test system with low initial price and low overhead that could make 100% testing cost-effective.

On time. RCA signed in mid-1971 to develop Equate for $650,000. Delivery was set for June 1973. So far, say RCA spokesmen, development is ahead of schedule, and the Army Electronics Command's Production Engineering branch in Philadelphia should receive the first system on time. What's more, the Army's desire for low initial cost and overhead should be met.

In quantity, Equate could sell for as little as $300,000 for use in commercial environments; units built to military specifications would probably cost $200,000 more. In contrast, the price is $1.5 to $2 million for a Dimate system. Also, while Dimate could test only to 500 MHz and required 11 racks full of discrete test equipment, Equate runs up to 18 GHz and takes only a third as much floor space.

To cut the number of true rf components, each has been made to cover as broad a band as possible. A single attenuator, for example, covers a band from 1 to 12 GHz. Components also do double duty: generators serve as local oscillators, and attenuators not only control stimulus amplitude, but they also simulate range attenuation (as in radio or radar applications).

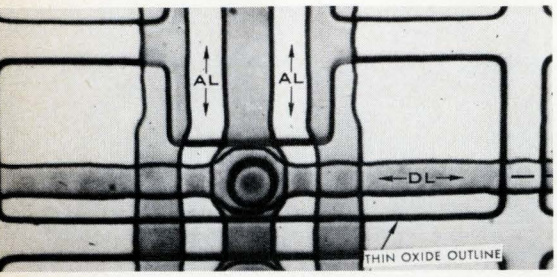
An Equate program is constructed from a series of subroutines, each of which may allow the system to emulate a complex hardware setup. To compose an appropriate test program, the user need only know the specifications to be checked and their tolerances, as well as the logical sequence of events in the test procedure.

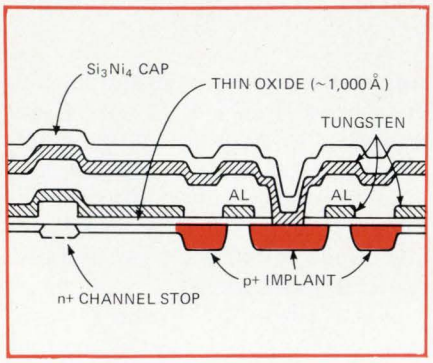
After acceptance, RCA plans to begin marketing Equate nationwide. As soon as it compiles statistics that it hopes will show that 100% testing can at least be cost-competitive with sampling, RCA plans to pitch the system to most major military contractors, the airlines—which are already interested in cutting overhead by automating testing—and other military services. There already have been some nibbles from other services. And Equate's software flexibility means that it can be tailored to different needs, keeping the price low. □

Memories

Bell builds fast p-MOS RAM

Those who have counted out p-channel MOS technology for fast mainframe applications had better take another look. Using a single-





Fast p. Bell Labs has built this p-MOS memory that has an access time of under 150 ns, dissipates 100 milliwatts.

transistor cell construction in p-channel silicon, Bell Laboratories has built a 1,024-bit random-access memory that operates from 10-volt clock systems, has a conservative access time of less than 150 nanoseconds, and dissipates only 100 milliwatts for the entire memory. This performance compares with about 350 ns and 350 mW for presently available 1,024-bit p-RAMs, such as the 1103.

More significant, the Bell RAM was built with fairly loose 10-micrometer fabricating rules. And although the Bell researchers didn't say so, it's clear that if tighter 5-μm geometry is used, the device could be operated at 50-ns access times, even faster than any n-channel 1,024-bit memory on the market. What's more, it would be almost as fast as the new bipolar 1,024-bit RAMs that are now coming on the market.

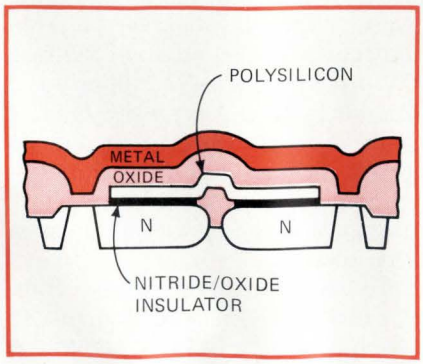
The key to Bell's single-transistor approach is an ion-implanted process and double-level tungsten refractory metal system that minimizes the number of contacts within the array, making the memory more reliable and giving higher yields. Because no contacts are needed between the first tungsten metalization and the silicon, only one contact is required for every two cells, compared to the two or three contacts per cell for conventional silicon-gate RAMs.

Alignment. The refractory metal also serves as an alignment step, as in the silicon-gate process; self-alignment here minimizes the cell area (5 mil^2/bit), while reducing the capacitance on the data lines. (This data-bus capacitance, which robs the memory of speed, was responsible for the failure of previous attempts at single-transistor cells.)

Cell fabrication is accomplished with an ion-implanting step for source, drain, and channel stop. During the fabrication, one of the tungsten metal layers is used for one side of the cell capacitor, and a standard diffusion for the other side, with a standard thin oxide between them. Cell capacitance is about 0.4 picofarad, compared to 0.7 pF for the bus line. This high ratio of cell capacitance to bus capacitance means that the data swing outputs in excess of 0.2 milliampere differential current can be detected quite easily by conventional sense amplifiers. □

Mostek does away with cell contacts

Although there's much talk about 4,096-bit n-channel random-access memories, precious few products are actually on the market—only Microsystems International Ltd. of Montreal has one. Undaunted, Mostek Corp. of Dallas has developed another n-channel process that should cause even more talk.



Simpler. This single-transistor-cell n-channel RAM eliminates all cell contacts within the array. It's by Mostek.

What Mostek has is a single-transistor-cell technique that eliminates all cell contacts within the array. The results promise to be impressive: 300-nanosecond access time, active power of only 60 microwatts per bit, and transistor-transistor-logic compatibility in both inputs and outputs. And since only one transistor per bit is required, instead of the three or four needed by other n-channel approaches, there's a possibility for even more density.

A single-transistor cell requires that charge be stored in a capacitor. Clearly, this storage capacitor must be as large as possible because when the transistor is turned on during a read cycle, the charge is redistributed between the cell capacitance and the bus capacitance (a single bus serves 64 drains in an entire row of cells). Consequently, if the logic swings are to be great enough to be sensed with a sense amplifier, the storage capacitor must be big and the bus capacitance small.

To Mostek, this indicated a self-aligning gate process, which would minimize the bus capacitance. But in most silicon-gate processes, the polysilicon cannot cross a diffusion, so the row-select line would have to be metal and the bus line would have to be a diffusion—requiring a contact for each cell.

No contacts. The new Mostek process, a combination of self-aligning and metal gates, gets rid of all the contacts, while yielding a suitably large storage capacitor in small enough chip spaces to accommodate the 4,096 bits on the chip. Self-aligned metal gates are used for the transistors, while polysilicon forms the grounded plate of the storage capacitor and makes the interconnections throughout the circuit. No contact holes are required within the cell matrix.

Eliminating contacts greatly simplifies the technology, since the creation of contact holes is one of the major factors in reducing yields

from MOS fabrication—there are 7,000 contacts in the cell matrix of a conventionally built 4,096-bit RAM.

In fabrication, an n-type diffusion is used to fabricate the bus as well as to make the transistor source and one plate of the storage capacitor. Again, the other plate of the capacitor is made by a grounded polysilicon layer. In addition, an oxide-nitride sandwich is used for the storage capacitors because nitride has a higher dielectric constant than does oxide, resulting in 2.5 to 3 times the capacitance per unit area. □

Charge coupling used in memories

Though the work in charge-coupled devices being aired these days is mostly confined to facsimile and vidicon-type imaging, the charge-transfer technique is destined to impact semiconductor memories as well. RCA, Fairchild Semiconductor, Bell Labs, IBM, General Electric, and Texas Instruments all are known to have laboratory programs in CCD memory. Others probably conducting research include Intel, Hughes, National, and Signetics.

But taking a CCD memory to the market is much tougher than selling the imaging type, because the memory makers already have at their disposal excellent technology in self-aligned MOS, and solid-state imaging has next to nothing. What's more, CCDs are inherently serial, not lending themselves to random-access schemes, and this could shut out a good piece of the memory market. However, parallel accessing could conceivably be used.

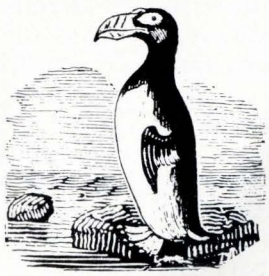
Nevertheless, for shift registers, charge coupling has a lot going for it: it has no inter-cell connections, so its yield should be high, and it should be cheap to build. Since its parts are small, it should be very dense, and it's fast. Indeed, many predict CCD register chips of 10,000 bits with data rates of 20 megahertz. Some experts believe that this kind of shift-register component will signal the end of medium-size disks, which move, are big, and require interfacing of magnetic and semiconductor technologies.

Bell Labs thinks so. Using a two-level refractory gate-channel process that requires only a slight modification to standard MOS-device fabrication, workers at Bell's Murray Hill, N.J., labs have built exploratory CCD shift registers, ranging from 16 to 128 bits in length, that bear out the promise of charge-coupling for memories. Significantly, quite loose (10-micrometer) fabricating rules were used to build these devices, but even so, it appears that the process makes 4,000-bit chips feasible. If commercially tighter photolithographic methods are used—with, say, 5- to 6-μm tolerances—then 8-kilobit register chips would result.

Bell uses a double-implant process. A barrier implant under the gate gives the device a charge-flow bias and makes a two-phase structure possible. A heavily doped implant between adjacent CCD electrodes forms conductive regions, which render device performance insensitive to electrode widths and interelectrode gaps—two yield-killers of earlier devices. Because of this inter-cell implant, the Bell registers, which are called "conductively connected charge-coupled devices," or

NOAA team uses doppler radar as a super bird-watching system

Bird-watching is popularly pictured as requiring no more equipment than a quiet afternoon, a wooded area, and binoculars. But a pair of researchers at the national oceanic and atmospheric administration (NOAA) would bring ornithology up to date by using doppler radar to track birds in flight. Preliminary results indicate that the technique could help pilots dodge flocks of birds around airports, as well as help ornithologists solve some of the ages-old mysteries of bird migration.

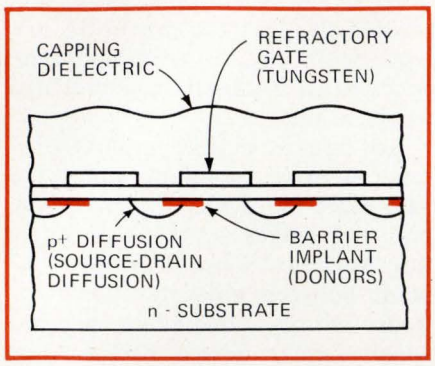


Electronics engineer John L. Green and physicist Ben B. Balsley, amateur ornithologists at NOAA's Aeronomy Laboratory, Boulder, Colo., say that doppler is better than conventional radar used by some sophisticated bird-watchers because it can give a continuous measurement of the bird's movements toward, or away from, the antenna. As different bird types yield different spectral signatures, doppler radar could be used to catalog specific species characteristics, meaning that birds under study would no longer have to be captured and banded to determine their habits

"We did the experiment at low power with a 'giant' 100-milliwatt laser at first," Green says. "We purposely used low power so we could see the birds and corroborate the results."

They now are building a 1-kilowatt laser to make measurements out to 1 kilometer—distance is a function of power and antenna gain, Green notes.

The part-time $46,000 study is funded by the Air Force, which loses several pilots and millions of dollars worth of jet-engine parts a year from collisions with birds. "The Air Force needs to know whether the target is a flock of small birds or one big bird," Green says. By June 1973, the research duo hopes to answer whether or not the technique can be incorporated easily into existing air-traffic control systems and whether the doppler radar technique can discriminate finely enough to satisfy all potential users.



Couples. Bell Labs has built exploratory CCD shift registers of 16 to 128 bits.

C^4D, will also be less sensitive to drifts in oxide charge in the space between the cells. All this adds up to higher yields and more efficient and faster devices. And most important, they are built by a process that Bell already has available at its production facilities. □

Ion implantation comes to op amps

That ion implantation has left the laboratory and taken its place alongside diffusion as a standard fabricating tool is not surprising. But the implantation technique has proliferated in areas never dreamed of for diffusion—in optical waveguides, light-emitting diodes, power amplifiers, and silicon bipolar transistors.

Now implantation is even being applied to the old operational amplifier, and the results are startling. Using implanted complementary transistors, workers at Bell Laboratories in Reading, Pa., have designed op amps with slew rates of 600 volts per microsecond. What's important is that these speeds can be achieved at very modest power levels: 50 milliwatts total is all that's required to power these devices, a power level several times smaller than other high-speed op amps that consume a great deal of power.

True, high-slew-rate op amps can be built with lateral pnp construction, but these devices dissipate upwards of several hundred milliwatts at the highest speed and require special techniques to remove the heat. Complementary pnp, on the other hand, conserves power and therefore can be operated fast—but it is hard to build with standard diffusion, since a double epitaxial structure is usually necessary for complementary structures.

Enter ion implantation. This method is ideal for building double epitaxial structures because, with it, the doping profile can be controlled to whatever degree is required. The result: complementary pnp and npn devices that are as stable and easy to fabricate as conventional lateral pnp.

Two epi layers. Bell's op amps are made with two n-type epitaxial layers on a p-type substrate, with boron implants at each level for precise profile control. First, a high-resistivity, n-type epitaxial layer is deposited. Boron is then implanted to form the collector of the pnp and also to isolate the npn. Next, the second, lower-resistivity, n-type epitaxial layer is deposited. After that, boron is again implanted on the surface of the pnp region and into the isolation areas of the npn in a manner that duplicates the pattern of the first layer. The boron is next diffused until the diffusion profile overlaps through the epitaxial layers.

Phosphorus is then implanted to act as a low-temperature predeposit for the base of the pnp. Next, the npn base diffusion is adjusted to give the required sheet resistance for diffused resistors—about 200 ohms per square. Then the pnp and npn emitter diffusions follow. □

Interdigitation for high power

Getting high power out of a microwave transistor is no mean trick—at high frequencies, device losses are high, efficiency is low, and most of the power goes up in heat. But Daniel Ch'en, a microwave-device specialist at Texas Instruments, thinks he has the answer: interdigitated emitter-electrode structures, rather than matrix types, for powers that range to, say, 10 watts and more at frequencies of 3 gigahertz and higher.

Although interdigitated transistors have been used in many military microwave projects, they are not widely commercially available. But Ch'en thinks that their time has come.

To prove his point, Ch'en and his colleagues at TI's Central Research Laboratory have built 3-GHz interdigitated transistors that are probably better than any commercial matrix structure.

Achieving 45% efficiency, these transistors generate 10 W of continuous power at 3-GHz with a 9-decibel gain.

The use of arsenic-diffused emitters for high f_T is especially well suited to the interdigitated emitter structure. The reason is that the resulting higher series resistance that kills performance in the matrix structure can be avoided with the interdigitated device by using a boron-doped oxide. Indeed, when these emitters were phosporous-diffused, f_T of 4-GHz was obtained with 1-micrometer geometry. This lead to a 50% increase in f_{max} over other devices.

Ch'en also has good ideas for achieving these high powers at higher X-band frequencies. Under development at TI is a double-metal interdigitated design. The first layer of metal would be the interdigitated emitter, say; then a thin dielectric layer would be added for isolation, then over the dielectric would go another set of electrodes for the base.

This double-metal technique has the advantage of minimizing the difficulty of narrow spacing between electrodes that's needed for high-frequency, high-power operation. The dielectric would allow the electrodes to overlap so that fabrication rules need not be so stringent. Another advantage is that, since the base-electrode pattern is now on the bottom of the chip, flip-chip heat-sinking methods are a natural. And removing heat from a transistor op-

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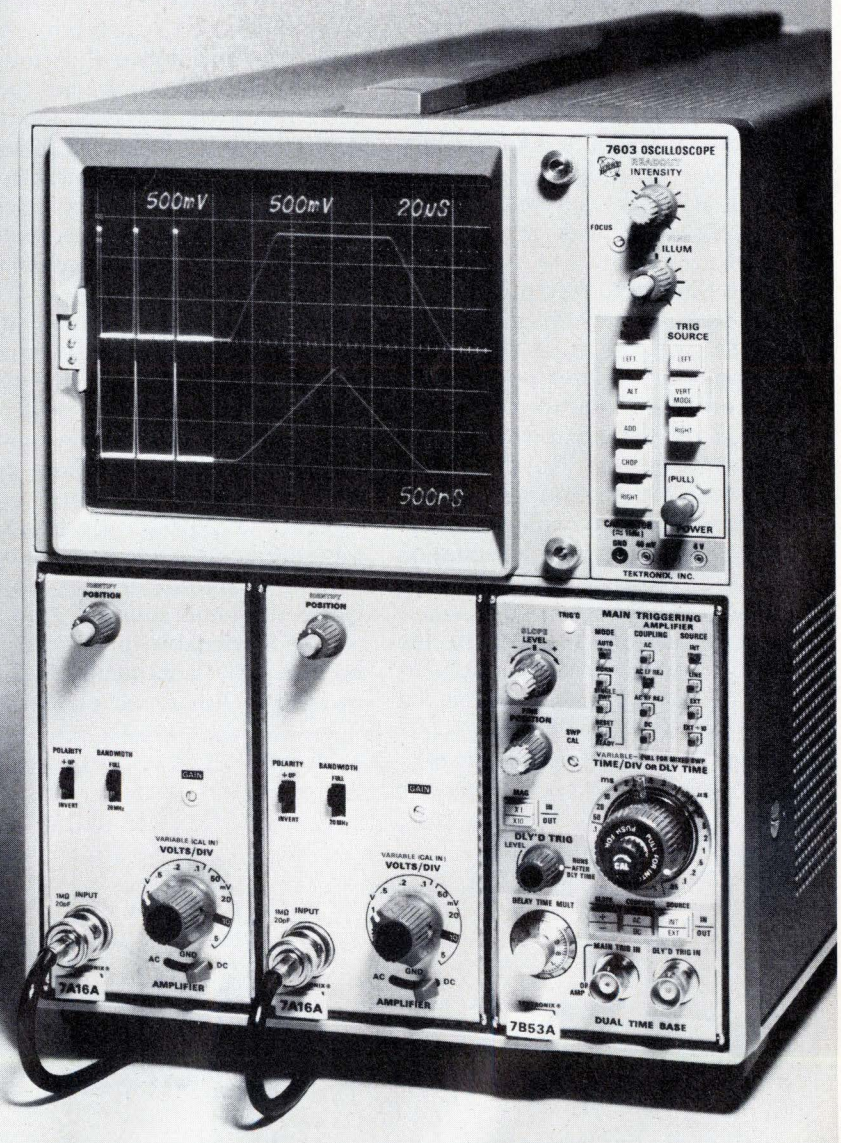

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erating at, say, 10 GHz with 10 W is going to be a major consideration for design engineers. □

Space electronics

SEP looks into the moon

Apollo 17, the last scheduled moon lander, also is scheduled to perform the most exacting geological experiments yet in the Apollo series—perhaps the most highly sophisticated ones in the truncated spaceflight series. Among them is the so-called surface electrical-properties experiment, or SEP, which uses radio emission to "see" into the moon in hope of discovering unsuspected layering, large subsurface rock masses, and perhaps even water.

Gene Simmons, MIT professor of geophysics, conceived and developed the experiment. A solar-powered radio transmitter on the surface transmits data to a receiver mounted on the lunar rover. Both were built by the Raytheon Co. Equipment divison, Sudbury, Mass.

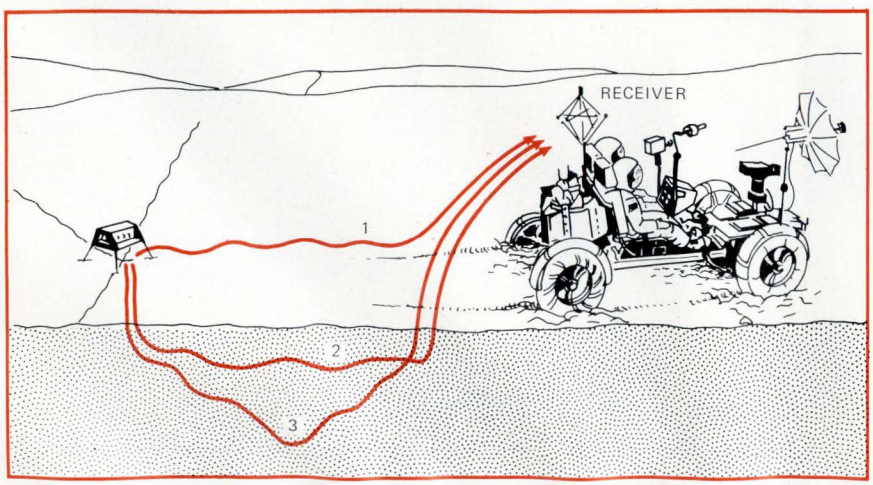
Interferometry techniques measure the dielectric and attenuation properties of the moon's surface. A reference radio path in free space above the surface (path 1 in the drawing) is compared to a subsurface wave (path 2), which is delayed an amount proportional to the dielectric constant of material just below the moon's surface. This delay produces an interference pattern between the two waves, which is recorded at the SEP receiver and brought back to earth for analysis.

A third propagating radio wave will be reflected from any subsurface layers that have significantly different dielectric properties. Thus, the SEP experiment will be able to detect such layering as deep as 1 or 2 kilometers into the moon's crust.

Since dielectric constants vary slightly with frequency, six separate frequencies will be transmitted consecutively and repeated periodically as the moon rover traverses the surface. The frequencies are about 1, 2, 4, 8, 16, and 32 megahertz. Each frequency also will be sampled for each of two transmitter polarizations and for each of three mutually perpendicular receiver-antenna orientations.

While astronauts on the surface are conducting the SEP experiment, high-frequency radio waves will be beamed down from the orbiting command module in an attempt to make a similar subsurface profile over a much larger area of the moon. The radio-propagation speed measurements made possible by the SEP will calibrate this experiment, called the lunar sounder. And since for the foreseeable future, radar will be the only continually available method of lunar and planetary exploration, this sort of calibration is a necessity for accurate studies of other planets. □

Under the skin. Using interferometry techniques, Apollo's SEP will measure dielectric and attenuation properties of moon's surface. The object is to "see" what lies below it.



NASA plans a heavyweight

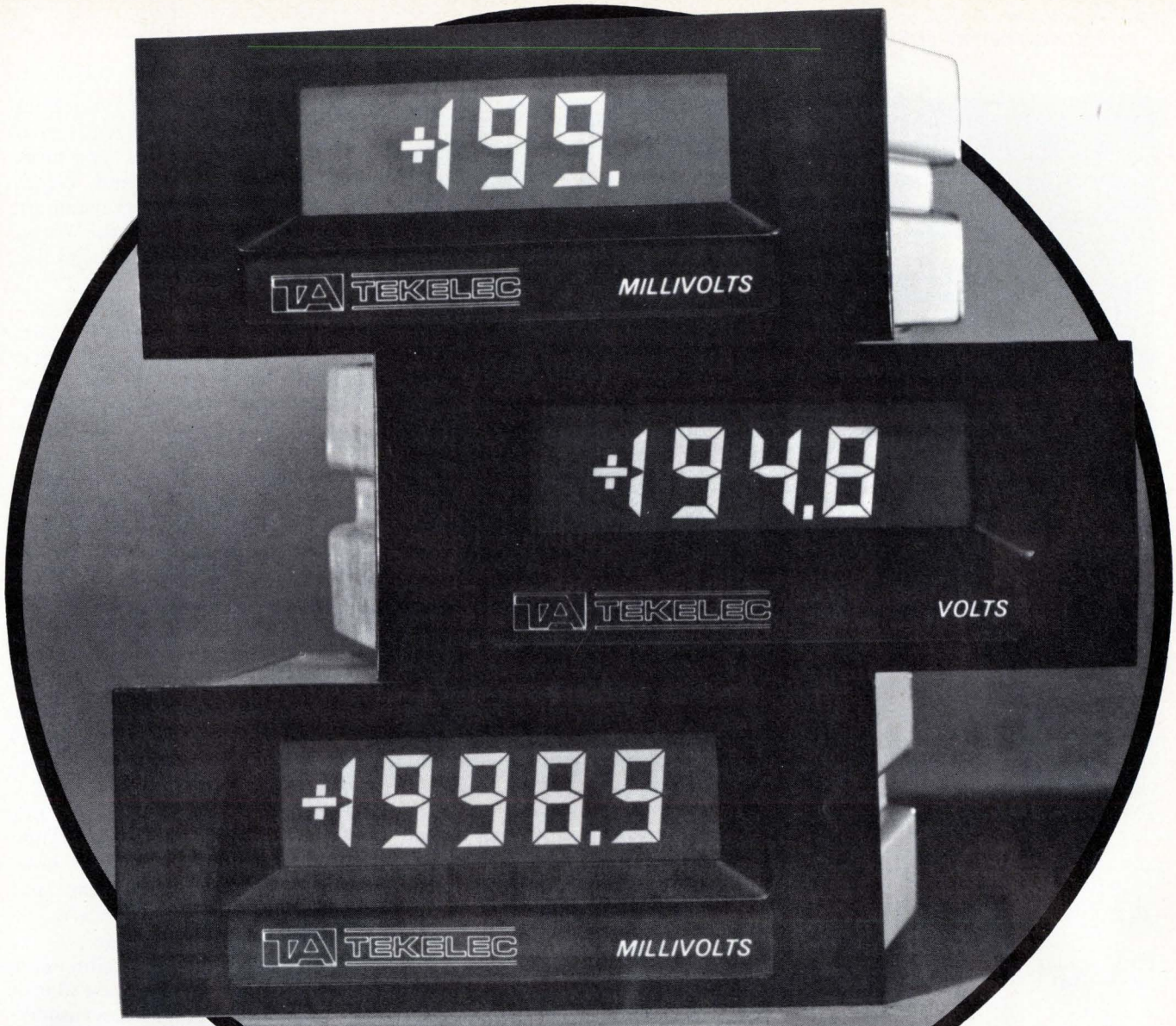
NASA is asking Administration approval to begin developing an Earth Observation Satellite (EOS) in fiscal 1974. If approved, the new satellite would be the first of a projected series of heavyweight satellites that would be huge trucks weighing up to 5,000 pounds at launch.

"EOS would be the first space-shuttle-compatible spacecraft," states Charles W. Mathews, associate administrator for applications. When the shuttle becomes operational late this decade, it will affect satellite design because it can be used to repair satellites in orbit, or retrieve them, thus changing some concepts of reliability. Moreover, to cut costs, NASA is turning more toward modularization of proven subsystems. Thus, "EOS will be a basic spacecraft with plug-in weather- and earth-sensing modules," Mathews says.

The preliminary design shows a cumbersome-looking satellite that would unfold like a Chinese box to deploy solar cell panels and sensing apparatus.

"It looks like a box because it really is a shipping crate," comments Arch B. Park, chief of the earth resources survey program. Design of EOS could use existing hardware, but the satellite would have a very large earth-viewing area for important day and night global coverage, he says, and pack a lot of gear. For comparison, the successful General Electric-built Earth Resources Technology Satellite (ERTS-1) launched this year weighed about 2,200 lb at launch.

EOS is the first of three projected families of basic spacecraft NASA wants to build. But the other two, the middleweight Interior Operational Satellite (IOS) and the lightweight Small Applications Technology Satellite (SATS), have yet to



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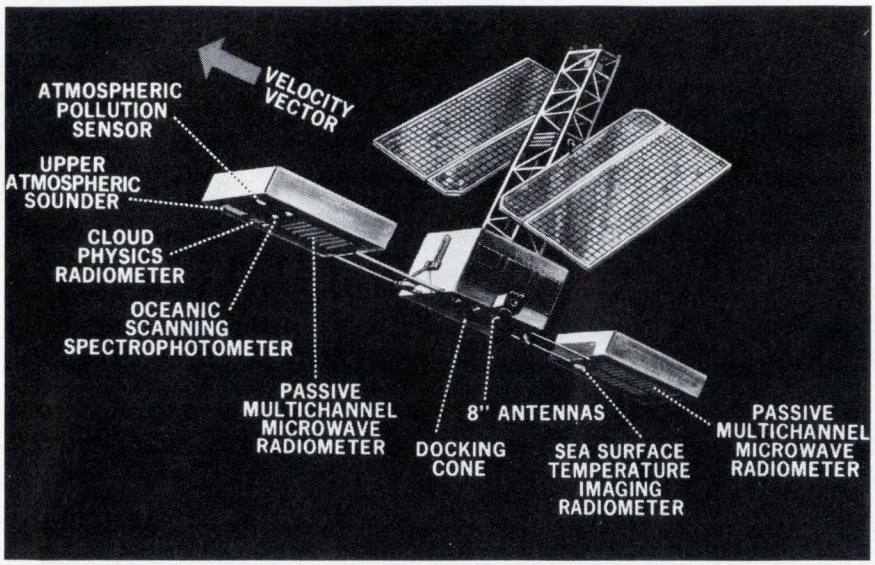

Big boy. NASA's proposed Earth Observation Satellite would weigh up to 5,000 lbs at launch, is billed as the first space-shuttle-compatible spacecraft, is first of a series.

surface as proposed new starts. NASA also is toying with "mass-producing" them in multiple lots. The EOS design contract would consider the costs both of building only one, or one a year for several years. □

Contracts

Army laying down Design-to-Cost law

A series of Army-industry seminars being held around the country shows that the Army is deadly serious about implementing the Defense Department's cost-cutting Design-to-Cost directives [*Electronics*, Aug. 28, p. 25]. The latest seminar, held last week at the Army's Electronics Command, Ft. Monmouth, N.J., was pegged specifically at cutting the acquisition costs of electronic equipment.

In general, the regulation emphasizes six basic policies, together with procedures for a "realistic systems-acquisition program." These policies include reducing both the requirements-generation and development times, and trading off costs of an item in the number that is to be procured against its performance.

In addition, the Army will try to make decisions regarding a program's progress at a much higher level than it has in the past, setting up new review committees to make assessments at predetermined program points. Also, more precise funding priorities will be set up so that work can proceed at top speed on programs that are critically needed. This means that certain marginal lower priority programs may be dropped entirely to make sure that funds will be available for the higher-priority items. "If it's worth doing, let's do it," declares Jack Greenman, chief of the Policy and Compliance division of ECOM's Procurement and Production directorate.

Another policy is to establish the cost of a production unit as a performance objective and write it into the original development contract. "Bands of performance" acceptable to the Army may be specified, together with the amount of money per unit that the Army desires to spend, he continues. Then it's up to the contractor to make the necessary tradeoffs to achieve the over-all cost-performance specifications.

At the core of the Army's changed procurement practices is its AR (Army regulation) 1000-1, "Basic Policies for Systems Acquisition by the Department of the Army," issued last summer. Within the last three weeks, seminars have also been held by the Army's Missile, Tank-Automotive, and Aviations Systems Commands. And next month should see at least two more commands—Munitions and Weapons—sponsor their own meetings. The seminars deal with the "commodities" handled by the respective commands.

Already, the Electronics Command has released several requests for proposals that embrace the new concepts, says Greenman. Since none has been decided yet, Greenman won't discuss them. □

Government electronics

Coast Guard wants improved Loran

The U.S. Coast Guard wants to revamp the Loran navigation network in a multiphase effort that promises to create a large market in new navigation gear. If approved by the White House and Congress, the Loran 70s program would upgrade the existing Loran C network with fourth-generation equipment and entirely phase out the domestic Loran A network within 10 years.

Although the budget climate is cloudy these days, the Coast Guard expects that the program eventually will be funded. For one thing, the new Loran C equipment will perform better and operate more economically. For another, the Defense Department will stop using Loran A by 1975 and is unwilling to support civilian uses. Beginning with fiscal year 1973–74, the service wants to spend about $50 million over five years to upgrade Loran C and $54 million in five years to replace Loran A. There are an estimated 14,000 marine Loran A users, mostly fishermen, plus airborne users.

To upgrade the Loran C equipment, the Coast Guard is about to award a $500,000 contract for a new prototype monitor receiver and some production units. It also plans to issue a request for proposals this winter to buy a prototype Loran C transmitter in late summer. The $1.5

million transmitter will be part of a $3.5 million prototype Loran C station the Coast Guard is building in Presque Isle, Maine. The service will act as systems integrator for the transmitter, antenna, and communications, for which it will contract separately. A production decision is scheduled to be made in the summer of 1974.

To improve Loran C performance and reliability, the stations "will be automated as much as possible," says Comdr. William F. Roland, chief of the Systems Development branch. The computer will have about 8,000 words of memory, about the size of a PDP-11/20, maybe an 11/40. Unlike the rest of the equipment, it will not be redundant. Should the computer fail, the station will continue to operate at the condition just before failure until the computer is fixed.

Replacing the approximately 30 Loran A stations would call for building 11 new Loran C stations and modifying six others to cover the continental coastline and southern Alaska, Roland notes. The existing Loran C system has eight chains containing a total of 31 transmitting stations. For lower user costs, the service has contracted with Teledyne and Litton to develop less-expensive Loran C receivers.

Overall, Roland emphasizes that with the Loran 70s program, the Coast Guard "has no intention of going worldwide" to replace Omega. "We're looking for shorter range and much higher precision."□

Hittinger's success with Solid State leads to job as RCA consumer chief

If RCA's naming of William C. Hittinger to direct its consumer-electronics operations says anything, it is that his management at the long-unprofitable Solid State division in Somerville, N.J., has been deft and skillful. Taking over as vice president and general manager of the division in early 1970 [*Electronics*, April 13, 1970, p. 46], Hittinger has reportedly steered 1972 operations into the black in the last quarter. In addition, the division has achieved leadership positions in the semiconductor industry for the first time.

As a result of Hittinger's direction, RCA's Solid State division now styles itself the No. 1 supplier of linear ICs for consumer-electronic products—with many of the ICs undoubtedly winding up in RCA's own consumer products. And the division also finds itself in a dominant position in C-MOS devices. It has, for example, recently received a $1 million contract from Martin Marietta Corp., Orlando, Fla., for C-MOS chips to be used in a pocket pager. And the company is also in strong contention for a million-dollar award from Chrysler Corp. for C-MOS in a seat-belt interlock system.

What's more, the Solid State division is a leading supplier of power transistors for automobiles. Another million-dollar contract was received two months ago from Chrysler for transistors to be built into its electronic ignition systems and for C-MOS chips to go into watches and clocks. The result of all this activity is that the division plans to expand its production facilities by more than 30% next year.

Hittinger, 50, as executive vice president for RCA Consumer and Solid State Electronics, also will be responsible for RCA Sales Corp. and RCA Distributing Corp., which are concerned with marketing the firm's TV sets, radios, stereo phonographs, and other consumer-electronic products. He succeeds 64-year-old Barton Kreuzer, who is nearing retirement age, as head of the Consumer Electronics division.

Kreuzer is noted at RCA for his development of the all-solid-state color-TV receiver chassis. RCA and Zenith are hotly vying for the lead in color-TV sales, a situation which will undoubtedly receive Hittinger's immediate attention. Kruezer, who has 44 years with the company, will continue as an RCA executive vice president at corporate headquarters in New York until his expected retirement in early 1974.

Meetings

FJCC finds core makers happy

Semiconductor manufacturers aren't the only ones going full speed to keep abreast of the surging demands of a newly vigorous computer industry. The bulk of computer memories being delivered is still made with ferrite cores, core planes, and stacks; the result is that core makers at the Fall Joint Computer Conference, held early this month in Anaheim, Calif., report that business is booming. In fact, Eugene Prince, vice-president and general manager of the Ampex Computer Products division, Marina Del Rey, Calif., says that Ampex is adding 30,000 square feet to its facility in Hong Kong, where the division's cores are strung.

Prince looks for the core business to remain strong for at least 18 to 24 months. "We never did more core business than we're doing now," Prince says, adding that both his division's core and its semiconductor-memory-component operations are "going at capacity to meet mainframe needs." Despite recent corporate fiscal difficulties, Prince notes that the Computer Products division is "having its best year ever, with more sales and earnings than ever before." The division makes a variety of tape, disk, core, and semiconductor memory lines, including a broad range of IBM-compatible equipment for OEMs and end users.

Lockheed Electronics Corp.'s Data Products division in Los Angeles is also doing solid business in core products. Karl Hinrichs, the division's director of engineering, says he doesn't see any slackening in core demand, but points out a bit ruefully that core prices continue to drop. Says he, "We're shipping more and earning less on core products."

A marketing man for Fabri-Tek Inc., Minneapolis, points out that the firm did more business in the first six months of fiscal 1973, which ended Sept. 30, than it did all of last

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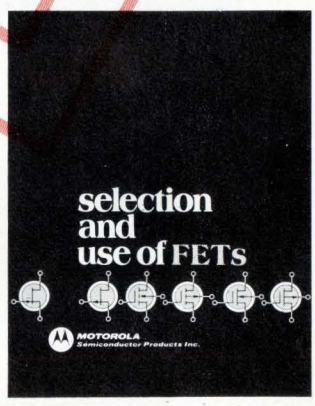

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year. Fiscal 1972, while slow, wasn't the worst year in the company's history. Fabri-Tek makes OEM core-memory planes, stacks, and systems, plus extended core systems for end users of IBM 360 and 370 computers.

Both the OEM and end-user segments in the first half of the current fiscal year "enjoyed exceptional growth over last year. And we're on our way to enjoying our very best year," the spokesman says. He's particularly pleased because Fabri-Tek broke into the black at the end of the second quarter of its first six months of fiscal 1973 after several successive profitless quarters.

Ampex's Prince has said for about two years that semiconductor memories would overtake cores in sales by 1975. He still foresees only a little slippage, if any, in that forecast. But while his division gears up for making its own n-channel MOS memory components and is building IBM plug-compatible memory systems incorporating its own bipolar semiconductor parts, the core lines at Ampex and its competitors keep humming along.

Attendance at the FJCC, the last one ever, reached almost 20,000, with 165 companies occupying all 408 booths. This compares with 144 firms in 294 booths at the Spring Joint in Atlantic City. Next year, the two shows will be combined in New York in June; 250 to 300 exhibitors and 30,000 to 50,000 attendees are expected. □

News briefs

Americans look north

RCA and American Satellite Corp., which is a joint venture of Fairchild Industries and Western Union International, were first and second to announce that they plan to inaugurate a domestic U.S. satellite communications system by leasing transponders on ANIK-2, the Canadian telsat to be launched next April [*Electronics*, Nov. 6, p. 33]. With U.S. approval, the two companies would operate a limited earth-station network for several years to get experience until the long-delayed U.S. domsat issue is resolved [*Electronics*, July 3, p. 72]. Other U.S. companies also have expressed interest in using the Canadian system [*Electronics*, Aug. 28, p. 32].

Litton names new president

With Roy Ash, 19-year president of $2.5-billion conglomerate Litton Industries, going to Washington to take over the president's Office of Management and Budget, Fred W. O'Green has been named president by chairman Charles B. (Tex) Thornton. O'Green has been with Litton 10 years, most recently as executive vice president with responsibility for shipbuilding, defense electronics, and components. O'Green looks for few major changes in the company, but he and Thornton agree that future acquisitions and divestures will attempt to get the company back on the basic technological track in which it has been most successful.

Britons, DEC in $25-million deal

A dual-processor computer system from Digital Equipment Corp., Maynard, Mass., will become the brains behind Europe's largest international telephone exchange in 1974. Through Plessey Telecommunications, Liverpool, the British post office has purchased a DECsystem-1055 for more than $25 million to handle traffic analysis, international accounting, and performance-monitoring within the exchange. When the system is in operation, it will have a capacity of 144,000 calls per hour via 20,000 satellite and cable telephone links.

Brazil to use ERTS-1

Brazil will soon join Canada in receiving and processing data from the U.S. Earth Resources Technology Satellite (ERTS-1). Bendix International has received a contract for more than $4.1 million from Brazil's Institute of Space Research to build an image-processing and recording system to handle data on the type, distribution, and extent of Brazil's natural resources. Bendix's Aerospace Systems division will build the new facility.

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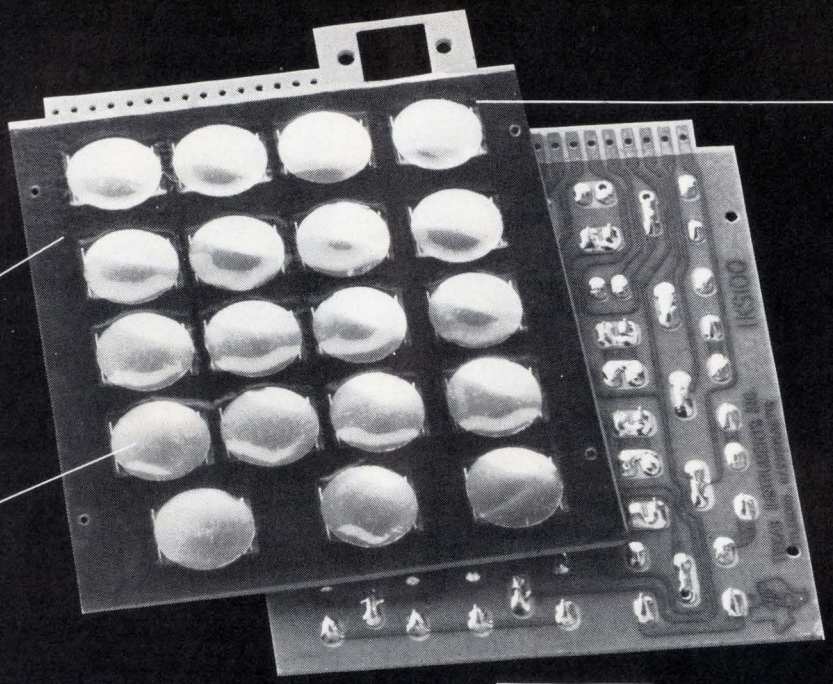

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Makers debate ECL compatibility

To use compensated ECL or not is a question confusing users; TI and Fairchild say it's needed; Motorola leads a group that says it's not

by Stephen Wm. Fields, San Francisco bureau manager

Decisions to commit system designs to one or another type of 10,000 emitter-coupled logic are becoming confused by claims and counterclaims about the relative merits of compensating for voltage and temperature variations in these circuits.

And as the number of ECL suppliers increases, the question of compatibility between like parts from different makers has become important, not only to design engineers, but also to the manufacturers themselves, because the ECL industry is just approaching its strongest growth period. Projected 1972 sales for ECL circuits, including memory, are about $38 million, and 1973 could become a $50 million year.

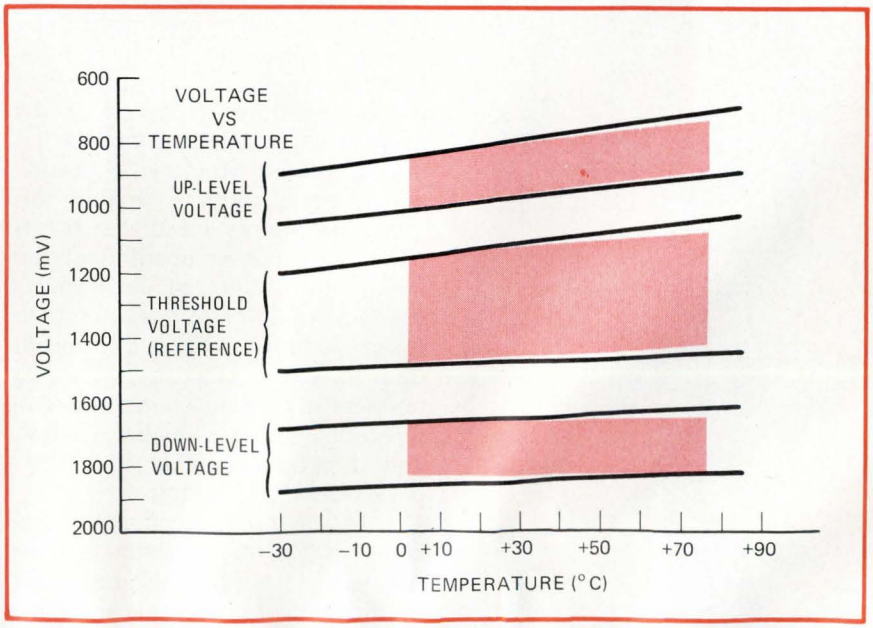
While the 10,000 ECL family has been growing rapidly, its origins go back only to late 1970, when Motorola's Semiconductor Products division in Phoenix, Ariz., delivered the first units, which were uncompensated. By early 1972, Signetics Corp., Sunnyvale, Calif., and National Semiconductor Corp., Santa Clara, Calif., came on as second-sourcers.

With the multiple 10,000 suppliers, demand swelled, and to meet the demand, Motorola added new members to the family. Today, Motorola's line consists of some 38 part types, and 50 will be available by the end of this year. Stan Bruederle, ECL product marketing manager, promises that "some 20 parts will be added to the line next year."

Mixing families. Compatibility problems became acute last year when TI said that it, too, would be making 10,000 ECL, but that it would add voltage compensation. Recently, Fairchild followed suit with a 10,000-type with only voltage compensation. Parts made by Motorola, Signetics, and National can all be mixed in a system; there's no question that TI and the new Fairchild 10K parts can be mixed with the Motorola, Signetics, and National parts, but there has been a question about whether or not these, in turn, can be mixed with TI's and Fairchild's voltage-compensated parts. Voltage-compensated circuits have built-in voltage regulators and thus have much higher tolerance to power-supply variations than uncompensated circuits. While compensated 10K families can be mixed with uncompensated families, the reverse is more difficult to accomplish.

With temperature compensation, a more serious situation exists. Temperature compensation in ECL circuits means that the voltage threshold does not change with changes in temperature. Conversely, non-temperature-compensated ECL experiences shifts in threshold with changes in temperature. Thus, when a designer relies on the non-drifting nature of temperature-compensated ECL, he may not mix in non-temperature compensated parts with his system and vice versa. For example, with a temperature differential of, say, 25°C and with certain power-supply conditions, the noise margin is substantially reduced. As Motorola's Bruederle puts it, "Under these conditions, the noise margin would be such that reliable operation could not be guaranteed." Thus, even though some of Fair-

Neat fit. The 10,000 series ECL that TI is shipping (shaded area) is compared with the data sheet specs from Motorola for the same part. After a redesign of temperature coefficient, TI's voltage-compensated parts now match the uncompensated Motorola parts very closely.



child's 95100-series parts have 10,000 pin-outs, Bruederle and other ECL marketing executives contend that they should not be mixed with other breeds of ECL.

Fairchild says that if a system is designed for worst-case conditions, a 25°C differential, mixed-ECL parts will work. But the more important question is whether or not they will work reliably. And it appears that Fairchild thinks such a system is not reliable, because it has decided to come out with what it calls 10K-plus ECL. By using a metal-mask option on the 95100 parts that have 10,000 pin-outs, Fairchild bypasses its temperature-compensation feature and ends up with voltage-compensated 10K parts. These can be easily mixed with other 10,000 parts in a system. Fairchild is charging the same prices for both its 10K and 95K parts.

TI took what was basically the Motorola-10,000 circuit approach, deciding not to add temperature compensation to its 10K family. But TI did add voltage compensation. In terms of typical numbers for the uncompensated Motorola parts, whose down level will change at the rate of about 0.23 millivolts per millivolt of change in power supply, the voltage-compensated TI parts (as well as the new Fairchild voltage-compensated parts) change at only 0.03 mV/mV of change.

Dave Davies, ECL marketing manager at TI, says that the ECL customer can look at this voltage spec two ways. "Either he makes his power supply fixed—which is very expensive—or he can try to make his power supplies drift in the same direction. This is how Motorola advertised a 10% tolerance on its power requirements—all of the supplies have to drift together. And while this can be done if they are in the same rack, there is a problem when you go rack-to-rack—one supply can go up, and the other can go down."

The second choice, Davies says, is voltage-compensated ECL like TI's. "I've heard estimates on the order of $1 per watt in savings if the customer can use a 5% power supply instead of the 1% supply.

In reply, Bruederle states, "Going rack-to-rack with ECL, the hardest thing to do is to maintain signal integrity. So we recommend that people use a line-driving and receiving technique with a twisted-pair environment (differential mode). This essentially unlocks the two racks, and so power-supply variation in one has no effect on the logic level in the other. The receiver can care less about the relative position of the signal because it's operating in a differential mode."

Although, for some unexplained reason, it makes no difference in the operation of the circuits, TI designed the temperature coefficient of the parts at 2.8 mV/°C and not the 1.1 mV/°C of the Motorola, Signetics, and National parts. And while this didn't necessarily mean that the TI parts were not compatible, it did mean that users of both parts needed two different sets of tapes to make incoming tests. It also meant that to ensure meeting Motorola temperature specifications, TI had to screen its parts to a smaller window, and a certain number of "good" parts were not shippable.

TI has now redesigned its voltage-compensated 10,000 series to have the same 1.1 mV/°C temperature coefficient as Motorola. TI and Fairchild, however, are claiming that because of voltage-compensation, their parts offer some definite user advantages. And this puts the other three companies in a difficult spot.

What the big boys do. George Rigg, ECL marketing manager at Signetics, says, "The big boys [big mainframe makers, who are the large users of ECL] do it their own way, anyway. They write their own specs, and so far, their specs for all customers except one have been written so that voltage-compensation is not allowed." He adds, "One major company has written an open-ended spec that will allow either compensated or uncompensated parts to be used." And so for now, Signetics is not planning to produce compensated ECL.

At National, the question is still up for grabs. Jeff Kalb, manager of bipolar operations at National, says, "We are not designing any circuits with voltage compensation, but we know how to do it." Tom Thorkelson, ECL marketing manager at National, adds, "We are evaluating the market potential of a voltage-compensated ECL family."

Even Motorola's Bruederle admits, "We are running some evaluation tests on compensated ECL, but the customers are accepting our present family the way it is, so now we have no intention of adding voltage compensation to our line." □

Not yet, but maybe. Jeff Kalb at National says his firm is investigating voltage compensation for 10K ECL circuits.

The other ECL

About a year ago, Fairchild Semiconductor and Raytheon Semiconductor, both of Mountain View, Calif., announced another type of ECL. The Fairchild family was designated the 95100 series. Both companies offered ECL that was "easy to use" or "easy ECL" because its on-chip regulating circuitry compensated for power-supply and temperature variations so that there was no significant change in noise margin or logic level, and thus the systems designer didn't need particularly tight power-supply of cooling tolerances. But these families could not be interchanged with Motorola's 10,000 family. And it was the 10,000 family that became the most popular ECL choice.

International

Israel pushes electronics exports

Paced by military production, industries turn to overseas customers; excellent technology benefits from low R&D and manufacturing expenses

by Sigismund Goren, McGraw-Hill World News, Tel Aviv

The development and export of Israeli electronics are closely aligned with the strength of the country's military systems, and there is now a push to increase the already extensive exports of military electronics. Defense Minister Moshe Dayan told the graduates of the Command and Staff College last August, "There is no other area in which the development and sophistication of means of warfare are so striking as in electronics."

A high rate of exports keeps the production lines moving at the required pace, encourages the infusion of advanced technology to keep competitive, and maintains an influx of much-needed foreign cash. And inasmuch as the Middle East may be headed for a lengthy period of cease-fire, if not peace, "more and more of the local output will have to be channeled to export markets, and more efforts will be necessary to this effect," says Eli Katzir, managing director of Koor Systems, which produces printed circuits.

In fact, military preparedness is a major reason for Israel's competitive position in electronic exports. Foreign sources attribute the deadly efficiency of the Israeli air force largely to sophisticated electronics. It is rumored that electronic devices also protect sensitive defense sectors of the cease-fire line. And the Israel Aircraft Industries, a company owned by the Defense Establishment, recently undertook to export $38 million worth of Gabriel missiles to unidentified customers. This in itself is a good indication that even more advanced missiles are being developed or manufactured.

The U. S. buys less than half of Israel's electronics exports. Other large customers include Holland, Belgium, the United Kingdom, Iran, and a number of countries in Africa.

Exports, which totaled 500 million Israel pounds ($118 million) in 1971, are expected to double by 1975. And Israeli officials and businessmen are determined to find more foreign markets.

Oded Vered, manager of the technical products department of the Israel Export Institute in Tel Aviv, says that exports of electronics, which totaled $2.6 million in 1967, jumped to $28 million in 1971. Israeli officials hope that exports will reach $100 million by 1975. To achieve that target, a government program has been established to provide for more:

- research and development,
- reliability control and emphasis on international standards, including U. S. military specifications,
- participation in international exhibitions,
- cataloging of international standards,
- and servicing in the market areas before and after sales.

And in the next year or two, Vered says Israel will establish two major after-sales servicing centers for its electronic exports; one will be located in Western Europe, and the other in the U. S., probably on the West Coast.

The rise in exports that may necessitate such centers stems from research and development investments by the Israeli government of nearly $300 million from 1967 to 1972. As a result of these "investments," the Israeli electronics industry is exporting a wide range of military electronics hardware, including communications and radar fire-control systems, advanced circuitry and microminiature electronics. Major

Communications exporter. Assembly line for communications equipment at Tadiran. The company is one of the major producers of vehicular, backpacked, and airborne transceivers.

non-military exports include telecommunications and medical-electronics equipment, as well as various types of instruments.

The effectiveness of the country's various R&D programs is attributed largely to the low salaries paid to highly skilled engineers and technicians—less than half the rates of their counterparts in the U. S.

For the same reason, manufacturing costs are cheaper in Israel than in other advanced countries. "We provide more performance and quality per dollar," boasts Mark Shavit, general manager of Monsel Electronic Instruments Ltd., Haifa, founded jointly in 1968 by the U. S. Monsanto Co., St. Louis, and Elron, a Haifa company.

Israel's reputation for high-quality military products has helped the export effort considerably. "We have gained a good reputation as suppliers to our defense establishment, and this helps a lot," says Danny Miron, marketing manager of Electronics Corporation of Israel (ECI). "The world knows that if they (Israeli defense officials) buy, the product is good."

Of the nearly 100 electronics manufacturers in Israel, the largest is Tadiran Israel Electronics Industries Ltd., in Tel Aviv. Regarded as one of the world's major producers of military communications equipment, Tadiran exports 50% of its output. This includes airborne, vehicular, backpacked, and hand-held single-sideband and fm transceivers, electronic switchboards, and intercommunications sets. For this gear, Tadiran has developed IC and hybrid components, modular subsystems, monolithic quartz crystals, crystal discriminators and filters, and highly sophisticated digitally controlled synthesizers.

The company, which in 1971 exported $12 million worth of equipment increased that amount to $15 million in 1972.

ECI, which was mainly geared to consumer-goods production, started making industrial and military electronic equipment two years ago. Miron says ECI's output now consists mostly of military electronics and includes sophisticated intercommunications systems.

Greater effort. Plans in 1973 call for more export efforts. Heading ECI's export line are navigation systems, air-control towers, and telemetry systems. Next come high-quality intercom systems, featuring memory circuits to retain long-distance telephone calls when stations

Product switch. Two years ago, ECI was geared to consumer electronics, but has switched to industrial and military hardware.

are busy or unattended, a master-to-master system, and an optional tie-into public address systems.

By 1974, 50% of printed-circuit production by Koors Systems will be exported, says Eli Katzir. The company, which set up its plant in July, 1971 in Petah Tikva, near Tel Aviv, is largely export-oriented. Katzir says Koor Systems Printed Circuit Plant Ltd. has established markets in Belgium, West Germany, and Switzerland. Advanced negotiations are going on with clients in the U. S., Singapore, and Hong Kong.

The company's prices, particularly for multilayer printed circuits, are about 40% cheaper than prices of European competitors, he says, largely because of cheaper labor in Israel. Furthermore, "we are better geared to supply the goods faster than large foreign companies, when smaller or medium-size orders are involved.

Monsel Electronic Instruments Ltd. makes test and measurement instruments. "Our specialty is digital instruments, particularly counter-timers," Shavit says. Exports approximate $1 million yearly, and 60% of the goods goes to the U. S., while 40% is directed to France, Holland, Germany, Scandinavia, Switzerland, and the UK.

Future exports. "We provide more performance and quality per dollar," Shavit adds. "We sell, among others, to several defense establishments in the world." He did not specify which ones.

The company projects an export growth in counter-timers of 15% to 20% a year for the next five years. Shavit thus summarizes the future outlook: "We are planning to diversify our product line in the general instrumentation field to achieve an over-all company growth of about 15% a year. A further growth and sophistication is also anticipated in the industrial market. This will be reflected on new products which will be released by Monsel in the not-too-distant future."

Motorola Israel, Tel Aviv, which had exports of $2 million in 1971, increased that figure to $7 million in 1972, mostly for communications systems and automation equipment. In Africa, it has provided a service organization, which is important to underdeveloped countries. □

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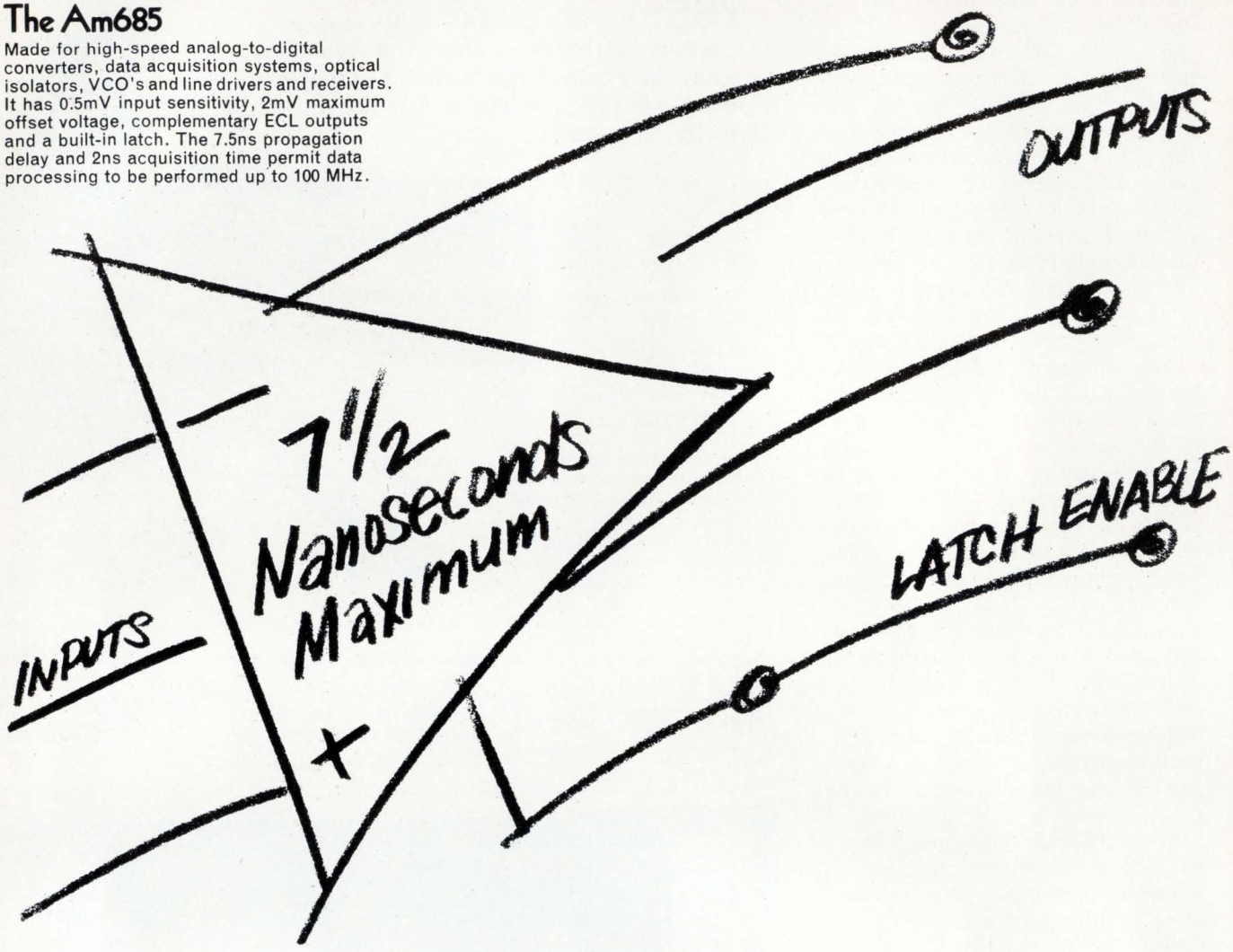

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Washington newsletter

Inter-agency fight delays navigation system decision

An intense squabble among elements of the Departments of Transportation and Defense and the White House Office of Telecommunications Policy has arisen over **whether to use Loran C or Differential Omega for a coastal navigation system.** It is seen as putting off selection of a system for a year, a decision originally planned for the end of this year at the latest. **Reportedly favoring Loran C are the Air Force, Army, most of DOT and the Coast Guard,** which prefers to operate that system. **The Navy is split,** with the submarine groups favoring Loran C but surface operations wanting Omega, as does OTP apparently. The FAA also is reportedly against any hyperbolic system, for fear that such a system might lessen aviation support for its own VOR/DME navigation network. The White House Office of Management and Budget has yet to weigh in.

The coastal confluence system would improve East Coast coverage out to 120 nautical miles, and extend service to all of the Great Lakes, the West Coast, and the Gulf of Mexico. A best guess sees Loran C for the coasts and Omega for the high seas.

Interior Department wants an ERTS-C

Highly pleased with the success of the first Earth Resources Technology Satellite, launched this year, the Interior Department is proposing **to start an estimated $40 million ERTS-C program** for fiscal 1974. Subject to White House and congressional approval, the ERTS-C would carry similar instruments to the first ERTS and ERTS-B, which is scheduled for launch next year. **A $5 million thermal-scanning package for sensing earth temperatures might be added.**

Arinc reconsiders communications network

After deliberating on its announced plans for microwave communications networks in the Los Angeles and Chicago areas [*Electronics,* Dec. 20, 1971, p. 22], Aeronautical Radio Inc. has decided to see **whether it can buy the service more cheaply from other companies and beat the estimated $8 million cost** of building its own microwave links.

As an example of other technologies it's looking at, the airlines' communications-service organization asked the following companies to submit ideas by February: American Satellite Corp. (a joint venture of Fairchild Industries and Western Union International), Comsat, Datran, GT&E, MCI, Nebraska Consolidated Communications Corp., Southern Pacific Communications Corp., Western Telecommunications Inc., and Western Union.

NSF survey forecasts record company R&D

Electronics companies will **spend 25% more in company-funded research and development between now and 1975,** according to a National Science Foundation survey of 50 of the country's largest corporations. Overall, companies will spend a record $14 billion annually by 1975, up from $11.4 billion in 1972. The rate of increase also is rising to 6% a year, compared with an annual 4% hike between 1969 and 1971, which barely kept ahead of inflation.

NSF forecasts **increased employment of engineers and scientists as well.** About 260,000 will be employed in R&D by 1975, up from 240,000 this year and 225,000 in 1969.

Washington commentary

Military buzzwords for 1973: warranties and standardization

Like most giants, the Defense Department's reflexes are not very fast. But when it does begin to stir, there is no mistaking it. Recognizing that it is not getting the most reliable hardware for its dollar, the American military machine appears to be taking its cue from another monster movement—the nation's consumers—as it begins to push for product warranties and increased standardization as a means to hold down costs. Both concepts, certain to impact electronics heavily, will get increasing exposure in 1973 as part of the Pentagon's Design-to-Cost program unveiled last summer by Defense Research and Engineering director John S. Foster Jr. [*Electronics*, Aug. 28, p. 25].

Though the broad-scale inclusion of maintenance warranties in contracts is certainly months, perhaps a year or more, away, it is an action that industry suspects is bound to come. And with it must come increased hardware standardization, to offset the relatively small size of some military markets that now makes warranties uneconomical.

A look at Sears

When Foster first laid out the Design-to-Cost concept, he expressed the conviction that its success would depend on the ability of industry's managers to make their engineers believe "costs are a problem they individually must face." Failure of Design-to-Cost is unacceptable to DOD, contends Foster, because "we are running out of money."

The National Aeronautics and Space Administration, which is running out of money even faster, sought to expose its personnel to new cost-cutting techniques earlier this year by sending them to plants specializing in production of televisions, appliances, and automobiles. It was a move that intrigued Pentagon managers, who note that those industries stress "standardization of components, modules, and subsystems." Barry Shillito, assistant defense secretary responsible for installations and logistics, observes, for example, that "there are only two basically different chassis for the entire line of Sears television sets, and even they contain many common modules."

While a program of military-wide standards for subsystems and modules is recognized as achievable, it will take time. Developing a meaningful warranty system will be more difficult. "We probably will never develop a warranty for nuclear missiles. If they get used at all, they are used only once," quips one Pentagon leader sardonically, "and anything like Detroit's '12 months or 12,000 miles, whichever comes first' doesn't make any sense. Radios, on the other hand, are a different story. There we can standardize to a large degree. And we should be able to increase reliability by getting vendors to maintain them."

The road to warranties

How can DOD develop a warranty system for its military hardware? One Air Force memo now circulating in industry suggests an approach. Written by the Aeronautical Systems division's Robert C. Perdzock some 18 months ago, it contrasts the military and commercial approaches to the purchase of inertial navigation systems. Where the commercial market is "reasonably large" as a result of standardization, the military market is often small. Where competition is maintained throughout the system's lifetime with the airlines, it "ceases at contract signing" with the military. Where specifications provide a standard interface with other avionics on the commercial side, military specs are usually unique to each system. Where commercial suppliers remain involved in system maintenance, military contractors are disengaged as soon as possible.

All of this leads to the question of industry's ultimate goal: profit. On the commercial side, reliability pays, says Perdzock. With military procurements, it is more likely that unreliability pays. "How often have 100% spares been necessary and procured" for military inertial navigation systems? he asks. The argument that vendors are interested in reliability because of follow-on procurements is put down by Perdzock on the ground that specifications unique to a given system make follow-on orders unlikely in most cases.

Commercial users of inertial navigation systems, says Perdzock, "have generated a market, sustained a competitive environment, and made it profitable for suppliers to provide a quality product" by requiring standard interfaces to expand production runs and paying the makers to warrant equipment and fix it at no cost when it fails. The Air Force, on the other hand, "has tended to stifle competition, once a contract has been signed, has been hindered by a limited marketplace (sometimes self-generated), and has, perhaps unwittingly, made unreliable hardware more profitable than its counterpart."

The system can be changed, of course. And there is every indication now that it will at least begin in the year to come. **—Ray Connolly**

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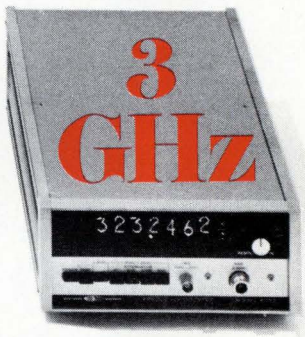

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Symphonie satellite launching plans are out of tune

Delays have dogged the Franco-German Symphonie telecommunications satellite program since its inception in 1967. So it is with well-developed skepticism that engineers working on the spacecraft plan for a launch one year hence.

Indeed, they try not to think about the crucial meeting of the European space ministers coming up at the end of December, at which they may very well decide to give up the Europa 2 launch vehicle project altogether, leaving Symphonie with no way to get into orbit. Paris wags already are branding the program with names ranging from "Unfinished Symphonie" to "Symphonie Pathetique."

If the space ministers decide to junk the Europa 2 rocket, which never has achieved orbit in 12 firings, Symphonie will have to look elsewhere for transportation—first at the U.S.'s NASA, and as a last resort possibly in Moscow. Either route would entail delays of at least another year and a half, pushing Symphonie's launch date back to 1976.

Sliding deadlines and international politics notwithstanding, the Franco-German Symphonie team has developed a versatile spacecraft that can handle analog and digital signals. A variety of tests are planned, including voice, data and fm color TV transmission.

In anticipation of an on-schedule launch early in 1974, ground station hardware from Thomson-CSF and Societe Anonyme de Telecommunications is being installed now at Pleumeurbodou in France and Raisting, West Germany. Both stations have dish antennas of about 15 meters in diameter.

The satellite will handle a 6-gigahertz uplink and a 4-GHz downlink on a transponder bandwidth of 90 megahertz. While Symphonie is designed to test several transmission systems that are likely to be used in future satellite communications, the most advanced in preparation at Centre National d'Etudes de Telecommunications is a time-division multiple-access (TDMA) system.

Refinements. The TDMA concept is similar to that in use on Intelsat 4, but with some refinements. The spacecraft itself is unusual in that it will have three-axis stabilization in a geostationary orbit.

One refinement to be tested will be the clock-coherent operation mode, replacing the asynchronous mode that most ground stations use. Under the technique, each TDMA frame is divided into a specific number of clock periods, and all data bursts are coherent to the clock. At each ground station, two clock generators will be required, one for receive, the other for transmit. The receive-side generator is synchronized in phase and frequency by the clock of an incoming sync burst. A discriminator output signal controls the transmit-side clock frequency for outgoing bursts. The result is greater precision of synchronization, hence the possibility to reduce the guard time between data bursts. □

Italy

Selenia cruises with ship radar, computer

Terrestrial travelers of old who were having troubles with their navigation could take some comfort from the dictum that all roads lead to Rome. A lot of modern mariners, too, have been following roads to Rome to get help with their navigation problems. That's because Rome is the headquarters of Selenia, a company that is charting a winning course for itself in marine radar.

Selenia officials maintain they have some 70% of the world market when it comes to radars for big merchant ships. And the Italian company has what amounts to a best-seller in marine-automation hardware. It had the first production model of its navigation and anti-collision system on view at the Genoa boat show earlier this month. Selenia already has orders for 18 systems and figures to sell between 40 and 50 yearly for the next few years. Raytheon Co., a minority stockholder in Selenia, handles worldwide sales of the system, which cost about $55,000.

Courses. In Selenia's system, as with conventional radar navigation systems, images are displayed on a standard 16-inch plan-position indicator display. At the same time, it automatically tracks up to 40 ships in groups of 10 and in order of priority. Selenia maintains that its equipment is the first to show both true video plots and automatic target tracks at the same time.

All the tracks are analyzed for possible collision courses by the system's computer, a Selenia model NDC 16. Anytime there's a danger of collision, a buzzer sounds, a red light flashes, and the dangerous targets on the PPI start to flicker. The men on the bridge thumbwheel in the values for the minimum acceptable closest approach and the time before closest approach that they want the warning.

If the ship has to change course and speed to avoid a neighbor, the system comes to the aid of the navigator again. He can call up a trial maneuver, telling the computer whether he wants to turn to starboard or port. The computer then computes the minimum maneuver that skirts the danger. The officer on the bridge also can feed the computer his choice of new course and speed, and the computer will check the maneuver. □

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International newsletter

Thomson group and AEG-Telefunken drop semiconductor plans

The vigorous recovery of Europe's semiconductor market has prompted France's Thomson group and West Germany's AEG-Telefunken to break off efforts to merge their semiconductor operations. The much-anticipated link-up, which would have created a new semiconductor force in Europe with about $70 million in annual sales, "is no longer essential to our survival," admits one official at Sescosem, one of the Thomson group.

The collapse comes as a disappointment to international-minded European firms, which had hoped the two electronics companies would set a useful precedent for future cross-border mergers within the Common Market. Thomson and AEG-Telefunken had been aiming to establish a holding company called Eurosem, chartered in Luxemburg, which would streamline their semiconductor production, allowing each the benefits of high-volume production of fewer items. Besides the market rebound, insiders say, the talks failed because of disagreements over the make-up of the board of directors. Sescosem president Olivier Garetta would have been the chief executive, but the Germans objected to giving him a tie-breaking power in board decisions. **Another obstacle was the French government, which refused to give Eurosem's French operations a tax easement** unless Thomson could have 51% control. This, of course, was unacceptable to the Germans.

Sharp to sell remote tuner, character generator in U. S.

A character-generator circuit that triggers brief displays on TV screens of the channel selections in 6- to 7-inch numbers has caught on fast in Japan since Sharp Corp. introduced it on three remote-control models last August. Now Sharp plans to offer it to U.S. set makers. **Remote tuners haven't done well in the U.S. market, but the convenience of the channel display could make them more attractive in this country.** Sharp also will sell the MOS LSI character-generator chip to other Japanese TV manufacturers in the near future. The chip itself was designed for Sharp by Hycom Inc. of Santa Ana, Calif., a firm backed by Sharp. Hycom has the chips made to its design by U.S. MOS makers. To date, more than 150,000 of the chips have been shipped to Sharp.

German process metalizes without a vacuum

AEG-Telefunken has developed a **chemical-galvanic process for metalizing ceramic substrates without high-vacuum equipment.** The new technique, which it calls the chemical metalizing system, works at normal ambient pressure levels. This, the company hints, should spell a big saving in fabrication costs of thin- and thick-film components and stripline devices.

In the CMS process, worked out at AEG-Telefunken's Ulm laboratories, copper forms the initial metal layer, and it is applied to the substrate in an electroless deposition step. It can then be galvanically built up with additional copper or with gold. A tight bond between the metal and the substrate is achieved by depositing silica during the electroless metalization step and by subsequent sintering. **The substrate materials that can be used are aluminum-oxide-ceramic, beryllium-oxide-ceramic, ferrite, titanate, and zirconium.** Results obtained with glass, sapphire, and steatite have not been satisfactory so far, but the Ulm researchers are working to make their process suitable for these materials.

International newsletter

Sweden delays on central registry of personal data

The Swedish government has made one of its most embarrassing payments: almost $1 million to Saab-Scania for development work and some hardware for a central registry of all Swedes. **Parliament refused to go along with establishing the registry—at least until a royal commission on personal integrity in connection with government data banks had presented a final proposal.** The government had given the order to Saab in expectation that the lawmakers would go along. One argument that the government used—that contracts had already been signed—did not convince parliament.

French device vies for U.S. circuit breaker market

A high-performance electronic switching module from France is entering the race for a share of the U.S. market in ground-fault circuit interrupters. **The shockproof circuit breakers required as of Jan. 1, 1973, on all outdoor outlets of U.S. residences have been mandatory in new homes in France since the mid-1960s.** The French technique, developed by LEAD in Grenoble, has been licensed to Shields Engineering Co. of Wilmington, Del. LEAD also is in negotiation with Siemens of West Germany for a license agreement.

LEAD claims that its technology outperforms competitors by triggering a relay even when one supply wire lead is broken. The device functions independently of the power supply by accumulating energy in a capacitor. In the event of a ground fault, the capacitor discharges into a voltage-sensitive electronic switch, which trips the relay and breaks the circuit. The European standards call for a trip value, or minimum operating current, of 25 milliamperes, which the LEAD device has. Shields currently is adapting the module to function at the 5-mA trip value of the U.S. standard.

Computer system to fill West German trucks

Starting early next year, West German truckers can tap computer services to help them achieve greater efficiency in their operations. The Central Association for Road Transport in Frankfurt is now installing two IBM 370/135 computers that will **store and process information on supply and demand of trucking capacity across the country.** Over a 1,000-mile leased data-transmission line, the computers will tie together 15 regional centers where IBM CRT terminals will display the supply and demand information. By telephoning such centers, truckers can, for example, **offer their available load space or find out where goods can be picked up for transport.** The fee that truckers must pay for this service amounts to about 30 cents for each ton of goods transported. The association says that trucking firms in neighboring France and the Netherlands have shown interest in the Datafreight system.

Disk memory designed for rough jobs

A small British memory-disk drive maker, Process Peripherals Ltd., has developed a 220-track, fixed-head disk drive unit **beefed up to remain unaffected when subjected to shocks up to 40 g,** the company claims. It uses a standard 14-inch, 17.6 megabit oxide-coated disk. The company says the unit makes possible random-access disk storage in rough, mobile environments, where cores have to be used now. To prevent the head pads from touching the disk when vibrated, each pad can roll, pitch, and lift on multiple spring mountings and is designed to generate air pressure of 6,500 pounds per square inch between head and disk.

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If you do not, you are unfortunate. Because whether you own one or not, you are most assuredly helping to pay for one.

Somebody has to. A featherbed is an unnecessary job that pays somebody for doing nothing. And for every somebody who is paid for *not* working, there has to be a somebody who *does* work, to foot the bill.

There are all kinds of featherbeds in this rich and benignly negligent country.

The most visible, and the most publicized, carry a union label. They are the result of quite open and perfectly legal agreements to pay some specially favored people for doing nothing—or as next-to-nothing as human ingenuity can devise.

But there are others. Some of the plushest of all featherbeds are to be found, cleverly camouflaged, in executive suites. Some of the snuggest are built into the very structure of federal, state and local bureaucracies. Some of the coziest are discreetly tucked away in the private recesses of the various professional establishments. And some of the most sumptuous are those precious family heirlooms that are generously handed down from generation to generation.

No one knows how many featherbeds there are in the U.S. No one knows how much the total bill for featherbedding actually comes to. But there are some things we do know, and others we can surmise.

In the construction industry, for example, we know that featherbedding is open, unabashed and rampant. According to a survey by *Engineering News-Record*, anywhere from 15% to 40% of the construction payroll dollar goes to pay for work not done. For time wasted in adherence to restrictive work rules, or for time spent in meaningless, unproductive activities.

The cost of this sanctioned, legalized waste in the construction industry is an estimated $16-billion a year. Which is $16-billion added, unnecessarily, to the cost of everything built in this country—homes, apartments, stores, factories, roads, highways, bridges, schools, churches and hospitals.

Executive and white-collar featherbedding is less visible and hopefully, less prevalent. But it is painfully apparent that, judging by the results, somebody, somewhere, has too often been paid too much for doing too little. At a cost reckoned in inefficient and ailing companies, lagging and troubled industries, and spectacular failures and bankruptcies.

With regard to the ancient and apparently ordained institution of bureaucratic featherbedding, we know that the combined federal, state and local government payroll has increased 88% in the last ten years, to a total of $110-billion. Today there are more government employees (14.4-million of them), making more money (average salaries up 64%). But if there has been a corresponding increase in bureaucratic efficiency, or the quality of government services, it has escaped the attention of most taxpayers.

Featherbedding in the professions is, in the nature of things, a moot question. Mere laymen can only guess at what goes on behind the impenetrable screen of fraternal solidarity and lofty mystique. But even mere laymen, when they pay their bills, are painfully aware that, of all the costs of living in a fantastically expensive world, the cost of professional services has increased the most, with the most devastating impact.

Finally, we know that the American economy as a whole has become markedly less productive, at a cost in terms of lost output of about $60-billion in the last two years. Part of the decline in productivity, and part of the

featherbed?

$60-billion loss, surely must be charged against the featherbed account.

Any attempt to define the nature and suggest the extent of featherbedding in our society runs the risk of misinterpretation. In spite of the very obvious fact that the overwhelming majority of union members, of business men and white-collar workers, of government employees, and of doctors, lawyers, engineers and educators, belong to and make up the working majority.

Any attempt to quantify the total cost of featherbedding in the U.S. runs an even greater risk. It is almost certain to be wrong.

But at whatever risk, it must be said. The real extent of featherbedding, and the real cost, can be summed up in two words—too much!

Because featherbedding, whatever else it is, is clearly waste. Deliberate, purposeless, wanton waste of time, money, energy, effort, talent and spirit.

And no economic system, whatever its strengths and capacities, can tolerate endless and unlimited waste. At some point, the system becomes not just markedly less productive, but fatally less productive. Costs mount, prices and taxes rise—and keep on rising, ever faster, until the system breaks down.

The American economic system is not at, or near, the breakdown point. But it is at the point where most of us are finding that, in every area of our lives, we are paying progressively more and more for less and less.

Part of what we are paying is the cost of deliberate, needless waste, with its cancerous effect on productivity. So that the real problem with featherbedding becomes clear.

The problem is not that some people, by hook or by crook, are getting something for nothing. It is that a lot of people—most Americans—are increasingly getting nothing for something.

The problem is not that featherbedding is a cynical con game, played by a favored few at the expense of the tolerant and permissive many. The problem is that it is a *losing* game, played or permitted at the common and disastrous expense of us all.

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This is the fifth of a series of editorial messages on a variety of significant subjects that we hope will contribute to a broader understanding.

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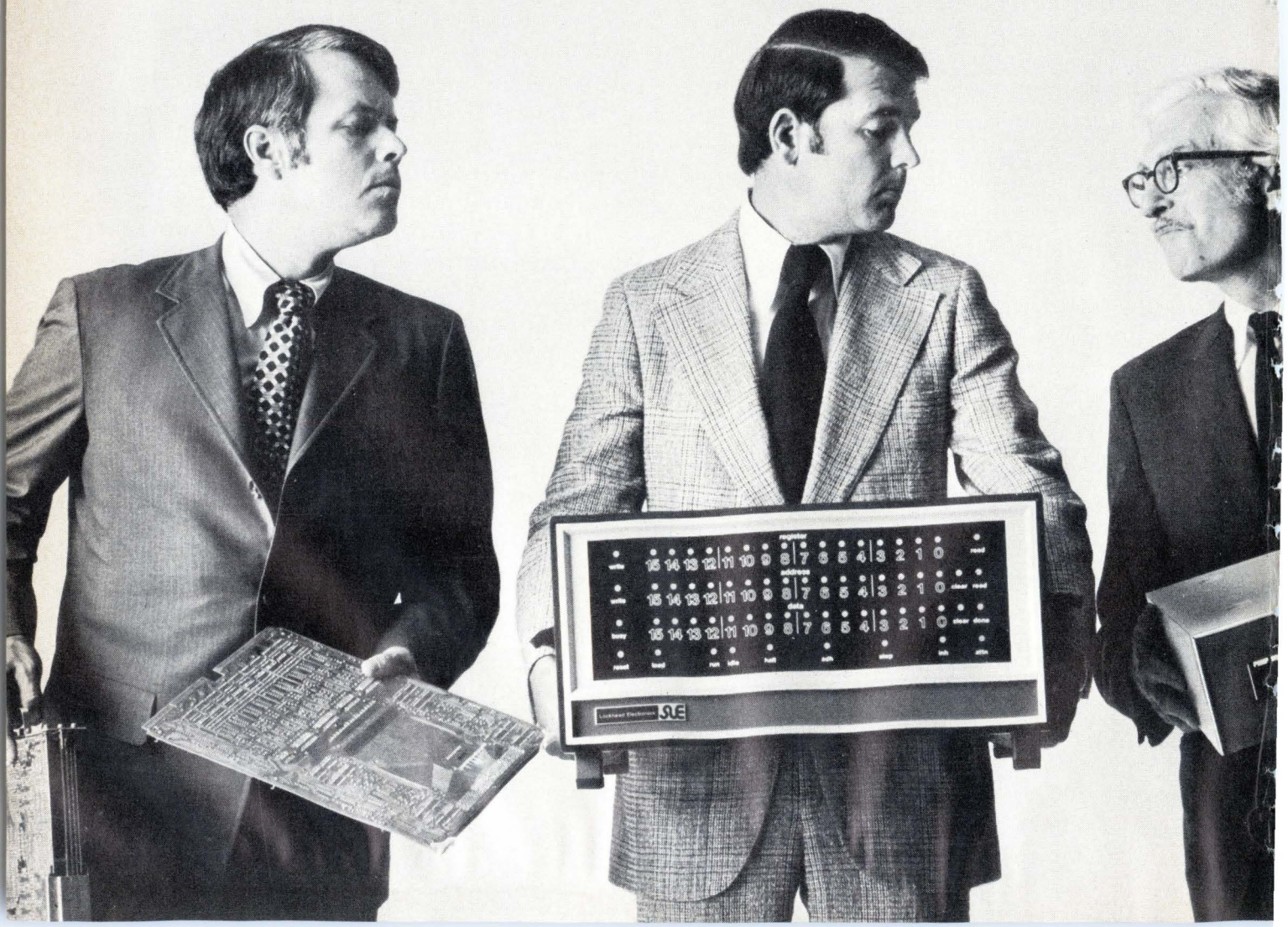

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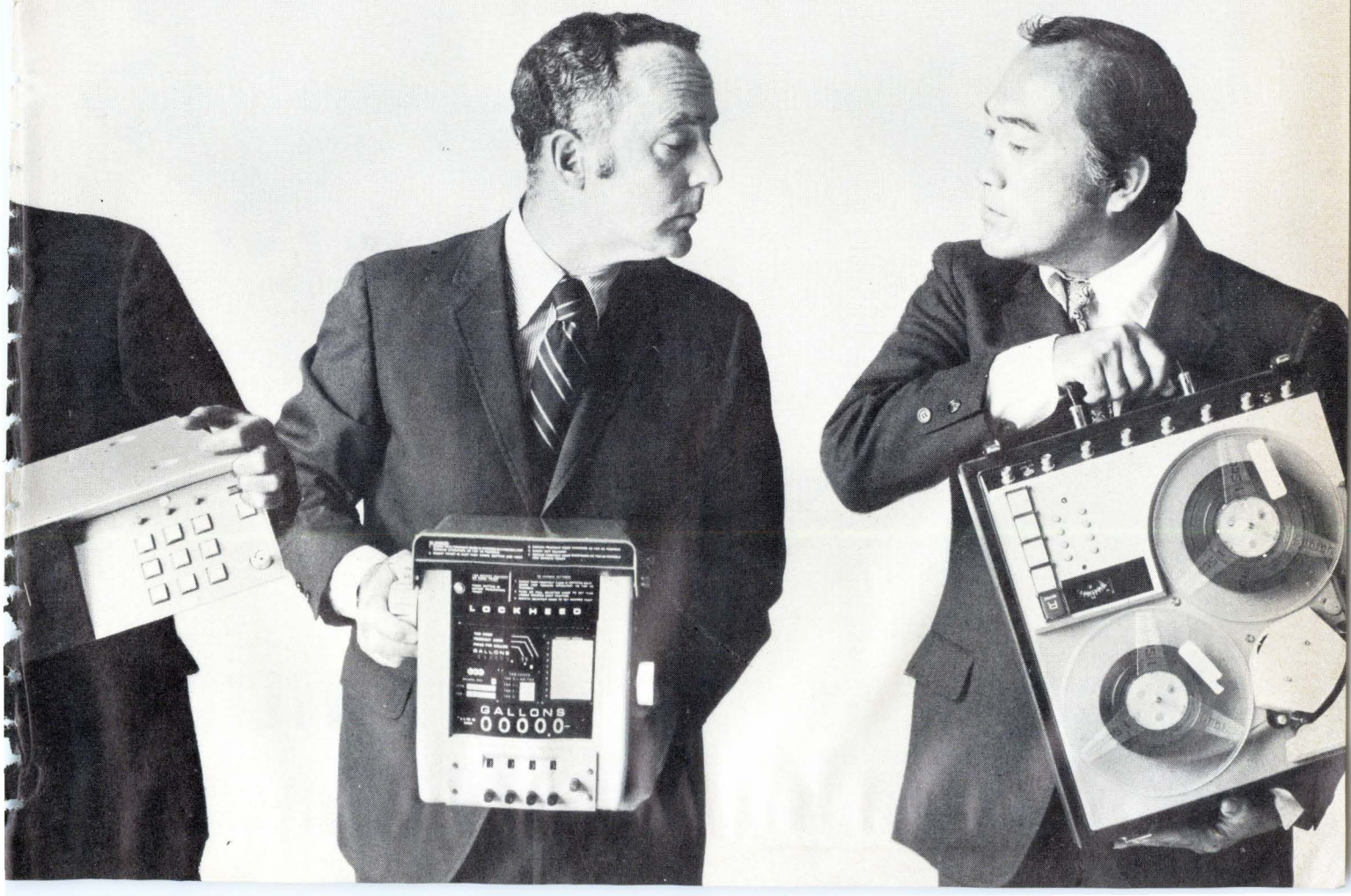

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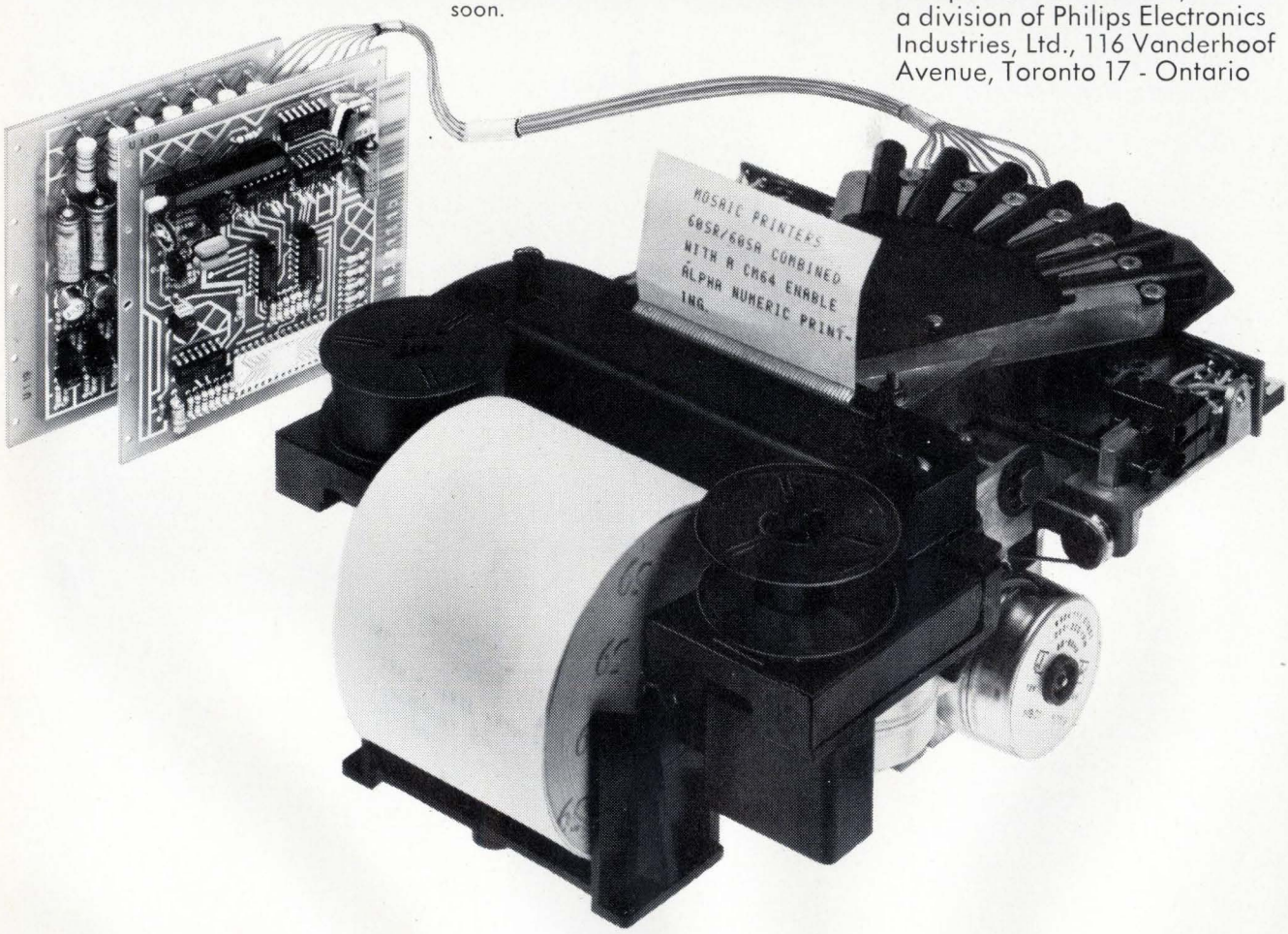

PHILIPS Electronic Components and Materials

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Color TV stars as Western European electronics markets to grow by 11%

Components, especially ICs, to soar, as strong minicomputer sales lead computer growth and as governments stimulate communications output; but industrial electronics and test equipment will fare poorly

☐ Western Europe has made great strides toward becoming a less-patchwork place to do business. The big trading bloc, the European Economic Community has signed up three new member countries, Denmark, Great Britain, and Ireland. And free-trade arrangements have been made with most of the other countries that ring the original six Common Market members—Belgium, France, Holland, Italy, Luxembourg, and West Germany.

As it does every year, *Electronics* sent its reporters throughout Western Europe to size up the outlook for the year ahead. In their sessions with marketing people at some 200 companies, trade associations, and government organizations, the field men were warned over and over that inflation would undoubtedly bloat the forecast figures.

Added up, the markets forecast for the 12 countries surveyed come to $12.3 billion for 1973. That is 11% higher than the figure for 1972, $11.1 billion. Price rises account for about half the nominal growth. Throughout this report, market estimates are calculated at factory sales prices for domestically produced equipment and at customs-insurance-freight (CIF) for imports. All estimates are in current prices.

Along with putting a deceptive gloss on forecast figures, inflation has spurred some real, but not necessarily healthy, growth in consumer electronics. Consumers, in fact, accounted for nearly $4 billion—slightly more than 36%—of this year's equipment business.

Most entertainment-electronics producers figured—and figured rightly—that the Olympic Games at Munich would boost color TV this year. Market watchers at Philips Gloeilampenfabrieken, the Netherlands-based leading set-maker in Western Europe, say sales of color sets shot up a startling 75% during the first half of 1972, and they predict a gain of 35% for the second half. The forecast for color TV this year is $1.61 billion, some 52% above last year's level.

Next year, too, color-TV figures will run very strong forming about half an entertainment-electronics market of over $4 billion. Very possibly stiff curbs on consumer spending may be set up next year to cool down the economy in Britain, France, and elsewhere.

Computer growth sags

For computer makers this year, it's been a question of finding customers for the hardware. Time was when annual surges of 20% or more occurred. This year, gain was 12%, and the prospect for 1973 is a rise of 15%. The consensus forecast puts the 1973 market at $3.5 billion (rentals are figured on an "if-sold" basis).

The gains will be shared fairly evenly among small, medium, and large data processing systems. However, minicomputers, are skipping ahead at something like 30% a year. A lot of existing systems will be upgraded, though. As for market shares, 1973 for European companies will be another year of trying to pare down the dominant position of IBM. West Germany's Siemens and France's Compagnie Internationale pour l'Informatique have started teaming up, and Philips may work out some ties to the combine. However, a pan-European consolidation still seems out of reach.

Communications-equipment producers can count on another year of steady growth. Next year's forecast is for a market of $2.66 billion, up 11%. But with plant-equipment investments sluggish in nearly all of the countries surveyed, sales of industrial-electronic hardware will move up only 8%. Test-equipment makers also face a year of small sales growth. There seem to be more buyers, but there's also much skirmishing on

CONTENTS

66 West Germany
68 United Kingdom
71 France
73 Italy
75 The Netherlands
76 Sweden
78 Spain
79 Belgium
80 Switzerland
81 Austria
82 Denmark
83 Norway
83 Finland

prices, especially for oscilloscopes.

As for components makers, they rode the color-TV boom and could do little wrong this year. The market bounced up some 11% to reach $3.77 billion. The outlook is for a $4.13 billion year in 1973.

Look for shortages of some components, particularly semiconductors, during the year ahead. Sales of semiconductors ran an estimated $691 million this year and are pegged at just under $800 million for 1973, with particularly strong integrated-circuit sales. □

West Germany

All across West Germany these days, there's a sort of consumer-electronics festival underway. Shops are jammed with crowds snapping up nearly everything in sight, particularly color-TV sets. And it's not just the usual Christmas buying binge. All this year, in fact, set makers have been hard put to keep dealers stocked.

All told, 1973 should mark a solid rise for the country's electronics markets. Werner Matschke, director of sales and marketing policy at Siemens AG, puts the rise at between 8% and 9%. Manfred Beinder, head of market research at the ITT group's Standard Elektrik Lorenz AG (SEL), pegs it slightly higher. *Electronics*, weighing inputs from dozens of West German businesses, forecasts a 9% increase for equipment markets—components excluded—next year. That's $3.68 billion, all told.

It's not hard to spot the leaders—computers, communications gear, and consumer electronics. The likely laggards are industrial electronics and avionics.

Consumers clamor for color TV

"It would be wishful thinking to believe that the phenomenal sales registered this year will continue unabated," says one trend watcher. And it would be difficult to repeat the stunning climb of color-TV sales throughout Western Europe this year. The forecast puts West Germany's share of the market at $495.5 million for 1972, a solid 30% above last year's level.

Consumption undoubtedly won't rise as much in 1973; sales should run about $570 million. But that's a lot of business. "Around 1.4 million sets," is the word from Johanna von Ronai-Horvath, head of market research for Graetz GmbH and Schaub-Lorenz GmbH, both ITT entertainment-electronics outfits. "About 1.35 million," says Cay Baron Brockdorff, manager for sales and marketing at Loewe Opta GmbH. At Grundig AG, largest of the country's set makers, the word is "between 1.4 and 1.5 million." Things look so good to Grundig that the company was stepping up its color-set output to some 1,400 sets a day at year-end.

Full transistorization, large-scale application of integrated circuits, and 110° picture tubes are standard features. Grundig has adopted modular chassis design and remote-control station selection by ultrasonics. The others are following suit.

All is not black for monochrome TV. To be sure, it looks as if 1973 will be the first year that color-set production in units will reach the level of black-and-white sets. But a rising demand for portables will keep monochrome sales from falling as fast as most people had thought they would. The share of portables in the monochrome market was 11% in 1969, and this year, Gerhard Grosse, general manager of Deutsche Philips GmbH, puts the share of portables at about 40%. Next year's market for monochrome will be about $210 million, *Electronics* predicts.

As for the radio market, there's nothing spectacular in sight. It will hover at about $240 million this year and $245 million in 1973. Peter Brandt, manager for the radio sector at Deutsche Philips, figures sales will hold at about 8 million receivers annually—not counting under-$8 pocketables— through 1975.

But there will be definite shifts within the market, Brandt says, "that will lead to a considerable increase in value." Over the next few years, he explains, the percentage of table models will drop as the shares of higher-priced portables, radio-recorders, and stereo systems increase. Stereo systems now have 12%, and Brandt estimates that the figure could be 25% by 1975.

The new product to watch next year is the Telefunken-Teldec video disk playback unit, called TED, for television disk. TED will hit the market next August, right after the West Berlin Radio Show. The set, which plays records containing some 10 minutes of color programing, will be ticketed at about $300. Rolf Schiering, audio-visual marketing manager, predicts that TED will show roughly the same growth pattern as that for color-TV sets. This would mean that within five years after TED hits the market, some 2.2 million units would be operating in West German homes.

And computers continue to climb

No matter what the whims of the economy, the computer market in West Germany always moves in one direction—upward. "The rates of growth may vary from year to year, but that's mainly due to shifts of emphasis within the market, rather than to any let-up in demand," says Johannes Macher, a market researcher at Siemens. As for near-term prospects, Macher predicts that sales of data processing equipment will go up some 12% this year and in 1974. *Electronics*' survey turned up a gain of 10%—from $947 million to $1.076 billion.

Communications going up. Symbolic of telecommunications growth, West Germany's latest earth station takes shape at Raisting, and will work through Symphonie, a French-German satellite.

Growth rates of 12% and more seem feasible for some time to many computer-market specialists. Even after a decade and a half of computers in West Germany, one points out, less than 20% of the 250,000-odd West German enterprises regarded as "computer-prone" have turned to data processing. At the beginning of 1972, about 10,000 systems were in use, according to Diebold-Deutschland GmbH, a computer consultant firm. These systems are worth about $3.73 billion; add the value of data-acquisition equipment, and the total comes to $4.66 billion. Peter Feuser, manager of market research at Diebold, estimates that roughly 14,400 systems will be installed by the end of this year. The figure includes process computers.

Feuser says that unit sales of process-control systems this year shot up far faster than those of "universal" systems. Gains for the two were about 29% and 7%, respectively, during the first half of 1972. This disparity reflects the onrush of minicomputers. Already well established for tasks like scientific technical problem-solving in industry and at universities, minicomputers are now moving into such fields as communications, transportation, warehousing, printing, and health.

Digital Equipment Corp.—no surprise—leads the minicomputer market. By the end of this year, DEC figures to have about 1,200 systems operating in the country. Helmut J. Peröbner, general marketing manager, pegs 1972 minicomputer sales in West Germany at $50 million, which includes systems operating in conjunction with large computers. For the next year. Peröbner predicts a market growth of 20% to 25% for minis.

Large systems have bright prospects too. Wilfried Born, manager of market development at Sperry Rand GmbH, foresees a move toward large computers for international bank networks that will speed up country-to-country money transactions. Similar networks are in the offing to tie together Continent-wide hotel associations to handle reservations and related jobs.

There's a move under way in West Germany to make computer services widely available to doctors. Regional centers, each with a large computer, will help doctors with their administrative chores, particularly the processing of vouchers for the government health plan. Sperry Rand's Univac will supply its 1106 computer for the first three centers. Siemens and IBM are also vying for future business, which could be considerable.

Well posted?

West Germany's communications-hardware makers had a magnificent showcase for their wares this year at the Munich Olympic Games. But with so many big communications projects finished off for the Games, there's bound to be some tapering off this year. However "there's not going to be a post-Olympic slump," says Karl A. Saxl, a Siemens forecaster. There's a replacement market in telecommunications hardware, for one thing. Then there are such projects as electronic-data and telephone-switching systems, as well as new pulse-code-modulation networks to keep communications makers reasonably busy next year.

However, West Germany's post office, the biggest single customer for communications hardware, most likely won't have its detailed budget until early next year. But industry people believe spending for telecommunications will be 10% to 13% higher in 1973 than this year's $1.9 billion. A lot of the money goes for buildings, cables and the like, but plenty should be left for electronic hardware. The *Electronics* survey turned up a 12% gain, to $685 million, from this year's $612 million for communications hardware items.

West German Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**3,361.8**	**3,679.4**
Consumer products	1,268.0	1,337.5
Computers	947.3	1,076.4
Communications	611.5	685.0
Industrial electronics	306.3	329.6
Test and measuring equipment	100.4	108.2
Medical electronics	128.3	142.7
Components	**1,222.4**	**1,329.7**

Exchange rate: $1 = 3.22 marks

Still not a big-money project, but worth watching, is the post office's development program for the EWS electronic switching system. The system's stored-program control computer has a core memory with a capacity of 256 kilobytes and a cycle time of 1.5 microseconds. It is supported by a Siemens 4004 computer, which is used for external-maintenance diagnostics. The PCM-compatible system can handle both space-division and time-division multiplex transmissions.

The EWS system is a joint development by Siemens, SEL, Telefonbau und Normalzeit (T&N), and Deutsche Telefonwerke und Kabelindustrie AG (DTW). It will start field trials at Munich by the middle of next year, handling 1,000 telephone subscribers under normal traffic conditions. The second and third EWS systems will be installed for trials in late 1973 and early 1974 in Stuttgart and Darmstadt. By 1975, all eight central switching exchanges in the country are to have EWS systems for regular telephone communications.

As for data switching, the post office has its first electronic system (EDS) under trial at Munich and plans to cut it over for regular service next year. Two more systems are slated to go into operation next year in Mannheim and Frankfurt. The system's design was worked out mainly by Siemens, with SEL participating.

The post office is also pushing PCM systems. By the end of this year, there will be about 80 30/32-channel PCM systems operating in West Germany. Twenty to 30 systems will be added annually through 1975, says Theodor Irmer, the man responsible for PCM system planning. "The demand is for much more than that," Irmer says, "but we are keeping the number purposely low because we'll have a standardized and uniform version for large-scale introduction in 1975." Presently there are four system designs being used—from Siemens, AEG-Telefunken, SEL, and TeKaDe-FGF.

One standard version for regular service in 1975 and beyond will be the PCM-30, a 30-channel system that transmits at 2,048 kilobits per second. Retaining the best features of the four present designs, the PCM-30 will replace low-frequency cables in short-haul networks. A standard 120-channel system with rates of 8

megabits per second will also be used for phone communications in large metropolitan areas. Once videophone communications get under way on a regular basis, the 120-channel system will also provide that service. It's also intended for microwave transmissions above 10 gigahertz. For data transmission, there'll be a third class of PCM equipment with rates of 1 megabit or more.

Günter A. Holzmann, assistant sales director at Rohde & Schwarz, says a boost of sorts will also come from replacing transmission equipment in service for 10 years and more with solid-state hardware. "With Germany one of the best radio-covered countries in Europe," Holzmann says, "network expansion has become a small business factor. Hardware replacement is providing a bigger thrust."

Another lift will come from navigational aids and air-traffic control systems at airports, Holzmann says. He also forecasts a good rise—8% or so—for the mobile-radio equipment market. That market is getting a lift from orders by operators of taxi fleets, road-construction and first-aid vehicles, and fire-truck and police-car operators. Big price drops for mobile-radio equipment, averaging 50% for some standard gear, is one factor behind the spurt in demand, Holzmann says.

Queuing for components

When West Germans, as they're now doing, stage a long-lasting consumer-electronics festival, it can only mean a lot of tinsel for components makers. Only a year ago, their outlook seemed as dismal as the further reaches of the Black Forest. Now they're wondering how to cope with bulging order books.

Delivery times are stretched out, particularly for consumer-grade components—from simple discrete devices on up to picture tubes. Even some types of integrated circuits are hard to get. "All the while, set makers are crying for more, lest their production lines come to a standstill," says an official at Valvo GmbH, the German components subsidiary of Philips.

So there's a strong market for components in sight. Joachim Prange, a components-market analyst at Siemens, figures there'll be a 10% rise. SEL's Manfred Beinder thinks the spurt could be 15%. *Electronics'* survey spots the market for components at $1.33 billion in 1973, up 9% over the 1972 estimate of $1.22 billion.

Scoring an above-average increase next year will be semiconductors. Siemens' Prange pegs it at 15%. Considering integrated circuits by themselves, the rise will be twice that for semiconductors—roughly 30%, Prange predicts. *Electronics'* survey shows much the same gain.

As it was this year, the consumer sector will be the biggest semiconductor user in 1973 too. It'll buy $110 million worth, $12 million more than this year, says Dirk G. Vogler, manager of marketing administration at Texas Instruments Deutschland GmbH. The industrial sector, Vogler estimates, will consume about $82 million worth, up $7 million from this year. Sales to computer makers will be $55 million, a gain of $5 million. The military and space markets, Vogler says, will stay flat at $15 million.

As for integrated circuits, bipolars still account for the largest chunk of the business. Next year, $30 million worth of bipolar devices will be sold, versus $12 to $13 million of digital-MOS types, Vogler says. Despite the euphoria, most semiconductor makers are keeping their cool. With the disastrous years of 1970 and 1971 still stinging memories, semiconductor producers are adding capacity with caution. "The industry lost too much money in the past from over-reacting," summarizes Fritz G. Höhne, director of sales and marketing at Intermetall GmbH, an ITT semiconductor company. □

United Kingdom

To visitors, Britain has a certain consistent charm. The guard still changes at Buckingham Palace with precision and polish. Piccadilly is as raffish as ever. Shoppers still crowd Oxford Street.

So long as those shoppers continue to spend money, electronics markets will run strong in Britain. And the glow from color-TV screens makes for most of the brightness in the outlook. The *Electronics* survey points to an equipment market of $2.39 billion, a strong 11% increase over the 1972 estimate of $2.14 billion. Computers figure to perk up, and communications and components won't be bad. Not much is expected, though, in instruments and industrial electronics.

But electronics is an exception to the general economic growth, which will hop to 4% this year and could register nearly 4% again in 1973. However, the spurt will come almost entirely from a boom in consumer durables, and there's no solid sign yet of what's really needed—a thoroughgoing round of plant investment. While consumer-goods makers prosper, steel makers and chemical manufacturers, for example, face more slack times, and unemployment is a problem.

If the long-awaited plant-investment cycle actually starts, 1973 has to be a very good year. If it doesn't, a relatively small hitch, such as the upset when Britain starts operating next Jan. 1 in the Common Market, may halve the 4% projection. And last year, the nation's real growth ran less than 2%.

Bright island

Britons have been unbelievable this year when it comes to color television. A year ago, industry optimists were forecasting perhaps 1.5 million sets in 1972. But the actual figure is going to be around 1.7 million sets, worth $570 million. Some now predict that the market in 1973 will climb on up to 2 million sets. *Electronics'* survey puts the value at $710 million. With that big chunk assured, the consumer electronics market will push past $1 billion next year.

With dealers running short on stocks, set makers aren't about to slow their output to make radical model changes. Hence U.K. color-TV receivers still have 90° tubes, except for the few intended for PAL export markets, where 110° tubes are the norm. But there'll be circuit improvements. More home-market sets will feature touch tuners made by three technologies—discrete, bipolar and MOS—and an extra integrated circuit or two

will appear here and there. In particular, more sets will use integrated low-level synchronous detectors. The favored designs are by Motorola and Philips.

Hi-fi equipment makers can expect a good 1973, too. Because it's hard to tell when a high-priced phonograph actually becomes a hi-fi set, there is some confusion in the figures. Some people in the business swear that "unit audio" shot up this year by 50%, in terms of pieces sold, and could repeat that performance next year. *Electronics'* survey, on the other hand, shows a more modest climb from $70 million this year to $95 million in 1973. At any rate, there certainly is growing consumer interest in good sound, which is being backed by a burst of marketing initiative by stores and discount houses.

Technology has had strong impact on the video-player market. When Rank-Bush-Murphy Ltd. found it couldn't produce electronic video-recording (EVR) players economically, the company abandoned the line, leaving Philips Electrical Ltd. and its licensee, Thorn Electrical Ltd., as the only companies delivering video-playback hardware. They probably will have no difficulty unloading every cassette player they have through most of next year. Sony and Teldec won't hit the British market before year-end.

Computer makers convinced of comeback

It's been bangers and bitters, rather than caviar and champagne, for computer companies this year. Last year's slump in orders has hit this year's deliveries, and *Electronics'* survey pegs 1972 business at some $450 million, about 5% off the 1971 level.

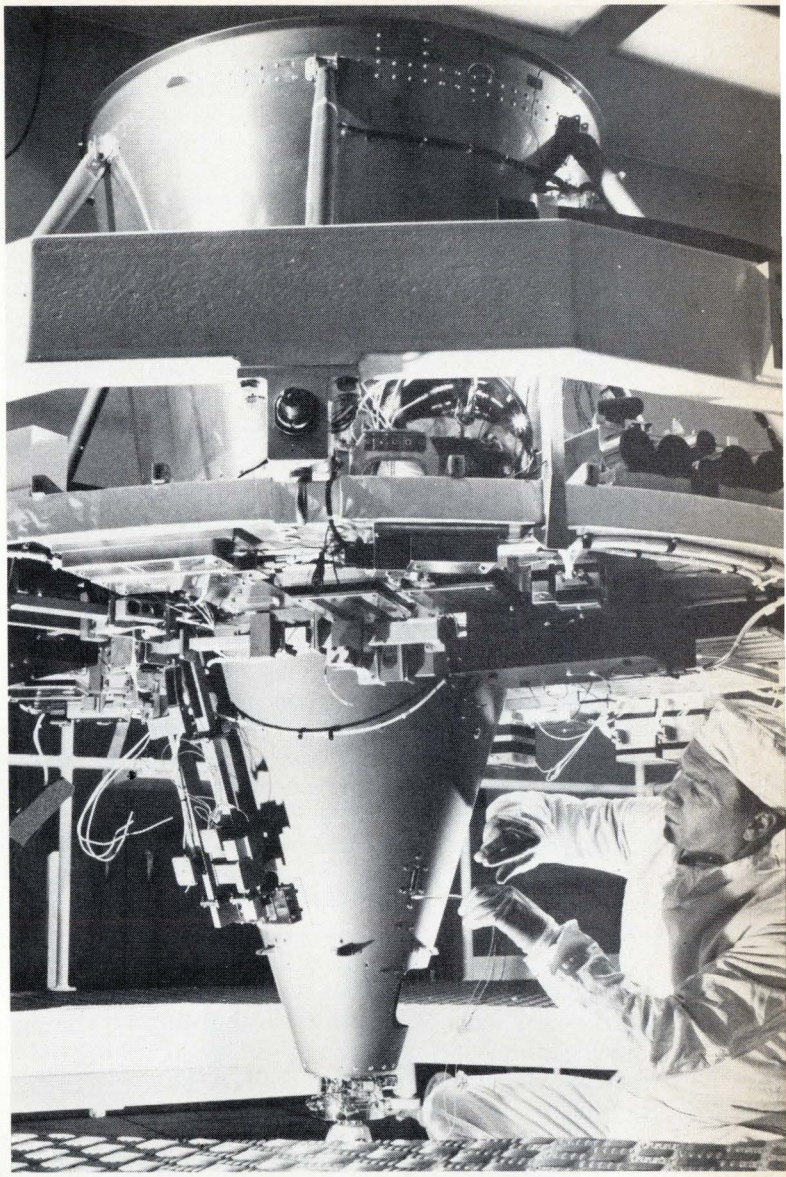
The fare figures to get richer during 1973. The forecast: a 15% gain to $517 million, even better than the previous peak year, 1971. Naturally enough, the sector where orders slumped most last year—small systems destined for smaller businesses—is the sector that recovered fastest. Public-sector orders dropped off less and are picking up again less quickly. Alan Wakefield, manager of marketing objectives for International Computers Ltd., says ICL's private-sector orders are standing about 25% higher than a year ago. ICL, of course, has the biggest share of the British market.

Wakefield sees two main growth trends for 1973. First, many operators of medium-size machines are adding memory and processor power, particularly to turn batch systems into communications-type systems by adding remote visual display units (VDU). Following from that, there's a steady boom in peripherals. Large disk files—60 megabytes or so—are selling well. Investors are often national manufacturing, distribution, and retail chains.

British Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**2,140.3**	**2,395.0**
Consumer products	966.0	1,098.5
Computers	450.3	517.0
Communications	496.8	535.5
Industrial electronics	138.8	149.7
Test and measuring equipment	66.8	70.9
Medical electronics	21.6	23.4
Components	**893.7**	**974.6**

Exchange rate: $1 = 41.5 pence (1£ = $2.40)



Preflight testing. A prototype of Britain's Skynet 2 military communications satellite is tested at Marconi Space and Defence Systems.

One important question for the computer industry should be answered next year: Will ICL announce its new computer range, designed to take over from the two existing older lines it inherited when it was formed three years ago? Probably it will, for two reasons. First, the longer ICL waits, the better start it gives competitive new ranges, particularly IBM's. Second, the company's order book isn't excessively high (it's bad to introduce new models when demand is running high, because too many people are put off by long delivery delays).

Minicomputer sales were less affected by last year's recession, and a steady 10% increase in sales seems likely. Data concentration, originally touted as the main outlet for minis, is developing only slowly. Most minicomputer sales are for single units to universities and company research departments. The original-equipment-manufacturer market for industrial gear, particularly machine tools, is growing fast in numbers;

growth in value is something else because OEM systems are very basic.

There's no sign of an upturn for industrial process-computer makers, though. For them, the low level of business that's persisted for a couple of years now seems to be permanent. Investment by oil and chemicals producers will be significantly less than in 1972; worse still, upturns in gas, steel, and electricity won't compensate.

On the technical side, 1972 was a year for development, and in 1973, some of this work will get to market. About mid-year, Ferranti Ltd. is likely to formally announce its new military computer, so far the only British machine with a full Schottky-TTL processor. Before that, the company could take the wraps off some new fast process controllers. A year ago, core stores still had a cost edge on MOS memories, but now that's turned around, at least for small sizes. Look for some British minicomputers with semiconductor memories next year.

Communications-equipment makers have the steady increase in post office telephone and telegraph equipment buoying their sector, as always. So the prospect overall is for a rise, albeit nothing to get really excited about. The *Electronics* survey spots the 1973 market at $535 million, up 8% on the $497 million of this year.

One bunch of equipment makers whose sales message is coming through loud and clear is the land-mobile crew. Sales for the sector moved up 10% this year and something like that looks likely for 1973. Pye Telecommunications Ltd., the market leader, believes in growth to the extent of boosting its sales staff. Other makers see signs of a slowdown. Indisputably, though, buyers are asking increasingly for sophisticated extras such as selective calling. That makes it tough for smaller producers.

Production of more sophisticated radio systems is looking up as well: a whole new family of military mobiles called Clansman will roll off the lines of a half-dozen factories. There's also a steady demand for expensive equipment for North Sea oil rigs and new-generation single-sideband equipment for shipping.

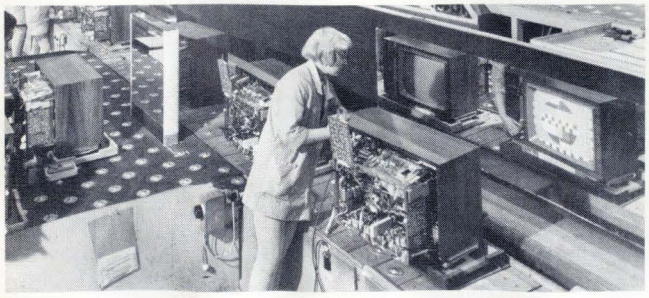
As for the radar industry, "it's going through a difficult time in terms of orders," maintains Douglas Smee, assistant managing director of GEC-Marconi Electronics Ltd. In particular, the home market for large aircraft-surveillance radars is based almost entirely on the demand for replacements, and dependency on export orders is not good for financing research and development.

More money is being spent on displays and data-handling systems, though. Installing the large IBM 9020D flight-data-processing system for air-traffic control over southern Britain will involve spending some $50 million over five years or so for development and production of display systems. Direct-view storage tubes, electronic data displays, touchwire data-entry devices, electro-optical runway fog detectors, and doppler VOR beacons will all be used in greater numbers next year.

Avionics, too, is looking slightly brighter. British companies ended up with a fair share of the development orders for the British-German-Italian multirole combat aircraft, and that has boosted morale. Production of avionics for the Jaguar and Harrier jet fighters and some military helicopters is rising steadily. There are good prospects that British Aircraft Corp. will get an initial production order for its Rapier low-level antiaircraft missile with blind-fire attachment. On the civil side, 22 production Concorde supersonic transports have now been authorized, meaning steady orders for its avionics. And China has placed unexpectedly large orders for Hawker-Siddeley Trident-3 jet transports. But there's worry about the future of civil avionics. Next year, the government must fund some advanced project, such as a short-take-off transport, or R&D teams may break up, and Britain fall behind.

Space-electronics companies won't breathe easily until Europe's space ministers finally agree to an integrated work program. Once that happens, spending should tend toward a more concentrated effort in a European program. Present space work in hand at British companies includes subcontracting for Hughes Aircraft Co. on Intelsat spacecraft, two military communications satellites slated for launch next year, a scientific satellite, a technology-proving satellite, and participation in European Space Research Organization programs. Most important for the future, Hawker-Siddeley and Marconi Co. are doing project definition of a geostationary experimental communications satellite.

For the instrument business, it's a mixture as before. That means little over-all growth, with gains chalked up by automatic systems at the expense of conventional bench instruments. The best growth sector is the communications industry, which will take more network analyzers, generators, synthesizers and counters.



Bright picture. Color sets, like these being made at Thorn Electrical Industries' Bradford plant, racked up a boom year in 1972.

Components sales snap back

Components suppliers in Britain went into 1972 figuring they'd fare poorly. Happily, that wasn't the case, thanks to the surge in color-TV set output. To make things even better, prices of semiconductors firmed for all sorts of reasons. The most obvious, of course, was the fairly sudden end to the price war for standard ICs.

All told, then, components consumption moves up a smart 13% this year to $894 million, according to *Electronics'* survey. Next year's outlook is solid, too—up an additional 9% to $975 million. Demand, thus, has caught up with supply. That's one supposedly immutable law of a free economy. In fact, demand for some consumer components is outstripping supply, and some shortages are inevitable. There's another law of market economics that says suppliers usually over-react when

their order books bulge during a boom in prosperity.

Semiconductor producers, particularly, will face temptations to add capacity. The survey predicts a 15% rise in the market next year to $193 million from this year's $168 million. One big lift will come from builders of telecommunications equipment. Along with discretes, there's a wide market opening up for MOS LSI chips for push-button telephone pulse generators. Custom MOS also will go into several U.K.-made instruments and calculators. For its calculator, though, Sumlock Comptometer Ltd. will take bipolar LSI from Ferranti Ltd. Deliveries of 1,024-bit semiconductor random-access memories will build up slowly, and new systems incorporating ECL and Schottky-TTL will add something to demand for the rarer logic circuits.

Light-emitting semiconductors are catching on very slowly in England. American products will still dominate the small market, but Plessey Co. could grab a foothold with high-brightness yellow emitters.

Gas-discharge displays aren't doing any better. But in the belief that they might, Ferranti Ltd. will join Burroughs and Mullard Ltd. next summer in offering a panel 5 by 2 inches with two rows of 20 characters each. CRT displays, however, should do well, particularly those for computer and airborne use.

For automobile electronics, it will be another year of slow progress in Britain. Car makers are too hard hit by inflation to introduce pricey technical changes. But Smiths Industries Ltd. will mass-produce, mainly for Ford Motor Co., a hybrid version of its IC-based tachometer. There'll be more electronic ignition bolt-on conversions in the accessory shops, too.

As for new components technology, Plessey and GEC Semiconductor Ltd. will both offer nonvolatile metal-nitride-oxide semiconductor (MNOS) read-mostly memory arrays in small quantities. GEC will market linear arrays of charge-coupled devices that can be used as shift registers, analog signal processors, or image readers feeding gray-scale information out serially.

Tri-glycine-sulphate room-temperature infrared detectors haven't displaced cooled types in the military market, but have found growing civil sales where lower sensitivity will do. Examples are spectrometers and radiometers, which previously used bolometers or Golay cells. The military will continue to take virtually all the output of direct low-light intensifiers, and for the first time, a British acoustic surface-wave device will get into British equipment when a filter developed by Microwave and Electronic Systems Ltd. is built into a prototype pulse-compression radar. □

France

Traditionally, the French have had their doubts about anything that's not truly French. And a dominating national trait has been bullheaded individuality. But much is changing throughout Western Europe, including the traditional French outlook. International cooperation in matters financial and industrial, in fact, figures to burgeon in 1972.

Electronics will have its share. The "native" French computer companies are working on deals that will link them with German firms, now competitors. And finance

Fare game. Computers are the ticket for Air France, which has added a Univac 1106 to link 130 passenger terminals at Orly airport.

minister Valéry Giscard d'Estaing has already started taking anti-inflationary measures in harmony with France's Common Market partners. The aim is to bring Europe-wide inflation down to 4% in 1973.

What worries people in the electronics industries is a nagging feeling that the government's anti-inflation measures—like tightening up on credit—have been tempered to keep voters reasonably contented until the parliamentary elections next March.

"All nongovernmental markets in electronics could feel a slowdown after the elections, depending on the scope of the measures Giscard takes," says Henri Batlle, chief of the Fédération Nationale des Industries Electroniques (FNIE), the trade association. "The second half of next year, we could be in for a squeeze."

Industry is clearly on its guard for a series of new economic policies. "We can't keep on this way, with salaries going up 10%–12% and prices 6% a year," says Raymond Genêt, chief of economic studies at RTC La Radiotechnique-Compelec, a Philips company. "Credit

Market factors. It's digital instruments that are providing what little luster there is in the French instrument market.

will probably have to be restrained further, among other things." Even so, electronics marketing men are forecasting a clear upturn in 1973. *Electronics* forecasts sales of $2.22 billion for equipment in 1973, up 11% over the 1972 estimate of $1.96 billion.

Color TV takes on a new hue

There's no question that the impetus is coming from consumer electronics. Genêt of RTC says, "The color phenomenon is serving as a driving force for the electronics industry as a whole." Edouard Guigonis, vice president for marketing at Thomson-CSF, rates the consumer market as "very, very good—far from saturation." Thomson-CSF is France's largest electronics group.

This year, the color-TV market at long last started to take off as sales shot up to some 450,000 sets, nearly a 50% jump from last year's figure of 300,000 sets. Next year's number should be above 600,000. That's still nowhere near the German and British figures, but it's enough to keep French set-makers bustling. The government-controlled broadcasting agency ORTF on Dec. 31 will inaugurate its third network, with all-color programing. Although relay facilities are only partially installed, the major population centers will receive the third program. Set manufacturers are hoping—most likely in vain—that the wider choice will force an upgrading of program quality, adding a further fillip to color sales.

Another consumer area climbing fast is the portable-radio market. Transistorized sets retailing at around $20 were virtually unknown in France only two years ago. But last year, about 200,000 were imported from Singapore, and this year imports are expected to total around 900,000. But, because the profit margins are so small, French producers let the Asians take over the small-portable market a few years ago. To the surprise of the French, however, the Singapore radios—from a variety of firms, including Philips—have created a substantial market that could gross over $30 million next year.

Trans-Rhine computer combine takes shape

In the computer business, it's tough trying to play David when Goliath happens to be IBM. So France's proud native computer producer Compagnie Internationale pour l'Informatique (CII) has decided to share slingshots with West Germany's Siemens AG. The two plan to pool computer research and development, share manufacturing, and combine marketing efforts for a new line of machines. Philips Gloeilampenfabrieken very likely will also join the combine.

Other computer makers in France view this new togetherness with some skepticism. "Our guess is that they will have a tough time marrying their technical efforts, not to mention their financial structures," says one competitor. At the outset, anyway, there will be a problem on how to share losses, since the partners get heavy financial support from their national governments.

Nevertheless, CII and Siemens have successfully worked out details of their accord, and they hope to sign before year-end. Germans already were on the scene in marketing capacities at CII's suburban Paris headquarters, and CII had French personnel working in Germany with Siemens to help the two operations mesh in 1973.

French Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**1,959.0**	**2,215.7**
Consumer products	529.3	604.5
Computers	636.8	717.8
Communications	522.6	597.5
Industrial electronics	121.2	133.4
Test and measuring equipment	83.3	91.2
Medical electronics	65.8	71.3
Components	**692.8**	**759.4**

Exchange rate: $1 = 5.01 francs

Meanwhile, CII president Michel Barré is determined to take on Honeywell-Bull and IBM-France in non-government markets in 1973. The company's turnover this year will top $160 million. Next year, Barré will be shooting for the magic number of one billion francs (some $200 million). Barré and his competitors can count on a strong market to joust over. *Electronics'* survey points to a $718 million computer market in France next year, up 11% over this year's estimated $637 million. To some data-processing market seers, the figure will look low. Maxime Bonnet of Honeywell-Bull, for example sees an 18% expansion as possible next year. In his view, minicomputers and small systems will step out at a 20% pace, and large machines will do well too. Medium machines, he feels, won't grow as fast because they are losing ground to fast-improving small systems.

France comes up in communications

Although ordinary telephone subscribers can't hear much difference yet, the massive investment in telecommunications equipment that has been coming out of the government's coffers means good times ahead for hardware producers selling to the Ministry of Post and Telecommunications. The ministry won't make good on its public promise, made last spring, to have telephone service "normal" by the end of 1973. But there's been $860 million spent this year to upgrade telecommunications facilities, and $1.13 billion more is slated for next year, including cable-laying costs.

Some $15 million of the 1973 money will go for electronic telephone-switching hardware as the telephone administration begins a serious shift out of conventional exchange equipment. There are two main contenders for this business, the ITT subsidiary, Compagnie Générale des Constructions Téléphoniques (CGCT), and the French company, CIT-Alcatel. CIT-Alcatel this year landed orders for four small time-division multiplex systems, destined for rural areas in Britanny.

Next year, there'll be orders for urban exchanges, and CGCT expects to score with its space-division equipment. After 1973, the pace of electronic-switching installations will be stepped up progressively to reach about 100,000 lines yearly by 1975, about 10% of the administration's switching installations at the time. The

long-term goal is to have about half the nation's exchanges operating electronically between 1980 and 1990.

Overall, telecommunications is perhaps the healthiest segment of the French electronics industry. "There are some clouds on the horizon, however," warns Gabriel Coron, economic specialist of the telecommunications trade association. "We can't be sure this rate of government investment will continue beyond 1975." Coron says that French suppliers could end up with a huge excess production capacity if government investment drops off suddenly.

To guard against this menace, CGCT, CIT-Alcatel and other companies are trying to increase their exports to 20% of their turnover by the end of 1975. The current figure is only 12%. Government export credits are being made available to help them win orders abroad.

At home, the struggle for the private French market in electronic-switching equipment continues, apart from government orders. CGCT claims the lead with PABX equipment totaling 58,000 lines, followed by IBM at about 25,000 lines, and CIT-Alcatel and Ericsson-France at 12,000 lines each. This lucrative market is expected to jump about 20% next year.

Strength for semiconductors seems sure for 1973

What's good for the "native" computer firm CII is good for the "native" semiconductor company Sescosem, strategists of President Georges Pompidou's regime obviously believe. So Sescosem, the long-struggling semiconductor maker under the wing of Thomson-CSF, tried this year to team up with West Germany's AEG-Telefunken, but negotiations broke down last month, ostensibly because of legal problems involved in setting up a holding company in Luxembourg. Before the breakdown, however, Sescosem officials admitted privately that the real problem was splitting up product lines.

This falling out comes at a time when the market climate is particularly benign for semiconductor suppliers, which makes decisions to go it alone less painful. *Electronics'* consensus forecast is for a market of $140 million next year, up 11% from an estimated $126 million this year. Along with good over-all growth, Sescosem's marketing director, Bernard de Charentenay, foresees a particularly attractive market in computers. Technology is tending to stablize while orders grow, he's observed, and that means a longer product life for some semiconductor devices. "Our computer customers are not changing models as fast as they used to," he says. "These days it's more a question of their refining technology, adding on, and modernizing." De Charentenay says certain transistor and diode lines have thus lasted a good deal longer than some forecasters expected.

But if semiconductor makers are riding high again, there's still concern that the price wars of only yesterday might recur. "There's a clear upturn now," says Motorola's French marketing services manager, Claude Chaskelevitch, "but we are a bit afraid of 1974. This business runs in cycles." Chaskelevitch says that next year is bound to see heavy investment by some semiconductor makers. "All this will bear fruit—bad fruit—in 1974, if it gets out of hand. We are keeping our investment under control, just to be safe," he says.

Motorola is banking on telecommunications and computers to help boost semiconductor orders. French consumer-electronics firms are slow to transfer to ICs, however, says Chaskelevitch, because the biggest local market, color-TV sets, is limited by France's Secam system. Export prospects for special Secam circuits are nil. "Nobody is particularly eager to develop ICs for such a small market," Chaskelevitch says. □

Italy

In Italy this fall, nationwide labor contracts again come up for a three-year renewal. And cynics are wondering whether the country's economy—once a worthy monument to Italy's post-war recovery but shaky for the past three years—will continue to sink slowly like Venice, or will rather appear to topple without ever actually falling, like the leaning tower of Pisa.

Signs are that the economy will lean, perhaps precariously, but not sink. Trade-union leaders talk belligerently, but they seem to have learned that excessively high wage boosts lead to higher prices and the threat of unemployment. A first major contract, for chemical workers, went through in double-quick time in October, an encouraging sign. Strikes this time around are less violent, and demonstrations smaller and more orderly than three years ago.

But the economy continues to lack spark, even though consumers are spending more than they did a year ago. Italian investors are still shy, but the government and foreign capitalists have moved in over the last two years. In the fall, economic observers were predicting a real increase of something under 3% for the country's gross national product this year. This is a certain improvement over 1971's real growth of 1.4%.

Until wages-and-fringes contracts for the major industries are argued out, it is hard to get a solid fix on 1973. As always, too, there's Italy's chronic political instability. Barring a long-lasting wave of strikes or some catastrophic capers in Rome, the economy stands a reasonable chance of maintaining the upturn it marked this year. Whatever the real growth, the 1973 figures in current-money terms almost surely will reflect an inflation of at least 5% to 6%.

The same has to be said of any market forecast, of course. *Electronics'* survey this year indicates an equipment market of $1.05 billion for 1973, or getting on for 12% above the estimated $945 million for 1972. But the gain loses a lot of luster when uninflated.

In fact, no luster at all brightens the prospect ahead for consumer electronics, for Italy still has not started up with color television. For industrial electronics producers, too, prospects are gloomy. There's much that's sunny, though, in the outlook for the telecommunications sector. Nor have the computer makers had to water their Chianti, although they have seen better times. As for components makers, they can expect their home market to move up from the $249 million logged this year to $273 million in 1973. How different it would be if Italy, like its neighbors, were in the midst of a color-TV climb.

Despite a dawdling economy, computer makers man-

age to keep sales growing respectably. This year, the market on an "if-sold" basis will run about $342 million, according to *Electronics'* survey. That makes a 15% gain over 1971. For the year ahead, an 18% gain looks possible: the forecast is for a market of $405 million.

Besides the rise in value, the market structure will shift. One big producer figures that something between 75% and 80% of new installations are small machines bought by small and medium-size companies. The main reason for this rush is obvious. With the New Year, Italy will align herself with other Common Market countries and put an added-value tax into effect. Merchants everywhere will have added bookkeeping to do, and that spur is getting them into data processing.

Computers in government

All this is not to say that IBM, Honeywell Information Systems, Sperry Rand's Univac division, and the lesser lights in the Italian computer business plan to forsake large machines. The government remains a sterling big-system buyer, so much so that one EDP-company executive says that if he had it to do all over again, he would locate his Italian headquarters in Rome and not Milan.

Last year, for example, the Ministry of Finance set up a nationwide data processing system, and so did the Ministry of Posts and Telecommunications. IBM got that business. This year, Univac landed contracts for big systems with Italcantieri, the state-run shipyards, and Italsider, the state-owned steel company. The Ministry of Justice, too, took delivery this year on a Univac 1106 for an information-retrieval service for lawyers.

Still more government business is in the offing. The railroad system is evaluating tenders for a big system, and prospects at the universities in Rome, Milan, Naples, and Bologna are good. Even better, when the national bureaucrats in Rome are sated, the local governments will be heavily in the market. There is still no sign, though, as to when the government might earmark loads of lire to automate the hospitals. When the time comes, it will be happy days for an outfit called SAGO (for Sistema Automatico Governo Ospedaliero). SAGO was formed early this year to bring together the main Italian companies with competence in hospital automation—I.M.I., Montedel, Selenia, Pignone Sud, Olivetti, and a Fiat subsidiary called Sorin.

Whether business is good or bad in Italy, there is always a lot to talk about—more, in fact, than the telecommunications network can handle. But SIP, the state telephone agency, is pushing hard to pare down the present six-month waiting period for new subscribers, all the while improving service generally. Currently, the agency adds some 800,000 phones a year to the network. This year, the government granted a rate increase for phone service, but to get it, the agency had to promise to do even better.

Communications coming on strong

Spending on telecommunications in 1973, then, will run close to $1 billion. SIP's biggest supplier is Società Italiana Telecommunicazioni Siemens, like SIP itself a member of the government holding company IRI's STET group. But Telettra, GTE, the ITT standard subsidiary FACE, and the LM Ericsson subsidiary Fatme all stand to pick up considerable business too.

As SIP expands its network, it is bettering its technology, naturally. For short-haul trunks, for example, it has a program for switching to pulse-code modulation. This year, some 8,000 channels-worth of cable PCM links with hops averaging between 12 and 15 miles were installed. The links actually have 30-channel groups and a 2-megabit transmission rate. Next year, SIP will start using an 8-megabit rate on 120-channel equipment (four groups of 30) paired with microcable developed by Pirelli, and will also begin on PCM radio links.

The market for conventional microwave relays is also good. GTE has a $5 million job for 2,700-channel hardware that is slated to go into service in 1974.

SIP, like most other West European telephone agencies, has electronic switching in mind. And although the solution for the long term almost surely will be fully electronic exchanges with time-division multiplexing, SIP still has to make up its mind as to what kind of space-division hardware it will use before then. And since the government has its say about SIP, politics will be a factor in the decision.

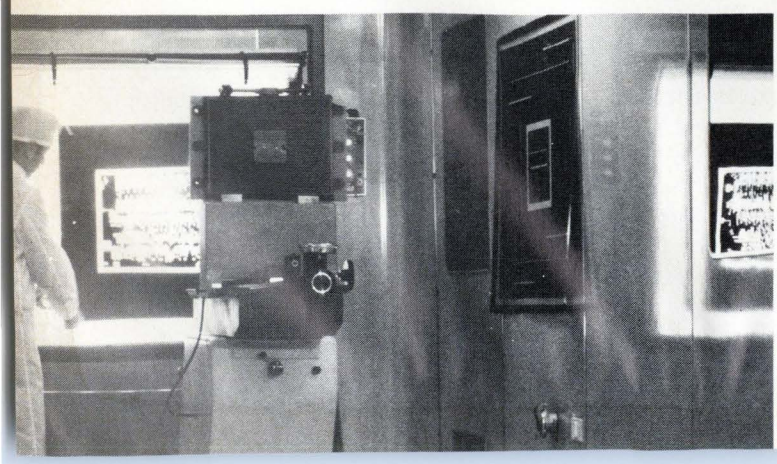
Politics affects the national broadcasting organization RAI also. RAI is officially autonomous, and, until this year, had five-year contracts to run the country's radio and television networks. Now it just has a one-year renewal for 1973, and that's that for any coherent investment program in broadcast equipment. Under debate, too, is whether cable TV should be wrested from RAI and turned over to some other body—SIP, for example. So politics may stunt growth in yet another market.

Set makers wait for the rainbow

Politics is painful, too, for Italian TV-set producers. The government has decided no color network will go on the air before 1974. Even worse, the debate over which color system to use—the West German system PAL or the French system Secam—is still unsettled.

Until this summer, set makers figured the choice would be PAL, hands down. All were geared up to produce PAL sets, and RAI was ready to broadcast using it. But then Georges Pompidou's government renewed its pitch for Secam and that was enough to make color TV another squabbling point for Italian politicians.

A lot of would-be buyers have followed the govern-



Applied technology. At General Instruments Europe, a leading Italian MOS house, the move is toward standard MOS circuits.

Italian Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**944.6**	**1,053.8**
Consumer products	220.8	236.5
Computers	341.7	404.7
Communications	221.8	238.9
Industrial electronics	95.3	101.6
Test and measuring equipment	31.8	36.0
Medical electronics	33.2	36.1
Components	**248.7**	**273.2**

Exchange rate: $1 = 580 lire

ment's lead and postponed decision. As a result, the consumer electronics market, for which TV sets the tone, is flat. *Electronics'* survey predicts a modest rise from an estimated $221 million this year to $237 million in 1973. The only glow in the market is a fairly robust business in small-screen second sets.

A solider market shows for solid state

Italian component makers can find plenty to complain about, but not as much as last year. To be sure, little is doing in domestic color-TV production, the market mainstay elsewhere. But equipment production nonetheless should be enough to boost consumption of components to $273 million in 1973, according to *Electronics'* survey. That's a boost of 10%—not too bad.

Semiconductor suppliers, who suffered mightly in 1971, saw prices firm up this year as excess supply finally got sopped up. End result was a jump up to $48 million from last year's $41 million. Next year will see a further rise to $58 million. according to the survey.

Nonetheless, caution is the word at SGS/ATES, the Italian semiconductor producer that last year was tucked into the fold of the state-controlled electronics group STET. One major concern is the rise in labor costs that is certain to come out of the year-end contract negotiations. SGS/ATES plans to counter as best it can with high production runs of standard devices. One main push will be with high-power integrated circuits for radio and TV sets. General Instrument Europe, a heavyweight in Italian MOS because of its plant at Naples, also will shift more toward standard MOS circuits. □

The Netherlands

Talk with a Dutch businessman these days, and the conversation usually gets around to inflation. Unhappily, rising prices and wages have become as prominent in the country's economic pattern as the windmills in the flat Dutch countryside. The outlook for 1973 is for a hike of at least 6% in the consumer price index and an upward jump of 12% or 13% in wage costs.

There will be other, less worrisome developments to talk about, though. The balance of trade figures to stay positive, industrial production will move up by some 6.5% to 7%, and the gross national product looks set to grow 4.5% or so in real terms.

One thing seems sure. There'll be a lot of spending money around for consumer durables in 1973, and Philips Gloeilampenfabrieken will be there, as always, to sop a lot of it up. Largely because of strong markets in consumer goods, computers, and communications, *Electronics'* survey foresees a $596 million year in 1973 for electronics equipment, a respectable 11% gain over the estimated $538 million for 1972.

Color TV carries on

At Philips headquarters in Eindhoven, the company's business strategists look at Holland as just another West European market. And as far as color TV goes, the country is exactly that. Sales have been running surprisingly high this year, and a strong market is in sight next year. *Electronics'* survey puts the 1972 market at $88 million, up one-third over the 1971 figure. For 1973, the forecast is a strong further climb to $103 million.

Except for monochrome TV, consumer electronics figures to stay on this year's high plateau. Hi-fi, particularly, is going to higher levels in sales, as well as decibels. All told, the consumer electronics sector should hit sales of $228 million next year, according to the survey. The estimated figure for 1972 is $213 million.

There are no bounds forward in technology in sight for 1973. F.C. Romeijn, a top technology-watcher at Philips, expects a continuing shift to ICs among the set makers, but foresees no immediate end to the variety that now exists in splitting up functions among chips for color-TV sets. In Romeijn's view, the next consumer product to make a heavy impact on the market, starting around 1975, will be video-recording equipment. Philips, remember, has video-tape hardware on the market and is readying a video-disk system.

As for computers, Holland should turn out a little better than the run-of-the-mill West European country. Philips planners predict an expansion of 15%, on the average, for Western Europe. *Electronics'* survey predicts a 1973 market of $157 million for computers and related hardware in the Netherlands, up from an estimated $134 million this year. That's 17%.

Dutch don't stint on communications

Holland resembles most other West European markets, too, when it comes to communications. There's a solid growth for years ahead as the Posts, Telegraph, and Telephone (PTT) people keep the country abreast of its needs. To do so, the PTT spends about 0.9% of the Dutch gross national product for telecommunications investments. Last year's figure, for example, was $280 million. By 1980, it will be $525 million.

A lot of the money goes for real-estate and for cable-

Dutch Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**538.1**	**595.7**
Consumer products	212.6	228.0
Computers	134.2	157.0
Communications	74.6	84.6
Industrial electronics	56.4	59.8
Test and measuring equipment	45.5	49.6
Medical electronics	14.8	16.7
Components	**166.2**	**180.9**

Exchange rate: $1 = 3.23 florins

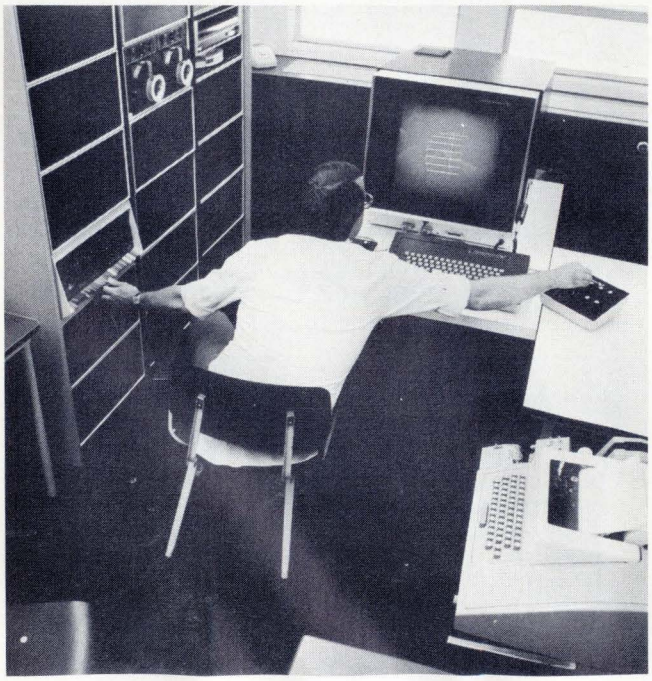
laying costs, of course. But the PTT plans to spend heavily for new hardware. The first semielectronic exchange for telephone service, a 1,000-line affair, was cut over last month in Utrecht. Philips Telecommunicatie Industrie of Hilversum supplied the hardware, called PRX.

Next year, the aim is to cut over five or six more exchanges for a total of some 25,000 subscriber lines. After that, say Philips phone people, there'll be 40,000 more lines a year, starting in 1976. Philips has this business but not a stranglehold on telephone switching in the country. "Our share is less than 50%," insists Jack van Straalen, managing director of Telecommunicatie.

Along with its public system exchange equipment, Philips has a line of private exchange equipment. After a fast start in recent years for PABX hardware, the company is looking forward to a "consolidation" in 1973 and a real growth of some 5%. That's the expectation of Anton Philips, grandson of one of the company's founders and in charge of the private-switching sector.

With semielectronic switching on the way to becoming mundane in the Dutch telephone system, the PTT plans to try out other new technology. Dirk Van den Berg, a top PTT executive, says the field trials for picturephone service will start in mid-1973 and run for a year, though PTT doesn't expect to have full-fledged picturephone service until 1980.

Further proof the agency really plans ahead is its decision on trunk lines for the 1980s. "We'll skip millimeter waveguides and go right to glass-fiber bundles," says Van den Berg. Eventually, the network will be fully digital, with bit streams for telephone, telegraph, and data transmission multiplexed over the same glass-fiber lines. Long before optical transmission, though, the country will be graced with a backbone trunk network operating at a 60-megahertz bandwidth. Hardware will be from Philips, and start-up date is "around 1975."



At work. The scene could be in any West European college lab. This Digital Equipment Corp. minicomputer is at Nijmegen University.

All this communications activity will benefit test-equipment makers, who need all the benefit they can get. Jan Schapers, sales manager for Hewlett-Packard's Benelux operation, rates the sector as having "much promise". Particularly strong next year, he feels, will be microwave test gear with gains perhaps as high as 25%.

The entire Dutch market for instruments should expand some 8% to 10% next year in the opinion of Rien van Dijk and Henk Bodt, top men in Philips' Test and Measuring Instruments department. In other words, a lot of plain price rise and very little growth are in store.

As everywhere else in the industry, the accent at Philips is on digital instruments. But Bodt is convinced that analog instruments still can hold their own in the lower-price ranges. Philips' 2403 multimeter, he points out, retails for about $125 and offers 1,000 hours of operation between battery changes, 10 megohms input impedence, a linear ohm scale, and automatic protection against over-ranging. The cheapest digital instrument with competitive performance sells for $175, Bodt maintains. On this matter, Bodt would get no argument from H-P's Schapers. He doesn't expect there can be a big market for digital multimeters until there's a battery-operated version that could sell for between $125 and $150—well below current price levels. □

Sweden

It's not always necessary to read the financial pages of the *Dagens Nyheter* to get a solid feel for how the Swedish economy is faring. There's been all sorts of front-page news of economic import in recent months.

The Social Democrats, who've run the country for 40 years, have put together an employment package intended to create more jobs by spurring plant investments, woefully low for the past two years. Government economists now say that the outlook is for a real growth next year of 4% to 5%. Although the economy won't be running in high gear during 1973, at least it will be in second, and that's comforting after a couple of years of chugging along in compound low.

The electronics market, then, seems sure to rev up. *Electronics'* survey forecasts a $555 million year in 1973 for assembled equipment, up 10% over 1972's estimated $507 million. Consumer electronics and computers will be the market leaders. The outlook is satisfactory for components makers, so-so for communications equipment and industrial-equipment producers, and sad for military electronic-equipment makers, who have a dwindling home market (inflation more than offsets the slight rise in military spending) in sight.

Consumers are heavy spenders

Although unemployment is a problem for the government, nobody at Svenksa Philips or Luxor Industri AB has had to face the problems of layoffs. Quite the contrary. The two companies are the main producers of TV sets in Sweden, and they've both stepped up capacity.

This year, sales of color-TV sets shot up from 1971's $103 million to an estimated $152 million. Even before

the heavy Christmas-buying season began, retailers realized they were in for a record buying spree. The annual December tax refund of overdeductions topped those of previous years, and in early November, display ads were urging customers to do their Christmas color-set buying "before the big rush."

The pace won't be as frenetic next year: a market of $170 million looks likely for color sets. Hi-fi hardware is selling strong, too, and consumer electronics as a whole figures to be a $270 million affair in 1973.

Luxor, a privately held firm, has been chalking up orders abroad, as well as cornering about one-third of the high-hopping home market. This year's big coup was a sale, worth about $4 million, to a British rental company. Luxor figures its set sales will boom upward between 25% and 50% annually for the next three years. The sets will be coming out of a unique plant: no assembly lines. Employees work at their own pace. Axel Holstensson, Luxor's 82-year founder and owner, thinks assembly lines create too much stress.

Computer makers see no end for terminals

Like Luxor's TV builders, Sweden's computer crew is operating in a low-stress environment. The market for computers and related equipment seems slated to surge from $104 million this year to $121 million in 1973, *Electronics'* survey shows. That's a solid 17% climb.

Big systems will shine next year. The biggest, which will eventually link some 2,000 savings-bank offices in the four Nordic nations, was started this year in Finland. Next year, at least 50 Swedish bank offices will go on line. As Saab-Scania's big deal, Saab minicomputers in each office work with terminals from Facit AB.

Swedish Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**507.4**	**554.6**
Consumer products	246.5	270.0
Computers	103.5	120.8
Communications	58.6	57.8
Industrial electronics	54.7	59.3
Test and measuring equipment	19.1	20.4
Medical electronics	25.0	26.3
Components	**121.4**	**130.6**

Exchange rate: $1 = 4.71 kroner

Svenska Philips' big deal is a nationwide system for Svenska Handelsbanken. The first hardware went in this year, and by the end of 1973, some 400 of the bank's 500 branch offices should be on line. Meanwhile the biggest bank in the country, Skandinaviska Enskilda Banken, is moving ahead with a national on-line network that uses terminals from West Germany's Nixdorf.

The demand for terminals has meant a major boost for StanSaat, owned jointly by ITT's Swedish subsidiary, Standard Radio and Telefon AB, Saab-Scania, and the Swedish state. Göran Rynger, sales director for data ter-

First of its kind. Cashier terminal in Svenska Handelsbanken's on-line teller system is initial installation in what will be a $12 million system. Transactions are registered and displayed and account information can be called from local, regional, and central files.

minals, predicts that StanSaab will sell 2,800 CRT display units next year, 800 more than in 1972.

"Commercial installations will be one-and-one-half times greater than government installations in the future," he says. Until now, the state has been the major buyer. StanSaab has some 60% of the Swedish terminal market, and should get even stronger because it now has the terminal business of Facit, the office-machine maker that was on the verge of collapse until acquired by the Wallenberg industrial empire in November.

Look for further consolidations in the computer business next year. Saab-Scania is the only Swedish producer of general-purpose computers, but a number of companies are involved in special-purpose computers and peripherals—LM Ericsson, StanSaab, Facit, and the big electrical-machinery producer ASEA, to name the largest. The government wants to get these companies working together in some way to strengthen them against foreign competition.

The government apparently means business. This fall, it overruled the military brass and Statskontoret, the agency that handles government computer purchases. Both had recommended IBM hardware for a data processing system destined for military administration. On government orders, the job went to Saab-Scania, partly to avoid possible layoffs and partly to strengthen the company.

Components makers contemplate Common Market

As with equipment, there'll be a pickup in the components business, too. Last year, equipment makers in the country made do with $112 million worth of components, according to *Electronics'* survey. This year's figure is an estimated $121 million, and the consensus forecast pegs the 1973 market at $131 million. "I think we're in an uptrend that will peak out perhaps in 1974," says Ingar Ferner, managing director of the importing-distributing house Erik Ferner AB.

There's a solid ring to the semiconductor market, too. It's charted for a gain to $19 million next year from this year's $16 million. "Orders are rising for ordinary products like diodes and transistors," says managing director Dick Lundquist of ASEA's semiconductor subsidiary, HAFO. "And we've been surprised at the interest in MOS and C-MOS circuits. We've gone directly to LSI, although we thought there would be a period of about a year when customers would want MSI."

Even though complexity doesn't hurt when it comes to ICs, it will cause problems under Common Market customs regulations. Sweden, always anxious about its neutrality, opted out of full membership in the enlarged market and is making do with a free-trade arrangement. The deal calls for Swedish equipment to get into the nine-nation trading bloc duty-free only if 60% or more of its value is of Swedish or Common Market origin.

All this means that designers, purchasing agents, and export managers will have to ponder over the right component strategy for EEC export models: Buy cheap from U.S. and Japanese components makers and pay the tariff? Use a mix of hardware from inside and outside the market? Or simply skirt the problem by setting up a plant inside the EEC in Denmark or Germany? Industrialists started to look at the problem before the ink was hardly dry on the EEC-Sweden agreement. The solution will be of major concern as 1973 starts. □

Spain

While the bullfights and flamenco festivals keep hordes of tourists coming to play at the resorts, the Spaniards themselves are working to build up industry in the rest of the land. They are getting results.

This year's gross national product zoomed up 16% to reach some $42 billion at current prices. To be sure, this nominal rise has to be discounted for inflation and for last year's revaluation of the peseta. But even so, there is still a solid 7.5% economic growth to report.

Much the same sort of growth seems assured for 1973. And with it will come a 10% rise in Spanish electronic-equipment markets, *Electronics* forecasts. Here the figures in the charts are $498 million for 1973, up from an estimated $452 million for 1972. Reflecting the drive to industrialize, the growth will come from just about every sector but entertainment electronics.

The government moves in

If the planners in General Francisco Franco's government have their way, electronics in Spain will do better still. The planners, working with electronics-industry executives, are aiming at boosting the country's electronics consumption to $1.266 billion by 1975—part of the government's "El Tercer Plan" to build up the economy during the four years ending in 1975.

To meet the electronics target, which includes conventional telecommunications equipment, the market has to grow just about 24% yearly. At the same time, "El Plan" predicates yearly rises of nearly 25% for production, nearly 24% for exports, and nearly 22% for imports. The goals look highly ambitious, but a lot of industry people think they are realistic.

Along with strong growth, the government intends to restructure the industry. "The idea is to have two or three big companies operating in each sector," explains José-Maria Calpe, an executive at Philips Ibérica. As a first step, the government has banned new companies in professional electronics, except when the Ministry of Industry approves. At the same time, the government holding agency, Instituto Nacional de Industria, has

Spanish Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**451.9**	**498.2**
Consumer products	147.2	151.0
Computers	110.0	125.9
Communications	139.0	155.4
Industrial electronics	34.0	40.3
Test and measuring equipment	7.2	8.3
Medical electronics	14.5	17.3
Components	**88.2**	**94.4**

Exchange rate: $1 = 62.5 pesetas

been scouting around the U.S. and Europe for possible joint-venture partners. Some sort of national electronics combine could be the result.

Spanish companies will have their say in the restructuring, however. The government for the first time has allowed them to form an industry-wide trade association. The organization, Asociación Nacional de Industrias Electónicas (Aniel), will be set up early next year.

So far, it looks as if government planners intend to confine their restructuring effort in computers to peripherals. This fall, the word around Madrid was that talks were on with IBM, Sperry Rand's Univac division, National Cash Register, and perhaps others about peripherals-producing plants in Spain. But as of late November, no firm takers had appeared, even though the bulk of the government's business eventually will go to companies that manufacture in Spain.

And a lot of government business is in the offing. Now that "El Plan" has been approved, many government agencies are shopping for systems. So even though business with the big banks should slow next year—the tax credit for new investments expired in July this year—business all told will be good. *Electronics* forecasts a $126 million market for 1973, up 15% from the estimated $110 million in 1972.

Spain's lone native computer producer, minicomputer maker Telesincro SA of Barcelona, keeps on growing. It has added a new model with a stored program to its line of small office computers—the earlier models had hard-wired programs—and will extend the line further next year. Production is slated to move up to 35 machines monthly during the next year, compared to this year's average of 20 machines. The next big step, production manager Francisco Roig hints, will be a "highly intelligent" terminal.

This year, Spain finds itself with a minicalculator maker in Barcelona as well. Cahue Industrial SA, better known by its trademark Vanguard, markets its four-function, eight-digit, floating-decimal-point machine for just under $300. Alberto Farrés, Vanguard's export director, says the company plans to sell the calculators through radio-TV dealers.

Communications lines open up

Communications will keep coming on strong during the Third Plan. Among other things, the state-controlled telephone organization Compañia Telefónica Nacional de España plans to add some 2.5 million telephone subscribers to its rolls over the next three years. Automatic dialling will be extended with some 38 big new telephone exchanges, and a special data-transmission network will be added. The military, also, has strong communications commitments. The air force, for example, has some $141 million earmarked for communications hardware. No question, then, that the market for communications equipment will be strong. *Electronics* puts the figure for 1973 at $155 million, up 12% from 1972's $139 million.

A trio of ITT subsidiaries—Standard Eléctrica SA, Marconi Española SA, and Compañia Internacional de Telecomunicación y Electrónica SA—dominates the telecommunications business. But the phone company has encouraged a trio of newcomers to set up plants in the country. These would be joint ventures with LM Ericsson, of Sweden, General Cable Co., of the U. S., and a still undesignated company, probably American.

Consumer electronics, however, will not fare nearly as well. The outlook is for a stagnant market—$147 million this year, $151 million in 1973. The market figures to dawdle until color TV comes along. Experimental broadcasts using the PAL system have already begun, but there are no known plans to start full-fledged color programing next year. Actually, the country still lacks coverage for black-and-white in some areas although that is changing fast. □

Belgium

Some welcome changes are on hand for Belgium. The prospects are for a slightly improved economy for 1973. The government expects the gross national product to expand about 4.5% in 1973. Consumer spending figures to be a strong factor in the rise, as in other North European countries. But a pickup of some 2.5% in fixed investment is also expected next year—a welcome sign after virtually no rise in investment this year.

Last year's recession seemingly has run its course, and a strong market is on tap in Belgium for electronic-equipment makers. *Electronics'* survey arrived at a forecast of $388 million for 1973, up from an estimated $340 million this year. In keeping with her neighbors, Belgium will find most of her equipment-market growth in consumer electronics, communications, and computers. But as for components, Belgium should do a lot better than her neighbors.

Belgium got off to a late start in color TV. But the market has been bounding ahead like a hare ever since colorcasts started on the Belgian networks some two years ago. Sales of color sets bounced up nearly 50% this year to reach $25 million. Another big leap is in prospect for 1973. The forecast is for $37 million, and that figure could be low.

Although no other product comes close to equaling color TV output, consumer electronics as a whole can't help but have a good year. It will be an $80 million market next year, up from this year's $69 million.

No matter what the color-TV market in Belgium turns out to be, it will be less than the country's output, largely because Philips Gloeilampenfabrieken has been exporting some of the output it has been steadily building up at a plant in Bruges that is jointly owned by its

Belgian Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**340.5**	**387.9**
Consumer products	69.1	79.5
Computers	96.6	112.3
Communications	95.2	110.0
Industrial electronics	47.2	50.8
Test and measuring equipment	23.2	24.5
Medical electronics	9.2	10.8
Components	**118.8**	**136.2**

Exchange rate: $1 = 45 francs

subsidiary Compagnie Belge de Radio et de Télévision (CBRT). Philips is not talking, but some industry people think the Dutch company has tapped CBRT for a whopping expansion of production. The output could hit some 285,000 color sets by 1974.

Even without a spurt at CBRT, TV-set production in Belgium will show a solid increase. This year's figure for all producers will be around 140,000 color sets, and it will rise to at least 160,000 sets next year. And monochrome sets are in heavy production, too. Saba, a West German consumer-electronics affiliate of General Telephone and Electronics Corp., transferred most of its black-and-white production facilities to Tienen this year and expects to be turning out 225,000 sets annually.

The hustle by TV producers to step up their output, of course, augurs good things for components producers. They will do relatively better in Belgium than in a lot of neighboring countries. *Electronics'* survey puts the market at over $136 million, up 15% over 1972's nearly $119 million. Good as it looks, that figure may even be low. "The market could grow between 12% and 18% next year," says Herman de Clerq, managing director of Siemens' Belgian subsidiary.

Communications-gear makers thrive

Another group making business better for components suppliers is Belgium's communications-equipment makers. The Régie des Télégraphes et Téléphones (RTT) has pioneered in semielectronic switching and thus bolstered the market. In good part because of semielectronic switching equipment, communications-hardware sales in 1973 will move up a solid 16% next year to $110 million, according to *Electronics'* survey.

The electronic-switching contracts are finding their way mostly into the order books of Bell Telephone Manufacturing Co. (BTM), an Antwerp-based subsidiary of ITT. BTM started by cutting over some 10,000 lines for the RTT in 1970 and has been building up steadily every year since. Next year, the company expects to cut over some 100,000 lines of its Metaconta 10C electronic switching gear. The equipment has reed-relay switch points controlled by minicomputer.

This year's business included the additional lift of a $10 million satellite-communications earth station, which went into service this fall. But the home market is just half the story for BTM and the other Belgian telecommunications equipment producers like Manufacture Belge de Lampes et de Matériel Electronique (MBLE). A full 50% of their output goes for exports.

Computers are set for a good rise—from this year's $97 million to $112 million next year, the survey predicts. However, industrial equipment is down for another near-flat year on the market chart. There is one bright spot, though. Ateliers de Constructions Electriques de Charleroi (ACEC) has a contract to supply 43 traction units for the Brussels metro system. ACEC, a Westinghouse subsidiary, says that $5.3 million of electrical equipment is involved and that 40% of that will go for electronic controls. □

Switzerland

Time was when the Swiss economy ticked along beautifully, like a well-adjusted chronometer. Now the movement is behaving erratically, and the government has started tinkering with it—so far to no avail.

The spiral that has perturbed the oscillations is an inflationary one. Although industrial investment lags, the Swiss are earning more, spending more, importing more. All this has sent the consumer price index up over 7% this year. Wages rose even more. All told, then, 1972's nominal growth of 12% for the gross national product means a real growth of only 4%.

More of the same seems in store for 1973. There will be good growth, particularly because of consumer spending, coupled with inflation. That condition makes for a good market in electronics equipment for all but producers of industrial electronics. Business next year should run some $362 million, or 12% above the estimated $323 million for 1972. The government this month announced some strong anti-inflation measures, however, which could make a difference in 1973.

Entertainment electronics will show the way, along with computers. Spending for telecommunications will remain strong, but spending for military electronics will slow down. The government, facing its first deficit since 1945, announced this fall that it couldn't afford to spend the $340 million it had earmarked earlier for new jet fighters this year. Inflation is again part of the explanation for components, which seem set for a solid gain to $98 million for next year from this year's $87 million.

Color TV continues Alpine climb

Like mountaineers, Swiss entertainment-electronics producers love steep slopes, especially on sales curves. This year's figures for consumer electronics then, were no disappointment. Spurred by summer sales of color TV sets to Olympics watchers, consumer-electronics sales by manufacturers and importers moved up from $72 million last year to $89 million this year. Next year's rise will not be as dramatic, but it will be admirable. The forecast is a rise to $101 million for 1973. In numbers of sets, the television market should come close to 200,000 next year, with color receivers about half the total.

In telecommunications, the Swiss Post, Telephone and Telegraph agency (PTT) has budgeted some $280 million for new telephone and telex installations in

Swiss Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	323.2	361.8
Consumer products	89.0	101.0
Computers	109.8	127.5
Communications	58.9	61.9
Industrial electronics	40.5	43.5
Test and measuring equipment	15.3	16.9
Medical electronics	9.7	10.9
Components	87.1	98.1

Exchange rate: $1 = 3.84 francs

1973. Total investments by the agency will come to more than $5 billion during the current 10-year investment plan. In computers, too, PTT has big plans. It has already computerized the routing of telegrams in its Zurich switching center and now plans to automate its postal checking service. The PTT, with a turnover of some $15 billion a year in its banking activities, wants to have the operations fully controlled by a computer center in Fribourg by 1980. A pilot installation, based on Univac hardware, is under test at Berne. Other PTT automation plans involve the agency's administration and letter sorting.

Times keep good for electronic watches

Swiss watchmakers continue their push into electronics movements, which are selling particularly well in the U.S. Girard-Perregaux SA reports that its 10% gain in turnover this year comes mainly from sales of its quartz-crystal watch. The company's timepiece, which contains ICs from Motorola, retails for $250 in the U.S. Ebauches Electronics, the big producer, has been doubling its output every year for the past three years and this year hit a level of 2 million movements. There will be further gains next year, but not a doubling.

Ebauches still makes three basic kinds of electronic watches, with transistor-controlled balance wheels, tuning-fork resonators, or quartz crystal as the fundamental timing device. So far, the third generation—the quartz-crystal types—has been made with conventional watch faces having "hands." Next year, Ebauches will get into serious production of a quartz-crystal electronic "movement" that drives a liquid-crystal display. The watch will show continuously the date, the hour, the minute, and the second. The movement can be guaranteed accurate to within a minute a year.

In industrial electronics, another flat year lies ahead. One hope, though, is point-of-sale hardware. Supermarkets are springing up all over in Switzerland. Automation has already had its first trial this year in the Migros chain. Zellweger Ltd. built the checkout hardware. The readout is by laser and optical scanner.

At CERN, the European Organization for Nuclear Research, outside Geneva, some $5 million has been allotted next year to meet ongoing needs for electronic equipment. In the next two years, however, the high-energy research center will invest in a sophisticated control system, to cost some $30 million and be used with CERN's super-proton synchrotron, scheduled to come on line in 1976. This will be a computer-based multiplex data-acquisition and -analysis system. □

Austria

For years, the electronics industries in Austria had waltzed along in three-quarter time. Lately, they've stepped up the tempo to the four-quarter beat of the foxtrot. Moving with the new beat, the country's electronics markets should whirl upward to a 10% gain in 1973, *Electronics* estimates. There'll be sales of some $261 million for assembled equipment, up from the 1972 figure of $228 million.

Computers will gain the most, but communications won't trail far behind, even though the government intends to put the brakes on public spending to help slow inflation. Medical electronics is not yet big, but it's growing fast, and so is instrumentation. And since Austrians adore color TV almost as much as Strauss waltzes, there's comfortable growth for consumer electronics.

Austrian Electronics Markets Forecasts
(in millions of dollars)[1]

	1972	1973
Assembled equipment, total	**228**	**261**
Consumer products	73	80
Computers	58	72
Communications	52	59
Industrial electronics	20	22
Test and measuring equipment	14	15
Medical electronics	11	13
Components	**40**	**44**

[1] Electronics' estimates, not consensus figures.
Exchange rate: $1 = 23.2 schillings

Computer sector heads steadily upward

Austria stacks up as an interesting market for data processing equipment. For the long term, marketmeisters expect annual growth of 15% through the 1970s. Next year the upswing should be 20%, estimates George Schennet, a spokesman at Sperry Rand's Univac division in Vienna. That would lift the 1973 market for EDP gear—minicomputers, process-control machines, and desk calculators excluded—to some $72 million and bring the total value of computers installed to about $460 million. More than 800 systems, worth nearly $500 million, are now operating.

Austria has no computer production of her own, so the market is a free-for-all for foreign companies. IBM, inevitably, has jabbed hardest. IBM now has a 60% share of the number of systems installed. In terms of value it's nearly 70%. What's left is divided mainly among Sperry Rand Univac, Siemens AG, and Honeywell-Bull, in that order. The latter two firms are running neck and neck with sales of about 8% and 7%, respectively.

One of the biggest systems on the scene is one destined for Austria's oldest bank—and still among the largest—the Erste Osterreichische Spar-Casse (EOSC). It has contracted for a Univac 1106, which will tie together more than 300 terminals installed at some 50 bank branches scattered over the Greater Vienna area. The computer is programed to handle up to 50,000 transactions per hour on a real-time basis. The turn-key project for EOSC is scheduled for completion early in 1974 and will cost about $2.5 million.

Tax overhangs entertainment electronics

It's hard to find an Austrian household without television. About 70% of the 2.4 million households in the country now have a set each. As for color, the number of permits issued had climbed to 125,000 by mid-1972, three and a half years after colorcasting started. This translates into a 5.2% saturation level. The end of 1972 may see the level at 7%.

For next year, the big question is whether the consumer market can grow as fast as it has in the past. "What could well dampen consumer spending is the continuing inflation and the added-value tax that's

coming up," says Erich Bartoschka, head of the Austrian Association of the Electronics Industry. The added-value tax, to be introduced Jan. 1, amounts to 16% for many consumer goods. "Just how much the tax will affect consumption is difficult to predict," Bartoschka says. "But from intuition, I would say the entertainment sector should grow 10% next year." *Electronics* projects growth from $73 million this year to $80 million for 1973. Price hikes notwithstanding, sales of color TV sets should continue strong. Bartoschka's prediction: between 75,000 and 80,000 sets in 1973, about 90,000 sets the following year, and well over 100,000 in 1975. By then, nearly 17% of Austrian households should have color sets.

In receiver design, set makers are keeping abreast with the technology followed in neighboring countries. Color sets have from three to six integrated circuits and black-and-white receivers from two to four. What's more, with semiconductors abundant, receiving tubes are all but gone from most sets now being made.

Though the over-all radio market is nearly flat, car radios are enjoying a boom. In 1970, for example, Austria gobbled up more than 35,000 car radios and the following year, 70,000. Nearly all of them came from manufacturers abroad, with West German makers supplying roughly 60% of them. But next year, Japanese producers could well become the market leader in car radios, as they presumably already are in the declining market for black-and-white receivers.

Schillings galore for telecommunications

Austria's Post and Telegraph Administration has embarked on a massive spending program for telecommunications. P&T communications outlays, fixed by a law passed last year, will total $97 million in 1973 and go up to $167 million in 1975. From then on through 1980, annual expenditures will hover around the $200 million level.

Austrian P&T people find it increasingly uneconomical to pay for using satellite ground stations in neighboring West Germany. So the country will get a satellite terminal of its own. For the project, the P&T is allocating nearly $19 million from now until 1976, when the terminal is expected to be operational. The P&T has not yet picked a prime contractor for the project, but Siemens is generally considered the top contender for the job. The German firm already has a contract to look for a suitable site for the terminal.

With the markets for communications, entertainment electronics, and other sectors doing well, it's not surprising to find sales of components going strong. *Electronics* pegs next year's market at $44 million. "The semiconductor market in Austria has been booming all over the place," says Fritz G. Höhne, director of sales and marketing at West Germany's Intermetall GmbH, a member of the ITT-Semiconductor group. This year, semiconductor sales climbed 20% over 1971, bringing total Austrian consumption to about $8.4 million. For 1973, the market is expected to climb even more rapidly—by 30%. This should lift the semiconductor market value to $11 million, according to Höhne.

Foreign companies dominate in the Austrian components market. But there's one Vienna-based firm that's made its mark. That's Akustische and Kinogeröte GmbH, which has developed into a world-class producer of microphones. □

Denmark

Wonderful Copenhagen and the rest of Denmark goes into the Common Market next month, and that should make for many fewer melancholy Danes in the business community.

Denmark's problem in recent years, remember, has been a lopsided excess of imports over exports. This year, government curbs on imports worked, and imports stagnated. Meanwhile, exports continued to climb—for industrial products, this year's gain was something like 15%. The end result is that the 1972 deficit was only a tenth of 1971's $480 million.

It's hard to see how such dramatic improvement in the balance of payments can continue into 1973. There will be lower tariff barriers next year because of the Common Market, for one thing. Also, imports will probably be stimulated by a pickup in plant investment. Businessmen have great expectations about working in a 260-million-person market and have begun to equip themselves accordingly.

Working outside Denmark is nothing new for the country's electronics producers, mostly instrument makers. Their output this year was some $360 million, up 20% over the 1971 figure. Exports amounted to roughly $215 million. Next year, the industry trade association, headed by Erik Petersen of radio-communications-maker Storno A/S, expects about the same thing.

Color TV tonics market

As usual, the home market for assembled electronics equipment won't keep pace with the gains foreseen by the Danes who turn out hardware (most of their output is exported). *Electronics'* survey puts next year's market at $264 million, up from an estimated $236 million for 1972. That works out to 12%.

Like most other countries in the trading bloc she joins on Jan. 1 next, Denmark has a good thing going at the moment in color TV. Sales should bounce up in 1973 to $40 million, nearly 30% above this year's figure. It's a stunning performance, considering there was a near-

Danish Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**236.4**	**264.0**
Consumer products	91.2	101.3
Computers	56.2	67.0
Communications	47.0	50.3
Industrial electronics	25.3	27.3
Test and measuring equipment	11.5	12.4
Medical electronics	5.2	5.7
Components	**64.1**	**70.0**

Exchange rate: $1 = 6.90 kroner

50% jump this year. All told, the consumer sector will edge past $101 million in the year ahead, *Electronics* forecasts.

As for component suppliers, they're "100% sure 1973 will be a good year," as an executive at a major supplier puts it. The Swedes seem set for a near-10% gain to $70 million in 1973. In 1974, it could well be considerably better. Norwegian and Swedish equipment makers will be setting up plants in Denmark so they can operate inside the Common Market, and there's a brand new batch of customers for components. □

Norway

Norwegian sailors presumably still are singing their sea chanteys as lustily as ever. But the tune that a lot of the country's businessmen are hearing these days sounds more like the blues.

The difference in airs comes from the country's referendum this fall on entering the Common Market. The seafaring and farming folk up-country voted overwhelmingly against it. The vote went the other way around industrialized Oslo. But when the totals were in, Norway was out of the big European trading bloc.

It couldn't have come at a much worse time for industrialists. Over the past two years, the growth rate for the Norwegian economy has been edging downward. This year, for example, the gross national product improved 4.5% in real terms, a 0.5 percentage point off the 1971 growth. It doesn't look all that bad until you realize that consumer spending is carrying the economy and it's lackluster. Industrial investment, the key to solid growth for a modern economy, still lags.

Like Sweden, Norway expects to make some sort of free-trade arrangement with the nine-nation economic community, so the setback may not turn out as serious as first thought. But it has to be a handicap to be halfway inside a trading bloc but to have no real say as to what goes on therein, which is what a free-trade arrangement amounts to.

Even with the country out on the fringes, 1973 looks like a reasonably good year for electronics. Assembled-equipment consumption should move up to $189 million next year from the estimated $170 million logged this year, *Electronics'* survey forecasts. Color television and computers are the main reasons why.

Officially, the Norwegian Broadcasting Corp. won't begin colorcasts until 1975. But the agency now airs about 10 hours of test programs a week. In addition, some parts of the country can pick up Swedish stations. The combination was enough in this year of Olympic games to touch off a boomlet in color TV. Sales reached some 40,000 sets.

That's enough, many market watchers are convinced, to trigger a lasting rise until full-fledged programing starts in 1975. Prospects for 1973 are for something like 55,000 sets. There's no striking action in sight for tape recorders, hi-fi hardware, or radios, however. So color TV alone will carry the consumer electronics sector up a solid 16% to $43 million next year, *Electronics* predicts.

Computers, too, will bolster the total figures. The forecast for data processors and related equipment is a climb of 13% next year. That will put the market at $53 million, according to the survey. □

Norwegian Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**170.1**	**189.3**
Consumer products	36.5	43.0
Computers	45.8	53.2
Communications	51.2	52.5
Industrial electronics	23.1	25.2
Test and measuring equipment	9.3	10.5
Medical electronics	4.2	4.9
Components	**38.6**	**46.0**

Exchange rate: $1 = 6.60 kroner

Finland

The business outlook in Finland these days is as rosy as the skin of someone who's just had an overlong session in a sauna. And like that country's long-distance runners, Finnish businessmen thrive on competition.

Electronics producers will have plenty to compete for in the home market next year. *Electronics'* survey pegs next year's market at $112 million, up from this year's $96 million. That is a solid 17%, which makes Finland the fastest-stepping market for electronics equipment in Western Europe. Like neighboring countries, Finland can count on strong rises in computers and communications. Unlike the others, Finland figures to move up sharply in industrial electronics and instruments.

There's been marked improvement this year throughout the economy. Growth in the private sector went up 7%, and at the same time the government cut back inflation to 7%, too. The balance of payments improved; corporate profits shot up 10.6%. Much the same sort of good business news is expected to come out of Finland during 1973. About the only thing businessmen can find to worry about is the impact of Finland's free-trade pact with the European Economic Community, which augurs tougher competition.

Computer makers can bank on it

For computers, a spurt is in sight—a 21% rise to $22 million from this year's $18 million. The country's two largest banks will order nationwide on-line systems. Kansallis-Osake-Pankki (KOP) plans to spend between $12 million and $17 million for a hookup with some 2,000 terminals. Nordiska Forenings Banken (NFB) has in mind a 1,000-terminal affair. As Hakan Nordquist, spokesman for Oy Nokia puts it, "It looks like the largest order ever for electronics in Finland."

Oy Nokia, the country's largest electronics producer, already has a foot in the NFB vault. The bank's central computer is a Honeywell 6000, and Nokia represents Honeywell Information Systems in Finland. Angling for the business, along with IBM, are Philips of Holland, Nixdorf of West Germany, and DataSaab of Sweden. Whoever gets it almost surely will set up a plant inside Finland to produce terminals.

Computer terminals of another sort will add a fillip next year to the sales of Ollituote Oy, the country's top producer of medical electronics equipment. The com-

pany has a contract with Sitra, the Bank of Finland fund for research and development, to develop and produce five computer-compatible electrocardiogram transmitters. They'll be linked by the end of 1973 to a central computer through data-communications gear developed at the University of Kuropio. Eventually, there'll be EKG terminals spotted at some 350 regional health centers and linked to some three to 10 main centers with computers for EKG analysis.

Industrial markets up and away

Strength in industrial electronics sets Finland apart from other West European electronics markets. The survey points to a near 25% rise to $12.7 million next year, up from $10.7 million this year. Nokia will pick up a share, so will Oy Strömberg-Engineering, and so will Outokumpu Oy, the state-owned mining outfit.

All three are strong in process controls for such industries as papermaking and ore-refining, and all three have scored strong successes in exports. Nokia, in fact, aims to have half its electronics business coming from outside Finland by 1975. Outokumpu's Metor metal-detection hardware has been in service as an anti-hijacking aid at West European airports for two years already, and is now going into U.S. international airports.

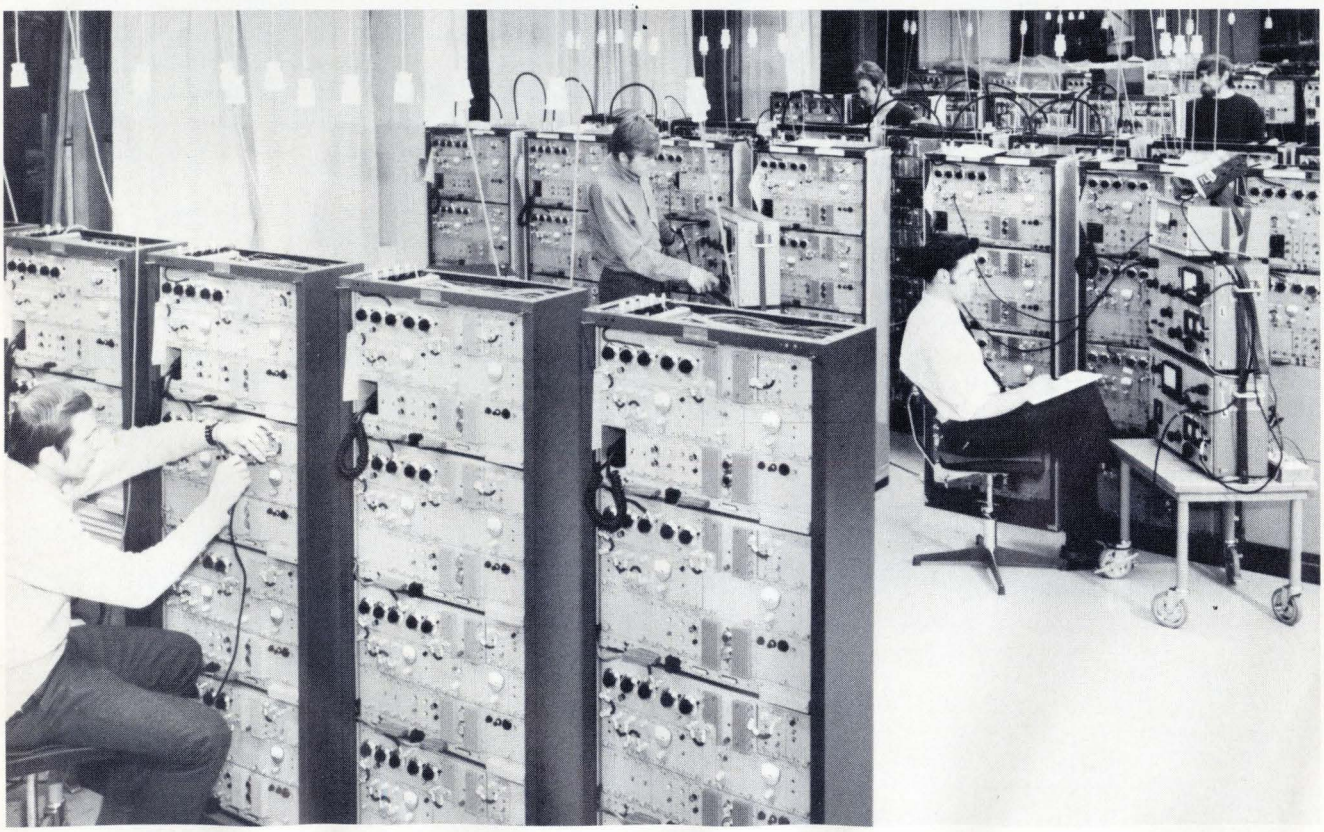
Consumer electronics markets won't grow as heftily as other sectors, according to *Electronics'* survey. The forecast is a rise to $33.5 million next year from the estimated 1972 market of $31.8 million. Nonetheless, "We are supremely hopeful for the coming year," says Pentti Immonen, spokesman for Salora Oy, the largest Finnish entertainment-electronics producer. Salora sees a strong year ahead for color TV at home. And it's looking for a lift in stereo equipment, in part due to its new Trisonic system, which will go on sale in the spring of 1973. So far, the company hasn't said much about it except that the system combines a speaker for a summed channel with a pair of single-channel speakers.

No matter how predictions turn out for the home market, Salora has it made for 1973. The company has an order from a British TV-rental outfit to supply some 80,000 sets worth $50 million, and it's doing well in neighboring Sweden. All this, Salora says, makes it the fastest-growing electronics company in Finland. □

Finnish Electronics Markets Forecasts
(in millions of dollars)

	1972	1973
Assembled equipment, total	**96.1**	**112.3**
Consumer products	31.8	33.5
Computers	18.3	22.1
Communications	20.0	26.2
Industrial electronics	10.7	12.7
Test and measuring equipment	5.3	5.9
Medical electronics	10.0	11.9
Components	**30.7**	**35.7**

Exchange rate: $1 = 4.20 marks



Link. Finland's fast-growing communications network is one of the reasons that Oy Nokia, maker of this 24-channel radio link equipment, is the country's largest electronics producer, with 60% of the Finnish telecommunications-hardware business.

European 1973 components markets

	Belgium		Denmark		Finland		France		Italy		Netherlands		Norway		Spain		Sweden		Switzerland		United Kingdom		West Germany		Total	
	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973
Passive and electromechanical, total	**69.0**	**76.4**	**41.3**	**45.0**	**16.2**	**20.0**	**437.6**	**472.2**	**151.0**	**164.7**	**99.5**	**108.6**	**24.6**	**26.8**	**52.3**	**56.8**	**84.9**	**89.2**	**61.6**	**68.6**	**502.0**	**543.3**	**774.1**	**840.2**	**2,314.7**	**2,511.8**
Antennas and antenna hardware	2.1	2.2	4.5	5.0	1.7	1.9	28.8	31.5	6.0	6.6	3.8	4.0	1.4	1.5	4.1	4.3	3.4	3.8	3.4	3.7	3.6	3.8	42.0	45.0	104.8	113.3
Capacitors, fixed	9.0	10.5	8.0	8.8	3.6	3.8	63.0	65.5	28.4	30.1	15.0	16.0	3.4	3.8	13.0	14.2	18.5	19.4	9.7	10.5	81.5	88.1	127.5	139.3	380.6	410.0
Capacitors, variable	2.0	2.3	0.7	0.8	0.5	0.5	3.0	3.2	4.6	4.8	1.6	1.5	0.3	0.3	3.4	3.5	1.5	1.6	0.5	0.6	5.7	5.9	10.0	11.0	33.8	36.0
Connectors, plugs, and sockets	2.9	3.4	2.3	2.5	1.7	2.1	46.5	51.5	11.0	12.2	5.8	6.3	2.1	2.3	3.7	3.8	5.5	5.8	4.4	5.8	61.7	66.4	25.5	28.0	173.1	190.1
Crystals and crystal filters	1.3	1.5	0.8	0.9	0.5	0.6	5.6	6.2	2.1	2.3	1.6	1.7	0.4	0.5	0.6	0.7	2.2	2.3	1.8	2.0	9.8	10.8	7.6	8.5	34.3	38.0
Delay lines	1.3	1.5	1.1	1.2	0.2	0.3	3.2	3.5	1.6	1.7	1.8	1.8	0.4	0.4	0.1	0.2	0.7	0.8	0.3	0.4	3.2	3.4	5.0	5.2	18.9	20.4
Displays (except solid state devices)	0.3	0.3	0.2	0.2	0.1	0.2	4.7	5.2	0.5	0.6	0.6	0.8	*	0.1	0.2	0.2	0.1	0.3	0.2	0.3	4.6	5.0	6.5	6.7	18.0	19.9
Ferrite devices (except TV yokes and flybacks)	2.3	2.6	0.7	0.8	0.6	0.7	5.0	5.6	6.1	7.0	3.5	4.0	0.9	0.9	1.6	1.7	1.1	1.2	3.0	3.2	8.4	8.5	24.0	27.5	57.2	63.7
Filters and networks (except crystal)	0.9	1.1	1.0	1.1	0.1	0.1	6.0	6.5	2.0	2.1	1.1	1.3	0.8	0.9	0.7	0.8	3.0	3.2	0.5	0.6	3.2	4.1	5.5	6.2	24.8	28.0
Loudspeakers (OEM type)	3.7	4.3	1.8	1.9	1.2	1.4	7.5	7.8	6.6	7.3	5.5	6.0	1.3	1.5	2.1	2.1	4.9	5.2	1.2	1.3	16.7	17.3	16.5	17.0	69.0	73.1
Microphones (OEM type) for incorporation into equipment	0.9	1.0	0.4	0.4	0.1	0.1	1.9	2.0	0.4	0.4	1.2	1.3	0.1	0.1	0.2	0.3	1.2	1.3	0.3	0.3	4.0	4.5	12.0	12.3	22.7	24.0
Potentiometers, composition	2.4	2.8	1.8	2.0	0.8	1.2	9.3	9.8	5.5	6.0	3.8	4.0	0.7	0.8	2.7	2.9	2.5	2.6	1.8	2.0	14.4	15.5	44.0	50.0	89.7	99.6
Potentiometers, wirewound	0.6	0.7	0.3	0.4	0.2	0.2	7.6	8.3	1.5	1.7	1.2	1.2	0.3	0.3	0.5	0.6	1.2	1.3	0.6	0.5	11.0	12.0	13.5	15.0	38.5	42.2
Power supplies (OEM type) for assembly into equipment	3.3	3.7	1.8	1.9	*	0.1	23.5	26.0	7.7	8.5	4.7	5.0	1.5	1.6	1.7	1.9	2.9	3.1	2.0	2.1	26.0	28.0	23.0	25.5	98.1	107.4
Printed circuits	8.7	9.5	2.0	2.2	3.1	3.8	22.4	24.8	15.0	16.5	9.5	11.0	2.0	2.2	1.4	1.5	4.8	5.0	5.0	5.5	25.0	30.0	40.0	45.0	138.9	157.0
Relays	5.5	5.5	2.7	2.9	0.6	0.7	38.5	41.9	11.5	12.6	8.8	9.5	2.4	2.5	4.5	4.7	6.4	6.5	4.5	4.9	46.8	50.5	53.0	56.0	185.2	198.2
Resistors, fixed and wirewound	5.5	6.5	2.8	2.9	0.9	1.2	32.0	34.5	9.5	10.3	7.2	8.0	1.4	1.5	2.7	2.9	6.1	6.2	3.9	4.3	36.1	40.0	48.5	51.0	156.6	169.3
Servos, synchros, and resolvers	0.8	0.8	0.3	0.3	0.1	0.1	7.1	6.9	2.3	2.4	1.5	1.7	0.1	0.1	0.8	0.9	1.0	1.0	1.8	2.0	13.8	15.5	19.0	21.0	48.6	52.7
Solenoids and FHP motors	4.0	4.0	1.5	1.5	0.1	0.1	80.0	86.5	11.0	11.5	7.5	8.5	0.4	0.5	3.5	4.5	5.3	5.3	8.0	8.6	74.5	78.0	175.0	185.0	370.8	394.0
Switches (for communications and electronics)	4.0	4.0	1.7	1.9	0.6	0.7	11.5	12.5	3.7	4.1	3.8	4.0	1.6	1.7	1.4	1.2	2.6	2.8	2.2	2.5	16.0	17.0	26.0	29.5	75.1	81.9
Transformers, chokes, and coils (includes TV yokes and flybacks)	7.5	8.2	4.9	5.4	0.1	0.2	30.5	32.5	14.0	16.0	10.0	11.0	3.1	3.3	3.4	3.9	10.0	10.5	6.5	7.5	36.0	39.0	50.0	55.5	176.0	193.0
Semiconductors, discrete, total	**12.4**	**14.3**	**9.1**	**10.1**	**5.0**	**5.4**	**85.1**	**91.4**	**33.2**	**37.8**	**18.3**	**19.6**	**5.1**	**5.8**	**14.1**	**15.4**	**10.3**	**11.5**	**11.3**	**12.5**	**108.7**	**114.1**	**163.5**	**178.5**	**476.1**	**516.4**
Microwave diodes, all types	0.3	0.3	0.2	0.2	*	*	1.9	2.1	0.9	1.2	0.5	0.5	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	2.4	2.6	2.0	2.5	9.0	10.4
Rectifiers (including diodes rated more than 100 mA)	1.2	1.4	1.5	1.9	1.7	1.8	14.5	16.5	5.5	6.0	2.0	2.2	0.9	0.9	3.3	3.6	1.4	1.6	1.0	1.1	15.5	17.0	28.0	30.5	76.5	84.5
Signal diodes (rated less than 100 mA, including arrays)	2.2	2.4	0.8	0.9	0.1	0.2	7.0	7.0	2.3	2.3	2.9	2.9	0.5	0.6	1.9	2.1	1.4	1.5	1.8	2.0	11.8	11.5	17.0	19.0	49.7	52.4
Thyristors (SCRs, four-layer diodes, etc.)	1.3	1.5	0.8	0.9	1.0	1.0	6.9	7.6	2.3	3.2	1.7	1.9	0.4	0.5	0.9	1.1	1.2	1.3	1.0	1.2	8.5	10.5	19.0	23.0	45.0	53.7
Transistors, power (more than 1-W dissipation)	2.2	2.6	1.6	1.8	1.0	1.1	13.0	14.0	5.5	6.5	3.7	4.3	0.9	1.1	1.3	1.5	2.1	2.2	2.5	3.3	17.0	18.0	25.5	29.5	76.3	85.9
Transistors, small signal (including FETs and duals)	4.6	5.5	3.6	3.8	1.1	1.2	36.8	38.5	15.0	16.2	6.5	6.8	2.1	2.3	5.8	6.0	3.5	4.0	4.2	3.9	48.0	49.0	63.0	65.0	194.2	202.2
Zener diodes	0.6	0.6	0.6	0.6	0.1	0.1	5.0	5.7	1.7	2.4	1.0	1.0	0.2	0.3	0.7	0.9	0.5	0.6	0.5	0.6	5.5	5.5	9.0	9.0	25.4	27.3
Semiconductors, integrated circuits, total	**5.9**	**8.0**	**2.5**	**3.7**	**0.7**	**1.1**	**37.3**	**44.3**	**13.9**	**18.4**	**9.1**	**11.1**	**2.2**	**3.0**	**1.5**	**2.4**	**5.5**	**7.5**	**5.3**	**7.2**	**52.3**	**69.0**	**58.5**	**74.5**	**194.7**	**250.2**
Hybrid ICs, all types	0.5	0.7	0.3	0.5	*	0.1	6.0	6.5	1.0	1.1	1.5	2.0	0.2	0.4	0.4	0.6	0.4	0.5	0.8	1.0	6.3	7.0	6.0	6.5	23.4	26.9
Digital bipolar, small (less than 12 gates)	2.2	2.4	0.5	0.6	0.1	0.1	9.5	10.0	6.0	5.5	3.5	4.1	0.6	0.7	0.4	0.5	1.0	1.2	1.9	2.2	14.0	15.0	18.0	17.5	57.7	59.8
Digital bipolar, MSI (12–100 gates)	0.7	1.0	0.4	0.5	0.2	0.3	5.5	6.5	2.3	3.0	1.2	1.2	0.2	0.3	0.1	0.2	1.3	1.9	0.7	0.9	9.0	11.0	9.0	12.5	30.6	39.3
Digital bipolar, LSI (more than 100 gates)	0.2	0.3	0.1	0.2	*	*	3.0	3.5	0.2	0.5	0.4	0.6	*	0.2	*	*	0.6	0.8	0.4	0.6	6.0	9.0	5.5	7.0	16.4	22.7
Digital MOS, small and MSI	0.5	0.7	0.4	0.4	*	*	1.5	1.8	0.5	1.0	0.3	0.5	0.1	0.2	*	*	0.3	0.4	0.2	0.2	3.5	5.0	1.5	3.5	8.8	13.7
Digital MOS, LSI	0.4	1.0	0.4	0.9	*	0.1	3.8	5.0	0.6	2.3	0.7	1.0	0.1	0.1	*	0.2	0.7	1.2	0.5	0.8	3.5	7.0	7.0	8.5	17.7	28.1
Linear ICs, except op amps	0.9	1.2	0.2	0.3	0.2	0.3	4.5	7.2	2.3	3.5	1.1	1.2	0.6	0.7	0.5	0.7	0.8	1.0	0.5	0.9	6.0	8.5	8.0	15.0	25.6	40.5
Op amps, monolithic only	0.5	0.7	0.2	0.3	0.2	0.2	3.5	3.8	1.0	1.5	0.4	0.5	0.4	0.4	0.1	0.2	0.4	0.5	0.3	0.6	4.0	6.5	3.5	4.0	14.5	19.2
Semiconductors, optoelectronic devices	**0.7**	**0.9**	**0.2**	**0.3**	**0.4**	**0.5**	**3.5**	**4.5**	**1.0**	**2.0**	**0.6**	**1.2**	**0.1**	**0.2**	*	*	**0.3**	**0.4**	**0.8**	**1.2**	**7.0**	**9.5**	**5.5**	**9.0**	**20.1**	**29.7**
Tubes, total	**30.8**	**36.6**	**11.0**	**10.9**	**7.8**	**8.7**	**129.3**	**147.0**	**49.6**	**50.3**	**38.7**	**40.4**	**6.6**	**10.2**	**20.3**	**19.8**	**20.4**	**22.0**	**8.1**	**8.6**	**223.7**	**238.7**	**220.8**	**227.5**	**767.1**	**820.7**
Tubes, cathode ray (except for TV)	0.1	0.1	0.3	0.3	0.3	0.3	8.8	9.5	1.2	1.3	2.0	2.1	0.1	0.1	0.3	0.4	0.5	0.6	0.3	0.4	9.7	10.7	7.5	7.5	31.1	33.3
Tubes, power types (including microwave)	3.2	3.5	2.6	2.8	0.3	0.4	30.5	32.5	9.5	10.5	6.8	7.7	1.1	1.2	2.5	2.7	5.4	5.5	2.6	3.0	31.0	33.0	20.0	21.0	115.5	123.8
Tubes, receiving types	3.5	3.0	1.8	1.6	1.1	0.9	20.5	20.5	10.1	8.5	5.7	5.1	1.2	1.0	6.0	5.5	1.8	1.8	2.0	2.0	28.0	24.0	21.0	16.0	102.7	89.9
TV picture tubes, black-and-white	8.0	7.5	0.7	0.6	1.4	1.2	20.5	21.0	25.0	26.0	7.2	7.0	0.9	0.9	11.5	11.2	1.2	1.1	0.8	0.5	30.0	26.0	19.8	18.0	127.0	121.0
TV picture tubes, color	16.0	22.5	5.6	5.6	4.7	5.9	49.0	63.5	3.8	4.0	17.0	18.5	3.3	7.0	*	*	11.5	13.0	2.4	2.7	125.0	145.0	152.5	165.0	390.8	452.7
Total components consumption	**118.8**	**136.2**	**64.1**	**70.0**	**30.7**	**35.7**	**692.8**	**759.4**	**248.7**	**273.2**	**166.2**	**180.9**	**38.6**	**46.0**	**88.2**	**94.4**	**121.4**	**130.6**	**87.1**	**98.1**	**893.7**	**974.6**	**1,222.4**	**1,329.7**	**3,772.7**	**4,128.8**

Factory prices in millions of dollars.

Note: Estimates in this chart are based on market data supplied to Electronics by more than 180 companies, government agencies, and trade associations. The figures show consensus forecasts for consumption of components to make equipment destined for both home and export markets.

Participants were asked to base their estimates on factory prices for domestic components and at cost-insurance-freight (CIF) for imported components. Figures in this chart should be compared with those published in previous years only after making adjustments to reflect changes in categories and in rates of exchange. The estimates in this chart were converted into U.S. dollars at the following rates (for $1):

Belgium 45.0 francs
Denmark 6.90 kroner
Finland 4.20 marks
France 5.01 francs
Italy 580 lire
Netherlands 3.23 florins
Norway 6.60 kroner
Spain 62.5 pesetas
Sweden 4.71 kroner
Switzerland 3.84 francs
United Kingdom 41.5 pence (1£ = $2.40)
West Germany 3.22 marks

*Less than $75,000

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European 1973 equipment markets

Factory prices in millions of dollars.

Note: Estimates in this chart are based on market data supplied by more than 180 companies, government agencies, and trade associations. The estimates are for equipment consumed in a country whether manufactured there or not. Imports are valued at cost-insurance-freight (CIF).

Some categories and all currency rates in this chart are different from those of previous years. Both these factors should be considered when making comparisons. The conversion rates used for this chart (for U.S.$1) are:

Belgium 45.0 francs
Denmark 6.90 kroner
Finland 4.20 marks
France 5.01 francs
Italy 580 lire
Netherlands 3.23 florins
Norway 6.60 kroner
Spain 62.5 pesetas
Sweden 4.71 kroner
Switzerland 3.84 francs
United Kingdom
41.5 pence
(1¢ = $2.40)
West Germany
3.22 marks

[1] Includes "stand-alone" minicomputers but not computers that are integral parts of navigation, process control, and like systems.

*Less than $75,000

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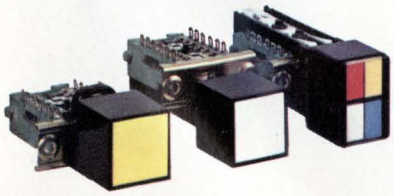
	Belgium		Denmark		Finland		France		Italy		Netherlands		Norway		Spain		Sweden		Switzerland		United Kingdom		West Germany		Total	
	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973
Consumer products																										
Audio tape recorders and players	4.0	4.6	16.5	18.3	5.0	5.5	40.5	48.0	19.0	20.5	20.8	21.5	3.9	4.0	11.0	11.5	16.5	17.5	11.5	13.5	33.0	33.0	173.5	185.0	355.2	382.9
Hi-fi equipment	4.5	5.0	19.5	20.5	3.6	4.8	23.0	28.5	6.0	6.5	22.5	26.5	3.5	4.5	6.2	7.0	27.0	34.5	7.5	9.0	70.0	95.0	74.0	82.5	267.3	324.3
Phonographs and combinations	4.1	3.9	3.7	3.5	0.5	0.6	40.7	45.0	20.5	22.0	23.5	22.5	2.4	2.6	9.5	9.0	14.0	14.0	5.5	6.3	45.0	45.5	45.0	45.0	214.4	219.9
Radios (including car radios)	6.5	7.0	9.5	10.5	4.8	4.8	101.8	113.5	44.0	45.0	28.0	30.0	5.6	5.6	18.5	18.5	20.5	21.0	13.0	14.5	75.5	80.0	240.0	245.0	567.7	595.4
TV sets, black-and-white	25.0	22.0	11.0	8.5	13.1	11.8	145.7	140.0	130.0	141.0	29.3	24.5	6.0	5.3	102.0	103.0	17.0	13.0	11.5	9.8	162.5	135.0	240.0	210.0	893.1	823.9
TV sets, color	25.0	37.0	31.0	40.0	4.8	6.0	177.6	229.5	1.3	1.5	88.5	103.0	15.1	21.0	*	2.0	151.5	170.0	40.0	48.0	580.0	710.0	495.5	570.0	1,610.3	1,938.0
Total	**69.1**	**79.5**	**91.2**	**101.3**	**31.8**	**33,5**	**529.3**	**604.5**	**220.8**	**236.5**	**212.6**	**228.0**	**36.5**	**43.0**	**147.2**	**151.0**	**246.5**	**270.0**	**89.0**	**101.1**	**966.0**	**1,098.5**	**1,268.0**	**1,337.5**	**3,908.0**	**4,284.4**
Computers and related equipment																										
Digital computers, central processors[1]	45.0	52.5	28.2	34.0	10.7	10.7	284.2	308.5	189.5	232.0	62.0	74.0	25.0	28.3	43.7	50.2	45.5	53.5	45.1	53.0	242.0	267.5	440.0	497.5	1,460.9	1,661.7
Mass memories	23.0	25.5	18.0	20.5	0.5	1.2	159.4	183.3	75.0	85.0	38.8	42.0	11.0	12.5	28.4	33.1	23.0	26.5	30.0	35.0	74.0	89.0	210.5	233.5	691.6	787.1
Read-in and read-out equipment	13.5	16.0	6.0	7.5	3.1	4.1	117.5	135.1	42.5	47.5	12.5	15.0	3.9	4.6	17.5	19.3	12.7	15.0	8.0	9.0	67.4	82.5	149.0	176.0	453.6	531.6
Remote terminal equipment	8.0	10.0	2.1	2.6	2.4	3.6	34.2	39.0	9.5	12.0	7.2	9.0	2.6	3.8	11.2	12.6	13.7	16.0	7.5	9.5	24.0	31.0	29.5	35.0	151.9	184.1
Analog and hybrid computers	1.2	1.3	0.3	0.3	0.1	0.1	5.9	6.0	1.3	1.8	1.6	1.5	0.9	0.9	0.9	1.0	1.1	1.2	4.2	4.5	2.4	2.6	9.8	10.9	29.7	32.1
Converters, analog-digital and digital-analog	0.9	1.0	0.1	0.1	0.5	0.5	3.6	3.9	2.9	3.4	2.6	3.0	0.6	0.6	0.8	0.9	0.5	0.6	4.5	5.0	1.5	1.9	3.5	3.5	22.0	24.4
Electronic desk calculators	5.0	6.0	1.5	2.0	1.0	1.9	32.0	42.0	21.0	23.0	9.5	12.5	1.8	2.5	7.5	8.8	7.0	8.0	10.5	11.5	39.0	42.5	105.0	120.0	240.8	280.7
Total	**96.6**	**112.3**	**56.2**	**67.0**	**18.3**	**22.1**	**636.8**	**717.8**	**341.7**	**404.7**	**134.2**	**157.0**	**45.8**	**53.2**	**110.0**	**125.9**	**103.5**	**120.8**	**109.8**	**127.5**	**450.3**	**517.0**	**947.3**	**1,076.4**	**3,050.5**	**3,501.7**
Communications equipment																										
Broadcast equipment	3.5	3.0	3.2	3.4	4.0	4.8	35.0	30.0	6.0	4.0	3.2	3.2	6.1	5.0	14.8	15.6	2.0	2.0	5.0	5.0	16.0	16.0	12.0	14.0	110.8	106.0
Closed-circuit TV	2.7	3.0	0.8	0.8	0.2	0.2	9.5	10.5	8.8	9.7	2.1	2.1	0.5	0.7	1.7	2.5	0.5	0.5	1.5	1.9	4.3	4.8	12.0	13.5	44.6	50.2
Intercoms and intercom systems	5.5	5.9	2.7	2.9	0.5	0.6	26.0	29.0	4.1	4.5	6.5	7.0	2.0	2.1	1.2	1.6	1.5	1.6	3.5	3.5	10.0	10.5	15.5	17.0	79.0	86.2
Microwave relay systems	1.2	1.5	3.8	4.0	2.4	3.6	50.0	55.0	19.0	23.0	2.0	4.0	3.7	4.1	8.5	9.5	7.0	5.0	1.5	1.6	4.0	4.0	41.0	43.5	144.1	158.8
Navigation aids, except radar	14.7	15.0	11.5	12.0	1.2	1.4	29.0	30.5	38.5	41.0	8.8	10.0	10.8	11.0	16.0	18.5	6.0	5.5	15.0	15.0	80.0	85.0	75.0	82.0	306.5	326.9
Radar	9.0	9.5	5.5	5.5	2.0	2.4	90.0	95.0	20.0	19.0	15.0	17.0	9.7	10.0	8.3	10.5	4.0	4.2	10.5	10.0	102.5	110.0	130.0	148.0	406.5	441.1
Radio communications, except broadcast	6.0	6.6	7.7	8.5	3.3	3.8	55.0	60.5	13.0	14.5	21.5	23.5	5.5	5.5	30.0	32.0	16.5	17.5	7.5	9.5	115.0	125.5	105.0	115.0	386.0	422.4
Telephone switching, electronic/semielectronic	36.5	44.0	0.1	0.1	1.4	2.4	11.5	14.0	1.4	1.7	1.0	2.5	1.2	1.3	*	*	1.1	1.1	0.4	0.4	30.5	38.5	2.0	2.0	87.1	108.0
Telephone and telegraph carrier equipment	15.0	15.0	6.5	7.3	3.6	5.2	155.7	193.5	75.0	81.5	10.0	10.5	8.5	9.5	53.0	58.0	13.6	13.0	9.0	10.0	89.5	91.2	168.0	195.0	607.4	689.7
Wire message equipment	1.1	6.5	5.2	5.8	1.4	1.8	60.9	79.5	36.0	40.0	4.5	4.8	3.2	3.3	5.5	7.2	6.4	7.4	5.0	5.0	45.0	50.0	51.0	55.0	225.2	266.3
Total	**95.2**	**110.0**	**47.0**	**50.3**	**20.0**	**26.2**	**522.6**	**597.5**	**221.8**	**238.9**	**74.6**	**84.6**	**51.2**	**52.5**	**139.0**	**155.4**	**58.6**	**57.8**	**58.9**	**61.9**	**496.8**	**535.5**	**611.5**	**685.0**	**2,397.2**	**2,655.6**
Industrial equipment																										
Industrial X-ray gauging and inspection	0.8	0.8	1.2	1.3	1.3	1.4	7.2	7.9	2.5	2.6	2.3	2.5	0.7	0.7	0.8	0.9	2.2	2.4	0.8	0.9	6.1	6.5	14.8	16.5	40.7	44.4
Infrared gauging and inspection	3.2	3.2	1.0	1.1	0.2	0.2	9.0	9.7	6.0	6.5	3.3	3.5	1.2	1.2	1.1	1.2	0.9	0.9	1.6	1.6	13.8	14.2	31.5	33.0	72.8	76.3
Machine-tool controls	1.1	1.3	1.0	1.2	0.4	0.6	7.0	7.7	5.5	6.2	1.1	1.2	0.8	1.0	1.5	2.0	1.7	2.0	4.2	4.4	8.8	10.3	15.0	16.0	48.1	53.9
Motor speed controls	4.8	4.9	2.8	2.9	1.2	1.4	5.0	5.5	5.2	5.6	6.5	6.5	1.9	2.0	3.9	4.2	5.3	5.5	4.6	5.1	12.0	13.0	18.0	19.5	71.2	76.1
Photoelectric controls	0.2	0.3	0.3	0.4	0.2	0.2	2.4	2.6	1.2	1.3	0.7	0.8	1.1	1.2	0.6	0.7	1.0	1.1	1.8	2.0	4.5	4.8	8.2	8.5	22.2	23.9
Power electronics equipment	1.5	1.7	0.4	0.5	3.6	4.3	6.8	7.8	4.5	4.8	2.0	2.5	0.3	0.4	1.4	1.7	2.1	2.2	1.3	1.4	4.2	4.5	10.0	11.0	38.1	42.8
Process-control equipment	35.0	38.0	18.2	19.5	2.9	3.6	75.0	82.5	68.0	72.0	36.4	38.5	16.5	18.0	21.3	25.6	40.5	44.0	25.2	27.0	82.0	88.5	193.0	208.0	614.0	665.2
Ultrasonic cleaning and inspection	0.2	0.2	0.1	0.1	0.2	0.2	3.0	3.2	0.6	0.7	2.6	2.7	0.3	0.3	0.4	0.5	0.3	0.3	0.3	0.3	1.2	1.3	2.8	3.1	12.0	12.9
Welding equipment	0.4	0.4	0.3	0.3	0.7	0.8	5.8	6.5	1.8	1.9	1.5	1.6	0.3	0.4	3.0	3.5	0.7	0.9	0.7	0.8	6.2	6.6	13.0	14.0	34.4	37.7
Total	**47.2**	**50.8**	**25.3**	**27.3**	**10.7**	**12.7**	**121.2**	**133.4**	**95.3**	**101.6**	**56.4**	**59.8**	**23.1**	**25.2**	**34.0**	**40.3**	**54.7**	**59.3**	**40.5**	**43.5**	**138.8**	**149.7**	**306.3**	**329.6**	**953.5**	**1,033.2**
Test and measuring instrument																										
Amplifiers, laboratory type	0.2	0.2	0.1	0.1	0.1	0.1	2.2	2.4	0.6	0.6	0.8	0.9	0.1	0.1	0.1	0.1	0.3	0.3	0.5	0.6	1.1	1.2	2.1	2.0	8.2	8.6
Calibrators and standards, active and passive	0.7	0.7	0.2	0.2	0.1	0.1	3.2	3.5	1.7	1.9	3.3	3.3	0.5	0.5	0.3	0.4	0.4	0.3	0.8	0.8	3.1	3.3	3.1	3.5	17.4	18.5
Components testers	1.5	1.6	1.0	1.1	0.1	0.1	6.5	7.5	2.1	2.5	4.2	4.5	0.8	0.9	0.4	0.5	2.4	2.4	0.5	0.6	1.7	1.9	3.3	3.8	24.5	27.4
Counters and timers	3.4	3.7	1.0	1.0	0.4	0.4	4.9	5.2	2.7	3.0	3.2	3.6	0.5	0.6	0.6	0.7	2.0	2.3	0.9	1.0	6.3	6.5	7.5	8.1	33.4	36.1
Electronic meters, analog	1.8	1.8	0.6	0.6	0.3	0.3	3.5	3.4	1.1	1.1	2.2	2.1	0.5	0.5	0.3	0.3	0.6	0.7	0.3	0.3	4.0	4.2	2.8	2.9	18.0	18.2
Electronic meters, digital	2.1	2.3	1.1	1.2	0.3	0.5	4.7	5.5	1.2	1.5	1.8	2.0	0.2	0.3	0.3	0.4	1.0	1.0	0.8	0.9	5.7	5.9	4.8	5.3	24.0	26.8
Electronics meters, all panel types	–	–	1.0	1.3	0.6	0.7	2.8	2.8	2.0	2.5	0.6	0.8	0.6	0.8	–	–	1.8	2.0	1.2	1.3	3.5	3.3	5.0	5.5	19.1	21.0
Generators and synthesizers (pulse, signal, sweep—to 1 GHz)	1.6	1.6	1.2	1.3	0.5	0.5	7.0	8.0	2.4	2.6	3.6	4.1	0.5	0.6	1.0	1.1	3.2	3.2	1.6	1.7	4.3	4.9	6.8	7.4	33.7	37.0
Microwave test and measuring instruments (above 1 GHz)	0.1	0.2	1.0	1.1	0.4	0.4	6.5	7.2	3.5	4.0	7.3	9.0	1.8	1.9	0.6	0.7	0.8	0.9	0.4	0.6	5.8	6.3	10.0	10.5	38.2	42.8
Oscillators	1.1	1.1	0.2	0.2	*	*	5.4	5.9	2.6	2.6	1.5	1.5	0.2	0.3	0.4	0.4	0.2	0.3	0.6	0.6	2.4	2.6	4.5	4.7	19.1	20.2
Oscilloscopes and accessories	3.5	3.7	1.7	1.9	1.1	1.2	19.0	20.0	7.0	8.2	7.0	7.2	1.2	1.3	1.1	1.3	3.4	3.6	2.6	2.9	16.7	17.0	19.1	21.3	83.4	89.6
Power supplies, laboratory type	3.6	3.6	0.4	0.4	0.1	0.2	5.0	5.5	1.4	1.5	1.4	1.4	0.4	0.5	0.4	0.5	1.1	1.2	0.8	0.9	3.4	3.8	6.0	6.3	24.0	25.8
Recorders	2.6	2.8	1.8	1.8	1.1	1.2	10.5	12.0	3.2	3.3	6.5	6.6	1.2	1.3	1.2	1.3	0.9	1.1	3.5	3.8	5.2	6.0	24.0	25.4	61.7	66.6
Spectrum analyzers (audio to 1 GHz)	1.0	1.2	0.2	0.2	0.2	0.2	2.1	2.3	0.6	0.7	2.1	2.6	0.8	0.9	0.5	0.6	1.0	1.1	0.8	0.9	3.6	4.0	1.4	1.5	14.0	16.2
Total	**23.2**	**24.5**	**11.5**	**12.4**	**5.3**	**5.9**	**83.3**	**91.2**	**31.8**	**36.0**	**45.5**	**49.6**	**9.3**	**10.5**	**7.2**	**8.3**	**19.1**	**20.4**	**15.3**	**16.9**	**66.8**	**70.9**	**100.4**	**108.2**	**418.7**	**454.8**
Medical electronics equipment																										
Diagnostic equipment, except X-ray	1.4	1.8	2.0	2.2	2.9	3.6	12.0	14.0	6.7	7.5	3.3	3.4	1.4	1.9	2.8	3.9	4.5	4.5	2.0	2.1	2.4	2.7	11.7	13.0	53.1	60.6
Patient-monitoring equipment	0.9	1.0	0.4	0.5	1.4	2.1	5.4	7.0	4.4	4.8	2.5	3.0	0.5	0.6	1.7	1.9	2.0	2.5	0.7	0.8	0.6	0.9	12.0	13.7	32.5	38.8
Therapeutic equipment, except X-ray	0.8	1.0	0.3	0.3	1.7	1.9	3.4	3.3	1.6	1.8	1.0	1.3	0.6	0.6	0.7	0.9	1.5	1.8	0.5	0.7	0.4	0.7	8.1	9.0	20.6	23.3
X-ray equipment, diagnostic and therapeutic	6.1	7.0	2.5	2.7	4.0	4.3	45.0	47.0	20.5	22.0	8.0	9.0	1.7	1.8	9.3	10.6	17.0	17.5	6.5	7.3	18.2	19.1	96.5	107.0	235.3	255.3
Total	**9.2**	**10.8**	**5.2**	**5.7**	**10.0**	**11.9**	**65.8**	**71.3**	**33.2**	**36.1**	**14.8**	**16.7**	**4.2**	**4.9**	**14.5**	**17.3**	**25.0**	**26.3**	**9.7**	**10.9**	**21.6**	**23.4**	**128.3**	**142.7**	**341.5**	**378.0**
Total equipment consumption	**340.5**	**387.9**	**236.4**	**264.0**	**96.1**	**112.3**	**1,959.0**	**2,215.7**	**944.6**	**1,053.8**	**538.1**	**595.7**	**170.1**	**189.3**	**451.9**	**498.2**	**507.4**	**554.6**	**323.2**	**361.8**	**2,140.3**	**2,395.0**	**3,361.8**	**3,679.4**	**11,069.4**	**12,307.7**

Press here to save on lighted pushbutton switches.

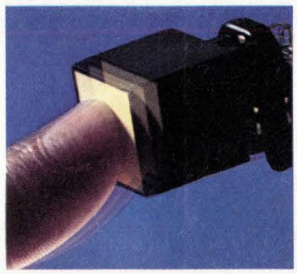
buys all the switch you need.

Oak's Series 300 gives you good looks and a small price-tag in lighted pushbutton switches. Plenty of switching performance for most jobs, without paying a premium. Even the Series 300 Split-Legend/4 Lamp Switch is less than $1.60 (normal latch, 2P2T, glass alkyd insulation, no engraving, less lamps.)



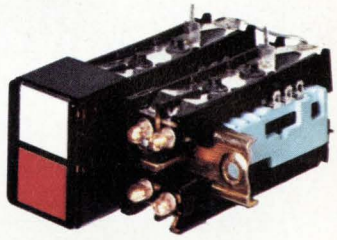
Three versions with switching up to 4P2T.

Choose from single, dual, or four lamp display as well as non-lighted type. One to twelve station, momentary, interlock, alternate action, or any combination available on the same switch bank. Lockout feature available for all types. Power Module 3A125VAC. Lighted indicators are identical in size and appearance, but without switching.



Built to take it.

Series 300 is built for reliable performance and long life. Applications galore —bank terminals, calculators, and copy equipment.

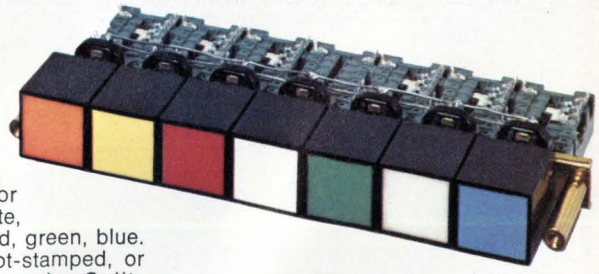


Modular design.

Single-legend/single-lamp, split-legend /4-lamp, and single-legend/redundant lamp switches have snap-on lamp holders. Plus replaceable legend plates, lens caps, and button assemblies. Front-panel relamping, too, without special tools on all types.

Gang them up by the dozen.

Order up to 12 switching stations on a single channel, any switching mix, with convenient panel-mounting studs. Color selection: white, lunar white, yellow, amber, orange, red, green, blue. Choose silk-screened, hot-stamped, or engraved-and-filled legends. Split-legend switches can be specified with any two, three, or four colors on insertable legend plates.



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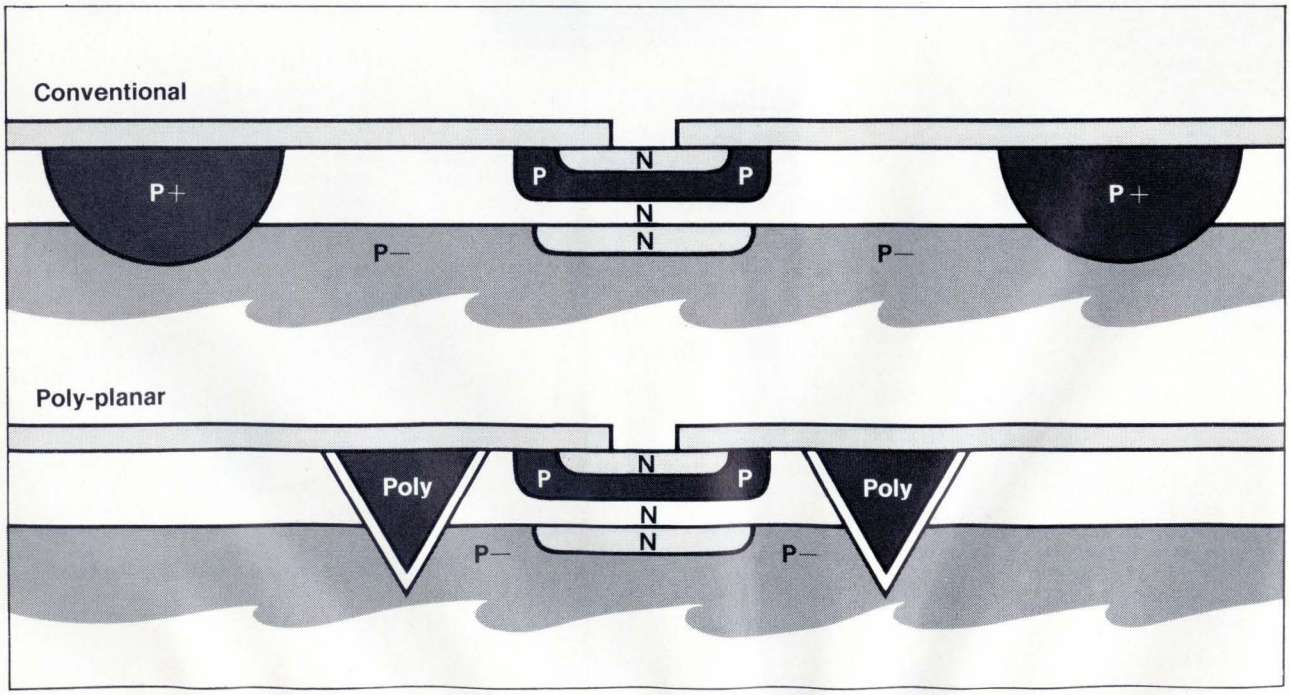

Poly-planar makes it denser. *Compare the two diagrams shown here. The one at the top represents a cross-section of a chip fabricated through use of the conventional isolation diffusion process. The diagram above represents a chip manufactured with our Poly-planar process, demonstrating a packing density twice as great as in the conventional device.*

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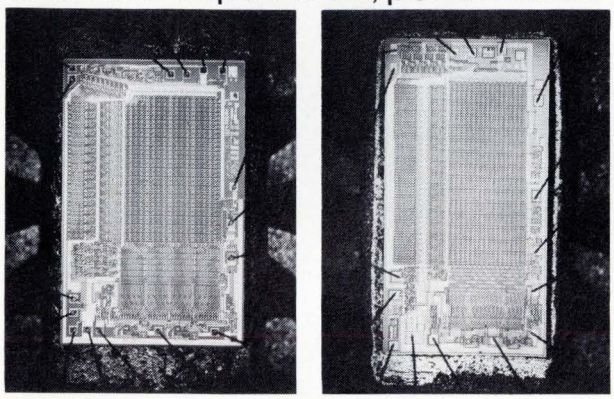

Twice the memory capacity at no increase in chip area. *At left is a photo blow-up showing the circuit density of a typical Harris 1024 PROM. At right is our new HPROM-2048, fabricated through use of our Poly-planar process, demonstrating isolation to isolation spacings half that of conventional devices and yielding a 4/1 improvement in density.*

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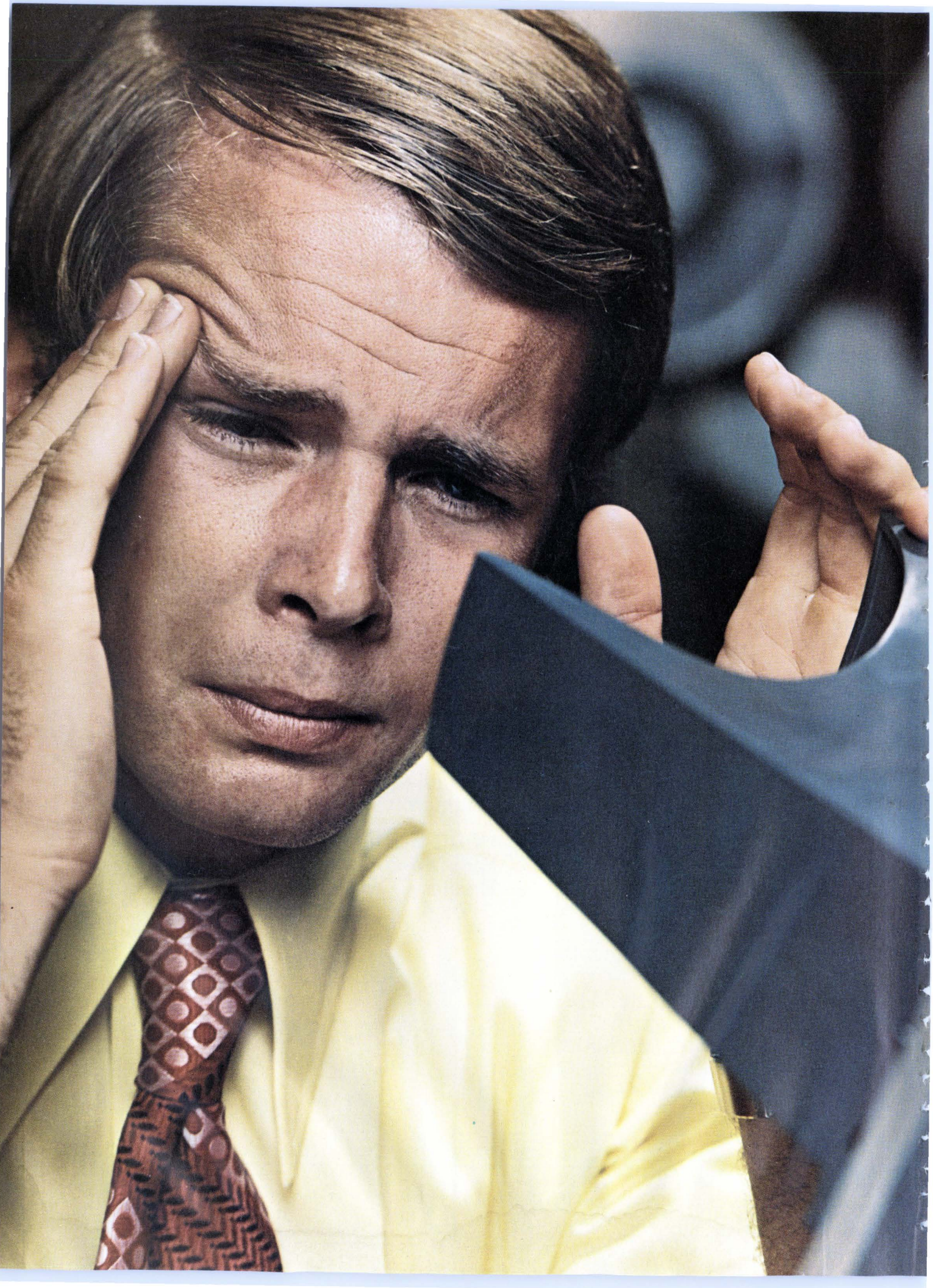

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Superior Technology. HP believes the most important part of a scope system is the CRT—the interface between you and your measurement. As the pioneer in practical applications of dome-mesh magnification, HP was first to expand the size of high-frequency CRT's to 6 x 10 cm; first to 8 x 10 cm; and first to 10.4 x 13 cm—all in high-frequency mainframes. HP was also the first to use dome-mesh technology to substantially lower power requirements for CRT deflection (making possible the only line of 35 and 75 MHz portable scopes with built-in battery packs—scopes that really are portable).

From The Storage Leader. HP was first with variable-persistence mesh storage for commercial applications—to give you a stored trace many times brighter than bi-stable tubes, and without annoying flicker. Variable-persistence, with its ability to build up waveform brightness, was the first CRT innovation that gave you a trace bright enough to let you tackle most single-shot or low rep-rate measurements problems. All you do is adjust persistence until the integrating storage effect brings your waveform up to a bright, clear display.

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Scopes Are Changing; Think Twice.

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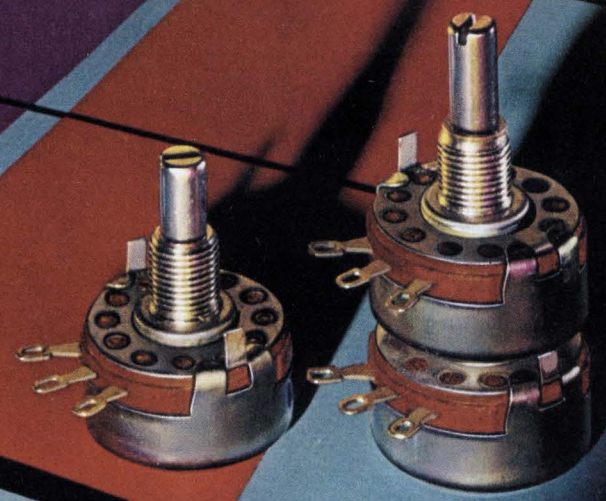

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New 4,096-bit MOS chip is heart of fast, compact computer memory

Process, circuit, and system designers combine to build basic IC, new storage module, and memory with capacity of 262,144 bytes; array specifications are even higher than those of present 1,024-bit systems

by John Bayliss, R. Johnston, and John Freeman, *Microsystems International Ltd., Ottawa, Ont., Canada*

☐ Advances in large-scale integration techniques have made possible larger computer memory capacities in smaller space with increasing speed of access. These capabilities have brought within the realm of probability data-processing concepts that have been talked about for years, but never seriously implemented.

The steadily unfolding state of the art poses a challenge that engineers and their employers can't resist. A number of companies have built higher-capacity chips of smaller size. But developing a new memory system that continues to improve on existing memory capabilities poses a challenge of the first magnitude.

The new products must have flexibility, reliability, performance, low cost, and volumetric efficiency—all of which have been repeatedly improved by successive generations of ferrite-core arrays, the earlier semiconductor buffer memories, and most recently, by the many digital systems based on a 1,024-bit p-channel metal-oxide-semiconductor memory.

This basic MOS chip is the 1103, so-called by its originator, Intel Corp. Although it was introduced only a couple of years ago, the 1103 has been well accepted, and many suppliers are now manufacturing equivalent units in large quantities. From this IC, memories of as many as 8,192 words of 12 bits each can be built on one printed-circuit board of 8 × 10½ inches. This size and capacity compare favorably to high-density ferrite-core arrays, and the cost, performance, and reliability are comparable to or better than core can provide.

The 1103 is therefore a hard act to follow. Improving on it calls for the talents of an engineering team with expertise in process, circuit, and memory-system designs. Microsystems International Ltd. formed such a team.

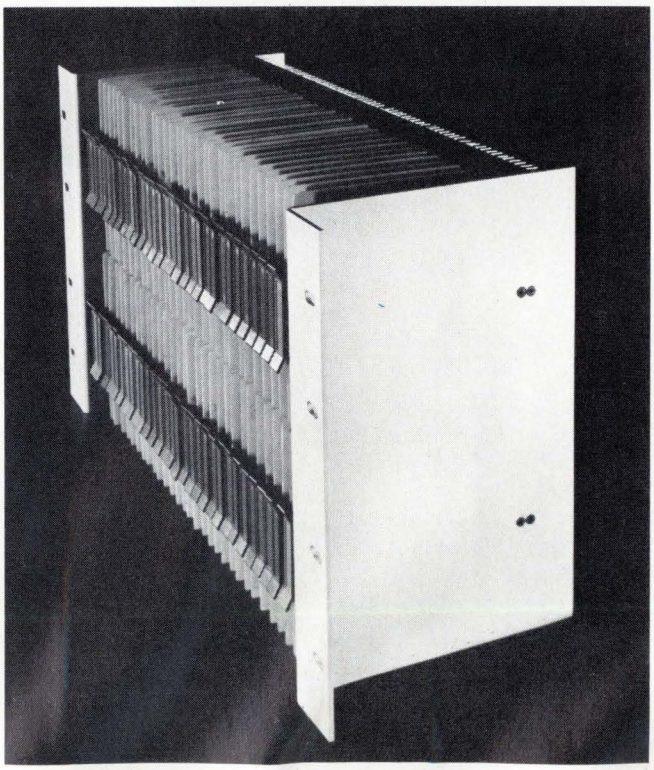
Its resulting system is based on a 4,096-bit n-channel array, called the MF-7112. The memory is designed into 4-kilobyte modules, consisting of eight to 10 of the new chips and a few other standard components mounted on a board only 5 inches square.

From these modules, a memory system (Fig. 1) with a capacity of 262,144 bytes has been built to mount in a standard rack 10½ inches high and 8 inches deep. The system has a full cycle time of 600 nanoseconds. Its read access time is 400 ns, read cycle time is 500 ns, and write cycle time is 600 ns. Read/modify/write time is also 600 ns, plus the length of the pause taken for modification.

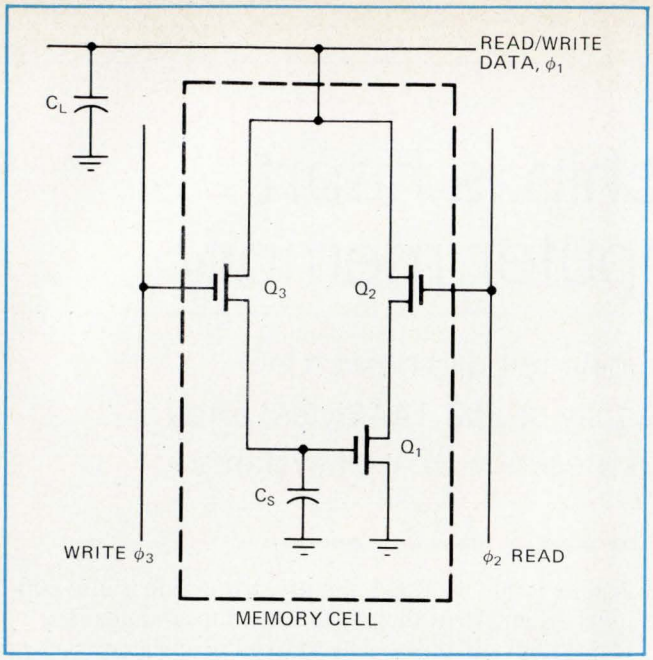
The system dissipates 330 watts—150 microwatts per bit—from four power supplies of +15, +10, +5 and −2 volts, all with ±5% tolerances. These four power supplies fit in another rack space equal to that occupied by the memory.

A design modification for the 4-kilobit component is expected to improve the read access time to 300 ns in the 262-kilobyte system, with corresponding improvement in other speeds.

The first determination of the Microsystems International team was the optimum size for a memory system building block, or basic storage module (BSM). The



1. Memory system. This small rack-mounted chassis, 10½ inches high, stores 262,144 bytes on 64 basic modules using a 4,096-bit MOS integrated circuit. Its access time is 400 nanoseconds.



2. Storage cell. Capacitance stores binary digit in memory cell of new 4-kilobit array. Unlike cell of familiar 1-kilobit array, it can be used in read-only mode, but data inverts on every cycle. Bit identity is in terms of phase relative to separate status cell.

BSM is analogous to a core mat with drivers and sense amplifiers; it can operate by itself without any external equipment, other than a power supply and the principal timing pulses.

A major requirement of a BSM is flexibility, so that it can be used in many applications without substantial redesign. This capability permits a reasonable volume of production over a long enough time that design and engineering costs are negligible in comparison to the costs of parts, assembly, and testing.

In the past, particularly with other technologies, BSMs have tended to become larger and larger with successive designs. But as medium- and large-scale integrated circuits become more cost-effective, they point in the opposite direction—toward smaller BSMs.

These, in turn, can be made simpler and more reliable if they are used on a multiplexed bus that carries both address and data on the same lines. This reduces the number of lines in the bus, and the number of pins in the connectors, reducing the cost and improving the reliability of the connectors. However, if multiplexing requires a substantial increase in the number of components on the BSM, it defeats its own purpose.

Therefore, the cost and complexity of a memory system is lowest if the bus is multiplexed and the necessary multiplexing and demultiplexing circuits in the BSM are designed right into the LSI memory circuits, This permits large numbers of BSMs to be used in parallel for a large memory, and it permits interleaved and multiport organizations with only a small amount of added complexity.

These considerations led the engineering team to choose a BSM design 1 byte wide (8 bits plus parity), with options of 4,096, 8,192, or 16,384 bytes per module, depending on the size and speed of the memory to be built from the module.

With that choice made, the next decision was the capacity and organization of the ICs from which the BSM would be assembled. A module of 4 kilobytes (9 bits per byte) could be assembled from 36 of the standard 1103s, arranged so that a single access could address nine chips at once for a 9-bit parallel readout. But a more compact package was considered desirable.

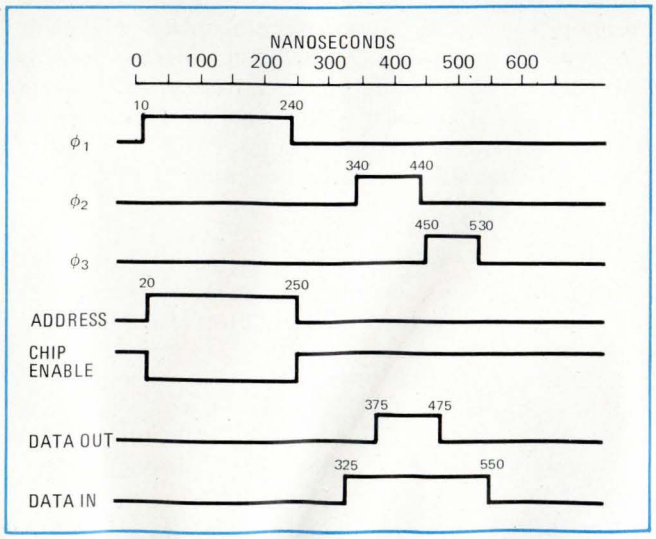
Quadruple size

A sensible projection from the 1,024 or so bits of the 1103 seemed to be 4,096 bits, based on the semiconductor industry's history of quadrupling packing density every two years. But the conventional p-channel silicon-gate MOS technology used in the 1103 isn't practical for such a high density because it would lose speed in the larger array. N-channel enhancement-mode MOS, on the other hand, besides achieving the necessary speed and packing density, permits compatibility with transistor-transistor logic circuits because of its low threshold.

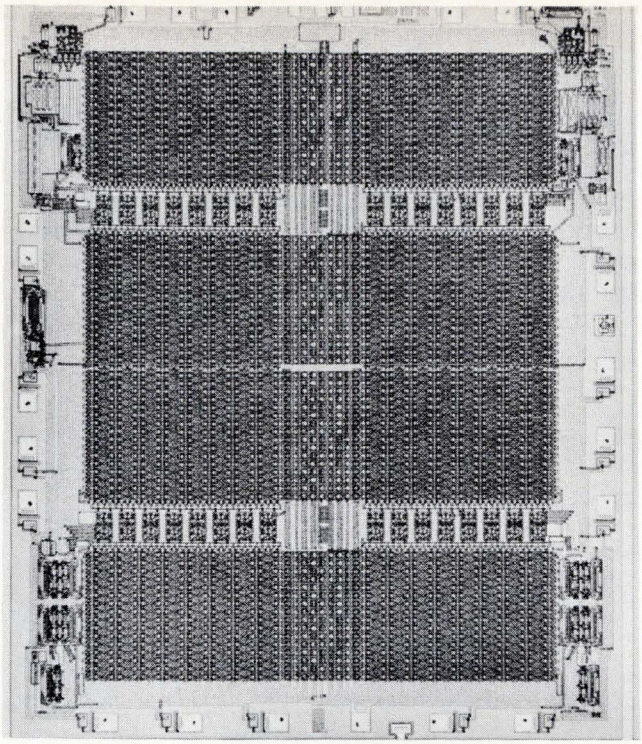
In establishing design goals for the memory, the development team built extensively on experience with the 1103 and other arrays. For example, every read cycle of the 1103 is followed by a write cycle, internally controlled on the chip, and a batch of 32 refresh cycles must be taken after every several thousand normal cycles to ensure that stored data hasn't leaked away. The "rewrite" is itself actually a refresh cycle, except when new data is being stored, because the readout doesn't affect the stored data *per se*.

But the 32 separate refresh cycles are necessary anyhow because there is no way of knowing which cells have been accessed and which ones haven't. And time has been wasted on most of the accesses between refresh cycles because in most memory applications, about 85% of the cycles are readouts, while only 15% involve storing new data.

In contrast, in the 4-kilobit array, successive read cycles are possible without intervening write cycles, and the separate refresh operation can be completed in only



3. Three clock pulses. First pulse ϕ_1 precharges data line (Fig. 3), second pulse ϕ_2 conditionally discharges line through cell. For reading, only these pulses are required. For writing, third pulse ϕ_3 transfers state of data line to storage capacitance, inverting the data.



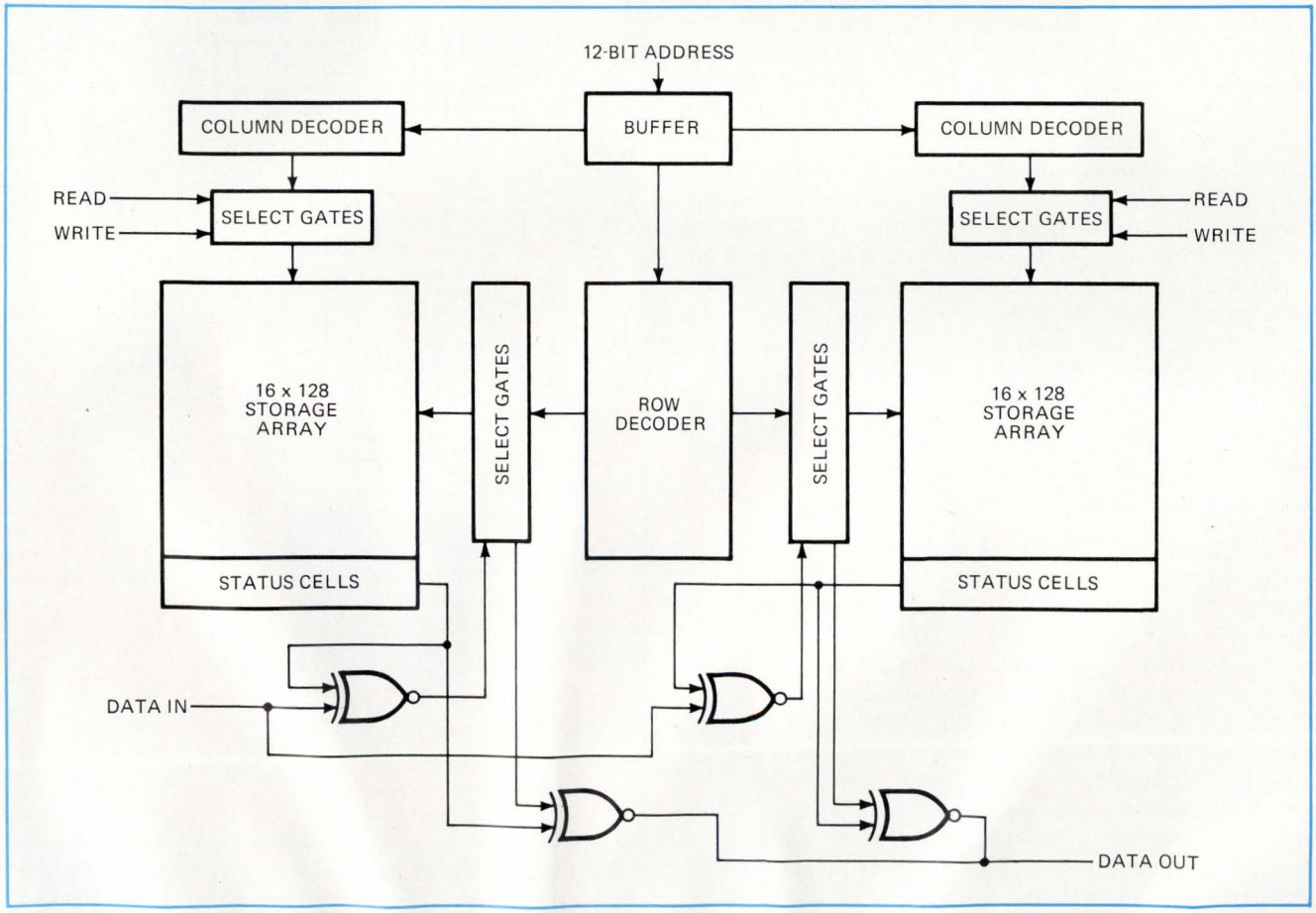
4. 4,096 bits. Chip measures 204 by 168 mils, contains 32 columns of 128 storage cells. Left-and-right halving expedites refreshing; four segments top to bottom are an aid to row-address decoding.

16 cycles because the columns of cells are refreshed two at a time. Furthermore, permitting successive read cycles in the larger array turned out to have another advantage—it eases some of the timing requirements that are quite critical in the 1103. Two of the 1103's input signals are a precharge and a chip-enable; the first "sets up" the chip at the start of a cycle, while the address lines stabilize, and the second actually selects one of the 32 rows of cells for readout. These signals must overlap by a prescribed amount whose maximum and minimum values differ by only 30 ns or so. This critical timing is not required in the 4-kilobit memory.

Compatibility with TTL's 3-V signal levels for data and control lines, as previously mentioned, is another design goal. But clock inputs are permitted a high level of 15 V. The extra wallop gives the circuit extra speed, but does not itself present a disadvantage in terms of speed because any practical clock driver has a relatively limited fan-out and can produce the high-amplitude clock pulse with a very short rise time.

Three-transistor cell

The storage cell in the MF-7112 4-kilobit memory chip contains three transistors (Fig. 2). Superficially, it resembles the familiar 1103 storage cell. The principal difference is that in the 1103, the source of transistor Q_3 is connected to a separate write-data line, instead of to the common-data line shown, while the line



5. Chip layout. Buffer at top holds address, permits multiplexing of address and data on one bus. Storage array cells repeatedly invert stored data; status cells follow the inversions to define the binary state of each storage cell. Exclusive-NOR gates complement incoming data being written and outgoing data being read, as required, to permit external system to work with conventional dc levels and pulses.

TABLE 1. OUTPUT PHASE RELATIONSHIP

Memory cell capacitance	Status cell capacitance	Output data
Discharged	Discharged	1
Discharged	Charged	0
Charged	Discharged	0
Charged	Charged	1

Discharged capacitance presents ground level to data line; charged capacitance presents 3-volt level.

serving the source of Q_2 is termed the read-data line.

To read the cell, clock pulse ϕ_1 initially precharges data line capacitance C_2, which is quite large because the line is connected across the chip to 32 cells. Then ϕ_2 conditionally discharges this capacitance through Q_2 and Q_1 to ground. The condition is established by the capacitance C_s, which turns on Q_1 if it is charged. In this way, after ϕ_2, the data line carries the complement of the charge on C_s.

This read cycle of ϕ_1, ϕ_2, lasting 500 ns (Fig. 3), can be repeated as many times as desired on a single cell or on various cells at random without affecting the charge on C_s. But to store new data in any given cell, a third clock pulse ϕ_3 turns on transistor Q_3, which connects the data line to C_s. Since the data-line capacitance is at least 20 times as great as C_s, its level is affected only slightly by this action. The read/write cycle lasts 600 ns. A pause can be inserted between ϕ_2 and ϕ_3 to permit a read/modify/write cycle.

As in any dynamic-memory cell, the charge on C_s, representing the stored data, is subject to leakage. Therefore, to assure its continued integrity, it must be refreshed from time to time—approximately every 2 ms. Refreshing, like writing, constitutes a sequence of three clock pulses; the third pulse transfers the charged state of the data-line capacitance to C_s. However, since the readout by the first two pulses puts the complement of the originally stored charge on the data line, the absolute value of the stored data is inverted with every refresh cycle.

Data equals charge

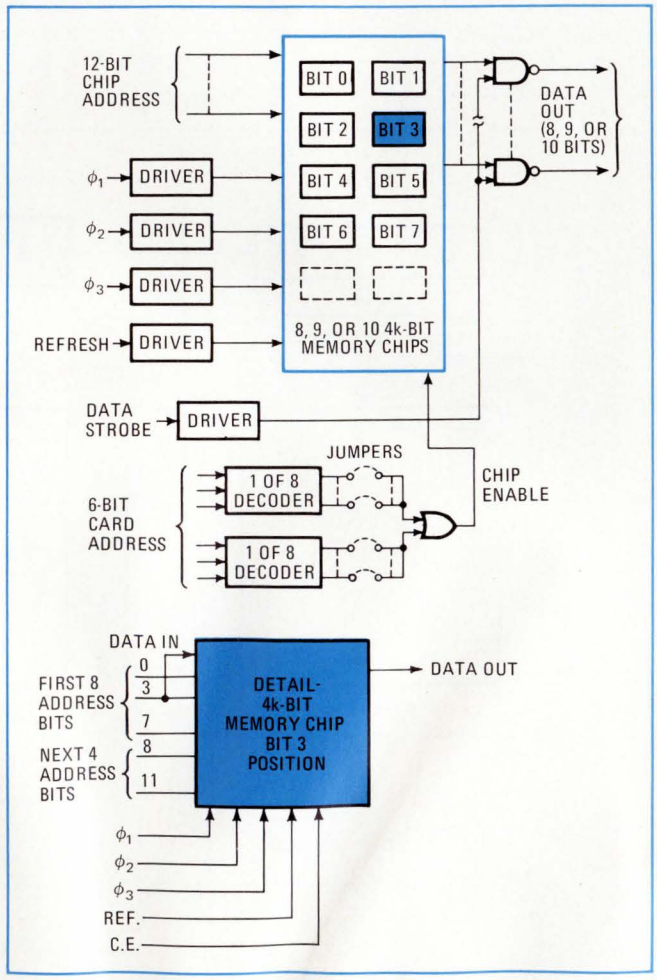
All dynamic MOS arrays store data in the form of a charge on a parasitic capacitance, and reading that data amounts to checking the capacitance to find out whether it is charged or not. In conventional arrays, if the capacitance is charged, the storage cell addressed contains a 1; if the capacitance is discharged, the cell contains a 0. These arbitrary designations for the data can be reversed at the designer's whim, provided he is consistent throughout a given design. But the MF-7112 binary designations change, not at anybody's whim, but with every refresh cycle. For this reason, the state of stored charge cannot be assigned any arbitrary identity. Nevertheless, the external appearance of continuously stored data must be preserved.

To do this, every column of 128 memory cells also includes an extra dummy location called a status cell. No external data can be stored in the status cell, but the state of its storage capacitance C_s changes with every refresh cycle, as do the real cells. Its data line, which is not shared with any other cell, is connected to one input of an exclusive-NOR; the main data line is connected to the other input, and the NOR is strobed by ϕ_2.

Since all real data cells are either in phase or out of phase with the status cell, the output of the exclusive-NOR is a consistent 1 or 0 level for any addressed cell at any time (see Table 1). Another exclusive-NOR, driven by an input-data line and the status cell and strobed by ϕ_3, generates the proper level for writing.

The chip itself, measuring 204 by 168 mils, contains 32 columns of 129 cells (Fig. 4), counting the status cell. This array, however, is divided into two groups of 16 columns each (Fig. 5). Each half has its own data input and output lines. However, the two inputs are connected on the chip, as are the two outputs, so that only one pair is accessible externally.

Even though the refresh cycles are only rarely required, they do take time; the halving of the array allows two rows to be refreshed at once—one in each half. During refresh cycles, the operation of the address decoders is modified to make this possible, effectively



6. Basic storage module. Eight to 10 memory chips can fit on one card 5 inches square. The one data-input line on each chip is connected to a different address-input line on each chip, thus multiplexing addresses and data. Output buffers gate read data onto the same bus. Decoders and chip-enable line select one of many cards.

Canada's major leaguer

Beating out such heavy hitters as Texas Instruments, Intel, and other MOS leaders, quantity production of the new 4,096-bit n-channel RAM at the heart of the Microsystems International Ltd. memory system has moved that company into the semi-conductor big leagues. Moreover, the success of MIL, which has been in business only since the summer of 1969, is also a triumph for a Canada determined to develop a semiconductor capability of its own that can bring with it a certain independence from U.S. firms.

In the past, Canada has relied on a policy of attracting multinational companies and encouraging them to "rationalize" their product lines. Under this arrangement, a company chooses a particular product that it will develop and manufacture in Canada and market worldwide, providing jobs both for engineers and blue-collar workers while helping to offset Canada's unfavorable balance of trade, which is currently totaling about $900 million yearly in electronics.

With ICs regarded as the "building blocks of the future," says T.C. Jones, director of industry and trade development within the Electrical/Electronics branch of Canada's Department of Industry, Trade and Commerce, "we couldn't see any way that companies like Texas Instruments, Fairchild, or Motorola could do a rationalization job in Canada."

The only way, then, to support its electronics industries was to develop "a viable microelectronics business of our own," asserts MIL's president, A. Olaf Wolff. To both the Canadian government and Bell Telephone of Canada, the nation's largest user of semiconductors, the venture seems to be doing admirably.

By the end of 1972, Wolff expects his company, which is the only commercial manufacturer of semiconductor ICs in Canada, to be operating profitably at a $20 million annual rate. Sales for the fiscal year ending Dec. 31 should hit $14 million, with roughly half going to the United States, estimates Joseph L. Chenail, director of marketing and sales. And he predicts that sales, working off a $16 million January backlog, will double in 1973.

At MIL's nucleus back in 1969 were some 400 people in what had been the $25 million Advanced Devices Center of Northern Electric Co., the manufacturing arm of Bell Telephone of Canada. In addition, there were about 60 people from a branch laboratory of the telephone company's top-level research facility, Bell-Northern Research.

MIL now has some 1,100 employees occupying a 340,000-square-foot research, development, and manufacturing facility in Ottawa, a headquarters office in Montreal, and a small assembly facility recently established in Penang, Malaysia. Included also are seven sales offices in the U.S., operated by Microsystems International Inc., Palo Alto, Calif., and either offices or sales representatives in various countries of Europe, and in Japan, Hong Kong, Australia, Israel, and New Zealand.

To the initial complement from Northern Electric—it owns 60% of MIL, the rest is publicly held—were added sizeable gobs of cash. The largest amount comes from the Canadian government, which has made available $48 million in loans and conditional grants. But unlike awards made to private industry in the U.S. by agencies such as NASA and the Defense Department, $12 million of this sum is loaned interest-free and must be repaid. The remaining funds are conditional grants in that they must be repaid only if MIL shows a certain level of cumulative profit—set fairly high at 10% of sales—during its first five years. So far, MIL has used only about half of the available government funds—which it has had to match with its own money—for capital equipment, product development, and engineering. Thus, Northern Electric has made $20 million available over a period of years, $20 million has been raised through a public stock issue, and a $10 million bank line of credit has been opened.

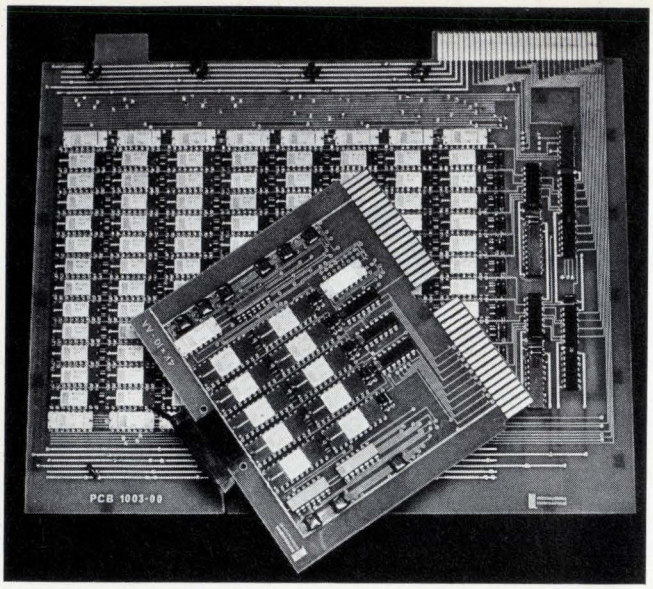
MIL's products are aimed at the broad target of telecommunications, with emphasis on both "microsystems" and "international," Wolff asserts. An important objective was to get production lines operating as quickly as possible, which was done through licensing agreements. MIL bought its silicon-gate MOS and bipolar memory expertise. Concurrently, the company developed its own n-channel technology which, when ready, was phased into an on-going, experienced production operation, Chenail points out. The n-channel 4,096-bit memory chip and system described here are probably the most technologically significant of MIL's products thus far.

Initially, the company started in early 1970 to build a broad line of bipolar linear products, fundamentally copying such devices as 709 and 741 operational amplifiers and introducing improvements and new products of its own, Chenail says. At the same time, MIL was supplying all of Northern Electric's semiconductors, either by buying or building them itself. In addition, it embarked on the production of hybrid thin- and thick-film circuits, including a thin-film tantalum process, and produces such electronic telephone components as tone generators, receivers, ringers, frequency-shift keyers, and two-wire/four-wire networks. These it markets internationally, as it does all products, to all telecommunications companies, even those competing with Northern Electric.

In February 1971, MIL, under license from Intel Corp., Mountain View, Calif., began shipping p-channel MOS RAMs and shift registers, and by June of that year, the popular 1103 RAM began coming off its production lines. Chenail says MIL is now the world's largest MOS memory supplier, surpassing even Intel itself in 1103 output.

Early this year, MIL began shipping its own n-channel products—1-kilobit static RAMs and 2-kilobit shift registers. A few months ago, it was up to volume production of bipolar standard and programable ROMs licensed by Monolithic Memories Inc., Sunnyvale, Calif. Added to these is MIL's own line of gallium-phosphide light-emitting diodes. Last month, the company announced a licensing agreement with Nortec Electronics Corp., Santa Clara, Calif., to manufacture a single-chip MOS device for eight-digit, four-function calculators. At the same time, it announced a $5 million contract to supply the chips to calculator maker Rapid Data Systems & Equipment Ltd., Rexdale, Ont., Canada.

As for the future, MIL spokesmen predict that their company will be in the thick of things, concentrating its own research on the more advanced technologies, rather than on price-eroded standard logic families. And with an open-door information-exchange policy apparently existing between it and Bell-Northern Research, MIL could exploit, should it choose, virtually any of the "hot" technologies, including bucket-brigade and charge-coupled devices and bubble memories. —Alfred Rosenblatt



7. Mutt and Jeff. Large card, built with 1103-type 1,024-bit chips, contains about twice as many bits as small card, which uses the new 4,096-bit chips. In addition, the former is much more than twice as large and is more complex in other ways as well.

turning the 32-by-128 array into a 16-by-256 one.

Because of the addressing technique, when the full array is to be refreshed, only 16 cycles are required, instead of the 32 that would be needed if the array were not halved. These refresh cycles constitute only 0.43% of the total number of available read-only cycles.

But, should even this refresh cycle take up an unacceptably large proportion of time, the memory can be refreshed during normal operation if every row of 128 cells is exercised by an external source at least once every 2 ms. If at the end of the 2-ms interval some rows have not been accessed, operation must be interrupted to refresh these inactive locations. This approach requires 32 cycles to refresh the entire array, but if all rows are active, the routine consists of normal read/write or read/modify/write cycles, and no time is lost.

Module design

From these 4-kilobit memory components mounted in standard 22-pin dual in-line packages, the basic storage module is assembled. Nine memory components can be considered the standard, for the 4,096 bytes each contain 8 data bits and 1 parity bit. If nonredundant storage is required, without the parity, only eight 4-kilobit chips would be necessary.

For a more complex error-detection or correction scheme on longer words, packaged with data and check bits on each of several cards, or for storing two binary-coded decimal digits with independent parities in each digit, 10 chips can be used.

In addition to the memory components, the BSM also contains clock drivers, bus drivers, and select logic so that the system containing the BSM can drive many similar modules and so that the BSM itself can communicate with the larger system without restraints imposed by the memory components' driving capabilities.

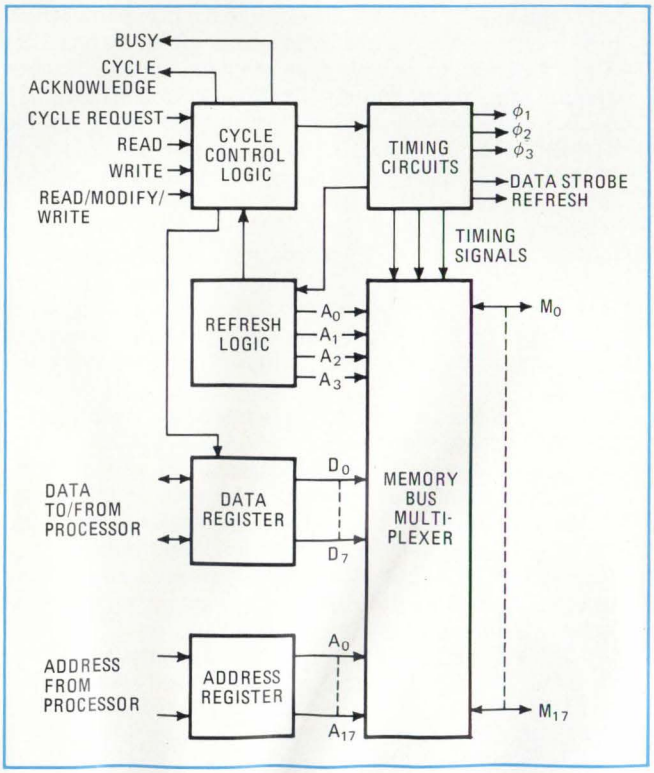
An important feature of the MF-7112 is its ability to latch the address lines. Therefore, the same bus can carry addresses as well as data. To address 4,096 positions, a 12-bit address is required, so the bus to which the BSM is connected contains 12 lines (Fig. 6). These are connected on the BSM to the 12 pins on each 4-kilobit memory component.

In addition, nine of the 12 lines are connected to the data-input lines on the nine chips—a different line for each chip. The nine data-output lines go to nine buffer gates with open collectors, available in standard four-gate packages. From these gates, the data is strobed onto the same bus that carries addresses and input data. The open collectors permit the use of several BSMs on one bus; a set of common-collector loads is required for the system, one on each line in the bus.

Small board

This combination of the 4-kilobit memory with its internal address latches and the external output buffer performs the multiplexing and demultiplexing function, with no additional components on the BSM. Because multiplexing sharply reduces the number of connections to the outside world, the BSM can be packaged on a 5-inch-square printed-circuit board with only 28 contacts along one edge, all on the same side of the board, a feature that reduces plating costs and connector costs and increases system reliability. Furthermore, it permits all the BSM cards and the associated control card, described later, to be interconnected by a bus on a simple one-sided motherboard, onto which the cards are plugged.

In general, the BSM will be used in multiples, rather



8. Control board. This logic, packaged on a single printed-circuit card, forms the interface between a central processor and the memory built around the 4,096-bit chip. The latter, with these controls and a source of power, is completely self-sufficient.

than singly. For example, a memory of 262,144 bytes can be assembled from 64 BSMs plugged into a common bus. However, these 64 BSMs require additional addressing capability. It's available through the chip-enable line, an input that blocks all the decoders on the chip, except when it is at ground.

In the occasional one-chip or one-BSM application, the chip-enable line, which is common to all the memory components on the BSM, is permanently grounded. For the 262-kilobyte system, it can be connected to a positive-OR gate driven by two 1-out-of-8 decoders with true low outputs. Jumpers at the decoder outputs give each BSM a unique address. When both decoder outputs are low, the output of the OR is down.

The two decoders are driven by six extra address lines that identify one of the 64 BSMs. On this BSM, the decoders ground the chip-enable line, latching the 12 chip-address lines and starting a cycle. On the other 63 BSMs, the chip-enable line remains positive, and the chip-address lines are ignored.

The BSM card itself is a double-sided board with undemanding tolerances. Lines on the card are 15 mils wide, with 15-mil spaces between them. No more than one line passes between any two of the holes, spaced 100 mils apart, through which package pins are mounted. The board contains no ground plane as such, but the conductors carrying the various power-supply voltages to the mounted packages form a grid that serves as a virtual ground plane.

When two BSMs of equal capacity are compared, one built with 4-kilobit arrays, such as the MF-7112, shows a marked improvement over one built with 1-kilobit arrays such as the 1103, as shown in Table 2 and in the photograph (Fig. 7).

TABLE 2. COMPARING TWO 4-KILOBYTE-BY-9 BSMs

	Built with 1-kb RAMs	Built with 4-kb RAMs
Storage ICs	36	9
Other ICs	23	8
Resistors	20	14
Capacitors	24	8
Total components	103	39
Connector type	Double	Single
Connector contacts	64	36
Module failures per 10^6 hours	12.87	3.95
MTBF at 55°C, hours	7.8×10^4	25.5×10^4
Read access time, ns	400	350
Read cycle time, ns	700	500
Write cycle time, ns	700	600
Refresh cycles	32	16
Refresh interval, ms	2	2
Refresh time, % available time	1.28	0.43
Power dissipation, watts	15	5

Memory controller

Control signals for a memory system, such as the 262-kilobyte memory mentioned previously, are generated by a control board (Fig. 8). This board accepts requests from the central processor, translates them into signals useful to the BSMs, and relays data both ways. The cycle-control-logic block is the direct interface with the processor, accepting and acknowledging requests and signaling "busy" during the course of any memory cycle, including a refresh cycle; when "busy" is up, no processor requests can be honored.

The timing circuits generate data strobe and refresh signals to the BSMs and the memory-bus multiplexer; they also provide clock signals for the BSM and precharge, read, and write signals for the multiplexer, with TTL amplitude. These two groups of signals are nearly identical in timing and waveshape. Those signals driven to the BSMs are there shifted to the 15-V level.

Refresh logic provides the 4-bit addresses for the 16 refresh cycles that are required every 2 ms. During these cycles, the timing circuits signal "refresh" to the BSMs, and the signal locks out the chip-enable line. However, the 16 cycles are interspersed among read and write operations at a rate of one cycle approximately every 125 μs and rotated so that the entire array has been refreshed within the required time interval. This staggering of refresh cycles has less impact on time-sensitive computations that may be in process, and also smooths out the power requirements of the memory system.

During a read cycle, the control board acknowledges the request and signals "busy," clears the memory-bus lines and puts an 18-bit address on the bus. As described previously, the 6 high-order bits select one of the 64 BSMs, and the other 12 are strobed into the address buffers on that BSM at the end of the precharge signal (ϕ_1). At this time, the bus is cleared again and prepared to receive the data (on nine lines) taken from the addressed memory; this data is strobed into the data registers at the end of the read signal (ϕ_2).

During a write cycle, operation is similar, except that no data strobe is issued at the end of ϕ_2. Data coming out of the addressed location thus dies at the output buffer gates on the BSM, while new data to be written waits in the data registers on the control card. This is gated to the bus during the write phase (ϕ_3) and then to the data input lines in the BSM.

A read/modify/write cycle combines these two operations, with a pause if necessary between ϕ_2 and ϕ_3 for the processor to modify the contents of the data register in the control card.

The entire system consists of the 64 BSMs and one control card in a standard rack-mount module containing 68 connectors in two rows. Each row contains 32 single-sided connectors and two double-sided connectors. The BSMs plug into the 64 single-sided connectors, the control card into one of the double-sided ones, and cables between the memory system and the processor into the other three double-sided connectors.

This new system makes distributed memories suddenly look very practical. These memories are small units packaged adjacent to those portions of the system that use them, sharply reducing transmission-line delays along interconnecting wires and thus reducing effective access time. Distributed memories can also be used with special addressing means to implement special logic features, such as stack or pushdown stores. □

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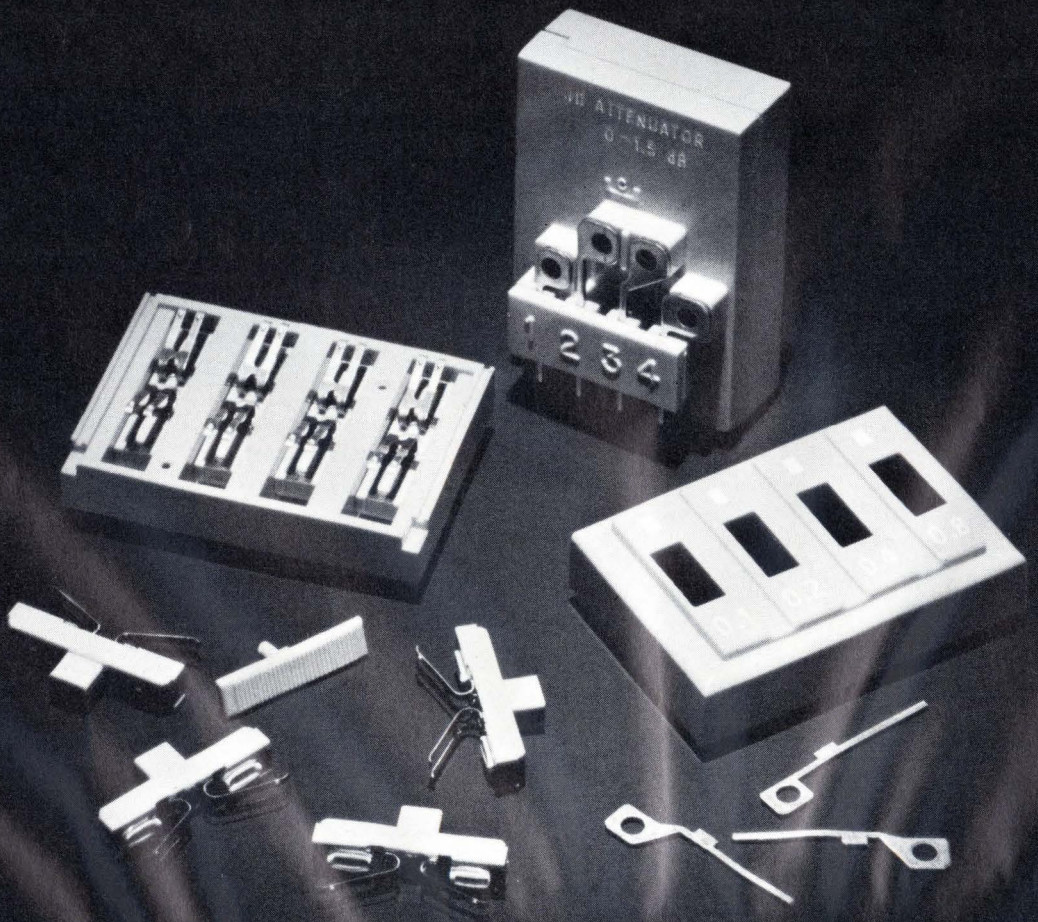
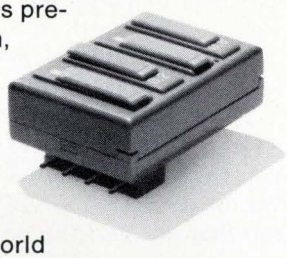


TRW/Cinch ceramic substrate attenuator assemblies illustrate Cinch's abilities to control the contact spring forces precisely during fabrication, and to weld tiny gold dots to the spring materials. Advanced manufacturing techniques such as these have helped make Cinch a leading world producer of connectors, sockets, and other electromechanical devices. (For further information, circle 71 on the reader service card.)



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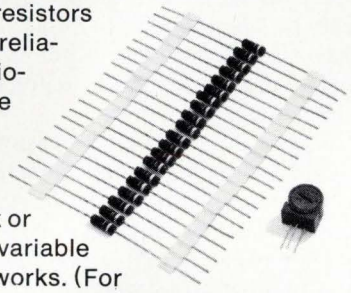
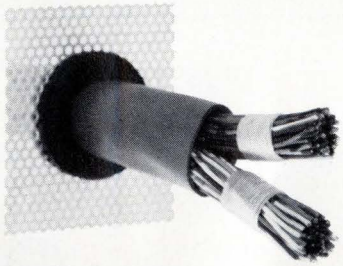
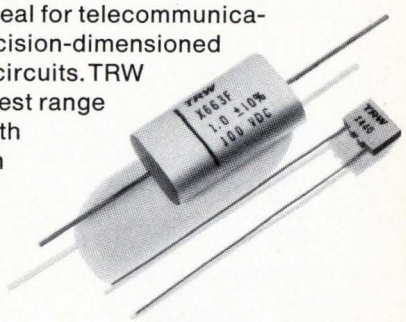


TRW/Holyoke wire, cable, and cable assemblies are produced in unlimited variety to meet critical requirements. These include such demands as lowest cross-talk for telecommunications, minimum impedance discontinuities for RF, and enhanced flame retardancy for home entertainment wiring. Shown is a 52-pair telephone cable, an example of a long-life, high-reliability requirement. (For further information, circle 73 on the reader service card.)



TRW metallized film capacitors are available to fit almost any design requirement. Typical are the tape-wrapped X663 (ideal for telecommunications use) and the precision-dimensioned X440 for high-density circuits. TRW makes by far the broadest range of film capacitors—both metallized and foil—in terms of dielectrics, case styles, shapes, capacitances, and voltages. (For further information, circle 74 on the reader service card.)



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Precision auto tachometer squelches point bounce

by James B. Young
Canadian General Electric Ltd., Peterborough, Ont., Canada

A tachometer circuit for automobiles with capacitive-discharge ignition systems suppresses point bounce while measuring motor rpm accurately to within 1%. The circuit, which has an operating temperature range of –20°F to 150°F, can also be used as a temperature-compensated ratemeter or to eliminate relay-contact bounce.

Many automobile tachometers do not work properly with a capacitive-discharge ignition because this type of system employs the breaker points only for triggering an SCR. The voltage waveform across the breaker points, therefore, consists of a series of 14-volt pulses, rather than the 200-v spikes that exist in the usual kettering ignition system.

The tachometer circuit shown is composed of three sections: a relaxation oscillator at the input for point bounce suppression, a monostable multivibrator for pulse generation, and a buffer for driving a meter.

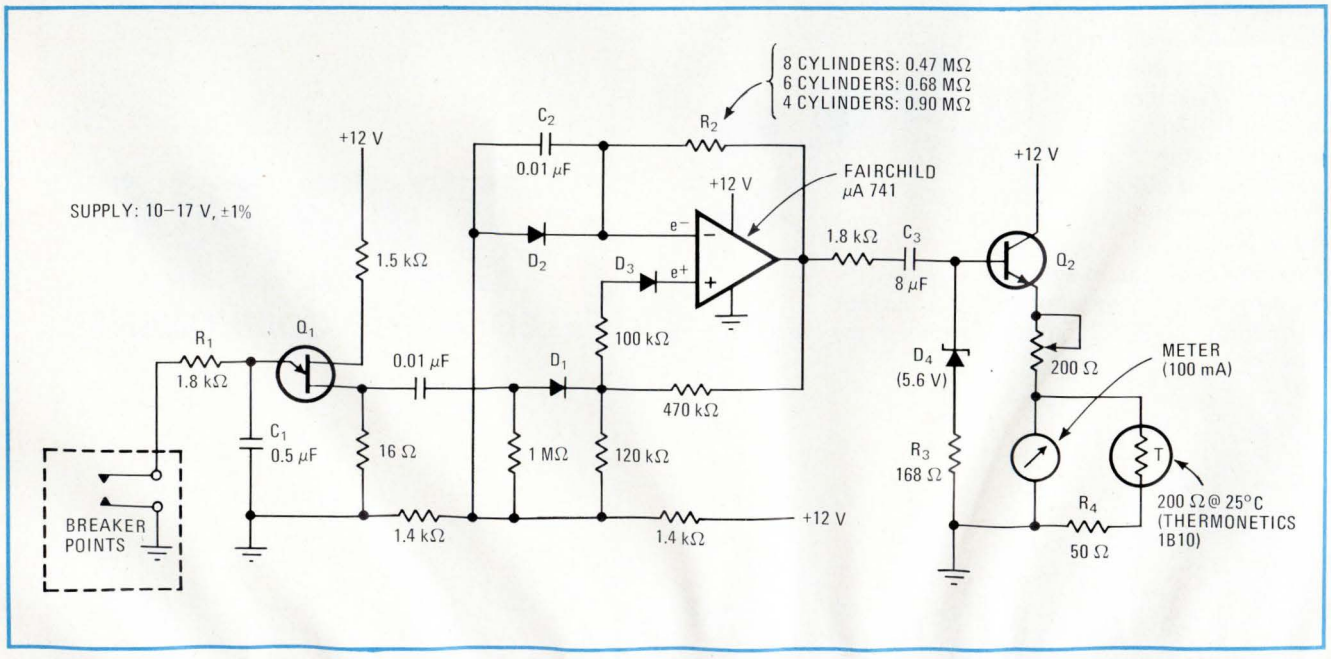
Unijunction transistor Q_1 is operated with an emitter current that is larger than its valley current so that it will not turn off after triggering. When the points open, capacitor C_1 charges through resistor R_1 until Q_1 fires (in 0.5 to 0.7 millisecond) and triggers the monostable. The current through R_1 keeps Q_1 on and prevents C_1 from charging until the points close. If the points bounce upon closure, they will not be open long enough to allow C_1 to charge and fire Q_1 again.

For every point opening, the monostable produces a pulse having a fixed width and amplitude. Normally, the output stage of the operational amplifier produces a negative saturation voltage. But when a positive trigger from the relaxation oscillator is applied through diode D_1, the op-amp's output switches to a positive saturation voltage, causing capacitor C_2 to charge positively through resistor R_2. Capacitor C_2 stores the charge until e^- is greater than e^+, and the op amp switches back to its stable state.

Diode D_2 clamps the voltage across C_2 to about –0.6 v, while diode D_3 provides temperature compensation for changes in D_2's junction-voltage drop. Both of these diodes should be kept in thermal contact with each other. Since the op amp is left floating so that it can be operated from a car's single supply voltage, it has a small positive output voltage when in its untriggered state, making capacitor C_3 necessary to decouple the meter.

Zener diode D_4 and resistor R_3 regulate the output against supply voltage variations, and the thermistor compensates for temperature variations in the base-emitter voltage of transitor Q_2. If a meter with a full-scale current rating of less than 5 milliamperes is used, the thermistor, as well as transistor Q_2 and resistor R_4, can be omitted. □

Measuring rpm. Intended primarily for automobiles with capacitive-discharge ignitions, tachometer circuit accurate within 1% is immune to breaker-point contact bounce. When points open, capacitor C_1 charges until unijunction transistor Q_1 fires and triggers one-shot formed by op amp. Point bounce is suppressed because C_1 takes 0.7 millisecond to charge before Q_1 can fire. Circuit can operate from –20°F to 150°F.



Agc rf threshold detector provides fast slewing

by Roland J. Turner
American Electronics Communications Corp., Lansdale, Pa.

In both radar and communication systems, an automatic-gain-control loop is commonly employed to keep signal level constant for enhanced signal detection. As systems become more adaptive, the agc loop must be more sophisticated, frequently forcing simple circuits to perform multiple functions.

Meeting this demand is an rf threshold detector for the agc loop in an rf receiver. The detector can process signals of 1 megahertz to 1 gigahertz with a slew rate of several volts a microsecond. It also permits delayed agc operation and can perform over a wide range of temperature and supply-voltage variations.

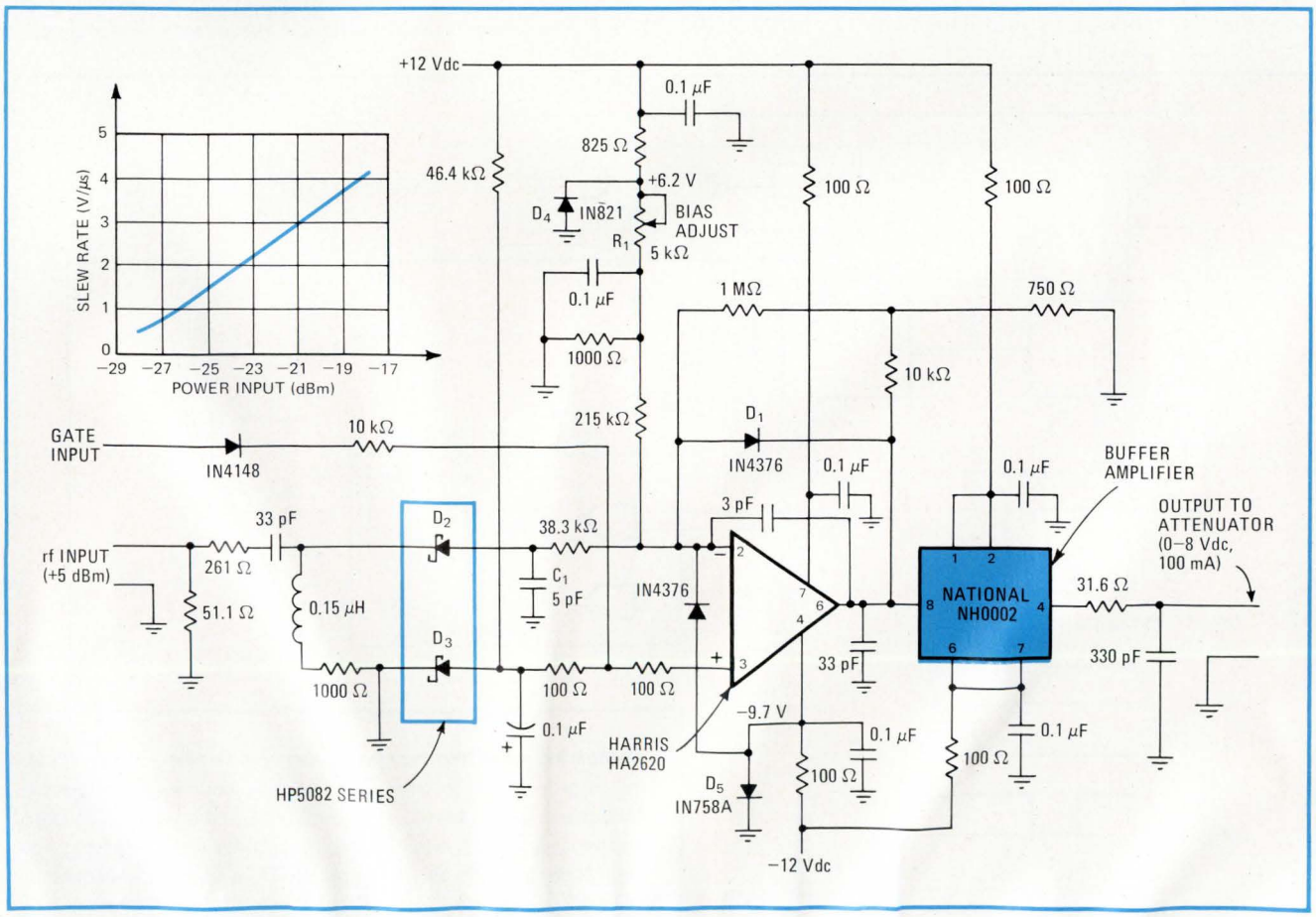
Furthermore, below the detection threshold, the signal can be processed linearly in the rf section of the receiver. Above the detection threshold, the output of the rf section is rapidly leveled so that such detrimental effects as limiting and hangup cannot occur in subsequent i-f stages. This fast action prevents the receiver from being desensitized at high signal levels and permits low-level targets to be detected even in the proximity of heavy clutter.

With the threshold power level (typically 0 to 5 dBm) applied at the detector's rf input, the input voltages of the operational amplifier are equalized so that there is no output voltage. For signal levels below the threshold, the op amp's inverting input swings positive, relative to the noninverting input, and the op-amp output is clamped by diode D_1 near the quiescent bias voltage set by potentiometer R_1. This clamp prevents the output of the op amp from swinging to the negative supply voltage and enhances the recovery time of the detector at its threshold level.

As soon as the rf input develops 3 millivolts of rectified bias voltage across capacitor C_1, the detector's output goes positive to 1 V, thereby activating the agc loop in which it is installed. Only the differential offset voltage between the dual Schottky diodes, D_2 and D_3, is impressed across the op amp's differential input. The op amp provides 50 decibels of gain, while Schottky diode D_3 provides automatic temperature stabilization for the detector. Diodes D_4 and D_5 are temperature-stabilized reference diodes that desensitize the detector to power supply variations.

The rf section of the receiver is gated by switching the voltage at the detector's gate input from its normal

Closing the loop. Threshold detector for agc loop in rf receiver can handle broadband signals with frequencies of 1 megahertz to 1 gigahertz at slew rates as fast as 1 volt/microsecond. Dual Schottky diodes and high-slew-rate op amp account for circuit's speed. Temperature compensation, from 0°C to 60°C, is provided by diodes D_2 and D_3, while diodes D_4 and D_5 compensate for supply variations of ±6%.



−10-v bias level to 10 v. This overrides any signal condition, forcing the detector's output to go to 8 vdc and forcing the associated attenuator in the agc loop to its maximum attentuation state.

For power levels above the detection threshold, the detector produces 4.2 v at its output per decibel of input power over the operating temperature range of 0°C to 60°C. Less than 0.5 dB of loop dynamic range is consumed by the static offset voltage of the transfer function over the same temperature range.

Moreover, the transfer function remains constant and unaffected by ±6% variations in the supply voltages. Less than 0.3 dB of loop dynamic range is consumed by static offsets in the transfer function for the same supply variations. For signals greater than 2 dB above threshold, the detector slew rate exceeds 1 v/μs. □

Phase comparator for servo loops

by Francis E. Adams
San Bernadino Microwave Society, Corona, Calif.

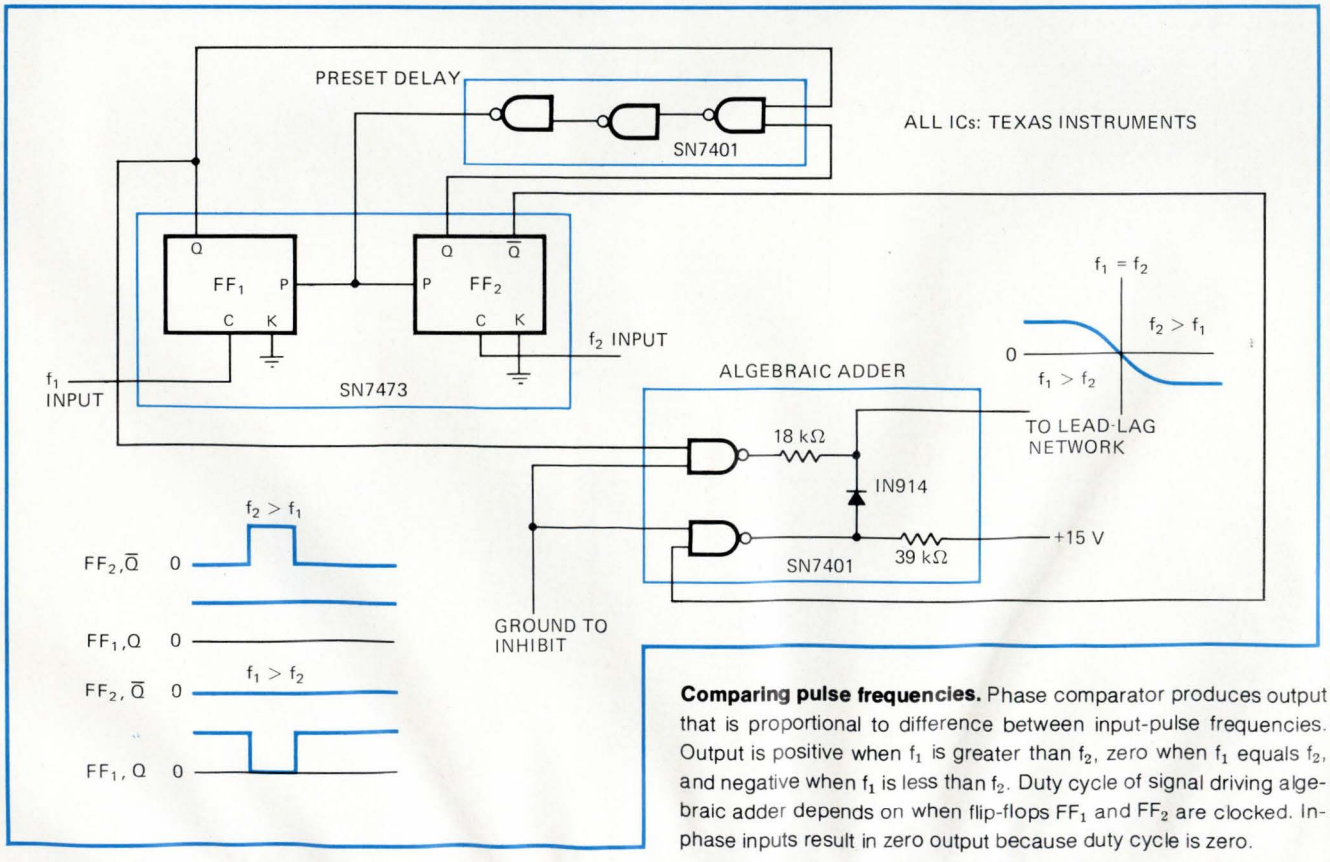
An easy-to-build phase comparator offers a number of advantages for use with dc servo motors and in voltage-controlled-oscillator loops. The output of the comparator is zero for inputs that are in phase, and, unlike the output of discriminators, it remains real, even for extreme differences in the two input-pulse frequencies. Moreover, the circuit, which is composed of low-cost, readily available ICs, can operate at a frequency that is limited only by the type of devices employed.

Both J-K flip-flops, FF_1 and FF_2, are preset so that their Q outputs are at logic 1. After an input pulse at frequency f_1 clocks FF_1 and causes its Q output to become logic 0, and an input pulse at frequency f_2 clocks FF_2 and produces a logic 0 at its Q output, the preset delay containing three NAND gates resets the flip-flops. The propagation delay time of these NAND gates assures that both flip-flops are preset.

The time lapse between FF_1 being clocked and FF_2 being clocked determines the duty cycle of the pulse train seen by the algebraic adder. As input pulse frequencies f_1 and f_2 approach each other, this duty cycle becomes smaller. When the two inputs are in phase ($f_1 = f_2$), the duty cycle is zero, except for a narrow contribution due to the preset time of the NAND gates, which is usually less than 1 microsecond.

If f_1 is greater than f_2, there is a positive output current that is proportional to the phase error. If f_2 is greater than f_1, then there is a negative output current, which is also proportional to the phase error. For $f_1 = f_2$, the output current is zero. □

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



Comparing pulse frequencies. Phase comparator produces output that is proportional to difference between input-pulse frequencies. Output is positive when f_1 is greater than f_2, zero when f_1 equals f_2, and negative when f_1 is less than f_2. Duty cycle of signal driving algebraic adder depends on when flip-flops FF_1 and FF_2 are clocked. In-phase inputs result in zero output because duty cycle is zero.

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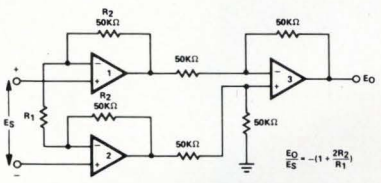

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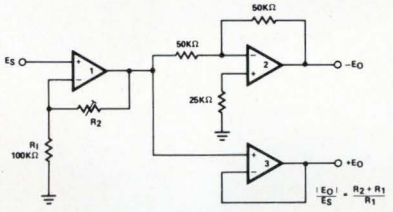
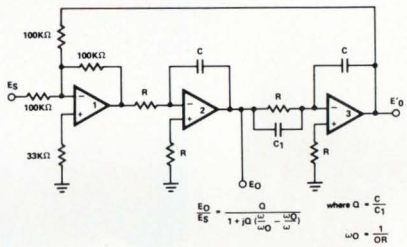


Precision phase splitter with good gain, high input impedance, low output impedance.



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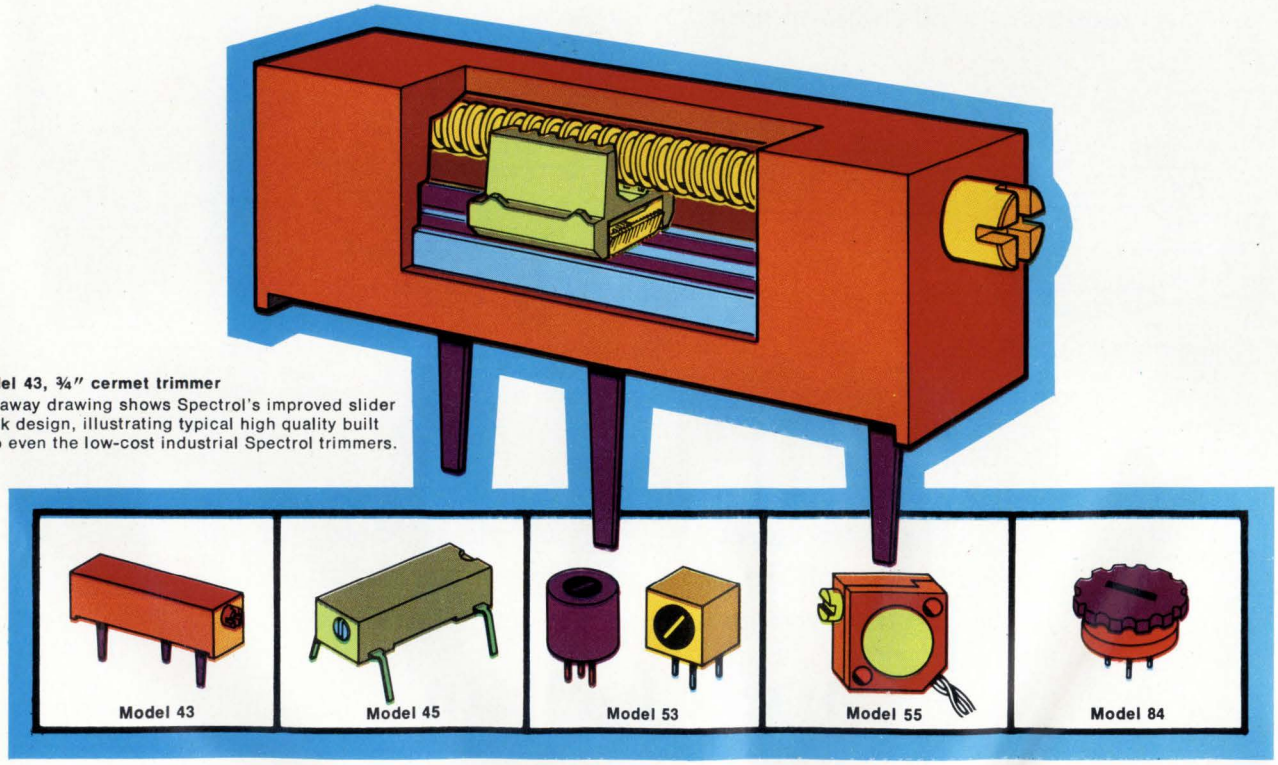

Model 43, ¾" cermet trimmer
Cut-away drawing shows Spectrol's improved slider block design, illustrating typical high quality built in to even the low-cost industrial Spectrol trimmers.

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Estimating substrate area and density for hybrid microcircuits

by Lyle F. Pittroff
Helipot Division, Beckman Instruments Inc., Fullerton, Calif.

When converting discrete circuits to their hybrid counterparts, the engineer usually must face either of two basic questions: how much substrate area will be needed to accommodate the circuits, or will it fit when the package and circuit designs have been finalized before the inquiry or layout-design phase? What's needed is a shortcut technique for easily estimating substrate area and determining component density so that at least you know you're in the right ball park. A technique that Beckman Instruments calls the unit system not only answers these questions, but, in addition, provides a yardstick for estimating yield factors in high-density applications.

The unit system consists of assigning a number of units of area to each circuit component and then adding up the total number of units to determine the required area. One unit is defined as the substrate area required for one general-purpose, thick-film resistor, rated at 100 milliwatts after trimming to ±2% tolerance. The table shows the number of units normally allocated for other types of conventional circuit elements. In each case, the number of units specified includes whatever additional area is required for terminations, resistor trimming, wire-bonding pads, and spacing between adjacent components.

If the circuit has been defined, but the package has not been chosen, the substrate area can be estimated. Start with an optimum one-unit resistor area of 0.015 square inches. Assign the proper number of units to each component in the circuit, according to the table, and total the number of units for the circuit. Determine the substrate area required as follows:

$A_s = (0.015 \text{ in.}^2)\, U_T$

where A_s is the required substrate area, and U_T is the total number of units. A potential package choice, based on available substrate area, can then be made from the many different styles available.

When the circuit and package designs are both firm, the component density in square inches per unit can be estimated. Add up the total number of units for the circuit, according to the table. Determine the available substrate area in the package size you intend to use. Calculate the component density as follows:

$D = A_s / U_T$

A component density of 0.015 in.^{2}/unit is considered a moderate density level if the supplier of your final package has the freedom to make pin assignments. Using more specialized fine-line screening techniques, densities to 0.006 in.^{2}/unit have been achieved. Note that component density is appraised in area per unit, instead of units per area. Area per unit is more directly correlated to layout dimensioning.

Some components require special consideration because of their large size or an unusually large number of leads. Since the unit system is strictly a shortcut method, a considerable amount of good judgment and common sense must be applied. The following general guidelines should be considered:

- It may be easier to deduct the area required for large capacitor chips before applying the unit system.
- High component densities are easier to achieve in smaller packages because of proximity to pins.
- Some circuits naturally flow from input to output without complex feedback interconnections.
- Packaging efficiency is usually greater in larger hybrid packages, but yield and testing help set the limit. □

TYPICAL UNIT SYSTEM COMPONENT AREAS

Component type	Units per component
RESISTORS (CERMET, THICK FILM)	
General purpose (up to 100 mW)	1.0 units
Precision, ratio tracking aspect ratio ≤ 4:1, ≤ ±1%	2.0 units
CAPACITORS	
Screened (cermet)	270 pF/unit
Chip capacitors 0.1" x 0.1"	2.0 units
DIODES, PASSIVATED CHIP	
Signal/switching	0.5 units
Zener/reference	0.5 units
Schottky/hot carrier	0.5 units
TRANSISTORS, PASSIVATED CHIP	
Bipolar small signal	0.5 units
Bipolar low/medium power	1.0 units
JFET	0.5 units
INTEGRATED CIRCUITS, PASSIVATED	
Linear (741, 710, 107, etc.)	2.0 units
Digital (935, 946, 7400, etc.)	4.0 units
MOS arrays (3101, etc.)	0.5 units/lead
MSI devices (74145, etc.)	0.5 units/lead

For metric-system applications, the unit system can be used as shown, except that the one-unit resistor area becomes 9,677 square millimeters.

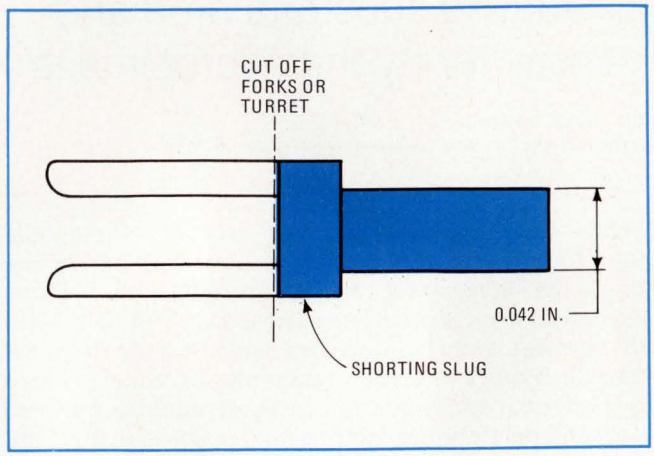
Make your own small switches for pc boards

by Ralph Wilbur
West Engineering Co., Santa Monica, Calif.

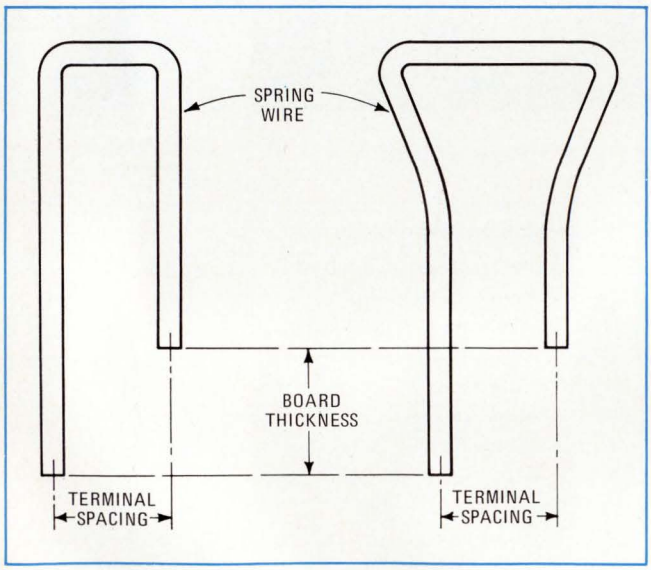
Testing and troubleshooting both breadboard and production circuit boards can often be simplified by permanently installing good-quality switches on the boards at strategic locations. Such switches, inexpensive and simple to make, take up little room on the boards. To build them, you'll need only a few standard terminals and a piece of spring wire.

A single-pole double-throw switch is constructed on prepunched or drilled circuit board by using five standard hollow gold-plated staked terminals and a section of spring wire. Four of the terminals are arranged in a square (say, 0.042-inch centers) and staked to a board. A piece of spring wire is then bent into an appropriate loop (see Fig. 1). A fifth terminal is trimmed to the base, as shown in Fig. 2, and sleeved over the short end of the spring wire. The long end of the wire is then inserted into one of the staked terminals and soldered into place. This becomes the shorting slug.

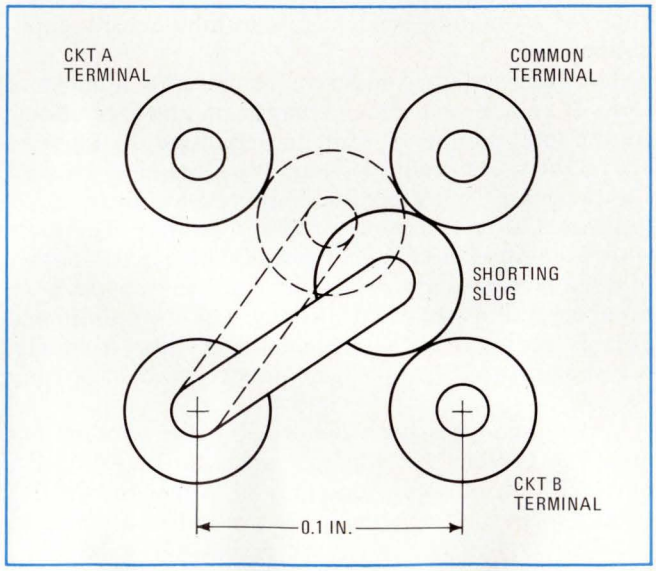
The result of all this is a movable shorting slug spring-loaded against two other adjacent terminal bases. Twisting or pushing the wire loop causes the shorting slug to snap into the detent formed by the other adjacent terminal base (Fig. 3). Connections can be made from either side of the board to wire or etched connectors. □



2. Shorting slug. Any type of hollow terminal will do, since only the bottom is used; gold plating stands up quite well.



1. Shaping up. The shape of the spring wire is less important than the terminal-spacing and board-thickness dimensions.



3. Small switch. Pushing the spring-loaded wire loop moves the shorting slug from one set of terminals to the other set.

Building timing circuits for noisy environments

by T.C. Matty
Transportation Division, Westinghouse Electric Corp., Pittsburgh, Pa.

It's true that it's easy to use pre-packaged one-shot circuits for timing and time-delay tasks, but be prepared to cope with problems ranging from excessive charging current to false triggering from external noise. This type of circuit is susceptible to false triggering because of its high gain and use of positive feedback. However, two extensively used circuits have an inherent noise immunity—the capacitor dump timer and the digital monostable.

The capacitor dump circuit (Fig. 1) is useful where low cost and moderate accuracy is important, but where external-frequency or clocking sources are not available. Noise immunity is achieved by discharging the energy stored by the timing capacitor through the input transistor. This makes the input requirements depend

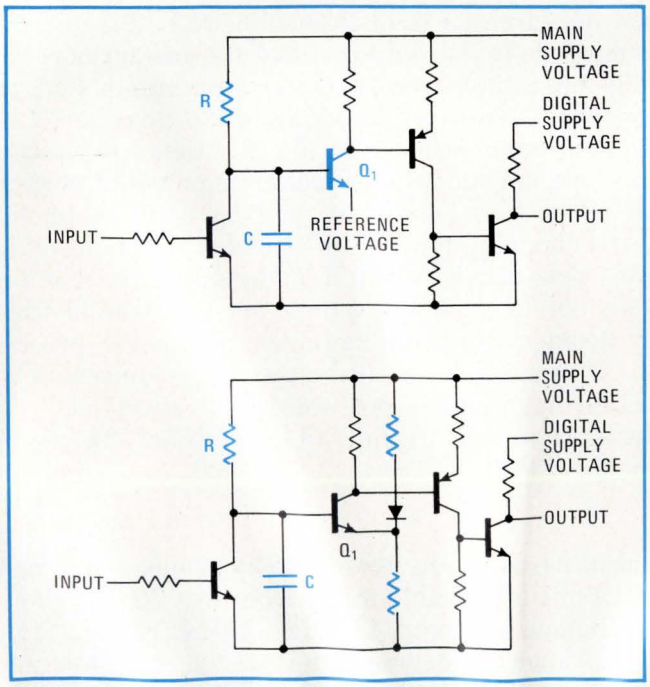
on the energy stored in the capacitor, as well as the input-transistor characteristics. Moreover, the RC timing circuit forms an inherent low-pass filter that further rejects noise signals.

Timing of up to 1 minute is possible with this circuit. Timing accuracy depends on several factors: the RC product, the relative variations of the reference voltage and supply voltage, and the level-sensing transistor Q_1. But since the sense transistor is reverse-biased during the timing period, its effect is negligible. Of course, a small amount of leakage current (about 10 nanoamperes) flows, but that in most cases can be neglected.

However, when a zener diode is used for the reference voltage, a resistor should be inserted in either the base or emitter circuit of the sense transistor to prevent excessive zener current from affecting the timing accuracy.

This circuit can be improved by eliminating the zener and using a resistive divider network as the reference voltage. This now establishes the decision point as the ratio between the timing RC and the resistor network. And adding a diode in the base or emitter circuit of the sense amplifier will compensate the circuit for most temperature effects. With these additions, the timing function becomes independent of the supply voltages. The timing accuracy depends only on the difference between the base-emitter turn-on voltage of Q_1 and the diode voltage drop. It's therefore important that the diode be chosen so that its characteristics match the base-emitter characteristics of the sense transistor. And, if the accuracy must be maintained over a wide temperature range, these characteristics also should track over that range.

This type of circuit has been tested over a 100°C change in temperature with less than a 2.5% total change in timing. For the diode-compensated case, the output time is equal to 0.7 RC; when no diode compensation is used, the base-emitter voltage of 0.5 V is added, and the output time will increase by the ratio of the base-emitter voltage drop to supply voltage.



1. Good noise immunity. Capacitor dump circuit gives moderate accuracy without external clocking; improved version uses divider.

Another approach that provides high noise immunity and accurate timing, if clocking frequencies are available, is the digital monostable circuit. The circuit (Fig. 2) can provide an output pulse duration of one clock period for every low-to-high input transition. Another feature of this circuit is that its output will have a width of a full clock pulse or no output at all. This feature virtually eliminates outputs caused by noise of false inputs because an output is generated only when an input is coincident with the transition of the clock line. Thus, if the clock input frequency is selected to be the lowest available or allowed by the system, the probability of coincidence between a clock-line transition and input is reduced (assuming that false inputs are random).

For example, if a Poisson distribution is assumed for noise inputs of sufficient amplitude and width to enable an input, then the average rate of coincidence is:

$$P = \lambda\tau \exp(-\lambda\tau)$$

As the clock-pulse width τ is reduced, the probability is also reduced and in the limiting case goes to zero. If τ is taken as 100 ns (the rise time of the clock) and λ as unity (the average rate of noise inputs), then P can be calculated.

$$P = 10^{-7} \exp(-1 \times 10^{-7})$$
$$= 10^{-7} \times 0.999999$$
$$= 10^{-7}$$

The calculated value for P is for the probability of coincidence between the random input and the edge of the clock input. There are, however, f edges per second (equal to the clock frequency), and this gives f chances per second for coincidence to occur. Therefore, the improvement in noise immunity is found by multiplying the probability of occurrence and the rate at which it might occur to give true probability, or rate R.

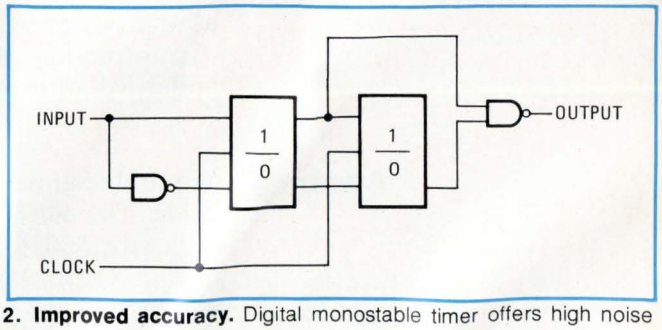
$$R = fp$$

If, for instance, an enabling noise pulse occurs once per second, then a standard monostable will generate a false output once per second. Using a digital monostable with the same noise input, a clock input of 1 kilohertz and a rise time of 100 ns, a false output will occur at the following rate:

$$R = 10^3 \times 10^{-7}$$
$$= 10^{-4} \text{ false outputs/s}$$

This is an improvement of 10^4, or an 80-dB improvement in signal-to-noise ratio. □

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



2. Improved accuracy. Digital monostable timer offers high noise immunity with improved accuracy, but needs clocking frequencies.

Engineer's newsletter

First semiconductor fuse handbook published

Incorrect fuse specifications can mean damage to semiconductors or equipment and lead to excessive costs. To help avoid such woes, International Rectifier Corp. has published what it says is the **first semiconductor-fuse applications handbook.** The company's applications engineers put together the 100-page book because they spend a great deal of time testing and researching fuses and talking to customers about fuse spec problems.

The four chapters cover fast-acting fuses, fuse characteristics, coordinating fuses with semiconductors, and applications. An appendix includes definitions and examples of fuse protection for external and internal faults. For a copy of the handbook, designated HB-50, write on your company letterhead to International Rectifier Corp., Semiconductor division, 233 Kansas St., El Segundo, Calif. 90245.

H-P shows how system can plot time-share results

Users of time-share programs who have been forced to plot results manually can now have an easier time of it. An HPPLOT User's Manual from Hewlett-Packard **shows how easily a time-share system can be commanded to plot point or line graphs, or even step or bar charts.** HPPLOT itself is a software program available to users of General Electric and Hewlett-Packard 2000 time-sharing systems.

The 22-page booklet is written for the terminal that's equipped with an X-Y plotter, **but should be interesting to anyone who plots computer output manually.** It lists commands, instructions, and sample plots. The publication is available from Hewlett-Packard at 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Inselek offers do-it-yourself SOS kit

If you are curious enough about silicon-on-sapphire ICs to wish to build your own, then the Inselek Co. of Princeton, N.J., has just the thing for you. **It's a novel do-it-yourself kit called the Instant SOS Kit that costs only $1,950**—the estimated cost of one man-month's effort, says David Dumin, manager of the company's Materials division.

The kit is designed to give engineers hands-on experience in designing and manufacturing SOS circuits **without redirecting a major portion of their development effort,** says Dumin. It includes a set of photomasks, instructions, and enough p-type and n-type SOS wafers to build p-channel, n-channel, deep-depletion, and complementary circuits right on present production lines. Dumin points out that "the instructions are sufficiently detailed to enable engineers to use the process directly as described, or to modify it to fit their existing equipment so as to produce SOS devices right in their own wafer-fabrication line."

Information on the kit is available from Dumin at Inselek, 743 Alexander Rd., Princeton, N.J. 08540.

Addenda

Motorola Semiconductor has issued its **new MECL handbook and design guide.** The 466-page volume is available for $2 from Box 20924, Phoenix, Ariz. 85036. . . . Signetics Memory Systems, 740 Kifer Rd., Sunnyvale, Calif. 94086, has issued a leaflet setting out the economic advantages of microprograming. Signetics maintains that a single 4,096-bit ROM can potentially save 2.5 cents per bit.

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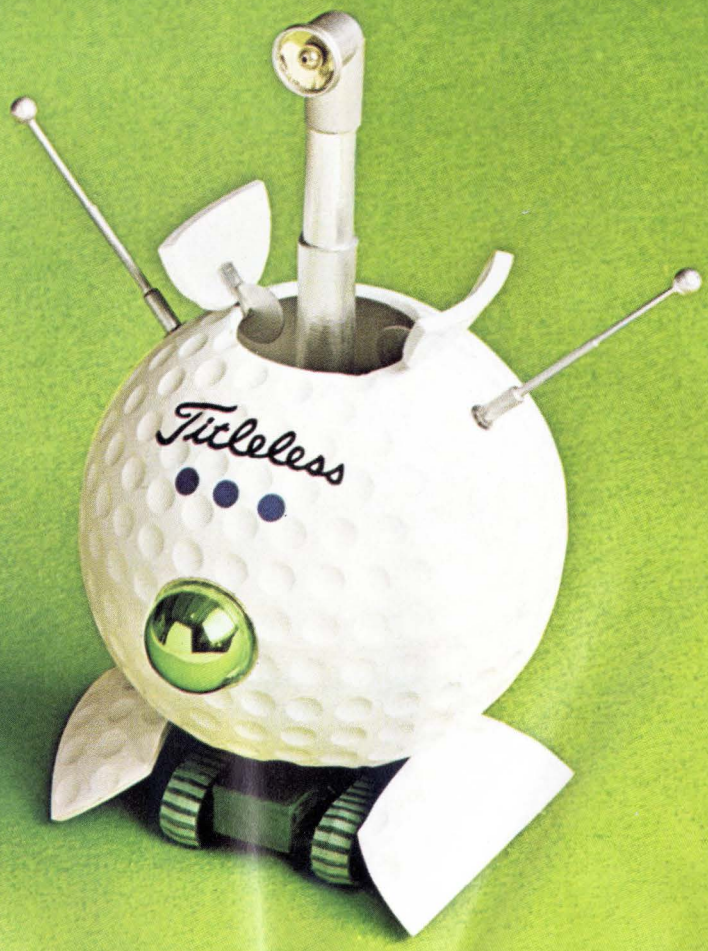

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Word generator is fast and flexible

As core of semiconductor test system, microprogramable unit can exercise memories with cycle times as fast as 10 nanoseconds

by James Brinton, Boston bureau manager

"There's no prepackaged answer to the semiconductor memory test problem—it's different for every customer. That's why we are concentrating on boxes that will make it possible to solve the divergent problems users have, rather than going all out for systems."

The speaker is John Connolly, president of Tau-tron Inc., Lowell, Mass. The company's newest "box" is a word generator, a microprogramable device capable of exercising memories that have cycle times as fast as 10 to 12 nanoseconds. System makers, either end-users or OEMs, could use the WG-304A as the core of a sophisticated system, either with or without computer control, but with none of the speed penalties so often found in computer-controlled systems.

The WG-304A runs in a variety of modes. At its simplest, it puts out repeated strings of 64 binary words 16 bits wide. At its most complex, it either can repeat, through microprogram control, a specified test series as often as the user desires, or it can generate data at an effective word rate of about 150 megahertz.

The WG-304A is more than a "building block." It is designed around two large read/write ECL memories to supply test-data, address, and microprogram storage. The system also contains a complex of control logic, clock generation and control, and other electronics.

Core of system. To build a test system around the WG-304A, it is necessary only to add appropriate format-conversion circuitry (although output is already TTL-compatible) and a test jig. However, because of its speed, it is almost sure to find its way into computer-controlled applications. Computer control will not only enable the device to live up to its throughput potential, but also speed up the process of loading data test words and microprogram instructions when necessary. But, as opposed to other computerized systems, there will be no slowdown with a computer because the WG-304A uses its own ECL memory to store and generate test routines, rather than having to depend upon the generally slower CPU/memory combinations often employed in such applications.

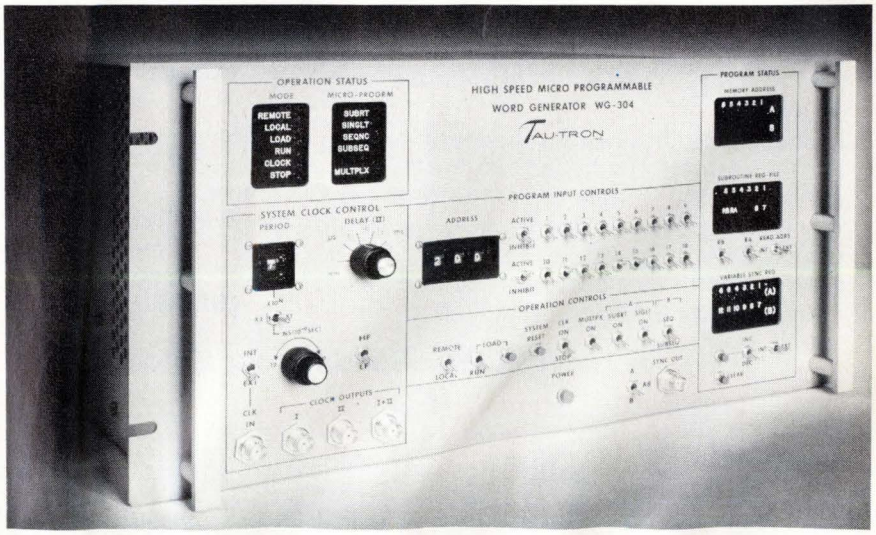
At liberty. Thus, while the user has complete freedom to structure the test sequence and the words within it, using either the WG-304A's front-panel toggles or a computer to load this information into the machine, the only speed limit is imposed by the fast ECL RAMs.

These RAMs, the heart of the system, have a total capacity of 2,176 bits. Divided into two storage matrixes, they are organized as 18 by 64 bits for the so-called A matrix and 16 by 64 bits for the B matrix. Both store 16-bit data-test words, but in the A matrix, two of the 18-bit locations are reserved for microcoded instructions.

The A matrix runs in either a "normal" or "subroutine" mode. In the normal mode, it cycles through its 64 data-test words over and over. But in the subroutine-controlled mode, it cycles selected words or strings of words as tagged by the control bits and the contents of a start-address register.

In its normal mode, the B matrix follows the output of the A matrix and is controlled by its address register, thus potentially yielding 128 test words in sequence. The progression of addresses is similar to the A matrix's normal mode of operation. But in "sequential" operation, the B

Memory exerciser. Under microprogram control, high-speed word generator can perform a variety of checkout procedures as the heart of a system for testing semiconductor memories.



New products

matrix cycles from its first to its 64th word at a rate controlled by the A matrix's stored commands.

Stop and return. The microprograming in the A matrix's storage locations is simple, with one of the two control bits acting as a stop call, halting the progression of output words and causing the matrix to return to a preprogramed start address. The second control bit acts as an increment command to the address controller of the B matrix.

And by adding this, Tau-tron engineers have made it possible not only to use the contents of the B matrix as part of the test routine, but also to use the B matrix as a storage location for the various addresses to be selected in the device under test.

In still another mode of operation, the basic system clock is delayed, superimposed upon itself to form a two-phase signal, and used to control a multiplexing operation in which the outputs of the two registers are interleaved—one from A, one from B, and so on. In this multiplexed mode, the highest outputs are possible: normal clock range is from 1 to 80 MHz.

Get set. The starting place in any given test routine is set by loading the start-address register (eight bits) and the sync-position register (12 bits) either from the front-panel controls or by remote binary computer input. Changing the content of the address register changes the test-start address and allows the user a wide variety of test sequences, alterable in real time.

Some users may wish to repeat an event several thousand times in succession. This is accomplished by loading the desired data word(s), address register content, and microinstruction. To simplify high-speed data collection, the WG-304A has a front-panel output that can arm a sampling scope or other instrument. Again, there's no speed penalty.

There will be variations of the WG-304A with larger, and perhaps smaller, data-storage matrixes. The line should span a price range from $12,000 to $25,000.

Tau-tron Inc., 685 Lawrence St., Lowell, Mass. 01852 [338]

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It's nothing unusual. Our various agents overseas, including Tekelec Airtronic of France, represent a very interesting line of Function Generators. The IEC Series 30. Four of the most advanced-concept test instruments available in the Free World. Designed to fit the exact needs of our customers, whether here or abroad. And priced from $295 to $495 to provide the most for the money. Take the IEC F34 (illustrated) for example. At $495, it does everything an oscillator can do and then some! Square waves and triangles, voltage offset, sweep, trigger, gate and pulse. Plus better sine wave purity than comparably-priced oscillators. The F34, like all Series 30 models, provides extra-special features that make it a bargain. Together with such inherent quality that we boast one of the industry's lowest "returned for repair" rates.

It may not require a 747 delivery to fulfill your need, but you can depend on IEC to deliver your new Series 30 Function Generator on time. Our John Norburg is ready to answer your questions. Contact him now. Get complete technical data by same-day mail.

IEC F34 Function Generator

SERIES 30 HIGHLIGHTS **F34: ($495)** — *Frequency Range:* 0.03 Hz to 3 MHz. *Waveforms:* Sine, square, triangle, dc, pulse. *Output Amplitude:* 10 mv pp to 10 v pp into 50Ω. *Sine Distortion:* <0.3% up to 30 kHz, <0.5% to 300 kHz, <2% to 3 MHz. *Rise/Fall Times:* <60 ns. *Offset:* ±5 v into 50Ω. *VCG Range:* >1000:1. *Operating Modes:* Continuous, Triggered, Gated, Tone Burst, Continuous Sweep, Triggered Sweep. *Sweep Width:* up to 1000:1. Set width directly on tuning dial. *Sweep Time:* 10μsec to 100 sec. *Other Features:* Voltage Analog of Frequency, Sync Input, Output Limit Indicator, plug-in IC's. **F33: ($395)** —Same as F34, but without Sweep, Tone Burst and Voltage Analog of Frequency. **F32: ($345)** — Same as F33, but without Pulse, Trigger and Gate Modes and Sync Input. **F31: ($295)** — Same as F32, but without VCG and Output Limit Indicator. Output Amplitude is 100 mv pp to 10 v pp into 50Ω.

IEC

INTERSTATE ELECTRONICS CORPORATION *A Subsidiary of* A-T-O Inc. Dept. 7000, Box 3117, Anaheim, Cal. 92803
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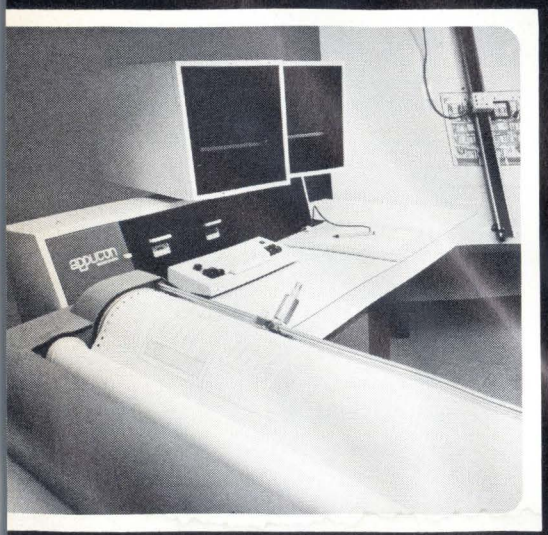
Circle 119 on reader service card.

Our $90,000 Applicon graphic system could save you $90,000 a year.



This is Applicon, the modern, computerized system that processes graphic data much the same way a computer system processes business data.

Applicon costs about $90,000 installed.

Yet you can realize savings equal to or exceeding the cost of the machine in a matter of months—thanks to Applicon's unique ability to speed drafting procedures and reduce turnaround times. Here's why:

Applicon data processing graphic systems handle input, storage, manipulation and output of drawn lines fed into its computer. They come with a full range of ready-to-use hardware and software. Fully compatible with conventional operations, they accept drawings and permit productive interaction by the designer or draftsman. Applicon produces drawings consistent with normal drafting conventions and is compatible with work flow methods. Graphics are produced *faster, more accurately* and at *less cost!*

To discover how much Applicon can save your company, write for the Management Guide to New Graphic Processing Methods to Applicon Inc., 22 Third Avenue, Burlington, Mass. 01803. Or, call this number: (617) 272-7070.

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Circle 120 on reader service card

Subassemblies

Standard uses rubidium cell

Atomic frequency reference built for communications, navigation, ranging systems

Regardless of its sophistication, a frequency standard, doppler radar system, or navigation aid is only as good as its own basic frequency reference. Now the prices of atomic frequency standards have fallen far enough, and their size has grown small enough for them to be able to compete with the less accurate crystal standards in military and industrial applications.

Frequency & Time Systems Inc., Danvers, Mass., is marketing a rubidium atomic frequency standard, the model FRK, that is packaged as a cube about 4 inches on a side and is priced at $5,500. Its 10-megahertz output is accurate to less than one part in 10^{-10} per month, long-term, and to less than five parts in 10^{-11} short-term. It maintains accuracy to within one part in 10^{-9} over an operating temperature range of -25°C to +65°C.

The FRK is designed for direct installation as a subassembly in time standards, high-performance communications systems, time-interval generators, radio navigation systems like Loran or Omega, and precise ranging systems. Radar applications hold promise, since in some systems the FRK could replace and improve upon the performance of stable local oscillators, complex arrangements of crystals, tuned cavity mounts, and ovens.

A rubidium vapor cell in the FRK helps to generate a servo signal, which in turn controls a crystal oscillator's output. Rf energy derived from the crystal is applied to the rubidium vapor, and light from a rubidium spectral lamp also passes through the cell, hitting a photodetector. This light is absorbed when the oscillator frequency matches the atomic resonant frequency of the rubidium. Thus, the photodetector generates an error signal to keep the crystal on the beam automatically. The standard weighs only 2.9 pounds and consumes only about 25 watts. A benchtop standard, the FRT, offers four frequencies—10, 5, 1, and 0.1 megahertz—with accuracy, stability, and spectral purity equal to or better than that of the FRK. It sells for $6,750.

Frequency Time Systems Inc, 182 Conant St., Danvers, Mass. 01923 [381]

Power transformers aimed at printed-circuit applications

Miniature plug-in power transformers, available in sizes from 1 to 24 VA, are specifically designed for printed-circuit applications and are available in open-frame or epoxy-molded versions. The units are offered with either a single 115-V primary or dual 115-V/230-V primary.

Signal Transformer Co. Inc., 1 Junius St., Brooklyn, N.Y. 11212 [389]

Gas-discharge displays interface with MOS LSI

Eight seven-segment planar gas-discharge displays are designed to interface with MOS LSI circuitry. The units are suited for dc or multiplexed applications with or without blanked zeros. Models in the SP-330 series are ⅓-inch versions, and in the SP-350 series they measure ½ inch. Both series reduce anode voltage, cathode current, and blanking requirements.

Sperry Information Displays, P.O. Box 3579, Scottsdale, Ariz. 85257 [339]

Audio low-pass filters provide sharp attenuation

A series of passive low-pass filters called the VSA-50 covers 300 to 1,000 Hz at the 3.0-dB attenuation point. Cutoff permits 50-dB attenuation 50 Hz from the cutoff frequency. The series VSA-100 covers 1.1 kHz to 3 kHz at the 3.0-dB cutoff point with 50-dB attenuation 100 Hz from the cutoff frequency. Impedance is 600 ohms in and out, and it can be supplied as balanced or unbalanced. Price is $160 in 100-lots.

Conolog Corp., 5 Columbia Rd., Somerville, N.J. 08876 [390]

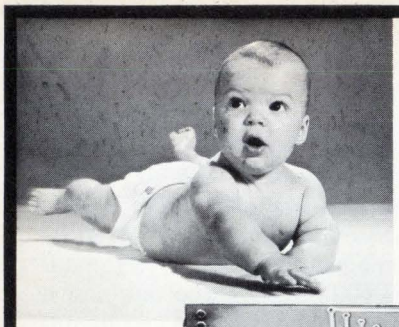
Digital-to-analog converter settles in 50 nanoseconds

The DAC395-12A high-speed digital-to-analog converter is aimed at uses in CRT and graphic display systems. The current-output unit settles in less than 50 nanoseconds and has 12-bit resolution. To assure that the speed is realized, the output current is 5 mA and directly drives coaxial cables. By terminating the cable, an output voltage of up to +1.25 V can be achieved, minimizing the effects of stray capacitance and noise. Linearity is to within half the least significant bit (±0.0125%).

Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. [383]

Detector-preamplifier is also a video amplifier

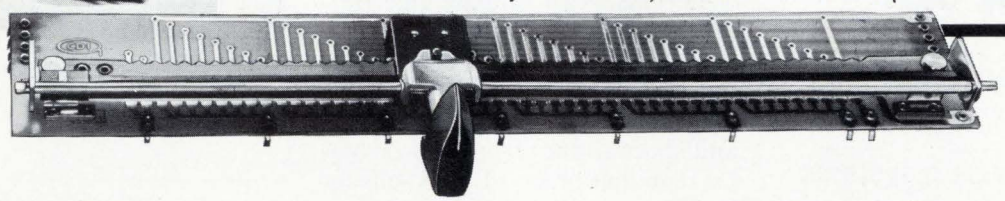
Packaged in a dual in-line configuration, an integral photodetector, low-noise preamplifier, and video amplifier is designated the model DDV325. The unit is designed for applications where only avalanche photodiode modules have been previously used. Radiant power of 10 nW at 905 nm incident on a 118-by-59-mil silicon photodetector results in an output signal of 10 mV over a



Beautiful New Babies

BOTH TRULY REMARKABLE

CDI's New Baby: Series SL, Linear Slide Switch (Pat. Pending)



REMARKABLE BECAUSE:

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2 Available with solder lugs or dip solder termination for p.c. use.

3 Mounts EITHER left/right OR up/down (versatile).

4 Single or multiple position selectors.

5 Over 1,000,000 detents life.

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200 megohms min. insulation.
1000 volts min. dielectric strength.
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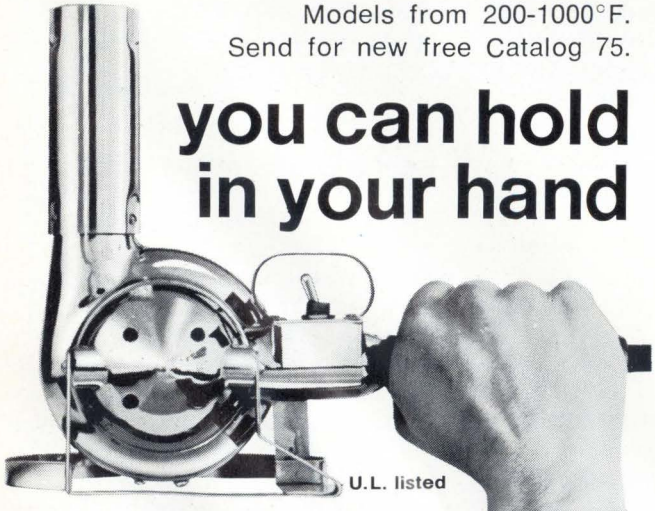

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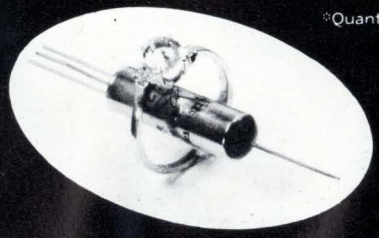
For 29¢* – How Good Can This New Reed Relay Be?

*Quantity of 1 million



DAMN GOOD!

Our new 1A Series offers Mil Q 9858A specs at the lowest commercial prices: Hermetically sealed coils —Magnetically shielded for high density packing— Switches 1 amp or 250V @ 20 watts — Coil voltages of 1, 3, 5, 6, 10, 12, & 24 volts—Contact resistance less than 100 milliohms — Micro size .275" OD x .950" long.

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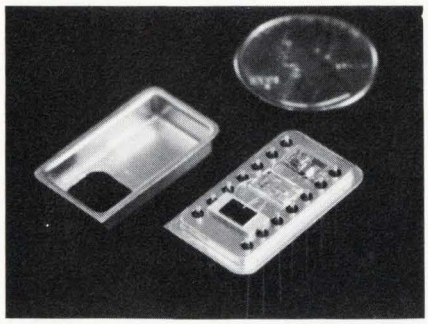
Circle 158 on reader service card

New products

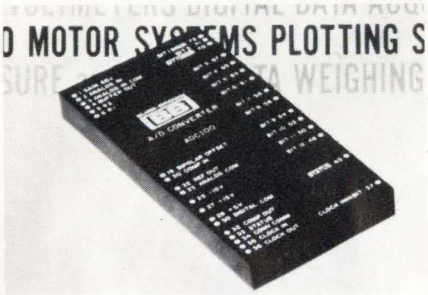
10-mHz bandwidth. Rms noise voltage is less than 5 millivolts over the bandwidth of the device. Price is



$190 for one to nine units.
Meret Inc., 1815 24th St., Santa Monica, Calif. 90404 [384]

Integrating a-d converter offers high resolution

The ADC100 a-d converter is designed for use in industrial process control, data logging, and high-accuracy instrument applications. Maximum linearity error is 0.005%, and maximum drift is as low as 5 ppm/°C. The unit is available with



BCD or binary coding and unipolar or bipolar inputs. The binary units have user-selectable resolutions of 12, 14, or 16 bits, and the BCD units are available with four-digit or four-digit-plus-sign coding. Price is $225 in quantities of one to nine.
Burr-Brown Research Corp., International Airport, Industrial Park, Tucson, Ariz. [385]

Power supplies designed in card-cage configuration

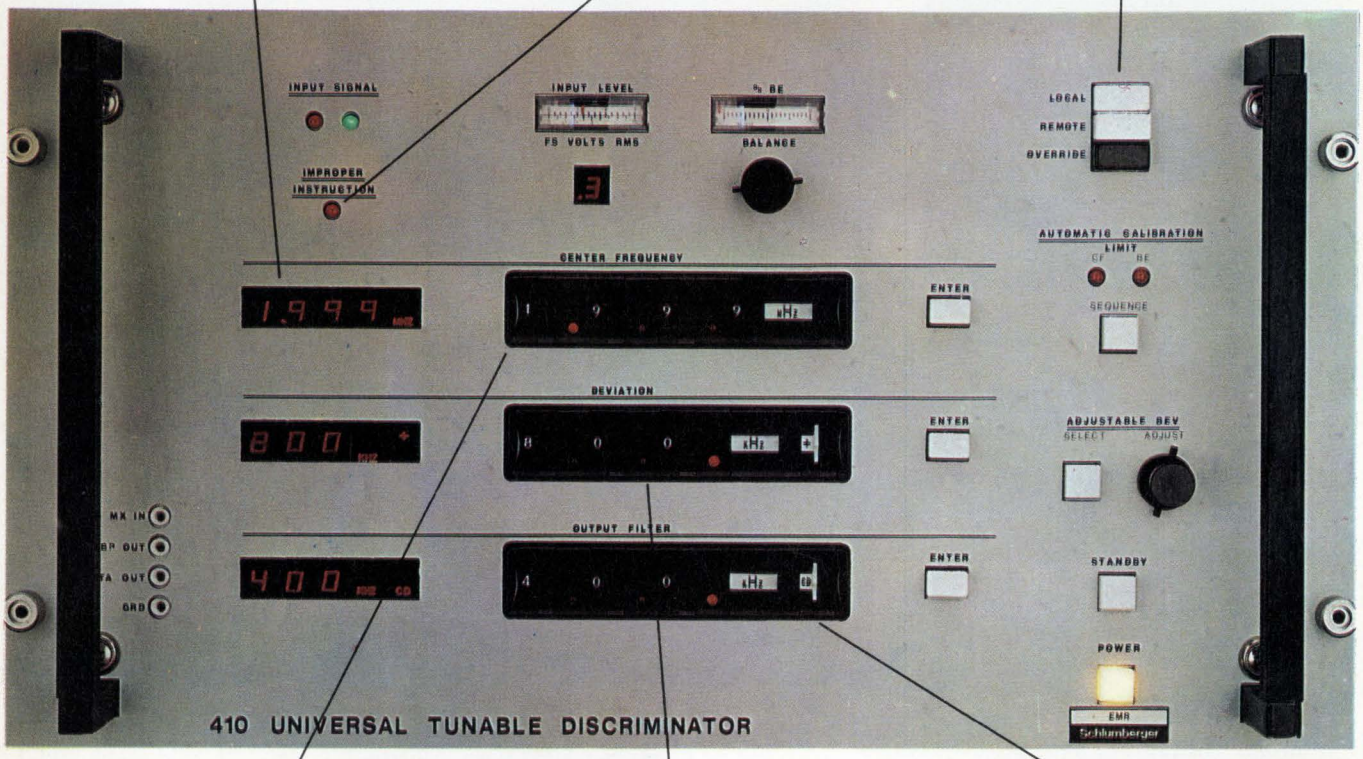
Designed to provide engineers with flexibility in determining power requirements in prototype work, the

2,000,000,000 DISCRIMINATORS

Stored operating instructions always displayed

You can't fool it . . . it flags bad instructions

Program from front panel or computer: or override computer



Select any center frequency; 200 Hz - 2 MHz

Select any deviation; ±1% - ±40%

Select any data cutoff; 1 Hz - 400 kHz, CA/CD

...IN JUST ONE UNIT!

EMR's new UTD (Universal Tunable Discriminator) can be tuned by computer or front panel control to demodulate virtually any FM data signal. With over 2 billion different settings, the UTD can accommodate all standard IRIG channels, multiples thereof and just about any "odd ball" channel you can name. Find out how the UTD combines this flexibility with top performance and ease of maintenance in our EMR 410 UTD Brochure. Or, better yet, call us and ask for your own demonstration. The odds are 2,000,000,000 to 1 that we can handle your FM data.

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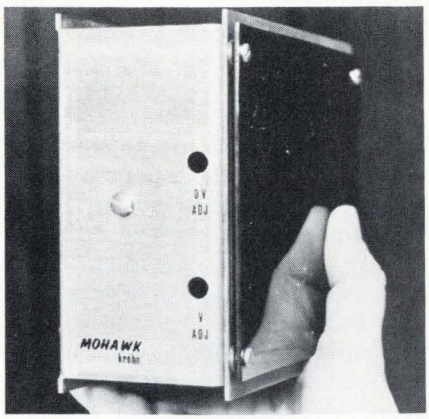
series 3127 power supplies slip into a card cage alongside the circuit boards. This eliminates problems associated with cable routing, installation, and noise. Input voltage is

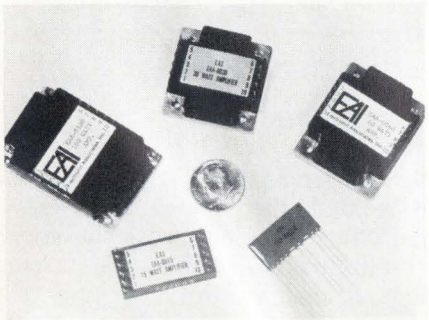


105 to 130 Vac, 50 to 60 Hz, and output voltage is adjustable and floating from 4.4 to 28.6 Vdc. Eleven models are available, and price is $86.

Mohawk Industries Inc., 73 N. Second St., Easton, Pa. 18042 [386]

Audio power amplifiers put out 15-100 watts cw

A family of hybrid audio power amplifiers ranges from 15 watts to 100 W of continuous output power for audio servo drive and low-frequency (less than 50 kilohertz) ap-



plications. The 15-W unit operates from a single 30-V supply while the 30-, 60-, and 100-W amplifiers run on split supplies ranging from ±15 V to ±50 V. All drive output loads carry from 3 to 8 ohms at full power with distortion of less than 0.1% typical.

Electronic Associates Inc., West Long Branch, N.J. 07764 [387]

Instruments

Generator runs off cell 10 hours

Starvation current levels conserve battery power in portable function generator

With portable test equipment becoming increasingly popular, the stress placed on efficient design to conserve battery power has also intensified. The latest, and a good example of engineering for efficiency, is the Krohn-Hite model 5600 function generator. The generator emits sine, square, or triangular waves into full-rated loads for seven to 10 hours. Its nickel-cadmium battery pack recharges overnight.

The designer of the generator and company president, George Hite, emphasized efficiency throughout design. He stayed with class B amplification wherever possible, using emitter-follower outputs. Wherever

possible, he ran subsystems at what were called starvation levels in the days of tube design. The square-wave generator was an exception. He used peak-to-peak swings of 15 volts to achieve rise times of less than 50 nanoseconds over the generator's range of 0.002 hertz to 2 megahertz.

But the starvation current levels don't translate into sloppy performance. Maximum distortion of the sine-wave output is only 0.5%, and more typically is 0.25%. Square waves show total aberration of less than 5%, while triangular waves are linear to 99% up to 200 kHz, and more than 95% to 2 MHz. Nor does frequency response suffer. It is flat to within ±0.1 decibel to 200 kHz and to within ±0.5 dB to 2 MHz.

While it offers a 50-ohm unbalanced output, the 5600 also has a 600-ohm balanced output, which enables the generator to fit applications in telephonics, analog and digital communications testing, and professional audio testing.

Elimination of the ac line during most applications not only pays off in portability, but also in reducing radio frequency interference and removing grounding and ground-loop problems. This, in turn, makes possible applications in vans or aboard ships, where only relatively "dirty" motor-generator power is available. Since the generator is isolated from its chassis, it can be used in low-noise applications like geophysics.

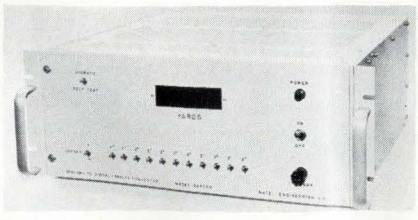
A specification that Hite is especially proud of is the 0°C to +50°C operating temperature range.

Price of the model 5600 is $395, and delivery takes about six weeks. The battery pack costs $70.

The Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass. 02139 [351]

Position indicator offers angular offset capability

A synchro angle-position indicator, designated the model 2X4060, is a display system offering angular offset capability. The five-digit LED

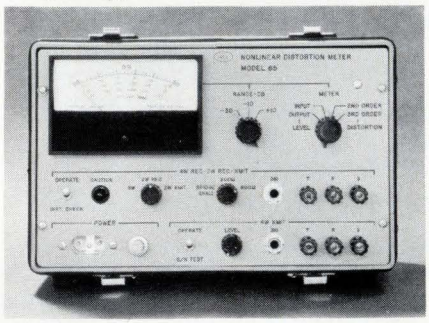


readout displays the synchro angle with an error of ±0.01°, and a digital output is provided for computer or digital recorder use. The system includes power supplies, and angular offset is accomplished by means of toggle switches located on the front panel. Price is $3,700.

Natel Engineering Co., 8944 Mason Ave., Canoga Park, Calif. [354]

Distortion meter is aimed at communications uses

The model 65 nonlinear distortion meter displays amplitude nonlinearity by the measurement of intermodulation distortion. The unit has applications in the communications industry. The model 65 detects and logarithmically displays second- and third-order intermodulation distortion products generated by a dual-frequency, narrow-band psuedo-



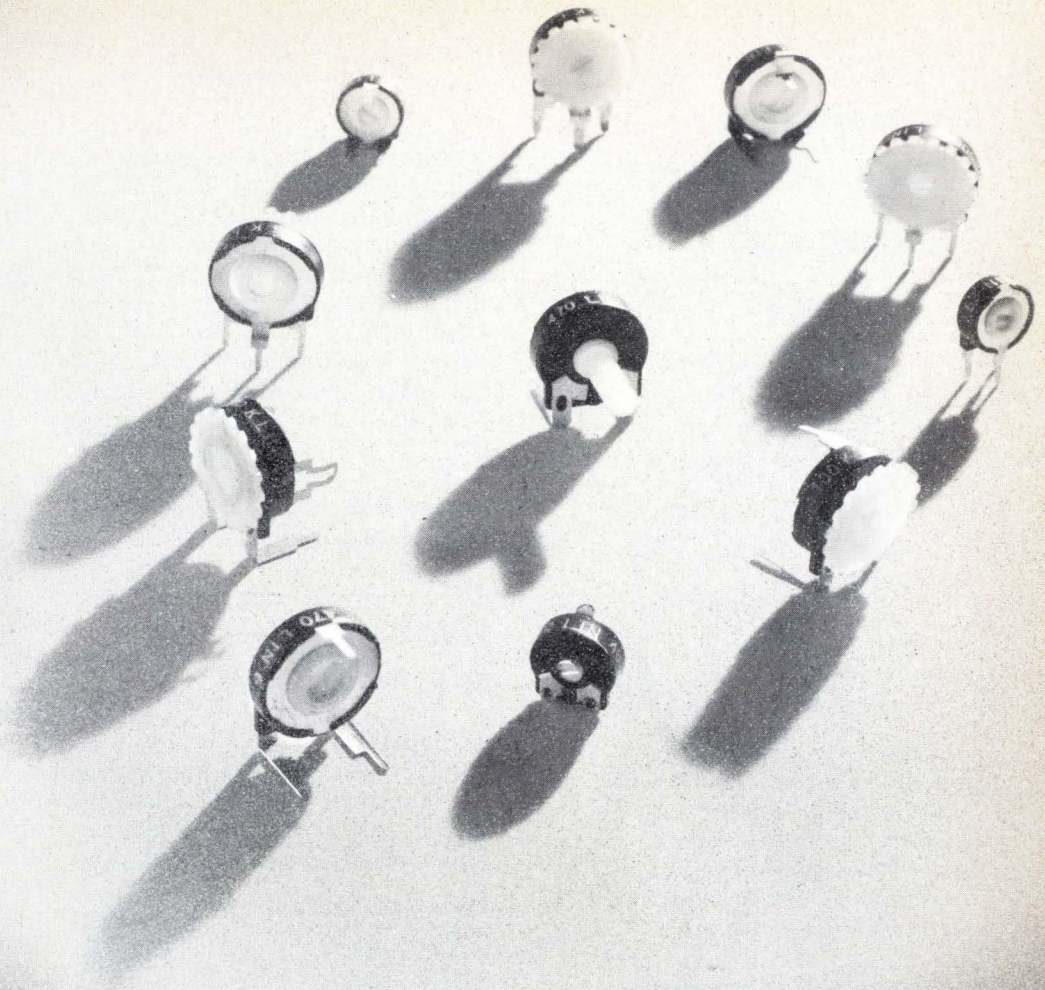
noise signal. Operating over an input range of 0 to 40 dBm, it provides direct distortion readings to better than 50 dB below the input signal level.

Hekimian Laboratories Inc., 322 N. Stonestreet Ave., Rockville, Md. [355]

Distortion analyzer is fully programable

A distortion analyzer-ac voltmeter is designated the model 334A-H25 and offers complete programability on all functions, ranges, and settings. Remote control is by parallel BCD TTL logic. A dc output and an interrogation circuit are included so that an external controller can de-

Way out on their own



There is no competition for Piher trimmer pots. They really *are* ahead of the field.

When you need low-cost, quality encapsulated trimmer potentiometers, you need Piher.

Fully enclosed construction protects the carbon track and wiper against dust, dirt, humidity, moisture and mechanical damage—factors which shorten components life, create open circuits and increase noise. The housing will withstand soldering temperatures up to 320°C, and advanced dual wiper design reduces contact resistance to <1%.

Piher trimmer pots are manufactured with metric or other standard terminals in a comprehensive range which can meet every application. They can be ordered for either horizontal or vertical mounting on P.C.B.'s.

These 10mm and 15mm dia. products (PT.10 and PT.15 Series) are insulated for screwdriver adjustment and are fully interchangeable with those from other manufacturers.

They are flammability test approved to UL-94 standard.

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Circle 127 on reader service card

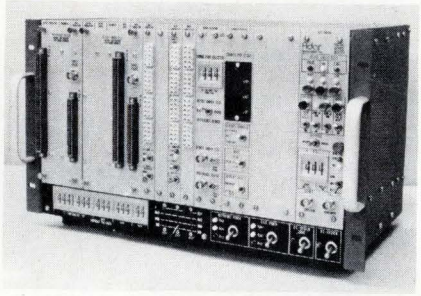
New products

termine the status of the instrument during measurements. The unit can be manually controlled with backlit front-panel pushbuttons. As a distortion analyzer, the instrument measures total harmonic distortion from 0.1% to 100% full scale in seven ranges. As an rms calibrated voltmeter, it measures input levels from 0.3 V rms to 300 V rms full scale in 13 meter ranges. Price is $3,600.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. [359]

Digital device tester is MOS/bipolar-compatible

A digital device tester comes in either a rack-mounted or a desktop version, and will test and debug any digital device from DIPs to modules and cards. The unit performs pass-

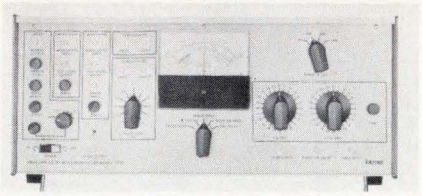


fail tests and also has fault-isolation capability. Other features include MOS/bipolar compatibility, and provisions for attaching loads to the item under test at both input and output.

Adar Associates Inc., 85 Bolton St., Cambridge, Mass. 02140 [358]

Delay-measuring system operates from 0.1 to 10 MHz

An envelope delay-measuring system operates in the range of 0.1 to 10 MHz for video signals, and 25 to 250 MHz for rf signals. The unit contains everything in one package, including a low-harmonic-content sweep generator. Delays are ±30 ns to ±1,000 ns, measured in four ranges, and resolution is 2 ns. Price of the delay-measuring system is



$3,700. Delivery time is 60 days after receipt of order.

Telemet Co., Amityville, N.Y. 11701 [356]

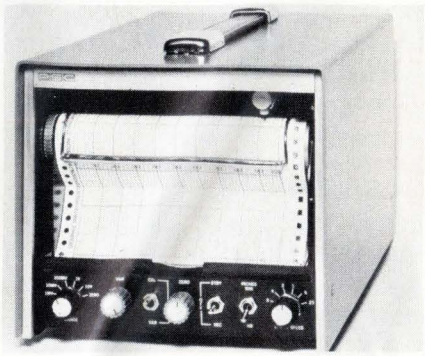
Scope has 2-millivolt sensitivity across 10 MHz

A sensitivity of 2 mV/cm across the full 10-MHz bandwidth plus dual-beam operation are features of the model PM3232 general-purpose oscilloscope. Applications are in telecommunications, television, education, computers and peripherals, and electronic maintenance. The unit also offers universal triggering facilities including automatic level, dc coupling, and automatic TV-line/frame selection. Price is $900.

Test & Measuring Instruments Inc., 224 Duffy Ave., Hicksville, N.Y. 11802 [357]

Strip-chart recorder is accurate to within ±0.5%

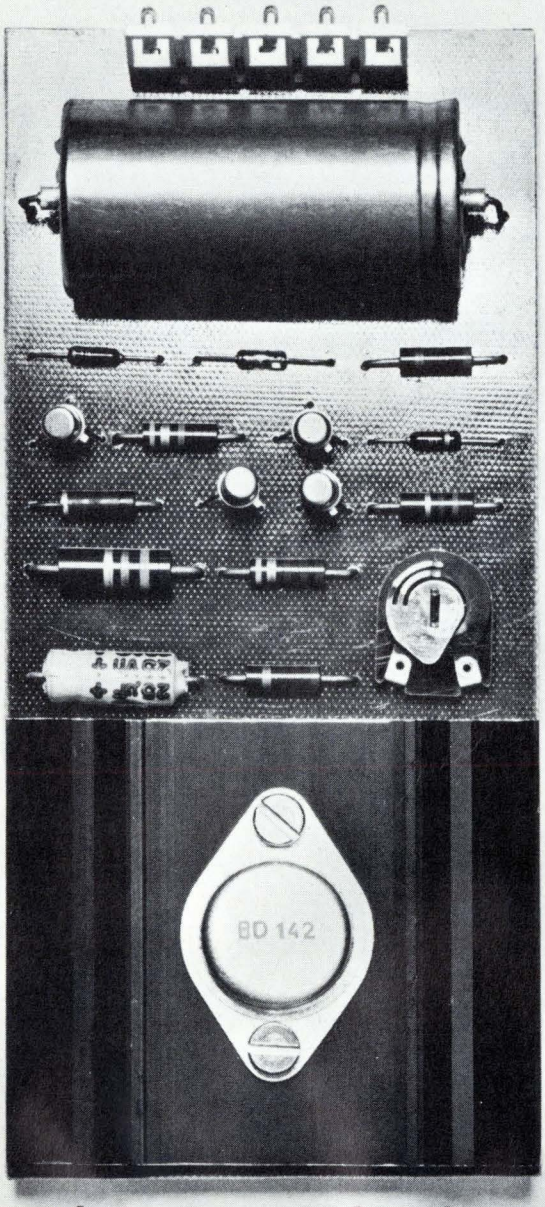
A portable strip-chart recorder, model 714, measures 5 by 6 by 10 inches and uses 4-inch calibrated grid chart paper in 24-foot rolls. The recorder is accurate to within 0.5%

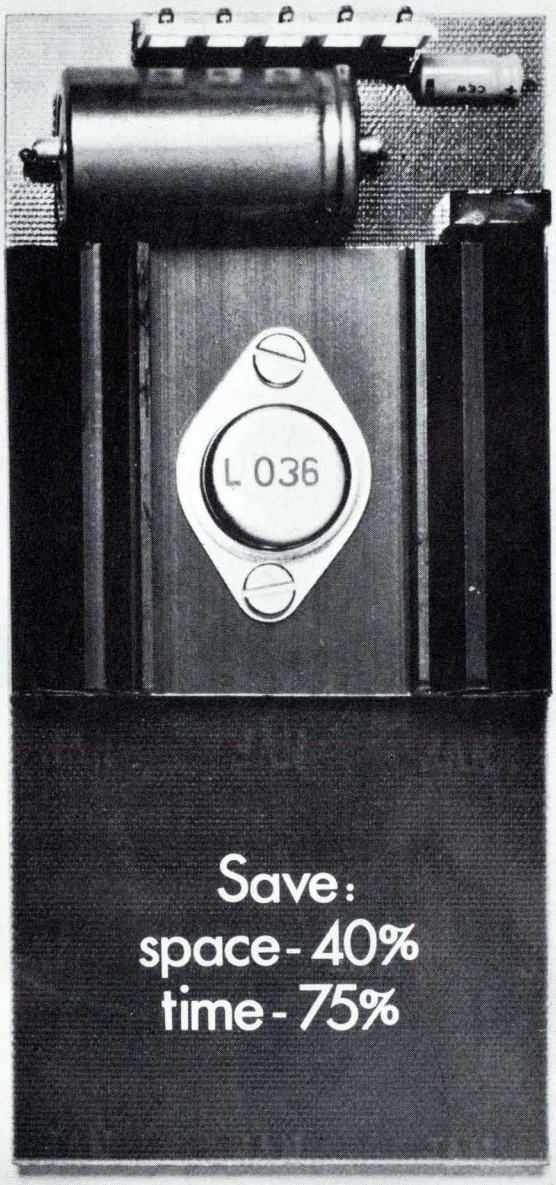


of full scale and features 12 chart speeds. Input resistance is 10 megohms on all ranges, and the pen has a response time of 30-in./s.

Precision Standards Corp., 1701 Reynolds, Santa Ana, Calif. 92705 [360]

Bestsellers





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Both these DC power supplies are short circuit protected and will give you twelve volts at half an ampere.
The one on the right, built with the L 036 integrated power voltage regulator, saves you only 10% in component cost, but 40% in printed circuit space and 75% in component assembly time.
And, as an added advantage, you get better noise immunity.
SGS/ATES has a full range of high performance integrated voltage regulators.
What's more, they are available at very competitive prices.
However, if you still prefer the solution with discrete components, we shall be pleased to supply you with all the transistors and diodes necessary.

Type	Output Voltage (V)	Regulated Output Current (mA)	Max. Input Voltage (V)	Package
L 123	2÷37	150	40	TO - 100/DIP
L 005/TBA 325 A	5	850	20	TO - 3
L 036/TBA 325 B	12	720	27	TO - 3
L 037/TBA 325 C	15	600	27	TO - 3
TBA 435 A	8,5	130	20	TO - 39
TBA 625 A	5	130	20	TO - 39
TBA 625 B	12	130	27	TO - 39
TBA 625 C	15	130	27	TO - 39

SGS

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USA: 435 Newtonville Ave., Newtonville, Mass. 02160, tel.: 617-9691610
UK: Planar House, Walton Street, Aylesbury, Bucks, tel.: 0296-5977
France: 58, rue du Dessous des Berges, Paris 13e, tel.: 5895223
Germany: 809 Wasserburg/Inn, Post Box 1269, tel.: 08071-721
Sweden: Postbox, 19501 Märsta, tel.: 0760-40120
Singapore: Lorong 4 and 6, Toa Payoh, Singapore 12, tel.: 531411

ATES

B Communications

A $500 message for the engineer who buys digital IC's but not in sufficient number to warrant the investment of thousands of dollars in automatic testing gear.

THE MESSAGE

That's it. The Model 1248 IC Functional Tester from Electro Scientific Industries. This little $500 box will tell you exactly what you want to know most about your incoming ICs — all those in TTL, DTL, and CMOS families in DIP, TO-5, and flat configurations — which is whether or not their inputs and outputs are functioning in the expected manner. And it will give you this information in absolute terms, right now, *before* you install them on a PC board. (The Model 1248 makes more than 1 million tests on a device in a few seconds at the touch of a button.) No comparisons with a "good" IC are necessary.

What it won't do, and you shouldn't care less at the price, is make measurements of propagation delays, threshold voltages, the effects of output loading, or the magnitudes of input currents under various logic or temperature conditions. It isn't meant to. It *is* meant to test one IC at a time and tell you immediately if that device has developed an input or an output malfunction. And this it does, every time, and we guarantee it.

Write or call us for the complete story on this ingenious little IC tester, and ask about out free trial program.

Electro Scientific Industries
13900 N.W. Science Park Dr.
Portland, Oregon 97229
Telephone: (503) 646-4141
Telex: 36-0273

e|s|i

Data handling

Printer built for CRT terminals

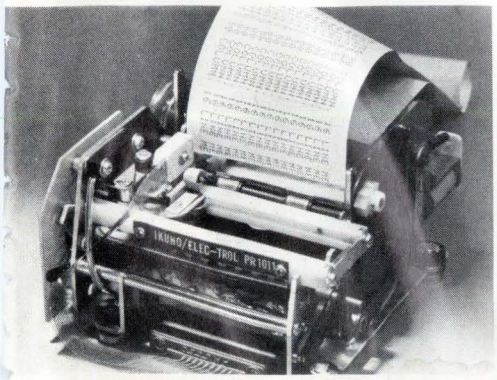
Unit provides alphanumeric hard copy on electrosensitive paper; sells for under $500

Obtaining hard copy for low-cost terminals has been a sticky problem and one that must be solved before computers move into many areas. A novel solution is offered by Elec-Trol Inc. The company's new printer provides hard copy for less than $500, including electronics, says president Raymond S. Freed, compared to $3,000 to $4,000 for other line printers with similar speed and capacity.

The new Elec-Trol PR1011 prints blocks of 80 columns by 16 lines in 12 seconds, equivalent to 100 characters per second, 10 times the speed of a standard teleprinter, but with a new twist: a modified calculator mechanism prints the block on its side on a 2¾-inch tape. An external ROM character generator, such as the Mostek MK 2408P, provides a standard 5-by-7 dot matrix that prints any numeral or symbol.

Product manager Anthony W. Muoio says a major use of the printer will be to provide hard copies of selected data from CRT terminals having 64 and 80 characters by 16 lines. The company is also working on a printer for 25 lines by 80 characters, but any line length is possible.

The printer was derived from the Ikuno/Elec-Trol PR1001 alphanumeric printing mechanism used in calculators by replacing the conventional 9-track head (which provides a 5- or 7-by-9 matrix) with a split 10-track head. A mechanical locked-timing mechanism assures even column spacing.



The paper is electrosensitive; it's covered with thin carbon and aluminum layers, and an 80-volt pulse vaporizes the aluminum, leaving the desired characters. The paper comes with a variety of colored backings so that red, blue, or black characters are printed when the aluminum is vaporized. The paper costs slightly more than thermally sensitive paper.

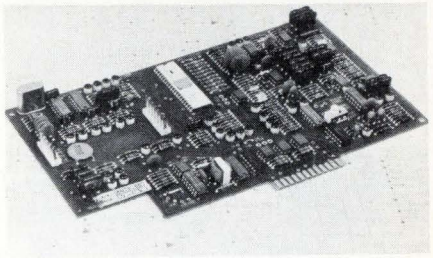
The printer is priced at $220 in quantities of 1,000, or $389 in singles, and the electronics, which Elec-Trol doesn't supply at present, depends on the application. Two 16-character buffers are required for a CRT-terminal or computer application, for example, and refresh storage is already available, whereas for a communications serial-by-character terminal, 16 80-character registers are needed; the Signetics 2529 480-bit static shift register at about $4 can store one 80-character line, so 16 would be required to store an entire message. Other control electronics would cost about $50, Muoio says.

The printer, which is 6½ inches wide by 6 in. deep by 3 in. high, weighs 4½ lbs.

Elec-Trol Inc., 26477 N. Golden Valley Rd., Saugus, Calif. 91350 [361]

LSI modem card aimed at end users

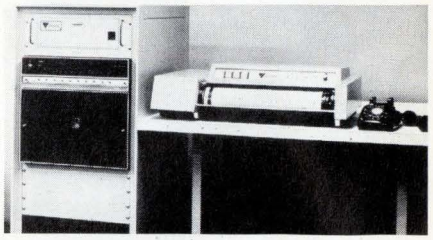
Combining a crystal-stabilized transmitter and receiver with MOS LSI technology, the 1,200/1,800-baud plug-in-card modem is designated the 202 series. The unit allows a single 45-cubic-inch printed-circuit board to accommodate all Bell 202 C/D/E options and many customer-specified features. The quartz-crystal oscillator, along with active-filter elements, eliminates jitter, frequency shift and noise effects. Price of the modem is $366; the pc card sells for $256.



Novation Inc., 18664 Oxnard St., Tarzana, Calif. 91356 [365]

Graphic transmission system designed for large documents

The GX-100 graphic transmission system is geared for use with large documents. The unit transmits black and white information at a resolution of either 100 or 200 lines per inch over telephone lines. Drawings



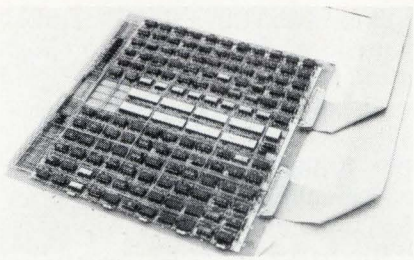
of about 11 by 17 inches can be transmitted in typically one minute, 10 seconds; letter-size documents take 30 seconds or less. The all-digital system is configured around a 16-bit high-speed minicomputer and uses a model GC-3A automatic graphic-data digitizer for its document input. Price is about $100,000 and lease cost per month is $3,000.

Visicon Inc., Box 1008, State College, Pa. 16801 [366]

Multiplexer is built for use with Nova-line computers

An eight-channel multiplexer called the model EDS-8 is designed for use with Nova computers. It occupies one slot in the computer chassis and may be expanded to handle up to 128 ports by the addition of an expansion chassis holding additional port cards. Data rate for each port is

New products



individually selectable under program control to any speed from 110 to 9,600 baud, and the multiplexer can accommodate any combination of teletypewriters, typewriters, CRT terminals, modems and other RS-232-C-compatible devices. Price is $3,500 and a complete 128-port system costs $120 per port.

Educational Data Systems, 2415 Windward Lane, Newport Beach, Calif. 92660 [367]

Programing simulator is also a microcontroller

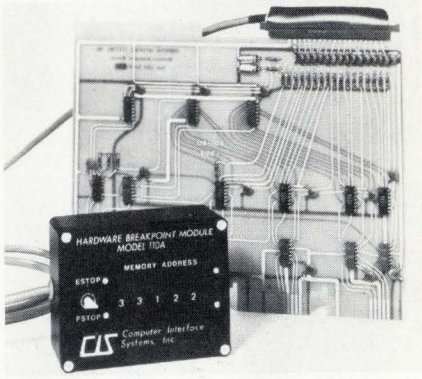
The model CBC-4 is primarily designed to function as a programing-prototyping simulation tool for the

incorporation of LSI microcomputers in new and existing equipment. In itself, the unit is also a programable microcontroller that can replace minicomputers in many applications. The CBC-4 allows immediate start-up on a design project using microcomputer chips, and with the exception of special I/O boards, the unit with a teletypewriter is a stand-alone development system.

Applied Computing Technology Inc., 17815 Sky Park Circle, Irvine, Calif. 92664 [368]

Hardware breakpoint module is a program-debugging aid

Program debugging is available to the PDP-8E user in the model 110A hardware breakpoint module. The unit provides the capability to halt PDP-8E programs at selected memory locations (breakpoints). The unit consists of a switch-panel assembly, cable-connected to a printed-circuit board that plugs



directly into any unused Omnibus slot. No modifications to the computer are required. Price is $485, and delivery time is 30 days.

Computer Interface Systems Inc., Box 58, Piscataway, N.J. 08854 [369]

Disk drive stores from 0.5 to 8 million bits

The model 914 fixed-head-per-track disk cartridge drive measures 7 by 19 by 22 inches, and weighs 46 pounds. Storage capacities range from 0.5 to 8 million bits using a plug-in module containing 16 tracks per module. Rotation speeds of

1,800, 2,400, and 3,600 revolutions per minute result in average access times of 17, 12.5, and 8.5 ms respectively. The number of sectors per track is variable from 1 to 2,400. OEM quantity price is from $1,200 to $2,500 depending on storage requirements.

Dataflux, 1195 E. Arques Ave., Sunnyvale, Calif. 94086 [370]

Semiconductors

IC d-a converter resolves 8 bits

Monolithic device for $5.95, designed as building block, requires external circuitry

Monolithic digital-to-analog converters aren't new—both Motorola and Precision Monolithics Inc. have 6-bit models, and PMI has a 10-bit version. Motorola now has a monolithic d-a converter that it claims is the most practical in the most popular range. The new 8-bit MC1408 requires some external circuitry, unlike the PMI 10-bit converter, but sells for only $5.95 in the 100-piece commercial temperature range compared to $35–$45 for the PMI unit. The external circuitry required with the Motorola part can be as simple as a single $1 type 723 voltage regulator, which contains the required voltage reference, an op amp, and a few passive parts.

Ronald A. Campo, Motorola's linear IC product planning manager, says the company went to 8 bits rather than 10, and to separate reference and op amp, because "it's practical and manufacturable. The old 6-bit version (MC 1406) opened up new types of applications, but most current demand is for 8, 10 or 12 bits." Campo says that the 1408 is well within the classic 8-bit accuracy to ±½ bit, but lower-cost versions meet 6- and 7-bit requirements. The new 6-bit version (MC 1408-6) is priced at $4.95, the same as the 1406, but the 1408 differs from the earlier part in offering the more popular positive logic: maximum output occurs with all inputs high.

Aside from the low cost that results from its producibility, Campo says Motorola's building-block approach provides versatility: the parts permit multiplying and high-speed current output, hence are easier to use in analog-to-digital applications. Motorola will offer in January a companion a-d control circuit incorporating a dual comparator and high-speed op amp. A conventional MOS or TTL up-down converter is also needed. "This application is dependent on the fact that our d-a converter puts out current rather than voltage," Campo points out.

"The d-a will become the op amp of the next few years. If the price is right, there'll be lots more applications, and that's why we're trying to keep the d-a and a-d interface inexpensive," Campo adds. The MC1408 operates on ±5 volts, and is packaged in a ceramic dual in-line case. A full-temperature-range version sells for $8.50.

Technical Information Center, Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. 85036 [411]

Pnp-npn complementary pairs achieve 10 amperes

Pnp-npn complementary-pair power transistors offer identical gain characteristics over a wide collector-current range. Current gain matching is uniform from less than 100-mA to 10-A collector current. In addition, input voltages are identical over the same collector-current range. Saturation voltages are low, and collector-to-emitter voltage rating is 140 V. The KSP series is priced from $7.50 to $37.

Kertron Inc., 7516 Central Industrial Dr., Riviera Beach, Fla. 33404 [413]

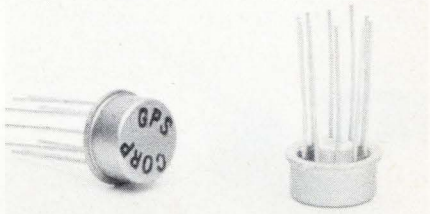
MOS chip is designed for 8-digit personal calculator

The C-500 MOS chip is designed for use in 8-digit personal calculators, and can handle numbers in excess of 20 digits. The unit features four function operations, constant in all four modes, chain operations, and power calculations. Entries are made in algebraic form with floating-point entry and results. A minus sign is used to indicate negative numbers. The unit is contained in a 24-lead DIP and can be interfaced with various seven-segment displays. Price is $26.75 each.

General Instrument Corp., 600 West John St., Hicksville, N.Y. 11802 [415]

Linear hybrid microcircuits are accurate to within 0.5%

A line of four quadrant analog multipliers is designated the 4100 series and composed of linear hybrid microcircuits with accuracies to within

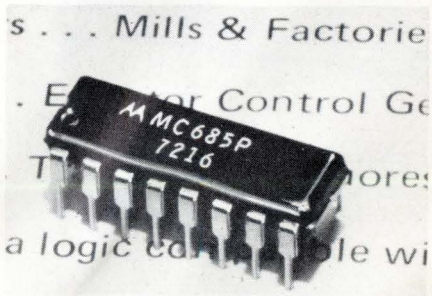


0.5%. Full-power response is 800 kHz and bandwidth is 1 MHz. The units offer a slew rate of 45 V/μs. Applications are in multipliers and in control and instrumentation systems. Price starts at $15.

GPS Corp., 14 Burr St., Framingham, Mass. 01701 [414]

High-threshold logic circuits aimed at control jobs

Four high-threshold logic circuits are aimed at demanding applications, including machine tool and process controllers, computer peripherals, appliances, and measuring equipment. The units are the



MC686 4-bit shift register, the MC684 decade counter, the MC685 binary counter, and the MC688 dual J-K flip-flop in a 16-pin package. Operating temperature range

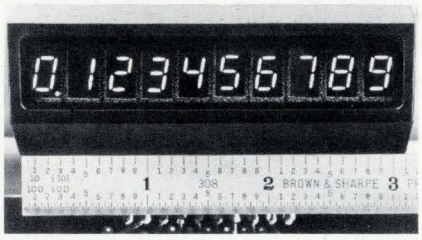
New products

for all the devices is from −30° to +75°C. Price ranges from $1.70 to $6.30, depending on model and quantity.

Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Ariz. 85036 [416]

LED digits are priced at $3.95 in quantities of 100

A line of light-emitting-diode digits is said to halve the cost of LED displays. The FND-70 ¼-inch-high digits cost $3.95 per unit in 100-lots and are suited for applications in computer-terminal readouts, digital panel meters, and desk calculators. Cost reductions are a result partly of



reducing the amount of gallium arsenide phosphide used in each digit, and partly of an assembly method that eliminates hand operations required to align light-emitting sources.

Fairchild Camera & Instrument Corp., Semiconductor Components Group, Microwave & Optoelectronics Division, 464 Ellis St., Mountain View, Calif. 94040 [417]

Inverter SCR guarantees turnoff time of 20 μs

A 125-ampere rms inverter SCR is designated the model 81RM and features a maximum guaranteed turnoff time of 20 μs, permitting the use of smaller commutating components. The device also has a soft recovery characteristic that reduces the generation of transients that can endanger control circuitry. Voltage rating is 1,000 v, and the thyristor is insensitive to reverse voltage. Full data is provided for high-frequency applications, up to 10 kHz with some current derating. A 100-volt version is priced at $24 for 10 to 99

3M introduces laboratory recorder quality without the cost.

We built the Series 120 Recorder/Reproducer with one objective in mind: to provide laboratory instrument features without laboratory instrument cost. It's a compact, 4-channel recorder that uses 1/4" tape with any combination of direct or FM signal electronics. Its features are exceptional:

- All DC tape transport drive
- Five tape speeds from 15/16 to 15 ips
- Phase-locked capstan drive
- Direct—70 Hz to 64 KHz at 15 ips
- FM—DC to 5 KHz at 15 ips
- Up to 10 seconds repeat scan
- 4 to 60 ips forward search speed
- +50% to −30% vernier variable playback speed
- 10-1/2" reels for up to 12 hours of recording

We placed special emphasis on the recorder's design for ease of operation and maintainability. Controls are located for accessibility and quick viewing. The rear panel of the recorder is used as one large inter-connecting panel with all boards plugged in directly. Assembly is extremely simple allowing rapid and easy access to any component.

The Series 120 Recorder/Reproducer can be the most useful research tool you have, as well as the easiest to use. That's what we had in mind. For more information, contact 3M Mincom Division, 300 South Lewis Road, Camarillo, California 93010. (805) 482-1911.

INSTRUMENTATION PRODUCTS
Mincom Division 3M COMPANY

Circle 135 on reader service card

New products

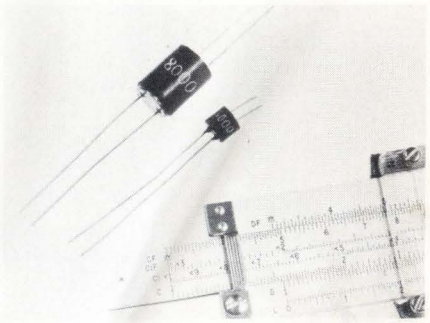
pieces. Delivery is from stock.
Semiconductor Division, International Rectifier Corp., 233 Kansas St., El Segundo, Calif. 90245 [419]

Driver is suitable for party-line operation

A three-level line driver is pin-compatible with the National Semiconductor model 78/8831. The type Am78/8831 can be operated as either a quad single-ended or a dual differential driver, and it is suitable for party-line operation where several drivers are connected to the same bus. The devices are available in both military and commercial temperature ranges. Price ranges from $5.95 to $16 in 100-lots, depending on packaging and temperature specification.
Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, Calif. 94086 [418]

Opto-isolators use cadmium sulphide detectors

Two LED opto-isolators with cadmium sulphide photodetector cells are designated the Photomod series CLM 6000 and 8000. The 6000, a miniature low-power and -resistance unit, is available in axial-lead packages, and provides noiseless switching in addition to complete isolation



in TTL-to-TTL interfaces. The 8000 is a hermetically sealed axial-lead version that operates with photocell voltages up to 220 vdc or peak ac, and is designed to drive SCRs and Triacs from line voltage.
Clairex Corp., 560 S. 3rd Ave., Mount Vernon, N.Y. 10550 [420]

Everything you need to know about power supplies is right here in this little box.

Only $94.00 complete

The equivalent of 25 cubic feet of catalogs sits right on your desk in this little 4″ x 6″ box.

The most complete Power Supply Catalog File available anywhere . . . 6667 current catalog pages have been collected and organized on microfiche cards — 98 pages per card. Every major source of power is listed, indexed and easy to find.

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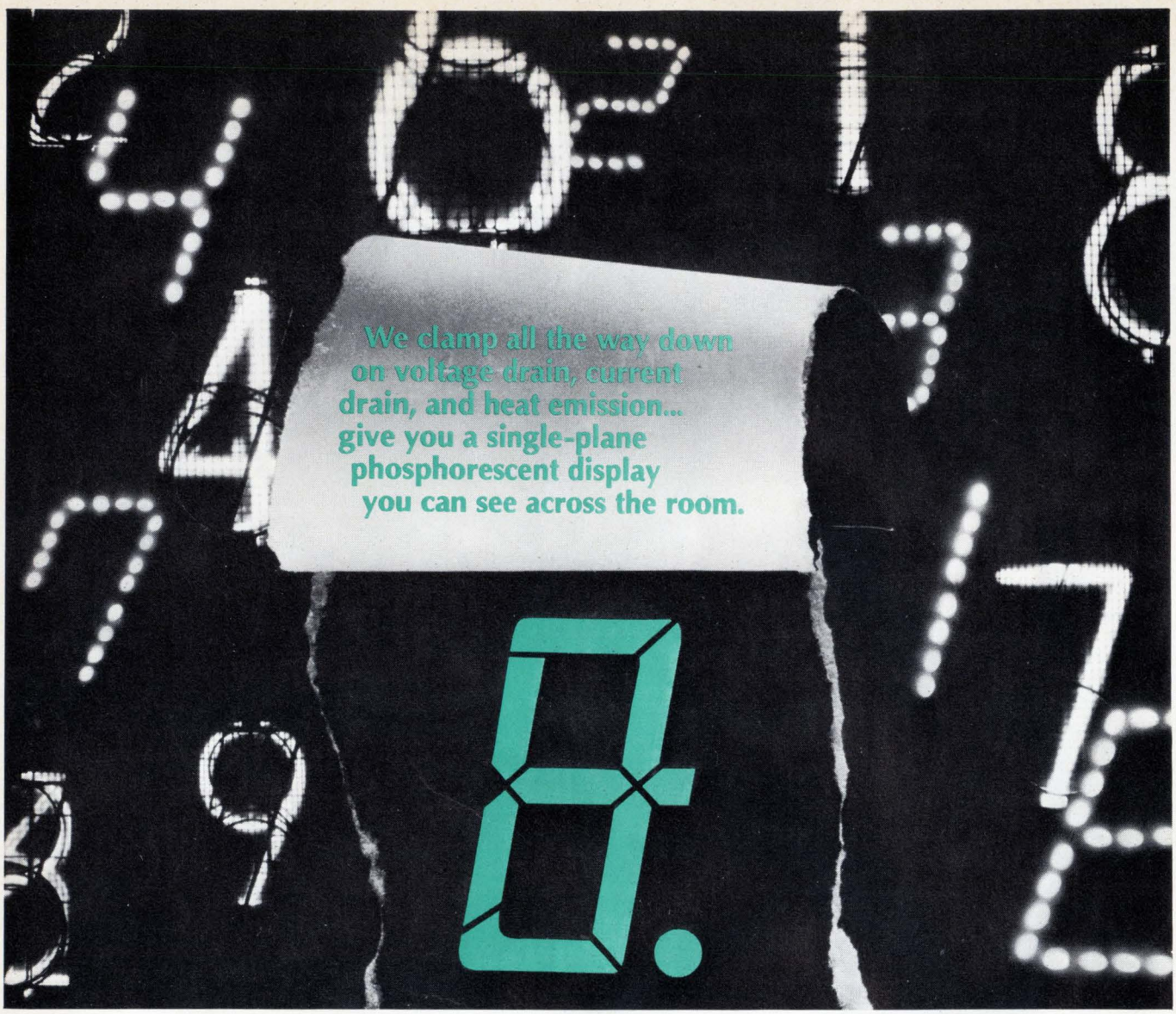
Never before available: This is the first microfiche series from the Electronics Catalog Retrieval System. The microfiche cards fit any standard reader and there is space in the box for up-dated information.

Special introductory offer: If you don't already have a standard microfiche reader, you can order the new Kodak Ektalite 120 *with your purchase* of the Power Supply Catalog File at the special low introductory price of $85.00 (delivery included).

The Ektalite 120 is a desktop reader weighing less than five pounds. It's compact, noiseless, easy-to-use. All you do is feed in the microfiche from left to right, and manipulate the control knob to locate the image you want.

McGraw-Hill Electronics Catalog Retrieval System



We clamp down fully
on the disadvantages of other displays.
Our digital readouts,
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with 8, 10, and 12 digit readout,
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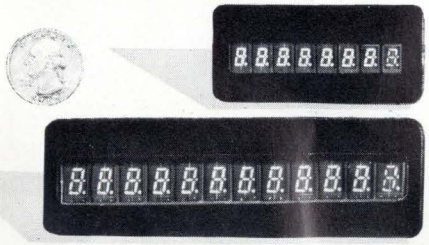
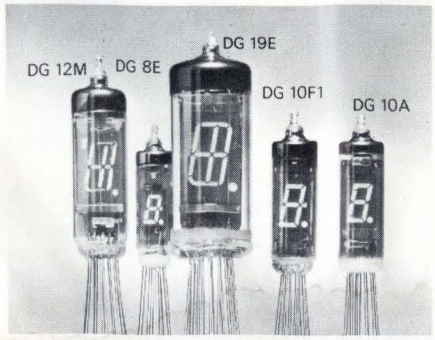
low-current drain,
and stability advantages over
conventional displays.
All have eye-easy phosphorescent
segments with digits on a single-plane
for optimal visibility
under ambient light.
It's a natural green glow,
so soft and clear you can see
it across the room.
But the best comes last:
They're competively priced
for all modern applications
in calculators,
digital clocks, voltmeters and counters,
and a host of others.
Count on us.





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New literature

Diodes. Codi Semiconductor, Division of Computer Diode Corp., Pollit Dr., Fairlawn, N.J. A four-page specification sheet describes 300 voltage-variable capacitor diodes. Circle 421 on reader service card.

Tape reader. A line of photoelectric punched-tape readers for commercial, industrial and ruggedized military applications is described in a 56-page catalog available from Electronic Engineering Company of California, 1601 East Chestnut Ave., Santa Ana, Calif. 92701 [422]

Displays. A short-form catalog from Analogic, Audubon Rd., Wakefield, Mass., describes the company's data-conversion and display products, and includes pricing information. [423]

Encoder. Trump-Ross Industrial Controls Inc., 265 Boston Rd., N. Billerica, Mass. 01862. A six-page catalog lists the company's incremental encoder products and accessories. [424]

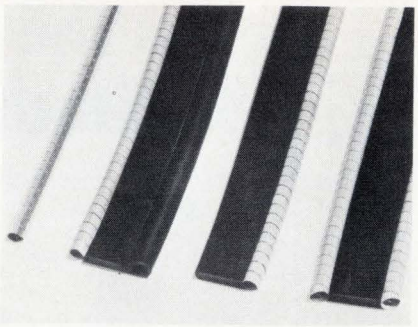
A-d conversion system. An eight-page brochure published by Data Technology Corp., 2700 S. Fairview St., Santa Ana, Calif. 92704, provides details of the Multiverter II, an analog-to-digital data conversion system. [425]

Capacitors. General Instrument, The Capacitor Division, 165 Front St., Chicopee, Mass. 01014. An all-line catalog is divided into three sections covering dipped silver-mica, aluminum electrolytic, and Mylar film capacitors. [426]

Disk storage system. A single-sheet data bulletin is being offered by Pacific Micronetics Inc., 5037 Ruffner St., San Diego, Calif. 92111, describing the Fastrack 010 series head-per-track disk storage systems. [427]

LED displays. Opcoa Inc., 330 Talmadge Rd., Edison, N.J. 08817. Data sheets on the company's Solid-Lite light-emitting diode numeric displays cover the specifications on 0.33 and 0.77-inch characters. [429]

New products/materials



For applications where electrical shielding gaskets are required, a new type of electromagnetic-interference "weatherstripping" reportedly overcomes some of the problems of conventional mesh and finger stock. It's a helical spring made of thin, flat metal called Spira. The spiral gasket is available in stainless steel or tin-plated beryllium copper, either alone or bonded to a rubber extrusion, and it provides high-frequency contact for doors and other joints in electrical equipment.

According to the inventor, George M. Kunkel of Electro-Data Technology, Burbank, Calif., the relatively wide material guarantees a low impedance path for electromagnetic current through the microwave range, and the resilient spring material insures good contact throughout the life of the bond. He says that the spring, like finger-stock emi shielding, makes good contact (typically 0.6 milliohm for 1 lb per linear inch) but cannot break off, as the fingers sometimes do.

The basic shield is available in sizes from 3/32 to 11/32 inch in standard, low-contact-resistance and low-pressure varieties (the latter suitable for joining surfaces fastened by ¼-turn fasteners). It is provided in lengths or in continuous endless gaskets.

The spiral gasket is also available bonded to hard rubber for convenience in positioning, to provide a "stop" to prevent excessive deflection, and to provide a partial moisture and dust seal. The use as a stop eliminates the need for a torque wrench in installation. Price is about 45 cents per foot with the attached rubber in 1,000-ft lengths. Other versions include adhesive backing,

Our waves sweep the field at 20 MHz

The Systron Donner Model 421 Sweep/Function Generator brushes competition aside. The combination of **superior frequency response** (±1 dB to 20 MHz), an **internal 200:1 linear sweep generator** up to 50 KHz sweep rates and simple, accurately settable **sweep limit dial indicators** leaves other 20 MHz function generators eating the 421's dust.

Frequency accuracy specs are in percentage of setting, not the deceptive "% of full scale."

An indicator warns of output distortion due to combined dc offset and signals in excess of the ±10 volt limits.

Both the sweep ramp output and the sine, square or triangle waveform output may be externally triggered or gated to produce a single cycle or signal burst.

Price of the Systron Donner Model 421 Sweep/Function Generator is $895. If you don't need the sweep capability, you can buy the 20 MHz Model 420 Function Generator for $785.

Call your nearest **Scientific Devices Office** for detailed specifications or a demonstration, or contact Datapulse Division, 10150 West Jefferson Boulevard, Culver City, California 90230. Telephone (213) 836-6100; TWX 910/340-6766; Telex 67-3219. **In Europe:** Systron-Donner GmbH., Munich W-Germany; Systron-Donner Ltd., Leamington Spa U.K.

DATAPULSE
DIVISION

SYSTRON DONNER

The Systron-Donner Instruments Group:
Alpha Scientific ☐ Computer Systems ☐ Concord Instruments ☐ Datapulse ☐ Kruse Electronics ☐ Microwave ☐ Trygon Electronics

New products/materials

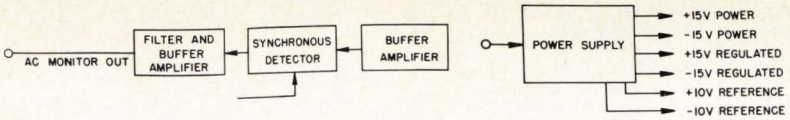
and positive-moisture seals can be used in place of the flat rubber.
Electro-Data Technology, 2808 Naomi St., Burbank, Calif. 91504 [476]

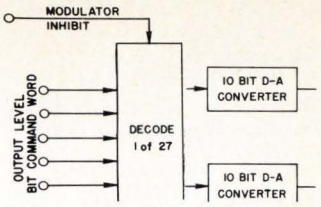
Techni-Silver E is a clear, high-speed, silver-plating solution that produces permanently hard silver deposits with a mirror finish. The material will deposit 0.0001 inch in two minutes in rack-plating or in eight to 10 minutes in barrel-plating. Tensile strength of the deposit is 78,000 to 85,000 pounds per square inch.
Technic Inc., P.O. Box 965, Providence, R.I. 02901 [477]

A silicon reacted with tallate and called Airout eliminates air voids in resin formulations, as well as craters in films. No separation appears in long-term storage, and sweat-out or greasy surfaces will not result. Air-out will not downgrade resin formation or adhesion, or interfere with electrical or physical properties.
Isochem Resins Co., Cook St., Lincoln, R.I. 02865 [478]

Cermacast 511, a magnesium-oxide zircon formulation suitable to 2,800°F, is a ceramic water-mix material that can be poured, dipped, or sprayed around components to be potted or end-sealed. The material will set up in two hours and after a bakeout at 200°F is ready for use. Curing is recommended at up to 2,000°F to develop maximum physical properties and moisture resistance. Dielectric strength is about 265 v per mil at 260°C, and resistivity is 10×10^9 ohms up to 600°C. Price is $33 per quart and $58 for a gallon.
Aremco Products Inc., P.O. Box 145, Briarcliff Manor, N.Y. 10510 [479]

Casting resin, Stycast 35, offers low-loss tangents and low dielectric constants for applications in microwave cavities, microwave lenses, spacers, and encapsulation of high-frequency coils and capacitors. There are six types of material in the series, all with loss tangents below 0.001 from 60 Hz to 10 GHz
Emerson & Cuming Inc., Canton, Mass. 02021 [480]





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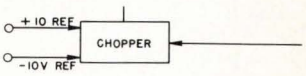

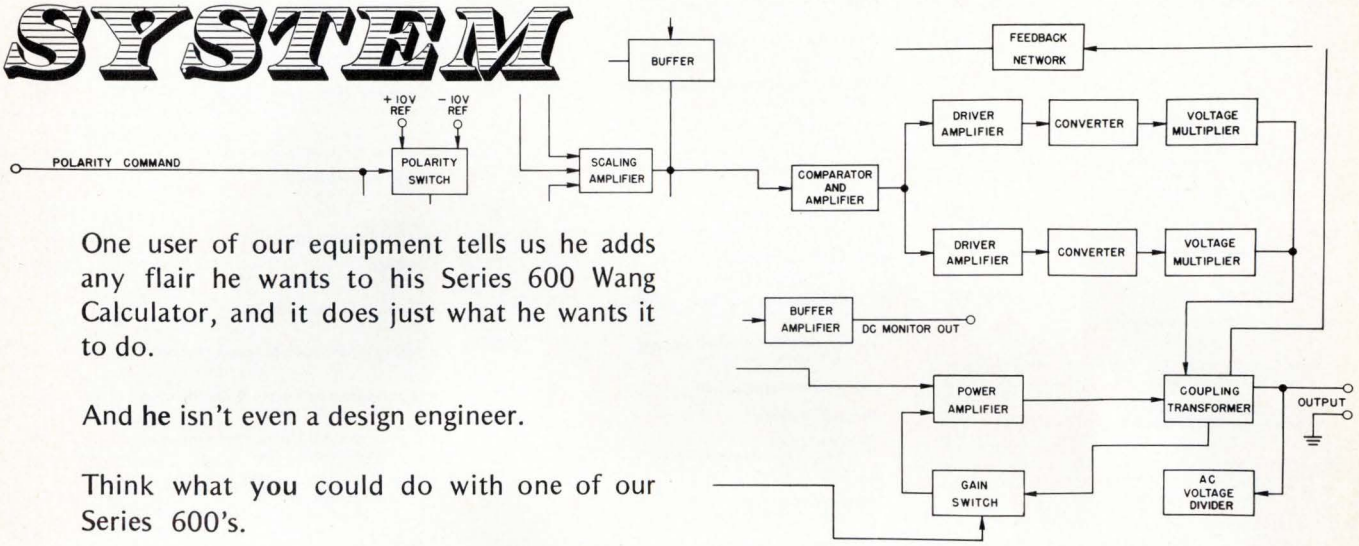

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And he isn't even a design engineer.

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■ **Abbott Transistor Labs., Inc.** 6
Technical Adv. Agency

* **Adret** 25E

Advanced Memory Systems 57
Writing Unlimited

Advanced Micro Devices 48
Keye/Donna/Pearlstein

Agfa Gevaert 145

Alco Electronic Products, Inc. 136
Marketronics Advertising

Allen-Bradley Company 96
Hoffman, York, Baker & Johnson, Inc.

* **AMP Italia** 45E
Studio Dolci

Analogic Corporation 15
Grover and Erickson, Inc.

* **Annitsu Electric Co. Inc.** 46E
Diamond Agency Co. Ltd.

Applicon, Inc. 120
Johnson, Raffin & Lingard, Inc.

■ **AVX Ceramics** 13
Allied Advertising Agency, Inc.

Bendix Corporation, Electrical Components Div. 24
D'Arcy-MacManus-Intermarco, Inc.

Boeing Electronic Products 136
Cole & Weber

Burndy Components 18-19
Van Leeuwen Advertising, Inc.

* **Carlo Erba** 7E
Studio Dema

■ **Chicago Dynamic Industries, Inc.** 122
Burton Browne Advertising

■ **Clairex Corporation** 4th Cover
Black-Russell-Morris

Colorado, State of Commerce and Development Division 128
Frye-Sills, Inc.

■ **Colorado Video, Inc.** 148
O'Connell-Colbum, Inc. Creative Business Communications

■ **Custom Electronics, Inc.** 140
Laux Advertising, Inc.

Data General Corporation 115
The Advertising Group

Datatron, Inc. 20
Larry Courtney Company

‡■ **Digital Equipment Corporation** 52
Creamer, Trowbridge, Case & Basford, Inc.

* **The Digitran Company** 18E
Janson Advertising, Inc.

* **Ducati Elettrotechica Microfarad** 38E
Studio Busoli Gastone

Duncan Electronics, Inc., Sub. of Systron Donner Corp. 37
Enyart & Ross Advertising, Inc.

Edo Western Corporation 140
Technical Services for Industry

Electronic Applications Co. 122
Art Wroobel & Associates

■ **Electronic Navigation Industries** 12
Hart Conway Co., Inc.

Electro Scientific Industries 130
Com/Mark Communications Group

* **Electro Scientific Industries** 55E
Com/Mark Communications Group

ELMEC s.n.c. 134
Tecnostampa

EMR-TELEMETRY 124
Industrial Communications

* **English Electric Valve Co. Ltd.** 16E-17E
C. R. Casson Ltd.

Fairchild Semiconductor, Inc. 94-95
Carson/Roberts, Inc. Adv., Div. of Ogilvy & Mather, Inc.

General Automation 58-59
Chiat/Day Inc., Advertising

■ **General Electric Electronic Components** 28
Robert S. Cragin Inc.

■ **General Electric Co., Semiconductor Products Dept.** 2
Advertising & Sales Promotion
Syracuse Operation

* **General Instrument Europe S. P. A.** 40E
Studio Hedy

Hamilton Digital Controls, Inc. 132
Graystone and Ramsy, Inc.

Harris Semiconductor 90-91
Tucker Wayne & Company

Hermes Electronics Ltd. 118
Public & Industrial Relations Limited

■ **Hewlett-Packard** 92-93
Tallant Yates Adv. Inc.

■ **Hewlett-Packard** 17
Richardson Seigle Rolfs & McCoy, Inc.

■ **Hewlett-Packard** 22-23
Tallant/Yates Advertising, Inc.

■ **Hewlett-Packard** 1
Tallant Yates Advertising, Inc.

■ **Hipotronics Inc.** 47
Kenmarc Advertising Inc.

Hitachi Metals Ltd. 139
Asia Adv. Agcy. Inc.

Hysol Div., The Dexter Corp. 125
Stahlka, Faller & Klenk, Inc.

■ **Interstate Electronics Corporation** 19
Chris Art Studio Inc.

Ise Electronics Corp. 138
Shinwa International, Inc.

* **ITT Cannon Electric GmbH** 2E-3E
Werbeagentur

■ **Johnson Company, E. F.** 123
Martin Williams Advertising

■ **Kepco Incorporated** 5
Weiss Advertising

■ **Lambda Electronics Corporation** 3rd Cover
Michel Cather Inc.

Lockheed Electronics Company 62-63
McCann-Erickson, Inc.

McGraw-Hill Magazines 60-61

* **Magneti Marelli** 26E

Markem Corp. 116
Creamer, Trowbridge, Case & Basford, Inc.

Master Appliance 122
Klau-Van Pietersom-Dunlap, Inc.

* **Mesucora** 36E
Sepic

* **Micro** 58E
DP Industrie

Microfiche 136A-B,137

Micro Power Systems 46
Associated Adventures

* **Microtecnica** 50E

* **Microwave & Electronic Systems Ltd.** 20E-21E
Hall Advertising Ltd.

■ **3M COMPANY—Mincom Division** 27,135
D'Arcy-MacManus-Intermarco, Inc.

MOS Technology, Inc. 2nd Cover
Henry S. Goodsett Advertising, Inc.

■ **Motorola Semiconductor Products, Inc.** 39
E B Lane & Associates, Inc.

* **Nippon Kogaku K.K.** 53E
K & L Advertising Agency

■ **Oak Industries, Inc., Switch Division** 21
Buchen Advertising, Inc.

* **Ohmic** 23E
Promoazur

* **Ing. C. Olivetti & C., S.p.A.** 13E
Studio Giuliano Blei

* **D. Olivetti & C. Spa** 37E,39E
Studio ECO

* **Oscilloquartz SA, Neuchatel** 6E,52E
M. R. Hofer Werbeagentur BSR/EAAA Bern

* **Philips Elcoma** 8E,28E,42E
Tag-Intermarco delaMar

* **Philips Elcoma** 10-11,64
Tag-Intermarco delaMar

* **Philips Electrologica** 15E
Tag-Intermarco

* **Philips N. V. Pit/T & M Division** 54
Marsteller International S. A.

* **Phillips Industries** 49E
Omnific Advertising Ltd.

Piher International 127
Scott MacTaggart Advertising

* **Plessey Arco** 31E,33E
A. & E. Bologna

* **Portescap** 41E
IVA

‡ **Prime Computer, Inc.** 54
Grover and Erickson, Inc.

PROCOND S.p.A. 12
Quadragono

* **RCA Electronic Components** 5E
Al Paul Lefton Company, Inc.

■ **RCL Electronics, Inc.** 14
Morvay Advertising Agency

* **Rohde & Schwarz** 1E,11E

Schauer Manufacturing Corp. 12
Nolan, Keelor & Stites

* **Schneider R. T.** 48E
Intermedia

Secrets of Successful Job Hunting 147

* **Sescosem** 19E,51E
Perez Publicite

SGS-ATES 129
STUDIO B Communications

Siemens Aktiengesellschaft 52
Linder Presse Union GmbH

Signetics Corp., Sub. of Corning Glass Works 89
Hall Butler Blatherwick, Inc.

* **Silec Electronique** 44E
France M-1

Siliconix 109
Robertson West, Inc.

* **Sodeco** 29E
Thomas Stocker

■ **Spectrol Electronics Corp.** 110
J M R, Inc.

■ **Sperry Information Displays Division** 7
N A Winter Advertising Agency

■ **Systron Donner Corp.—Datapulse Div.** 141
Bonfield Associates

■ **Systron Donner Concord Instruments** 51
Bonfield Associates

* **Tadiran Israel Electronics Industries Ltd.** 35E
Pelled Advertising & Public Relations Ltd.

* **TEAC Corp.** 4E
Dentsu Advertising Ltd.

Tekelec Inc. 35
James Bischof & Associates

■ **Tektronix, Inc.** 33
Dawson, Inc.

* **Telettra** 47E
Studio Grafico Carlo Stefanoni

■ **Texas Instruments Incorporated, Control Products Division** 41-42
Kenyon & Eckhardt Advertising, Inc.

Toko, Inc. 47
Hakuhodo, Inc.

■ **TRW, Electronic Components Division** 104-105
The Bowes Company

■ **Unitrode Corporation** 8-9
Impact Advertising

U. S. Capacitor Corp. 148
S. Michelson Advertising

■ **Wang Laboratories, Inc.** 143
WLI Associates Advertising

Wima, Westermann 16

Yokogawa Electric Works Ltd. 22E
General Advertising Agency, Inc.

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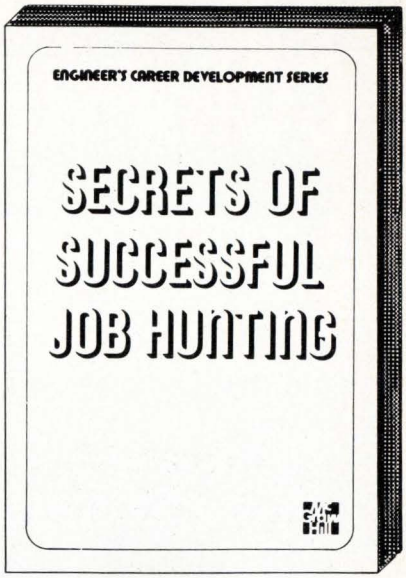

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Your Job-Hunting EQ*	TRUE	FALSE	VARIABLE
1. It's bad taste to "sell" your qualifications	□	□	□
2. Every resume should have a photo with it	□	□	□
3. List with as many employment agencies as possible	□	□	□
4. Your personal interests will bore an interviewer	□	□	□
5. Always state your exact salary requirements	□	□	□
6. A quick thank-you note makes you seem overanxious	□	□	□
7. Questions about fringe benefits are "unprofessional"	□	□	□
8. Enthusiasm will make you appear overeager	□	□	□
9. Ask for a 10-20% salary increase in a new job	□	□	□
10. Type as many carbons as possible of your resume	□	□	□

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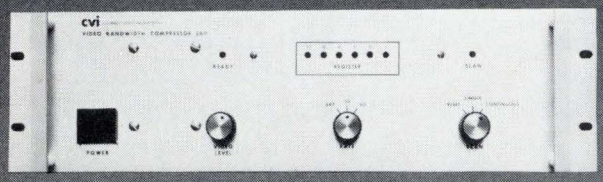

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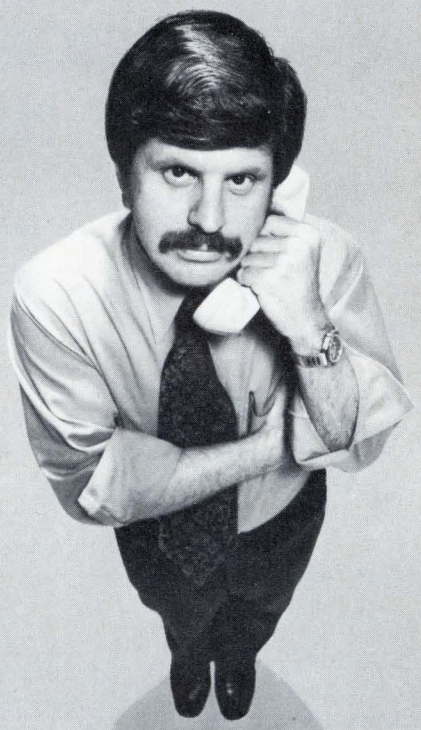

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