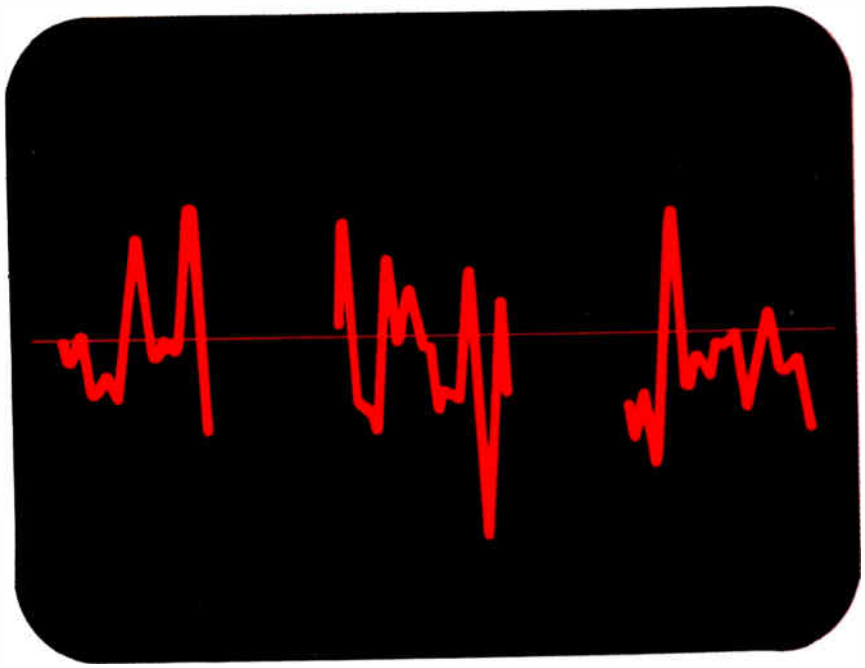
December 21, 1970

$1.00 A McGraw-Hill Publication

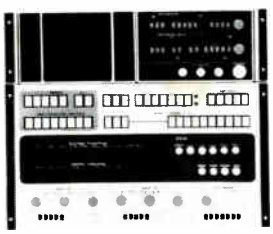
Electronics

Europe's market: new heights, or plateau in 1971?



can you afford to miss part of your data?

At Time/Data, *real-time signal analysis* means continuous processing of your data – all of your data, all of the time – for maximum statistical accuracy. We offer three systems fast enough to guarantee real-time analysis whatever your needs. But speed isn't all. Our task-oriented systems are also easy and fast to use, reducing set-up costs and true processing time. They feature:



- User-designed controls and alphanumeric displays – eliminates complex sequence of button-pushing or tedious programming via teletype.
- The speed of the hard-wired, digital processor combined with the flexibility of the general-purpose computer.
- Complete software package for true "one-button" operation. No need to know or learn computer programming.

Time/Data Signal Analysis Systems

	1923C	1923B	1923A
Maximum Frequency Range	0-50 kHz	0-50 kHz	0-50 kHz
Maximum *Real-Time* Frequency Range	0-500 Hz	0-18 kHz	0-30 kHz
Power Spectrum Processing Time (for 1024 points)	1 sec	28 ms	17 ms
Price (FOB Palo Alto, Calif.)	$43,500	$65,000	$85,000

All three systems also provide Fourier Transforms, Cross Spectrums, Transfer Functions, Coherence Functions, Correlations, Convolutions, Cepstrum, Averaging – and much more. May we discuss these systems with you in terms of your measurement needs?

Call your nearest GR District Office or write to General Radio, 300 Baker Avenue, Concord, Massachusetts 01742, or Time/Data, 490 San Antonio Road, Palo Alto, California 94306. In Europe, write to Postfach 124, CH 8034, Zurich, Switzerland.

Time/Data
A GR COMPANY

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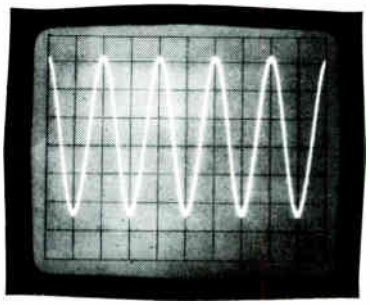
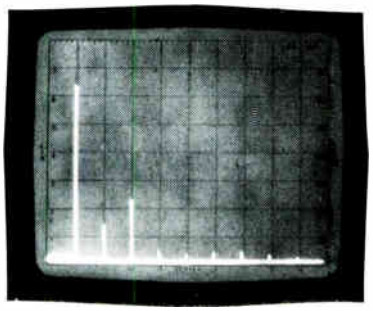
Circle 900 on reader service card

If you only see this

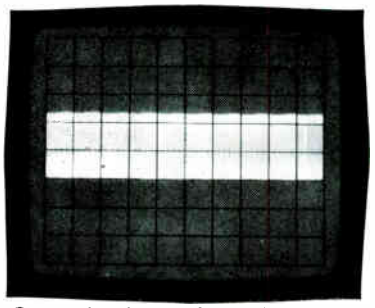
look what you're missing.



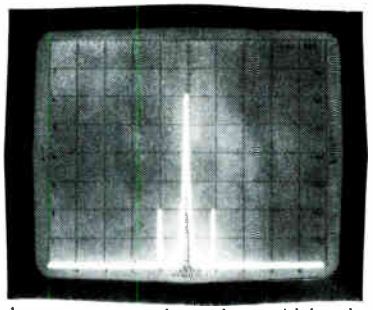
Conventional scope display of 5 MHz signal appears undistorted ⟶



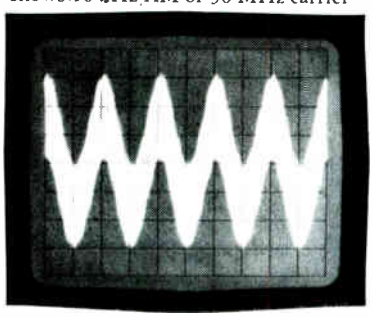
but spectrum analyzer display shows 2nd harmonic 50dB down and 3rd at −40 dB.



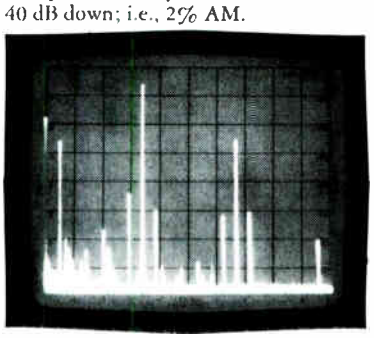
Conventional scope display barely shows 10 kHz AM of 30 MHz carrier ⟶



but spectrum analyzer shows sidebands 40 dB down; i.e., 2% AM.



Conventional scope display merely shows "fuzzy" sine wave ⟶



but spectrum analyzer identifies parasitic oscillations.

You're missing the wealth of information you need for *complete* signal analysis.

There's only one lab tool that fully characterizes oscillators, mixers, modulators, amplifiers, filters and systems, both in design and test stages. This tool is an HP spectrum analyzer, the oscilloscope that operates in the frequency domain.

One of the analyzers covers 1 kHz to 110 MHz, another goes from 500 kHz to 1250 MHz, and a third unit covers 10 MHz to 18 GHz (extendable to 40 GHz). Because frequency response is flat, each provides absolute amplitude calibration — and you can read out in dBm or volts (down to <-120 dBm or 0.1 μV). The >70 dB distortion-free dynamic range permits you to measure signals with very wide amplitude differences. You can sweep as wide as 2 GHz, then reduce the scan to zoom in for a closeup of any portion down to 0.001% of the initial sweep. Selectable bandwidths provide resolution as high as 10 Hz at RF, 100 Hz at microwave frequencies.

So why struggle with half the picture when evaluating signal characteristics?

With one of these RF sections:
8553B (1 kHz-110 MHz), $2200
8554L (500 kHz-1250 MHz), $3500
8555A (10 MHz-18 GHz), $5975

plus either of these IF sections:
8552B (highest resolution), $2850
8552A $2150

and a 141T Display Section:
with variable persistence CRT, $1700
— you'll be all set for fast, accurate and thorough signal analysis.

For complete information on this universal measurement tool — or a demonstration — contact your HP field engineer. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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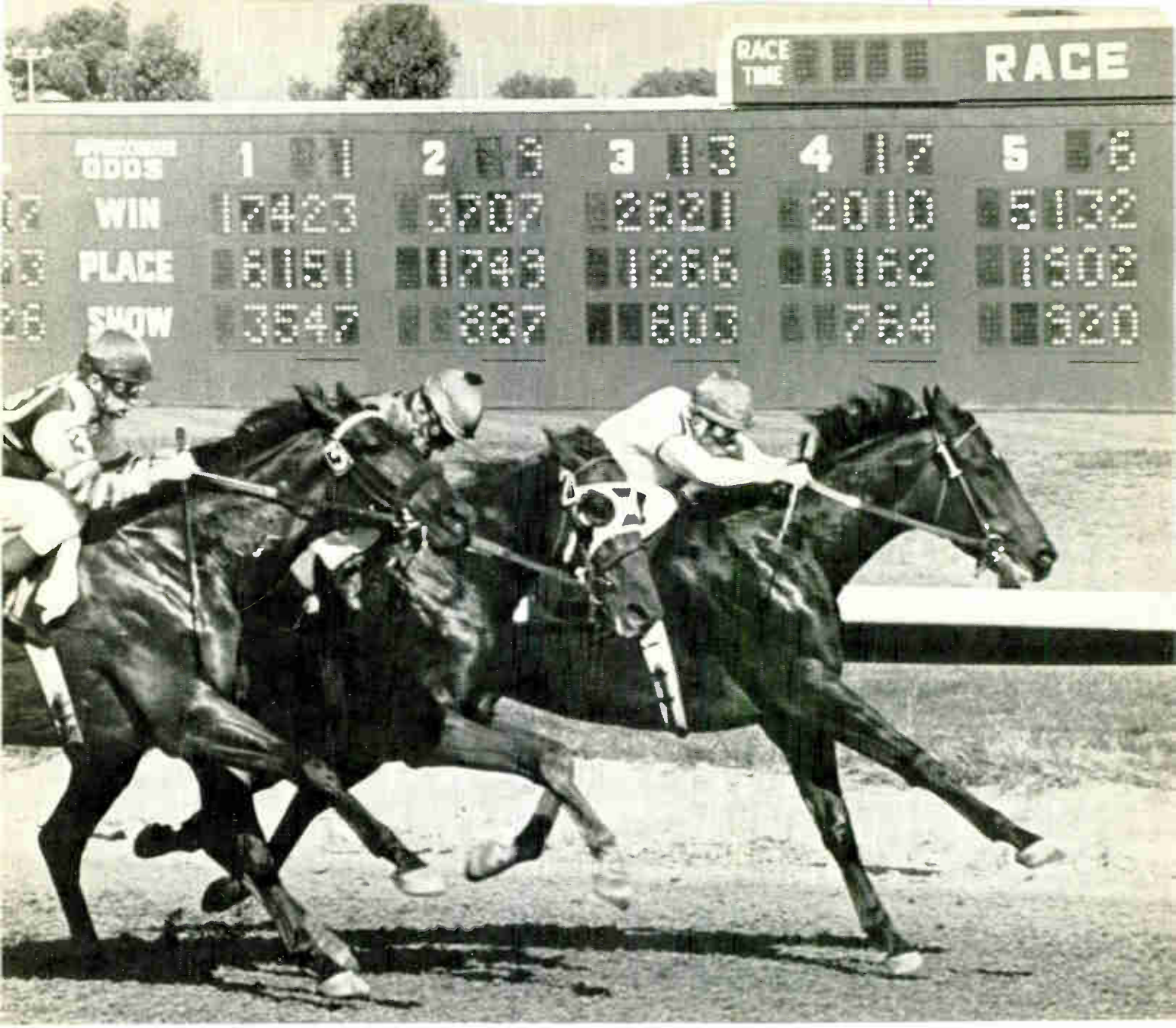
HEWLETT hp PACKARD

SIGNAL ANALYZERS



With $250,000 a race riding on his system, this OEM places his bets on an HP tape drive.

American Totalisator has just computerized its world-famous Tote Board. So odds and payoffs can be posted instantly. And with indisputable accuracy.

Unless the computer "crashes."

In which case, you've got a mob of outraged race fans to contend with. So the computer is backed up with HP's 7970 Digital Magnetic Tape Recorder. If there is a "crash," the 7970 can be relied on to get the numbers back on the board in minimum elapsed time.

Reliability makes the 7970 a money winner for American Totalisator. Its exclusive HP features assure trouble-free operation from 10 to 37.5 ips.

And to make sure the 7970 stays in the winner's circle, there are 141 Hewlett-Packard sales and service offices around the world to serve you and your customers. If a 7970 should need work, simple plug-in service cards permit repairs on-site with minimum down time.

American Totalisator chose the HP 7970 Digital Magnetic Tape Recorder for reliability. If you want a sure thing, just call your local HP field engineer. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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MAGNETIC RECORDERS

Circle 2 on reader service card

Electronics

Volume No. 43, Number 26 December 21 1970

Electronics

About this issue

Two newcomers to *Electronics*, staff will be spending the Christmas season farther south than they thought earlier in the year. Paul Franson two weeks ago opened the new Dallas bureau after moving his wife Teddy, daughters Chris and Wendy, and "the two Burmese cats who run the family" from the Boston area, where he had worked for Teradyne.

A graduate of North Carolina's Davidson College and a former Ft. Meyers, Fla., high school math teacher, Paul did graduate work at the University of Georgia, then joined 73 Magazine, a ham radio publication, as editor. Later experience included a stint in technical communications at Motorola Semiconductor in Phoenix, so for Paul the Southwest is familiar territory. Paul is also known around ham circles as WA1CCH and WA7KRE. He builds his own gear and experiments with vhf and higher frequencies.

The second new arrival is Larry Armstrong, who, after completing a stint in the McGraw-Hill training program, moved to *Electronics'* Washington bureau. Larry is a journalist by training, gaining his master's degree last June from Northwestern University's Medill School of Journalism. While there, he worked in the school's Washington-based news service, gaining valuable experience in covering the Capital.

So although the economy is contracting, *Electronics* is expanding. In fact, the magazine is looking for an engineer. Interested? Then see the ad on page D4 at the back of this issue.

Anxiety over U.S. electronics markets is running pretty deep in Western Europe. The team of reporters, editors, and market experts sent out by *Electronics* to check what's in the cards for Europe in 1971 found themselves swamped with questions about what was going to happen on the American side of the Atlantic. The widespread price cutting in digital ICs prompted the most questions, and, relying on *Electronics'* reputation for up-to-the-minute reporting, a surprising number of sources asked the equivalent of, "What's the lowest TTL price you've heard of today?"

For the full story (see p. 57) on 1971 trends, our bureau chiefs Mike Payne in London and John Gosch in Frankfurt covered their countries, while McGraw-Hill World News men handled the other nations. Stewart Toy did France, James Smith toured the Benelux countries, and Jack Star filed on Italy. Chief correspondent Robert Skole wrapped up Scandinavia, with an assist from John Heaslip in Denmark. Laura Pilarski and Don Curcio, chief correspondents in Switzerland and Spain, rounded out the reporting team. Meanwhile Oliver Ball, European special projects manager, and Arthur Erikson, Paris-based international managing editor and coordinator for the survey, were busy chasing down the numbers that describe 1971's prospects.

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The "C" in IC's stands for Circuits

—therefore the AD503

...a 5pA FET Op Amp in a TO-99 Can

Nowadays, the only way to achieve a *major* advance in IC performance is to combine advanced *processing* techniques with complete mastery of advanced *circuit* design. One manufacturer does that: Analog Devices . . . Circuit Specialists.

Here's a perfect example: the AD503, an FET-input IC op amp with 5pA bias current, and a slewing rate of 6V/μsec. To put it bluntly, the AD503 outperforms every other FET/IC design, in every significant parameter, by wide margins.

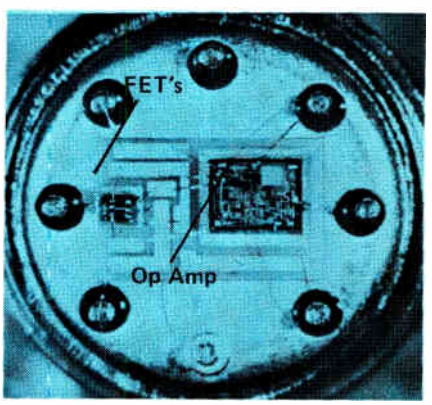
The spec summary we've shown stacks the AD503 against the best conventional FET/IC op amp. You'll see why we made the AD503 pin-interchangeable with the 740 and 741. We expect to cure a lot of your nagging design headaches — simply by saying: "Retrofit with the AD503!"

Here's how we do it: the AD-503 is a *dual-chip* IC, combining a monolithic dual FET chip with a specially designed monolithic amplifier chip. This permits *independent optimization* of both chips, since they are processed independently, each with the most favorable starting materials and doping levels for its function. Consequently, the yield is high, the cost is low, and the performance is superb. The AD503, in other words, is not limited by the processing constraints inherent in single-chip FET op-amp designs like the μA740.

Soon to come: specially optimized versions of the AD503 . . . one with 1pA bias current . . . an externally compensated version with 40V/μsec slew rate . . . and one in which we use laser trimming to reduce the offset to 1mV max.

The AD503, like all of our new *fourth-generation* devices, was created by the most experienced team of linear processing and circuit engineers ever assembled. And it is manufactured in one of the few microcircuit facilities that is currently capable of large-volume fourth-generation processing.

For complete and explicit data on the AD503 and six more extraordinary new IC devices, get our new 16-page Engineering Brochure on *fourth-generation* IC's from ANALOG DEVICES, INC., 221 Fifth St., Cambridge, Mass. 02142.
Evaluation units? Certainly! Immediately! Call Stan Harris at: (617) 492-6000; *TWX:* (701) 320-0326; *and he'll send up to 5 —at the 100-piece price!*



Parameter	AD503J	μA 740C	AD503K	μA 740
Max V_{os} (mV)	50	no max spec*	20	20
Max I_b (pA)	50	2000	25	200
Max ΔV/ΔT (μV/°C)	75	no max spec*	25	no max spec*
Min Gain	30K	no min spec*	50K	50K
Min CMRR (dB)	65	no min spec*	70	64
Min Slew Rate (V/μsec)	4	no min spec*	4	no min spec*

*Manufacturer gives this parameter as typical value only. (Note that only the AD503 is completely min and max specified; the μA 740C is almost completely unspecified.)

ANALOG DEVICES
Circuit Specialists

Readers comment

Service note

To the Editor: The story on the effects of IBM's entry into the minicomputer market [Nov. 9, p. 35] implies that Teradyne has had to take over service responsibilities for minicomputers used in its systems because of poor service from the manufacturers. In fact, the minicomputers used in our systems have always been serviced—quite satisfactorily, we think—by the manufacturer, Digital Equipment Corp. It is true that minicomputer service arrangements generally leave much to be desired, but in this connection we regard DEC as a notable exception.

Frederick Van Veen
Teradyne Inc.
Boston, Mass.

Right ratio

To the Editor: In the final paragraph of the article on PCM converters [Oct. 26, p. 161; p. 11E in the international edition], both video signal-to-quantizing-noise figures of 50 decibels are wrong. They should read 60 dB. The ratio obtained in practice from the eight-bit system is thus in close accord with theory and is also close to the signal-to-noise ratio required by video analog main links.

V.G. Devereux
British Broadcasting Corp.
Tadworth, Surrey

Refreshing realism

To the Editor: William Taren's article on the real cost of semiconductor memory systems [Oct. 12, p. 94] was refreshing. We share Mr. Taren's concern over the current marketing techniques of some of the semiconductor and core houses. They would lead one to believe that a handful of parts at minimal cost represents the answer to all memory system problems and costs. Perhaps the article will encourage a more professional and realistic approach by these suppliers to memory and storage needs.

Henry S. Craumer
Senior sales representative
Corning Glass Works
Raleigh, N.C.

Actual Size!

Fully automatic: DC to 3 GHz–$2,295.

S-D's new 6053 counter:

Automatic operation, plus a new low sensitivity, high input impedance 200 MHz amplifier add up to one thing—a new high in counter performance. By automatic operation, we mean just that. All you do is hook up to either the BNC or "N" type connector and push the range button. It's really simpler than using an ordinary frequency meter!

Other key features and specs: 3½" half rack configuration. Resolves 3 GHz to 0.1 Hz. Remote programmable. BCD recorder output. 10 mV rms on 200 MHz input. Choice of 7 or 9 full digits.

The $2,295 price comes out to only 77¢ per MHz! For that, why settle for 500 MHz, when the new S-D 6053 goes right up to 3 GHz?

Ask your local Scientific Devices office for complete data or a demonstration or contact: Concord Instruments Division, 888 Galindo St., Concord, CA 94520. Phone: (415) 682-6161. TWX: 910-481-9479.

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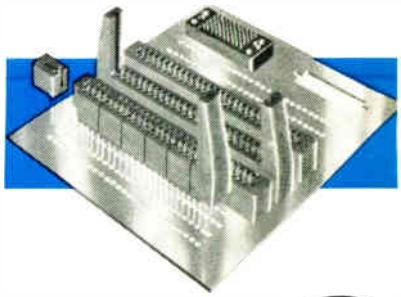
Another S-D instrument first! Electronic counters/Digital voltmeters/Pulse generators/Data generators/Time code generators/Sweep generators/Spectrum analyzers/Digital panel meters/Digital clocks/Signal generators/Oscillators/Laboratory magnets/Precision power supplies/Analog & analog-hybrid computers/Data acquisition systems.

THESE



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Interconnections for the Seventies

TEMS ARE READY
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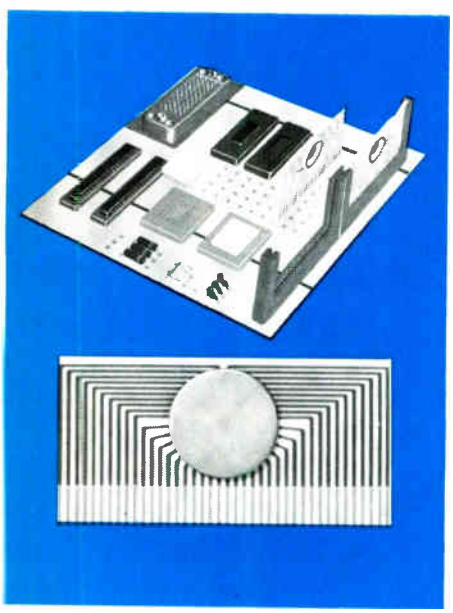

Substrate Connectors

There's no limit to the packaging system requirements Winchester Electronics is prepared to meet right now. Our AccurSystem® packaging is the interconnection industry's most comprehensive line of back-panel mounting, precision connectors. It offers interconnect capability for PC logic boards, dual-in-line devices, and advanced MSI/LSI circuitry.

What's more, you get cost and performance advantages right down the line. Meet critical application tolerances with true contact positioning standard frame mounting HW series edgeboard wrappable connectors. Provide inexpensive built-in ground or voltage planes with modular plate connectors. Upgrade reliability and slash end-item costs with the unique solderless termination concept of our AccurPlane glass-epoxy PC back panels. These combination ground/voltage boards accept both IC sockets and edgeboard connectors, and are available in a multilayer configuration with reduced discrete wiring requirements.

Our years of experience work to your advantage — with the advanced engineering know-how that gives you right-now answers for connector applications from A to Z.

Our total-system approach to interconnections includes an in-house wrapping capability. Write for additional information: Winchester Electronics, Division of Litton Industries, Main Street and Hillside Avenue, Oakville, Conn. 06779, or call toll-free (808) 243-3566.

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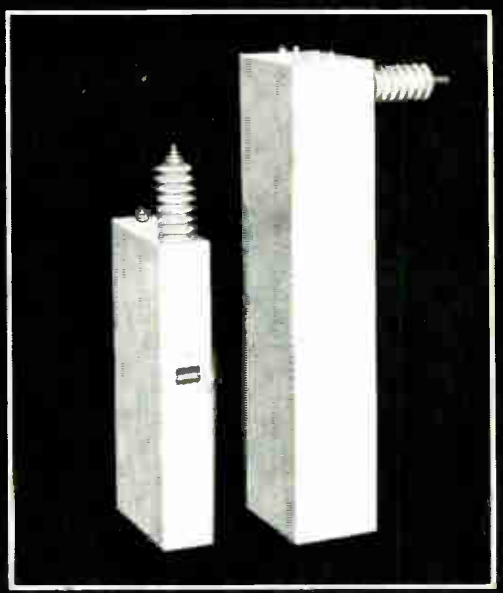
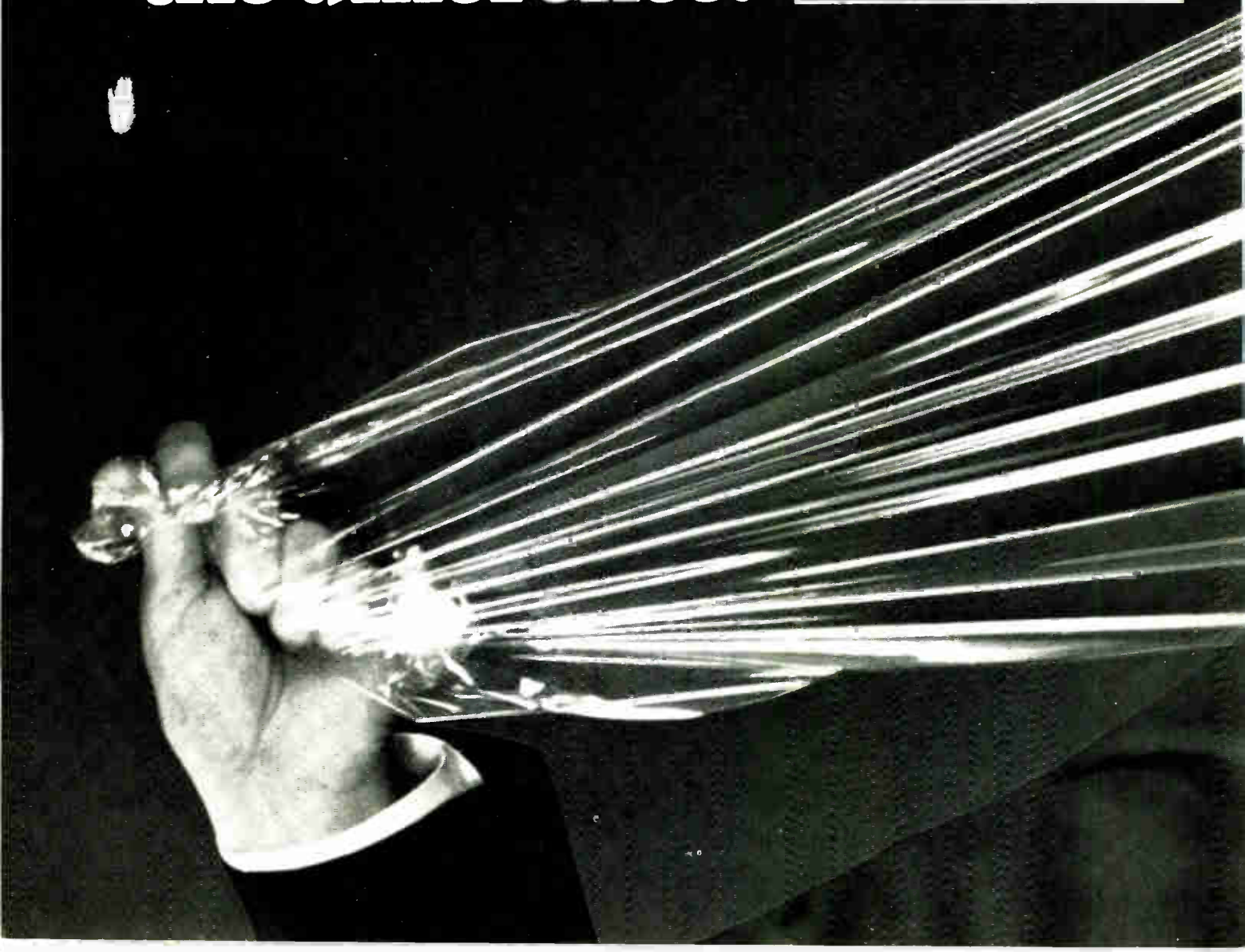
Rexene makes the polypropylene.

GE makes the capacitor film.



That makes the difference.



Rexene polypropylene* resin (PP 41-E-3) can be fabricated into film with dielectric properties far superior to those of other polypropylene films used in capacitors to date.

The Materials Business Section of General Electric knows it.

That's why this GE division uses only a PP 41-E-3 type resin to make the film it provides to capacitor manufacturers. Rexene started working with GE some years ago to develop a unique formulation for capacitor applications. Because of the dielectric properties of Rexene polypropylene, the GE film has a low dissipation factor which minimizes the chance of thermal runaway. It is resistant to such impregnating solvents as trichlorobiphenyl liquid and has a broad temperature range, so it operates more efficiently than paper and other polymers at higher temperatures.

Other advantages of film made of Rexene PP 41-E-3: fewer faults per area; resistance to high electrical stresses; greater cleanliness; improved performance, efficiency and economy.

This is just one example, among hundreds, of how Rexene polypropylene improves product performance. There are dozens more in the product and packaging problems you face now. For details and application help, call or write: Rexene Polymers Company, P.O. Box 37, Paramus, New Jersey, 07652. Or call (201) 262-6500.

You've got it made with

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*Produced under the Joint Venture with El Paso Products Co., Subsidiary of El Paso Natural Gas.

What's the prognosis for Medical Electronics?

DOCTORS, HOSPITAL ADMINISTRATORS, AND ENGINEERS CAN FIND OUT BY ATTENDING THE

3rd National Conference & Exposition on Electronics in Medicine
April 13-14-15, 1971/Sheraton-Boston/Boston, Massachusetts
Presented by Electronics/Management Center
in association with McGraw-Hill Publications
Electronics/Medical World News
Modern Hospital/Postgraduate Medicine

- What's available in patient-monitoring equipment and what's needed?
- What can computers do in medical record keeping and data analyses that they couldn't do before?
- How safe is medical electronics equipment – from the standpoints of both patient and operator?
- How stringent are major test equipment requirements of the clinical laboratory?
- What are the most effective techniques now in use in multiphasic screening?
- What are the key problems in hospital electronic equipment buying and maintenance?
- How will the Cooper Committee report affect new device control legislation?

These questions will be fully explored at a series of unique workshop sessions during the three-day 3rd National Conference on Electronics in Medicine to be held in Boston next April.

The 1971 meeting will include 50 per cent more topics and speakers than the previous conference. Morning sessions will feature speakers who have been selected for their expertise as well as for the articulate manner in which they convey their knowledge to a professional gathering such as this.

The enthusiasm of the '70 conferees for the afternoon panel/workshops has won a repeat performance – this time with topical discussions and specialists who will lead the workshops. They'll attack problems from all sides, then invite attendees to become active participants in the sessions. Conferees will have a chance to join at least two of the six workshop sessions.

An important adjunct to the technical program will be an exposition of new hardware (and software) in the medical electronics field.

SPEAKERS:

Dr. John Knowles, General Director
The Massachusetts General Hospital
Boston, Mass.: Feature address

Dr. Donald M. MacArthur, former
Deputy Director (Research & Technology)
Department of Defense
Topic: Hospital of the future

Dr. H. Fernandez-Moran
The University of Chicago
Topic: Information storage

Dr. Charles Edwards, Commissioner
Food and Drug Administration
Topic: FDA's role in medical device legislation

William Goodrich, General Counsel, FDA
Topic: Evaluating present and proposed regulatory practices

Professor Oliver Schroeder, Director
Law-Medicine Center
Case Western Reserve University
Topic: Medicolegal aspects of electronics in medicine

Dr. Arthur C. Beall, Jr.
Baylor University, College of Medicine
Topic: Device legislation: Another look

Dr. Cesar A. Caceres
Professor and Chairman
Department of Clinical Engineering
The George Washington University Medical Center
Topic: Cardiac screening

Dr. Octo Barnett
Director, Laboratory of Computer Science
The Massachusetts General Hospital
Topic: Hospital automation

Dr. John B. Henry, Professor and Director,
Dept. of Pathology
State University of New York
Upstate Medical Center
Topic: Multiphasic screening

Dr. Julius Korein
Dept. of Neurology
New York University Medical Center
Topic: The computer and the medical record

Dr. Max Harry Weil
Associate Professor of Medicine
Presbyterian Hospital, Los Angeles
Topic: Patient monitoring

Dr. Joel Nobel, Director of Research
Emergency Care Research Institute
Philadelphia
Topic: Evaluating equipment

Dr. Dwight E. Harken
Chief, Thoracic Surgery
Peter Bent Brigham Hospital
Topic: Periontogenic diseases

Dr. William A. Spencer, Director
Texas Institute for Rehabilitation and Research
Topic: Electronic prosthetic devices

Dr. Allen Wolfe
Barnes Engineering Company
Stamford, Conn.
Topic: Thermography

Dr. Aida S. Khalafalla
Senior Principal Research Scientist
Honeywell
Topic: Plethysmography

Mr. Roger S. Powell
National Heart & Lung Institute, NIH
Topic: Electrical energy systems for
artificial hearts

EXHIBITS:

New medical electronics instrumentation and support equipment will be featured in the exposition that accompanies the technical program. Many manufacturers will display equipment that can be demonstrated or operated on site in the exhibit hall (John B. Hynes Civic Auditorium, adjacent to the Sheraton-Boston).

Among those companies which plan to display their most advanced equipment are American Telephone and Telegraph Co., Bio-Optronics, Biotronics, Birtcher Corp., Civil Systems, Coulter Electronics, DeVilbiss, Dyonics, Goodman Brothers, Graphic Controls, Honeywell Inc., Humetrics, Intec, Isotopes (Teledyne), Macro Service, Mechanics for Electronics, Mediquip Corp., Medical Information Technology Inc., Motorola, Raytheon, Sanders Associates, Sloan Technology Corp., Princeton Fluidics, T & T Technical, and Technicon.

Exhibits will provide an important opportunity for attendees to see first hand (and in some cases even operate) the latest equipment and instrumentation designed specifically for medical applications.

WORK SESSIONS:

Patient monitoring: Leader, Dr. Howard Hochberg; Roche Medical Electronics; A discussion of routine and critical problems in patient monitoring, including available instrumentation and equipment needed to provide improved monitoring.

Computers in medicine: Leader, Dr. William E. Chapman, Palo Alto Medical Research Foundation. What the computer can and can't do in medical record-keeping, data analysis, and medical history taking.

Safety clinic: Leader, Allan F. Pacela, chief research scientist, Beckman Instruments. A forum at which doctors and engineers will be able to exchange views on what is available and what is needed to improve the safety of medical electronic equipment from the standpoint of both patients and operators.

Laboratory automation: Leader, Dr. Hugo C. Pribor, Director, Institute of Laboratory Medicine. Perth Amboy. A discussion of the major test equipment requirements of the clinical laboratory, with a critical evaluation of present and future needs.

Multiphasic screening: Leader, Dr. Allen Pryor, Latter Day Saints Hospital. What are the most efficient techniques now in use and how can they be improved? This session will probe the question.

Impact of electronics instrumentation in hospitals: Leader, A. Allen Weintraub, Administrator, St. Vincent Infirmiry, Little Rock. Key problems center on selecting and organizing electronics equipment in the hospital to get maximum immediate benefit.

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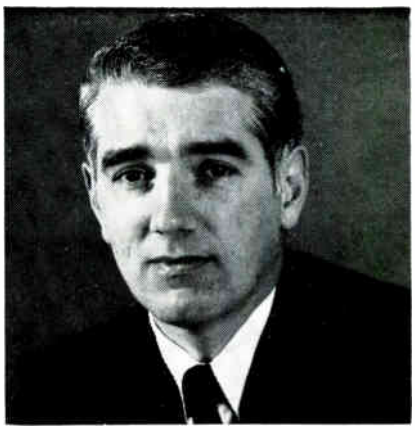
Who's who in electronics



Richard

The task facing Donald F. Richard, North American Rockwell Microelectronics Co.'s new director of domestic sales, might be likened to that of a gourmet chef who has to add just the right amount of each ingredient or he won't get that precise taste he's after. Similarly, the 38-year-old Richard has to add just the right number of domestic salesmen to the NRMEC payroll or he could end up with more work than the plant can handle, despite its considerable capacity.

"We have a target for adding people in the near term," Richard says, "and part of my job will be to determine the number and types of people we want. We'll have to be very flexible in the next year, as will all semiconductor manufacturers, in a soft market."

Until now, the Anaheim, Calif., manufacturer of MOS/LSI arrays has been riding the crest of big contracts from Sharp Corp. of Japan, which uses NRMEC circuits for its Micro-Compet minicalculator. But the production capacity in NRMEC's main plant has outstripped Sharp's needs and the firm has been building inventory, so much so that NRMEC had to lay off 170 production workers this month.

"It's difficult to say how large our sales force will be," Richard says, "because one of three situations could come through and slow the growth of that force." It's clear, though, that NRMEC isn't looking only for the $30 million kind of contracts it received from Sharp. "We'll be looking for commitments that don't have the large contract dollars of the Sharp effort," Richard says.

His parting with American Micro-Systems Inc., where he was a member of the corporate staff, was amicable. His reasons for leaving the Santa Clara, Calif., firm and joining NRMEC, include "a tremendous potential for growth and a tremendous capability. It will be a big challenge to marry these to market needs. I thought it was a unique opportunity."

Does the U.S. face an engineer shortage despite today's high unemployment rate? Jesse R. Lien fears it's true; the senior vice president of Sylvania Electric Products predicts that while there may be more men than jobs now, by 1975 the country could be short 70,000 engineers or more. And the effect would be painful.

He bases his fear on several reasons: "Foremost, the present recession is a transient thing," he feels, "and the engineers walking the streets today will find work—perhaps sooner than they think.

"Second, as spending rises again in both civilian and governmental sectors, the demand for engineers should increase—meanwhile, the relative number of engineers entering the field is declining," he maintains. "While the number of college graduates rose from about 3 million yearly in 1958 to about 7.5 million in 1968, the number of engineers per year remained stable at about 300,000 or so," a relative fall of more than 50%, he notes.

"Worse," he says, "I think we can look forward to a decline from the 300,000 level to something like 200,000 to 250,000 within the next few years," largely because of public disenchantment with technology in general, and more specifically, because recessions have made professional engineering look less palatable than it is.

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Who's who in electronics

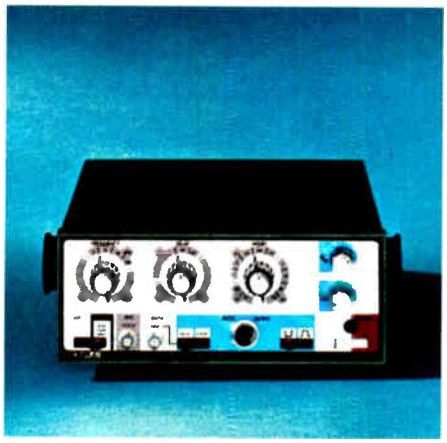
high school guidance counsellors have been directing students away from engineering careers," he says. "The 1963 recession was transient too, but unfortunately the counsellors' attitudes outlasted it and have been reinforced by the present one."

But more than anything else, Lien fears what he calls today's negativism. "Many are beginning to react almost as if technology were evil by definition," he says. "Many place the burden of proof on technology, rather than its application—or even fail to distinguish between the two. Thus the climate has become so depressing that talented men now are entering other fields."

When Alvin B. Phillips went looking for someone to head his design operations at the fledgling General Digital Corp. [*Electronics*, June 22, p. 14], he settled on Viatron Computer Systems as the best place to find one. Phillips, president and chairman of the Santa Ana, Calif., firm he founded to manufacture MOS/LSI arrays, figured the experience of Richard M. Perrin would make him ideal for the job.

Perrin, 28, agreed, and came aboard last month as General Digital's manager of MOS/LSI design engineering. Phillips felt Perrin's experience in working with just about every MOS vendor as Viatron's manager of array design would be invaluable at General Digital. For his part, Perrin decided he wanted to work with a semiconductor vendor rather than a user. "It wasn't because I thought the grass was greener on the vendor side," Perrin says. "I just want to round out my experience."

Perrin explains his desire to work for a small company this way: "I was attracted to General Digital because the work is a lot more challenging than it would be working for an established company. I won't have to push against the heavy weight of decisions that have been handed down from above. I'll have to make my own decisions and live with them."



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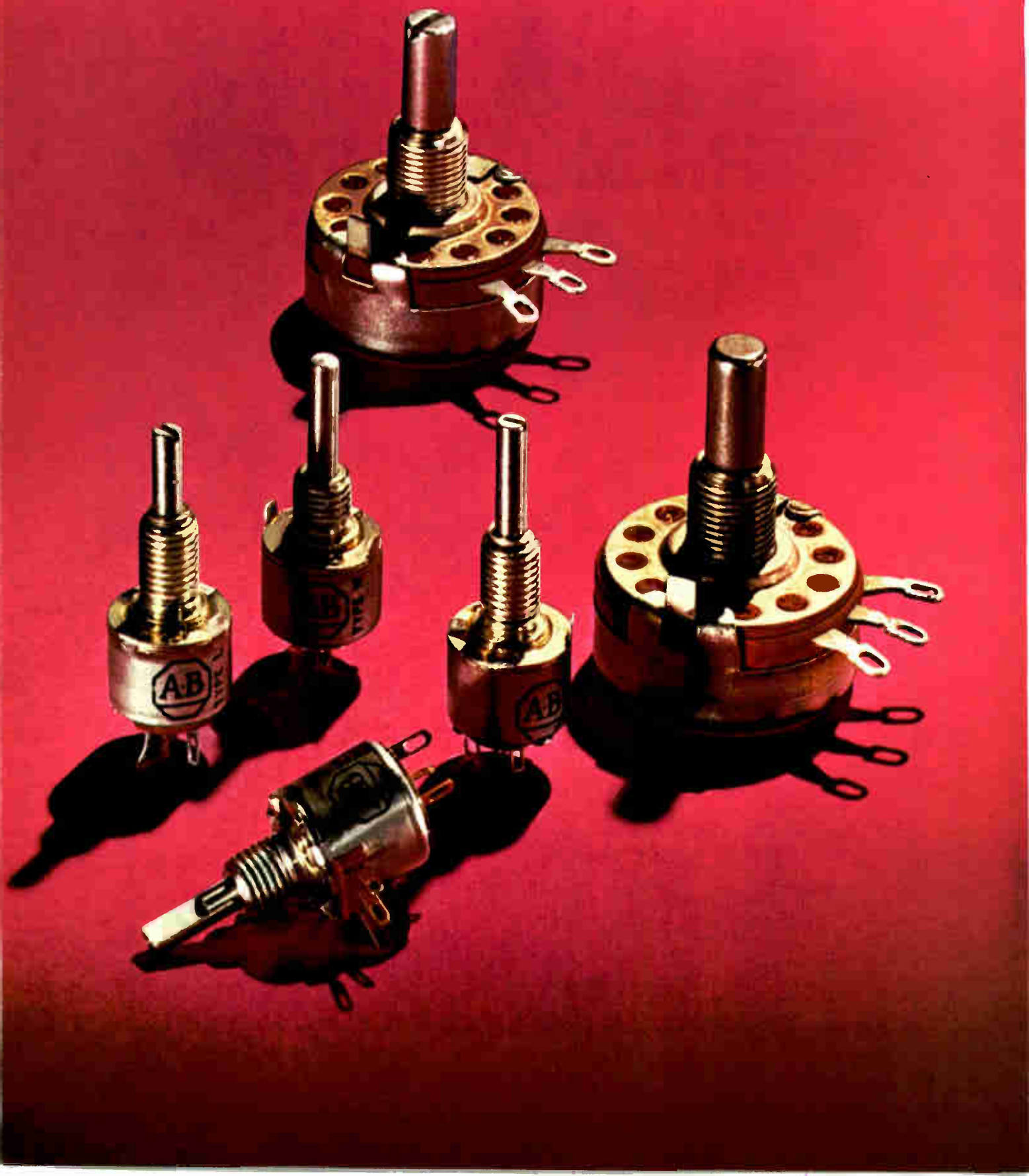

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	TYPE J— STYLE RV4	TYPE K	TYPE G— STYLE RV6	TYPE L	TYPE W	TYPE GD
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POWER at + 70°C	2.25 W	3 W	0.5 W	0.8 W	0.5 W	0.5 W
TEMPERATURE RANGE	−55°C to +120°C	−55°C to +150°C	−55°C to +120°C	−55°C to +150°C	−55°C to +120°C	−55°C to +120°C
RESISTANCE RANGE (Tolerances: ±10 and 20%)	50 ohms to 5.0 megs	50 ohms to 5.0 megs	100 ohms to 5.0 megs	100 ohms to 5.0 megs	100 ohms to 5.0 megs	100 ohms to 5.0 megs
TAPERS	Linear (U), Modified Linear (S), Clockwise Modified Log (A), Counter-Clockwise Modified Log (B), Clockwise Exact Log (DB). (Special tapers available from factory)					
FEATURES (Many electrical and mechanical options available from factory)	Single, dual, and triple versions available. Long rotational life. Ideal for attenuator applications. Snap switches can be attached to single and dual.	Single, dual, and triple versions available. Long rotational life.	Miniature size. Immersion-proof. SPST switch can be attached.	Miniature size. Immersion-proof.	Commercial version of type G. Immersion-proof.	DUAL section version of type G. Ideal for attenuator applications. Immersion-proof.

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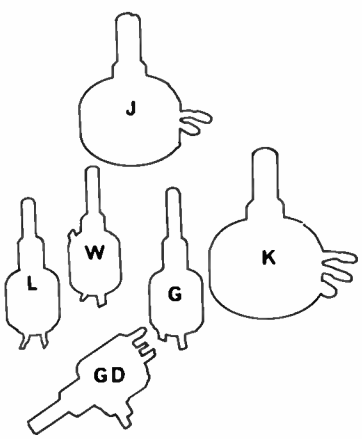

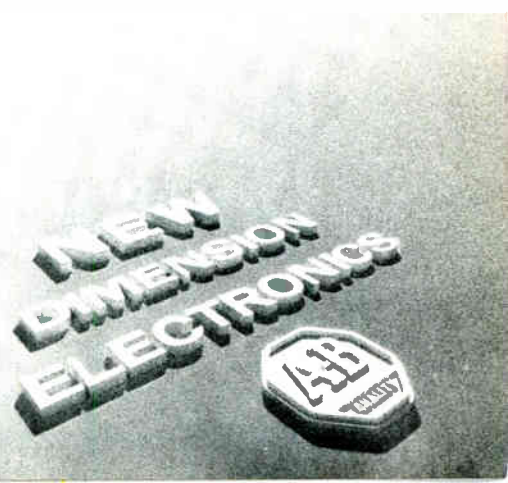

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Meetings

Calendar

Reliability Symposium, IEEE; Sheraton Park Hotel, Washington, **Jan. 12-14.**

Optics in Microelectronics, Optical Society of America, Stardust Hotel, Las Vegas, **Jan. 25-26.**

Winter Convention on Aerospace and Electronic Systems (WINCON), IEEE; Biltmore Hotel, Los Angeles, **Feb. 9-11.**

International Solid State Circuits Conference, IEEE; Sheraton Hotel, University of Pennsylvania, **Feb. 17-19.**

International Convention & Exhibition, IEEE; Coliseum and New York Hilton Hotel, New York, **March 22-25.**

Reliability Physics Symposium, IEEE; Stardust Hotel, Las Vegas, **March 31-April 2.**

European Semiconductor Device Research Conference, IEEE, DPG (German physical society), NTG (German communications society); Munich, **March 30-April 2.**

USNC/URSI IEEE Spring Meeting, Statler Hilton Hotel, Washington, **April 8-10.**

National Telemetering Conference, IEEE; Washington Hilton Hotel, **April 12-15.**

Conference & Exposition on Electronics in Medicine, Electronics/Management Center, Medical World News, Modern Hospital, Postgraduate Medicine; Sheraton-Boston Hotel and the John B. Hines Civic Auditorium, **April 13-15.**

Relay Conference, College of Engineering, Oklahoma State University Extension, National Association of Relay Manufacturers; Stillwater, Okla., **April 27-28.**

Southwestern IEEE Conference and Exhibition, Houston, Texas, **April 25-May 2.**

International Microwave Symposium, IEEE; Marriott Twin Bridges Motor Hotel, Washington, **May 16-20.**

Call for papers

Symposium on the Applications of Ferroelectrics, IEEE; IBM Research Center, Yorktown Heights, and Holiday Inn, White Plains, N.Y., **June 7-8. Feb. 8** is deadline for submission of abstracts to Prof. L.E. Cross, Materials Research Lab, Pennsylvania State University, State College, Pa. 16802.

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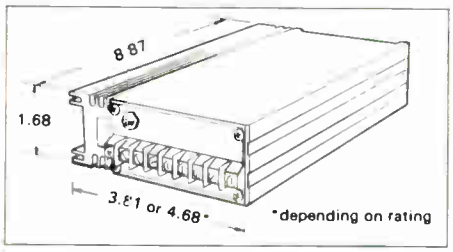

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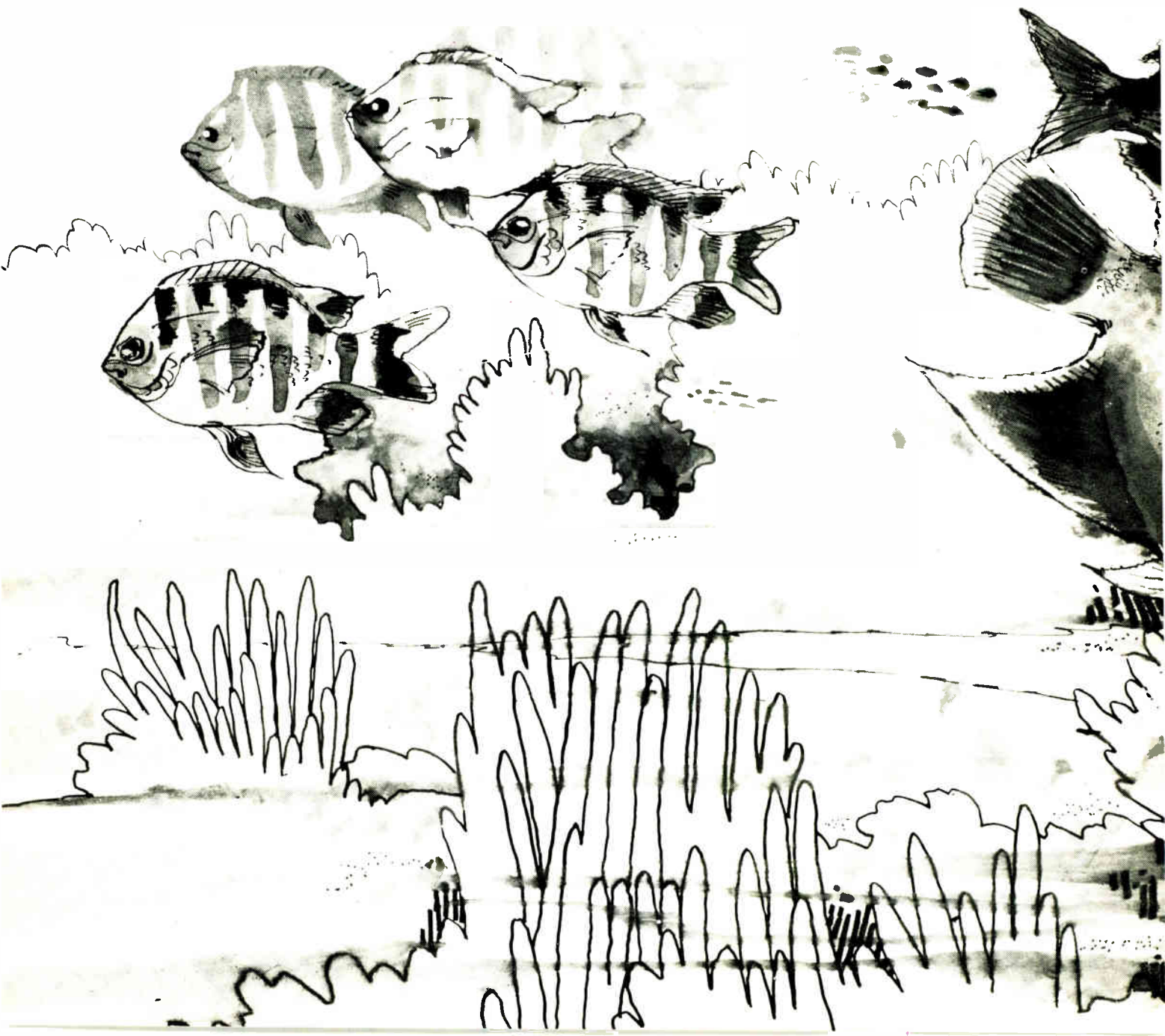

Think of sonar as a pair of eyes. The only trouble with the eyes is that no one has been able to precisely check them under working conditions.

Basically, that's the concept behind the sonar range of AUTEC, the United States Navy's Atlantic Undersea Test and Evaluation Center.

Our Electro Dynamic Division is building and will install the entire complex of shore-based, shipboard and underwater systems for this sonar range for the Navy. AUTEC is located off Andros Island in the Bahamas.

When it's completed, AUTEC will have the first system able to check all the performance characteristics of sonars in a working ocean laboratory.

The AUTEC sonar range will measure the three-dimensional beam patterns and source levels of various sonar devices and analyze signal content and performance levels of advanced sonar systems.

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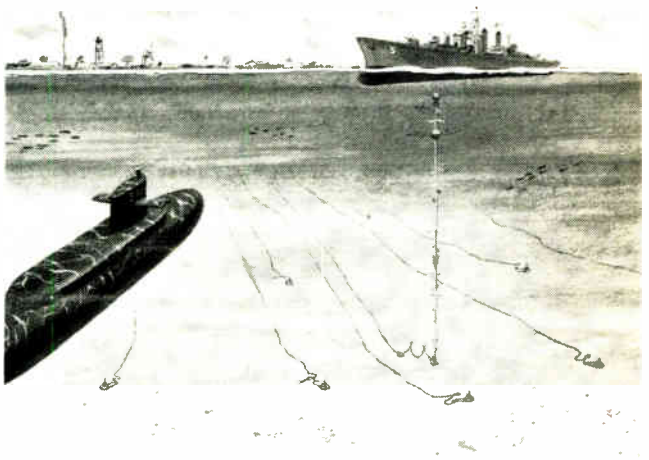

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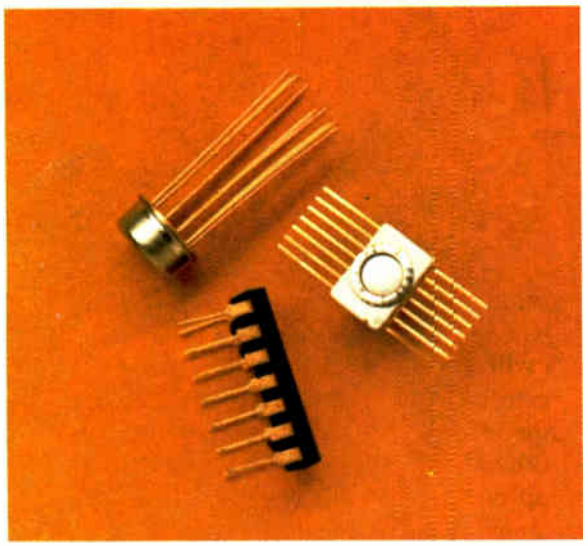

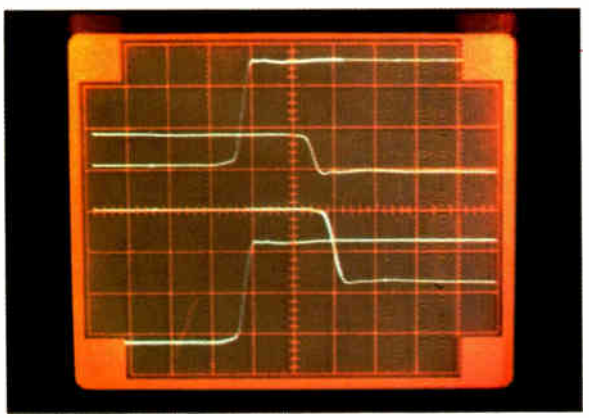

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Electronics Newsletter

December 21, 1970

Fairchild turns to linears as digital sales sag

The slump in the digital integrated circuit market is forcing many manufacturers to turn to linear ICs, and Fairchild Semiconductor says it will introduce a series of linears within the next few months.

One, says the company, is an extremely low-power op amp that will make the 735 obsolete. "It will draw only a microwatt of power," adds a spokesman, "which is less than others draw for input current alone." Also coming is a phase-locked loop circuit that can work directly with crystals (for cheap frequency reference) that's scheduled to cost less than $3. Finally, Fairchild is promising "the first linear Schottky barrier product," which will provide very high-speed operation.

$1 million RCA chips to go into watches

RCA has landed a million-dollar IC order for the Pulsar digital readout wristwatches that will be made for the Hamilton Watch Co. by Electro/Data Inc. of Garland, Texas. The order includes digital circuits, linear arrays, and complementary MOS chips [see p. 83].

George H. Theiss, president of Electro/Data, says Hamilton has ordered 1,000 Pulsars. Production will start next month. While the prototype contained 44 ICs, the watches will actually contain only 22. C/MOS will be used for the stages of the watch that are always on; linears will drive the light-emitting diodes in the pushbutton display.

AMI to offer CAD facilities to end users

American Micro-systems Inc. is about to join the list of circuit makers offering computer-aided design facilities to end users. The Cupertino, Calif., MOS/LSI manufacturer is seriously considering permitting those users to do their own work in portions of its CAD center. W.W. Vallandigham, senior vice president, says AMI will offer for sale a software program that makes AMI's Burroughs 2500 computer terminal look like a Control Data Corp. model 200 terminal for the CDC 6600 time-sharing system in Palo Alto, Calif. AMI's Burroughs computer is on-line with the CDC system. Further, AMI also may make available its circuit analysis, logic simulation, test verification, and layout programs—all without any need for the user to work with AMI engineers.

AMI is not alone in its approach. Collins Radio has made portions of its CAD facility and programs available on an as-needed basis. [*Electronics*, Nov. 23, p. 32] without insisting that the customer go through the entire Collins system. Both firms, however, will still do custom chip design and production for customers seeking the complete interface.

IBM gets bulk of Wild Weasel

IBM's Federal Systems division has snared the largest chunk of the preliminary work for the Wild Weasel electronic countermeasures system to go on the F-4 aircraft. The $8 million contract is for the initial phase of the Radar Homing and Warning System (RHAWS) and is viewed as prelude to a potential $100 million production run.

Other components of the system will be developed by Loral Electronics —$2 million for the display—and Texas Instruments—$1.6 million for the computer. McDonnell Douglas is the prime contractor.

Loral's loss of the RHAWS work to IBM was a blow, particularly since the New York City firm had invested more than $500,000 in its proposal.

Electronics Newsletter

New MOS firm to market tester

General Digital Corp., the MOS/LSI manufacturer founded last spring by Alvin B. Phillips [*Electronics,* June 22, p. 14], has taken the wraps off its first product—and it's not an MOS array. The Santa Ana, Calif., company will market an MOS tester, called the Spartan 770, it developed to meet its own needs. Phillips, who is president and chairman of GDC, says the machine will do functional and parametric testing, with functional speeds of up to 5 megahertz, thanks to hybrid LSI driver comparators located just a few inches from the test socket.

The machine uses a 1,024-bit bipolar random-access data pattern memory accommodating 40 data channels, plus its own special-purpose mode control computer instead of a general-purpose minicomputer. Phillips says the latter feature eliminates the software headaches associated with many current testers. What's more, elimination of the software will allow General Digital to sell the machine for less than $100,000 Phillips says.

The Spartan 770 will test devices with up to 52 pins, and can be programed manually with thumbwheels or automatically by means of punched cards or tapes. Phillips says it will find uses in both diagnostic or engineering testing and production testing.

NRMEC processing other firms' ICs

To use its elaborate and technologically advanced beam-lead integrated circuit facility more efficiently, North American Rockwell Microelectronics Co. is processing ICs from other manufacturers.

NRMEC accepts diffused IC wafers from its customers, designs the beam lead pattern for them, and deposits the beam lead metalization. The beam-leaded ICs are returned to the customer as a wafer, or are laser-scribed into chips. Circuits as complex as a 1,024-bit ROM can be handled. The company also can put on solder bumps for flip chips.

IBM kills charge for extra store use

Spurred by competition from the independent peripheral equipment builders, IBM has eliminated the extra-use charges for all its multiple-spindle disk storage units. Previously, the customer was entitled to 22 eight-hour days of use for a basic rental, with extra charges for night shifts and weekends. One of the units, the 3330, has been termed the largest commercial product on the market in terms of total revenue.

Addenda

National Semiconductor is offering a calculator kit that consist of five MOS ICs: keyboard interface chip, arithmetic chip, register, control ROM, and timing chip. All are standard designs, but are customized via a special metalization pattern. National has 12 customers for the kit . . . Independent peripheral equipment makers lost their first opportunity to take a major award away from computer mainframe manufacturers when the Internal Revenue Service bought its system complete from Control Data Corp. Yet industry sources complain that CDC's $29.3 million award represents a "buy-in" on a program originally pegged near $40 million. Included in the price for the IRS nationwide information retrieval net are 3,600 CRT displays—for which CDC will supply its 65054 model—plus 10 CDC 3304 medium-scale computers and 360 printers . . . Motorola Semiconductor is automating nearly all its IC and discrete component processes. Automation extends from wafer preparation to photoetch and diffusion. The key installation is a bank of 22 diffusion furnaces under real-time control of twin CDC 1700 computers.

New FET V-O-M features
8 Low-Power Ohms Ranges . . .
0.005 V AC Full Scale

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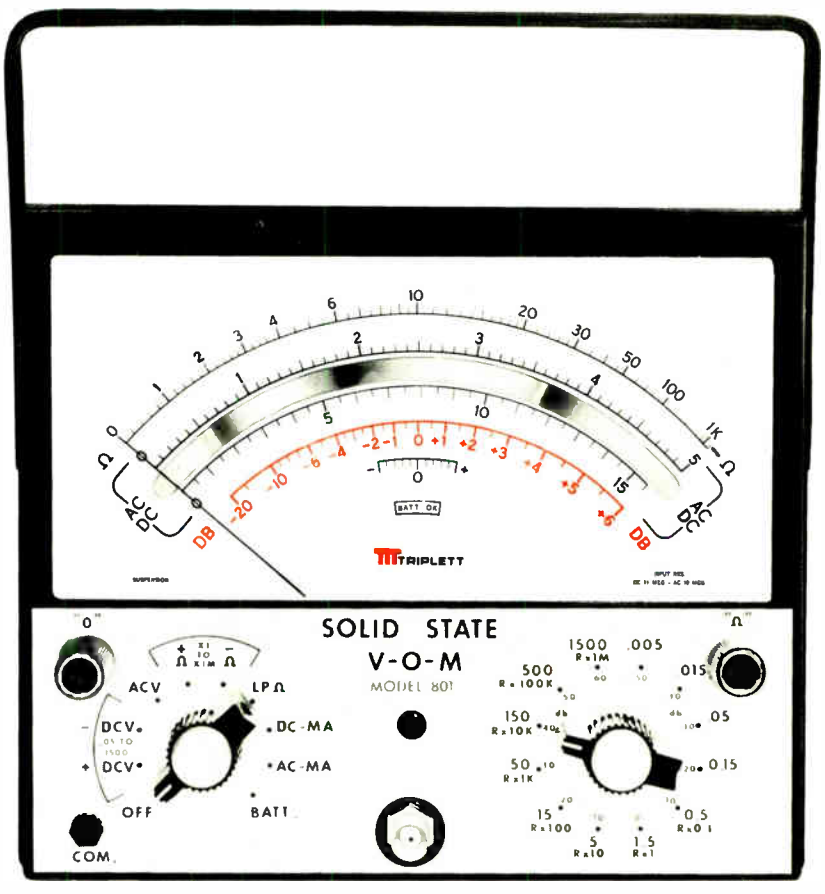

Model 801

1. 8 ranges of low-power ohms at 35 mV with 1 ohm center scale.
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3. 8" meter has simplified scale with only 2 arcs for 46 AC/DC ranges.

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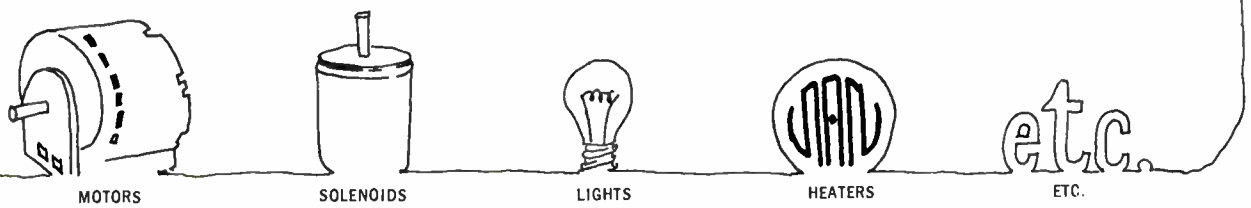

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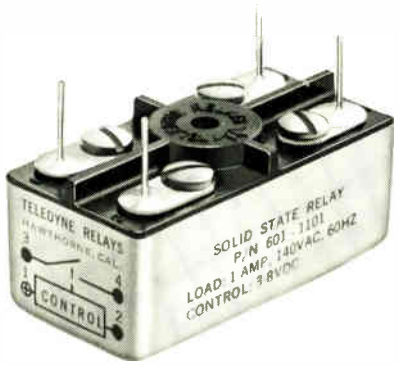
- Total isolation between control and load circuits (4-Terminal Network)
- All solid state (NO REEDS)
- Zero voltage switching available to minimize RFI
- Transient protected on input and output
- PC board or screw terminal mounted



PART NUMBERING (Economy Line)

INPUT (CONTROL) VOLTAGE RANGE	OUTPUT VOLTAGE RATING	OUTPUT (LOAD) CURRENT RATING & PART NUMBERS				
		1 AMP	3 AMP	5 AMP	7 AMP	10 AMP
3-10 VDC	140 VAC	601-1001	601-1002	601-1003	601-1004	601-1005
	280 VAC	601-1006	601-1007	601-1008	601-1009	601-1010
6-32 VDC 15-45 VAC	140 VAC	601-1011	601-1012	601-1013	601-1014	601-1015
	280 VAC	601-1016	601-1017	601-1018	601-1019	601-1020
20-75 VDC 60-140 VAC	140 VAC	601-1021	601-1022	601-1023	601-1024	601-1025
	280 VAC	601-1026	601-1027	601-1028	601-1029	601-1030
9-15 VAC	140 VAC	601-1031	601-1032	601-1033	601-1034	601-1035
	280 VAC	601-1036	601-1037	601-1038	601-1039	601-1040

NOTE: Add "P" to P/N for printed circuit (pin) mounting only.

ECONOMY LINE PRICE/QUANTITY (Typical)

LOAD	QUANTITY		
Amps @ 140 VAC	10 - 24	100 - 249	1000 - 2499
1	$12.20	$ 8.75	$ 6.65
3	13.50	9.70	7.35
5	15.30	10.60	8.10
7	16.60	11.55	8.80
10	18.45	12.80	9.75

PART NUMBERING (Zero Voltage Turn-On)

INPUT (CONTROL) VOLTAGE RANGE	OUTPUT VOLTAGE RATING	OUTPUT (LOAD) CURRENT RATING & PART NUMBERS				
		1 AMP	3 AMP	5 AMP	7 AMP	10 AMP
3-8 VDC	140 VAC	601-1101	601-1102	601-1103	601-1104	601-1105
	280 VAC	601-1106	601-1107	601-1108	601-1109	601-1110
7-85 VDC	140 VAC	601-1111	601-1112	601-1113	601-1114	601-1115
	280 VAC	601-1116	601-1117	601-1118	601-1119	601-1120
90-280 VAC	140 VAC	601-1121	601-1122	601-1123	601-1124	601-1125
	280 VAC	601-1126	601-1127	601-1128	601-1129	601-1130

ZERO VOLTAGE TURN-ON LINE PRICE/QUANTITY (Typical)

LOAD	QUANTITY		
Amps @ 140 VAC	10 - 24	100 - 249	1000 - 2499
1	$21.60	$15.00	$11.40
3	22.95	15.94	12.11
5	24.30	16.88	12.83
7	25.65	17.81	13.55
10	27.45	19.06	14.50

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Rectifier diodes become Trapatt oscillator source

40-cent devices show outputs of hundreds of watts with efficiencies of up to 75% for low-cost power sources

The simple rectifier diodes in your hi-fi set could be ultrahigh-frequency Trapatt oscillators in disguise—or perhaps something even better. Scientists at Sandia Laboratories, Sandia, N.M., and MIT Lincoln Laboratory, Lexington, Mass., have found that common FD-300 rectifier diodes can become the basis of low-cost uhf oscillators with pulsed outputs of tens and even hundreds of watts—and efficiencies as high as 75%.

Sandia's R.J. Chaffin and E.P. EerNisse were tipped off when they found that a simple glass-packaged, wire-lead FD-300 could generate measurable output in the Impatt mode at about 3.5 gigahertz. And since these silicon planar diodes cost only 40 cents each, the team decided that more investigation was in order.

They designed a coaxial mount for the more efficient subharmonic Trapatt oscillation mode—another inexpensive approach, using off-the-shelf parts from General Radio—and bought 100 FD-300s. Fully 83 oscillated, and some yielded 68-watt pulses at 630 megahertz. Typical efficiency was 12%. Though performance was uneven, with some diodes pulsing at only 4 W, average output for the 83 diodes ran above 35 W.

Lincoln Laboratory's Daniel F. Kostishack then set out to duplicate the Sandia work—and wound up exceeding it, and perhaps discovering a new mode of oscillation. Kostishack notes that neither the diodes nor the mounts were optimized for any specific characteristic. Also, he adds, the ultrahigh efficiency of three-diode units doesn't fit into any theoretical scheme available. Neither Impatt nor Trapatt mathematics match this performance.

Using the Sandia mount and 200 FD-300 diodes—apparently a better batch than Sandia's (all generated at least 40-W pulses at the same duty cycle)—Kostishack biased the diodes at a repetition rate of 1 kilohertz, pulsing them for 0.3 to 0.5 microsecond. Bias voltage and current varied from less than 175 volts to more than 240 V, and from less than 2.5 amperes to more than 3.5 A.

Kostishack almost immediately overshot the Sandia results, achieving 110-W pulses with 25% efficiency at 630 MHz. And his oscillator, like Sandia's, proved tunable over a 50-MHz band.

Kostishack also tried the FD-333 diode, which has slightly higher capacitance and breakdown voltage than the 300. The 333 generated a respectable 152-W peak power at 630 MHz; efficiency with this device was 30%.

But the best results with single-diode units were achieved with a microstrip version of the oscillator using the same FD-300s. Typical outputs here were 200 W at 760 MHz, with 25% efficiency. This version could be tuned over a band from 400 MHz to 1 GHz.

The real eye-opener, however, came out of Kostishack's work with parallel FD-300s in the coaxial mount. Biasing three of them as he had the single-diode units, he eventually achieved repeatable 395-W, 0.2-μs pulses at 570 MHz. The efficiency was a surprising 75%.

These results show that the three-diode unit apparently is some kind of optimum configuration; a four-diode oscillator generated only 160 W with 19% efficiency.

One disadvantage of the technique is that the diodes must be operated in a short-pulsed mode to avoid overheating—the small leads can't sink much heat.

Avionics

Navy chief okays common avionics

Ever mindful of what it costs to buy and maintain the growing number of black boxes needed in Navy aircraft, Chief of Naval Operations Elmo Zumwalt has finally cried "Enough!" And in ordering the Naval Air Systems Command to come up with a common avionics system for Navy aircraft, Adm. Zumwalt started up the Navy's newest avionics program, the Integrated Tactical Air Control System.

If it proves successful, says Ron Bauman, Itacs project engineer,

the Navy will be able to have its avionics cake and eat it, too. For while Itacs could be used as an integrated communications, navigation, and identification system (I-CNI) with a single waveform for all three functions, it will also permit the use of tactical uhf communications; tactical air navigation (Tacan); and identification, friend or foe waveforms expected to be around for many years.

Designed for use in all Navy aircraft during the 1980s, Itacs would use Navair's Advanced Avionics Digital Computer to supervise the standard rf boxes that would be developed to fill existing and future avionics needs. Extracting data from these many waveforms, however, is well beyond AADC's capabilities. Hence, one of the more difficult developments Itacs faces is the universal modem, a matched filter that will be interfaced with the processor through a multiplexer system.

Flexibility is the key to the universal modem. "The filter we're working on will be extremely wideband," Bauman says. "It also will be programable so we can load software into the processor and change filter characteristics just before we take off."

In this manner, he says, the Navy will be able to randomly change its electronic tactics before each mission simply by changing software. Similar changes also will enable the Navy to adapt its avionics equipment to new communications, navigation, or identification schemes without expensive hardware changes.

Because the system requires a high degree of flexibility and must be easily maintained, Bauman plans to turn to modular construction. He is hoping that LSI developments at Navair and by industry will permit a 10,000-stage filter, to be fashioned out of a few wafers that can operate at 100 megahertz. "It's a good challenge for LSI technology," he says.

Bauman says each Itacs module will be equipped with a power regulator that will filter out the induced transients so destructive in solid state avionics components. He also wants built-in test equipment.

A final development on the Itacs list is a common antenna system using dispersed arrays on the plane's surface. Preliminary work on dispersed array antennas already has been performed at Ohio State University, he says, "and it works. One of the things it can generate and receive is an I-CNI waveform. It also has tremendous implications for IFF or data links" because of its high-gain potential.

Bauman says that within six months, Navair will present the program to industry at a bidder conference. The tentative program plan then calls for annual funding of about $2 million a year through the 1970s. An advanced development model is expected to be readied in fiscal 1973 and flight tests will begin in fiscal 1978.

Consumer electronics

Treasury blasts Japanese exports

Though Dec. 4, 1970 is unlikely to be recalled as a day that will live in infamy, it does mark the likely beginning of a U.S.-Japanese trade war with television receivers as weapons [*Electronics*, Aug. 3, p. 128]. On that day, Assistant Secretary of the Treasury Eugene T. Rossides ruled that both monochrome and color television receivers from Japan "are being, and are likely to be, sold at less than fair value" on the U.S. market. Four days later, Rossides started a second, smaller fight by ruling that Japanese ceramic and aluminum electrolytic capacitors were also being sold at a lower price in the U.S. than they command in the home market.

Both decisions now go to the Tariff Commission, which has scheduled industry hearings on TV receivers and capacitors for Jan. 26 and 19, respectively, and by early March will determine the extent of injury, if any, caused to domestic industry by the dumping, and the amount of duty to be assessed against the imports. The determination is largely a formality, since the commission has found injury in 12 of the last 13 cases before it.

If injury is found, industry observers feel that Japanese manufacturers would choose to avoid paying duties by narrowing the price margin between sets marketed in the U.S. and at home—especially as higher prices on receivers sold in the U.S. would assuage the anger of Japanese consumers over double pricing.

The Electronic Industries Association of Japan (EIA-J) claims that the Treasury action is an attempt to slow the flow of Japanese imports so that U.S. manufacturers can take over the market in small, portable TVs first developed by the Japanese. By producing in low-wage offshore markets like Taiwan, Hong Kong, Singapore, Mexico, and Korea, U.S. firms can undercut the Japanese market. Wages in Taiwan, for example, are about a third of those in Japan. And twin-plant operations astride the U.S.-Mexican border permit U.S. manufacturers

JAPAN'S RISING TV SUN

The U.S. Treasury Department cites these receiver import figures:

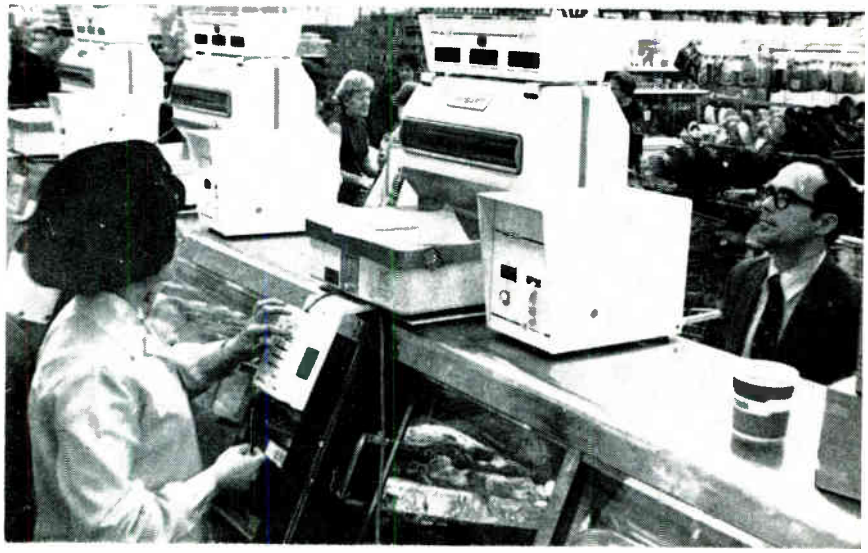
	MONOCHROME (in thousands of dollars)	COLOR
1967	65,731	52,321
1968	80,784	104,915
1969	111,928	138,688
1970 (Jan.-Sept.)	86,000	96,000

to export components to Mexico for assembly, and import the finished product without paying duties on the U.S.-made components.

The EIA-J charges that last summer's changes in antitrust enforcement policy were too close to the breakdown in the textile quote negotiations between the U.S. and Japan to be merely coincidental. Traditionally, the Treasury has accepted written price adjustments and promises of future good behavior as sufficient reason to let offenders off the hook. Under the new policy, retroactive to withholding of appraisement by Customs, dumping cases are being pursued to an affirmative or negative decision. EIA-J claims that written price assurances had been submitted by the time of the policy change, but the Treasury counters that the assurances had not yet been accepted.

The Treasury's decision that Japan is dumping TV sets is based on its study of more than 50% of the market, say Treasury sources, and does not single out specific Japanese manufacturers. But the companies looked at the longest and hardest were the five largest exporters—Matsushita Electric Industrial Co. (Panasonic), Tokyo Shibaura Electric Co. (Toshiba), Hitachi Ltd., Sharp, and Sanyo Electric Co., according to the American EIA.

The Treasury is in the process of investigating some 15 other items imported from Japan, including large power transformers, high-voltage porcelain insulators, electron probe microanalyzers, and several glass products. Decisions are due within a month for items that have been under investigation for more than a year.



Weighing game. Retrofitted system adds readout to scale, and provides accurate weight, price information on printed label.

Industrial electronics

Computerized deli scale ends expensive problem

The delicatessen department, also called the deli section, is a good moneymaker for supermarkets, accounting for as much as 8% of sales for some stores. From the retailer's viewpoint, the deli counter, with its high-priced custom-measured cold cuts and salads, also represents the source of most pricing errors because purchases cannot be prepackaged and labeled as in the meat department.

To get out of this pickle, a supermarket chain and a broad-based electronics engineering firm have computerized appetizing department sales. The result is a scale system that weighs purchases, computes selling price from unit price input, and prints a price tag for payment at the checkout counter. The scale even subtracts "tear weight"—the weight of the container or heavy wrapping paper that customers have been paying for ever since the first delicatessen dispensed its first order of smoked Nova Scotia salmon.

The system developed by Applied Information Inc. of Moorestown, N.J., consists of a display computer that reads out net weight on both the customer's and the clerk's side of the scale, a 10-digit keyboard for entering unit price which appears on the display after three keys are depressed, a printer that produces the price tag only after the customer reads the scale and the clerk pushes a print button on the keyboard, and a proprietary sensor that connects the spring balance scale to the digital readout computer. The whole system can be attached to the scales already in use.

The scale is accurate to 0.01-pound and has a capacity of 15 lb. The unit-price capacity for the computer is $9.99 while total price capacity is $99.99.

These scales will go into all 88 stores of the Supermarkets General Corp. chain in New Jersey, New York, Pennsylvania, Connecticut, and Delaware. According to Garland Smith, director of technical services for the chain, the scales reduced errors dramatically at two trial stores. Prior to initiating the project, Smith found that 90% of all packages from the appetizing departments in the chain were improperly priced. The net effect of all these errors favored the customer by 4%. Total identified error amounted to 3% of gross profit or between $500,000 and $1 million a year when projected for the entire chain.

Space electronics

ATS-F laser canceled as Aerojet fails spec

The F model of the Applications Technology Satellite will not carry Aerojet General Corp.'s laser TV link. That's because the El Monte,

Calif., company failed to meet specifications despite expenditure of virtually all its $5 million contract money [*Electronics*, Jan. 19, p. 42]. NASA program manager Harry Gerwin acknowledged cancellation of Aerojet's contract after the company said it would be unable to deliver a qualified flight model for the ATS-F launch scheduled for May 1973 without spending at least $10 million, double the bid price. With NASA's first $5 million, Aerojet delivered "a lot of breadboards, but none of them met the specifications," says Gerwin.

NASA is negotiating for a substitute laser with Hughes Aircraft Co., Culver City, Calif., loser in the initial competition, and Sylvania Electric Products, New York, according to another agency official at the Goddard Space Flight Center. But Gerwin calls this only a "possibility" and "an experiment where the capabilities will be more limited."

The canceled Aerojet laser would have had a 10.7-micron carrier, theoretically allowing it "to carry all of today's TV communications over one link," says Gerwin. The experiment, a major application of the ATS-F, was designed to provide operational experience in transmission of TV bandwidths to and from a satellite.

With the original experiment canceled, Gerwin says a possible substitute could be a carbon dioxide laser beamed down at earth stations. The ATS-F project manager concedes that no data is available on propagation of space-to-earth laser signals. "But," he adds, "they must be known. Maybe we can design equipment of operational use and get it."

Contracts

SST funding attack worries avionics firms

Commercial avionics makers are more disturbed by the threat to a 15-year production run of 500 supersonic transports than they are by the controversy as to who pays for Boeing's first two prototypes. For even though the prototype and production decisions are inseparable, money for the first is all but spent, while production funds—including an estimated $66 million for avionics—are far in the future. Cancellation of this year's funding, says a Boeing official, would have little impact on existing avionics subcontracts; the Government will be obliged to pay for work already done and let the contracts expire.

Topping the SST's $600 million avionics list is Sperry Rand Corp.'s Flight Systems division, where a spokesman estimates the operation would get $500 million of the total. Sperry has built avionics for all major commercial aircraft now in service except the Boeing 707. Now, however, it is running out of orders and, says one official, "If the SST gets shot down, we're going to run out of things for a lot of people to do."

Sperry's Phoenix operation holds $12 million in development contracts for SST avionics. By far the largest is a $10.5 million order for a digital flight control system. Essentially a sophisticated autopilot, the system uses a computer to keep the craft on course, to give the flight crew position updates, and to predict where the plane will be at specified periods of time. The system also displays malfunctions as they occur.

An $861,000 contract also was awarded to Sperry for two CRT displays that would be positioned directly in front of the pilot. The electronic attitude director indicator would replace the present electromechanical flight director. The multifunction CRT display would present Mach and altitude curves to aid the pilot in climbouts and letdowns. It also could be used to display maps.

Sperry's third contract is a $780,000 award for development of a digital air data computer, much like the unit scheduled for use in the F-15 fighter. In this unit a vibrating diaphragm would sense airspeed, altitude, and angle of attack data that could be called up by the flight crew.

Flight Systems division sources say that Boeing has told the firm to continue its avionics work. Most of the funds for the development efforts already have been paid.

Other contractors that would lose valued markets but not existing contracts include Litton Industries, whose inertial navigation platform is slated to go into the SST; Kollsman Instrument Corp., which holds a $400,000 contract for development of an air data flight indicator; and Moog Inc. and Bendix's Electrodynamics division, which are under contract to develop "fly-by-wire" control units.

Transportation Department analysis says Congress must make $184.9 million available to it to pay for work already done if the program is canceled. The issue is further confused by the fact that only $105.1 million of this sum was authorized by Congress. Another $12 million would be needed to terminate the contracts, Transportation says.

Air traffic control

Microwave ILS asked by international group

After three years, an international team of avionics experts has defined the tentative parameters of a Landing Guidance System, the eventual successor to today's Instrument Landing System. Present ILS is limited by low frequency, it can't handle curved paths or flare-out, and its off-runway usefulness is limited.

Approval by The Executive Committee of the Radio Technical Commission for Aeronautics is certain. The commission sponsored the effort that culminated in the report from its Special Committee 117, a report that includes the provisional signal format for the LGS as well as a series of recommendations for follow-on work.

However, the better part of a decade will separate the acceptance from the installation of any sort of universal system at airports around the world. Every effort has

been made to insure international participation. Further, the conferees wanted to make certain that the recommendated techniques could support a signal structure compatible with both a limited capability system and one with an extensive capability. Also, they sought a signal format that could be handled by equipment that general aviation could afford to purchase and maintain.

The tentative operational requirements of an improved ILS took a year to formulate. These were translated into performance specs for seven distinct levels of capability (grass field to major airport), and 500 companies were asked to propose systems compatible with all these levels. Of the 23 proposals received, seven were for microwave scanning types, the sort eventually selected as the most promising, and the companies that had submitted them were asked to write a common specification.

Simultaneously, a team of avionics manufacturers' representatives was brought into the advisory loop to make sure the specification was in line with what could actually be manufactured, while an economics advisory team provided inputs concerning the market and the practical limits on equipment cost for the various user categories.

The provisional signal format is based on the use of either a conventional scanning-beam system in which angular information is contained in the signal modulation, or a Doppler system in which equivalent modulation is generated by actually shifting the position of the radiating source: a linear array is sequentially fed a single signal, and the source thus appears to move. The aircraft's position with reference to the runway centerline then determines the frequency and sequence of the resultant Doppler terms it receives. The classes of service range from simple straight-in azimuth guidance from ± 20° off the extended runway line, to curved azimuth and elevation guidance paths for up to ± 60° off the runway line (and +40° back course), including precise DME, missed-approach flareout and, potentially, rollout guidance as well.

LGS will consist of a C-band (around 5 gigahertz) elevation and azimuth guidance elements, A K_u-band (around 13 GHz) flareout elevation guidance element, a C-band element for missed-approach azimuth and optional elevation guidance, a DME operating at an adjacent frequency in C band, and an optional K_u-band element for guiding military aircraft in azimuth. Ground system costs are very roughly estimated at $218,000 for a limited-capability installation, and between $500,000 and $600,000 for one with full capability. Airborne equipment costs for a minimal system are similarly estimated to be $5,500, and one with all the extras (but not built to Mil-Specs) will cost around $21,000.

Commercial electronics

Stock quotes available in home or office

Investors soon will be able to get their latest stock market prices at home—without having to call their brokers' offices. By renting an inexpensive terminal supplied by a Philadelphia company, Sonex Inc., they can get quotes directly by querying a central minicomputer.

Called Marketline, the system will be operating next month in Philadelphia. At a monthly rental as low as $16.50, the PSQ-100 terminal may become the first computer input/output device to find its way into homes—or hotels, motels, golf courses or anywhere else.

Stock quote systems supplied to brokers' offices by companies such as the Ultronic Systems division of General Telephone and Electronics and the Bunker Ramo Corp. are much more expensive, partly because they read out the latest stock prices in real time, incurring a substantial per-terminal fee from the stock exchanges. Marketline quotations, on the other hand, avoid such charges by giving prices that are delayed 15 minutes. The brokers' systems with their cathode-ray tube displays also are more elaborate, requiring an interface box renting for hundreds of dollars to drive individual terminals.

In the Marketline, prices are displayed on four RCA hot-filament Numitron readout tubes. And the unit, little larger than a telephone, is installed simply by plugging it into a 115-volt electrical outlet, says Sonex' Marvin E. Rogers. A user dials the central minicomputer using his own telephone, places the phone's handset on an acoustic coupler built into the terminal, and queries the computer with a telephone-type push button keyboard. Prices are provided for New York and American Stock Exchanges and the Over-the-Counter market.

The keyboard has 16 keys, arranged in a 4-by-4 matrix. Keys include the digits 0 thru 9, and individual keys for high, low, opening, and last prices. (Bid and asked requests for over-the-counter stocks are made with the opening and high keys.) Two other keys connect the terminal to the computer, and send on a request after it has been punched on the keyboard. All stocks have special codes.

Prices up to $999 7/8 can be displayed. The last of the four digits is an integer but it is to be read in eighths. A plus or minus sign to the left of the numbers indicates whether a price has changed.

As many as 256 incoming phone lines can be multiplexed into the minicomputer—an Interdata model 4 with a million-bit drum memory. Requests can be processed in less than 5 seconds, says Rogers. Phone calls can be received from anywhere, but to avoid tying too many subscribers into a single computer Sonex will install computers in other cities beginning in the spring.

Medical electronics

Why Westinghouse quit the medical business

Eyebrows rose when Westinghouse agreed to sell its medical products divisions. But that apparently was the only way that the giant Pitts-

burgh manufacturer could get out of its chronically ill X-ray business. And Westinghouse is even willing to accept a side effect: It's now out of the fast-growing market for patient-monitoring systems. Vice president Paul Gaddis states it succinctly when he says: "We do not intend to be in medical electronics."

Gaddis is the man engineering the sale of the medical divisions to Generale de Radiologie (CGR), a large French X-ray house [*Electronics,* Nov. 23, p. 127]. Going over to CGR are a manufacturing facility in Baltimore, a marketing organization in Cheverley, Md., and a planning group—the Medical Systems department—also in Cheverley. Like other Westinghouse executives, Gaddis won't comment on the sale itself, pointing out that the deal is still subject to the approval of CGR directors and stockholders.

But it's no secret that Westinghouse has been having trouble with its X-ray line for some time. "Their products and their marketing operation haven't shown a consistent track record over the last 10 or 15 years," says an executive at another X-ray company. "They just never lived up to what should have been their potential and capabilities."

But at Westinghouse, Herbert Hinckes, manager of the CGR-bound Medical Systems department, puts it this way: "Competitors, like CGR, Philips, Siemens, and even GE, have a worldwide distribution base. Westinghouse is primarily a domestic company. Except for a few isolated countries, we didn't enjoy good foreign sales. Therefore the entire sales base, which has to pay for research and development, was a lot smaller than that of some of our competitors. When you look at it on this basis, it's a pretty smart move for Westinghouse."

Not everybody in the company thinks so. One insider at Westinghouse's Research and Development Center feels the company is "amputating a bad arm but taking too much with it." He's referring to the fledgling activity in patient monitoring. Two years ago the company got into the field by arranging with Mennen-Greatbatch Electronics of Clarence, N.Y., to buy and then resell that company's line of monitoring equipment. In the meantime, a team of 20 engineers started to design Westinghouse's own monitoring unit. Ironically, that unit—the computer-controlled Med 70—was unveiled just before Gaddis announced the CGR agreement. Apparently the system is being well received. Advance orders for the Med 70, says Hinckes, total over $250,000.

For its part, CGR won't decide which Westinghouse products to keep until the sale is completed. However, the French firm's administrative vice president, Bernard Mallié, says that CGR will continue, in general, to make most Westinghouse products. They'll carry the Westinghouse label for a number of years.

Companies

No Sharp slowdown, NRMEC insists

Success isn't always without its drawbacks. For example, North American Rockwell Microelectronics Co. in Anaheim, Calif., had startup problems in meeting its commitment to Sharp Corp. of Japan for MOS/LSI arrays used in Sharp Micro-Compet calculators [*Electronics,* May 25, p. 50]. But since NRMEC has succeeded in solving these problems, arrays have been coming off the line so fast that enough inventory has been built to necessitate a layoff of 170 production workers.

R.S. "Sam" Carlson, NRMEC president, says there has been no slowdown in deliveries to Sharp, despite rumors that Micro-Compet sales have been soft. "There has been no change in the original or follow-on contracts with Sharp," Carlson stresses. "We're still producing to contract rates, but we can't say that Sharp won't ask for a slowdown."

Carlson says NRMEC has been shipping circuits at a rate consistent with production of 30,000 calculators a month. At five arrays per unit, that works out to 150,000 MOS/LSI parts. "Our production has been catching up at a very high rate," Carlson points out, "and we have an inventory now, so we're doing what any prudent business would do—gearing our production rates to our shipments."

Speculation continues that since Sharp is assembling the NRMEC-built arrays, the Japanese firm soon will have its own wafer fabrication capability. Before that could happen, however, another phase of the original technical assistance agreement would have to be implemented to cover Japanese wafer processing.

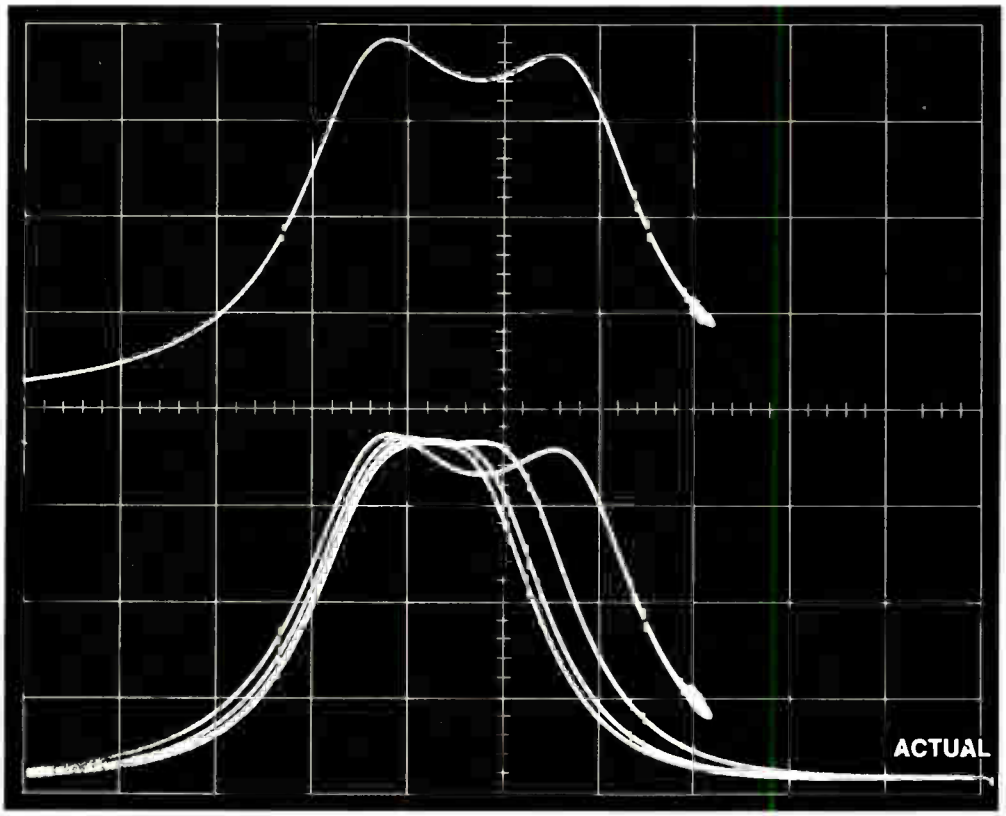
Carlson is reluctant to talk about joint ventures with Sharp, another possibility that's often rumored. The latest suggests Sharp and NRMEC have discussed a joint venture that ultimately would lead to manufacturing Sharp modems and terminals using NRMEC MOS/LSI. These arrays conceivably could be manufactured under some form of joint venture, although it appears that Sharp itself initially would produce the finished hardware. Carlson's hesitance to talk about a joint venture stems from the Japanese government's sensitivity to any such undertaking: government approval would have to be forthcoming before such a venture could be launched.

Communications

Coding, self-test keys to new Satcom modem

Prototypes of a new phase-shift keying modem, featuring differential coding, have been developed for the earth terminal of the Defense Satellite Communications System (DSCS), due for launch into a geostationary orbit in mid-1971. Incorporating forward-acting error-correcting coding techniques, the modem will improve the signal-to-noise ratio by 2 decibels, allowing bit error rates as low as 1 in 10^{10}.

Developed by the U.S. Army



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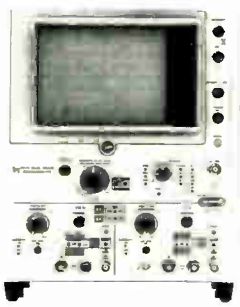

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Satellite Communications Agency (Satcom) of Ft. Monmouth, N.J., the modem will have several features not found in other modems. By means of external coding, the device will be capable of both hard and soft decisions. It will also have self-checking features, where a pseudo-random, 2,047-bit pattern is checked on a bit-by-bit basis. Coming from an 11-stage feedback register, the pattern can also be transmitted to any other modem in the system, checking it for proper operation.

Coding will permit reduction of signal power for more reliable operation. In addition to its internal code, the modem will be able to accept such codes as block, Viterbi, and threshold triple error correction. The goal for the internal coding will be an error rate of 10^{-5}, while with external coding, the error rate will fall to the 1 in 10^{10} figure. And this is for up to 1.544 megabits per second.

Tailored for several military users, the modem will be capable of operation at 50, 450, and 900 kilobits per second. It will also be able to interface with pulse-code modulation equipment operating at 192, 384, and 1,532 kb/s; the 1,544 kb/s rate is for a special user who wishes to tie into the Bell System's T-1 carrier.

The Satcom modem will be part of Phase 2 of the DSCS, which is divided into three stages. Stage 1A uses frequency-division multiple access equipment with fm modulation. While awaiting launch of the DSCS bird, it's operating as part of the Compass Link system. Stage 1B, set for mid 1972, will use the new Satcom modem. Stage 2, set for late 1974, will feature time-division multiple access, permitting data rates up to 40 Mb/s. Phase 1 of the system is presently operational and is using the Interim Defense Communications Satellite Program bird in a quasi-synchronous orbit.

Requests for quotes on the new modem were sent by Satcom to 50 potential bidders, though fewer than 15 are expected to respond. The completion schedule for the modem is set at 15 months to coincide with Stage 1B.

For the record

New picture. Energy Conversion Devices of Troy, Mich., has lifted a corner of the curtain of secrecy protecting its exploration of what it is calling ovonic imaging. A demonstration at a stockholders' meeting consisted of duplicating a photograph facing a plate that was coated with ovonic material and subjected to light from a conventional flash bulb. ECD officials said they were exploring commercial applications in the fields of photography, copying, duplicating, and printing.

Technical details were few. ECD founder Stanford Ovshinsky explained only that upon the applications of energy, in this case light, portions of the amorphous film were structurally transformed into a crystalline state which duplicated the field before it. The resulting image requires no chemical developing or processing.

Honeywell adds. Semiconductor memories took another step forward when Honeywell Information Systems announced its IM series. The new units are extensions of the company's long-established Datapak family of integrated-circuit buffers, registers, and the like—the difference being that the IMs have a larger bit capacity than anything previously offered.

Two versions are available—the IM-320, with 1,024 bits, and the IM-321, with 2,048. Both use Intel Corp.'s 256-bit static MOS memory—four in the IM-320 and eight in the IM-321.

Shift. One of the latest aerospace companies in the Bay Area to venture into the commercial electronics world is United Technology Center, a division of United Aircraft Corp. in Sunnyvale, Calif. And the device with which United plans to do it is a high-current solid state switch.

An offshoot of technology developed by United for the solid rocket boosters of the Titan 3-C launch vehicle, the switch is an on-off device that can handle surges of up to 1,000 amps resistive or reactive. It can use DTL or TTL.

Cost cut. Following up on its 55-cent ceramic edge-mount package for integrated circuits [*Electronics*, Oct. 12, p. 48], American Micro-Systems Inc. of Santa Clara, Calif., will introduce a 40-lead epoxy plastic edge-mount package early next year that cuts the cost to about 20 cents.

Making it. Energy Conversion Devices says it will beat the five-month deadline that comes due Jan. 27 for delivery of a test quantity of its 256-bit read-mostly memories to the Naval Avionic Facility at Indianapolis (NAFI). George Landers, ECD memory marketing manager, protesting speculation by NAFI sources that production problems with the controversial ovonic devices would delay delivery [*Electronics*, Nov. 23, p. 41] says, "ECD is not delinquent on any order," and adds that the company "is accepting orders for the RM-256 and is presently quoting two to three months delivery."

Exit Monsanto. As part of a corporation-wide economy move, Monsanto Co. is shutting down the West Caldwell, N.J., headquarters of Monsanto Electronics Instruments. Two subsidiaries will make the company's line of counters and signal sources—Monsel Electronic Instruments, Ltd., of Haifa, Israel, and United Systems Corp. of Dayton, Ohio.

Liability. An engineer could design a medical implant that saves a man's life, yet the engineer could be sued—successfully—by that man. At least that's the opinion of a Cleveland lawyer, Daniel Hammer. Hammer points out that a plaintiff need not, under certain conditions, prove that he was damaged by the device. All he must prove is that, with available technology and testing, he could have been given a better chance.

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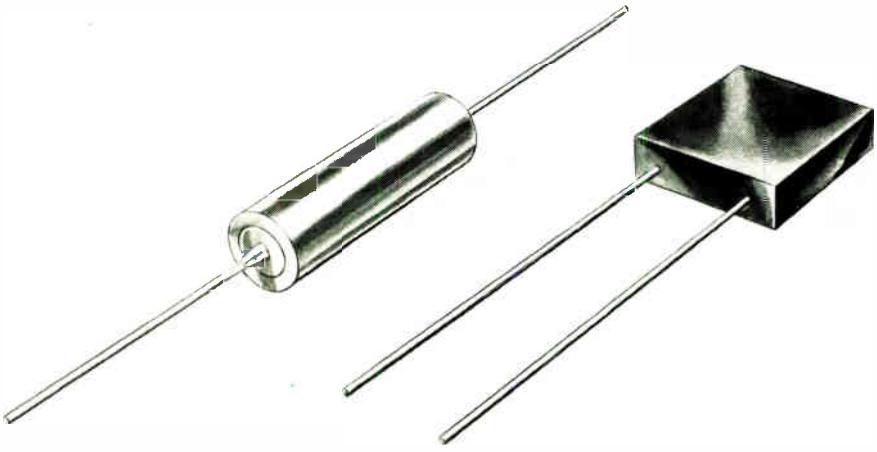

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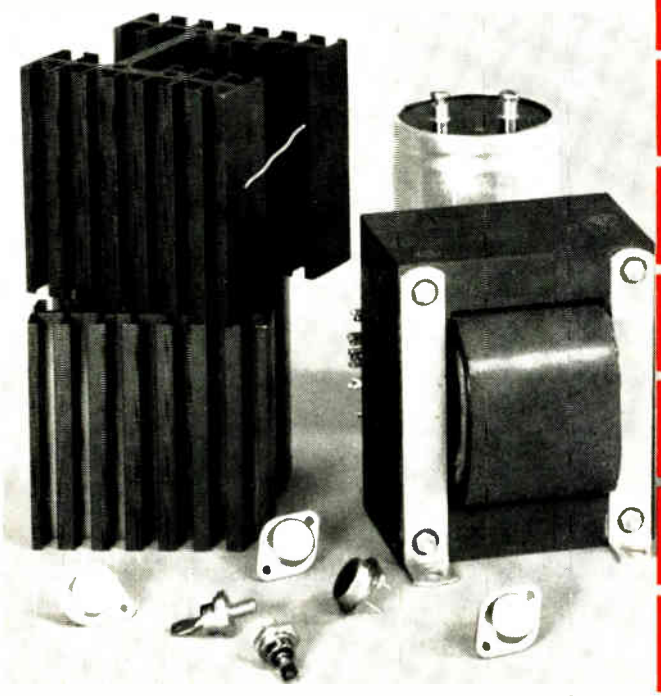

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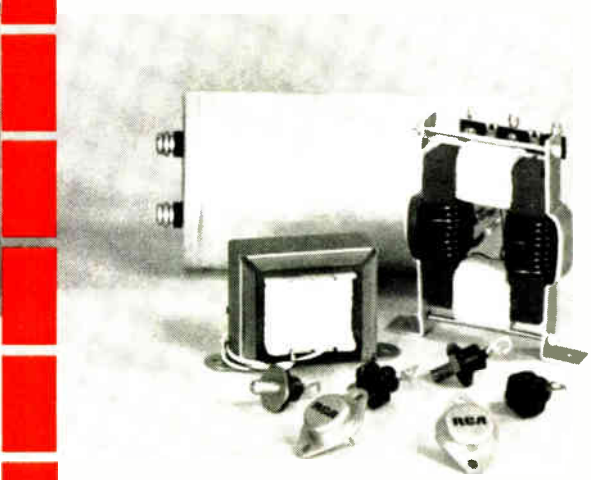

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Washington Newsletter

December 21, 1970

Army plans to test French missile . . .

In a move which seriously threatens four U.S. weapons systems, the Army Missile Command is set to begin a three-month testing of the Crotale ground-to-air missile defense system. The test systems, for which France's Thomson-CSF has a $1.4 million contract, will include at least four actual firings at target drones, including one simulation of a high-performance attack aircraft in supersonic flight. Though most details of the Crotale missile are classified, Thomson-CSF does claim a 6-second reaction time against targets coming in as low as 150 feet off the ground.

The Crotale (French for rattlesnake) is an all-weather, tactical mobile system using radar and infrared guidance. The testing program indicates the Army got the message from Deputy Defense Secretary David Packard, who is striving to cut U.S. weapons development costs and lead times. With Packard's blessing, the Army earlier this year decided to buy from ITT Gilfillan and test a field artillery radar known as Ratac, a joint development of France and West Germany [*Electronics*, July 6, p. 60].

. . . which threatens four U.S. systems

Crotale, which went into production last year for France and South Africa, is viewed as a distinct threat to Philco-Ford's Chaparral missile, General Electric's Vulcan antiaircraft gun, Raytheon's Improved Hawk and its successor, SAM-D, for which Martin-Marietta is producing the vehicle. Both Raytheon systems have encountered problems that have been criticized in Congress. What's more, an Army review board is studying SAM-D to see if the military threat justifies further development and if lowering performance requirements can cut its cost. Significant features of both Raytheon systems are duplicated in Crotale.

A high degree of success with the Crotale tests could shoot down more than $1 billion in U.S. production runs of the rockets, sensors, and vehicle-mounted electronic launch control centers, including tracking and command radars, needed by the four competitors. If Crotale joins the Army inventory, only a small part of that would go to the American manufacturer receiving the production contract under license from Thomson-CSF.

Datran looks for financing: Will Raytheon buy?

Data Transmission Co., the special-service common carrier that wants to build a nationwide, switched digital data net, is holding financial talks with Raytheon, say reliable industry sources. David Foster, president of the Washington-based company set up by University Computing, would neither confirm nor deny the Raytheon report. However, he did acknowledge that Datran is talking with a major communication equipment manufacturer. Raytheon already is set up as the designer of the Datran system pending Federal Communications Commission action on the application, which FCC sources say will come before the end of June.

Foster conceded that Datran needs financing for its $275 million microwave net, but says the investment banking firms of Kidder, Peabody & Co. and Salomon Brothers assure him that financing will not be a major problem. Nevertheless, Datran is said to be exploring other means, including the sale of a substantial minority interest which will let the present management run the company. No matter how the financ-

Washington Newsletter

ing is secured, Datran is expected to go public, leaving University Computing with an estimated 10% to 20% share.

$15 million sought for DOD tri-service communications net

The Defense Department's tri-service communications network that will succeed the Army's Project Mallard is scheduled for an estimated $10 million budget request in fiscal 1972, says Louis deRosa, Assistant to the Secretary of Defense for Telecommunications. In addition, deRosa expects to salvage the more than $5 million remaining in the Mallard account [*Electronics*, Nov. 23, p. 38]. **If Congress approves both actions, deRosa would have nearly $1 million more than was requested for Mallard last year.**

Two urban systems set by DOT for fiscal 1972

The Urban Mass Transportation Administration plans to spend $700,000 in fiscal 1972 on two electronic systems designed to improve urban rail transportation. **Tentatively budgeted for $350,000 is a rail diagnostic car development program.** The car would be pulled over urban tracks to analyze power pickup efficiency and roadbed quality, UMTA's rail expert says. **An equal sum will be spent by the Department of Transportation agency for studies of electronic monitoring and of communication and control systems for urban rail systems.**

USAF touts 621B as civil satellite

The Air Force Space and Missile Systems Organization, nervous about funding prospects for its 621B navigation system, which employs clusters of satellites, **is talking up its use by commercial and general aviation, as well as by the other two military services.** Airline use "could include a highly advanced instrument landing system," according to Lt. Col. Franklin Charette, program director. And general aviation could use a transponder to relay satellite data to a ground station for computation of the plane's position. **Samso, ordered to justify again the 621B design concept against competing systems technology, is spending another $1.5 million in studies which will add another year to the six years of design and analysis already completed.** Chief criticisms of the delayed system are its complexity, including the satellite cluster concept, and the varying lengths of signal delays caused by ionospheric propagation.

Addenda

President Nixon's nomination of Thomas J. Houser, Peace Corps deputy director, to the Federal Communications Commission could make Houser's the shortest term on record. **Houser will fill the unexpired term of Robert Wells, which ends next June 30,** and speculation is that he will not be reappointed . . . **The Commission on Government Procurement, already behind on a heavy work schedule, has just named a director and deputy for its R&D study group.** They are, respectively, Dr. William J. Price of the USAF Office of Scientific Research and United Aircraft Corp.'s C. Branson Smith . . . An image-building campaign by the American Institute of Aeronautics and Astronautics (AIAA) to demonstrate how member companies can use technology "to solve environmental and social problems" is rolling with the appointment of Sidney Sternberg, vice president of RCA, as committee chairman. **Reportedly a $1 million-a-year effort, the AIAA project will start with transportation and law enforcement problems.**

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In the decade ahead, electronics will be bringing the nations of the world closer together. Socially. Economically. Maybe even politically.

Right now the countries of Western Europe are collaborating on a high-capacity communications satellite system to handle television, air traffic and picturephone networks all over Europe, Africa and the Middle East.

So, by the end of this decade, nations that not too long ago used drums for communications will have picturephone service. Major sports events, such as the 24 hours of LeMans, will be beamed live to such obscure countries as Cameroon, Dahomey, Togo and Tanzania. While Sundays in Swaziland will be spent watching live bullfights from Spain.

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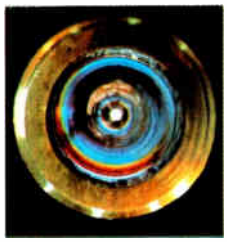

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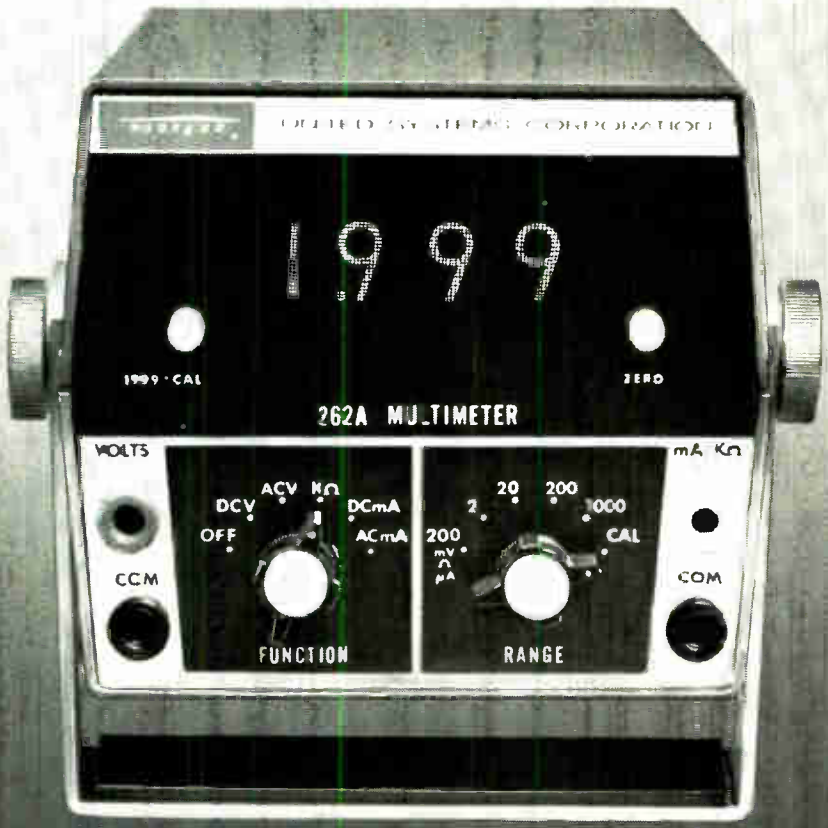

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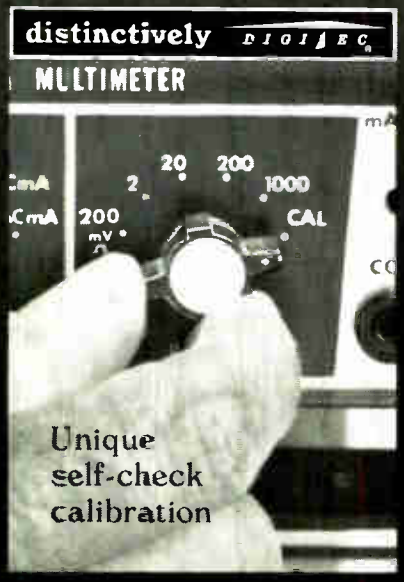

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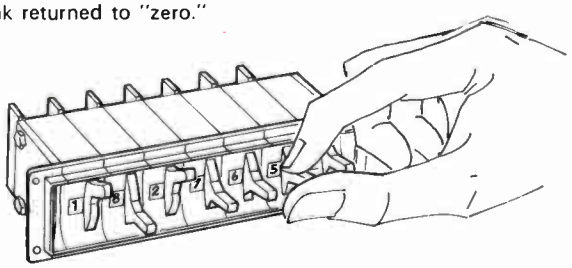

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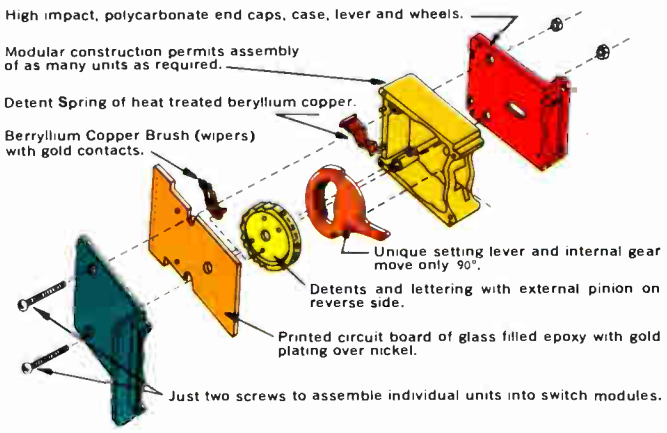

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Unified bus maximizes minicomputer flexibility

Faster memories or an unusual mix of input-output devices can simply be plugged into minicomputers that transmit addresses, data and control information over a single path instead of three

By David Chertkow and Roger Cady, *Digital Equipment Corp., Maynard, Mass.*

☐ To interconnect processors, memories and input-output elements, some of the newest small computers are using a unified bus—a single, long data path comprising several separate signal wires. In these systems, all the devices send and/or receive addresses, data, and control information by means of the same set of signals, and all the devices are connected with the bus by means of a single, standard interface.

As a result, the user can forget his fear of obsolescence, since he can plug in the faster memory or more powerful processor as quickly as technological advances make them available. He can also buy a minimum computer configuration to start with, and expand it as necessary. Or he can tailor a system to suit highly specialized needs: for large batch computation or signal processing, one system could have a large memory and few input-output devices, while for data collection or industrial process control another system might plug many peripherals and relatively little memory into the same bus length.

Such flexibility is in distinct contrast to the traditional system architecture of small computers, which in most cases has called for three separate buses for memory, input-output and direct memory access (DMA). These are usually physically as well as functionally separate, and not designed to permit easy interchange of computer elements.

According to some critics of the unified bus approach, however, the conventional system performs better. For one thing, they say, a unified bus degrades total system performance because the single data path between all components allows only one operation to take place at a time. For another, the bus is said to be very vulnerable to external noise.

Certainly, with just one bus it's possible for only one data transfer to occur at a time. But the same is true of three-bus machines: in conventional minicomputers, the input-output bus and the DMA bus never operate simultaneously, and linking the memory bus to the DMA bus always stalls the central processor. The supposed degradation is therefore more theoretical than actual. And actually, the unified bus may improve system performance, because the bus may be asynchronous—traditional bus structures are synchronized to the memory cycle time, so they may take longer to perform certain operations.

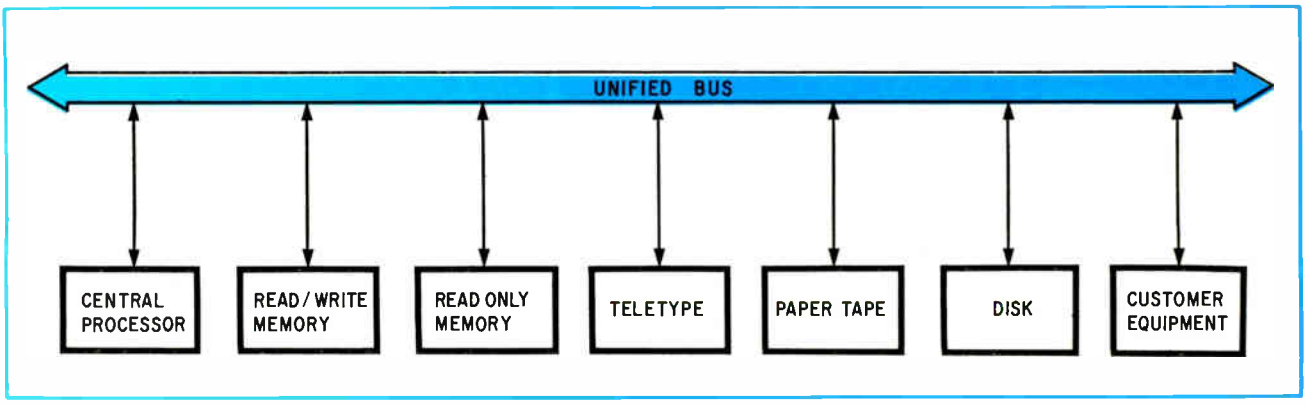
The second objection would hold water only if one were willing to admit that, while memory buses must be secure against noise, input-output buses need not be. But if this were true, the computer could not be used for input-output.

The immunity to real-world noise required by a unified bus is achieved through careful engineering of design aspects like the role of the bus as a transmission line with low-impedance terminations.

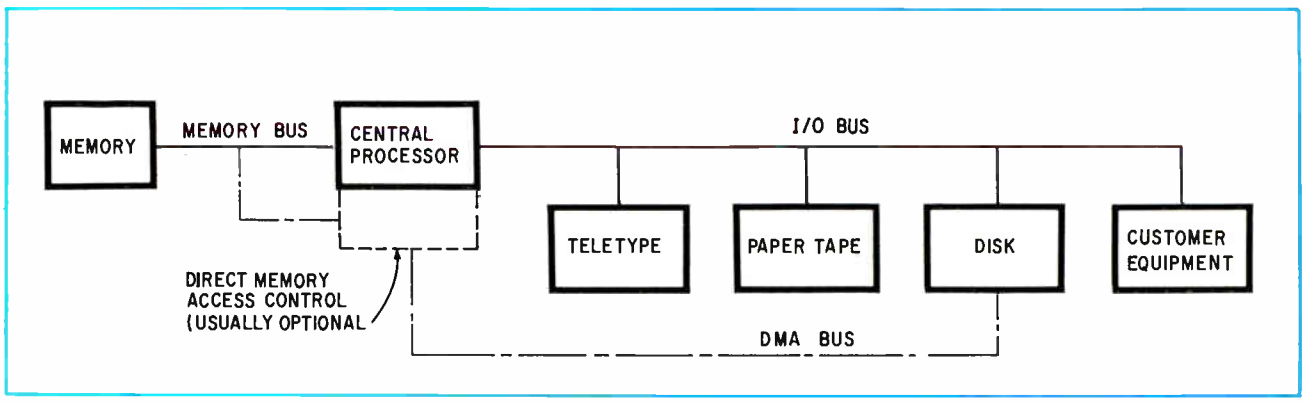
As a physical link between many independent units, the unified bus makes certain demands on the design of the attached devices. For example, because the bus is a transmission line, the receivers that monitor the signals on the line must have only a minimal effect on its distributed impedance. That is, they must have high impedance, if they're not to set up reflections on the bus. And because the bus can be driven from several sources, each output transistor—which may be part of a monolithic structure—should have an open collector, as in Fig. 3.

For these reasons, the usual connection from the collector through a resistance to a power supply is made at the end of the bus, rather than directly at the transistor. In this position it both terminates the line and loads the transistor; in any other position the line would be improperly terminated and reflections would occur. Also, the open collectors permit the drivers to be connected in parallel with other similar collector drivers, as in Fig. 4. This logic is commonly known as a wired OR.

Tri-state logic, recently introduced by a leading semiconductor manufacturer [*Electronics*, Sept. 14, p. 78], might seem an alternative solution to these difficulties. But it causes problems with buses that are electrically long. Though a tri-state scheme works well within a single electronic assembly, it doesn't fit into a properly terminated bidirectional bus scheme: the tri-state device relies on transistors to drive both



1. Unified bus. When a single multiwire path interconnects all units of a computer, the result is a flexible, expandable system that can readily be updated.



2. Traditional architecture. Small computers have usually been built with three separate buses, and so are not easy to adapt to specific applications or to improved technology.

its positive and negative levels, so that the bus cannot be treated simply as a passive terminated transmission line. Also, if the electrical transit time along the bus exceeds the signal rise time, the signal waveform deteriorates. Furthermore, no readily available tri-state devices are capable of sinking the necessary termination current. Finally, since inadequate voltage margins would occur if transistor-transistor logic devices were used as receivers, and since each TTL device would degrade the transmission line signals because of loading, even tri-state drivers would not alleviate the need for a special high-impedance controlled-threshold receiver.

A typical open-collector driver, DEC 8881, has the characteristics listed at far right, while a unified bus receiver can be implemented with a monolithic integrated circuit element such as DEC 380A, also described at right and shown schematically in Fig. 5.

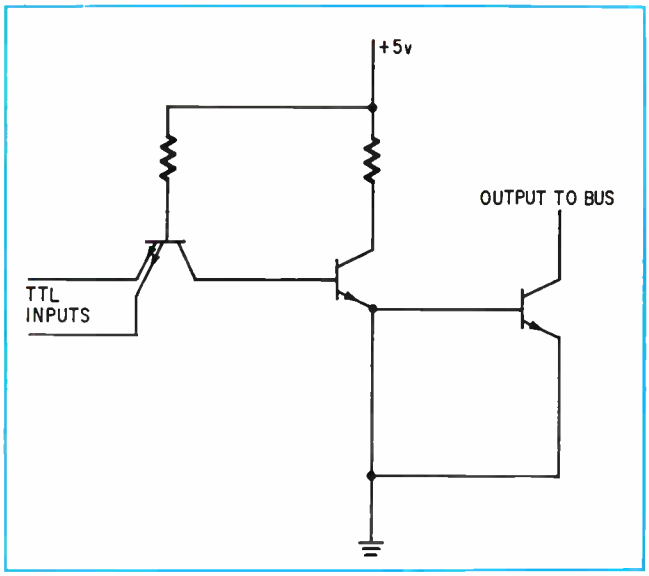
For any combination of interconnected transmitters and receivers in a unified bus system, it's important to know the range of possible values for the load resistance, shown in Fig. 6 as R_L. A large load resistance minimizes power dissipation, but to the detriment of switching speeds and immunity to coupled-in noise. But if the resistance remains below its absolute upper limit, the margins against noise on the power lines are not affected. The terminator must also match the characteristic impedance of the cable employed in the bus interconnection.

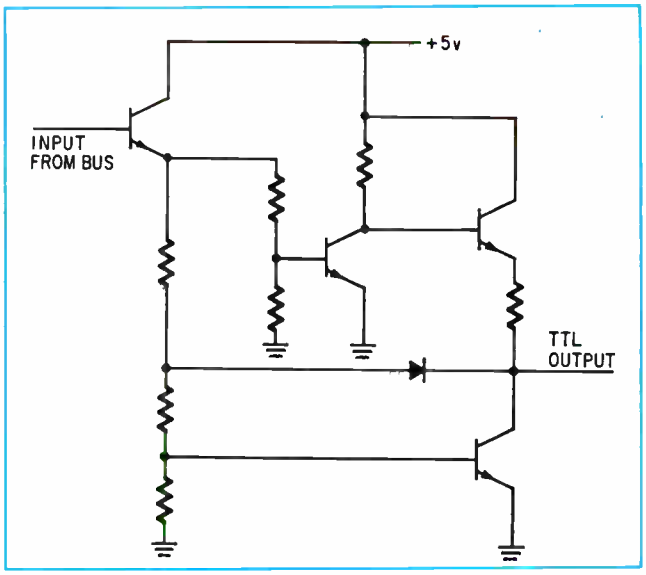
What determines the maximum value of R_L is the total leakage current, or the sum of the leakages through all the transmitters connected to the node, when they are all off, plus the input currents to all the receivers. On passing through the load resistance, this current creates a voltage drop that, if it is too large, forces the voltage at the common collector node below an acceptable minimum. The nominal voltage is 3.5 volts.

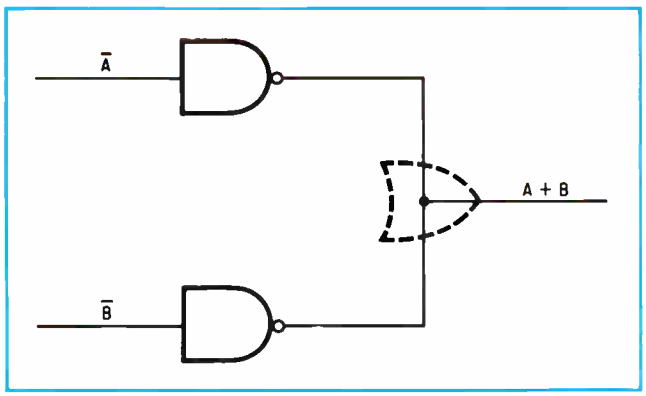
The minimum value of R_L depends on the current-sink capability of one transmitter, with no leakage. This current is much larger than the leakage current, and its voltage drop across R_L brings the collector voltage down to between 0.4 and 0.8 volt, depending on the collector-emitter impedance of the transistor.

The bus loading is also one of the complex of factors that determines the maximum length of the bus. The others are the distribution of receiver and transmitter taps on the bus, and its physical implementation—coaxial cable, flat cable or twisted pair. Bus lengths of over 100 feet are theoretically possible.

Many new machines are available that use the unified bus in one way or another. Two typical designs are Digital Equipment Corp.'s PDP-11 and PDP-8/E. The PDP-11 is a 16-bit processor, designed to meet the







3. Driver (above left). Open-collector design is essential because several drivers are likely to be connected to the bus. They share a common load resistor.

4. Wired OR (left). Several open-collector drivers whose collectors are electrically common can perform a logic OR function with no additional circuitry.

5. Receiver (above). A high input impedance is essential to these circuits to prevent them from affecting the distributed impedance of the bus.

demand for a modular system for real-time data acquisition, analysis and control. Its unified bussing scheme is called Unibus.

The PDP-11 architecture takes advantage of the Unibus in its method of addressing input-output devices by using the same format for I/O instructions as for memory reference instructions. Memory elements, such as the main core memory or any read-only or solid-state memories* that are attached, have ascending addresses starting at zero, while registers that store the status of individual peripheral devices have descending addresses, starting at the highest possible address.

There are generally several thousand memory addresses, but only two—one for data, one for control—for each simple peripheral device, and up to perhaps half a dozen for more complicated equipment like magnetic tapes or disks. The valid memory addresses run from 0 to 65,535; in a typical system, addresses 0 through about 32,000 would indicate locations in memory, addresses from 65,000 up would refer to input-output gear, and the intervening numbers would be reserved for future expansion.

The PDP-11 unified bus consists of 56 signal lines, to which all devices, including the processor, are

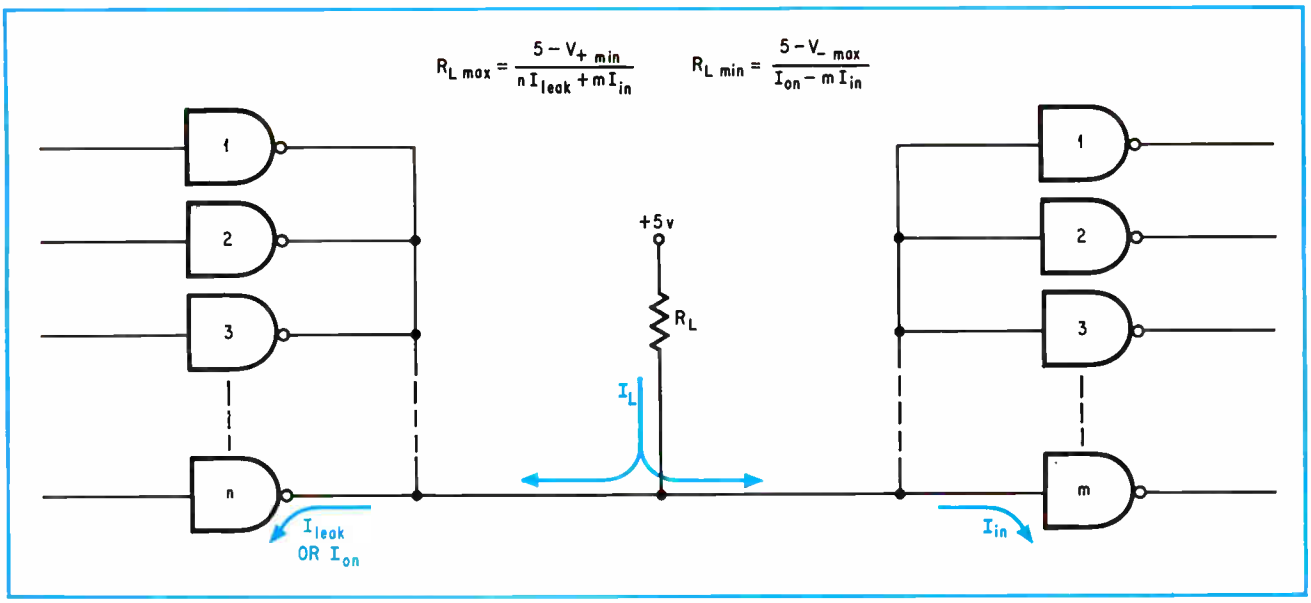
* These are not now available on DEC computers, but will probably be announced in the not too distant future.

Driver characteristics

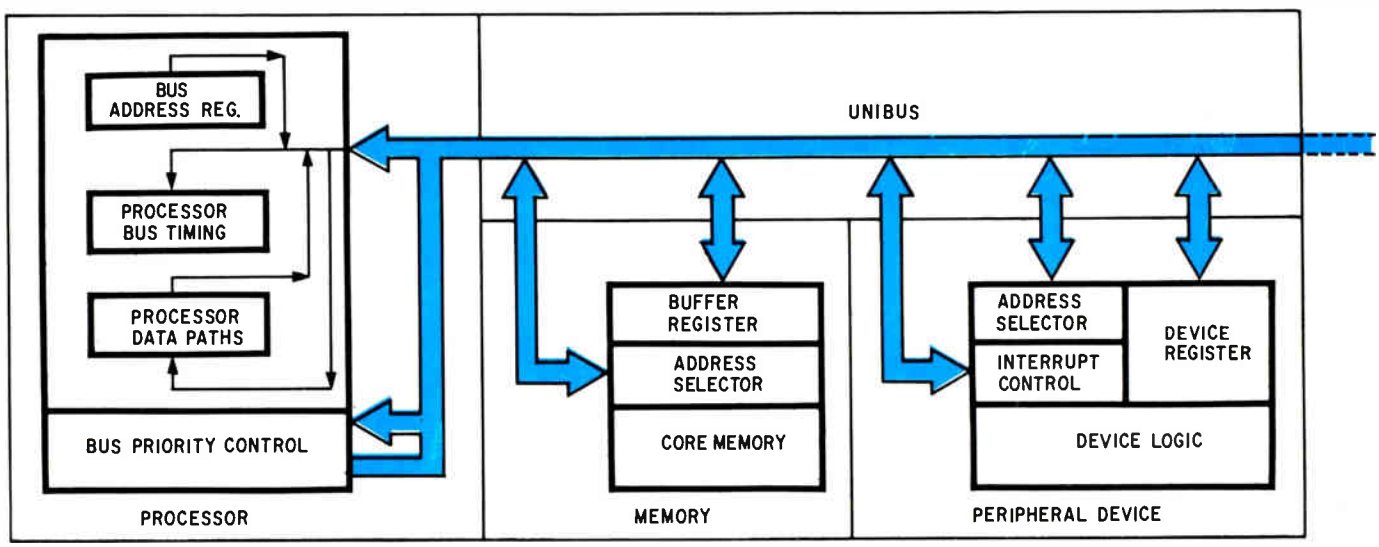
Input loading	1.25 TTL unit load
Low output voltage	0.8 V maximum
@ 50 mA sink	0.4-0.6 V typical
High output leakage	
@ 3.5 V	25 μA

Receiver characteristics

Input high threshold	2.5 V maximum
Input low threshold	1.4 V minimum
Input current @ 2.5 V	160 μA maximum
Input current @ 0 V	25 μA maximum
Output drive	7 TTL unit loads



6. Load resistance. Total leakage current determines the maximum value of R_L, when all the driving transistors are off. Maximum current drawn by one driver when it is on establishes R_L's minimum value.



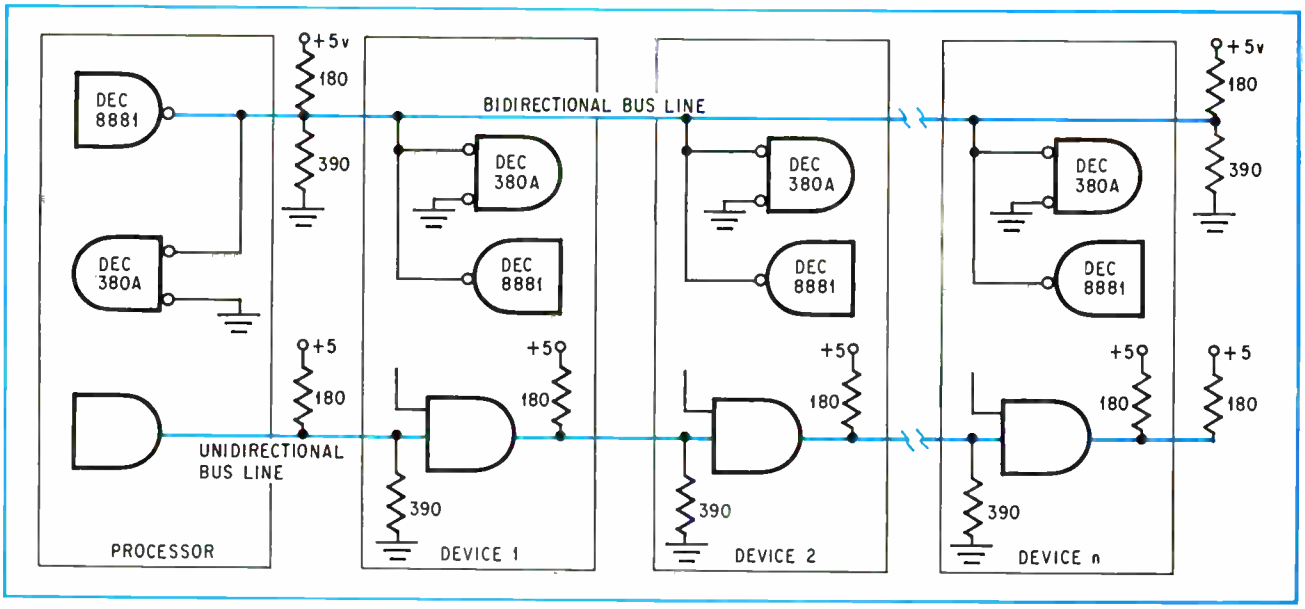
7. Unibus. In the PDP-11 there are 56 lines in the unified bus; 51 are bidirectional and the other five are unidirectional. Each peripheral device has from two to six addresses; the memory has several thousand.

connected in parallel, as in Fig. 7. On 51 bidirectional lines signals flow in either direction; these lines are terminated at each end by a resistive divider for each signal, as shown in Fig. 8. The remaining five unidirectional lines are used for priority bus control.

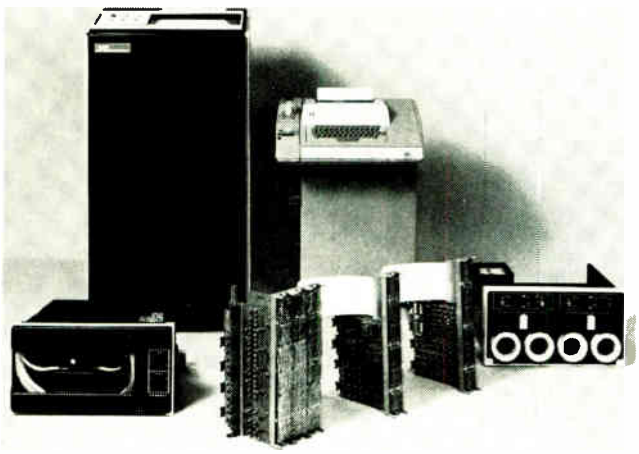
The logic 0 for Unibus signal lines is +3.4 volts; the logic 1 is between ground and +0.8 volt, which is the saturation voltage of the transmitter circuit driving the bus.

Communication between any two devices on the bus is in a master-slave relationship. During any bus operation, one device, the bus master, controls the bus when communicating with another device on the bus, called the slave. For example, the processor, as master, can fetch an instruction from the memory, which is always a slave, or the disk, as master, can transfer data to the memory, as slave. Master-slave relationships are dynamic: the processor, for example, may pass bus control to a disk, whereupon the disk may become master and communicate with a slave memory bank.

When two or more devices try to obtain control of the bus at once, priority circuits decide between them. The priority level of the central processor is programmable, and masks anything of lower priority on the bus. Other devices can have different priority levels, but their levels are fixed at the time of installation. A unit with a high priority level obviously always takes precedence over one with a low priority level, but of units with equal priority levels the one closer to



8. Terminations. In the Unibus each bidirectional line has a resistive divider at each end that matches the line's characteristic impedance. Unidirectional lines are short and need only loads, not terminations.



9. Plug-ins. The white cable interconnects units in different racks or panels, and plugs in the same way the units do.

the processor on the bus takes precedence over those farther away.

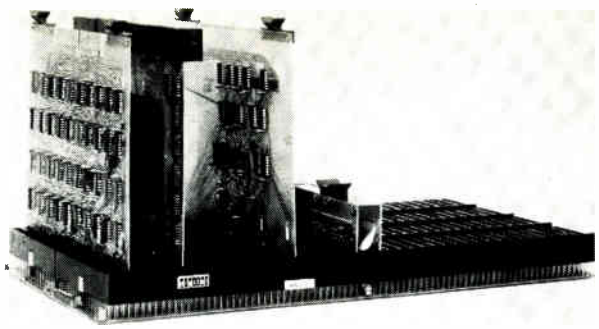
The diagram of the unidirectional line in Fig. 8 hints at this arrangement and its implementation. Suppose the processor has control of the bus when three devices, all of higher priority than the processor, request it. If the requesting devices are of different priority, the processor will grant use of the bus to the one with the highest priority. If they are all of the same priority, all three signals come to the processor along the same bus line, so that it sees only one request signal. Its reply granting priority travels down the bus to the nearest requesting device, passing through any intervening non-requesting devices, which simply regenerate the grant signal. The requesting device takes control of the bus, executes a single bus cycle of a few hundred nanoseconds, and relinquishes the bus. Then the request-grant sequence occurs again, this time going to the second device down the line, which has just been sitting there holding its hand in the air, so to speak. When all higher-priority requests have been granted, control of the bus returns to the lowest-priority device, usually the processor.

The processor usually has lowest priority because in general it can stop whatever it is doing without difficulty. Other devices, however, may be involved in some kind of mechanical motion, or may be connected to a real-time process, either of which requires immediate attention to a request.

The priority determination takes place asynchronously in parallel with data transfer. Every device on the bus except the memory is capable of becoming a bus master.

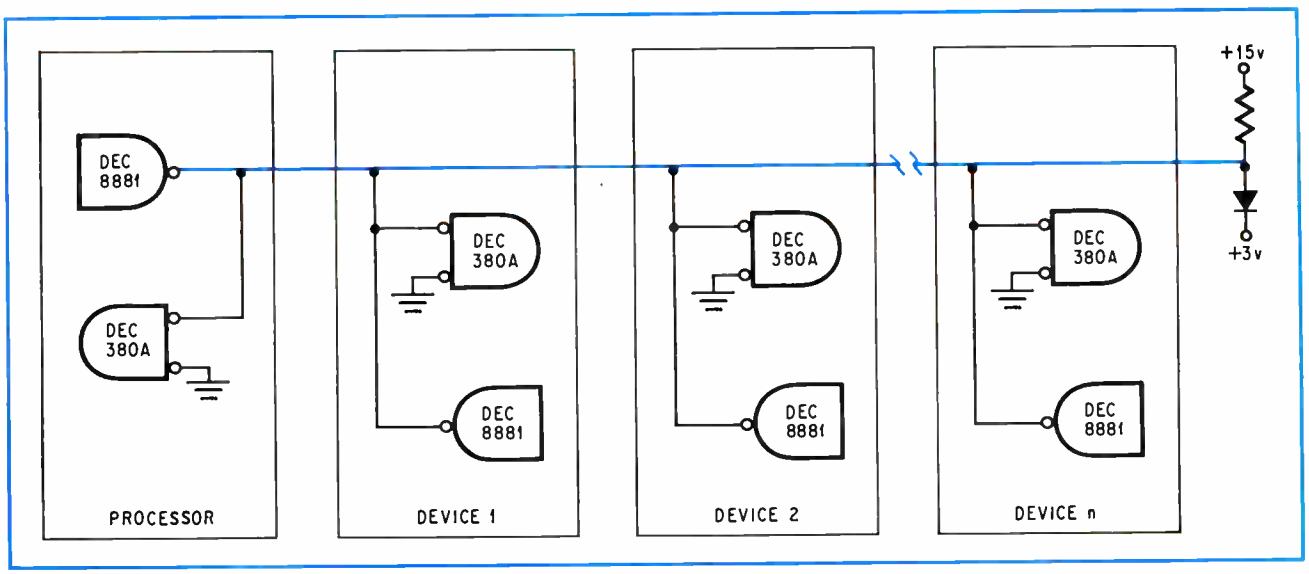
Communication on the bus is interlocked, so that each control signal issued by the master must be acknowledged by a response from the slave to complete the transfer. As a result, communication is independent of the physical bus length and the response time of the master and slave devices. This simplifies the device interface because timing is no longer critical, and slower logic types may be used in, for example, an industrial environment that requires large noise margins in the peripheral equipment. The maximum typical transfer rate on the Unibus is one 16-bit word every 400 ns, or about 2.5 million 16-bit words per second.

With Mylar-wrapped printed circuit cable, the maximum reasonable bus length is 50 feet minus the combined length of all stubs or taps—the wires connecting the actual bus to the receivers and transmitters. In some cases several units, including the processor, may plug into a single back-panel bearing the



10. Dense package (left). One Omnibus panel in the PDP-8/E can hold a processor with a 32,000-word memory and up to nine device controllers. More units can be put in a second panel.

11. Pull-up (below). Because the Omnibus lines are shorter than those of the Unibus, only a simple resistor-diode pull-up is required at one end of each line. There are 96 lines in the Omnibus.



bus conductors. Alternatively, the processor may be plugged into another panel on the same rack. In other cases a unit on the bus must be in a panel on a separate rack. Bus cables plug into the panel just as the units do, and the stub length runs from the cable plugging point to the card elsewhere on the panel. The photo Fig. 9 illustrates this arrangement.

However, this maximum length of 50 feet is obtainable only if the individual tap lengths are less than 18 inches, and if the loading is not more than one receiver and two transmitters per line. If most loads are concentrated at one end of the bus and a single load is at a distant point, the maximum length could change, provided that the crosstalk of the employed cable is low enough.

The Unibus is limited to a maximum of 20 unit loads. More than 20 would increase the leakage current to a level that, with the maximum allowable load resistance, would drop the output voltage too far below its nominal high state, and so would decrease the noise margin between the high and the low states. In applications that require more than 20 unit loads, a repeater may be installed.

In the PDP-8/E, the latest member of the PDP-8 family of small computers, another form of the unified bus is used. The PDP-8/E is a 12-bit processor with a 1.2-microsecond cycle time. With 4,096 words of memory, it sells for less than $5,000.

In the PDP-8/E the unified bus design, called Omnibus, has a maximum length of 7½ feet, and the computer functional units are densely packed—a processor with 32,000 words of memory and nine input-output controls requires only 10½ inches of panel space. This maximum length of the Omnibus, however, can accommodate two 10½-inch-high mounting boxes with 3½ feet of interconnecting cable, as Fig. 10 shows. With the dense packaging, this bus length is sufficient for the largest PDP-8/E systems.

Omnibus consists of 96 signal lines connected to each module slot. As with the Unibus, functional units like the central processor or memory can be plugged into the Omnibus in any available position. Omnibus signals are terminated at one end with a resistor-diode pull-up, as Fig. 11 shows.

Timing in the PDP-8/E, unlike the PDP-11, is synchronous, with signals generated by a timing module. Since the Omnibus is limited to a length of 7½ feet, bus delays are not a problem.

One of the most exciting aspects of the unified bus approach is the ease with which one may configure multiple processor systems. Since only one bus is necessary, very few building blocks are needed for systems that have multiple processors with shared peripherals or even a shared memory. In such configurations, the individual processors can be task oriented, and yield truly parallel processing with small computers. Moreover, because of the unified bussing, the systems, like the signal processor systems, may be field-expanded modularly and technologically updated for years to come. □

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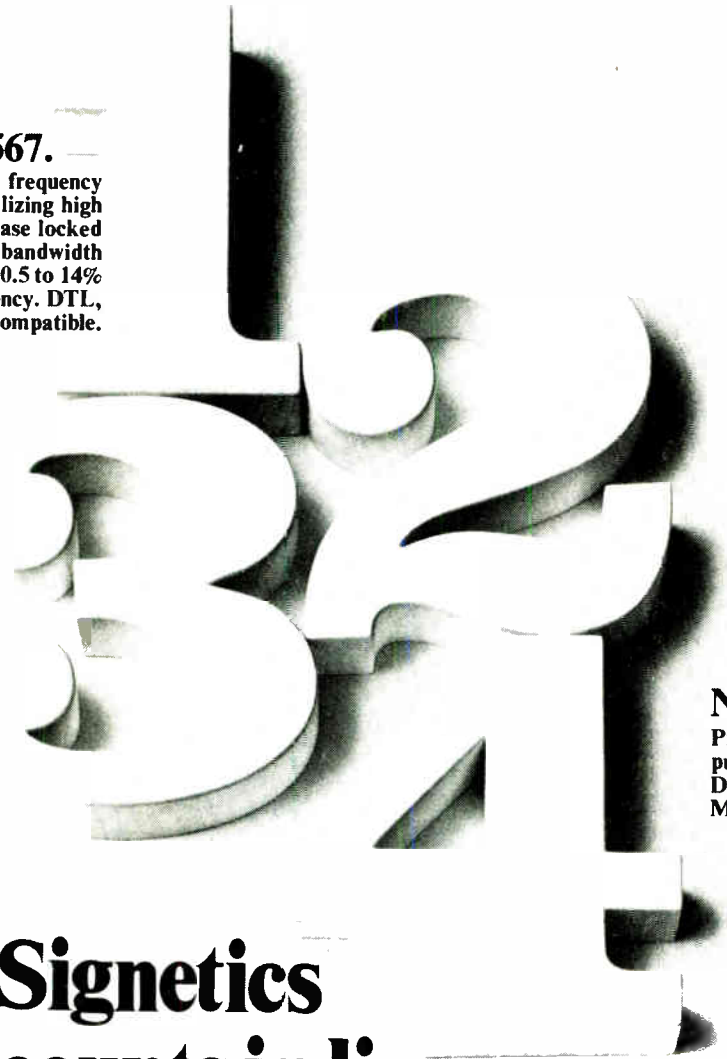

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Designer's casebook

Regulator gives overvoltage protection for TTL

By T.K. Hemingway
British Aircraft Corp. Ltd., London

Many applications require low-voltage regulators that must be stable and offer overvoltage protection without becoming too complex. In these applications, the conventional zener just won't do, while the voltage regulator that derives its low-voltage output from a much higher input voltage can endanger circuitry if its pass transistor fails.

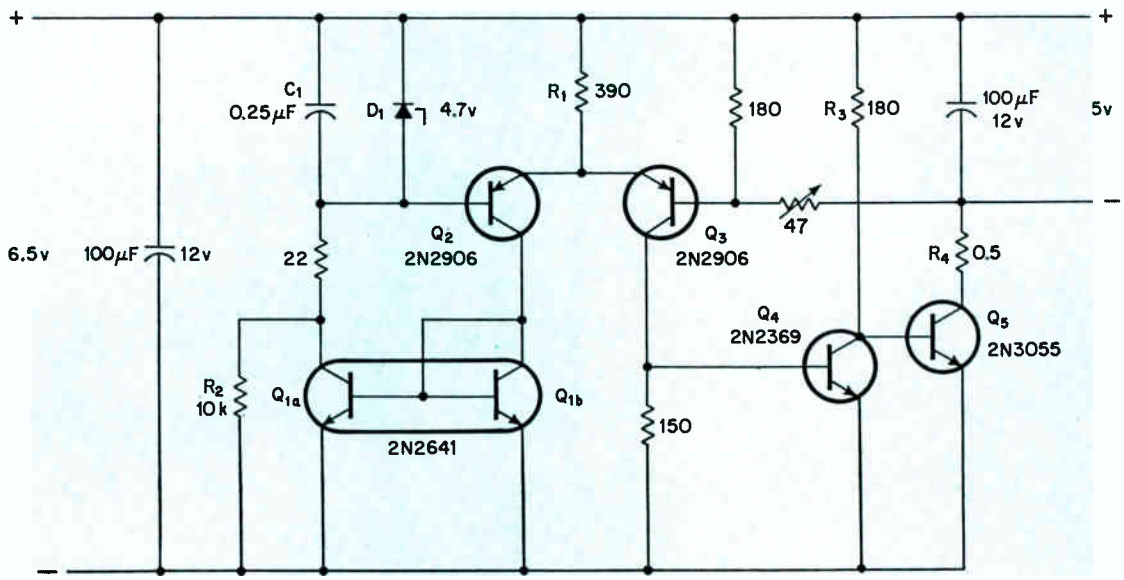
The circuit shown fills both requirements. It provides either 4 or 5 volts at 1 ampere from a 6.5-V supply, depending on the zener diode used, and offers adequate protection against overvoltages. A 3.6-V zener, for example, will give a 4-V output, whereas a 4.7-V zener gives a 5-V output.

Transistor Q_2 acts as a constant current drive for the zener. And adding Q_3 forms a comparator, which, with its associated feedback loop, provides excellent isolation from input variations. With Q_1 acting as a current mirror, the zener can be driven as shown even with a very low input-to-output voltage differential. R_2 is added to assure that the circuit starts; R_3 provides base drive and R_4 limits the transient collector current of Q_5, and C_1 prevents loop oscillations.

The circuit gain at dc is much higher than at first appears. This is because any tendency for the output voltage to fall below the preset level gives Q_2 more of a share of the current through R_1 since the base potential of Q_3 is going more positive. This increases the current in Q_{1b}, which also boosts the current in Q_{1a} and in the zener.

This gain in zener current tends to increase the voltage across the output. The mechanism operates in addition to the normal loop where, as the current through Q_3 decreases due to the assumed drop in output voltage, the current through Q_4 also decreases, allowing more of the current flowing through R_3 to drive Q_5. Therefore Q_5 conducts harder and the output tends to be restored.

Added protection. Circuit provides isolation from input variations and can operate with a very small input-to-output voltage differential. Overvoltage protection is needed only if external voltages reach the output directly, since a series regulator failure is no longer disastrous to external circuits.



Digital bidirectional detector keeps the count honest

By J. van Duijn
Unilever Research Labs, Vlaardingen, The Netherlands

Accurate measurements can be attained by using a set of square-wave detector signals generated by instruments such as optical interferometers, incremental shaft encoders, or moire gratings. The key is a bidirectional scheme that's essentially immune to noise and pulse jitter.

A directional change in the measured value of these signals (A and B in the timing diagram) is indicated by a corresponding change in the 90° phase relationship between them. Direction and number of cycles are sensed by a detector and a bidirectional counter.

The propagation delays through the gating on the set inputs of the up and down J-K sensors assure that per pulse period one of these sensors is set on the first leading edge of signal B. After a quarter cycle, J-K_1 or J-K_3 is reset by A or $\overline{A}$ on the overriding reset input. Jitter on signal A will result in resetting the appropriate binary on the first logical 0. The only evident restriction for honest operation is that jitter on the edges of A and B does not coincide.

J-K_1 will set—that is, Q_1 becomes binary 1—if A = 1 and B = 0 prior to the leading edge of B. The set input remains 1 through the trailing edge of the clock pulse $\overline{B}$ because of delays in the input gate and inverter. In reverse direction, J-K_3 turns on when both A and B are 0, prior to B's leading edge.

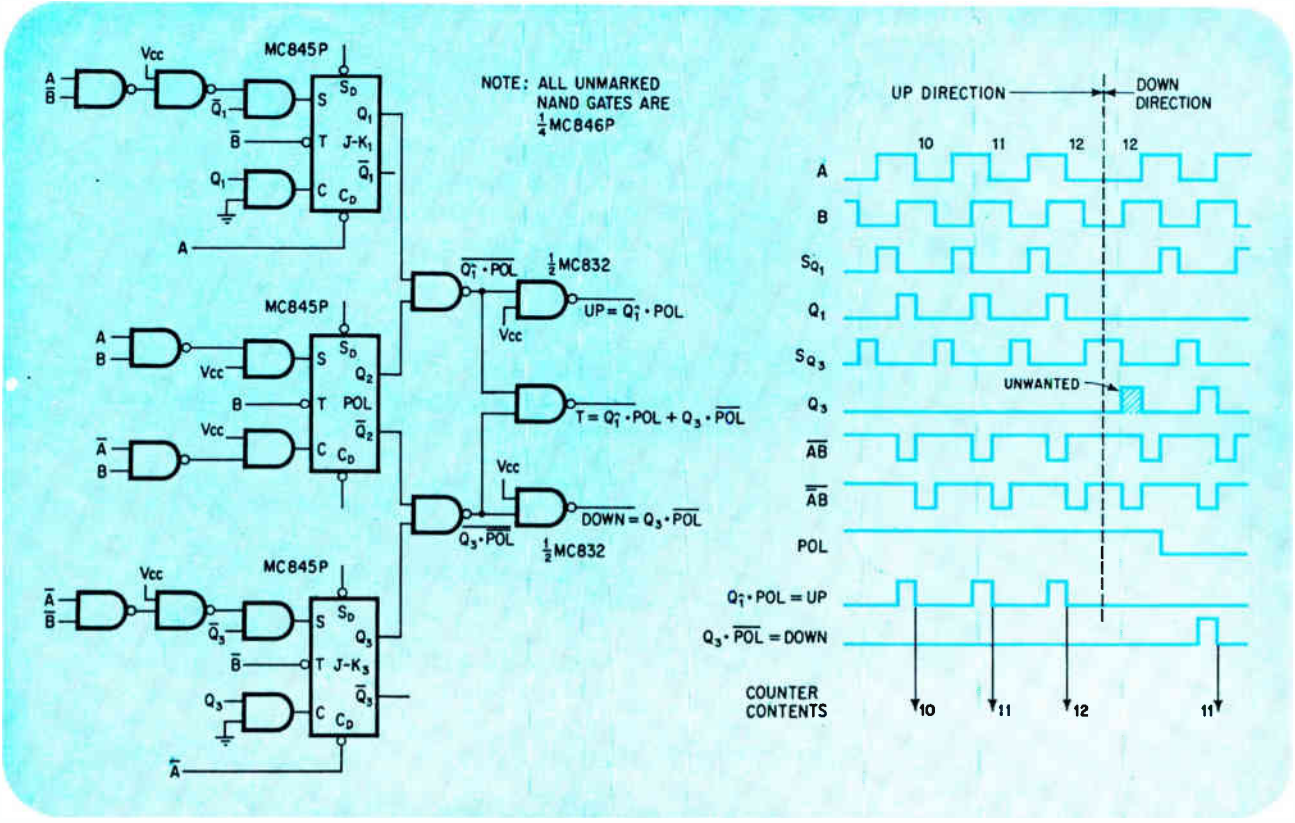
However, if only J-K_1 and J-K_3 were used, a systematic error could occur depending on where the direction is reversed. One such case is shown in the timing diagram, where A and B are both 0 before the rise of the first B pulse, so Q_3 can turn on and produce an unwanted down pulse. No down pulses should occur until the 12th cycle has been completed.

To prevent such outputs, POL enables or disables the appropriate pulse output line. Since POL is set or cleared by B, which is the complement of the two sensor set inputs, it therefore switches on the trailing edge of B to the state that represents the output pulse to be counted. In effect, it waits for the premature output to subside before allowing that output line to go binary 1. Since Q_2 is still high when Q_3 first goes high in the example, the down output stays low.

POL is also used for the clock generator, as it allows the center output gate to OR only the valid pulses and provide the correct number of pulses to the bidirectional counter's clock input.

Designer's casebook is a regular feature in Electronics. Readers are invited to submit novel circuit ideas and solutions to design problems. Descriptions should be brief. We'll pay $50 for each item published.

Noise immunity. Delays through the input gates on the J-K flip-flops ensure that the up or down sensor is set on the first leading edge of the B signal in noise systems. J-K_1 generates countup pulses; J-K_3, countdown units. The POL binary polices the J-K_1 and J-K_3 outputs to cancel out pulses generated by systematic errors that can occur under reversal.



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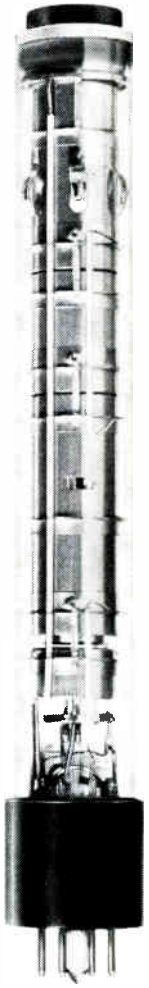

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Economic cooling puts chill on European electronics growth

The 14% rise predicted for 1971 reflects as much inflation as real gains, and government countermeasures have doomed the days of sharp annual spurts, computers, communications are big gainers, components, consumer goods lag

□ European economics forecasters have their own maxim for spotting trends: as Germany goes, so goes the Continent. And the word out of Germany these days is that the days of mercurial business index rises have ended. Headlines proclaiming that the boom is slowing pop up consistently in German business papers.

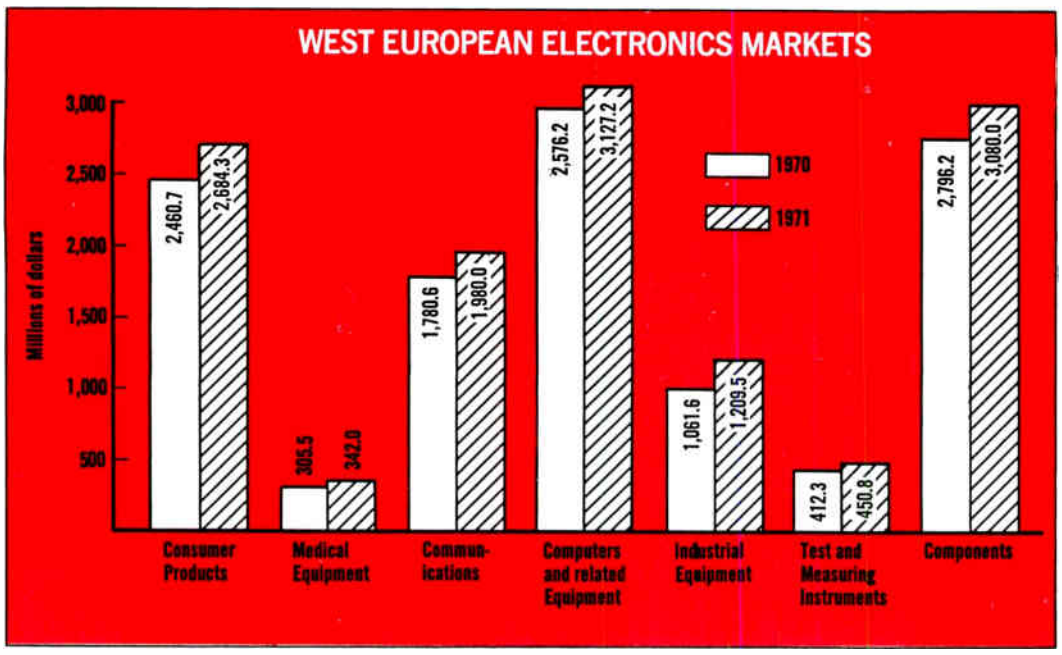
Much the same sort of news is the fare of business-page readers throughout the Continent. On the French side of the Rhine, for example, the story is that next year a turndown of economic growth can be expected. Local wrinkles also dampen the general outlook. Italy and Spain have their peculiar problems, along with the general ones. Great Britain, with a new Conservative government in charge, still finds its growth prospects lagging far behind those of the Continental nations.

What with top officials in most countries devaluing currencies, revaluing them, upping taxes on imports, and cutting back investments to cool down overheated economies, the news of slower economic growth would appear to make good reading. But the cooling measures so far haven't quenched price increases. Every country has had a taste of inflation this year and none seems to have prices or costs under firm control. In fact, the danger of inflation, more than the slowing of true economic growth, has put Western Europe's economic watchdogs on edge.

Added anxiety over the recession in the United States is gnawing on management at many European electronics companies. More and more, American producers are scouting for customers in export markets to help compensate for the difficult times at home—a course of action that's not calculated to help profit margins on the Continent. Japanese companies, also hurt by bad business in the U.S., are turning up on the scene, too.

All told, *Electronics*' 1971 market charts, a compilation of market data from more than 180 companies, government agencies, and trade associations, require some reading between the lines. The consensus forecast predicts a $9.79 billion market next year for electronics equipment in the 11 countries surveyed, a near 14% rise over this year's estimated $8.6 billion. It looks like the market's going to spurt until you remember that there's nearly as much price inflation as real growth in sight.

The forecasts for components, too, are deceptive,



Guide to European electronics markets

but in a different way. The outlook here is for a gain of about 10% to $3.08 billion. Actually, the number of components that equipment makers will gobble up next year will top the apparent rise considerably, largely due to a decline in component prices generally and a fall in semiconductor prices. Prices for integrated circuits, particularly transistor-transistor logic packages, have plummeted. Semiconductor salesmen will spend most of 1971 wondering when TTL prices will bottom out.

But there's nothing to cloud the spotting of the fastest moving sector in West European electronics—it's computers, far and away. Next year, new additions to the computer inventories of the 11 countries surveyed will push sales over $3 billion for the first time (rentals are counted on an if-sold basis), a rise of 21% the survey predicts, from 1970's estimated $2.58 billion.

The proliferation of computers is not snuffing out medium-sized machines, as some market seers earlier thought it would. "The camel-back thesis," says an executive who keeps close watch on European data processing markets, "isn't proving out." In this theory, the market sales curves would show big humps for very big and very small machines with little in between. There is a surge, though, for remote terminal equipment as the government-run phone networks of Western Europe improve their data transmission facilities.

Computer makers, after their strong showing this year and a rise that looks certain next, will supplant radio and TV set manufacturers as the best sellers in Western Europe. The two groups were neck and neck at roughly $2.5 billion this year, but the set makers can't count on more than a 9% rise next year. The consensus forecast for 1971: $2.68 billion.

Color TV practically singlehandedly is keeping consumer electronics from lolling in the doldrums. Sales of color sets should soar next year to $923.4 million, according to the forecast. The long-term outlook is solid, too. Germany, Great Britain, Sweden, and Holland are the only areas where there has been significant market penetration. When they start to slow, other countries, notably France and Italy, will take up the slack.

All the same, consumer electronics' hold on the number two position may not last long. By the mid-1970s, telecommunications surely will move up just behind computers, thanks to massive budgets for extending phone systems in Europe. More and more, spending for phone equipment is winding up in the coffers of electronics firms. Next year, though, communications equipment will rank only third. The forecast is for an 11% rise to $1.98 billion.

German bellwether shows signs of a slowdown

Despite the customary holiday buying binge. German businessmen have the gnawing feeling that it's not really business as usual. Their early warning systems already have picked up the first signs of a slackening economy, and a recurring headline in German papers is "Der Boom flaut ab"—the boom is ebbing.

The news is disturbing, but by no means alarming. West Germany's economy still has enough momentum to keep business on the upswing during 1971. Though chancellor Willy Brandt's coalition government has put the brakes on the economy, the gross national product will climb about 3.5% next year in real terms. That's not bad, although it's well short of the 5% to 5.5% logged this year.

The story line for the electronics industries is much the same, but the numbers are different. Manfred Beinder, who heads the market research department at the ITT subsidiary Standard Elektrik Lorenz AG, figures on a rise of 12% in the electronics market for 1971, compared with this year's 22%. Few would quarrel with Beinder's assessment. *Electronics*' survey pegs the 1971 market in West Germany at $2.95 billion, up 14% on the estimate of $2.58 billion for 1970. But a longer look at the details reveals that much of the rise comes from soaring sales of data processing equipment. Knock out the computer sector and the 1971 growth works out very close to Beinder's 12% estimate.

Along with computers, telecommunications will run exceptionally strong next year, thanks to a whopping 23% increase in telecommunications spending by the Post Office, the bread-and-butter customer. Entertainment electronics producers, on the other hand, can't count on much of a year. The small market rise that's in the offing will be covered largely by the warehouses full of sets that piled up during this year's spurt in production. Even worse off are components makers, particularly the semiconductor firms. A year ago equipment makers were clamoring for their wares, but supply has so outstripped demand that prices have tumbled. The firming-up may not come until 1972.

Entertainment equipment makers, large and small, experienced a dizzying 1970, with most companies ticking off sales gains of 15% to 20%. Next year, though, won't be quite the same. Says an official of Grundig Werke GmbH, "We view the situation with damped optimism." and Ulrich Prestin, product planning manager at Nordmende KG adds, "Not that 1971 won't be a good year; it just will not stand out as a remarkable one." The survey backs this view; it predicts a 4.5% rise—to $824 million from this year's $795 million—for consumer electronics sales.

Color TV, the mainstay of consumer electronics, passed an important milestone in 1970: some 650,000 sets were sold, pushing the number of German homes with color sets above 1 million. In 1971, manufacturers figure to sell more than 1 million color sets in a single year for the first time; however a lot will come from stocks that piled up this year. Most will go into the domestic market, which the *Electronics*' survey predicts will absorb $337 million of color sets. Even better, the Olympic Games are coming up at Munich in 1972, and manufacturers already are making bold

predictions for that year. When it ends, they forecast, some 4 million color sets will be in use; the current figure stands at about 1.4 million.

Despite the surge in television, radio has been showing a renaissance. The market will drift up slightly next year to $152 million, a turnabout from the dwindling of previous years. Portables and car radios are largely responsible for this trend; the 1971 market for car radios, for example, will be about 1 million units.

Whether 1971 will make a record for itself as a landmark year in TV set technology remains to be seen. A breakthrough could be scored by the 110° color TV tube, which allows a thinner cabinet, and appeared in small numbers this year. By and large, West German set makers and the retailers who handle their wares aren't particularly enthusiastic about the tube just now. With conventional 90° tube sets selling well, they argue, the market doesn't need any technological fillip. Some set makers, in fact, contend that the 110° tube comes two years too soon. Retailers, facing a shortage of qualified technicians, are fearful of the increased service and repair problems the tube's more complex deflection circuitry will bring.

But industry resistance is beginning to wear thin and at least one major tube maker, Valvo GmbH, the country's components giant and a subsidiary of Philips' Gloeilampenfabrieken, is counting on fast acceptance of the tube. Large-scale deliveries will start in January and during the first four months of 1971 Valvo's output of 26-inch 110° tubes is expected to reach 40% of its total picture tube production. The proportion will grow to about 90% by the end of 1971, say company officials.

Next year also will see further inroads of integrated circuits in TV receivers. To be sure, sets with ICs are old hat to German TV producers. "But what's going to happen next year is that the Grundigs and the Blaupunkts will all be ordering ICs by the 100,000s," maintains a top European sales official of Fairchild Semiconductor.

Another sure thing next year is a skirmish among makers of video recording systems. Sooner or later, VRs are going to be big business and the battle for market shares already has begun. Some hardware will be on the market next year, but the question of whose gear will prevail won't be answered until 1972. Among the contenders: Philips' video cassette recorder (VCR), RCA's SelectaVision, CBS' electronic video recording (EVR), and AEG-Telefunken's video disks.

Philips executives habitually say the company is never first into a market, but the company will definitely be in the vanguard of the VR skirmish. Starting around the middle of next year, Philips will offer three basic cassette systems for consumer applications. One, designed for black-and-white playback only, will sell for between $275 and $330. The second, for color playback, will range between $385 and $412. The third unit, a receiver packaged with recording and playback systems for both black-and-white and color, will be priced at about $550.

Philips figures that about 350,000 video cassette recorders will have been sold by 1975. By the end of this decade, with 1.5 to 2 million units in consumers' hands, a saturation level of 8% to 10% should be reached, the company says. But heavy buying won't start next year; it won't be until 1972 that a significant number of video cassette units will be in use.

German computer makers over the next few years figure to speed ahead like a Porsche on an autobahn. This year's market (with rentals counted at "if-sold" value) ran above $800 million, according to *Electronics*' survey; the 1971 forecast is a 26% surge to $1.02 billion.

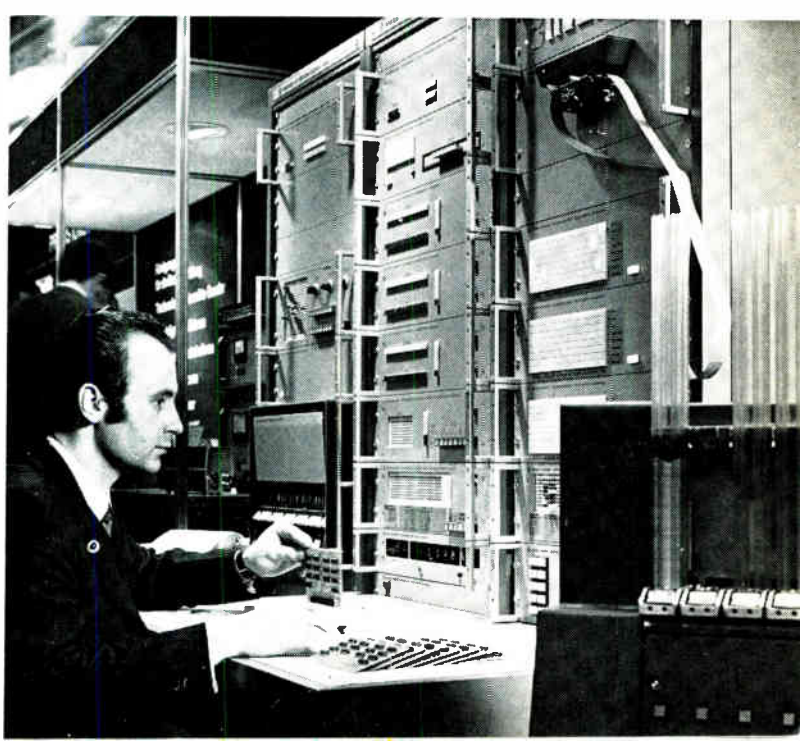
What's more, there are no signs of a letdown even though industrialists have turned wary about plant investments. "Streamlining industrial operations and plant processes is still a prime concern," says Harold Wunderlich, an official in the data processing division at Siemens AG and for that reason he predicts the computer market will double by 1975.

As for computer technology, 1971 will see evolution, certainly, but no revolution. Any talk about "fourth-generation" machines is scoffed at, even at IBM. Pointing out that the market is too big to accommodate the new software approaches that revolutionary machines would bring, one German computer expert insists, "a generation change is just not in the cards."

The deck does seem stacked, though, in favor of large systems. Government agencies and some professional groups are turning more and more to mass data banks linked to satellite computer installations to handle data growth. One of the latest of these networks is one based on a Univac 418-3 that, starting next year, will give lawyers and judges all over Germany direct access to legal precedents.

Siemens, of course, is thinking big for 1971: it's readying for delivery next year its biggest and most

Test by computer. The lash-up of computers and testing gear is growing in Europe as in the U.S. Typical is Rohde & Schwarz' computerized IC tester.



advanced computer, the model 60 of the Siemens 4004 series, with a store capacity expandable to more than one million bytes in 131-kilobyte steps. Intended for commercial and technical-scientific applications, the 4004/60 will rent at less than $13,500 per month. The computer is three times faster than its predecessor, the 4004/45: cycle time is 765 nanoseconds for four bytes.

The computer story is being repeated, albeit to a lesser extent, in instrumentation. Market watchers see a trend to "systems" that can carry pricetags as high as $200,000. Says Peter Kohl, marketing manager at Hewlett-Packard GmbH, "More and more customers are looking at large instrument systems with computer capability." He predicts that by 1973 these "dedicated" systems will account for 30% of instrument makers' sales.

This year *Electronics'* survey turned up a $105 million market for instruments. The prospects for 1971 are a near-10% rise to $113 million.

Communications equipment makers will be showing their busy signals during 1971. The industry's prime customer, the West German Post Office, has set aside more than $1 billion for improvements to its telecommunications network during 1971—that's 23% higher than in 1970. And although most of the money will go for telephone lines and such, plenty will be spent on electronics-larded pulse code modulation equipment, data links, and microwave networks. All told, *Electronics'* survey spots the communications market at $430 million for 1970 and predicts a rise to $488 million next year.

Chalk up a significant part of that rise to a record the German Post Office intends to set at the 1972 Olympic Games at Munich, where more electronics hardware—for score-keeping, for disseminating results and for transmitting them around the world—will be used than at any other sporting event ever. "Our goal is to insure that these games are broadcast by every possible means of communications."

To score its ambitious goal, Siemens is readying for the market next year a portable 13-GHz television relay system that gets live TV programs from remote spots into the regular signal-distribution links. The transmitter can be installed up to 18 miles from the receiver. Together with intermediate relay stations, also portable, distances of up to 90 miles can be bridged easily.

A crowd of firms is surging into the burgeoning market for display equipment. Right now, between 2,000 and 2,500 displays are installed in airline information systems and the like, about four times more than a year ago. Within the next 12 months, a Siemens market researcher predicts, the number will jump to between 5,000 and 6,000.

Another market that's coming on strong is equipment for pulse code modulation. Mainly experimental until now, PCM links next year will go into large-scale evaluation under operating conditions in public telephone networks. No less than 50 PCM links, based on the experimental work done by four major communications houses, will be used in short-haul communications in urban areas all over the country.

As for electronic switching, the Post Office is biding its time. The four trial systems already in service for several years must be evaluated still further before a final decision on a standardized design can be made, in perhaps another two or three years.

But though the Post Office isn't spending in this area, heavy outlays by other agencies more than compensate. West German flight control authorities, for example, have started to set up at different spots around the country big radar systems for controlling air traffic. Designed by AEG-Telefunken, these systems can spot high speed aircraft at altitudes up to 70,000 feet and at distances of more than 160 miles, as well as slow planes at low altitudes. Six such systems will be operational by 1975. The first, installed at Bremen airport at a cost of $5.5 million, is undergoing tests.

In semiconductors, *Electronics* last year noted: All the major producers have added new production facilities this year or plan to next year . . . Siemens, for example, is adding a six-story building to its main semiconductor complex at Munich; the addition is for ICs only. AEG-Telefunken, the Philips' subsidiary Valvo GmbH, and Intermetall of the ITT group of companies are expanding their lines. Texas Instruments opened its second plant in Germany this summer, SGS Deutschland GmbH its first. Fairchild Semiconductor . . . is building a plant at Wiesbaden and will start producing next year." [*Electronics*, Dec. 22, 1969, p. 89].

These lines explain the plight of component producers in West Germany today. Overreacting to the components shortage and the inflated order backlogs that developed two years ago, they overbuilt new production capacity, putting them at the mercy of the adverse market forces that take over when supply tops demand. To make matters worse, U. S. producers flocked to Europe this year looking for export business to pick up part of the slack they were experiencing at home. The end result was a price slump, and largely because of that slump the German components market next year will grow by less than 10%, to $961 million from this year's estimated $886 million.

Hustling the hardest for business next year will be the semiconductor makers, particularly their IC salesmen. Prices for standard transistor-transistor logic circuits have plummeted by at least 60% this year. At last month's Electronica trade show in Munich, for example, some standard TTL circuits were up for grabs at 10 cents a gate. The TTL packages are such bargains that equipment makers thinking about switching to MOS/LSI designs have in some cases postponed their plans.

Semiconductor makers, too, will have to change their plans if IC prices don't firm up. Putting it mildly, Ralph Bennett, product planning manager for Fairchild Halbleiter GmbH, admits, "Some companies may be forced to at least change the nature of their business." Says an executive at another company, "Not even the big houses are making much of a profit these days."

The difficult days, most market watchers think, will last through 1971. If they're right, the smaller houses will be hard put to stay in business.

Color sets, computers are Britain's cup of tea

The British voted themselves a new government last June and the change at 10 Downing St. has changed the places where the government's economic policies take their toll.

The departed Laborites kept consumers' pockets shut to hold down imports that caused the country's chronic balance of payments deficit. The new Conservative government considers restrictions on consumers distasteful. Also unpalatable to the Tories are the subsidies, loans, and investment incentives the Labor government doled out to industries it considered vital.

The Tories are winding up these programs. But one thing hasn't changed: Britain still hasn't found a way to muster the economic strength neessary for solid growth in gross national product. The growth rate, in real terms, is running less than 2%, well below estimates for other major Western European countries. What's more, with inflation running along at 7% a year in prices and 14% in wages, probably no businessman in the country is happy with the economic outlook.

But there's one comfort: the balance of payments position is acceptable right now, although not entirely satisfactory. So there's no immediate pressure on the Tories to force a Labor-flavored deflation on the economy. The consumer electronics surge that started this year, then, should run on through 1971. Computer-hardware purveyors also should do well, although their heavy imports of data processing peripherals will put the U.K.'s foreign trade balance in capital electronics expenditures in the red for the first time. With color TV and computers running strong, there's a good overall rise in store for 1971. *Electronics*' consensus forecast calls for a $1.8 billion market next year, up from this year's $1.6 billion.

What's nicer for the whole, though, isn't necessarily nice for all of its parts. Instrument sellers face a lackluster year. Avionics makers may suffer from cancellation of aircraft projects. And by the time the IC price war runs its course, the list of semiconductor sellers in Britain may shrink markedly.

Color television upstaged the rest of the players in this year's consumer electronics pageant, and will move even further ahead in 1971. Twelve months ago, set makers thought they'd sell 300,000 color sets to retailers and renters in 1970, but to their delight the actual figure was 450,000.

Embarrassed about their previous pessimism, industry men are now talking, with fingers crossed, about selling 750,000 sets worth $230 million next year. Worries about production capacity that contributed to last year's pessimism have been largely banished. "There's no doubt the industry will be able to make 750,000 sets next year," says Brian Reilly, managing director of Radio and Allied Holdings Ltd., home entertainment subsidiary of Britain's General Electric Co., the country's biggest electrical-electronics producer.

Mainly due to this surge, Reilly sees a drop in black-and-white sales from 1.75 million sets this year to perhaps 1.5 million, worth about $150 million, in 1971. Reilly's predictions match nicely with the *Electronics*' consensus forecast: a rise to $229 million for color sets sales during 1971 and a drop to $143 million for black-and-white units.

Technologically, 1970 marked a strong trend to solid state—four different all-solid state color sets are on the market—and to a lesser extent, to ICs. Philips Electrical Ltd. leads the pack with four ICs at present—a sound i-f amplifier, an eight-function "jungle" chip, a combined chrominance demodulator and PAL switch, and a stabilizer for the varicap tuner. Philips will add a red-green-blue matrix IC next year.

Many more television ICs will reach the market in 1971. For example, Mullard Ltd., part of the Philips Gloeilampenfabrieken group, will introduce a basketful. But Tom Jacobs, Mullard's technical-commercial manager for consumer products, doesn't expect to see any new sets with ICs next year. However, at least three makers will be using varactor tuners by late next year, against one now. And the present rectangular glass delay line in PAL sets, using only one reflecting face, will give way to a pentagonal unit which gets the same signal path length from three reflections; less glass means less cost.

For Jacobs, the lull in new IC sets can be explained readily. "Set makers will be preoccupied with moving to 110° tubes," he says, "and will get that settled before incorporating further ICs." Some 110° tube sets may get to market late next year, but early 1972, after the 1971 winter production push, is a more likely date for a mass switchover.

Keep an eye, too, on sales of hi-fi sets. Under stimulus from imports, particularly from Japan, sales have picked up this year and are ready to jump by 20% next year, bringing the total to $42 million.

Computer makers don't figure to do quite as well next year as they did in 1970. Their market leaped by 20% this year to hit $465 million. The 1971 jump—to $542 million—works out to 17%.

Expansion won't be the same for all hardware sectors, however. Processor deliveries aren't likely to increase by more than 10%, despite some very big systems ordered this year for 1971 delivery. By contrast, terminals and mass memories, particularly disk units, will push ahead by 33% to 50%. The 10% increase for processors, however, works out to considerably more than that in terms of computing power. For one thing, the price-performance ratio of computing systems is improving by about 15% a year. For another, some industry men detect an increasingly critical attitude among buyers, particularly in business computers, leading toward purchases of smaller processors, worked more intensively, than would have been chosen a year or two ago. "There's a tendency to move from highly supported to less supported systems for specific applications," says Iann Barron, managing director of Computer Technology Ltd., makers of the Modular One computer systems. On

top of that, a big chunk of the peripherals boom will come from units tacked on to improve existing processors.

The fastest-moving sector of the processor market will be right at the bottom end—systems costing up to around $15,000. These will be connected directly into electronic systems as controllers, monitors, and as data loggers, concentrators and disseminators. No company in sight can challenge the dominance of Digital Equipment Corp., and only two or three British firms are running in an otherwise American field. Clifford Cundall, sales manager of the Automation Systems division of Ferranti Ltd., one of the British competitors, says the new, small machines, including his firm's Argus 600 series, "are lowering the threshold of computer control into areas previously dominated by solid state and relay sequencers." But above all, believes Cundall, small machines will establish themselves next year as data collectors, disseminators, and switchers in communications systems. He's supported by David Seale, managing director of Micro-Computer Systems Ltd., a British small computer maker, who says, "There has been more talking than buying this year; there'll be more buying and less talk next year."

Another type of small system set for an upsurge is the office computer for use as a calculator, visible record machine, or accounting computer. Helping this trend is the switchover to a decimalized currency system that becomes official in February. But another big factor is the sales drive by Philips, Olivetti, and Japanese companies, which is convincing people that they can make do with very small systems that don't require trained programers. British Olivetti Ltd. reckons there'll be a market in Britain next year for more than 70,000 calculators in the up-to-$2,000 price range, about 80% of them electronic units.

Looking inside the cabinets, new memories will be much in evidence next year. International Computers Ltd. has $2 million in Plessey's plated wire memories on order; these by late next year will get into ICL's bigger systems where speed is paramount. ICL researchers are experimenting with emitter-coupled-logic-compatible TTL memories as associative buffer stores between the processor and the main store, and with content addressed bipolar memories for paging, but otherwise ICL seems committed to cores for the foreseeable future.

Semiconductor memories still are absent in small British computers apart from special cases like Elliott-Automation's military airborne machines. "There are too many different technologies offered at present," says Alan Clemmetsen, chief engineer of Arcturus Electronics Ltd., one of the British makers, "and if you commit yourself now you may have second sourcing and interface problems later."

Also, there's doubt among British computer firms that semiconductors will turn out to be cheaper than cores in the important 4-to-8 kiloword range of read/write random access memory. Hence semiconductor-memory salesmen will concentrate on peripherals next year, particularly video display terminals, where 1,000- and 2,000-character (8 bits each) read-only memories hold a cost edge over diode matrices.

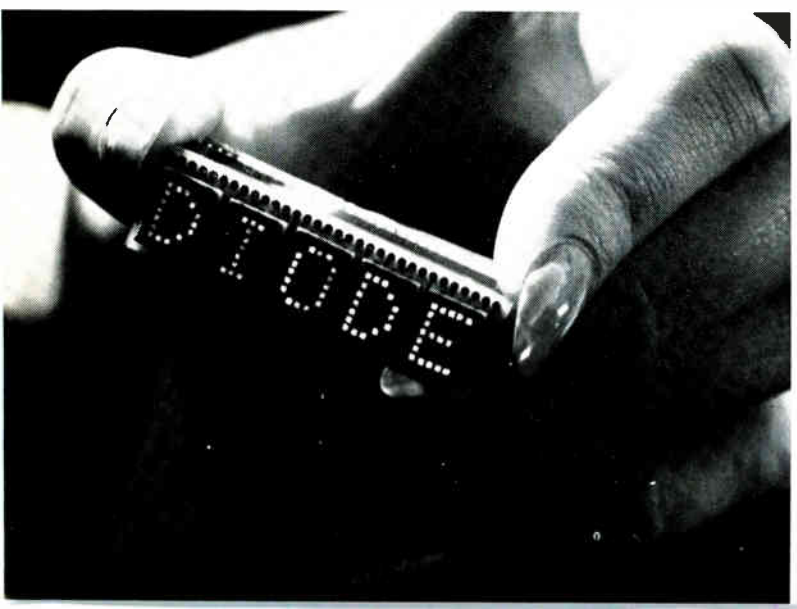
With dozens of different video displays on the market, the long-predicted boom may come off next year. Not far behind the pace setting terminals will be mass-storage units, particularly disks, as computer users move from the slower magnetic tape systems. Advanced input devices will get a boost, too; the best-placed categories will be key-to-disk and tape-to-disk systems, and optical mark readers. Just around the corner after 1971 are the Friden and NCR on-line cash register systems for big stores. Marks and Spencer Ltd., the biggest national clothing store chain, is showing greater interest.

All computer hardware sellers will be helped by the growing strength of the computer service bureaus, which look far more solid now than they did a year ago. On the other hand, domestic manufacturers show growing concern over the import content of hardware sold in Britain. Imports of systems, peripherals, and parts are up 70% this year over last. This spurt will push the excess of computer hardware imports over exports to at least $200 million in 1970; thus Britain, for the first time, will be saddled with a negative balance of trade in electronics capital goods of at least $20 million. This despite gains in export-import balances for nearly every other electronics equipment category.

British communications equipment makers will be pushing exports harder than ever next year to offset the sluggish business in sight at home. More and more, communications markets in Britain, already full of electronics, are turning into replacement markets, ruling out lusty growth. *Electronics*' consensus forecast is for 1971 sales of $467 million, up 9% from this year's estimated $428 million.

Some sectors will suffer an outright decline. One such area is broadcast equipment because the buying boom that developed when color TV came to Britain two years ago is now finished, and the next spurt won't come until the hardware now in use becomes outdated. There's one consolation, though. The uhf network will push steadily ahead, adding

On display. Brightening prospects in the semiconductor market, light-emitting diodes, like these made by Marconi, are finding more and more readout jobs.



about a dozen main transmitters and—hopefully—more than two dozen relay stations in 1971.

Of course, there are a few bright spots. Land mobile gear, both vhf and uhf, looks set for a 12% rise. Marconi Co. Ltd. will build a third satellite station at Goonhilly for the Post Office's transatlantic services, but presumably that will give Britain all the earth stations it needs for a while. The Post Office also is behind the slight edging up of microwave relays in the offing for 1971. Marine radio manufacturers should find things better starting in 1972, when the mandatory shift to single-sideband equipment starts to become effective.

British avionics never was a good place for pensioners to invest their life savings, and 1971 won't see a change in that situation. Cancellation of the British Aircraft Corp. 3-11 short-haul airbus has removed the avionics industry's main civil equipment prospect for the next decade. When present producton lines close down, avionics men will have to sell all civil built-in systems, such as autopilots, to foreign plane makers. The one possible exception is the Anglo-French Concorde supersonic transport—and the two governments may cancel that next spring, if it doesn't look commercially viable.

Pending this decision, the industry is relying on production runs of Hawker-Siddeley Harrier VTOL military planes for the Royal Air Force and the U.S. Marine Corps; Nimrod maritime patrol planes for the RAF, and possibly the South African Air Force; 200 Anglo-French Jaguar fighter aircraft for the RAF.; some Buccaneer and Lightning strike aircraft for export; some military helicopters; and established civil transports, like the Hawker-Siddeley Trident 3B airliner and the 125 executive jet.

In addition, standard avionics have been ordered for the two preproduction Concordes being built as well as long-lead avionics for six further production Concordes, so that no time will be lost if the plane goes into production. The consortium handling the British-German-Italian multirole combat aircraft (MRCA) is moving ahead on avionics, too: calls for proposals on 25 to 30 avionics subsystems for the trinational plane are out.

Instruments manufacturers' sales will advance at a measured pace next year. The fastest-growing sector looks like special-purpose instrument systems, but they're expensive. Hence, with tight money, it's likely that fewer standard instruments will be sold next year.

As for process control systems, deliveries will rise steadily through most of 1971. After that, the outlook's more doubtful, because the big plant builders like chemical and oil companies may cut back their investments next year in response to the uncertain general economic outlook. By year end, deliveries to petrochemical plant builders may be between 8% and 12% above 1970 levels. Controls for steel plants look set for a good year, but many smaller control systems, such as those in food and textile industries, may be curtailed.

For the long run, a good sign for electronics instrumentation is the steady shift to electronic control-system hardware at the expense of mechanical equipment. David Jenkins, a market watcher for Kent Instruments Ltd., reckons electronic units will take 50% of the market by 1971. About 40% of the controls for petrochemical plants are electronic; those for steel and power plants are nearly all electronic. Another good sign, though a small one, is the spread of electronic systems at the bottom end of the market, where small computers are making themselves felt.

Industrial and medical infrared imaging systems established themselves in 1970 and will push ahead next year, but are too expensive to make a significant jump. Machine tool numerical controls should have a better year now that Plessey Co. Ltd. controls manufacturing and marketing of most of the British NC effort.

Components makers in the U.K. have much the same problems as their counterparts on the Continent. Their customer list expands each year as auto makers, appliance firms, and others begin to incorporate components in their designs. But the break in prices, particularly in semiconductors, means the gain in value of components sales doesn't keep step with the surge in units sold. The *Electronics*' consensus forecast, in fact, points to a rather disappointing 10% rise for 1971, to $682 millon, from this year's estimated $620 million.

The fastest-growing sector, of course, is digital ICs, and that's precisely where the price-slashing has been the bloodiest. Standard TTL packages with complex functions have become so cheap, says a marketeer at Texas Instruments Ltd., that they will be appearing in more and more instruments, industrial equipment and also in computers, where some companies are eschewing custom circuits for standard ones.

What's more, there's plenty of technological competition, too. Both TI and Ferranti Ltd. reckon to have 3-nanosecond Schottky diode TTL circuits on the market next year, including some complex functions. But neither house is clear on where they'll be selling them. Both agree sales must cut in to the ECL market, but in Britain only ICL and Computer Technology Ltd. buy ECL in quantity, and both are committed to Motorola designs. Uprated instruments are a possibility, believes TI. Ferranti's sales manager, Brian Down, feels Schottky-TTL's real boon lies in providing speed without gold doping. This should make it easier to put linear and digital functions on the same chip, since gold degrades the linear elements.

MOS store sales will quadruple next year to total about $3.5 million, of which some $2 million will go for shift registers, and the rest for read-only and random access memories. These devices initially are destined for data processing peripherals as stores and microprograms; later they'll be used in processors themselves. The memories are mostly U.S. made, with capacities up to 2,048 bits in RAMs and 4,096 bits in ROMs; but Plessey Co. Ltd. and Marconi-Elliott Microelectronics Ltd. are getting into the market with their own silicon gate devices. Marconi also is working on bigger stores, beam-leading nine chips of 1,024 bits plus control logic onto a substrate to make a 9,000-bit hybrid read/write store. Apart from memories, the

market for custom MOS logic next year is likely to reach $2.5 million, up 25% on this year's figure.

Light-emitting diodes will show "a tremendous turn-on in sales next year," says Bill Stott of TI. So far, LEDs have been used almost entirely in film marking. Tony Peaker, in charge of Ferranti's gallium phosphide work, thinks film marking will still be the main market next year, but along with Stott he expects a boom in sales of individual diodes as low-voltage, low-drain indicators in portable equipment, and as optocouplers. Starting in January, Ferranti will offer red and green indicator lamps at $1.00 each in quantity, to be followed shortly by a green 35-diode monolithic GaP alphanumeric readout display. It's the first green array anywhere, believes Peaker. However, he may be outraced into the equipment stage by Monsanto, which claims its red 35-diode gallium-arsenide-phosphide array will appear in operational computer peripheral gear late in the year. More likely to be taken up quickly are the seven-segment numeric readouts offered by Monsanto and TI. Stott claims these will sell at up to 100,000 a year by the end of 1971.

Next year also will see some microwave ICs used in power amplifier stages of uhf radio-telephone equipment—a first for civil equipment. Use in military gear, particularly airborne receivers and transmitters, will become more widespread.

French deflation depresses electronics growth

Georges Pompidou has maintained his reputation as France's most august bon vivant during his 18 months in office, but his finance minister, Valéry Giscard d'Estaing, has had to settle for some very flat champagne. Forced to devalue the franc in August 1969, after big wage hikes left the nation reeling from inflation, Giscard d'Estaing, at Pompidou's bidding, sobered up the economy with cutbacks in government spending, credit restrictions, and incentives to convert citizen-spenders into savers.

The cure seems to have worked, thanks to the devaluation, for French goods in export markets have fueled a 21% export surge this year. Meanwhile, restrictions on French consumers have held imports to a modest 8.8% rise. The franc, as a result, is regaining much of the strength that was the pride of the late Charles de Gaulle before the May 1968 rioting.

But dampened home demand and austerity budgets for government agencies have left the usually fast-paced French electronics market—computers and telecommunications excepted—marking time through most of 1970. Of course, it's nothing like the near-recession in the U.S., but there hasn't been much growth either in consumer electronics, avionics, and instruments, all of which flourished during de Gaulle's heyday.

Fearful of drying out the economy too drastically, the government this fall began to turn on the tap again. Loans for consumer purchases and for plant investment have become cheaper and more plentiful. The electronics market already has benefited: TV sales, stagnant for the first nine months of the year, picked up this fall.

However, government spending—a crucial factor in the market—will remain stable in 1971, and few new equipment programs will plump out order books. French electronics executives fear this continued hold-down, coupled with some spillover into Europe from the U.S. recession, will make 1971 a difficult year in their home market, except for the privileged computer and telecommunications sectors.

The government agrees economic activity will slow down: it forecasts a net rise in the gross national product of 5.7% next year against an estimated 6.2% increase this year. Slower exports will account for much of the decline, in the government view. Exports are to rise only 9.5% in 1971, while imports should go up by 8.7%.

Pompidou maintains he can halve the inflation rate next year to 3%, from this year's 6%. But this official optimism is tempered by last year's performance, when government forecasters put 1970 inflation at only 3.9%.

The overall figures in *Electronics*' consensus forecast predict a strong rise in the equipment market next year—to $1.81 billion from this year's estimated $1.56 billion. However, practically all the strength lies in the computer and telecommunications sectors. The prevailing mood at most other electronics companies is mirrored by the survey's forecast for components: a modest 1971 rise to $561 million from 1970's estimated $506 million.

Semiconductor firms in France, as elsewhere in Europe, show the greatest apprehension about 1971 prospects. "The effects of the U.S. recession are showing in Europe," says Monroe Goldberg, general manager of Transitron-France. "American companies are pushing their excess production here, and with IC prices falling, customers are postponing their orders hoping to get better prices later. I'm afraid inventories are going to go low, and then people will suddenly want delivery tomorrow."

The TTL business is hardest hit. Motorola, for example, reports it has been selling TTL circuits in France this fall for around 25 cents a gate in large volume. Average prices early this year were around 45 cents. The company maintains it still makes a profit at this level, though some competitors scoff at the claim. "You can show a profit on anything if you keep your books right," says one.

One French TTL maker lost some major IBM orders this year when the U.S. slowdown led the big computer maker to import American-made subassemblies instead of buying locally. Such stories are common in France these days. "The gloom won't dissipate quickly," says Monroe Maller, Motorola's marketing manager for France.

Maller nonetheless sees a modest rise in total French semiconductor purchases next year, to around $116 million from his 1970 market estimate of $106

million. However, as recently as last June he expected the 1971 market would touch $130 million. The consensus forecast is more optimistic: $116 million for 1970 and $125 million for 1971.

Jean-Jacques Teillet, deputy director of the professional products division of RTC—la Radio-technique-Compelec, a French subsidiary of Holland's Philips—expects semiconductor sales to the consumer industry will rise since color TV (taking off gradually in France) will use more solid state components than black-and-white sets. The semiconductor share of TV set components should rise around two percentage points from its present 12%, he predicts.

Motorola sees consumer markets as a promising outlet for ICs next year. Hoping to latch onto the boom in French auto exports, Motorola is trying to sell auto makers IC light-dimming systems and other accessories. One French company, Paris-Rhone, is designing an IC antiskid system. Some executives expect linear ICs to take a chunk of the am-fm radio market next year and possibly to show up in i-f strips and other functional blocks in TV sets.

Starting nearly from scratch, MOS circuits will post impressive gains, Teillet feels, showing up increasingly in minicomputers and other small data processing machines next year. France's Logabax, for example, launched an electronic billing machine using MOS circuits at this fall's Sicob office equipment show in Paris. And French marketing men believe MOS read-only memories could pop up in big computers starting in 1972.

A market for solid state displays could develop in France next year, though many marketing men feel 1972 is a more likely takeoff date. Several companies are standing by with products, for example, RTC which has infrared light emitters for computer and instrument displays. And Thomson-CSF, the largest French electronics firm, has a new liquid-crystal display under development to replace the prevalent cold-cathode tubes.

Telecommunications will offer a growing market for components and microwave equipment next year. The French PTT postal and telecommunications agency plans to spend nearly $1 billion modernizing the telephone system in 1971, up 31% from this year's equipment spending level. All told, communications equipment markets will amount to $361 million this year and $425 million next, *Electronics*' survey predicts.

"As far as the telephone is concerned, France is an underdeveloped country," says Edouard Guigonis, commercial director of Thomson-CSF, which expects benefits from the government's drive to catch up in this field. The PTT, for example, two years ago switched from coaxial cable to microwave links for new intercity telephone trunk lines and will accelerate the pace over the next few years.

There's a jump in sight, too, for French space spending—it will rise in 1971 to $133 million from this year's austerity level of $100 million. However, most of the increase will go for France's greater share in rocket development cost of ELDO, Europe's international launcher agency, following gradual British withdrawal from that body. Little of this money will end up in electronics coffers. France's national space program will get only 6% higher funding next year, for a total of $70 million.

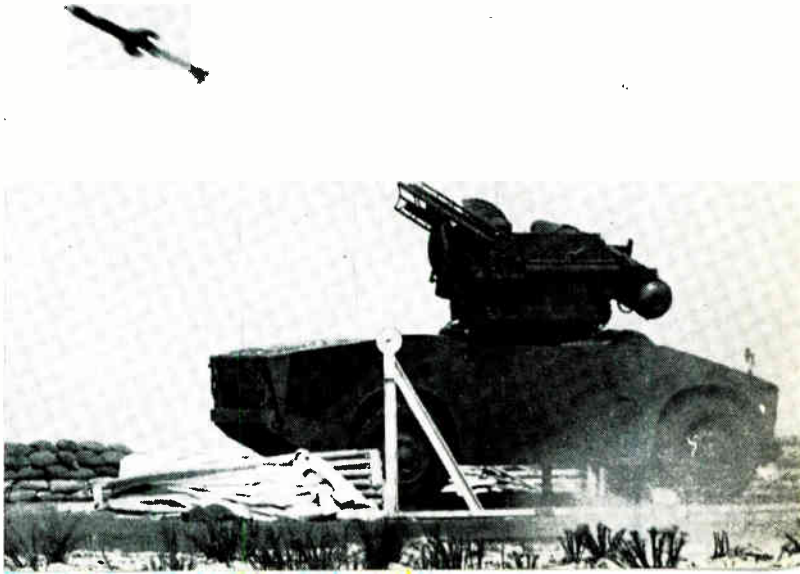
Nonetheless, electronics firms see a number of enticing space contracts in the offing. For example, orders to build two $4 million ground stations, one in France and one in Germany, for the Franco-German experimental communications satellite Symphonie should be awarded early in the new year, with others likely in the future. The satellite was to have been launched in time to relay TV broadcasts of the 1972 Olympics in Munich, but the project is delayed.

French space business also may be boosted by the upcoming telephone and TV satellite planned by the European Broadcasting Union (EBU) and the European Satellite Telecommunications Conference (CETS). ESRO, the Paris-based European Space Research Organization, is handling the design and likely will finance development of traveling wave tubes for satellite ground stations as a first phase during 1971. New TWTs will be needed because the EBU-CETS bird will operate with a 13-GHz up frequency and an 11-GHz down frequency. The 6-GHz and 4-GHz bands used by existing satellites are saturated. ESRO presumably will let study contracts to two competing groups late this year and then designate one of them the contractor in late 1971.

ESRO also has its hand in other satellites. Tentative spending plans for 1971 include $5 million for feasibility studies for an air-traffic-control satellite being examined by the U.S. and European countries. Then there's a $15 million to $20 million contract in the works for midyear covering a new scientific satellite called Cesar. Feasibility-study contracts for six other scientific satellities round out ESRO's 1971 list.

Looking further ahead French space firms feel they may land some business in the American post-Apollo space shuttle project. Although Britain showed little inclination to join a European team for the shuttle when European space officials met in Brussels last month to see what they might work out, the Contin-

To arms. Military electronics in France is getting a boost from such hardware developments as the Crotale ground-to-air missile from Thompson-CSF.



ental countries may put together a group to take part in the project. Optimists in French space circles figure European firms would get about 15% of the electronics business for the shuttle.

Military electronics spending will remain static next year, with few new development programs of any importance planned. Electronique Marcel Dassault, for example, will concentrate next year on ongoing programs like the doppler navigation system for the Anglo-French Jaguar fighter and the guidance system for the Franco-German Exocet ocean-going surface-to-surface missile.

"We're now producing things that were conceived between 1966 and 1968," says Guy Porcheron, Dassault's commercial director. "There are few new things, but 1971 should be a good year even so for us." Some of the newer things include:

- Rapace, a fire control radar for assault tanks. Dassault has started assembling prototypes and Porcheron maintains they are very promising for export markets. No orders are likely, though, before 1972.
- The Alpha-jet, a Franco-German trainer. With each country ordering some 200 planes added avionics business is in the cards for 1971. Each plane carries a small radar as well as the usual radio equipment.
- The Crotale air-defense missile for protection against low-flying aircraft. Thomson-CSF has already sold Crotales (French for rattlesnake) to South Africa, which financed its development, and to Lebanon. A $5 million order reportedly is in store next year from the French Air Force.

For computer makers, every year seems to be a vintage year and 1971 will be no exception. *Electronics*' survey points to another strong gain, up 18% to $624 million.

Maxime Bonnet, marketing director of Honeywell-Bull, the new company formed this fall when Honeywell took over General Electric's worldwide business computer operations including France's Bull-GE, says European markets aren't taking on the "camel-back" posture predicted by some computer seers. Instead of two humps in the sales curve—one for big computers, the other for small computers—with little in between, "the growth is across the board in France," Bonnet insists.

All the same, the big installations attract the most attention, and 1971 will see the order for France's most expensive computer system so far—a $16 million setup to automate airfreight customs at the upcoming Paris-North airport at Roissy-en-France, which is scheduled to open in 1973. Bidding for the business are IBM, Honeywell-Bull, and a new consortium comprising the government-backed Plan Calcul computer firm Compagnie Internationale pour l'Informatique (CII), Holland's Philips, and Britain's International Computers Ltd. (ICL).

The international trio seems to have an inside track for this business and also for a second French customs system, this one for highway freight traffic. The government wants CII to join a permanent European group of computer-hardware makers that could counter the current dominance of U.S. companies in data processing.

Following the bid on the Paris-North airport system, CII and ICL last month did form permanent bonds —but with Control Data Corp. of the U.S. as a third partner rather than Philips. The big Dutch firm reportedly is reluctant to institutionalize such ties.

CII, ICL, and CDC have set up a joint research and development subsidiary, International Data, which will coordinate the trio's future product lines to ensure compatibility. A joint marketing venture seems the inevitable next step. European data processing executives will be watching the new combine in the coming year to see if the three companies can pull off their computer coup.

However, CII fares with its foreign partners, it will remain the preferred supplier to France's largest computer user—the government. The state-backed company now claims that one out of every eight government agency computers is a CII machine. CII's share of new government orders is 7% and the aim is to boost that figure to 16% by 1974 or 1975, says Bruno Gastine, deputy director of CII's products section. Shorter-term prospects look bright, too; by the end of this month CII expects to have delivered 25 of its mainstay business machines, the Iris 50, and plans one-a-week deliveries during 1971.

Another standout in next year's French computer markets will be electronic desk calculators. The native company to watch is Schneider Radio-Television, which, after introducing its first calculator just over a year ago, has already won 15% of the French market, and expects to have 25% to 30% by the end of next year. That market should total around 35,000 machines worth $24 million next year, up from $17 million this year. Schneider's big selling point is the $530 price tag—lowest in France, the company claims—for its new 14-digit model introduced this fall.

Next spring the company plans to launch an inexpensive printout model using a mixture of LSI and MSI circuitry to simplify the electromechanical interface. Next September it will introduce a new line of two or three machines based entirely on LSI circuits, says Martin Birnbaum, director of Schneider's professional electronics division. Plans apparently also are afoot for a pocket-sized semi-consumer model based on LSI.

The instruments market will rise only a few percentage points next year, predicts Jean-Noel Hervé, European marketing manager for Schlumberger Ltd. Few would dispute Schlumberger's view—it became the undisputed leader among French instrument makers last year by acquiring the Compagnie des Compteurs, among whose subsidiaries was oscilloscope-maker CRC. The censensus survey shows a 7% gain to $77 million.

This generally lackluster outlook shows a few bright spots, however—industrial telemetry, for one. Schlumberger installed oil-flow monitoring systems in two big French pipelines this year—Paris to Le Havre and Marseilles to Strasbourg—and expects other pipeline contracts next year. The company is trying to develop telemetry markets in oil refineries and other process operations.

In consumer products, the story once again is that color TV is failing to catch on as quickly as had been

expected. A year ago, set makers predicted sales would double in 1970 to 220,000 units. But Jacques Fayard, head of Thomson-Brandt's Consumer Products division, says he now doubts sales will go above 190,000 sets despite the government's recent relaxation on installment buying and its reduction of the sales tax on TV sets.

There's more government succor in sight for set makers. In a bid to boost color TV sales, the broadcast authority has announced that work will start next year on a third, all-color, TV network. Even so, Fayard is predicting only 275,000 color sets will be sold next year and about 1.2 million black-and-white sets, the same number as this year. Government forecasts indicate that it will be 1975 before color and black-and-white unit sales curves meet. In value, though, color will come close next year. The survey forecasts $145 million for black-and-white and $130 million for color.

Color TV makers probably will introduce 110° picture tubes in their sets next December or by January 1972. They've agreed to launch their slimmer sets at the same time to avoid upsetting the market, particularly during 1971 Christmas buying. The 110° sets will cost about $50 more than 90° tube receivers, largely because of the high-power transistors needed for the deflection circuits and the resulting heat-dissipation problems.

Consumer firms say the radio sales outlook for next year is gray, except in better-quality fm sets. Hi-fi equipment prospects are good, partly because technical refinements are permitting good-quality reproduction at lower prices. The French market for standard tape recorders will grow little if at all next year, say the manufacturers, but they believe cassette recorders will sell well.

Video recorders are at least 18 months away from finding any market in France, believes Fayard of Thomson-Brandt, which has the license for CBS EVR system for France. "We are still reflecting, thinking things over," says Fayard. "There are lots of problems to solve."

Italian industry's tempo is keyed to investments

At Milan's famed La Scala, the plots hold no surprises: sopranos, contraltos, tenors, basses and the chorus all follow the librettos meticulously. In Rome, too, the political game of musical chairs continues essentially as before: every time there's a sour chord the music stops until the orchestra can agree on who's to be the new first violinist. The country's industrialists, by way of contrast, are behaving unexpectedly.

Italian economists figured that, after four months of strikes late last year and the resultant 20% rise in wages, there'd be heavy spending for labor-saving equipment this year. But it didn't happen, and it may not be in the offing until the second half of next year. "Largely because of the high cost of money—13% or more even for blue-chip companies—companies are ordering very cautiously," explains an executive at Hewlett-Packard in Milan.

This caution about plant investment is reflected in the government's state-of-the-economy statistics. Industrial production during the first eight months of the year rose only 3%. Productivity slumped enough to push prices up more than 5%, spoiling Italy's splendid anti-inflation record of recent years. Apart from a few optimists, no one expects this year's real growth in gross national product to approach the 6% that seemed so easy to achieve 12 months ago.

And next year? That will depend in large measure on how soon the tempo of plant investment picks up. This fall, the government's economy watchers were predicting that the real growth in 1971's GNP would run between 5% and 7%. If they are reasonably on target, 1971 should go down in the records of electronics producers—entertainment-set and components makers excepted—as a reasonably good year. Trouble is, a lot of people think their estimate is high.

Electronics' consensus survey spots next year's electronics market at $924 million, up 11% over this year's $833 million. As in the other large countries of Western Europe, telecommunications and computers are where the strength lies. Other sectors have much less market muscle: the outlook for radio and TV set makers is grim, and there's little to cheer components makers, largely because many equipment makers have parts inventories to work off. The soft domestic components market is coming at a bad time since U.S., Japanese, and other European producers are—like the Italians—hustling to recoup in export markets business lost at home.

Nor will there be many market blessings for consumer electronics producers to count next year. Their chronic complaint, that there's no color television in firm sight, persists. The government is slated to make up its mind next year whether Italy will use the West German PAL color TV system that prevails in Western Europe or the Secam system that is used in France. That means there's no chance of color before 1972.

In addition, set makers this fall suffered a tailspin of TV sales in October. But even before October, the outlook was far from brilliant. *Electronics'* consensus survey forecasts a 1971 consumer electronics market of $229 million, a scant $2 million higher than this year's estimated figure.

But there are compensations in export markets. Sales abroad of TV sets totaled 300,000 units during the first six months of 1970, compared with a 12-month total of 483,000 in 1969. This year's final figure will include some 30,000 color sets for the West German market, as well as a strong push in small TV sets—11-inches and 12-inches—that's cementing the Italians' position as Western Europe's main source of minivideo.

Components producers, too, have compound woes. Like their brethren elsewhere in Western Europe, Italian parts makers reacted too vigorously to last year's components shortage and overdid the new

capacity. To make matters worse, most equipment-making domestic customers didn't expect the 1969 strikes to last as long as they did, and kept accepting deliveries of components. That resulted in a huge buildup of parts inventories, not helped by further sporadic strikes this spring.

All told, Carlo San Pietro, the president of Mial SpA, and also head of the components section in the industry trade association, Associazione Nazionale Industrie Elettrotechniche ed Elettroniche, sees practically no chance for growth in components sales next year. Less pessimistically, however, *Electronics*' consensus forecast puts the market at $266 million next year, 9% above the estimate for 1970.

This modest gain—last year, San Pietro points out, the parts people rang up a 15% gain—comes mainly from semiconductors. Despite the world-wide drop in digital IC prices, the Italian semiconductor market should log a nearly $10 million rise in 1971. That would put 1971 buying just under $50 million.

Sales of linear monolithics will more than double, says Enrico Villa, the international market research manager at Societa Generale Semiconduttori (SGS). The best-selling packages, he predicts, will be a sound i-f strip for TV sets, an audio driver for radio sets, and an audio output circuit for TV sets.

And the sooner the better, say MOS producers like SGS and General Instrument Europe SpA, because some of their potential customers are postponing a switch from TTL to MOS until the "final" prices for TTL become known. To speed the switchover, GI has come on the market with a shift register tucked into a 14-lead dual in-line plastic package that just about halves the unit's cost. Arno Nash, GI's top man in Europe, has high hopes the company's Naples plant can have a 40-lead plastic package ready for the market by the fall of 1971. Adopting a 40-lead plastic design would slash the cost of the package alone from $4 to about $1, he thinks.

Along with their traditional customers, semiconductor sellers have new markets opening up. "The auto industry will give electronics its next major boom," predicts Giancarlo Maimone, the managing director of ATES Componenti Elettronici SpA, under the umbrella of the state holding company Istituto per la Ricostruzione Industri. And indeed there are small rumblings. Magneti Marelli SpA, an auto accessories producer controlled by Fiat, says it has an electronic ignition system potentially cheap enough to go into mass produced cars. Automobile people believe the system, which Marelli labels AEC 103, could turn up as standard equipment in some Fiat lines by the middle of next year.

An area that will continue on the up-and-up next year in Italy, though not quite as lustily as this year, is data-processing hardware. *Electronics*' survey forecasts an 18% rise to $358 million from the estimated $301 million business logged in 1970. This year's gain was better than 20%, but the computer makers aren't singing the blues over the slight easing in growth—there's too much going on for that.

Computer terminals in particular are coming on strong. As you'd expect, IBM, Olivetti, Honeywell-Bull, and lesser computer service companies continue to expand their time-sharing networks. Olivetti, for example, has set up a time-shared facility to prepare tapes for numerically-controlled machine tools. Users can tie into the facility with their own terminals or take their drawings to Olivetti machine-tool service centers around Italy, all of which have terminals.

New uses for computers are being discovered by Italy's cities. This year Milan's municipal transport company used a computer to diagnose its complex surface and subway network and came up with a new system of routing which cut out hundreds of miles of wasted and overlapping routes. The same city is also hooking up a computer to tie in with weather instruments and air pollution detection equipment. The setup will tell Milan 12 to 24 hours in advance if smog is likely to develop, allowing it to implement "smog alert" measures to reduce air pollution.

Some process-control manufacturers figure to do well, despite the caution over plant investment that prevails in Italy. Vincent Benini, the marketing manager of the automation division of Selenia Industrie Elettroniche Associate SpA, says 1970 was a breakthrough year for the company, also state owned. He puts the market for process-oriented data-handling hardware next year at slightly more than $50 million. Another process-control computer company that expects to make strides next year is Laben, a Montecatini-Edison unit.

To better its position in the market, Selenia has a new small computer in the works to follow its current GP-16 model. The GP-18, which will be ready next fall, is the faster of the two, with a 1-microsecond memory cycle compared with the GP-16's 2 μs, and has a much larger memory—128 kilowords as compared with 32 kilowords.

Enough telecommunications orders from the government-run phone company will be handed out to keep the talking sweet at communications equipment

Blow-up. Symbolic of Japan's growing challenge to European companies on their own ground is Hitachi's billboard contest against domestic makers.

makers. John B. Arnold, senior vice president of General Telephone & Electronics International, says the growth rate for telecommunications equipment will be about 30% to 50% higher in coming years than in past years. He sees the push coming from data transmission and international links by satellite. All told, the telephone-equipment market over the next five years should run $2.2 billion, of which SGS' Enrico Vialla figures that 10% of the total will go for electronics hardware.

And it's not only in phones that communications equipment companies will find growth. For one thing, there's a long-term program underway to automate air traffic control in Italian skies. The first phase covers central Italy and should be operating by 1972. Selenia is the prime contractor, working with IBM and CGE-FIAR, a subsidiary of the General Electric Co.

There's some space business, too. Both Selenia and Laben have contracts with the European space organizations, ELDO and ESRO. Selenia also has antenna jobs for Intelsat 4 and will design 12- and 18-GHz antennas for Intelsat 5. Finally, there's a national space effort whose next big project is tentatively a $20 million satellite called Sirio. It should fly in 1972 and will carry telecommunications experiments, including a Selenia-made package to check attenuation of 12- and 18-GHz transmissions.

All told, the consensus is that 1971 will see a $152 million year for the communications-equipment market, up 8% from the 1970 figure of $141 million.

Government help bucks up Swedish industries

A native satellite program, a rash of IC applications, a renaissance in color TV, and government joint venture operations will cast the longest shadows for electronics next year in Sweden.

Long left to fend its own way in socialist Sweden while the government's productivity practitioners fussed over ailing industries like textiles and shipbuilding, electronics this year is garnering unusual attention. "The electronics industry is doing all right," says Erik Petterson, planning chief of the Ministry of Industry. However, he and his fellow planners intend to make it do better. They see electronics as a vital adjunct to the country's traditional metal-ore-wood industrial base.

The government's strongest move so far was its partnership with Standard Radio and Telefon AB and Saab-Scania AB in a new company called Stansaab AB. It will be a computer-based company specializing in educational, medical, and traffic (both ground and air) control systems.

When it starts up officially on Jan. 1, Stansaab will have 700 employees and a fat order book taken over from Standard Radio. From Standard the new company also inherits considerable expertise in medical electronics and traffic control systems. Saab's contribution is computer knowhow. As for the government, its participation should give Stansaab an inside track with government buyers although the Swedish government goes out of its way to avoid favoritism.

Another government move should provide a boost to video tape recorders—the state and the Swedish consumer cooperative federation have set up a company to produce video tapes, particularly for education. With two large private companies also in this business, 1971 should see the first major marketing efforts for VTR in Sweden.

Although it won't mean much for electronics companies' coffers next year, it looks like the government move with the greatest impact for electronics will be the expected approval of a Swedish satellite project, with initial funding expected to turn up in the 1971/72 budget. The project the Swedes have in mind is a meteorological satellite in a polar orbit with a Saab on-board computer. The satellite project also could end up as a joint venture with private industry putting up part of the money. The satellite project is sure to get tremendous publicity and provide a strong psychological lift for the electronics industry.

The industry's collective psyche at the moment already is fairly upbeat, with a strong upturn in sales on tap for 1971. *Electronics'* consensus survey forecasts equipment sales of $535 million next year, a rise of 16% over this year's estimated $461 million. As expected, data processing hardware will register the strongest gain. But a good year is also in store for consumer electronics, communications equipment, and industrial gear. The soft spot is components, in for only a 10% rise.

Long strides also are in store for color TV next year. *Electronics'* consensus forecast is for a near-50% jump—to $112 million from this year's $83 million. Consumer electronics as a whole will rise from this year's $201 million to $231 million in 1971.

Hi-fi will do its part, too. Next year, Swedes will buy some 200,000 stereo systems at an average price of $300. "Money is tight, so Swedes are not buying new cars," says one dealer. "They're buying hi-fi sets instead."

What's more, a new tonic for hi-fi sales should develop in 1971 when the National Board of Telecommunications, which controls the airways, and the Swedish Broadcasting Corp. (SBC) are expected to resolve their conflict on stereo fm broadcasts. The board wants to use a Swedish channel-splitting technique: SBC wants to use the pilot-tone system that's fairly standard worldwide. The compromise apparently will make the Swedish system the norm on one fm channel for educational broadcasts. The other two channels then would broadcast music using the pilot-tone technique.

Components makers in Sweden encountered double trouble this year: the country's biggest group of parts buyers, the set makers, slowed their buying as the 1969 boom in color TV fizzled out, so, as elsewhere in Europe, prices fell. Next year won't be sensational: the consensus forecast calls for a $104 million

components market, up 10% from this year's estimated $94 million.

As everywhere in Europe, ICs are a concern. "Frankly, the semiconductor industry has gone mad," says Robert Goldsmith, managing director of Motorola Semiconductor AB. "TTL pricing is going to hell. They're selling below cost and people are buying hand to mouth."

However, Goldsmith notes a few bright spots in the Swedish market. "A lot of people are jumping in the MOS area," he says. "And there is a lot of interest in linear circuits, multipliers and op amps."

One of the first major users of MOS circuits in Sweden will be Facit AB, an office machine firm. Facit has a cooperation agreement with General Instrument Microelectronics Ltd. of Britain for development and manufacture of MOS circuits, and will be using them in desktop calculators. Several years ago, Facit surprised the Swedish business community by buying Japanese-made electronic calculators and putting its own label on them. Facit previously concentrated on mechanical office machines, but now it has determined to switch to electronics on its own hook; the first line of Swedish electronic calculators with MOS circuits should be on the market in 1971.

The computer outlook next year is for a healthy market gain of 24% to $108 million, up from this year's estimated $87 million. It should turn out to be the year of peripherals as the big Swedish bank computer networks go into operation. The first will be Svenska Handelsbanken's system, which will have $10 million worth of teller terminals made by Arenco Electronics, a subsidiary of Svenska Philips.

Sales of controls and instruments should move up adequately next year. To be sure, a tight money policy is holding off some plant investments, but in some cases, investments can't wait, particularly if they cut down on manpower needs in labor-tight Sweden. So look for a major push in 1971 for production and process control systems.

ASEA, best known for heavy electric equipment, will plump for the Combiflex equipment developed by its plant-building division. Saab-Scania will be selling a system, based on a Datasaab minicomputer, that features a "library" on circuit cards. And L M Ericsson has come into the market with the UAC 1610 process control computer.

The first UAC 1610 installation next year is destined for the Sandvik Steel Co. In that application the computer will be linked with about 60 terminals, including 20 printers, and will control production, planning and reprograming of processes. Because of Sandvik's worldwide reputation as a special steel maker, the system seems certain to attract considerable attention.

Much of the outlook for instruments depends on the government's military spending. "If the government gives a go-ahead for development of the interceptor version of the Viggen aircraft, this will spur a lot of business," says Ingvar Ferner, general manager of Erik Ferner AB, a major importer of instruments. He also points out that a number of expanding universities need laboratory instruments now. He adds that, although relatively few Japanese instruments are sold in Sweden today, "they'll be big here in a few years."

In communications the sector to watch is electronic telephone switching, not so much for the Swedish market itself, but rather for what L M Ericsson is doing. Ericsson has piled up so many export orders from around the world, including East Bloc countries, that the company has had to add substantially to the facilities of its resistor-and-capacitor-producing subsidiary, Rifa.

To keep Ericsson competitive in world markets, the telecommunications board teamed up with the company this summer to form a research-and-development firm called Ellemtel Utvecklings AB, to concentrate on electronic switching and data communications. One of the first projects is a pulse code modulation experiment on a telephone line between Stockholm and two suburban towns.

The telecommunications board also will spur the communications market next year by pushing land mobile systems and an fm telephone paging system. And added help is in store for land mobile from the police. They are testing their System 70, which adds some extra dimensions to police radio: a system to flash a signal light or blow the horn of a police car when a policeman is out of the car and headquarters wants to talk with him; an alarm button on the car radio that signals for help to other police cars in a wide radius; and a method of allowing patrolmen in cars or on the beat to be interconnected via radio to telephones.

Dutch electronics firms temper optimism

There's much about Holland that's distinctive—the tulips, the windmills, the dikes, the Edam cheeses, and Philips' Gloeilampenfabrieken. The Eindhoven-based industrial giant will push past the $4 billion sales mark this year, solidifying its ranking as the largest electronics company outside the U.S. During the first nine months of 1970, the company and its worldwide network of subsidiaries managed to rack up $2.97 billion in sales, an 11% gain over the 1969 period.

Unfortunately, Dutch distinctiveness does not include the Dutch economy. Like her Common Market partners, the Netherlands has inflation to cope with, and there's a slowdown in sight next year for real growth in the country's output of goods and services. There'll be a lesser slope, too, on the curves which plot spending for plant investment.

Consumer prices in Holland this year rose 5%, enough of a squeeze on spending power to trigger a wave of work stoppages this fall. Most Dutch employers responded with a $110 bonus for all hands—which, of course, added to the inflationary pressures. Next year's price rise may hit 6%; the final figure

depends on how stiff the extra taxes are which the government plans to slap on consumer goods. As for the economy's overall growth rate, it's expected to slip down to 4.5% in 1971 from this year's 5.5%. Each percentage point works out to some $300 million.

Despite the uncertain overall outlook, there's optimism about 1971 at Philips and at lesser companies marketing electronics in Holland. *Electronics'* consensus forecast points to consumption of $474 million in equipment next year, up 13% from this year's $420 million. There's little that's unusual in the expected market pattern, and the consensus figures jibe reasonably well with the estimates Philips' marketeers make for all of Western Europe: data-processing hardware zinging up between 20% and 24%; automation and instrumentation moving out between 12% and 15%; telecommunications ringing in with a gain of 10% to 15%.

As for the Dutch consumer electronics market, Philips figures that replacement items like black-and-white TV sets and radios will bear the brunt first if consumer spending slackens, whereas color TV sales will be good—"providing, of course, that the downturn is not serious, in which case no one can predict what will happen."

The forecast: radio, TV, phonograph and tape recorder sales of $111 million in 1971, up from 1970's $98 million. Practically all the increase is to come from color TV, with some slight help from hi-fi and tape recorders. Good times or bad, black-and-white TV will drop from $33 million to $31 million next year.

For computer companies, the outlook in Holland for 1971 is a good, $116 million year, according to *Electronics'* survey—or 21% up on this year's estimated $96 million. Data-processing hardware is one of the rare domestic market sectors not dominated by Philips.

Philips' line extends from big machines on down to "large" desk calculators. However, small desk calculators are too good a market for the company to ignore and Philips is poised to enter one way or another. Its components-producing division Elcoma has readied a set of MOS circuits for desk calculators—though they're destined for outsiders, Elcoma people maintain. The MOS circuits will add to next year's expected 30% rise (in units) for semiconductor consumption by computer makers in Holland. Because of the softness in IC prices, however, the dollar increase will run only some 10%, bringing this segment of the semiconductor market to $8 million.

In telecommunications, 1971 will mark some noteworthy steps toward electronic exchanges, with Philips and ITT's Dutch subsidiary the main contenders for the business. It's the year in which the government-run telephone system plans to switch over from electromechanical exchanges, and the Benelux competition has apparently won out over L M Ericsson of Sweden, once in the running with an experimental exchange at Rotterdam.

Instead, late this year at Utrecht, Philips will start installing a PRX 205 exchange, which has reed-relay switchpoints, operating under the control of a special computer. The Dutch Post Office (PTT), which runs the phone system, will give the 1,000-line installation a trial and, if it proves out, give Philips the go-ahead to add 6,000 or 7,000 lines in 1972-73. That would make it the first commercial electronic exchange in Holland.

Electromechanical switching gear for telex exchanges is also slated to bow out in favor of electronic hardware by the mid-1970s, according to the lookout of the crew at Philips Telecommunicatie Industrie, the communications equipment subsidiary that operates out of Hilversum, some 15 miles southeast of Amsterdam. It's ITT, though, that will get the first crack at this market: its Dutch subsidiary, Nederlandsche Standard Electric Maatschappij, has a contract to supply the PTT next year with a 1,000-line Metaconta 10C electronic telex exchange, and there may be a second one in the works. The Metaconta system also pairs reed relays and a process-control computer.

Other lifts to Holland's communications sector next year will come from the astronomical satellite that's the centerpiece of the national space program, and from "offset" equipment the Germans will buy, mainly transceivers from Philips, to cover most of the cost of the Dutch Army's buy of Leopard tanks from the Germans. Toward the end of next year, Philips will begin work on the electronics portion of the Dutch PTT's $5.6 million satellite ground station.

Credit storm buffets Spanish electronics

The rain in Spain this year roared off the plain, and lashed the entire country with an economic squall that's still dampening the outlook for 1971.

The storm had its beginnings in the fall of 1967, when the Matesa scandal broke. It involved three former ministers of the Franco government and a Barcelona industrialist, who tapped them for $142.5 million in export loans and lost it.

After the storm subsided, the government cracked down on credit, partly to do in companies that were living mainly off government-backed credit and partly to cool off the economy, which burgeoned throughout 1969. In addition, the government invoked a deposit scheme to curb imports. The scheme, slated to run out at the end of this month, requires importers to deposit in the Bank of Spain for six months 20% of the value of anything imported.

The cooling-off gave consumer electronics producers a bad case of the chills. Their sales networks depend heavily on bank-financed time payments, and with credit shut off, TV set sales slumped. Instead of the near $100-million year set makers expected for 1970, sales of TV sets ran about $86 million.

Buffeted, too, by the crackdown on credit was another major segment of Spain's electronics market—computers. "No one has made a decision to buy a big system in the last half year," laments a computer-company sales manager.

Some major decisions by the government about the electronics sector—particularly the guidelines and

growth goals for the four-year economic plan that starts in 1972—still are pending, tingeing the outlook for electronics with uncertainty. Official forecasters, however, predict the Spanish economy will do well in 1971, logging a real growth rate of 6%. If it comes off, electronics should have a good year. The *Electronics*' consensus forecast, in fact, predicts a 1971 market of $362 million, and that's 13% higher than this year's estimated $320 million.

How good these forecasts will look 12 months from now depends in large measure on how fast the computer sector snaps back; computers and communications are the potential high-striders for 1971. By contrast, the TV set makers face a stagnant market. Components producers, hit by the price decline endemic in Western Europe, don't figure their sales rise will quite match the overall gain by the equipment makers. The forecast figures: $83 million next year, up 12% from this year's $74 million.

No matter how business goes, though, the lineup of electronics companies in Spain seems certain to come in for some serious shuffling. A blue-ribbon panel of high-level officials and industry executives has been putting together a white paper on electronics, and the government presumably will act on it next year. Both Philips' Gloeilampenfabrieken of the Netherlands and Italy's state holding company Istituto per la Ricostruzione Industri (IRI), are holding up multi-million-dollar plant investments until the guidelines become firm.

Insiders expect investment policy will be tailored to spur alliances between foreign firms and Spanish companies, especially outside the consumer electronics sector. But the joint ventures apparently will have to meet three conditions: do some research and development in Spain, keep royalty payments to the foreign partner to no more than 3%, and put no restrictions on exports. The last condition is aimed at giving Spain access to the Common Market when the foreign partner comes from a Common Market country.

The new guidelines have already steered one company to oblivion. Last year, government officials were thinking about setting up a state-run electronics company and even had a name for it, Empresa Nacional de Electronica. The idea has been dropped now that a closer look at the situation convinced them that in an international market like electronics, the only viable solution was to get Spanish interests into the business through tie-ups with international companies.

Quiet changes also have affected the lineup of suppliers to the government-controlled Compania Telefonica Nacional de España. There are recurrent reports that ITT's Standard Electrica has lost its near-monopoly position with the phone company. Standard got the inside track back in the early 1940s, when ITT's holding in Telefonica was nationalized. Now, apparently, General Cable Corp., Sweden's L M Ericsson, and Italy's Telettra all have had go-aheads to build plants in Spain to supply Telefonica and to produce for export markets.

Export aids may be in the offing for Spanish electronics companies as part of the government's plan to restructure the electronics industry. Even without them, the country's component makers and some set makers have made a modest start, working through a group called Secartys. Ignacio Tormo, the group's director, reports that exports this year ran $14 million, a gain of 20% over the 1969 figure.

Computer makers are counting on making up next year for the slowdown they suffered in 1970. "Business conditions delayed the orders, but the needs are still there," says Ignacio Vidaurrazaga, commercial director at the Univac division of Sperry Rand Corp.'s Spanish subsidiary.

Almost every big bank, he expects, will order a large-scale system from somebody, largely because of IBM's effort to drum up sales of its 370 models. Considerable growth also is expected from Spain's hundred-odd savings banks and from government agencies. In fact, business pops up practically everywhere you turn, and *Electronics*' consensus for the computer sector is a strong rise to $102 million in 1971 from this year's estimated $86 million.

IBM, as elsewhere, is the market leader. But Univac has distinguished itself with perhaps the most advanced system yet installed in Europe for data transmission. It's a $5 million (on an if-sold basis) affair that controls the switching of special data transmission lines the state-controlled phone company is setting up as an alternative to leased wires. The system, based on two Univac 418 computers, will handle up to 200 customer terminals in the country's main cities.

Telesincro SA, the sole native Spanish computer maker, sees a bright year ahead. Plans call for expansion of its sales network over all of Spain during 1971 and 1972; its salesmen now cover only Catalonia, Madrid, and the cities on the Mediterranean coast. Telesincro will add to its equipment offerings—all small office computers—in 1971, too. An IC machine will be put on the market with memory capacity expandable from 4 to 65 kilowords.

Consumer-electronics companies hit rough weather in 1970 and don't see much chance for any change in their market climate next year. "TV set production hit a high of 740,000 units in 1969," says F. F. Otten, who heads Copresa, the Philips components producing subsidiary in Spain. "This year's output will be between 550,000 and 560,000. Next year, we see a recovery to about 600,000 sets."

Otten's assessment of the 1971 market, sober as it is, looks on the high side to some others in the industry, who figure 1971 will wind up about the same as 1970. *Electronics*' survey predicts a slight gain only, to $125 million from this year's $120 million. Black-and-white TV sets amount to more than two-thirds of the market.

There's general agreement that the next surge in consumer electronics can't come until color TV arrives—not before 1972. That portends more casualties among the smaller, under-financed family firms that managed to barely survive this year's buffeting.

While waiting for the lift from color, set makers will ring in a few technological changes. Varicap tuners will catch on strongly next year, predicts Roselson SA, a leading producer of TV tuners. ICs will show up in quantity, too. Rafael Rizo, manager

for semiconductors and ICs at Copresa, figures some 40% of next year's sets will have monolithic voltage stabilizers for their varicap tuners. Audio i-f packages, he expects, will show up in some 30% of the 1971 sets.

Further off are video jungle circuits, which require redesigning a set's circuitry—and it's the wrong time for such a move for black-and-white sets, anyway. It's time, though, to get moving for anyone who hopes to corner a share of the linear IC market. Piher SA, the Spanish semiconductor producer, plans to do just that. "We'll probably be in production on linear ICs within two years," says Ricardo Balil, a Piher executive recently returned from a stint as the head of the company's U.S. subsidiary.

Color TV beams in Belgian outlook

The signs are good for Belgian electronics in 1971, despite some of the surface evidence. The country is showing the same symptoms of economic unease that distress its Common Market partners. Inflation looms, and to make it worse Belgium will shift to a value-added tax on January 1. The government hopes the tax will boost consumer prices, which rise on their own hook from 3% to 4% a year, by only 2% more.

The economy's growth rate, which hovered slightly above 5% this year, will fall off to around 4% in 1971. Plant investment is expected to sag; consumer spending, despite wage increases, might lag, too.

But color TV is coming. And there's a burgeoning market in electric telephone switching. What's more, the West German boom, though slowing, has spilled over into Belgium, bringing in new electronics plants and new business. The electronics market next year, then, figures to show a strong rise. *Electronics*' survey puts it at $302 million, up 13% over the 1970 figure of $267 million.

Consumer electronics will get a strong lift from color TV. Broadcasts are scheduled to start on January 1, but on a very limited program schedule. It will be mid year before the Belgian networks—one French, one Flemish will be programing substantially in color. It's not as much a drawback as it seems at first glance, because many viewers can already pick up colorcasts from neighboring France and Germany.

Sales of color sets, according to *Electronics*' consensus forecast, will bounce up to $15 million next year from an estimated $10 million this year. The surge would be even greater, some set makers say, were set costs not so high. The price bracket: between $650 and $750.

One reason for this relatively high pricing is the multiplicity of standards required for Belgium. In the southern half of the country and around Brussels, where French broadcasts can be picked up, sets must be able to handle both Secam and PAL color transmissions, plus four different black-and-white standards. This burden will be eased somewhat in 1971, though, when the Belgians shift their vhf transmissions to the 625-line CCIB standard, with negative image modulation and fm sound modulation, used in most West European countries. As it is now, the Belgians have positive picture modulation and a-m sound.

This harmonization of broadcasting standards is a plus for Belgian set makers, of course, since it helps shave costs. But some minuses may crop up, too. The move could open the market to German-made sets, some people think. It also may put additional pressure on Belgian set makers since it makes the market attractive to Spanish producers, who benefit from Spain's new tie with the Common Market.

The delay in colorcasts, surprisingly, helped black-and-white set sales. Instead of waiting, many would-be color buyers jumped into the replacement market. Black-and-white set sales will rise slightly next year, most market watchers feel. *Electronics*' survey predicts a gain of $2 million over 1969's $30 million.

Production, on the other hand, will zoom from 380,000 monochrome sets to 680,000 sets next year. Credit that to the color TV boom in neighboring Germany. Most of the surge will come from a new plant at Tienen built by the German firm Saba, a subsidiary of General Telephone & Electronics. Saba transferred its monochrome production lines across the border so that its home plant can concentrate on color TV.

With Saba now on the scene and expected to hit full production stride in mid-1971, Belgian components producers like Manufacture Belge de Lampes et de Materiel Electronique (MBLE), part of the Philips' Gloeilampenfabrieken group, seem to have a good year assured. The survey, in fact, foresees a very strong rise in components consumption for 1971, to $98 million from this year's $81 million.

MBLE readied for the rise with a new plant at Liege, which went into limited production of channel selectors, varicap diodes, and deflection units this fall. The first phase of the plant will be fully on stream during 1972 and it represents a $9-million extension to MBLE's components capacity. RCA also is on hand. The U.S. company has set up its first Continental production plant, a $10.5-million affair, in the Liege area. RCA will concentrate on semiconductor power devices.

Another fallout from the German boom is a jump in production at Sylvania's color-tube plant, located at Tienen. Sylvania, like Saba a company in the GT&E group, is now producing some 200,000 tubes yearly, but expects to hit the 250,000 level in 1971. Most of this production goes to German set makers.

And West Germany's Siemens has completed major plant expansions in Belgium, including new facilities for telegraphic equipment at Lanklaar. To come are a central injection-molding plant at Oostkamp, and a relay plant nears Mons or possibly in the Namur region. Siemens also plans to set up a research operation in Belgium in the telecommunications sector.

In communications, next year will see the first real takeoff of electronic telephone and telex switching on a commercial scale in Belgium.

Bell Telephone Manufacturing Co. (BTM), an ITT

subsidiary, will complete two Metaconta telephone exchanges for the Belgian Post Office (RTT) in 1971. One exchange will have 3,000 lines, the other one 10,000. These join a 1,000-line unit installed experimentally in 1967.

That's just a beginning. BTM will install another 40,000 lines in 1972. The RTT has a 600,000-line program in mind that should give the country some 80 local exchanges and 12 toll and transit exchanges by 1980. In all, Belgium's lead in electronic switching among the countries of Western Europe may last through the decade.

Bell's export-order list is substantial. There's an electronic toll switching system with a capacity of 6,000 incoming and 6,000 outgoing trunks in the works for the Australian telephone system in 1972. Bell already is at work on radio links for Thailand costing some $4.5 million. The company has a piece of a $3 million contract to build a communications satellite ground station in the Congo. In addition, as technical adviser to Congolese communication authorities, Bell is in a strong position should they decide to go ahead with an estimated $10 million of radio transmission facilities over the next two or three years. There's also a chance of ground-station work for the Belgian government in 1971.

Computer makers figure to do well in 1971. The *Electronics*' survey pegs the market at $80 million, up a sparkling 23% from this year's estimated $65 million.

Market leader IBM may lose some ground to Siemens and to Philips over the next few years. Because of heavy commitments by the two companies to build plants in Belgium, the government agreed to take 25% of its computer needs from them—as long as the prices are competitive. For all the computers now operating in Belgium, the total rental value runs about $55 million a year and the computer census is expanding between 15% and 20% yearly. Some 40% of the growth comes from buys by government agencies, so Siemens and Philips each stand to gain up to $1.5 million yearly in government orders.

Swiss EDP, consumer goods scale new peaks

Up to the year 2000, it appears, the Swiss working force will expand about as fast as a glacier moves. Additions to the work force, according to a government-commissioned study of the economic outlook over the next 30 years, will run about 0.5% annually, because the Swiss themselves aren't propagating as prodigiously as before and because they're keeping a limit on foreign workers. "Uberfremdung"—overforeignization—is as distasteful a concept to the Swiss as Dutch chocolate or Japanese watches.

Prosperity for the hard-working Swiss thus depends on productivity. So look for a continuing drive to automate in general and to straighten out inefficient production units in particular. Over the long run, then, electronics companies in Switzerland will be scaling new peaks.

Prospects are strong, too, for next year. *Electronics*' consensus forecast predicts a 1971 market of $288 million, a gain of 13% over this year's estimated $256 million. The strongest sectors: data-processing equipment and consumer electronics. But components makers should also do well, as should companies involved in telecommunications.

Computer makers, given the productivity imperatives that permeate the Swiss economy, figure to have another very good year in 1971. The survey predicts a market of $90 million, up from an estimated $70 million. The gains will come as the "gnomes of Zurich" and their banking brethren in Geneva and other cities continue to expand their data processing operations. Watchmakers, precision machinery manufacturers, chemical processors, and instrument makers also make up an important sector of the market.

Above all, the government is stepping up its computer buying. It's evaluating information retrieval at its Berne general computer center, which services civilian agencies on a batch basis. Multiprograming will start in 1971 and time-sharing will come in by 1973. The Swiss Post Office, which runs the telephone system, has a big computer project under way for its telephone information service.

"Watch out" is the watchword for the Swiss watchmaking industry. Still the world's largest producer of timepieces, the Swiss industry now realizes its good times could be running out. The Japanese are providing stiff competition in world markets, as are the Americans and even the Russians.

One industry trade group estimates that the world market for watch movements will reach 300 million pieces in 1980. To hold onto their share, the Swiss will have to double their current output. So they're counting heavily on electronic timepieces to maintain their worldwide lead.

Although the Japanese won a publicity battle by introducing the world's first electronic quartz watch at the end of 1969, the Swiss still are convinced they can snatch the market victory from the competition. At Marin, a village in the canton of Neuchatel, Ebauches Electronics will have knocked out 1 million electronic movements by year-end and plans to at least double its output next year.

Ebauches turns out three generations of electronic watches. One is an electrified classic movement in which a transistor circuit oscillates a balance wheel. The second is an advanced version of the Accutron, with its resonator shaped differently than the Accutron's tuning fork. Finally, there's the quartz-crystal-IC prototype, which the Swiss call the Beta 2.1. Ebauches has produced a batch of 6,000 that will be on the market early in 1971 under several brand names. The movements are a community production for a group of Swiss watchmakers.

Watch production represents a new market for semiconductor producers, but most of the business is going to a company called Faselec SA, owned partly by the watchmakers' trade association Federation Hor-

logere SA. For the moment, Faselec's lock on the business isn't bothering other components producers much. "It's still boom time in Switzerland," says one marketing expert of the outlook for components. There's a jump in store next year, he predicts, for both bipolar and MOS integrated circuits. *Electronics* predicts a 10% gain in sales, despite slumping prices for 1971. The forecast figures: $77 million next year, $70 million this.

In communications, the Swiss Post Office (PTT), the big spender, plans a steady expansion of the telephone and telex networks. The PTT also runs the country's broadcast transmitters and is engaged in a steady buildup of the color TV network. All told, the PTT will spend $180 million in 1971 for telecommunications, most of it to modernize the telephone system. Under way, for example, are automatic toll exchanges, a tax-impulse scheme for reckoning charges on long-distance calls made from phone booths, and extension of international direct dialing.

The long-awaited spurt in avionics may well not turn up on next year's calendar. Though some $300 million has been earmarked to buy a batch of new aircraft to supplement the present Mirage 3 fighters that are the mainstay of the Swiss Air Force, the decision on what plane to buy still drags on. To tide it over, the Swiss Air Force this fall ordered 30 reconditioned Hawker-Siddeley Hunters from Great Britain.

Meanwhile, the Swiss Army next spring probably will fund development of a Tacfire artillery fire-control system. The Data System division of Litton Industries already has completed the design study.

Swissair will be introducing jumbo jets on its routes in 1971, bringing with them a batch of ground testing hardware. The largest item ordered is an inertial navigation system test console. Swissair is looking into computer control for overhaul and maintenance.

Consumer electronics markets should tick along nicely next year. The survey points to a very strong rise in 1971, to $70 million from this year's estimated $61 million. Television sets, of course, are the market mainstay. Last year, some 133,000 were sold; 37,500 of them color units. Look for a 10% rise this year and next, says the radio-TV dealers trade association. What's more, the dollar rise is much higher, thanks to rising color sales. Also moving up nicely are cassette tape recorders and record players. Philips AG remains the big supplier of TV sets, with Japanese makers showing well in radios and recorders.

The industrial electronics sector looks good, too, as does instrumentation. The European Center for Nuclear Research (CERN) near Geneva, for example, has about $5 million budgeted for electronics equipment in 1971, not including computers.

Medical electronics also looks set for a sharp rise, so much so that the Swiss are mounting an international medical electronics and bio-engineering show, Medex, at Basel in March.

Exports dominate Danish electronics output

Danish government officials, remembering the Hans Christian Andersen fable, would like to believe that their economic ugly duckling—the balance of trade—will grow up into a swan. But it keeps looking more and more like a mud hen.

During the first six months of this year, the deficit in the balance of payments spurted to $365 million. In the two previous half-years it had been $212 million, a figure considered dangerously high. The spurt in the deficit was accompanied by a rise in prices corresponding to 6% to 7% annually, although the government has been striving to hold both down with a ceiling on private bank loans, a halt on government public works projects, and an increase in the tax on imports—from 9% to 15%. More deflationary moves are on tap next year, but there's no real assurance that they will work.

Paradoxically, what's bad for the economy is in one way good for electronics. Many inflation-conscious Danish savers are putting their money into hard goods like TV sets and radios. On the other hand, what's good for Danish industrial electronics is good for the economy. Automation equipment, computers, and similar hardware are a boon for a labor-short country like Denmark. What's more, the country's instrument producers are heavy exporters.

Their success in exports can be explained in a word: specialization. Except for hi-fi and set maker Bang and Olufsen A/S, the main Danish firms have won their place with instruments that few others make—like the sound-pressure gages of Bruel and Kjaer A/S, for example, or the anemometer instrumentation of Disa Elektronik A/S. This year, the Danes produced $204 million of electronics hardware and exported $124 million of it. Next year, a jump of 15% to 17% is expected for hardware output.

At home, the market should show strong demand for both consumer and industrial electronics. *Electronics'* survey predicts a $187 million market in 1971, up 13% from this year's estimated $164 million.

Erik Peterson, president of the Danish Electronics Producers Association, says that industrial hardware looks like the industry's mover in 1971. The forecast backs that view, predicting a 26% jump for computers—to $44 million from this year's $35 million—and a 15% gain for production and control electronics—to $30 million from $26 million.

Consumer electronics producers, too, seem set for a good year unless the government's deflation drive catches on much more firmly than anticipated. Credit the strong outlook to color TV. Most Danes can pick up two Swedish TV channels as well as the Danish one, while in parts of Southern Denmark, German TV is within reach. So there's plenty of color for anyone who wants to pay the price.

Many apparently do. The survey spots next year's market at $18 million, up from $13 million this year. Other consumer sectors, apart from tape recorders, should show little gain. But because of color TV, the sector overall will rise 13% to reach $51 million.

Ships welcome Norway's computers aboard

With the extremely rich oil strikes in the Norwegian sector of the North Sea, the country's shipowners are earning more money today than ever before. All the same, the overall growth of the Norwegian economy figures to be piddling next year. "We're not the Kuwait of the North yet," says an official at the Ministry of Industry.

This down-beat 1971 outlook will set the pace for consumer electronics. The Song of Norway next year will ring out loudly for computers, communications, ship systems, and components. And if *Electronics*' consensus forecasts turn out to be in tune, the Norwegian market will edge up 9% next year to $153 million.

In computers, the Norwegians will buy another $41 million worth of hardware next year, a 20% spurt. That's not unusual. What is, though, are the moves in sight by Norway's two native computer makers. A/S Norsk Data-Elektronikk of Oslo and A/S Kongsberg Vapenfabrikk of Kongsberg. Norsk makes a series of special-purpose, process-control and scientific computers. Kongsberg produces a military computer that is being used in mufti for numerical control systems. Both companies, though small, have their eyes on exports.

"We're expanding at a rate of 100% each year," says Norsk managing director Lars Monrad-Krohn, who founded the company in 1967. Translated into dollars and computers, Norsk sold about $1 million and 12 computers in 1969, about doubled those two figures in 1920, and is aiming to get close to $3 million and 50 computers in 1971.

The big area for Norsk computers from now on will be in ship control; up to now, the main customers have been Norwegian universities and research establishments. The firm's initial computer, Nord 1, with a capacity of 256 kilowords, has been followed by a minicomputer, Nord 2-B with half the capacity, and by Nord 5, a larger version to "compete" with machines like the Univac 1106 or the IBM 44.

Where does a small new computer maker start exporting in a world market dominated by international giants? "We decided to tackle the U.S. first," says Monrad-Krohn, "since it's larger and more competitive. If we can get a tenth of 1% of the market, it won't be bad for us. So why not try?" Norsk isn't selling on an "ours-cost-less" basis. Monrad-Krohn says prices of his computers are 10% to 50% above the competition. But he maintains the programing costs are much lower. "Our engineers look at computers from a programer's viewpoint," he says.

At home, Norsk's best market potential is in shipboard systems, the company reckons. A Nord-1 computer has been in operation aboard a Norwegian freighter for the past 18 months as part of a DataBridge system built by NorControl, a division of Noratom-Norcontrol A/S of Horten.

The DataBridge system ties an anticollision radar system, a navigation system, and an autopilot into a computer. NorControl also sells a computer-controlled engine-room system called DataChief and a loading-unloading system. "We've sold 15 DataBridge systems this year," says Torgner Torgersen, NorControl's sales manager, "and at least one DataChief system." Each sells for $80,000 and up.

An hour's drive from Horten, Norwegian weapons maker Kongsberg Vapenfabrikk is looking forward to strong growth in electronics next year, mainly on the civilian side. So far, NC systems for machine tools, flamecutters, and drawing machines have been the mainstays. Now, Kongsberg is moving into computer control systems, based on its SM-3 and SM-4 computers. Both were developed for military purposes primarily artillery control, although the SM-3 has been picked as the computer for NATO's Sea Sparrow missile.

Kongsberg, like other Norwegian electronics firms, will benefit from the current world shipbuilding boom. In fact, the company already holds between 80% and 90% of the world market for shipyard flamecutters. However, Kongsberg sees its biggest expansion in the coming year provided by computer-controlled drafting machines. "We'll be tripling deliveries next year," says Borre Ulrichsen, general manager of the industrial electronics division.

On the military side, Kongsberg's kingpin item next year will be the Penguin ship-to-ship missile. The Norwegian Navy has ordered Penguins for 26 patrol boats and five frigates. Also going into 1971 with a big military order is Simonsen Radio A/S, generally known as Simrad and renowned for its fish-finders. Simrad is producing a transceiver for the Norwegian Army. With NATO business in mind, the company has just developed a lightweight laser rangefinder for forward artillery observers.

As for components, the Norwegian market should edge up to $34 million next year. Norway's own semiconductor producer, A/S Akers Electronics, will push its custom-designed ICs. "The market is much larger than we thought," says an Akers executive.

Akers got into thin-film hybrid production to supply its own needs for the digital frequency synthesizers it makes for NATO military manpack radios. The company will go into production on a new synthesizer in 1971. The new unit covers a band from 1.5 to 30 megahertz with channel spacing of only 100 hertz. It can deliver an impressive 285,000 different output frequencies.

Along with its synthesizers and custom ICs, Akers will mount a strong sales drive next year for a small go/no-go optical reader based on a light-sensitive Schmitt trigger. Akers' parent company, Gustav A. Ring A/S, expects its sales—mainly intercoms—will move up 10% next year. A big item: a $3 million Garex system that integrates communications for air traffic control towers. Ring is supplying the system to the U.S. Air Force as a subcontractor to Raytheon. Ring next year will be pushing hard to sell systems—integrating video, telephone and intercom—for institutional use, as in schools, hospitals, and prisons. □

EUROPEAN EQUIPMENT MARKETS 1971

	Belgium-Luxembourg		Denmark		France		Italy		Netherlands		Norway		Spain		Sweden		Switzerland		United Kingdom		West Germany		Total	
Consumer products	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971
Phonographs and radio combinations	7.5	8.0	3.5	3.8	55.0	63.2	19.5	20.0	9.5	10.4	2.5	2.7	12.0	14.3	42.3	46.5	8.5	9.5	52.8	60.0	84.0	90.0	297.1	328.4
Radios (including car radios)	6.0	6.0	11.5	11.5	74.5	74.5	44.0	46.0	11.6	12.0	6.8	6.8	17.0	17.0	22.2	23.2	10.9	10.9	41.9	43.5	150.0	152.0	396.4	403.4
Tape recorders (for home use)	1.3	1.3	7.5	8.3	45.0	52.5	20.5	22.7	7.2	7.9	4.5	5.3	4.5	5.5	22.2	25.7	6.9	7.4	16.8	17.0	116.0	121.0	252.4	274.6
Television sets, black and white	30.2	32.0	9.3	9.3	155.0	145.0	142.0	139.0	33.0	31.0	12.2	9.5	86.0	88.0	30.9	23.2	12.9	10.6	161.6	142.9	175.0	124.0	848.1	754.5
Television sets, color	10.0	15.0	12.9	18.0	81.0	130.0	1.0	1.0	37.0	50.0	0.3	0.6	*	*	83.0	112.0	21.5	31.3	150.0	228.5	270.0	337.0	666.7	923.4
TOTAL	**55.0**	**62.3**	**44.7**	**50.9**	**410.5**	**465.2**	**227.0**	**228.7**	**98.3**	**111.3**	**26.3**	**24.9**	**119.5**	**124.8**	**200.6**	**230.6**	**60.7**	**69.7**	**423.1**	**491.9**	**795.0**	**824.0**	**2,460.7**	**2,684.3**
Medical equipment																								
Diagnostic equipment, except X-ray	1.0	1.1	1.2	1.3	10.5	12.0	3.5	4.3	2.1	2.2	1.0	1.5	1.0	1.2	16.0	18.4	1.8	2.0	9.6	11.1	17.9	19.1	65.6	74.2
Patient monitoring equipment	0.4	0.5	0.2	0.3	3.9	4.7	2.0	2.3	0.6	0.7	0.3	0.4	*	*	4.0	4.7	0.5	0.6	4.5	5.4	6.0	7.0	22.4	26.6
Therapeutic equipment, except X-ray	0.3	0.3	0.1	0.1	2.0	2.4	0.5	0.6	0.4	0.5	0.3	0.3	0.4	0.4	1.8	2.0	0.4	0.5	1.8	2.0	6.1	6.6	14.1	15.7
X-ray equipment	3.5	3.7	1.8	1.9	16.0	17.6	15.0	18.0	6.0	6.5	1.5	1.5	1.5	1.8	15.5	17.0	5.1	5.5	18.0	18.2	58.0	63.8	141.9	155.5
Other medical electronics equipment	2.4	2.6	1.4	1.5	12.0	14.4	3.5	3.8	4.0	4.6	1.4	1.4	2.5	2.8	5.0	6.0	0.3	0.4	8.0	9.0	21.0	23.5	61.5	70.0
TOTAL	**7.6**	**8.2**	**4.7**	**5.1**	**44.4**	**51.1**	**24.5**	**29.0**	**13.1**	**14.5**	**4.5**	**5.1**	**5.4**	**6.2**	**42.3**	**48.1**	**8.1**	**9.0**	**41.9**	**45.7**	**109.0**	**120.0**	**305.5**	**342.0**
Communications equipment																								
Broadcast equipment	3.0	3.0	4.9	5.0	12.0	24.0	7.5	6.0	6.0	6.5	6.0	6.0	6.5	7.1	2.0	3.0	5.8	6.9	23.3	22.1	28.0	40.0	105.0	129.6
Closed-circuit television	1.1	1.5	0.6	0.7	8.0	8.9	8.6	10.8	1.5	1.7	0.4	0.5	1.8	2.0	0.6	0.7	1.2	1.4	4.4	5.0	9.0	10.5	37.2	43.7
Intercoms and intercom systems	4.0	4.5	2.2	2.4	22.4	24.6	5.8	6.6	6.7	7.2	2.0	2.3	1.2	1.4	1.3	1.5	4.9	5.8	31.0	34.0	7.0	7.4	88.5	97.7
Microwave relay systems	2.0	2.0	4.0	3.0	35.0	43.5	9.2	9.8	10.1	11.0	3.9	4.1	6.0	8.0	8.2	8.2	2.2	2.5	6.4	7.7	26.4	29.9	113.4	129.7
Navigational aids, air and marine (except radar)	24.0	24.0	10.2	11.4	60.5	66.0	35.0	35.0	38.0	38.0	10.0	10.0	10.1	11.1	10.0	11.0	28.0	20.0	85.2	91.4	50.5	53.4	361.5	371.3
Radar, airborne, ground, and marine	8.0	8.0	5.4	5.9	90.0	95.0	15.0	16.0	12.0	12.0	8.0	8.0	6.4	7.0	4.0	5.0	10.0	10.0	69.9	73.8	90.0	97.5	318.7	338.2
Radio communications (except public broadcast)	4.8	5.0	7.6	8.4	48.0	60.0	19.7	21.2	6.8	7.7	4.2	4.8	3.5	3.8	8.2	8.8	3.5	3.6	79.2	86.4	100.8	104.9	286.3	314.6
Telephone switching, electronic or semielectronic	0.2	0.9	0.1	0.1	14.5	17.3	1.0	1.0	0.5	0.5	0.5	0.8	*	*	1.0	1.0	0.4	0.5	14.3	16.9	4.4	5.5	36.9	44.5
Wire message equipment (except telephone)	0.2	0.2	4.0	4.6	40.0	50.0	30.0	35.0	5.0	5.5	3.0	3.0	25.0	36.0	5.0	5.8	4.0	4.0	70.0	76.5	60.0	74.0	246.2	294.6
Other electronic communications equipment	7.2	7.9	4.6	5.3	31.0	35.5	9.5	10.5	10.8	12.0	3.0	3.0	11.0	12.0	7.5	8.0	4.5	5.0	44.4	53.0	53.4	64.5	186.9	216.7
TOTAL	**54.5**	**57.0**	**43.6**	**46.8**	**361.4**	**424.8**	**141.3**	**151.9**	**97.4**	**102.1**	**41.0**	**42.5**	**71.5**	**88.4**	**47.8**	**53.0**	**64.5**	**59.7**	**428.1**	**466.8**	**429.5**	**487.6**	**1,780.6**	**1,980.6**
Computers and related hardware																								
Analog and hybrid computers	1.0	1.2	0.2	0.2	5.2	5.9	1.2	1.3	1.4	1.5	0.8	0.9	0.8	0.9	1.1	1.2	0.3	0.3	12.0	15.6	7.8	8.0	31.8	37.0
Converters, analog/digital and digital/analog	0.7	0.8	0.1	0.1	6.4	7.5	2.0	2.4	1.5	1.6	0.4	0.5	0.6	0.7	0.4	0.5	0.4	0.5	4.8	6.0	2.5	3.0	19.8	23.6
Digital computers, central processors[1]	29.8	36.0	17.0	21.3	211.0	247.3	127.8	153.0	46.0	55.1	17.4	21.2	38.5	45.5	38.2	47.1	32.0	40.0	300.0	324.0	340.0	400.0	1,197.7	1,390.5
Mass memories, external	19.2	24.0	13.5	16.5	157.5	183.8	91.5	106.5	30.5	36.6	10.5	12.0	26.6	31.4	25.5	31.5	24.0	31.5	72.0	96.0	159.0	188.0	629.8	757.8
Read-in and read-out equipment	7.0	8.8	3.0	3.5	106.0	126.5	63.5	76.0	9.2	11.5	2.9	3.4	6.1	7.6	8.5	10.5	8.5	10.8	24.0	28.8	179.0	270.0	417.7	555.4
Remote terminal equipment	5.6	6.9	1.0	1.5	24.5	29.7	8.0	9.0	5.1	6.6	1.7	1.9	6.0	7.3	10.0	12.3	4.2	5.5	24.0	36.0	55.0	69.0	145.1	185.7
Electronic desk calculators	1.7	2.3	0.5	0.7	16.5	23.6	7.0	10.0	1.8	2.9	0.4	1.0	7.0	8.2	3.5	4.5	0.8	1.8	28.8	36.0	66.3	84.2	134.3	175.2
TOTAL	**65.0**	**80.0**	**35.3**	**43.8**	**527.1**	**624.3**	**301.0**	**358.2**	**95.5**	**115.8**	**34.1**	**40.9**	**85.6**	**101.6**	**87.2**	**107.6**	**70.2**	**90.4**	**465.6**	**542.4**	**809.6**	**1,022.2**	**2,676.2**	**3,127.2**
Industrial equipment																								
Industrial X-ray equipment	0.8	0.9	1.0	1.1	5.5	6.1	2.3	2.4	2.2	2.3	0.6	0.6	0.5	0.6	1.8	1.9	0.7	0.8	6.4	7.0	12.1	13.3	33.9	37.0
Infrared equipment	4.0	4.4	0.8	0.9	14.2	16.8	6.0	6.5	3.5	3.9	0.8	1.2	1.0	1.0	3.5	3.9	1.6	1.7	14.7	16.0	25.3	27.8	75.4	84.1
Machine tool controls	4.9	5.4	4.2	4.6	7.0	8.4	5.5	6.5	8.5	9.3	4.5	5.5	3.2	3.4	5.2	6.0	3.7	4.1	6.5	8.2	17.8	19.5	71.0	80.9
Motor controls	4.8	5.1	2.5	2.8	6.0	6.6	5.0	5.8	6.0	6.6	1.7	1.9	3.4	3.6	5.1	5.6	4.0	4.4	13.9	15.2	12.6	13.8	65.0	71.7
Photoelectric devices	0.2	0.2	0.3	0.3	2.1	2.3	1.2	1.3	1.4	1.5	0.5	0.6	0.4	0.4	0.9	1.0	0.4	0.4	4.0	4.5	6.9	7.6	18.3	20.1
Process controls and systems (including computers)	34.7	39.8	14.8	17.0	80.0	91.0	62.0	69.5	38.0	43.7	16.1	17.8	17.3	19.0	36.5	42.3	25.4	28.6	72.0	82.8	146.5	178.5	513.3	630.0
Welding equipment	0.4	0.4	0.2	0.2	5.2	5.7	1.9	2.1	1.2	1.3	0.3	0.3	2.5	2.6	0.8	0.9	0.6	0.7	5.8	6.4	10.2	11.3	29.1	31.9
Other production and control equipment	9.8	11.1	2.6	3.0	25.0	28.0	13.5	15.0	7.3	8.4	3.1	3.5	3.3	3.9	4.5	6.1	4.2	4.7	48.3	55.5	104.0	114.6	225.6	253.8
TOTAL	**59.6**	**67.6**	**26.4**	**29.9**	**145.0**	**164.9**	**97.4**	**109.1**	**68.1**	**77.0**	**27.6**	**31.4**	**31.6**	**34.5**	**58.3**	**67.7**	**40.6**	**45.4**	**171.6**	**195.6**	**335.4**	**386.4**	**1,061.6**	**1,209.5**
Test and measuring equipment																								
Amplifiers, laboratory type	0.2	0.2	0.1	0.1	1.8	2.0	0.6	0.7	0.7	0.8	0.1	0.1	0.1	0.1	0.3	0.3	0.2	0.3	1.2	1.3	3.0	3.2	8.3	9.1
Calibrators and standards	0.7	0.8	0.2	0.3	2.7	2.8	2.1	2.3	3.5	4.0	0.3	0.4	0.3	0.3	1.8	1.8	0.7	0.8	3.0	3.3	4.3	4.3	19.6	21.1
Components testers	1.3	1.4	0.7	0.7	4.5	4.8	2.5	2.8	3.8	4.3	0.5	0.7	0.3	0.3	2.7	3.1	0.5	0.6	1.7	1.8	4.2	4.7	22.7	25.2
Counters and timers	3.2	3.4	1.3	1.5	4.6	4.8	3.6	3.9	2.9	3.2	0.3	0.4	0.5	0.5	2.3	2.4	0.8	0.9	5.4	6.3	7.3	8.3	32.2	35.6
Electronic ammeters and voltmeters (analog)	1.8	1.8	0.8	0.9	3.0	3.3	1.5	1.6	2.0	2.0	0.3	0.4	0.4	0.3	1.0	1.1	0.3	0.3	2.4	2.5	4.0	4.0	17.5	18.2
Electronic ammeters and voltmeters (digital)	2.0	2.3	0.9	1.0	4.5	5.3	1.5	1.8	2.2	2.5	0.1	0.2	0.1	0.2	0.8	0.9	0.3	0.4	4.4	5.0	5.1	7.0	21.9	26.6
Microwave test and measuring equipment	0.1	0.1	0.8	0.8	9.8	9.9	4.7	4.9	7.1	7.6	1.8	1.9	0.2	0.3	2.2	2.5	0.7	0.8	6.5	7.5	13.0	13.6	46.9	49.9
Oscillators	1.1	1.1	0.2	0.2	4.4	4.7	1.7	1.8	1.9	2.2	0.2	0.2	0.3	0.3	1.2	1.4	0.4	0.5	3.0	3.1	5.5	5.6	19.9	21.1
Oscilloscopes and accessories	6.5	7.1	2.0	2.2	16.0	17.5	10.1	11.9	9.0	10.3	1.4	1.5	1.4	1.5	4.5	4.9	2.2	2.5	16.3	18.0	22.0	24.0	91.4	101.4
Power supplies, laboratory type	3.2	3.2	0.3	0.3	4.0	4.5	2.1	2.2	1.6	1.8	0.3	0.4	0.5	0.5	1.2	1.3	0.8	0.8	3.7	3.8	6.4	6.9	24.1	25.7
Recorders	2.5	2.8	1.8	2.0	9.3	9.5	5.4	5.9	7.5	8.6	1.1	1.3	1.1	1.2	3.5	3.8	3.0	3.3	5.8	5.8	19.4	20.5	60.4	64.7
Signal generators	1.5	1.8	0.4	0.4	5.3	5.4	4.5	4.8	3.7	4.3	0.6	0.6	0.8	0.9	2.8	3.1	1.3	1.4	4.7	4.8	7.2	7.5	32.8	35.0
Spectrum analyzers (audio to 1 GHz)	0.8	0.9	0.2	0.2	1.7	2.0	1.5	2.0	1.5	1.7	0.4	0.5	0.5	0.5	0.8	1.0	0.8	0.9	3.2	3.8	3.2	3.7	14.6	17.2
TOTAL	**24.9**	**26.9**	**9.7**	**10.6**	**71.6**	**76.5**	**41.8**	**46.6**	**47.4**	**53.3**	**7.4**	**8.6**	**6.5**	**6.9**	**25.1**	**27.6**	**12.0**	**13.5**	**61.3**	**67.0**	**104.6**	**113.3**	**412.3**	**450.8**
Total consumption, assembled equipment	**266.6**	**302.0**	**164.4**	**187.1**	**1,560.0**	**1,806.8**	**833.0**	**923.5**	**419.8**	**474.0**	**140.9**	**153.4**	**320.1**	**362.4**	**461.3**	**534.6**	**256.1**	**287.7**	**1,591.6**	**1,809.4**	**2,583.1**	**2,958.5**	**8,596.9**	**9,794.4**

Factory prices in millions of dollars

Note: The forecasts in this chart are based on business conditions and currency exchange rates as of Nov. 15, 1970. There have been changes in categories, so comparisons should be made with figures published in previous years' charts only after taking the revisions into account.

[1]Computers that are integral parts of navigation, radar, process control, and similar systems are not included here but are counted as part of the system.

*Less than $75,000.

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EUROPEAN COMPONENTS MARKETS 1971

	Belgium-Luxembourg		Denmark		France		Italy		Netherlands		Norway		Spain		Sweden		Switzerland		United Kingdom		West Germany		Total	
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971
Antennas, domestic	1.8	2.0	2.3	3.6	25.0	30.0	5.8	6.0	3.1	3.4	1.5	1.4	4.2	4.3	3.0	3.2	3.0	3.1	9.6	10.3	22.2	24.4	**81.5**	**91.7**
Capacitors, fixed	6.9	7.6	8.5	9.5	55.9	62.5	32.3	34.9	8.9	10.0	2.7	2.9	11.5	12.5	17.0	19.0	8.3	8.8	63.9	69.5	106.0	114.2	**321.9**	**351.4**
Capacitors, variable	1.7	1.9	0.4	0.4	6.1	6.9	3.4	3.6	1.7	1.9	0.4	0.4	2.5	2.6	1.9	2.2	0.6	0.6	4.9	5.0	9.0	8.6	**32.6**	**34.1**
Connectors, plugs, and sockets	2.7	3.0	1.9	2.1	37.0	41.5	10.0	11.2	5.5	6.2	1.7	1.9	3.6	3.3	3.3	3.4	4.5	5.1	47.4	53.6	46.8	53.0	**164.4**	**184.3**
Crystals and crystal filters	1.0	1.2	0.8	0.9	3.3	3.8	1.9	2.0	1.2	1.4	0.6	0.6	0.3	0.4	1.0	1.1	0.9	1.0	9.0	9.7	5.5	6.0	**25.5**	**28.1**
Delay lines	1.0	1.2	0.5	0.6	3.0	3.4	1.3	1.4	1.3	1.4	0.2	0.2	0.1	0.1	0.6	0.7	0.5	0.5	2.2	2.4	4.4	5.5	**15.1**	**17.4**
Ferrite devices (except TV yokes and flybacks)	1.8	2.0	2.0	2.2	13.5	14.8	5.8	6.6	3.5	4.1	0.9	0.9	1.5	1.8	2.0	2.1	2.0	2.3	4.5	5.1	16.5	16.5	**54.0**	**58.4**
Filters and networks (except crystal)	0.7	0.8	0.5	0.6	5.0	5.6	1.8	2.0	1.2	1.3	0.8	1.0	0.3	0.4	1.0	1.1	0.5	0.5	6.5	7.1	16.3	18.3	**34.6**	**38.7**
Loudspeakers (OEM type)	3.0	3.1	1.0	1.2	8.1	8.5	10.0	12.3	2.8	2.9	0.8	0.9	2.0	2.3	0.8	0.9	0.8	0.8	9.0	9.4	19.0	19.0	**57.3**	**61.3**
Potentiometers, composition	1.4	1.7	1.4	1.5	8.5	9.3	6.3	7.2	2.6	2.9	0.5	0.6	2.0	2.4	1.1	1.2	1.4	1.6	10.2	12.1	35.0	36.0	**70.4**	**76.5**
Potentiometers, wire-wound	0.4	0.4	0.5	0.6	2.5	2.7	1.1	1.2	0.7	0.8	0.3	0.3	0.2	0.3	1.0	1.1	0.3	0.3	4.9	6.5	8.5	9.6	**20.4**	**23.8**
Power supplies (OEM type)	2.6	2.7	1.9	2.1	10.2	11.3	8.8	9.7	6.5	7.2	1.3	1.5	2.1	2.3	2.8	3.0	1.5	1.6	7.5	8.7	15.5	17.4	**60.7**	**67.5**
Printed circuits	3.0	6.0	1.7	1.9	11.2	12.8	11.8	12.4	4.2	4.7	1.4	1.7	1.0	1.2	2.5	2.7	1.8	1.9	8.9	10.9	11.0	12.3	**58.5**	**68.5**
Relays	3.8	4.2	4.4	4.9	40.5	45.5	10.5	11.0	5.9	6.5	2.5	2.5	2.4	2.6	5.0	5.3	5.0	5.1	35.9	38.3	44.1	41.6	**160.0**	**167.5**
Resistors	4.0	4.8	2.7	3.1	23.9	26.8	7.0	7.7	5.4	6.1	1.2	1.3	2.1	2.4	3.8	4.1	3.7	4.1	36.8	39.4	50.0	56.0	**140.6**	**155.8**
Semiconductors, hybrid ICs	0.1	0.2	0.1	0.1	3.0	3.9	1.0	1.3	0.3	0.4	0.3	0.4	*	*	0.3	0.4	0.3	0.4	4.2	5.7	3.0	4.2	**12.6**	**17.0**
Semiconductors, monolithic digital ICs	2.8	3.9	1.0	1.2	25.9	32.0	12.6	15.5	4.5	6.0	1.0	1.3	0.1	0.3	3.2	3.9	3.0	4.4	34.6	42.7	32.9	39.9	**121.6**	**151.1**
Semiconductors, monolithic linear ICs	0.6	0.8	0.8	0.9	4.2	5.2	1.5	3.4	0.8	1.3	0.2	0.3	0.1	0.3	1.2	1.5	0.9	1.2	8.9	11.0	10.0	14.3	**29.2**	**40.2**
Semiconductors, rectifiers (over 100 mA)	0.9	0.9	0.5	0.6	14.6	16.9	3.5	4.5	1.3	1.5	0.4	0.5	0.3	0.5	1.2	1.6	2.0	2.3	22.4	24.0	15.4	16.3	**63.0**	**69.6**
Semiconductors, signal diodes (100 mA or less)	2.9	3.3	1.2	1.3	9.0	10.3	2.4	2.8	3.2	3.8	0.6	0.7	3.5	4.2	2.2	2.5	2.6	2.9	18.4	19.8	29.6	31.8	**75.6**	**83.4**
Semiconductors, transistors	5.8	6.4	5.9	6.7	48.1	42.9	23.8	25.2	7.7	8.8	3.7	4.1	1.9	2.3	10.1	11.3	5.1	5.3	58.2	61.1	85.5	92.9	**255.8**	**267.0**
Semiconductors, other	1.9	2.2	1.1	1.2	11.7	13.5	4.0	5.2	5.2	6.0	0.6	0.7	7.5	8.9	2.0	2.3	1.3	1.8	14.2	17.7	23.2	26.9	**72.7**	**86.4**
Servos and synchros	0.8	0.8	0.3	0.3	5.2	6.2	1.8	1.9	1.8	1.9	0.2	0.2	0.6	0.7	0.8	0.8	1.2	1.3	12.0	12.2	11.4	11.9	**36.1**	**38.2**
Switches (for communications and electronics)	1.8	1.9	1.8	1.9	9.5	10.5	2.4	2.7	2.4	2.6	1.6	1.6	0.9	1.0	2.4	2.6	1.4	1.5	16.0	17.9	27.0	28.5	**67.2**	**72.7**
Transformers, chokes, and coils*	6.5	7.1	3.5	3.8	25.2	28.0	12.5	13.5	10.0	11.1	3.1	3.0	4.5	4.7	8.6	8.9	5.8	6.0	22.8	23.3	46.0	45.0	**148.5**	**154.4**
Tubes, picture (for TV)	15.0	21.0	4.0	5.3	39.0	46.0	34.0	33.0	27.0	32.4	1.4	1.3	10.9	12.6	9.0	10.0	5.8	6.9	73.0	83.7	140.2	158.8	**359.3**	**411.0**
Tubes, picture (for other than TV)	0.1	0.1	0.1	0.2	9.2	10.1	1.2	1.4	2.0	2.3	0.1	0.1	0.2	0.3	0.3	0.4	0.3	0.4	6.0	6.9	5.4	6.2	**24.9**	**28.4**
Tubes, power	2.4	2.8	1.8	1.9	23.6	26.9	12.5	13.2	7.4	8.3	0.7	0.8	2.3	2.3	3.5	3.8	3.5	3.5	42.0	42.8	23.9	24.9	**123.6**	**131.2**
Tubes, receiving	4.0	4.0	1.5	1.5	24.0	23.5	13.5	13.0	6.0	6.0	0.5	0.4	5.8	5.7	2.2	2.4	2.1	2.1	26.0	25.0	23.0	20.8	**108.6**	**104.4**
Total consumption, components	**81.4**	**98.0**	**54.1**	**62.1**	**505.9**	**561.3**	**244.5**	**265.8**	**134.1**	**153.2**	**31.2**	**33.5**	**74.4**	**82.7**	**93.8**	**103.5**	**70.1**	**77.3**	**620.4**	**681.8**	**886.3**	**960.8**	**2,796.2**	**3,080.0**

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 figures show consumption of components used to build equipment for both domestic and export markets. Participants were asked to value components at factory prices if of domestic origin or at cost-insurance-freight (CIF) if imported. Some categories included in previous years have been dropped from the survey. Others, particularly semiconductors, have been changed to reflect changing market patterns. Therefore, comparisons of totals on this chart with those published previously should be made only after allowing for the necessary adjustments. All estimates were converted to dollars at the exchange rates in effect on Nov. 15, 1970.

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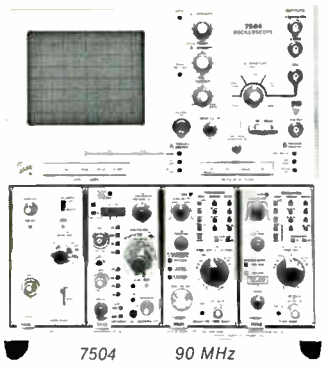
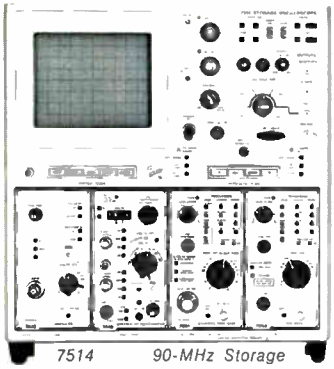
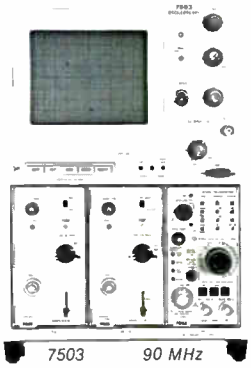


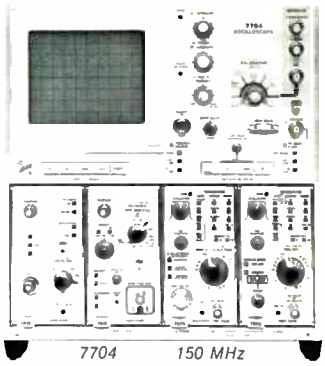
7504 90 MHz



7514 90-MHz Storage

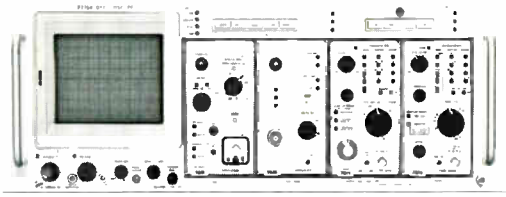


7503 90 MHz



7704 150 MHz

the time savers



R7704 150-MHz Rackmount

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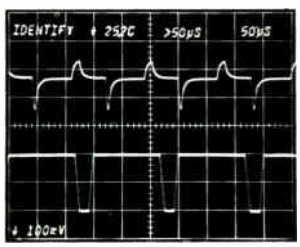

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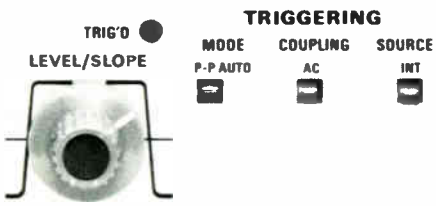

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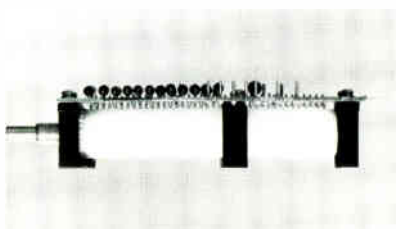

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New IC market: electronic watches

Though low now, production of solid state timepieces could soar to 50 million a year by 1975 if MOS chip and display cost cuts bring watch prices down

By Gerald M. Walker, *Consumer editor*

A revolution may be brewing in the watch industry. And it could be in full swing by as early as 1975 if U.S. semiconductor and display houses deliver on some heady technological promises. If the trickling changeover from mechanical to electronic timepieces does become a flood, it could create a significant new market for IC and display makers. But how big a market and how quickly it materializes depends on how successful U.S. companies are in selling their MOS and display technology to watchmakers here, in Japan, and even in the mainspring of the industry, Switzerland.

Right now, this new electronics market is made up primarily of high hopes. Watchmakers are committed to produce only 12,000 electronic timepieces in 1971, aiming at the small prestige market that can carry the $650 to $2,000 now being charged for electronic watches. As a result, semiconductor houses are only supplying limited quantities of low-power MOS ICs to the watchmakers.

The mass market will materialize when semiconductor houses are able to pare the volume price of their ICs to about $5 to $10 per chip, low enough to put electronic watches in the $50 to $100 retail price range. Semiconductor firms are so sure they can get their prices down that they optimistically expect to be making up to 50 million electronic watches a year by 1975 —or a third of the total U.S. watch business.

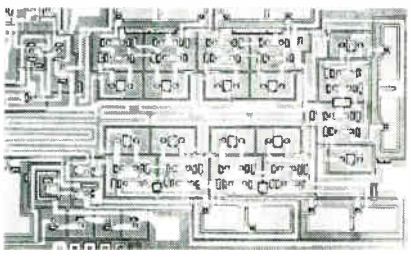
The electronic timepieces' big advantage over conventional watches is the higher accuracy and longer life promised in their use of high-frequency quartz crystal oscillators, monolithic circuits, tiny power cells, and displays. The electronics package could replace everything but the case; its cost would be split evenly among logic, associated circuits offering such extras as dimming of readouts, and the displays. The electronics in the cheapest projected watch, containing one logic chip, a simple display with hour and minute readouts, and no associated circuits, would cost from $10 to $20.

The electronic watchmakers—Hamilton Watch Co., Seiko of Japan, and the Swiss manufacturers' research consortium, Centre Electronique Horloger S.A. (CEH) —can do their shopping among several U.S. electronics companies. RCA, Motorola, Texas Instruments, and Intersil Inc. already are out drumming up semiconductor business with foreign and domestic customers. And moves are afoot to eliminate all mechanical parts, substituting light-emitting diodes and liquid crystal readouts for the usual watch hands. The market list of display makers includes Hewlett-Packard, Electro/Data Inc., RCA, and TI.

So far, three truly electronic watches—two battery-powered motor driven units and one with a solid state display instead of hands —are ready for the U.S. market; several others are in the prototype stage. Seiko of Japan will sell a $650 timepiece that uses a complementary MOS IC developed and produced by Intersil, Cupertino, Calif. Hamilton, in Lancaster, Pa., will market a $1,500 prestige unit that features a LED readout. Called the Pulsar, it's built with RCA (Somerville, N. J.) complementary symmetry MOS chips by Electro/Data Inc. of Garland, Tex. Seiko plans to make 300 watches a month; with production increasing toward the end of next year, total first-year output is pegged at 5,000 units. Hamilton has said that it will produce and sell just 1,000 Pulsars beginning in mid-1971.

The Swiss entry was developed by CEH, the research group. A quartz prototype designed by CEH, known as the Beta 2.1, was on display at the Swiss trade fair in Basel earlier this year; the first production run of 6,000 units is in progress now for worldwide distribution. According to the Swiss organization, the Beta 2.1 can be sold for under $600 in a plain case,

Timely. Light-emitting diode readouts and complementary MOS ICs give watches new look.



but the main objective is the $2,000 prestige market. Several Swiss companies could handle retail marketing for this watch.

U.S. electronics manufacturers also are supplying components for the Swiss watch industry. Intersil, for example, is providing CEH with a bipolar five-stage binary counter that divides down an 8-kilohertz signal to 50 hertz to operate a small synchronous motor. In addition, CEH has a year old contract with Hewlett-Packard Co., Palo Alto, Calif., to investigate the use of gallium arsenide watch readouts.

The success of electronic watches, of course, hinges on semiconductor technology. One of the more significant developments is RCA's "universal timing chip," ready for production for watches and clocks. The new chip, designated TA6030, has 23 counting stages for 1.5-volt operation from a single battery, but will also operate from a 15-V power source for other timepiece applications. After a year of studying this market, RCA decided to make a chip flexible enough to cover all the variables required by both watch and automobile clock producers. The input inverter for the crystal oscillator, therefore, will accommodate the range of quartz crystals used by the watchmakers.

Designed into this monolithic chip are three zener diodes for regulation at 5 V, 10 V, or 15 V, a range wide enough to make the chip adaptable to automobile clocks which run off widely variable outputs from car batteries.

Motorola also is involved in circuit development for the watch market. "Electronic watches will compete in the $100-and-up price range in 1971," predicts Arnold Lesk, director of the central research Laboratories at the Semiconductor Products division, Phoenix, Ariz.

He bases his cost projections on Motorola's expected production next year of an MSI chip that will be a combination of frequency divider, oscillator, and output circuit to the motor. Monolithic silicon gate complementary MOS circuits are in the preproduction prototype stage now, but costs should decline sharply in production.

"In reasonable quantities, the MSI circuit will cost about $5," Lesk predicts. "The aim of the watchmakers in the next few years will be to get the cost of the motors, crystals, and ICs down so that in 1975 maybe 50 million electronic watches will be sold. I think we're doing our part. Now it's up to the motor and crystal manufacturers to help reduce prices."

The prototype shown by Hamilton last spring has been changed significantly as a result of the cut in number of chips in the hybrid MOS circuit. Thanks to the ensuing lower power requirement, an expensive rechargeable 4-V battery has been replaced by a pair of 1.5-V throwaway power cells that last for 18 to 24 months and cost about $1 each.

The Pulsar's digital readout face of light-emitting diodes is an attractive feature, but it's not without its drawbacks. Because the LEDs are power-hungry, the wearer must depress an on-command button that turns on the diodes only when needed. The hour and minute light up for 1.4 seconds; if the on-command button remains depressed, the seconds also appear until the button is released. Though originally designed with a 27-pin matrix hybrid, the first 1,000 units will have monolithic seven-segment LEDs, which consume less power and are easier to program than the hybrids, says John Bergey, director of research for Hamilton.

Seiko's electronic entry has conventional hands controlled by a motor and a new pawl-and-ratchet scheme. The mechanism locks between pulldowns so that there is no chance of skipping between operations even if the wearer engages in violent exercise. This stainless steel model actually is the second electronic watch developed by the Japanese company: The first was announced in late 1969 and sold only in Japan for $1,250 in a heavy gold case.

Seiko's electronic logic circuit is the result of an 18-month joint venture between the watchmaker and Intersil. Unlike the bipolar circuit in the earlier watch, the new C/MOS circuit requires no resistors and only dissipates power when it changes from one state to another. Because most of the divider circuit runs at low frequency, the number of times a flip-flop changes state is low. Therefore, the entire circuit dissipates a small amount of power.

For example, the divider which counts down from 16 KHz to 1Hz is composed of 14 stages, but only the first five operate above 14 KHz, so the remainder of the circuit operates with very low power dissipation. On the other hand, bipolar circuits always require some current to flow even when none of the devices is changing state.

The C/MOS circuit used in the Seiko watch had to overcome an important problem: with a 1.2 V to 1.6 V power requirement, the p-channel's threshold has to be less than 1 V. To accomplish this, Intersil uses a structure of oxide silicon nitride aluminum, and a silicon gate.

As for solid state displays, many problems still must be overcome before LED and liquid crystal readouts are perfected. Says Hewlett-Packard general manager John Minck, "Most of the major watch companies have talked to us about LEDs, but present device efficiency is not good enough to permit continuous operation. A five-to-tenfold improvement is necessary."

Their high-voltage requirement is a problem in applying liquid crystals to low-power watches, but in the long run this type of readout may be used in more watches than LEDs because of its lower manufacturing costs. Both RCA and Texas Instruments, Dallas, are developing liquid crystal displays that could be used in watches.

Liquid crystal displays will eventually be used in low-priced electronic watches, Hamilton's Bergey points out, but the power supply problem must be overcome first. Seiko, on the other hand, expects to market a clock with liquid crystal display during the first half of next year. □

Contributors to this report included Larry Curran in Los Angeles, Charles Cohen in Tokyo, Stephen Wm. Fields in San Francisco, and Laura Pilarski in Zurich.

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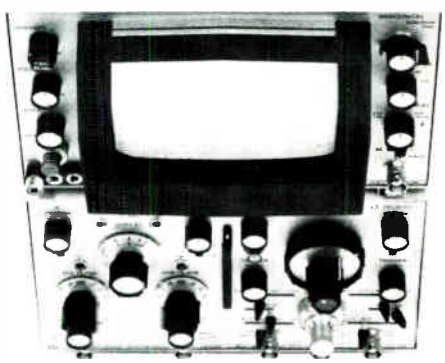

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Research and development

New realism pervades R&D

Because of hefty cutbacks in Government R&D funding, some firms have left the field, others are upping IR&D, all are trimming overheads

With military R&D a major casualty of government cutbacks in funding, electronics companies across the nation have found their fortunes suddenly going into reverse. Some have actually given up on the military R&D market and are moving into different and, they hope, greener areas. Others are attempting to capture military production programs by increasing their internal R&D and are slashing overhead relentlessly. Most, in any case, have redirected their R&D toward immediate payoffs in highly marketable products. However, several firms say their Government-funded R&D has remained level—and a few report that military contracts have gone up.

Yet many companies say they aren't worried that the R&D cutbacks will make them lose technological ground and place them at a disadvantage when business picks up again. Says one engineer, "Everyone is in the same boat, so why should we worry about falling behind our competitors?"

A less sanguine view is held by the Pentagon's Director of Defense Research and Engineering (DDR&E), John S. Foster, Jr. In his fiscal 1971 budget request for research, development, test and engineering, Foster pointed out that the $7.34 billion sought was $23.4 million below the prior year's appropriation and would buy 4% to 7% less effort in real dollars. "We will not be able to explore some promising technical opportunities relevant to defense, and we anticipate laying off technical personnel, closing certain laboratories, cutting out many contracts and stopping projects," he complained. Despite this lament, the House slashed nearly $391 million more from his request, appropriating some $6.95 billion.

Still, people in Foster's shop are now convinced that the worst is over, and they talk of a turnaround in research funding in the fiscal year beginning July 1, 1971. Development programs, though, are another matter. As Pentagon R&D managers see it, the four categories of development—exploratory, advanced, engineering, and operational systems—will get more money overall in the new Nixon budget, but the emphasis will be on exploratory and advanced development of new strategic weapons and communications systems. And even with the expected increases, most electronics companies will continue to feel the effects of military R&D cutbacks throughout the year.

One of these is Lockheed Electronics Corp., Plainfield N.J., which was hard hit by the curtailment of development funds for the tri-service three-dimensional radar and the failure of a market to materialize for its multifunction helicopter radar with an antenna in the rotor blade—both projects that it had backed heavily. With no new major military programs to bid on in the next few years, the company has not only reoriented its Military Systems division, but changed its name to the Products and Systems division. Military R&D will still continue with both internal and contract funds, but more R&D will go to developing commercial prod-

The comeback trail

As the cost of R&D continues to rise by what the Pentagon estimates as an annual 5%, a new budget request for fiscal 1972, which could easily run between $7.5 billion and $7.7 billion, isn't going to erase the nearly 30% decline in the U.S. technical effort over the past five years. But, say Directorate of Defense Research and Engineering personnel, approval of the requested increase by the Office of Management and Budget and the new Congress—two big hurdles—would represent a start toward rebuilding a strong industrial and academic R&D capability. Further, as the White House sees it, the new money will help revive a sagging economy by providing more jobs for scientific and engineering professionals—all voters whose support will be sought by Richard Nixon in 1972.

"It takes 12 to 18 months for Federal spending of this kind to trickle down to the community level," explains one Pentagon budget planner, "so the Administration has to move this year if it expects to make political capital out of R&D." Present estimates are that it will move.

But the biggest problems are technological, not political, say DDR&E staffers. Because some of the most advanced U.S. technology has been exposed in Southeast Asia through loss of reconnaissance aircraft and missile duds, DDR&E sees its inventory of classified electronics and countermeasures at a low point and badly in need of rebuilding. While research on tactical electronics systems, notably communications, is expected to decline, system development efforts to improve on what Deputy Defense Secretary David Packard calls "disappointing performance" will continue. This, however, is expected to affect only existing equipment contracts. Biggest R&D funding boost is expected to come in strategic systems to counter the Soviet Union, an area of technology unlikely to be affected by strategic arms limitation talks.

ucts, such as data communications equipment and automated factory equipment, says a company spokesman.

Others, like the Autonetics division of North American Rockwell Corp., Anaheim, Calif., have used company funds to develop finished hardware for several programs, some of which could lead to production contracts. Thus, the company hasn't reduced in-house R&D in proportion to the reduction in military R&D, but instead has cut overhead.

Officials at the Data Systems division of Litton Industries Inc., Van Nuys, Calif., say that the contract they won to develop and produce a new command and control system for Nike and Hawk Air Defense Missile Batteries was awarded to them in large part because they spent their own R&D dollars to develop a video processing system and advanced display console for the larger command and control system. The military customer was able to visit Litton and test actual hardware during evaluation, instead of having to assess a paper proposal. That, and the fact that Litton's L-3050 computer used in the system was already in the Army inventory, were major factors in Litton's winning the initial $8.5 million contract last July.

Most companies are taking a very close look at how they spend R&D money even on projects of seemingly immediate usefulness. A case in point is the Soniscan magneto-acoustic memory made by Sylvania Electric Products Inc. in Waltham, Mass. [*Electronics,* July 6, p. 49]. Although Soniscan is almost assured of a market in the Navy's advanced airborne digital computer, Sylvania is now studying the three possibilities of developing it internally, selling rights to the device on a royalty basis, or spinning off a partially owned company to take over the product, to discover which is least costly.

This hard-nosed approach to R&D is shared by James M. Early, vice president and research director of Fairchild Semiconductor, Mountain View, Calif. He sees 1971 as the year that "many central research labs, including Fairchild's, get product-oriented." After a bad year, Fairchild has cut its internal R&D by 10%, according to group vice president M.M. Atalla, and made project groups responsible for getting products from R&D into production.

Raytheon in Lexington, Mass., cut personnel at its Missile Systems division and Research division, and the Equipment Development laboratories consolidated its R&D. Now with a lower overhead and closer scrutiny of R&D, Raytheon maintains it's getting more for its research dollar.

Fairchild-Hiller Corp., in Germantown, Md., best known for its aircraft and space satellite programs, is spending most of its new internal R&D money on medical electronics. Bendix Corp. in Detroit, Mich., directs its nondefense R&D work at pollution control devices like laser smoke detectors, electronic fuel injection systems, and medical electronics—wherever the payoff is sure if the research succeeds.

Adding a postscript to the new practical look in R&D, Richard T. Dibonna, a vice president of Microwave Associates in Burlington, Mass., says, "I only want Government support if it means eventual profits; we organized ourselves to live without much Government R&D in 1970, and it's a very good thing we did, since we had about one quarter the amount of R&D funding we had in 1966."

Others, however, report military R&D hasn't dropped in their companies. While the test and evaluation part of the budget has dipped, exploratory development is up about 5%, advanced development up 18.5%, and engineering development up 36.7%. "We don't find our market changed," says a spokesman at Motorola's Government Electronics division in Scottsdale, Ariz. "The prime contractors will be hurt like hell, but what they're doing in the face of lack of funds for new systems is refurbishing old systems, which is good for our business." For example, he notes, B-52s are being given upgraded electronic warfare systems, and the Motorola division hopes to cash in on this with its system for "hiding" B-52s from the enemy.

Another company that hasn't suffered military cutbacks is Hamilton Standard in Windsor Locks, Conn., a subsidiary of United Aircraft. About four years ago, Hamilton decided to develop capabilities in on-board digital computation—and last year picked up several contracts for developing computer-based supervision control systems for the engines in the F-15, F-100, and F-104 aircraft.

ITT's Defense Communications division in Nutley, N.J. reports that it actually won more R&D contracts in 1970 than it did in 1969. Most recently it got a $6.3 million contract to develop and build two prototype Navy satellite terminals. Charles Haller, division president, attributes this success to the division's policy of sinking a lot of money into internal R&D to develop its technical capabilities.

Military funding also won't be reduced at the Mitre Corp. in Bedford, Mass., a nonprofit Federal contract research center with a funding ceiling controlled by the Department of Defense. And Government R&D at Varian Associates in Palo Alto, Calif., about a third of its total R&D, stayed the same for 1971. But the general decline in business will probably drop Varian's internal R&D budget down to $13.2 million in 1971, $1.1 million less than the 1970 sum spent by the company.

Similarly, a major northeastern electronics company, with 89% of its R&D Government-funded, reports no change in 1971 and an overall increase of 2.7% in its total R&D budget for a total of $247 million. But even so, the company has been forced to cut personnel and overhead. □

The contributors to this report included James Brinton and Gail Farrell in Boston, Lawrence Curran in Los Angeles, Stephen Wm. Fields and Marilyn Howey in San Francisco, Ray Connolly in Washington, Alfred Rosenblatt and Peter Schuyten in New York, and Jane Shaw, McGraw-Hill World News in Chicago. It was written in New York by William J. Bucci.

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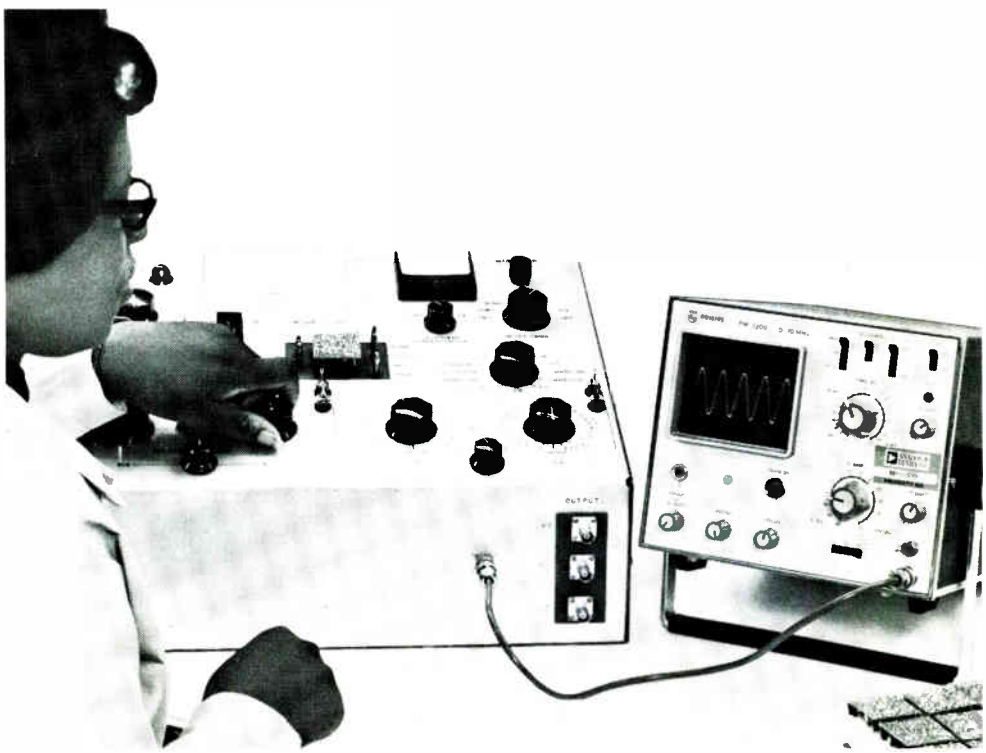

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Communications

Optical link firms see wide horizons

Inexpensive and portable, laser and LED data transmission systems have become strong contenders for short-haul applications

By Leon M. Magill, *Communications editor*

Installing a high-speed, short-range communications link these days can open up a can of worms for systems designers. With conventional microwave links and leased lines, they often run up against the crowded frequency spectrum or congested local telephone exchanges. And buried cable systems are expensive—$16 or more per running foot.

Yet there's one approach, until recently confined to research labs, that gets around the problems—optical links that use lasers or light emitting diodes to transmit data. Such links are now being sold by two companies, and, by the end of 1971, at least five more will enter the competition. Makers predict sales of their equipment for such applications as short-haul computer communication and closed-circuit or cable television will reach $5 million next year and jump to $50 million by 1975.

Cost is the big selling point for optical data links. A prototype $6,000 link at the University of Colorado in Boulder, for instance, replaced leased lines that University engineers say would cost over $5,000 a year in most locations. The lowest-priced optical system being sold now goes for as little as $2,900.

And prices could fall dramatically in the future, says Frank Goodwin, head of the optical communications section at Hughes Research Laboratories, Malibu, Calif. "I'll stick my neck out and say that one of these days you'll be able to buy a complete [optical] communications system for less than $50." That day, though, won't dawn until the next decade, he feels.

Initial optical links used noncoherent gallium arsenide LEDs and transmitted data at rates of up to several hundred kilobits per second over distances up to a mile long. And while some have stuck with the diodes for economy, others feel the laser is the best choice. They claim the laser can provide higher-power pulses of shorter duration, which can increase the link's capacity and help it punch through adverse weather.

Most frequently used lasers are the gallium arsenide diode and the helium-neon gas types. They're not without drawbacks, however: the latter requires complex circuitry while the former encounters heat dissipation problems at high pulse repetition rates.

The link at the University of Colorado operates over a 1-kilometer distance between a CDC-6400 computer and a remote terminal. Designed by electrical engineering professors at the school, the 40.8-kb/s noncoherent system uses a GaAs near-infrared LED transmitter and a silicon phototransistor receiver. The link has been so successful that some of the engineers formed University Instruments Corp. to build and sell similar units. A full duplex version at 50 kb/s sells for $6,000; with volume production this price will come down further, says a company spokesman. Other models run up to $25,000, "with most of them under $10,000," he adds.

But the only optical links sold so far are made by Computer Transmission Corp. of Los Angeles [*Electronics*, March 30, p. 145]. The company has sold two, and customers are evaluating three more. Called Optran, the links use GaAs LED transmitters and p-i-n photodiodes in their receivers and sell for around $2,900.

Martin-Marietta Corp. in Orlando, Fla. is developing a link incorporating a GaAs laser diode capable of 5-watt, 20-nanosecond pulses and a silicon photodiode detector in the receiver. Its link will be capable of 100-kb/s operation, and with improved diodes—Warran Birge, program manager of optical communications, feels RCA will make them available in 1971— 500-kb/s operation will be possible.

Holobeam Inc. of Paramus, N.J. has been achieving data rates of 2 megabits per second in the lab using an experimental RCA GaAs laser diode, without cooling, and the modulator developed for their laser voice communicator [*Electronics*, March 30, p. 92].

Helium-neon laser links are being offered by Quantronix Corp. of Smithtown, N.Y. and Georgetown Instruments of Washington, D.C. Since August the latter company's test link has been transmitting television pictures across the Potomac River, from Georgetown University to Virginia, and is preparing to offer a 20-30 MHz system with three working channels.

Both the Georgetown and Quantronix links use acousto-optic modulators and can transmit over 1.5-mile ranges. The Quantronix system will sell for under $10,000. Acousto-optic modulation also will be used in Zenith Radio Corp.'s projected helium-neon laser link, and the Chicago firm already is marketing such a modulator offering a 5-MHz bandwidth.

The latest experimental helium-

Probing the news

neon optical data link is an in-house unit built by Hughes Research Laboratories. The work was done essentially to prove that a heterodyne detector could be field ruggedized. Transmitter output is about one milliwatt and receiver sensitivity is "essentially ideal," says Frank Goodwin, head of the optical communications section. The link handles 50 million bits of data a second over a range of 1 to 3 miles, depending on weather, with an indicated error rate of less than one bit in 10^6, says Goodwin. And it can handle both digital and analog data, transmitting several television channels in analog form, or two in digital form.

University Instruments will have two of its high-speed—320 kb/s to 3 Mb/s—digital models in operation shortly. One is being installed between two towns near Denver over a three-quarter-mile path. The other, in New York, will operate over a 5.2 mile CATV path—the longest optical link to date, says Herbert F. Rikelman, University Instruments' president.

The company also has a low-speed digital model with data rates up to 320 kb/s that will be tested by Microwave Communications Inc., either in Chicago or Washington, its home town.

Data Transmission Co. tested the smaller-capacity Optran at its Falls Church, Va., headquarters earlier this year, and is planning to test Martin-Marietta's 100-kb/s system this month.

A Martin-Marietta analog link is being shipped to Telecommunications Inc., Denver, Colo., for trial. Though the initial test will involve a single 6-kilohertz voice channel, subsequent runs will be in multichannel format using time division multiplex for sending television.

Weather is a primary factor in optical data link reliability. University Instruments' Rikelman says the only failure during the Colorado University link's first few months was when a heavy snowstorm cut visibility to a few hundred feet. But this system has been reliable over the 1-km link in both heavy rain and fog, he adds. □

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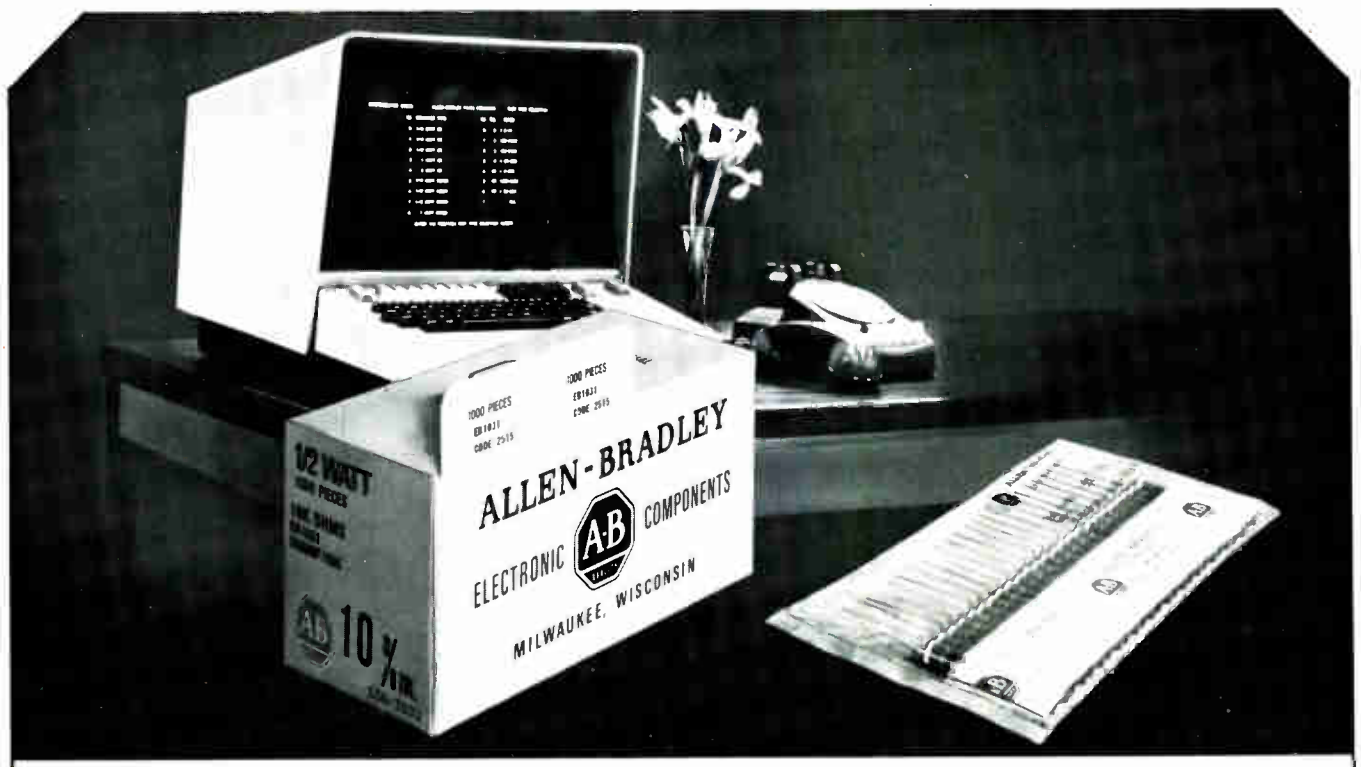

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Manufacturing

Dry photoresists gain ground

Thanks to its success in boosting printed circuit board yields, dry film process has captured 21% of the market in two years

By Stephen E. Scrupski, *Packaging & Production editor*

Hard pressed to boost yields of complex printed circuit boards, many manufacturers in 1968 jumped at a new dry-film process that promised an end to trouble with conventional liquid photoresist. Two years later, dry film has captured 21% of the total market and is used for 42% of all photoprinted boards. Next year, its market share is expected to rise to 29%.

Though the process requires a hefty capital investment, most of the larger pc board manufacturers made it, and are already beginning to pass on cost savings resulting from higher yields to computer companies and other customers. But many of the smaller firms, held back by tight budgets, are staying with liquid photoresist, and they're finding themselves at a competitive disadvantage.

The three companies which make dry film—E.I. du Pont de Nemours & Co. Inc., Wilmington, Del., Dynachem Corp., Santa Fe Springs, Calif., and Photopolymer Research Corp., Milwaukee, Wis., a subsidiary of W.H. Brady Co.—are therefore trying to get these companies to convert and, at the same time, going after the foreign market. Du Pont, the largest producer of dry film with its Riston, says it already has 25% of the high-quality pc market in Europe and 18% in Japan.

The dry film is still expensive, however. Compared with the 4 to 12 cents per square foot in 0.15 mil thicknesses of the liquid, a 1.5-mil thick film costs about 37 cents a square foot—a price that's keeping many pc makers from using the process for their less complex boards.

With the dry film process pc boards with line widths as narrow as 4 mils, spaced 4 mils apart, are being produced routinely—and the lines are sharp. Liquid photoresist, by contrast, is limited to line widths and spacings of about 10 to 15 mils, and may produce mushrooming lines that trap metal particles. Dry film is also more easily handled during manufacture, can easily be automated, protects plated-through holes during etching, and doesn't result in pinholes as does liquid photoresist.

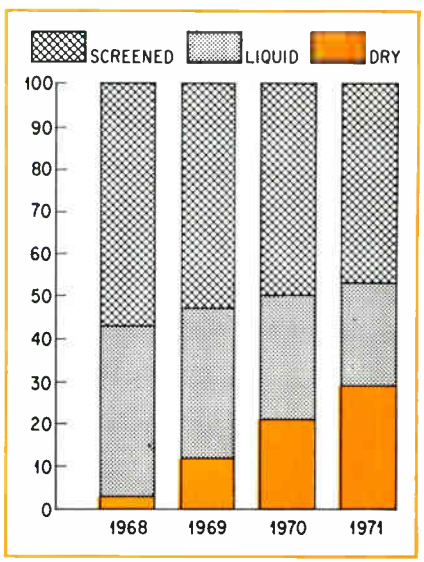
Changeover to the film process could be done simply by setting up a small manual facility, with a $2,750 laminator for applying the film and a $2,250 manual processor for developing it. But for large production runs, a conveyorized processor is a must, and it costs in the $18,000 range. Baron Blakeslee, Inc., Chicago, Ill., offers such a processor, as does du Pont.

One of the first to convert completely to dry film was Agard Electronics Corp. in New Hyde Park, N.Y. Herbert Schachter, vice president and chief engineer, reports that the company uses film for all etched as well as plated boards, and that the process offers consistent high quality.

Hewlett-Packard one of the largest in-house pc makers, has opted for dry film in only a small portion of its pc work. At the company's Palo Alto, Calif. manufacturing division, which supplies about 50% of all H-P's pc boards, only about 2% of production is dry film says Sherman Davis, printed circuits manager. He points out that H-P's Loveland division made a substantial investment in liquid photoresist equipment some time ago. "We'd like to try dry film photoresist," admits Walter Johnson, head of the Loveland printed circuit operation, "but with tight budgets right now, we're just not able to put the manpower on the evaluation program."

Despite this kind of hesitancy, makers of dry film continue to enter the market, to give du Pont, Dynachem, and Photopolymer a run for their money. Next year, for example, General Aniline & Film Corp., New York, N.Y., maker of positive liquid photoresists, will start selling the first positive dry-film photoresist, which the company claims will offer significant advantages over the present negative dry film resists. □

Upswing. Du Pont figures show percent of U.S. boards made with three types of resist. Overseas figures for dry film usage are : 1968, 0%; 1969, 2%; 1970, 6%; 1971, 14%.



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Swing to passive DIPs looks like a stampede

Ease of automatic insertion, compatibility with ICs drive other components toward package uniformity

As integrated circuits go, so go the passive components that surround them. Hence the rush by component makers to adopt the popular plastic dual in-line package—developed for ICs—for everything else on printed circuit boards.

Thick-film resistor networks in DIPs are being marketed by Sprague Electric Co., Mepco Inc., CTS Corp., IRC division of TRW Inc., Allen-Bradley Co., and Dale Electronics Inc., with Centralab division of Globe-Union Inc. soon to join the list. For those who need the higher precision performance of wirewound resistors, Dale will introduce DIP versions this month. Both Sprague and Mepco have packaged capacitors in this way, while Daven division of McGraw-Edison Co. has done the same for six-position switches. Trimmer potentiometers have been introduced by Amphenol Corp., and both Dale and CTS are planning to follow suit. Dale is also planning to go to market soon with toroidal cores, which Sprague has already put into the DIP, as has the Potter Co. Meanwhile, nearly a dozen companies have reed relays in DIPs [*Electronics*, Oct. 26, p. 127].

Corning Glass Works disclosed plans this month to put combinations of discrete components into DIPs. A 16-pin package called Cordip can contain as many as 20 components that include glass-tin oxide resistors, glass-dielectric capacitors, and diodes.

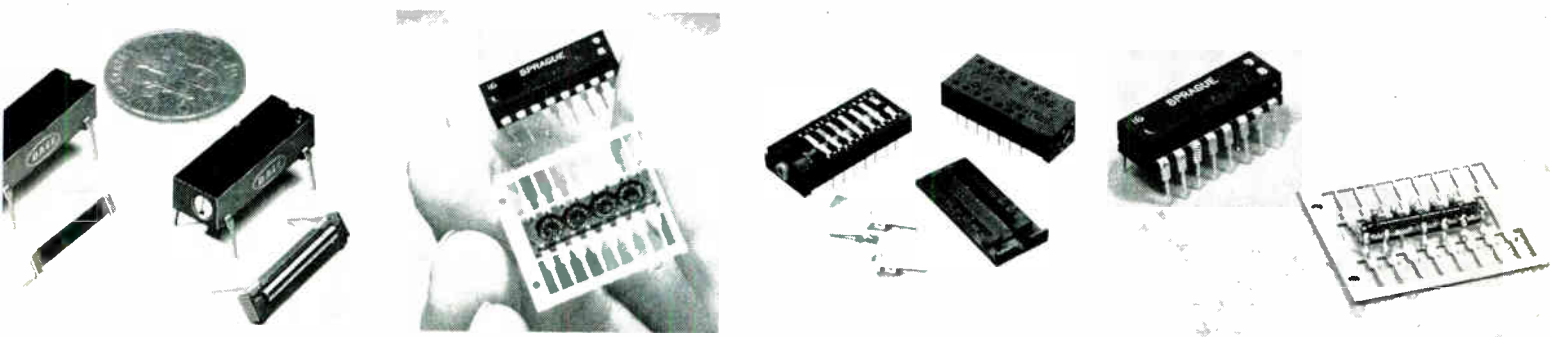
The end is not in sight. As U.S. labor rates continue to rise, and as imports from overseas areas with low labor costs pose ever greater threats, automatic insertion is catching on, and for this the DIP is well suited. Unlike older packages for ICs—the familiar TO-5 can and the flatpack—the DIP is compact, but not inconveniently small for handling by a machine. Its box-like shape makes it easy to stack and load automatically into the machine. Its relatively rigid, symmetrically arranged leads are easy to insert in holes in the pc board.

But while the DIP solved many IC assembly problems, the passive components almost always needed on the same board continued to resist conversion to automatic assembly methods, because of their wide range of shapes, sizes, and pin configurations. It's not surprising, therefore, that since the first DIP passive components appeared about a year ago in sample quantities, manufacturers have been enjoying brisk sales in an otherwise depressed market.

Other factors add to the appeal of DIP components—because a single DIP usually replaces several discrete passive components, a user need not stock components in as great variety and quantity. In addition, the DIP aids in removing heat from components in it.

Acceptance by customers has been rapid. Bob Mullen, product manager for hybrid circuits at

New housing. Passive components in DIPs include, from left: Dale Electronics' trimming potentiometer (film and wirewound), Sprague's quad toroidal inductor, Daven's multiposition switch, and Sprague's delay line.



New products

Mepco, notes that at the beginning of the year his company was receiving unsolicited requests for quotes on DIP networks at the rate of one or two a month. "Now, the rate has increased to several new requirements per week," he says.

Although the bulk of the business in these components will be in sales to the makers of large data processing systems, "EDP applications are somewhat downstream yet," Mullen says. "They'll be in next-generation equipment." Right now, most deliveries are going to manufacturers of peripheral equipment, who are able to respond much more rapidly to technological improvements in components. And although individual orders are not large, there are enough of them to generate sizable volume.

The trend to DIP is not unanimous. The Radio Materials Co., a division of P.R. Mallory & Co., sees no advantages to its customers in the DIP. And Mallory, the parent company, is not producing DIP components.

John Kirschner, general manager of RMC, points out that his customers are primarily makers of home entertainment equipment, "and (unpackaged) hybrid circuits are more relatable to that type of product. The extreme miniaturization of the DIP is not required."

More important than compactness, says Kirschner, are costs and flexibility. "Hybrid ceramic substrates give minimum cost and maximum flexibility," says Kirschner. He points out that each maker of consumer products has special designs and often alters these designs during a model year.

Sprague Electric Co. emphasizes a versatile DIP capability, offering resistor networks, capacitor arrays, inductive elements, delay lines, and combinations of these.

For its resistive networks, Sprague uses films of noble metals —technically "thin" films since they're only 400 to 1,500 angstroms thick, but deposited by silk screening, a "thick" film technique. Ed Geissler, manager of computer components marketing, claims that this approach combines the economy of thick film fabrication with the low noise of a continuous metal film. Individual resistors in the networks can have values of from 10 to 25,000 ohms, with a tolerance of ±1%. Temperature coefficient of resistance is typically within ±300 parts per million/°C.

Sprague uses ceramic capacitors in its DIPs, with ratings of from 10 picofarads to 0.1 microfarad. Solid tantalum capacitors are also used for high capacitances, up to four of them in a DIP, each with ratings of 2.2 μF and 3 volts dc to 0.22 μF at 35 V dc.

For inductive elements, Sprague uses toroidal inductors with ratings up to 5 millihenrys. Wideband pulse transformers are also available, tailored to the user's requirements for primary inductions and volt-second product.

One of the most interesting devices to join the trend is Daven's six-position switch in a 14-lead DIP. Bulky components like switches have set limits to the spacing between stacked pc boards, but the low-profile, 0.23-inch-high Dipswitch allows boards to be spaced only ¼ inch apart. With it, a total of six pairs of contacts can be programed to open or close in any desired sequence, simply by rotating a screwdriver slot on the front of the switch. Each screwdriver-slot position is positively detented and identified by a number.

With a body measuring 0.440 inch wide and 0.995 inch long, the Dipswitch is larger than the standard DIP used for ICs. However, the pin arrangement and dimensions, the critical factors in automatic assembly, are identical to those used for ICs: the pins are 0.100 inch apart, the rows 0.300 inch apart.

The Dipswitch has a piggy-back capability: any 14-pin DIP component can be inserted in it and mounted on its top. With no other wiring, an IC, for example, can thus be subjected to up to six different voltages for such purposes as field adjustments or circuit testing. And two switches can be connected in tandem by means of a coupling and optional rear shaft extension.

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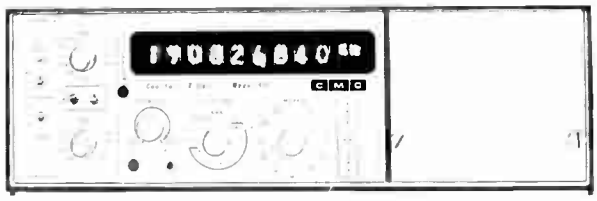
	HIGH VOLTAGE TYPE	V10	0.5A (T$_A$=25 C)	800V 1000V 1300V 1500V	
	HIGH SPEED TYPE	V09	0.8A (T$_A$=40 C)	200V 400V 600V	Trr 0.8 μsec
	AVALANCHE TYPE	V08	1.1A (TA=20 C)	400V 600V 800V	Avalanche power 40W (1m sec ⎍)
	AVALANCHE TYPE	V07	1.3A (TA=25 C)	400V 600V 800V	Avalanche power 40W (1m sec ⎍)
	GENERAL USE	V06	1.1A (TA=20 C)	100V 200V 400V 600V	
	GENERAL USE	V03	1.3A (TA=25 C)	200V 400V 600V	
Zener Diode	VOLT. REGULATOR	AW03	PERMISSIBLE LOSS 1W	ZENER VOLTAGE 2 – 5V	
	VOLT. REGULATOR	AW01	PERMISSIBLE LOSS 1W	ZENER VOLTAGE 6 – 33V	

Weight: 0.35g (0.01 ounce) Length: Min. 62mm (2.4 inch)

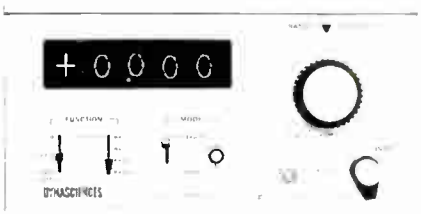
HITACHI

Head Office Section XH-E: 6-2, 2-chome, Ohtemachi, Chiyoda-ku, Tokyo 100
Düsseldorf Office: 4000 Düsseldorf, Graf-Adolf-Strasse 37, West Germany Tel. 10846
Hitachi America, Ltd.: New York: 437 Madison Avenue, New York, N.Y. 10022 Tel. 212 758-5420 **San Francisco:** 100 California Street, San Francisco, Calif. 94111 Tel 415 981-7871 **Los Angeles:** One Wilshire Building, 624 South Grand Avenue, Los Angeles, Calif. 90017 Tel. 213 624-0891
Nissei Sangyo GmbH (Deutschland): Düsseldorf, Am Wehrhahn 41, West Germany Tel. 36 09 03
Nissei Sangyo Co., Ltd., Taipei Office: Nanking Bldg., No. 165, Sec. 2, Nanking East Rd., Taipei 104 Tel. 570704

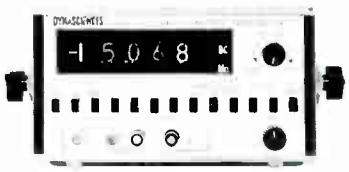
What do these instruments have in common???



THE CMC MODEL 901
Universal Counter-Timer



THE EG&G MODEL 736
Picoammeter



THE DYNASCIENCES MODEL 414
Digital Voltmeter

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Yes, CMC has just joined the Dynasciences bandwagon and become a part of the greatest thing in instrumentation since Hewlett met Packard! CMC brings to Dynasciences not only such state-of-the-art instruments as the high frequency Model 901 but also complete lines of medium and low frequency counters with medium and low price tags. CMC also contributes the famous Rutherford line of pulse and time-delay generators. And backing up those other two models, the 414 and 736, are the full lines of Dynasciences digital voltmeters and EG&G picoammeters. The acquired product lines – together with Dynasciences own line of products – present a formidable family portrait. All part of the same happy household – Dynasciences Instrument Systems Division.

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Components

Relay contacts are magnetized

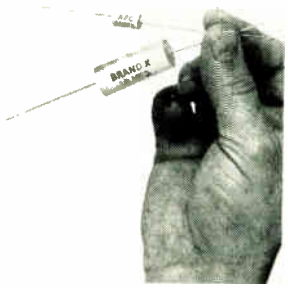
Reed-type devices maintain closed position without external field

External magnets or holding coils are needed to keep the contacts of reed relays closed—unless the contacts themselves are made of magnetic material with enough remanence to maintain closure. With this magnetic-contact approach, which Tempress Electronic Corp. developed for its Memreed latching reed switches, the operate coil need not be energized continuously and the contacts will remain closed during a power failure.

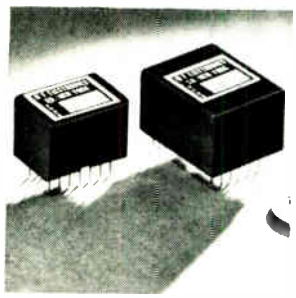
The switch was developed originally for telephone switching systems in Europe, where it has earned a reputation for long life, stability, and reliability. Because of its response to short pulses, the switch is also suited to accepting control signals from computers: the contacts respond within 1 millisecond to a control signal as short as 50 microseconds, which is enough to generate a field in the operate or release coil around the Memreed and cause it to open or close.

A related idea has been used by Western Electric, says Noah Siegel, Tempress sales manager. However, Western uses an external coil with remanence to maintain closure.

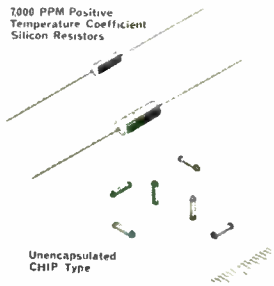
The Memreed switch is being used in a control and readout circuit in copying equipment. "Here, one switch solved a complicated circuitry problem in a simple manner, and prevented jamming in the machine," Siegel reports. The Memreed is also being used as a flip-flop with memory that consumes no power. The operate coil



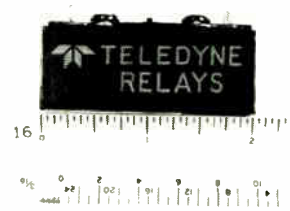
Tiny metalized-film capacitors, tradenamed Milifilm, employ an irradiating polycarbonate as the dielectric. They exhibit extremely high stability. The devices are being offered in three series (ACR, ACF and ACH), with capacitance ranging from 0.01 uF to 50 uF in voltage ratings of 50 V to 400 V dc. Active & Passive Components, 121-18 DuPont St., Plainview, N.Y. 11803 [341]



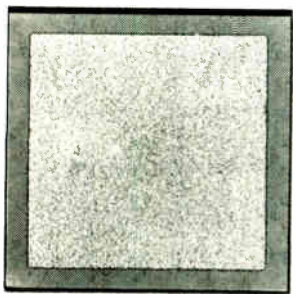
Clock oscillator modules are plug-in types and, depending upon the frequency, take the space of one or two dual in-line packages. Series 5404 generates a desired frequency from 5 to 15 MHz, with an accuracy of ±0.005% over 0 to 65° C. The 5405 obtains frequencies of 80 kHZ to 4.9 MHz with ±0.02% accuracy. MF Electronics Corp., 118 E. 25th St., New York 10010 [342]



Silicon resistors, called Plus-R, offer large positive temperature coefficients for temperature compensation and temperature measurement use. Line includes ⅛ and ¼ W sizes. All standard resistance values from 10 ohms to 10 kilohms are available, with tolerances of ±5% and ±10%. Angstrohm Precision Inc., 7811 Lemona Ave., Van Nuys, Calif. [343]

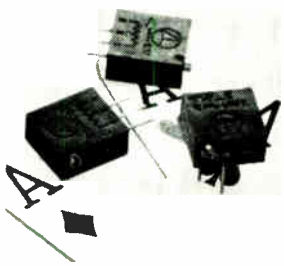


Solid state relays series 601 combine full four-terminal isolation and low cost. The line is for industrial applications where an increase in reliability and a decrease in maintenance is important. Relays are available in a wide range of control voltages from 3 to 75 V dc and 9 to 140 V ac. Some sell as low as $5.80. Teledyne Relays, El Segundo Blvd., Hawthorne, Calif. [344]

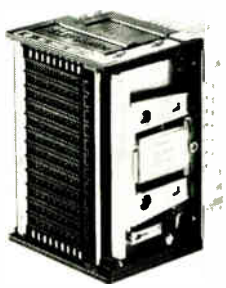


Chip capacitor is designed for use with hybrid L-C filters or R-C networks where low temperature coefficient of resistance is required. Electrodes are parallel to bonding surface allowing one wire contacting. Chips are 1 to 1 assembly compatible with ICs, diodes, transistors or other silicon devices. Sloan Microelectronics, 139 Maryland St., El Segundo, Calif. 90245 [345]

Twelve-position, miniature rotary switch is a 6-pole device with a maximum diameter of 9/16 in. With a contact resistance of 10 milliohms maximum initial, and with an insulation resistance of 50,000 megohms initial, the switch is available with shorting or nonshorting on any individual deck and for pc mounting. RCL Electronics Inc., 700 S. 21st St., Irvington, N.J. 07111 [346]



Wirewound trimming potentiometers series 2300 come in ⅜ in. square RT24 types. They are offered in P, W, and X terminal configurations. The three configurations can be supplied with a resistance range of 10 ohms to 20,000 ohms and a power rating of 0.75 watt at 85° C. Resistance tolerance is ±5%. Amphenol Controls Division, The Bunker-Ramo Corp., Janesville, Wis. [347]



Ordinate holding switch (OHS) possesses random access capability. The nine-pole, 12-position magnetic latching relay is for use in switching networks where optional coupling of one of several outputs to a single input is desired. Applications include switching in telephone exchanges, and other audio and control systems. AEG-Telefunken Corp., Englewood Cliffs, N.J. 07632 [348]

New products

of one switch is connected in series with the release coil of another.

Maximum dc ratings for the switch are 200 volts and 0.5 ampere. Contact resistance at 1 volt and 10 milliamperes is no more than 0.1 ohm. Unit price in lots of 100 is 85 cents; in lots of 1,000, it is 60 cents.

Tempress Electronic Corp., 666 Park Ave., East Orange, N.J. 07017 **[349]**

Only 130 milliwatts needed to trigger miniature relay

The big obstacle in miniaturizing electromechanical relays is sensitivity: the larger the coil size, the greater the sensitivity, requiring fewer milliwatts of power through the coil to close the relay's contacts. In designing a small double-pole, double-throw relay for mounting on a printed circuit board, engineers at Deutsch Filtors Relay division approached the problem by making the magnetic circuit more efficient, thus utilizing the maximum field to provide adequate sensitivity.

Usually there are four high-reluctance points in the magnetic circuit—two where the core joins the pole pieces and two working gaps across the contacts. The core-pole-pieces junction robs the working gaps of magnetomotive force that could be used to operate the relay. The Deutsch engineers redesigned the magnetic structure to eliminate these junctions. The result: the model 3111 relay operates at only 130 milliwatts, yet is contained in a package that measures only 0.23 x 0.5 x 0.4 inch—one-sixth the size of a crystal can relay.

The relay comes in two versions. One is a hermetically sealed device rated to carry a current of 2 amperes across the contacts at 28 volts dc. The other is intended for industrial applications; the package is not hermetically sealed and current rating is 1 A.

Price of the hermetically sealed version is about $11 each in 1,000 quantities, with delivery in six to eight weeks.

Deutsch Relay Division, 65 Daly Road, East Northport, N.Y. 1173- **[350]**

Instruments

How thin is thin film?

Monitor finds out by sensing oscillation period of crystal in deposition chamber

One standard technique of measuring the thickness of film being deposited on an integrated circuit or a ceramic substrate is to place a piezoelectric crystal inside the chamber and monitor its frequency shift as the material builds up on it. However, with frequency shift inversely proportional to the increase in the crystal's mass, a nonlinear relationship arises in those older, analog-type thickness monitors. But digital period measurement circuits produce a direct relationship between crystal mass and oscillation period for a much wider linear measurement range, allowing greater film buildup on the crystal before it has to be replaced.

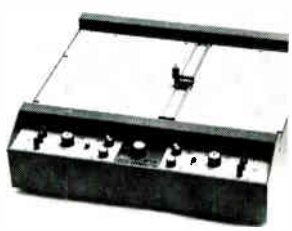
A digital thickness monitor from Inficon uses only one crystal for any material density. The new monitor includes digital ICs for period measurement allowing it to handle up to about 400,000 angstroms of aluminum before the crystal must be replaced. The density of the material is dialed in from a four-digit thumbwheel switch on the front panel. A density range of 1 gram per cubic centimeter to 30 gm/cc with a resolution of 0.01 gm/cc covers virtually all commonly used materials.

A thickness limit can be set with thumbwheel switches so that a control pulse will be generated for the shutter mechanism in the chamber when the desired limit is reached. A sliding door must be closed over the density selector for proper operation; this prevents the

Light-emitting-diode digital display panel meter type 3330 is half the size of a calling card and readable in sunlight. Elimination of tube-type readouts, including the 200-V circuitry necessary to drive them, reduces the size of the meter, and increases reliability and ruggedness to levels approaching Mil Spec requirements. Digilin Inc., 1007 Air Way, Glendale, Calif. [361]

Portable scanner is designed to measure electrostatic fields. It is particularly suited to manufacturing and research, since its sensitivity is only 2/10 V/cm. The instrument has five ranges plus battery test: 5, 50, 500, 5,000, and 50,000 V/cm full scale, positive or minus. Meter measures 2½ x 2½ x 8 in. Electrofields Inc., 9860 SW 40th St., Miami, Fla. 33165 [362]

Single-frequency, solid state radio interference meter model NM-21FFT is available in the range from 600 to 1,500 kHz. It has a cw sensitivity of 0.1 μV conducted and approximately 1 μV radiated. Output meter range is 60 dB, which, with a 60 dB step attenuator, provides a total measurement range of 120 dB. Price is $1,050. The Singer Co., S. La Cienega Blvd., Los Angeles [363]



X-Y recorders, Plotamatic 805 and 815, are precision instruments for preparing graphic output displays in applications not requiring a time base. Primary users include chemical, analytical and medical OEM producers, electronic labs, computer graphic output terminals, and desk-top calculator manufacturers. Bolt Beranek and Newman Inc., 1762 McGaw Ave., Santa Ana., Calif. [364]

Five-digit multimeter series 5300 is suited for either bench or systems use and features a modular design with field expandable plug-in converter boards, providing the ultimate in user flexibility. Standard unit features 45 ranges of dc, complete autoranging from 1 μV to 1,000 V, and excellent noise rejection. Dana Laboratories Inc., 2401 Campus Dr., Irvine, Calif. 92664 [365]

Tester model 365 is a low-cost unit for use as a production or maintenance tool to quickly check cables, harnesses, connectors, pc boards, etc. Settings available are: continuity current, 0.5 mA to 1A; resistance limit, 0.5 to 1,000 ohms; hi-pot voltage to 1,500 V; leakage resistance, 100 kilohms to 500 megohms. Oregon Technical Products, 1421 Old County Rd., Belmont, Calif. [366]

Programable fm signal generator model 6009 offers full computer or front panel control of percent deviation and of center frequency from 100 Hz to 10 MHz, together with voltage control of frequency deviation up to ±39.9% of center frequency. Dimensions are 19 x 7 x 20 in. Weight is 35 lb net. Price is $5,950. Reaction Instruments Inc., 215 Mill St. NE, Vienna, Va. 22180 [367]

Digital ac line monitor model 1262 is for measurement of ac line voltage between 100 and 130 V ac. Accuracy is ±0.2 V (2 digits) at a reference of 25° C with less than 1 digit additional error over a ±10° C ambient. Unit sells for less than $150 in quantities of 25, and less than $200 for single quantities. Weston Instruments Inc., 614 Frelinghuysen Ave., Newark, N.J. [368]

New products

Crystal clear. Digital thickness monitor uses crystal sensor.

possibility of mistaking the density setting for the thickness limit setting. A crystal life meter is included to indicate the total frequency deviation of the crystal. A pushbutton resets the instrument to zero before each run. A companion instrument under development will control the deposition rate by comparing the actual film thickness with an equivalent thickness from a ramp function representing the desired deposition curve. The results of the comparison will be used to increase or decrease the deposition rate.

Fred Schlereth, Inficon's director of engineering, says the crystal sensor head is significantly thinner than any competitive model and thus, with its oscillator circuitry outside the chamber, takes up less space in the chamber. The exposed surface of the crystal is grounded so that operation of the sensor head is unaffected by rf interference and accumulaton of ions. The crystal is edge-mounted for minimum mechanical loading.

The instrument has full scale ranges of 10 kiloangstroms and 100 kÅ. Resolution is 1 Å on the 10-kÅ range and 10 Å on the 100-kÅ range, while error is less than 3% for 100 kÅ of silver (silver is widely used as a specification model because of its ease of deposition). Minimum detectable thickness is 1 Å for a material with density of 1 gm/cc.

Price of the thickness monitor, including a sensing head, is $1,750. Replacement crystals are priced at $19.50 for a package of five. The rate monitor and controller will be priced at under $2,000.

Inficon Inc., 5 Adler Drive, East Syracuse, N.Y. 13057 **[369]**

BRIGHT, LARGE SCREEN DISPLAY AND HIGH SENSITIVITY (12 in)

MODEL 5121 ALIGNMENT SCOPE

Model 5121 is a X-Y oscilloscope employing a 12-inch cathode-ray tube for television. The vertical Axis has High Sensitivity and LINE SWEEP is built in.

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Sensitivity: More than 5mVp-p/cm, built in 20dB ATTEN Freq. characteristics: DC ~10kHz, 3dB Position Selector: INT ⟷ REMOTE
- HORIZONTAL AXIS
Sensitivity: More than 100mVp-p/cm, built in 20dB ATTEN Freq. characteristics: DC ~1kHz, 3dB Line Sweep: phase shift range, approx. 130°
- Marker Signal: Intensity modulation (polarity; auto)
- Deflection Destortion and Linearity: HORIZ. VERT. Less than 5% within graticule
- CRT: 310 DMB4

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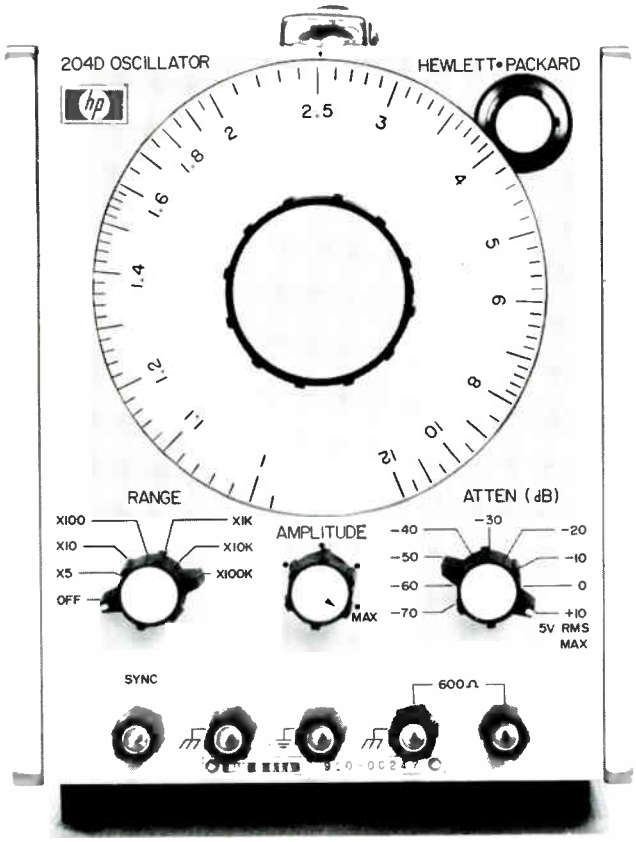

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But there is an easier way!

HP has been in the oscillator business for a long time. In fact they invented the first stable wide bandwidth Wein-bridge oscillator. And since that time HP oscillators have built a solid reputation for performance and reliability—in fact most of you have used them in the past.

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Or, write to Hewlett-Packard, Palo Alto, California 94304. We will send you complete information and application notes on HP's oscillators. Europe: 1217 Meyrin-Geneva, Switzerland. Prices on HP oscillators start as low as $215.

090/3

HEWLETT hp PACKARD

SIGNAL SOURCES

Subassemblies

Tachometer comes in kit

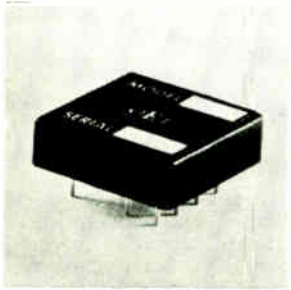
Instrument can provide digital control of motors using encoder techniques

Thanks to techniques similar to those found in ultra-high-accuracy optical encoders, the Dynamics Research Corp.'s Components division has developed a tachometer for controlling precision motors in instrumentation tape recorders, high-speed event recorders, and computer tape decks.

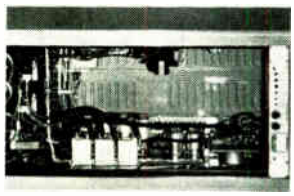
DRC's TK-700 series tachometers are supplied in kit form, an unusual procedure in this market, and are bonded directly to the shaft of the controlled motor. A typical kit consists of a glass disk 1.2 inches in diameter with radial, photomasked lines. This disk attaches to the shaft of the motor.

A light-emitting diode sends a beam through the spinning disk and into a silicon photodiode on the other side. Since the detector diode is behind a reticle of photoengraved lines, the light beam is obscured each time the disk spins its radial lines into position opposite the clear spaces between the reticle's lines. Thus the light beam is repeatedly attenuated, causing a sine wave output at the photodiode.

With simple counter circuitry, this sine wave can be used by itself to measure speed. But in the applications DRC is aiming for, it would pass through an amplifier stage and then through a wave shaper, finally putting out TTL-compatible pulses. With these pulses, high-accuracy digital control is possible. According to company spokesmen, steady-state accu-



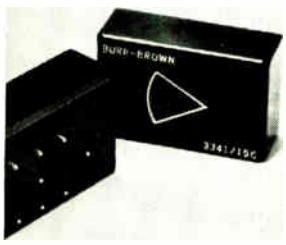
Operational amplifier model 9491A has a guaranteed 6 dB/octave roll-off rate typically beginning at 1.5 MHz and crossing unity gain at 1 GHz minimum. Features include a minimum open loop gain of 60 dB, and a minimum slewing rate of ±1,000 V/μs. Minimum closed loop bandwidth is 300 MHz. Price is $60. Optical Electronics Inc., P.O. Box 11140, Tucson [381]



Solid state dc supplies are for applications requiring 25 to 3,000 A and up to 75 kW. Regulation of ±0.05% to ±0.0005% of either current or voltage can be specified. Eight-hour stabilities of ±0.1% to ±0.001% are available. Output ripple is typically 3 to 5 mV pk-pk. Units feature temperature-compensated circuits. Alpha Scientific, 460 Roland Way, Oakland, Calif. [382]

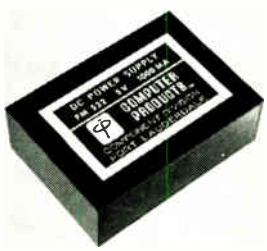
Low-cost ADC-300 series converters are tested, calibrated, system-ready, plug-in modules incorporating all of the functions necessary to perform conversions except for power supplies. Accurate to within ±0.025% of absolute, units in the series require no external reference voltage source, amplifiers, or trimming pots. Phoenix Data Inc., W. Osborn Rd., Phoenix [383]

Broadband power amplifier ARC-30L is a self-contained unit that delivers a minimum of 30 watts output over the frequency range of 1 to 250 MHz. Its instantaneous bandwidth and gain of 44 dB will provide full rated output of swept power over the entire frequency range when combined with a swept signal source of 1 mW. Amplifier Research Corp., Box 242, Fairview Village, Pa. [384]



Op amps 3341/15C meet the tough requirements of coaxial line driving. They have slew rates of 1,000 V/μs minimum and bandwidth of 50 MHz minimum. Output rating is ±10 V at ±100 mA, giving the amplifiers an output capability of ±5 V up to 20 MHz when driving a 50-ohm line. Burr-Brown Research Corp., Int'l Airport Industrial Park, Tucson [385]

Encapsulated, hybrid linear circuit divider model D-5040 requires no external amplifiers. For applications the unit includes instantaneous quotient of two variables, automatic gain control, low-level modulation, trigonometric function generation, and nonlinear servo design. Full scale accuracy is 0.5%. Price (1-9) is $160. GPS Corp, 14 Burr St., Framingham, Mass 01701 [386]



Pc mounting power supply module PM532 provides 5 watts of power in a package measuring 3.50 x 2.50 x 1.25 in. Voltage and current output are 5 V dc at 1 ampere. Line regulation is +0.05% maximum; ripple and noise, less than 1 mV rms; operating temperature range, −25° to 71° C. Computer Products, P.O Box 23849, Ft. Lauderdale, Fla. 33307 [387]

Power op amps develop either ±20 volts, 3 amperes, or ±12 V, 5A. Price for models 402, 403 and 404 is $85 each; models 406 and 407 cost $98, owing to their higher voltage gain values. Besides developing 60 watts continuous output, all five modules are rated for 80 watts internal dissipation. Analog Devices Inc., 221 Fifth St., Cambridge, Mass. [388]

racy would be more likely to be limited by the accuracy of the system servo oscillator or digital clock than by the tachometer. With electromagnetic analog tachometers, on the other hand, output ripple can keep error rates up at around 5%.

Instantaneous accuracy is specified at 1%. But typical units have halved that value. In fact, special models using more disk and reticle lines have yielded instantaneous accuracies as high as 0.01%. These figures are better than those for electromagnetic tachometers, whose instantaneous accuracies usually range from a typical 5% to lows of around 1.5%, according to engineers at Dynamics Research Corp.

The tachometer's low inertia is an advantage in applications which experience quick changes in speed. Inertia is far lower than that of the motors it would be used with. The TK-700 disk has less than 0.0001 ounce-inch-second^2 inertia; typical low-inertia motors for high-accuracy stepper applications, for example, have as much as 0.007 ounce-inch-second.^{2}

The tachometer also can be used as an encoder since DRC offers a two-channel output with the channels 90° out of phase. With these two data lines, it's possible to use the digital optical tachometer to derive not only angular velocity, but the direction of rotation and shaft angle.

There are three TK-700 models: the 701, with sine-wave output; the 702, with amplifier and pulse-shaping electronics, and the 703, engraved with up to 2,000 radial lines on a two-inch-diameter disk for increased resolution and accuracy. The standard 701 and 702 have 500 radial lines.

The 701 and 702 are available from stock and are priced at about $100 in evaluation lots; in thousand-unit lots, prices fall to less than $50 for the 701, and to about $75 for the 702.

Dynamics Research Corp., Components division, Wilmington, Mass. 01887 **[389]**

Price, safety stressed in power supply design

Low cost and special safety features were requirements when R.A.M. Electronic Systems Inc. designed two new power supplies for school equipment. "But now they're being marketed generally to industry because of their price/performance ratio," R.A.M. president Morris Messinger says.

Both units have a zero-to-25 volt dc output; the model 250, at $60, has a maximum output current of 500 milliamperes, and the model 251, at $90, puts out one ampere maximum.

The supplies' regulation system uses a low-noise differential amplifier with a specially processed zener voltage reference. This drives a series-pass output transistor. On the model 250, line and load regulation is 0.01%; ripple-and-noise figure is 500 microvolts. Line regulation for the 251 is 0.01% + 1 millivolt and the load regulation is 0.05%. Ripple and noise amount to 1 mV or less, peak-to-peak.

One of the most important features is an adjustable current overload control which can be used to set the tripout level of the power supply output.

If the load attached to the power supply draws more current than the unit is rated for, or more than the overload is set for, the special circuit is activated and the output goes to zero.

If the output is set to zero, it's a true zero across the output terminals, says Messinger. This is achieved by applying a slightly negative base-bias current.

Delivery of both models is from stock.

R.A.M. Electronics Systems Inc., 3253 N.E. Sandy Blvd., Portland, Ore. 97232 **[390]**

Semiconductors

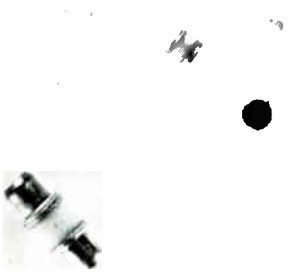
Multivibrator draws 14 mA

Low-power IC designed for instrument, avionics jobs where speed can be traded

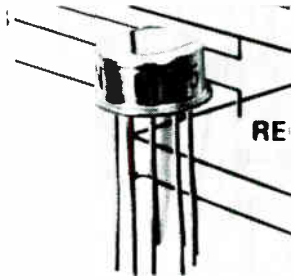
On the periphery of almost all logic designs is the single-shot multivibrator. This digital integrated circuit provides a pulse of known width and is used to build in logic delays, to synchronize information within a system, and to build oscillators. Like many companies, Advanced Micro Devices, Inc., makes different types of single-shots, including the 9601 and 9602, which are Fairchild part numbers and probably the biggest sellers in the world. But AMD's customers asked for still another—a low-power single-shot. And that's why AMD developed the AM26L02.

It's a dual single-shot multivibrator that draws only 14 milliamperes at 5.5 volts. Standard units like the Fairchild 9602 draw 56 mA at 5.5 volts. Of course, there is some reduction in speed, says Clive Ghest, a member of AMD's technical staff, but the speed/power ratio is much improved: "The power is only 25% of what it was, while the speed is 40%." Ghest also points out that most monostable multivibrators produce an output pulse when they are triggered by a rising input, but the AM26L02 can be triggered by either the rising or falling edge of the input pulse, "and we guarantee a pulse width variation of less than 0.6% over the complete temperature range," says Ghest, adding that the device also is retriggerable and resettable.

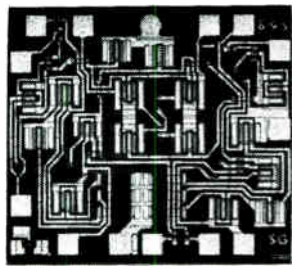
The low-power one-shot will find an existing market in the industrial instrumentation and portable in-



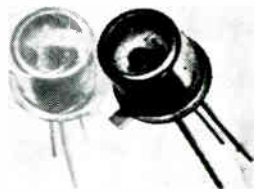
X and Ku band Schottky mixer diodes feature high reliability and low cost. Typical of the X band is the A2S106, which provides 6 dB max noise figure at 9.375 GHz. At Ku band the A2S122 provides 6.5 dB max noise figure at 16 GHz. Price (10-99) ranges from $12 to $36.50 for single units. Aertech Industries, Stewart Dr., Sunnyvale, Calif. [436]



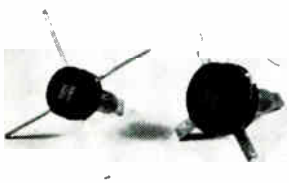
MOS devices MM4050/MM5050 and MM4051/MM5051 employ p-channel enhancement mode techniques to provide bipolar compatibility—+5 and −12 V. High frequency operation from dc to 1.6 MHz is achieved with a single phase clock. The devices are available in both commercial and military temperature ranges. National Semiconductor Corp., Santa Clara, Calif. [437]



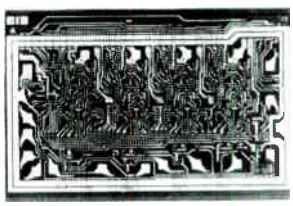
Balanced modulator/demodulator SG1596 is for use in suppressed carrier and amplitude modulation, synchronous detection, fm detection, phase detection and chopper applications. Features include carrier suppression up to −65 dB; common mode rejection, 85 cB typical. Operating temperature is from −55° to +125°C. Silicon General Inc., 7382 Bolsa Ave., Westminster, Calif. [438]



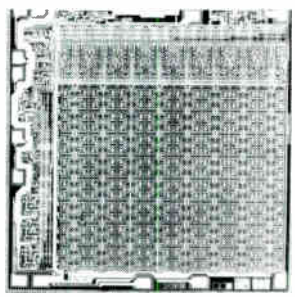
Three silicon phototransistors cover a light sensitivity range from 0.2 mA to 3 mA at 5 mW/cm², and maximum collector-to-emitter voltages from 15 to 50 V. Special features include 3:1 light sensitivity tolerance range as standard, and a flat window which eliminates the need for critical sensor positioning. Clairex Electronics, 560 S. Third Ave., Mount Vernon, N.Y. 10550 [439]



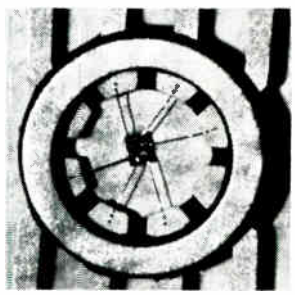
FM mobile communications transistors can deliver up to 28 W at 175 MHz. Units are factory tested to insure infinite VSWR capability. Low Q suits the devices for broadband applications in the 100 to 200 MHz frequency range. Units come in three types: two packaged in the MT-59 case, one in a TO-128 case. Solitron Devices Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. [440]



Binary hexidecimal up/down counter AM2501 offers active pull-up outputs to provide high speed with good noise margins. It features 25 MHz clock frequency operating speed. The unit offers synchronous preset capability that gives versatility and flexibility to the instrumentation or process control designer. Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. [441]



Integrated circuit IM5503 is a 256-bit, high-speed TTL, binary decoded, bipolar random access semiconductor memory with an access time of 75 ns, and low power dissipation of 1.5 mW per bit. It is organized 256 words x 1-bit and is for use in high-speed scratch pad, and buffer applications. It is available from stock. Intersil Memory Inc., 10900 Tantau Ave., Cupertino, Calif. [442]



Dual monolithic npn transistor type 2N4044 offers guaranteed 3μV/°C base-to-emitter voltage tracking. It is mounted in a hermetic flatpack (0.175 in. in diameter). The Tiny-Pak package has leads on standard 50-mil spacing. Minimum beta is 200 at a collector current of 10μ A, a V_{CE} of 5 volts. Mini-Systems Inc., Washington Park, North Attleboro, Mass. 02761 [443]

strument areas, where manufacturers are specially conscious of power requirements. "And because the AM26L02 draws less power, it runs cooler," says Ghest, "so some users may be able to eliminate a fan." Another application area is in aerospace and avionics systems. "Most of the people that asked for a low-power one-shot," says Ghest, "are makers of electronic countermeasures and general airborne digital systems. These people are much concerned with heat and power."

Before the low-power device was available, designers either used a high-power circuit (like the 9602) or built their own low-power units using discrete devices. "But many times, especially on some government contracts, they didn't have the time or money to design a discrete circuit," Ghest points out, "so they used the higher-power IC." Now they have a pin-for-pin replacement that can save about a quarter of a watt per circuit, he adds.

Since the fabrication process is not very complicated, it's surprising that no one else has made a low-power one-shot. Ghest feels "it has just been overlooked. If you wanted to make a low-power circuit, you usually started with the logic circuits, and I guess that no one came back to take a look at the peripherals and see what's needed in low-power devices."

In its process, AMD takes a normal set of circuit masks and separates out the base and resistor diffusion masks, which generally are put down at the same time. AMD puts the base down as before, with material that has a resistivity of about 110 ohms per square, but the resistor diffusions are made with 400-ohm-per-square material. Thus to produce the same voltage drop, the user needs only one-fourth the current and thus one-fourth the power.

Because the low-power process requires this extra masking operation, with the added risk of mask misalignment, it might be expected that yields would be slightly lower. But Ghest says that "our experience has shown that this drop is minor and so we are pricing the devices the same as the high-power units." In quantities of 100 pieces, the industrial-type, plastic device is priced at $5.95, and the hermetic, military unit at $13.50.

Delivery is from stock.

Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, Calif. 94086 **[444]**

N-channel MOS memory has 250 ns access time

It's no secret that, theoretically, n-channel metal oxide semiconductors have it all over their p-channel counterparts in terms of packing density and speed. It's estimated, for example, that carriers travel through the holes in an n-channel device about three times faster than in p-channel units. Yet, MOS makers generally have shied away from n channel because it's more difficult to produce—stray ions must be kept from getting trapped under the gate regions during fabrication; they can produce undesirable variations in the threshold voltage.

One firm, Cogar Corp., apparently has licked this problem and company spokesmen attribute the success largely to an ultraclean fabrication process during diffusion. They've developed a 1,024-bit n-channel MOS read-write memory on a chip that measures 125 mils on a side. Fully decoded, the chip itself has an access time of 100 nanoseconds. However, the memory comes in an 8,000-word by 18-bit configuration on an 8-by-9-inch card. Aimed at both the main memory market and high speed buffers, it has a 250 ns access time at the card level; cycle time is about 300 ns.

The basic device is a 500-angstrom-thick n-channel chip with aluminum gates. Phosphorus silicate glass is deposited over the oxide to prevent contamination of the junctions. The chip is hermetically sealed and flip-chip mounted on a ceramic substrate.

The 1,024-bit memory is priced at about 5 cents a bit in volume.

Cogar Corp., All Angels Rd., Wappingers Falls, N.Y. 12590 **[445]**

New literature

Automatic test systems. Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304. A six-page selection guide gives a quick overview of the capabilities and the many possible configurations of the series 9500 automatic test systems.
Circle **446** on reader service card

Ferrites. Ferroxcube Corp., Saugerties, N.Y. 12477, is offering a 164-page catalog to aid the inductive component and circuit designer in the selection of ferrite materials and components. **[447]**

Rechargeable batteries. RCA Commercial Engineering, 415 South 5th St., Harrison, N.J. 07029, has published an eight-page illustrated pamphlet on alkaline rechargeable batteries. **[448]**

Lighted pushbutton switches. Switchcraft Inc., 5555 N. Elston Ave., Chicago 60630, has issued an eight-page, full-color catalog on its series PL Push-Lite switches. **[449]**

Ladder networks. Angstrohm Precision Inc., 7811 Lemona Ave., Van Nuys, Calif. 91405, announces a catalog covering a large selection of encapsulated ladder networks. **[450]**

Power supplies. Acopian Corp., Easton, Pa. 18042. Three series of power supplies for limited space applications—low profile, and miniaturized single and dual output supplies for pc board mounting—are described in a six-page brochure. **[451]**

Converters. Helipot division, Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634, has released a comprehensive publication detailing the model 847 10-bit d-a and the model 871 a-d converters. **[452]**

Peripheral devices. Computer Products, P.O. Box 23849, Ft. Lauderdale, Fla. 33307, has published a 16-page technical brochure and companion eight-page price list describing the RTP7400 series real-time peripheral devices. **[453]**

Precision components. PIC Design Corp., 477 Atlantic Ave., East Rockaway, N.Y. 11518. Over 5,000 new precision components are among the 35,000 components available from stock and listed in catalog No. 35. **[454]**

MOS/LSI brochure. Texas Instruments Inc., 13500 North Central Expressway, Dallas 75222. Product descriptions for 34 standard MOS/LSI circuits are provided in a 212-page brochure. **[455]**

Tape search control. Chrono-Log Corp., 2583 West Chester Pike, Broomall, Pa. 19008. A two-page bulletin describes the series 8,000 time-code tape search control. **[456]**

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Honeywell

International Newsletter

December 21, 1970

Layoffs hit Swedish transistor firm . . .

While the Swedish electronics industry generally will benefit from the government's strengthening efforts [*Electronics*, Oct. 26, p. 157 or 3E], two companies, reacting to weaknesses in the economy, have announced layoffs. **Citing the poor market for transistors all over Europe, SGS Semiconductor AB, Sweden's only sizable transistor maker, will close down its production lines at the end of February and lay off 90 workers.** Another 37 employees in marketing, administration and testing will be retained to handle current inventory and future imports. Glenn Marshall, managing director, says that until last July he was doing some exporting to other European countries, "but then the Americans really started dumping and things got tough."

. . . and medical electronics maker

For AGA AB, a large diversified company, a cutback in military orders and slow sales of an advanced blood chemistry analyzer led to the layoff of between 200 and 300 of the 2,000 workers in its medical electronics division. AGA's electronic sales total about $20 million annually, about half from medical equipment sales. Until two years ago, 60% of electronic sales were to the military; today it is only 20%. The biggest slide on the medical side involved the AutoChemist, a multichannel blood analyzer that has the highest capacity of any machine of its kind—giving some 28 determinations on 135 patient samples per hour—with data stored and printed out via a PDP-12 computer made by Digital Equipment Corp. However, few labs or hospitals want or can afford such high capacity today.

Hitachi produces 16-mil memory cores

Starting up production of 16-mil memory cores, Hitachi joins Control Data Corp., which makes 15-mil cores, as a leader at the small-core edge of technology. Hitachi will offer a complete line of planes, stacks, and complete memories. It has already supplied the cores needed in the prototype four-megabyte memory for Japan's large-scale project computer, which has a cycle time of less than 450 nanoseconds. Actual switching time for the cores is 145 nanoseconds. Core material is lithium manganese ferrite, sintered in a Hitachi process that takes three minutes instead of the six hours previously required.

Avionics firms seek new business after drop of BAC 3-11

Look for steadily increasing sales pressure internationally from British civil avionics makers over the next decade. Cancellation by British Aircraft Corp. of its projected 3-11 short-haul airbus, due to lack of government backing, has left the major British makers of advanced flight control systems—Elliott Flight Automation and Smiths Industries—**with no foreseeable domestic outlet for new civil systems in development.**

Elliott is working on advanced autopilots, and Smiths on autoland systems, and neither can hope for more than minor work on the Lockheed Tristar and European A300B airbus, one of which must now be bought instead of the 3-11 by Britain's airlines. When present British civil transport production lines stop in three or four years' time, and if the Concorde is cancelled, both companies will have to sell all their major built-in civil avionics systems abroad. Subcontracting will be of some help and Smiths is arranging to build some autoland components for SFENA of

Paris, which has the flight control systems contract for the A300B. **There's also an outside chance that eventually the government may fund a development program on a new major civil STOL or VTOL aircraft project.**

Computer training promoted in German five-year plan

Taking no chances with the continued growth of its computer industry, the West German government plans to step up sharply expenditures in the EDP field. Under its second five-year data processing promotion program, to run through 1975, the government intends to set aside $1.15 billion—**20 times more money than was spent during the first five-year program.**

The emphasis will be on training and not, as in the first program, on direct industry support, for which only $226 million is slated. **Instead, $692 million, or 60% of the total, will be spent as part of an across-the-board training assistance scheme.** This money will be used for expanding training facilities for EDP personnel, promoting data processing courses at universities, and providing such institutions with better access to computer centers. The rest—$234 million—is earmarked for expanding the role of computers into new areas and for special scientific programs.

The computer industry has long been pushing for expanded training programs, warning that further computer growth would be seriously hampered unless more specialists were made available through government-financed programs. **By 1978, officials estimate there will be a demand for up to 420,000 EDP experts in Germany, seven times the present number.**

GT&E joins with Thorn to enter U.K. phone market

With the British market for private branch telephone exchange equipment growing to $70 million next year, Thorn Electrical Industries, the biggest British TV set maker, and General Telephone & Electronics International have joined forces to grab a share. Their new company, Thorn-General Telephone Ltd., is owned 50-50 by Thorn and another new company GTE International Ltd., which will sell GT&E data processing equipment in Britain. Thorn-General Telephone starts life with an order for a $250,000 electronic PBX.

Initially telephone equipment will be imported from the GT&E plant at Antwerp; later it will be manufactured in Britain. The sales emphasis will be on electronic exchanges using solid state circuitry and pushbutton dials on handsets. **Eventually the company plans to compete with Plessey Co., General Electric Co., and Standard Telephones and Cables, an ITT subsidiary, in bidding for post office public exchange contracts.**

Sweden to step up computer purchases

The Swedish government is likely to maintain its position as one of the largest single purchasers of computers in Europe over the coming five years. Statskontoret—the state agency that handles all government computer purchases, except military—estimates that it will need $70 million during budget years 1971-72 through 1975-76, under a long-term plan. The agency has a $5.5 million appropriation this year, $7 million will be needed next year, and $65 million will be required in the following four years. A major system expected soon will be a national, rather then the present regional, driver's license and auto license registry, with terminals in offices all over the country.

Santa is packing few electronic toys for European kids

Most makers feel that even the cheapest components push prices too high in this penny-conscious market

Playthings. While electronics firms have a foothold in Western Europe's toy market, this year they have taken few steps forward. Dolls with electronic innards, shown at Paris' Au Printemps department store, and a toy computer, on sale in Stockholm, are typical.

Although West European toymakers are stuffing more components, from tape recorders to integrated circuits, into their offerings this season, the land of toys is still pretty much closed to electronics. The barrier is cost.

"Although turning more and more to electronics, the toy industry will always remain a relatively small customer for us," says an official at Valvo GmbH, West Germany's largest components maker. The $250 million toy industry there absorbs only about 1% of the components sold to the entire West German entertainment electronic market.

The game is the same in France. Like their parents, who are slow to buy the latest electronic innovations like color TV, French children seem to be lagging in their demand for electronic toys. While some of last year's electronic novelties are back again this year, there's not a single new electronic product on the shelves, reports Bernard Périé, toy buyer for the big Paris department store, Au Printemps. Most of the holdovers are imports—like an electronic train that responds to a whistle, developed by Denmark's Lego—but a few are French. Société Exico, for example, makes several radio-controlled model sports cars.

In Scandinavia, one of the last frontiers of hand-crafted wooden toys, electronic playthings are a rarity. "Electronic toys are simply too expensive—at least in Sweden," says Harry Kleiman, sales manager of AB Alga, the country's largest maker of games and a major importer of play gear. "We've been thinking of coming out with electronic toys, but the prices are too high, and in the games field you have to have something special and translatable in order to export." Kleiman says his company has some serious worries about getting too remote from the child. "You can't let the toy be the leader."

However, there is one unusual item on the Stockholm toy counters this year: a $25 toy computer from East Germany that helps teach the fundamentals of logical operation. The Piko computer, however, is an adaptation of a previously designed West German toy called the Logicus, which has not made its way into exports market to the same degree as Piko. In fact, the West Germans accuse the East Germans of stealing the design.

Electronic marketing in the toy field has a strong international aspect. For example, the prime component sellers to the West German toy industry are Japanese: Valvo people estimate that they account for two-thirds of the value of components sold. "Japan's strength in the market stems from her ability to sell components at incredibly

low prices," the Valvo man says. "And for toy makers a difference of even a few pennies per component means a lot."

Therefore, in many cases a toy designed in Europe will have a large Japanese content. Max Zapf, a doll company in Bavaria—where 56% of West Germany's toy industry is concentrated—has developed a doll called Tina which starts walking on a hand clap or a whistle. Although an original German design, a Japanese firm produced all the electronics including the drive mechanism. Tina sells for between $21.80 and $24.50.

Three French dolls with electronic innards imported from Japan and Germany are intriguing Au Printemps shoppers. One has a tiny Japanese tape recorder: a switch in the $30 doll's back has a "record" and a "playback" position, allowing a child to babble into a microphone in the doll's chest and then hear a one-minute replay. Another doll, like Zapf's, starts walking when a vocal order or any loud noise is aimed at a microphone in its chest. The third doll sports a record player that accepts tiny 2-inch disks with recorded nursery rhymes.

As expected, model trains account for a substantial number of component sales, primarily diodes. These components, used in the power supply, really play only an auxiliary role in train operation. But electronics is getting a more active role here, too.

One example of this comes from the Danish firm Lego, which produces the familiar red and white plastic blocks that can be assembled into houses, bridges, trains, windmills and many other things. In one Lego electronic setup, a block containing five transistors, two diodes and several resistors and capacitors, is connected to a 4.5-volt motor and a crystal mike.

Lashed together with the standard Lego blocks, the setup can make a train that starts to run when a sound hits the microphone and stops when the sound is repeated. The electronic and the microphone blocks, which have see-through plastic covers, sell for slightly less than $11, including a whistle and connecting cables.

In a second, electronically more sophisticated, setup the discrete components in the electronic block are replaced by an IC, which makes possible more versatile train operation. On a short sound, the train moves forward, stopping on another short sound. On a longer sound, the train moves backwards. This $13.50 version reacts only to whistle-produced sounds.

In addition to electronically operated toys there are a whole lot of electronic experimenter kits on the European market. One is a kit called Licht-Elektronik (photoelectronics) made by Fischer-Werke in the Black Forest. The kit contains all sorts of components that can be used for photo-electronically controlling various self-assembled playthings like cranes, vehicles, and machinery. It won Fischer the "Oscar du Jouet" at the Salon de l'Enfance in Paris last month.

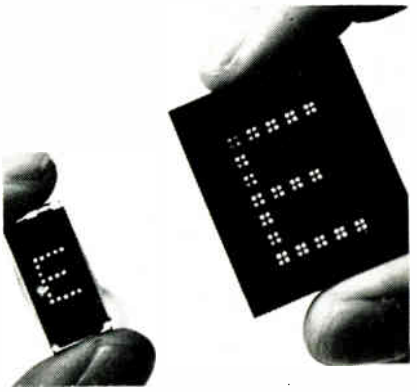
But the popularity of electronic kits for teenagers seems to be slipping. For one thing, instruction sheets have tended to be too difficult to figure out. A radio kit marketed by France's Pizon Bros. a few years ago was pulled off the shelves at Au Printemps when an electronic technician employed by the store could not assemble it properly. A walkie-talkie kit sold by Holland's Philips similarly has left the French market.

Japan

Dividing LED output gives larger characters

Following a systems design approach, Nippon Electric Co. engineers are developing new applications for light-emitting diodes by giving a lot of thought to the associated optical and electronic components. NEC is now offering both discrete light sources and hybrid IC displays, and has developed prismatic optical screens that make each diode appear to be four.

The spatial enlargement of each dot is valuable where display size is large compared with the size of the diode chip, because it provides illumination over a greater portion of the display, and improves legibility. The technique allows fabrication of character displays three to six times larger than previous displays, but uses the same size and number of diodes.



Enlargement. Sheet of prisms splits LED light, allowing larger displays.

Starting material for the diode is vapor-grown epitaxial gallium arsenide phosphide on a GaAs substrate. Rather than using the usual liquid epitaxial process for junction fabrication, the new diodes use a very shallow zinc diffusion process. Location of the junctions close to the surface increases efficiency; Nippon Electric engineers claim that diode brightness is double that of competing diodes for the same current. Life also is extremely long. Because the process is relatively simple and the yield is high, Nippon Electric is starting sales of discrete diodes at a price of 83 cents in lots of 100,000.

Emission from the diodes is centered at 6,600 angstroms, with a half-power bandwidth of 400 Å when operated at the recommended current of 30 milliamperes. Typical brightness is 500 foot-lamberts. Response time is 20 nanoseconds. Diode chips are 500 microns square.

When sold as discrete components, the diodes are sealed in a 5.5-millimeter-diameter can with a plastic lens. Nippon Electric has designed and put into pilot production two-segment hybrid IC displays using rectangular diode

chips, and three-dot displays using square diodes of the type used in discrete units. Still others are on the way.

Card and code number unlock cash dispenser

A credit card spells instant cash with a computer controlled dispensing machine that Fujitsu Ltd. has added to its real-time banking system. Fujitsu's system includes a multicontroller that can simultaneously handle up to eight terminal units. These can be a mixture of savings account terminals, checking and interbank exchange terminals, and cash dispensers. To the multicontroller, the cash dispenser is just a modification of the cashier-operated savings account terminals already working, and can perform all of its on-line functions.

Off-line or partially on-line cash dispensers made by other manufacturers dispense prepacked bundles of cash to get around the tricky problem of accurately handling cash. Fujitsu has made its system more versatile by building in banknote handling equipment that can be loaded with up to 1,000 notes of two different denominations. Most units probably will stack 1,000-yen bills ($2.78) and 10,000-yen bills ($27.78). Then it can dispense cash, banknote by banknote, up to the limit of the customer's account balance. The bank also can set a limit, for example, 99,000 yen, per customer.

Fujitsu has designed its system to use the standard Business Equipment Manufacturers Association card. Thus, in addition to serving as a key to obtain cash, the card can be used as a regular credit card for routine purchases. Fujitsu engineers say that there is little likelihood that the card will be duplicated. Magnetically recorded information is packed in at the high density of 210 bits per inch. Even if thieves obtained the equipment used for recording information on cards they probably couldn't forge them because the information is written in code.

What's more, the card has recorded on it a secret number known only to the card's owner and not printed in written form on the face of the card. To obtain cash from the dispenser, a customer, after keying in amount of cash desired, enters the secret number on a keyboard. If the secret number is not given correctly in three tries, the machine neither dispenses cash nor returns the card. If all goes smoothly, it takes about 10 seconds for a customer to key in needed information, and about another 10 seconds before cash is dispensed.

Fujitsu has orders for trial installations from six Japanese banks. One of them will be installing the equipment this month and the others will make installations early next year. These installations will be located initially in bank lobbies, but future installations will allow customers to withdraw cash in the evening or during holidays, or without going outside in inclement weather.

The cash dispenser is designed to operate under local control if the line to the computer center is out. In this mode the bank can put on the card a limit on the amount that can be withdrawn per transaction and also on number of transactions before card must be revalidated.

Price of the system in Japan is approximately $11,000. Fujitsu also has available in its catalog a card-issuing machine that encodes cards, makes changes in them, and verifies encoded information.

West Germany

Self-regulated heating eases chip bonding

Although known primarily as an instrument and test equipment house, West Germany's Rohde and Schwarz has made contributions in other fields, too. The latest development out of the company's labs is a hybrid circuit packaging technique that eliminates the need for metalization on chips and at the same time overcomes thermal degradation problems during chip mounting.

Developed by Hans Delfs, the principal researcher in the project, the new method uses a gold film on a substrate that is locally heated by a current pulse. The resulting formation of eutectic alloy is used to control the temperature during bonding. Thus, there is no excessive heat which, if uncontrolled, would damage sensitive circuit elements.

One technique that has been employed so far for getting around thermal degradation problems uses chips coated with a metallic layer on their mounting surface. This layer, usually of gold, allows chip bonding at relatively low temperatures by means of soft-soldering or by low-resistance pastes.

Another approach uses a eutectic mounting. Here the substrate is preheated on a hot plate and then momentarily heated at the spot where the chip is to be installed. The relatively high temperature required for bonding is obtained by infrared radiation, by current flow through the substrate, or by directing a hot gas stream to the particular spot on the substrate surface.

Both methods have their drawbacks, however. The first encounters temperature restrictions during the subsequent wire bonding and encapsulation processes. In the second, it is difficult to control the temperature, which rises almost exponentially as a function of time.

Delfs' new method minimizes these problems. It starts out by putting a strip of gold onto the substrate in an electroplating process. For thin film hybrid devices this strip is anywhere between 2 and 10 microns thick. The substrate, with the element to be bonded held in place by suitable holders, is put on a hot plate which brings the substrate temperature to about 280°C; two electrodes, one on each side of the element, are attached to the gold layer; a current is passed through them for further heating of that layer. The current is increased until 370°C, the tempera-

ture necessary for element bonding, is reached.

Normally, at this point a melt would spread rapidly to the strip edges in a direction perpendicular to that of the current flow. The resistance of the gold layer measured between the electrodes is only a few milliohms. But at the instant the eutectic melt is formed, the resistance increases due to the relatively large amount of melt, which has a specific resistance much greater than solid gold. Sudden overheating and a severed gold layer result.

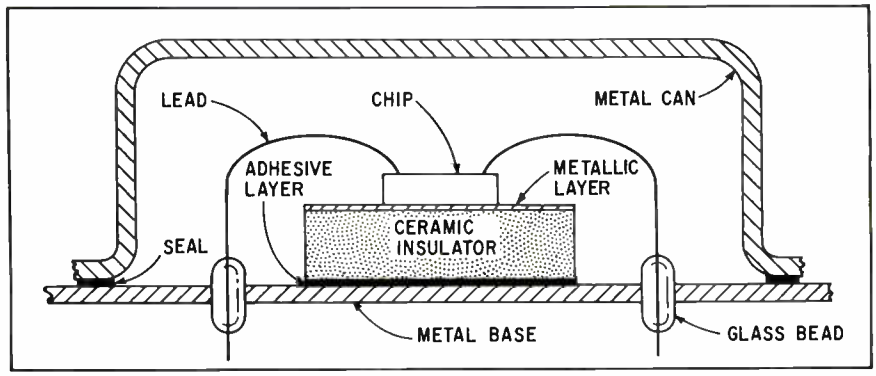
Exactly the opposite would occur, however, if an extremely constant voltage source with very low internal resistance were used for local heating. This is the key to Delfs' new technique: at the instant the eutectic melt is formed the dissipated power decreases with increasing resistance. Thus, the temperature stops rising or rises only very slowly, allowing good control of the bonding process. In this technique, then, the formation of the eutectic alloy itself is exploited to control the temperature like a thermostat.

Delfs readily concedes that his new bonding technique also has a few disadvantages. One is that a relatively expensive power source is needed to insure well-regulated voltage and low internal resistance. Another is that a relatively large amount of space is required for attaching the electrodes next to the chip. But even so, Delfs says, the new approach should prove advantageous in many applications where high-frequency transistors, Schottky diodes, or transistors with a high amplification factor—all very heat-sensitive elements—must be mounted.

Great Britain

Electrometer tube challenged by MOS transistor device

With its high input impedance, the metal oxide semiconductor transistor seemed like a good bet to replace the conventional electrometer tube in detecting and measuring very small currents. But researchers ran into problems with leakage and stability.



Stopping the leaks. The chief headache in designing the MOS device was minimizing leakage. Final design detects currents of 10^{-16} amperes.

Two Britons now have come up with an arrangement that, they say, has measured currents of 10^{-16} amperes. Further, they claim they've encountered no problems of stability in all-day operation. Leakage, which was the main obstacle, has been effectively eliminated, they say. The system is aimed as a solid state replacement for the tubes in radiation monitoring instruments, mass spectrometers, and pH measuring instruments. The device will function as an equivalent replacement for an electrometer tube, but not in the pin-for-pin sense, because the MOS package requires some extra circuitry.

The inventors are college lecturers. Bryan Hart, of North-East London Polytechnic, used to work for Transitron. Bill Barker, of Portsmouth College of Technology, was an electrometer tube researcher. The units will be made for them by Marconi-Elliott Microelectronics Ltd., which provided the original experimental devices built to the inventor's directions. Because the market is small and specialized, Marconi-Elliott will make devices as orders come in.

Hart and Barker use a dual MOS transistor layout, with a common drain to assure that the two transistors function together. In operation, the device forms the first stage of a high-gain amplifier in parallel with a high-value feedback resistor, so that the input current—which is what is being measured—will be equal to the output voltage divided by the feedback resistance. The input goes to one MOS gate. The other gate is a unity-gain output to the second, high-gain stage of the amplifier. The resistor is between the second stage output and the input MOS gate. An operational amplifier circuit connected between the sources of the MOS transistors keeps voltage on the output gate the same as on the input gate.

With this architecture the transistor needs to have very low inherent leakage, particularly with respect to low inter-electrode capacitances. It should also have no diode protection on the gate and as low threshold voltage as possible, so that voltage differentials promote the minimum leakage. It also has to be stable, and the pair of transistors have to be closely matched, particularly in threshold voltage over a reasonable temperature range. Because plenty of gain is provided by the amplifier circuit, the transistor does not need to have high gain—mutual conductance, usually the most important characteristic of a MOS transistor, is not important here.

Hart and Barker found that Marconi-Elliott offers suitable devices in its standard ranges. "It has to be a standard device to make it a feasible production project," says Peter English, ME's MOS products engineering manager. The innovation is in the mounting, packaging, and some additional circuitry which, they claim, cut leakage to an infinitesimal amount.

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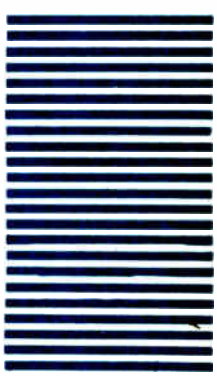

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Key no. **R-78** **The Overlay Transistor.** 15 pages. $1.00.

Key no. **R-64** **Field Effect Transistors. Parts I, II, and III.** 64 pages. $4.00.

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"Unencapsulated" regulated supplies designed to power operational amplifiers, linear and digital integrated circuits and transistor circuitry. Ideal for equipment where low power, small size, PC board mounting and low costs are essential.

Voltage and current ratings

LZ-10 SERIES SINGLE OUTPUT MODELS 2½" x 3½" x ⅞"

Model	Voltage[1] VDC	Current mA	Price[2]
LZS-10	5	450	$35
LZS-11	12	195	35
LZS-11	15	150	35

LZ-20 SERIES SINGLE OUTPUT MODELS 2½" x 3½" x 1¼"

Model	Voltage[1] VDC	Current mA	Price[2]
LZS-20	12	268	$55
LZS-20	15	300	55
*LZD-22	24	73	40
*LZD-23	24	129	55
*LZD-22	28	84	40
*LZD-23	28	143	55

*Single output ratings for dual output models connected in series

LZ-30 SERIES SINGLE OUTPUT MODELS 2½" x 3½" x 1⅞"

Model	Voltage[1] VDC	Current mA	Price[2]
LZS-30	5	900	$65
LZS-33	12	336	65
LZS-33	15	400	65
*LZD-32	24	186	65
*LZD-32	28	208	65

*Single output ratings for dual output models connected in series

LZ-20 SERIES DUAL TRACKING OUTPUT MODELS 2½" x 3½" x 1¼"

Model	Voltage[1] VDC	Current mA	Price[2]
LZD-21	± 5	300	$55
LZD-22	±12	73	40
LZD-23	±12	129	55
LZD-22	±15	90	40
LZD-23	±15	150	55

LZ-30 SERIES DUAL TRACKING OUTPUT MODELS 2½" x 3½" x 1⅞"

Model	Voltage[1] VDC	Current mA	Price[2]
LZD-31	± 5	500	$65
LZD-32	±12	186	65
LZD-32	±15	220	65

NOTES: (1) LZ Models are adjustable between the following limits: LZS 10 2 to 6V; LZD 23 ±8 to ±15V; LZS 11 8 to 15V; LZS 30 2 to 6V; LZS 20 8 to 15V; LZD 31 ±2 to ± 6V; LZD 21 ±2 to ±6V; LZD 32 ±8 to ±15V; LZD 22 ±8 to ±15V; LZS 33 8 to 15V

Consult factory for current ratings or voltages not listed above. (2) Prices are U.S.A. list prices only, F.O.B. Melville, N.Y., North Hollywood, California; Montreal, Canada. All prices and specifications are subject to change without notice.

FEATURES

Outputs
Single and dual (tracking) outputs

Regulation
0.15%—line or load

Ripple and Noise
1.5 mV RMS, 5 mV, pk-pk

Temp. coefficient
0.03%/°C

Tracking accuracy
2% absolute voltage difference (dual output models only) 0.2% change for all conditions of line, load and temperature

Ambient operating temperature
continuous duty from 0°C to +50°C

Wide AC input voltage range
105 to 132 Vac, 57-63 Hz

Storage temperature
—25°C to +85°C

60-day guarantee

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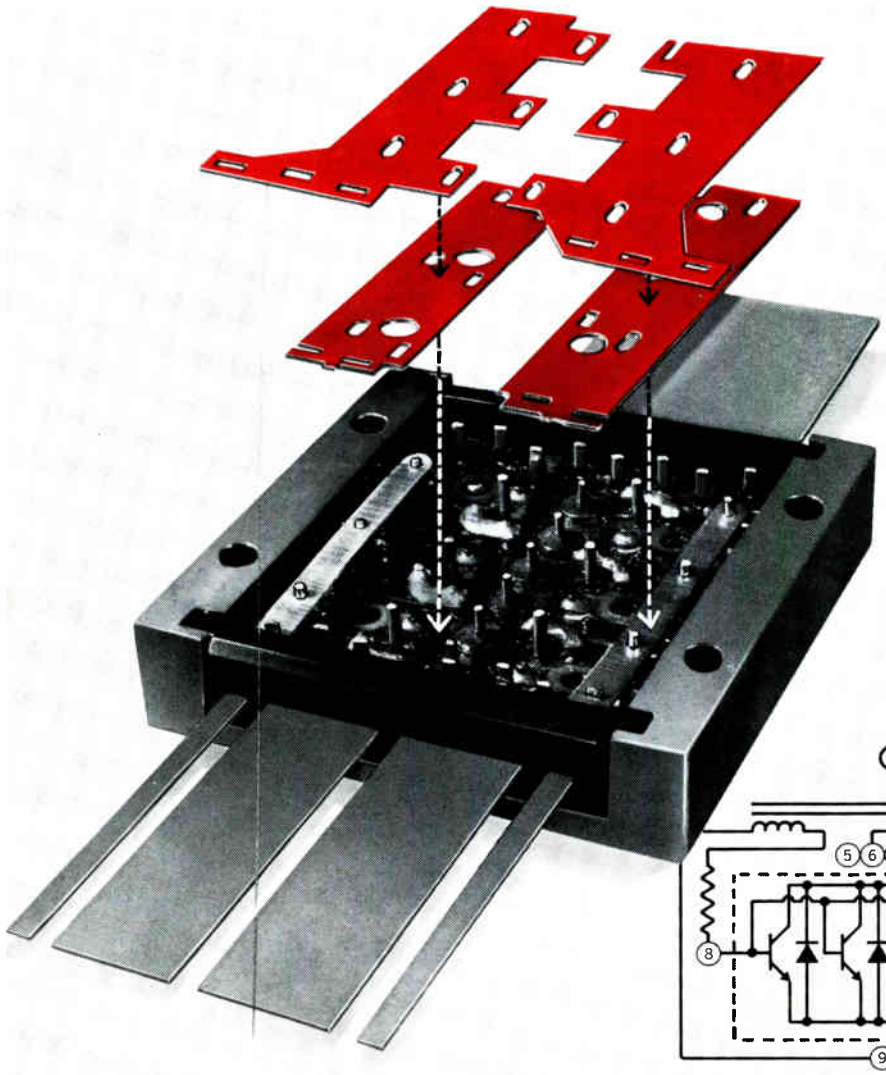
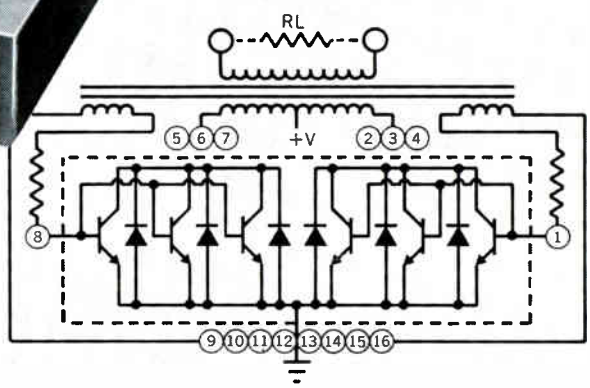
Circle 901 on reader service card

Introducing... A New Modular Concept in RCA Hybrid Power Circuits



Module shown actual size

Exploded view shows one of the standard interconnections of the RCA hybrid power module as used in a common-emitter inverter. That portion within the dotted lines in the circuit schematic represents the RCA module.



Take RCA transistor chips with current capabilities up to 80 A, rectifiers with peak currents to 80 A, and resistors to 10 watts. Interconnect them — in any number of ways. What do you get? A power capability up to 800 W, current capability up to 300 A!

Right now, RCA is mass-assembling a variety of thick-film hybrid high-power arrays that are ideal for switching and amplifier applications in military and industrial equipment. Modules are also available in unconnected versions, if you prefer to create your own design.

These hybrid power circuits offer obvious power circuit advantages, including: compactness, light weight, fewer parts, minimum assembly costs, factory-selected and matched components, and efficient built-in heat dissipation.

Look over the inverter example illustrated. Then call your local RCA Representative or your RCA Distributor for more information on the modular concept. For RCA's new, detailed brochure, "High-Power Arrays" (HPA-100), write: RCA, Commercial Engineering, Section 70L-21/UC2R, Harrison, N. J. 07029. International, RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P.O. Box 112, Hong Kong.

RCA

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