September 27, 1971

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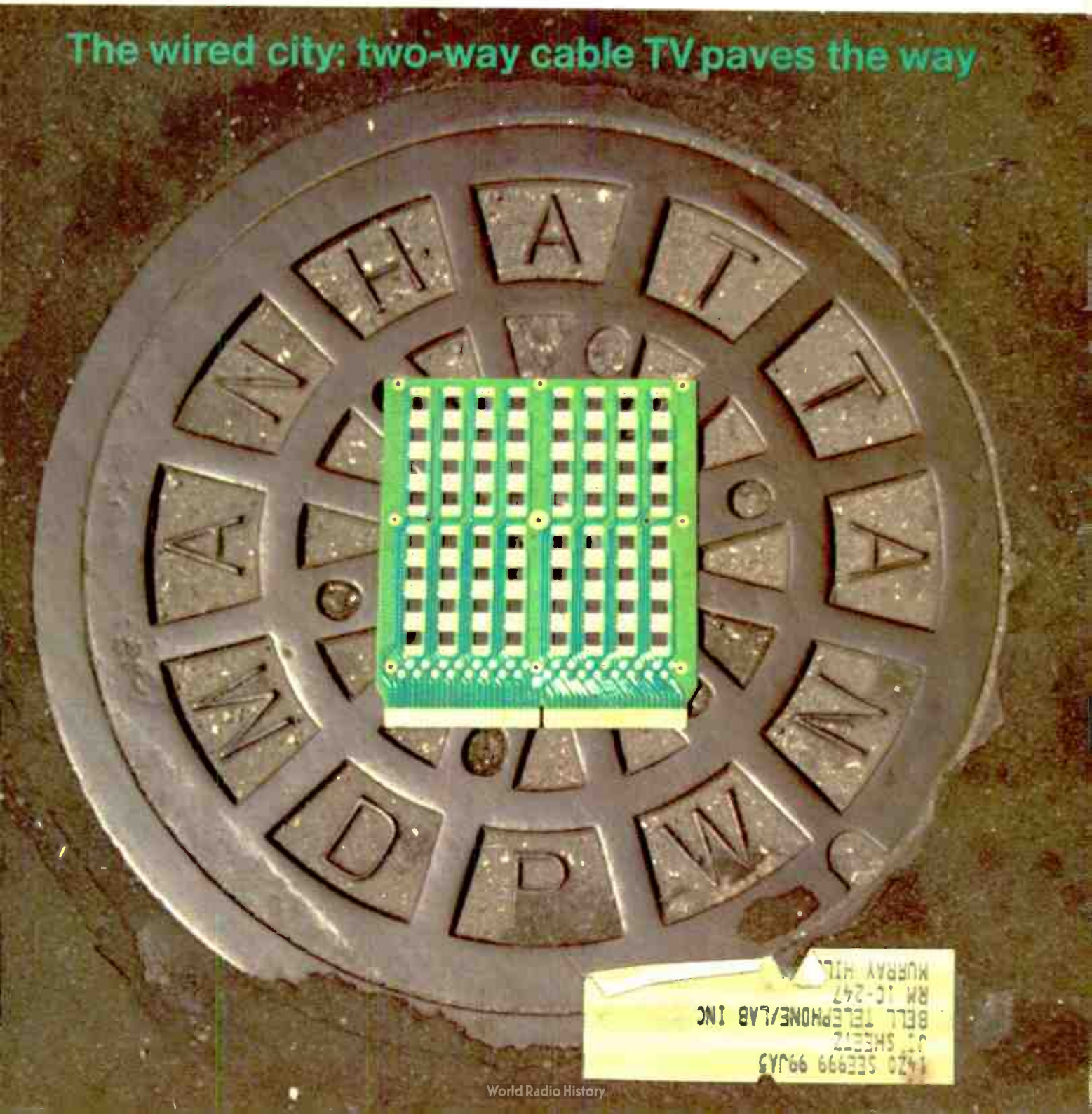
Electronics

The wired city: two-way cable TV paves the way



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090/88

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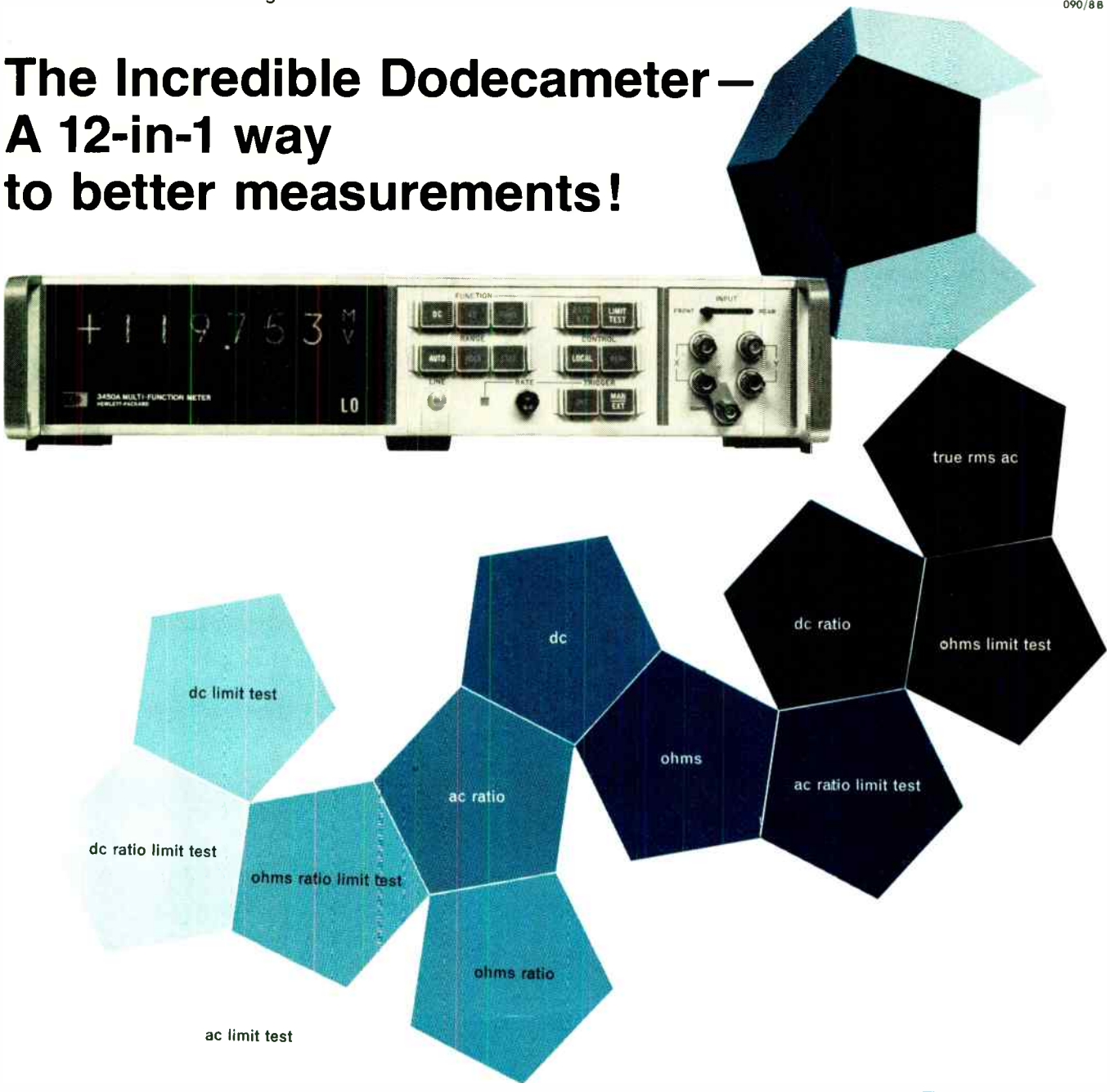

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SWEEP OSCILLATORS

Circle 2 on reader service card

Electronics
The International Magazine of Electronics Technology
September 27, 1971

Volume No. 44, Number 20

Electronics

Publisher's letter

This issue appears to be more than usually full of portents of the future reflecting opportunities and problems for the electronics community. Our chief portent-purveyor is Consumer Editor Gerald M. Walker, who not only produced our special report on cable television (p. 44), but also was in charge of polling our readers on how they feel about unions for engineers (p. 72).

To gather inputs for his cable TV report, Walker traveled to major conferences of CATV operators and visited companies that are getting heavily involved in producing the equipment that will be needed to implement the wired city concept. His verdict: two-way cable TV service is surely coming—and with it a whole raft of new services for business and the home that go far beyond mere entertainment.

Business is already using credit verification systems that can easily be adapted to CATV. The range of additional services includes banking from home, opinion polling, and even voting via the TV set.

But Walker sees two problems that must be overcome before cable TV can really develop into what its proponents envision. "First," he says, "the people who are going to buy the service have to get involved and exercise control over the programing that will be distributed, and make sure that they are more than just passive receivers of whatever the cable operators want to dish out. That means municipal governments and local community groups will have to work hand in hand to keep out the promoters who are just interested in profit."

The second problem, according to Walker, is more technical. "Although all the hardware exists and all the proposals are technically feasible," he says, "the kind of Mom-and-Pop operation that has characterized much of the CATV entrepreneurship up to now just may not be up to handling the complex systems problems involved in wiring up a large community and servicing it. That's going to take some sophisticated systems engineering."

So much for opportunities. In the problem area, the results of a poll published in the Aug. 2 issue show that nearly 80% of the respondents favor a strong organization, either a union or an association, built along the lines of the American Medical Association, to protect the economic well-being of electronic engineers. In November, the IEEE membership will have voted on constitutional amendments designed to strengthen that organization's role in looking out for the welfare of EEs. Since 53% of the respondents favoring an AMA type organization thought the IEEE should take the lead in forming it, this might presage a shakeup in the big professional society.

For a couple of engineers who can write, *Electronics* can offer an attractive editorial career. We're looking for people with a good background in components and instruments. If you're turned on by new developments in these areas and think you can turn our readers on, send your resume to our Executive Editor, at 330 W. 42nd St., New York, N.Y. 10036.

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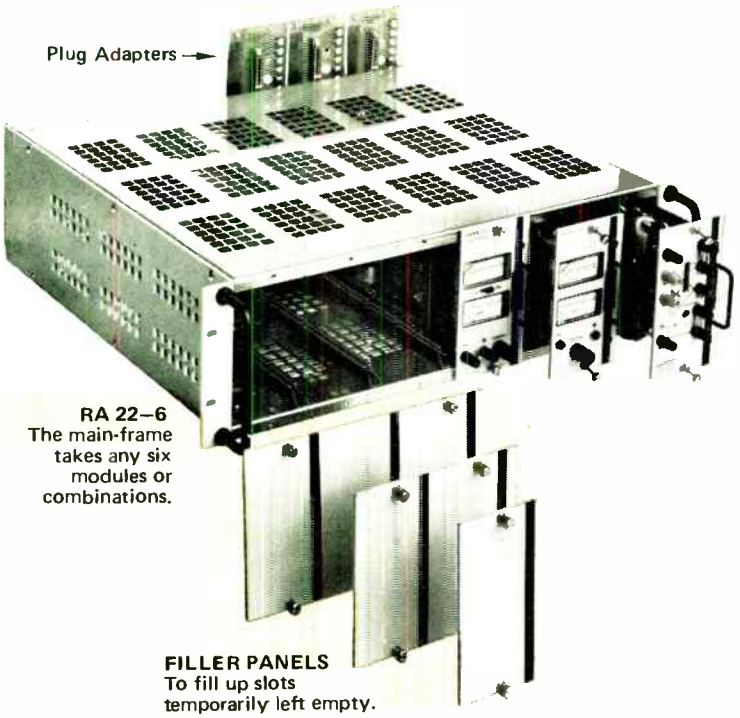
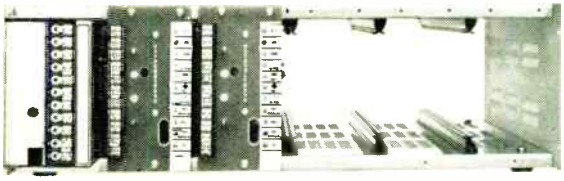
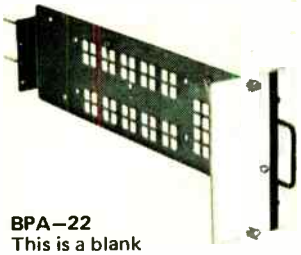


RA 22–6
The main-frame takes any six modules or combinations.

FILLER PANELS
To fill up slots temporarily left empty.

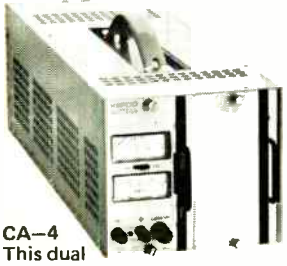


This is the rear of the 6-unit, rack mountable housing, RA 22–6, showing the location of the plug adapters, PC–2, which interface each model's male PC connector to an easy-to-use barrier strip. There is space for a bolt-on overvoltage protector (shown mounted on the left-hand slot). If you look carefully, you can see the coding pins which you can use to uniquely encode each slot so that no one can get the supplies mixed-up.



BPA–22
This is a blank slide assembly which you can use to mount your own circuits—or the lower-cost, unmetered Kepco power modules.

CA–3
Use this single unit housing to convert any of the plug-in supplies and amplifiers to a self-contained bench model.



CA–4
This dual housing will permit you to custom-make your own dual supplies. No tools or soldering; just plug in the supplies and plug-in the line cord!

CA–5
A 3-unit housing provides you with considerable flexibility in your choice of voltage or current regulators or, perhaps, a three amplifier manifold.

CC

CURRENT CONTROLLERS

Kepco's CC Series programmable current regulators feature a capacitorless output circuit that responds to load changes at speeds up to 2 μsec/V. A 10-turn current control with dual range sensing, operate a low-noise integrated control amplifier to provide exceptional stability and resolution. Regulation is 0.0005% for line, 0.005% for load.

MODEL	AMPS	VOLTS
CC 7–2M	0–2	0–7
CC 15–1.5M	0–1.5	0–15
CC 21–1M	0–1	0–21
CC 40–0.5M	0–0.5	0–40
CC 72–0.3M	0–0.3	0–72
CC 100–0.2M	0–0.2	0–100

PRICE: $209.00

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The OPS modules, with the suffix BTA are equipped with an operational patch panel for summing and feedback components. Gain is in excess of 0.5×10^6 V/V with an offset voltage coefficient $<20\ \mu V/^{\circ}C$. The fast-slewing unipolar amplifier is perfect for digital control or any rapid-fire programmed testing.

MODEL	VOLTS	AMPS
OPS 7–2BTA	0–7	0–2
OPS 15–1.5BTA	0–15	0–1.5
OPS 21–1BTA	0–21	0–1
OPS 40–0.5BTA	0–40	0–0.5
OPS 72–0.3BTA	0–72	0–0.3
OPS 100–0.2BTA	0–100	0–0.2

PRICE: $192.00

PCX-MAT

VOLTAGE REGULATORS

The PCX module, with the suffix MAT, sports a metered front panel with a 10-turn, high resolution voltage control. The low-noise integrated control amplifier regulates the output to better than 0.0005% for line, 0.005% for load. A multiterminal rear barrier-strip, interfaced with the printed circuit plug, provides access for remote control facilities.

MODEL	VOLTS	AMPS
PCX 7–2MAT	0–7	0–2
PCX 15–1.5MAT	0–15	0–1.5
PCX 21–1MAT	0–21	0–1
PCX 40–0.5MAT	0–40	0–0.5
PCX 72–0.3MAT	0–72	0–0.3
PCX 100–0.2MAT	0–100	0–0.2

PRICE: $180.00

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Readers comment

Gating delay

To the Editor: Edward E. Pearson's Designer's casebook [June 21, p. 64] does not consider the effect of counter clock gating delay on the overall counting rate. With at least four decades, the clock gating delay to the input gate of the nth stage is $2t_g + t_d + (n - 3)t_g$, where t_g is the gate delay and t_d the decade delay. Since clock conditioning must be completed between clock pulses, maximum allowable counter rate (f_{max}), which equals $(n - 1)t_g + t_d$, depends on the number of stages. For the TTL decades and gates used t_d is 60 nanoseconds and t_g 17.5 ns. When n = 4, clock rate is limited to about 9 megahertz; when n = 7 (the example considered in the article), maximum clock rate is 6 MHz.

Lawrence M. Leibowitz
Naval Research Laboratory
Washington, D.C.

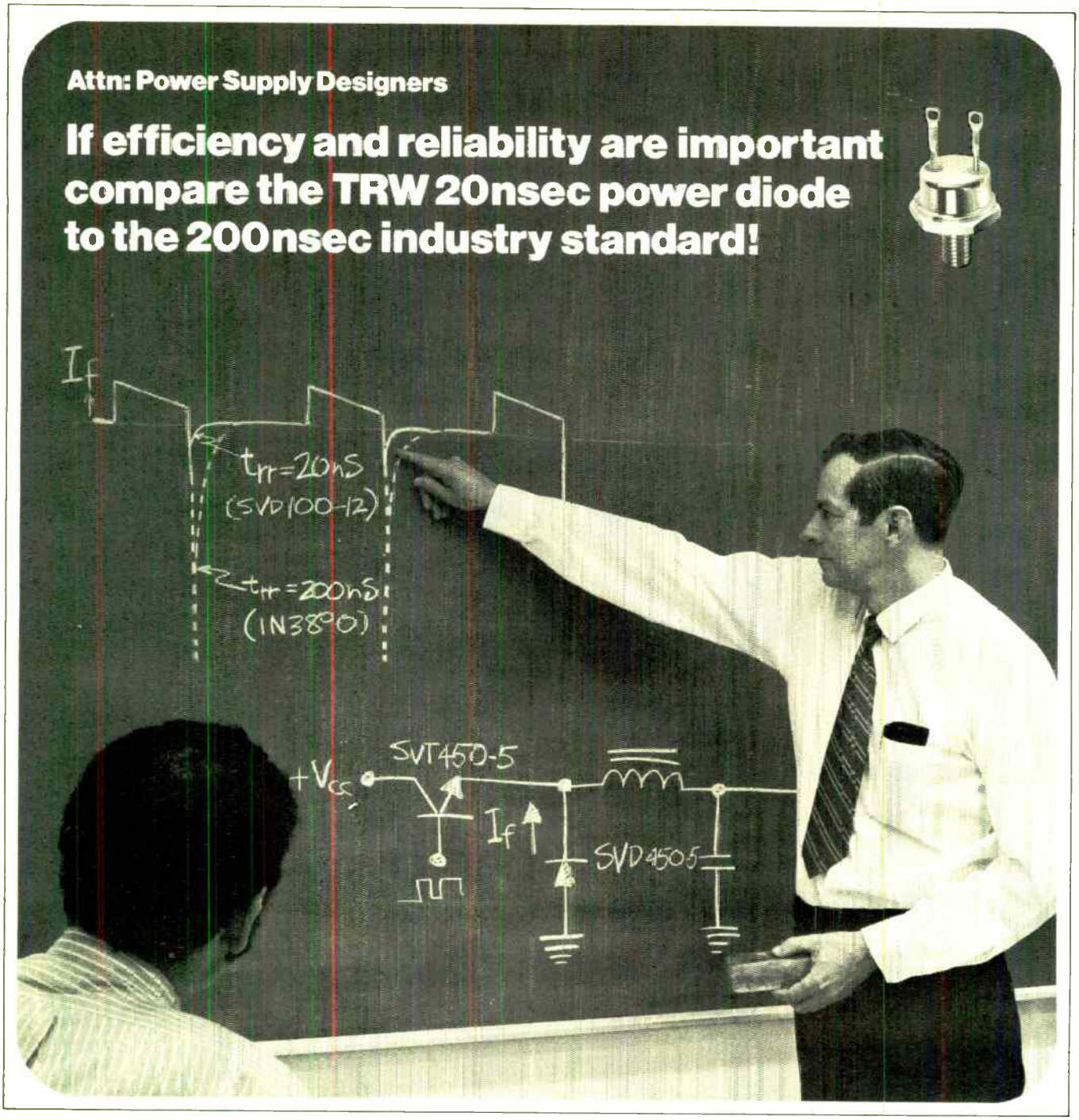
■ *Mr. Pearson replies: The rules of decimal counting and the sentence, "Therefore, G_7 stays high for only one clock period, G_8 for 10 periods, G_9 for 100, G_{10} for 1,000, and so on," must be examined. No decade changes until all less-significant decades have counted to 9. The least-significant decade reaches the count of 9 ten clock pulses after the next least-significant decade goes to 9. Regardless of number length, the least-significant decade must go through a 9-to-0 transition if any other decade digit is changing. This explains why G_7, the output gate of the least-significant decade, is in parallel with all subsequent clock gates. Clock speed depends only on the propagation path through the first decade, gate G_7, and one clock input gate. Clock gate conditioning is further enhanced because only one flip-flop of the type 7490 must be toggled to bring the count from 8 to 9. Maximum realizable speed for a broadside readout of the casebook counter is greater than 10 MHz. In addition, circuit operating frequency remains the same for any number of decades, as long as the fan-out capability of G_7 is not exceeded.*

They also served

To the Editor: The Publisher's Let-

Attn: Power Supply Designers

If efficiency and reliability are important compare the TRW 20nsec power diode to the 200nsec industry standard!



The SVD series diodes...high voltage (to 450V)...wide current range (1-30 amps)...fast (to 20nsec)

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TRW

Readers comment

ter [Aug. 2, p. 4] on the development of General Instrument's 2k RAM neglected to mention the significant contributions of Robert Green and Kent Smith of GI's Microelectronics Research Center in Salt Lake City. In fact, the turning point for the entire program came when Smith and Green flew into New York and were locked in a room with Lee Seely and myself for a solid week of brainstorming, with all contacts with the outside world severed. After two sleepless nights, history's first stream-of-consciousness RAM was conceived and by the end of the week the door opened and the embryonic RAM was announced to the anxious GI family. The task of reducing to practice, giving birth to, and nurturing the 2k RAM fell primarily on the shoulders of Smith and Green, who had to design, simulate, and lay out the chip and then design and build extremely sophisticated test equipment to perform the very challenging task of testing the memory chip for pattern sensitivity.

Leo Cohen
General Instrument Corp.
Hicksville, N.Y.

Lithium niobate prices

To the Editor: The article on surface acoustic wave devices [Aug. 2, pp. 22-23] failed to mention that the cost of $62.46 per centimeter cited for lithium niobate is for a very small quantity of crystals, custom grown to 12 inches and requiring very special handling during growth, cutting, and polishing. All of these factors account for the high price. As the leading supplier, we have been able to supply, in quantity, polished substrates a few inches long at a price per cm of less than $6. Lower costs have been achieved through growth of large-diameter boules, and through cutting and polishing of large lots of substrates. As the quantity usage of single-crystal lithium niobate approaches that of PZT, we anticipate that price per unit length will approach that of PZT.

L.J. Castelli
Crystal Technology Inc.
Mountain View, Calif.

MD-150: The MD-150 is a cascaded, computer controlled test system designed to optimally test all types of LSI devices at functional speeds of 5MHZ on the water level or in final package form.

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The system tests RAMS, ROMS, shift registers and semiconductor memories as well as random logic. The MD-150 tests MOS and bi-polar systems with equal ease.

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PRICING: The MD-150 costs less than one-half of other so-called competitive LSI test systems claiming 5MHZ operation. If you've been told pin-electronics are expensive – forget it. With the MD-150 Macrodata breaks the speed and price barriers. The MD-150 has no special set-up charges, no large, cumbersome software requirement using months of valuable test time; the MD-150 is priced complete—no add-on boxes promised for future performance and delivery.

ZERO OVERHEAD TESTING: Tired of software upkeep? Learning new languages with every new machine? The MD-150 eliminates the software overhead required by general purpose computer systems. No more software checkout required for device test programs, etc. In short—zero overhead testing.

MACRODATA DELIVERS: Our test systems are operating profitably in the field TODAY. Macrodata was the first to deliver the 2MHZ test system, the first 5MHZ system, the first to introduce and deliver firmware programs to test semiconductor memories. Macrodata test systems today are being used by most major semiconductor manufacturers and users.

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40 years ago

From the pages of Electronics, September 1931

Within the past month the editors have witnessed several radical new inventions in operation.

A new electronic light source exhibited in New York produces a flood of brilliant illumination from gas energized by cold electrodes operated on 100 volts. It is half-a-dozen times as efficient as tungsten lighting, and the device in other forms has possibilities for large-scale rectification and current control.

Again, a new filamentless radio tube now being developed by large independent interests, will apparently do everything the three-electrode vacuum tube can do—as amplifier, rectifier, and oscillator. Such tubes have a high amplification factor, are simple and easy to make, and can be manufactured for just a few cents each.

For a long period the useful part of the radio spectrum was thought to end at about 200 meters; then suddenly it began to expand; amateurs and experimenters had disproved existing theory and practice which led one to believe that on the shorter waves absorption would prevent the desired communications.

Unless all signs fail, the radio spectrum is due for another widening, again downward into a region now unused, virtually unexplored. The very reason why experimenters thought these very low waves useless, and why so few amateurs continued their experiments in the 5-meter region and below, may be the reason why they will come into wide use. They are not long-distance waves; they are short-length waves, short-distance waves, easily reflected and guided into narrow beams. And so vast is the region that all the transmitters that desire may find room.

Five short waves have been added to the two long waves granted by the Federal Radio Commission to the American Radio News Corporation, Hearst subsidiary, which is developing an automatic radio-typewriter system for news distribution to newspapers around the country.

People

Tactile television is what Bell Labs engineer Harry Boll calls his hat-mounted instrument that enables a blind person to "see"—using his skin as an artificial retina. Boll, a 43-year-old Ph.D. in electrical engineering, is supervisor of the Bell Laboratories Exploratory Structures group, and works on tactile TV as a hobby. "My six-year-old thought for sure I was building a robot and was disappointed when he found out what it was all about," says Boll.

Boll feels that 10,000 to 30,000 blind persons can be helped with a device like this. The basic principle is to convert shades of light and dark to air pressure using a Braille concept—lighter areas producing little pressure, darker areas producing greater pressure. Cadmium sulfide diodes in an 8 x 12 array sense light, which is converted to electrical impulses. These are then transduced to jets of air.

The human nervous system, Boll explains, is amazingly adaptable. "A skilled typist converts scrawled information into a typescript via her eyes, brain, and fingers. The skin is also an efficient transducer." Boll's aim is to have a blind person use a new modality to obtain visual data.

How accurate can this form of vision be? Boll says that with his current prototype, a blind person can perceive a stop sign at 100 feet and play volleyball with a balloon.

Boll is working on ways to reduce power consumption by using video scanners so that the device can be light, inconspicuous, and inexpensive. His latest idea is to use two solid state vidicons, each with an array of sensors the size of a pinhead, to gather far-field (telephoto) and near-field (wide-angle) data. The batteries for the sensors could be belt-mounted with the air pump array mounted on a vest. This way, a visual display could be felt on the abdomen—a kind of torsovision.

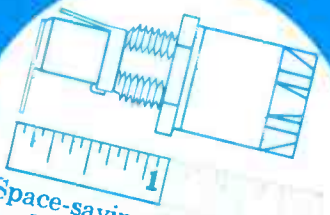
"I wanted to start a company to license new products in a way I had never tried," says John F. Rockett Jr., explaining why, after 20 years in the technology transfer field, he has founded Industrial Technology Interface Inc. in Boston. Previously, his clients had been companies looking for new products to develop and market, but he found this "an unsatisfactory way to optimize the marketing of new inventions." At his new firm, the clients are the technology owners and inventors, not the makers.

Rockett hired a market research firm "to find the people in client companies who are real sparkplugs," and wound up with a list of 500 names. They got letters asking what their interests and needs were and what salable ideas they had sitting on their shelves. His first client

Boll: Torsovision for 20,000 to 30,000 blind as light is converted to bursts of air.

only a BUSS fuseholder could have so many quality features squeezed into such a small package

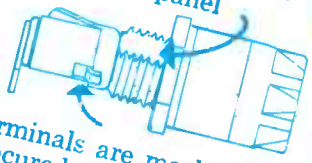
Space Saver!



Space-saving size: projects only one inch behind panel, only 1-25/32 inches overall length

Space Saver!

Made for installation in D-hole to prevent turning in panel



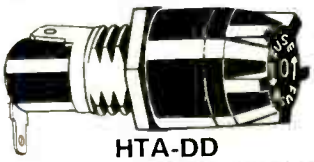
Terminals are mechanically secured in holder as well as soldered

Easy-grip bayonet-type knob –sturdy compression spring assures good contact

Knob grips fuse so that fuse is withdrawn when knob is removed

BUSS

HTA



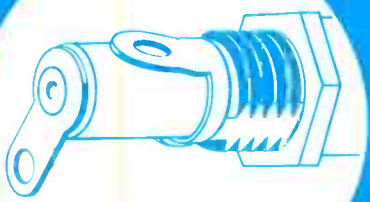
HTA-DD

HTA-HH

FUSEHOLDERS

FOR ¼ x 1¼ INCH FUSES

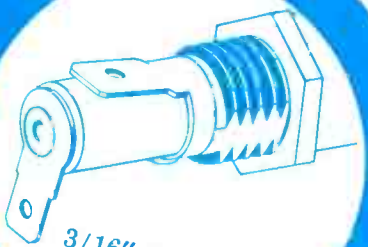
Knob has break-out hole to allow use of test probe



Solder Terminals (HTA)

Rated for 15 amps at any voltage up to 250

Dielectrically capable of withstanding 1500 volts A.C. between terminals and between terminals and panel



3/16" Quick-Connect Terminals (HTA-DD)

¼" Quick-Connect Terminals (HTA-HH)

For more information on the HTA Fuseholder and the complete BUSS QUALITY line of small dimension fuses, fuseholders, and fuseblocks, write for BUSS Bulletin SFB.

BUSSMANN MFG. DIVISION,
McGraw-Edison Co., St. Louis, Mo. 63107

SUPPLIED THE ECONOMICAL WAY . . . THRU DISTRIBUTORS

BUSS QUALITY FUSES

is MIT, but he has others, both individuals and corporations, in construction, education, mechanical engineering, and other fields as well as electronics. Rockett is now working on 10 products, and says he has agreements for several electronic products in the works. Among them are developments in the cable TV area, auto braking, and home heating and air-conditioning.

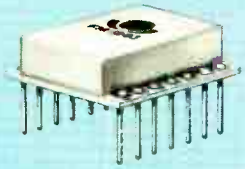
With these clients, Industrial Technology agrees to absorb all costs of placing the product in exchange for 30% to 50% of the royalties. Then consultants evaluate the product's technological, marketing, financing, and legal aspects.

In the second phase, Rockett's firm tries to identify potential licensees. "We are most successful with corporate entrepreneurs who are interested in growth and innovation," Rockett says. Royalties paid by U.S. companies on both U.S. and foreign patents total over $1 billion a year and Rockett has made "a conservative projection" that within a few years he can license $100 million worth of new products earning $1 million in royalties.

One reason for the gap, Rockett believes, is the "not-invented-here," or NIH, syndrome, whereby companies reject ideas presented to them by outsiders—exemplified, he says, by the rejection of the Xerox copying process by IBM and General Electric. A technology transfer service such as his, which has already tested and evaluated a new product and which has access to the most innovative men in a company, can overcome or bypass the NIH factor, Rockett thinks. His company also can try to persuade clients to license unused products and inventions.

He feels industry often is afraid of new ideas, and division managers who are rated according to return on investment are reluctant to gamble on untested ideas. "If you put R&D on a profit-and-loss basis you are a hell of a lot less likely to reinvent the wheel," Rockett contends. Increasingly, licensing will be arranged by technological transfer companies and they will become a major vehicle of new product development, Rockett says.

Centralab offers immediate delivery on functional modules



Centralab, the industry leader in thick film microcircuitry, now has combined its recent advances in packaging and chip hybrid technology to bring you five new functional modules available for immediate delivery from stock. These modules are sealed in ceramic packages with 14 swaged terminal pins universally spaced .600" row-to-row and .100" apart to facilitate printed circuit board mounting.

Module	Function	Rating	Suggested Applications
FM-1110	Power driver	1 amp @ 60v steady state	Interfacing with relay/solenoid coils, magnetic cores, lamps, etc. in computers, control consoles, test equipment, digital systems, etc.
FM-1203	Dual driver	300 ma @ 28v steady state	
FM-1403	Quad driver	300 ma @ 28v steady state	
FM-2100	MOS clock driver	200 ma with up to 30v shifts	To drive all popular MOS circuitry in calculators, computers and other digital systems.
FM-3110	Programmable multivibrator	Output pulse widths 200 ns to 12 μs	Delay, timing and pulse shaping in computers, control circuits, test equipment and other digital systems.
*FM-4110	RC clock oscillator	500 kHz to 6 mHz	Time base, square wave generators and tone signalling controls for computers, test equipment, etc.
*FM-5110	Overvoltage crowbar	Trip voltage 4.5 to 12.5v, < 1 μ sec response	To protect voltage sensitive devices such as IC's, MOS devices, etc.
*FM-5111	Overvoltage crowbar	Trip voltage 12.5 to 20.5v, < 1 μ sec response	
*FM-5120	Electronic fuse	Trip current 1 amp @ 40v, < 1 μ sec response	DC electronic equipment and systems where precise, fast current disconnect is required.
*FM-6110	Power operational amplifier	250 ma peak output current with supply voltages ± 15 vdc	Servo systems, test equipment, power supplies, etc.

DESCRIPTION

FM-1110, 1203, 1403: Single, dual and quad drivers
Designed to accept standard DTL and TTL logic levels and to drive loads which require high power. Consist of single or multiple NAND/NOR gates and high gain amplifiers.

FM-2100: MOS clock driver
Designed to accept standard DTL and TTL logic levels and universally drive MOS circuitry. Consists of a three input AND function followed by a power inverter.

FM-3110: Programmable monostable multivibrator
A flip-flop which, when triggered by an input pulse, generates an output pulse of prescribed width, with control through interconnection of appropriate package pins.

***FM-4110: RC clock oscillator**
An RC astable multivibrator and an output buffer stage capable of providing a square wave output at a predetermined fixed frequency. It can operate down to 5 Hz with the addition of external capacitors.

***FM-5110, 5111: Overvoltage crowbar**
A high speed electronic voltage sensing element and switch designed to protect voltage sensitive electronic devices by shunting out the supply voltage when high transients or other overvoltage conditions are experienced on the supply line.

***FM-5120: Electronic fuse**
The electronic equivalent of a fuse which features accurate threshold levels, high speed and reset capabilities. Available in a variety of current threshold levels.

***FM-6110: Power operational amplifier**
An operational amplifier designed to provide output capabilities far beyond those obtainable with equivalent monolithic IC's.

***These modules are scheduled for introduction in 1971.**

We welcome inquiries on any variation of the above modules and can provide rapid turnaround on samples and production quantities of custom modules. For design assistance or other information, write Sales Manager, Microcircuits, Centralab. Standard modules are also available through Centralab Distributors.

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Electronics Division
GLOBE-UNION INC.
5757 NORTH GREEN BAY AVENUE
MILWAUKEE, WISCONSIN 53201

M-7115

Meetings

Seminar on Telecommunications; IEEE, Mexico City, Oct. 6-9.

Second IFAC Symposium on Multivariable Control Systems; IEEE, Duesseldorf, Germany, Oct. 11-13.

Switching & Automata Theory; IEEE, Michigan State University, East Lansing, Mich., Oct. 13-15.

1971 Region 8 Convention-Eurocon; IEEE, Le Palais de Beaulieu, Lausanne, Switzerland, Oct. 18-22

Annual Electronic Connector Symposium; IEEE, Cherry Hill Inn, Cherry Hill, N.J., Oct. 20-21.

Electronic & Aerospace Systems Convention; IEEE, Sheraton Park Hotel, Washington, Oct. 25-27.

1971 Joint Conference on Major Systems; IEEE, Disneyland Hotel, Anaheim, Calif., Oct. 25-29.

Int'l Electron Devices Meeting; IEEE, Sheraton Park Hotel, Washington, D.C., Oct. 27-29.

Northeast Electronics Research & Engineering Meeting (NEREM); IEEE, Sheraton Boston Hotel, War Mem. Aud., Boston, Nov. 3-5.

Nuclear Science Symposium; IEEE, Sheraton Palace Hotel, San Francisco, Calif., Nov. 3-5.

CALL FOR PAPERS

Topical Meeting on Integrated Optics-Guided Waves, Materials and Devices; IEEE, Las Vegas, Nev., Feb. 7-9, 1972. Deadline for submission of abstracts to Optical Society of America, Integrated Optics Meeting, 2100 Pennsylvania Avenue, N.W., Washington, D.C., 20037, is Oct. 29.

Society for Information Display International Symposium; Society for Information Display, San Francisco, May 23-25, 1972. Deadline for submission of abstracts and draft-summary to John L. Simonds, Eastman Kodak Research Labs, Kodak Park, Rochester, N.Y. 14650, is Jan. 17.

Electronics Newsletter

September 27, 1971

TI to make Minimod package

Texas Instruments in Dallas is expected to sign a licensing agreement with General Electric to produce the Minimod film-mounted integrated circuit package developed by GE [*Electronics*, Feb. 1, p. 44]. Neither GE nor TI is talking at present, but it is expected that the TI versions, like GE's present parts, will be linear circuits (the technique seems best adapted to consumer applications). The continuous-reel packaging permits relatively simple automatic assembly operations.

When Minimod was introduced late last year, GE offered two circuits in the package, a threshold sensor and an operational amplifier. At that time, GE said it had two major customers already using the devices in production quantities, but these customers still haven't been identified. Machines to handle the devices in the customer's plant were developed originally by the customers themselves. But since then, two equipment producers—Kulicke & Soffa and Universal Instruments—have geared up to produce machines that should be introduced soon.

All along, industry observers have been saying that for Minimod to take hold, someone with a bigger catalog of chips than GE—for instance, TI—would have to jump in and start offering them.

Radiation sensor built for Air Force

Spurred by the increasing concern over the hazards to personnel of electromagnetic radiation [*Electronics*, Aug. 16, p. 35], General Microwave Corp., Farmingdale, N.Y., has developed a prototype of an ultra-broadband radiation sensor for the Air Force Systems Command.

Sensitive to frequencies from 12.4 gigahertz down to 20 kilohertz, the 1.5-inch-diameter sensor, which may be worn on a man's coat like a boutonniere, underwent calibration tests last week in an anechoic chamber at Rome Air Development Center, Rome, N.Y. The instrument—dubbed Raham, from radiation hazard meter—uses a radiation-sensing antenna made of an array of thin-film antimony-bismuth thermocouples. Power levels as low as 20 microwatts/cm^2 and up to 1 W/cm^2 can be sensed, says General Microwave, and an array 100 times more sensitive is planned. Present radiation hazard limits are set for microwave ovens, for example, at 10 milliwatt/cm^2.

General Microwave first used its thermocouple devices when it designed two of them into a microwave power meter covering the 10-megahertz to 40-GHz range introduced about eight years ago.

Now, under a $70,000 Air Force grant, the company is developing the lapel unit, complete with a pocket-sized electronics package, and a hand-held sniffer or probe unit with the sensor and electronics in a single package.

Samso expects to manage NATO satellite acquisition

Officials at the Air Force Space & Missile Systems Organization (Samso) in El Segundo, Calif., are "fairly certain" that the North Atlantic Treaty Organization will ask Samso to manage the acquisition of the NATO-3 communications satellite. Samso has prepared the satellite specifications under the control of Shape headquarters, and the specifications are due back from NATO nations before month's end.

If the specifications are approved, and Samso gets the nod to procure the satellite, requests for quotations would probably go out to industry late this year or early next, and a satellite procurement contract could

go out by mid-1972. Samso sources say the technology for the comsat is all within the state of the art, and no program definition phase is needed.

The specifications call for a synchronous orbiting satellite that could be either spin-stabilized or three-axis stabilized. Hughes Aircraft, Philco-Ford, and TRW could be spin-stabilized contenders, while a three-axis stabilized system has been discussed by General Electric, Lockheed, RCA, and Fairchild-Hiller. Samso officials aren't sure, however, that all these companies would bid.

Fastest computer in production

Goodyear Aerospace won't admit it, but it has received its first order for a Staran computer—**a military contract for one of the $1 million associative processors whose speed of 500 million operations per second is claimed to be a world record.** Delivery is set for March 1972. Goodyear formally disclosed production of the system this month with joint announcements at the Air Force Association meeting in Washington and the IEEE Computer Conference in Boston.

The Staran series [*Electronics,* July 6, 1970, p. 40] is aimed at such markets as intelligence data processing, ballistic missile defense, phased-array radar, weather forecasting, and air traffic control. **A preproduction Staran is being used by the Federal Aviation Administration at Knoxville, Tenn., for aircraft prediction and avoidance,** and Goodyear is pushing new models now in production for the FAA's route system.

Labor Dept. pushes harder for new jobs for engineers

Expansion of Federal attempts to put unemployed engineers back to work is "imminent," say **Labor Department officials, now preparing either to make their $42 million technology mobilization and reemployment program nationwide or to add 20 to 30 cities to their list of 14 target areas where defense-aerospace unemployment is concentrated** [*Electronics,* May 24, p. 21]. Grants to an engineer or scientist who lost his job in defense-aerospace cutbacks provide up to $500 for costs of travelling to a job interview, up to $1,200 for relocation, and virtually unlimited funds for training.

Although manpower administrator Paul J. Fasser, Jr., concedes that **the Labor Department has been stymied by the lack of available jobs—only 1,100 scientists and engineers drawn from its registry of more than 19,000 have been employed—he foresees** "several million new job openings annually" as a result of new job listing practices. **As of last week, any company with Federal contracts totalling $10,000 or more must list all available jobs paying up to $18,000 annually with state employment service agencies.**

Addenda

Control Data Corp. has received the first commercial order for its STAR-100 computer system [*Electronics,* March 30, 1970, p. 52]. The system is designed for use with many graphics display terminals. Control Data says that STAR (for string array) **can perform in the range of 100 million instructions per second. . . . In an effort to reorient its optoelectronics** business toward civilian segments of the electronics industries, Bendix is moving its opto division away from Ann Arbor, Mich., and the aerospace image of the divisions there, to Sturbridge, Mass. There it will merge with the Mosaic Fabrications division. **Some 20 top opto people will move to Sturbridge, where it's expected that new products in industrial control will emerge soon.**

DYNASCIENCES — Counters • Digital Voltmeters • Picoammeters • Pulse Generators

Excess Inventory!

Now, for a limited time only...

50% DISCOUNT on brand new instruments!

Special Inventory Reduction Sale Through November 30th With Full New Instrument Warranty

Due to excessive inventory of some instruments, Dynasciences management has agreed to offer an average discount of more than 50% on many brand new models. This special offer will continue only until November 30th, or until inventory stocks are brought into balance — whichever occurs first.

But, while it lasts here's your chance of a lifetime! Just imagine. Now, during this inventory clearance sale, you can buy a brand new, state-of the art, 200-MHz*, CMC Model 904 Universal Counter-Timer that normally sells for $1975 for only $969; or you can get CMC's 225-MHz, Model 616 Portable Counter that also sells for $1975 for only $695; and if you can use a digital printer, you can take home the CMC Model 415 that usually goes for $1650 for only $850!

For the rest of the bargains, just turn the page. Then act before it's too late.

Mail the coupon, or — for immediate purchase and delivery — call us collect (213) 341-0800

*Plug-in expandable to 18-GHz.

DYNASCIENCES

TELEPHONE: (213) 341-0800 TWX 910-494-1951 • TELEX 67-3382

☐ Okay, I know a bargain when I see one. Tell your local Rep to deliver a Model _____ ASAP. My P.O. # is _____

☐ I'm from Missouri. You can reserve a Model _____ for me at the special sale price, but have your Rep bring one around and show me before I buy.

☐ Keep a leash on your salesman until I've read the data sheet you're going to send me. Model _____.

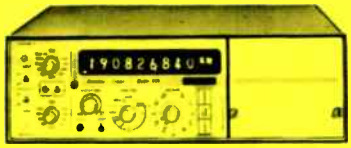
Name _____ Title _____

Company Name _____

Address _____

City _____ State _____ Zip _____

(Outside of USA, please use envelope and stamp. Foreign orders processed expeditiously.)



Model 901 ~~$2475.00~~ **$1345.00**

UNIVERSAL COUNTER-TIMER

The Model 901 is a state-of-the-art instrument. It is the industry's first, true, 200-MHz, universal counter-timer capable of achieving its range without prescaling, heterodyning, or using plug-ins...while also offering as part of its main-frame capability the measurement of frequency, period, multiple period average, time interval, ratio, multiple ratio averaging, totalizing, scaling, and the measurement of time interval from an external standard...plus a heterodyning capability for gigahertz operation.

Gate times are 1 μsec to 100 seconds in decade steps. A special feature of the display control is a fast reset to 10 μsec to accommodate those requiring maximum data gathering abilities. Input sensitivity of the 901 is 10mV for both A and B amplifiers.

The readout has nine decades with automatically positioned decimal point, large readout tube with units symbols, and an overflow lamp. Printer output in the form of BCD in the 1-2-4-8 code is a standard feature. Remote programming of the entire front panel controls, except trigger levels and attenuators, is an optional feature. Time Interval mode offers resolution to 10 nanoseconds. Gate output, useful in determination of the amplifier trigger points in the Time Interval mode, is a standard feature of the 901.

Model 904 ~~$1975.00~~ **$969.00**

The 200-MHz Model 904 is identical to the Model 901 except that it offers an eight-digit readout instead of nine, and BCD output is not provided.

901/904 FREQUENCY EXTENDER PLUG-INS

Model 931
~~$825.00~~ **$645.00**

Turret type, positive switching 100 MHz to 1.3 GHz Heterodyne Converter. Sensitivity is 50 mV across its entire range.

Model 933
~~$325.00~~ **$149.00**

Video Amplifier increases gain of Model 901 and 904 thirty times.

Model 905	Model 915	Model 925
~~$395.00~~	~~$355.00~~	~~$340.00~~
$249.00	**$229.00**	**$195.00**

Model 905 15-MHz FREQUENCY METER

The Model 905 Frequency Meter is a low-cost 15-MHz counter that is priced considerably lower than comparable competitive instruments. Although low-cost, it provides quality performance and is contained in a high-quality package that features a tip-up stand for easy visibility in bench work. It can also be rack mounted. Measuring only 4" x 5" x 8½", the 905 provides direct frequency measurement from DC to 15 MHz. It features a 1-MHz crystal oscillator time base with a stability of ±2 parts in 10^6 per month, and a five-decade in-line display is standard with display storage and automatically positioned decimal point. Wt. 3½ lb.

Model 915 TIME INTERVAL METER

A low-cost instrument that features a 1-MHz temperature-compensated crystal oscillator . . . triggers on positive or negative going pulses . . . can be operated in either a 1 μs or 1 ms mode, with a range from 0 to 99,999. Starts on the A-input and stops on the B-input, and permits reset even during the measurement operation. Same dimensions as and fully compatible with CMC's Model 905 Frequency Meter.

Model 925 ELECTRONIC TOTALIZER

Frequency range, from dc to 1-MHz, or dc to 100 Hz (internally switch selectable) with totalizing count from 0 to 99,999. Trigger level is automatic, and a pushbutton switch on the front panel resets the count to "0". Same dimensions as the 905 and fully compatible with the other compact instruments in this line.

Model 912 PRESET COUNTER
~~$630.00~~ **$195.00**

Model 913 DUAL PRESET COUNTER
~~$725.00~~ **$219.00**

Both models operate in either a "Limit Mode" or "Recycle Mode" with a frequency range (selectable by internal switch) of either 0 to 100 Hz or 0 to 10 KHz. In the "Limit Mode" "output" is held at the preset number until reset manually, while continuing to count: and in the "Recycle Mode" the counters hold the "pulse relay output" at the preset number, then reset to "0" and automatically resume counting. The Model 913 is equipped with a second bank of 5 preset switches, a second control switch so that there is independent control for each switch bank. Both units completely compatible with the other CMC compact instruments, but come in 16.8" widths for standard rack mounting.

Model 616
~~$1975.00~~
$695.00

Model 616 provides low-cost direct frequency measurement from 10 Hz to 225 MHz by means of a unique prescaler built into the instrument. It can be rack-mounted. All-silicon semiconductor circuitry assures dependable operation over wide temperature ranges. 1 MHz crystal time base; stability ± 2 parts in 10^7 per month. Seven decade in-line display is standard — eighth decade optional. Standard automatic decimal and display storage.

Model 631 ~~$775.00~~ **$395.00**

Model 631, turret-type, positive switching 100 MHz to 1.3 GHz Heterodyne Converter.

Model 633 ~~$300.00~~ **$89.00**

Model 633, 1 μsec resolution Time Interval Plug-in with range from 1 μsec to 10 sec.

Model 635 ~~$825.00~~ **$695.00**

Model 635, continuous tuning, 200 MHz to 3.3 GHz Heterodyne Converter.

Model 415
~~$1650.00~~
$850.00*
*11 columns

LOW-COST, DATA LOGGING PRINTER FEATURES IC DESIGN AND SUPERB MECHANISM

The new Model 415 Digital Printer employs IC design and utilizes IC sockets for accurate reliable performance and easy maintenance. Its mechanical printing mechanism is good for more than 5,000,000 cycles without an adjustment, is replaceable in the field, and provides the legibility of an electric typewriter. From 7 to 21 columns of line capacity are offered, and red/black printing with color selection by numerical field is provided . . . also floating decimal point, zero suppression, "print command" control over 3-input channels, and a remote control option. Speed is 3 lines-per-second, and printing stock is paper tape or fan-fold. The 415 measures 8½"w X 7½"h X 17½"d.

Model DM330 ~~$399.00~~ **$299.00**

Digital Multimeter

Model DM 330 provides full multimeter capability . . . with auto polarity, it measures DC or AC volts from 1mV to 1KV; DC current from 1nA to 10mA; and resistance from 1 to 10 Meg.

Model 1035A ~~$3475.00~~ **$995.00**

Model 1035 Picoammeter — developed for high precision standards and calibration laboratory use — provides unmatched performance, with a range from 10^{-5} to 10^{-12} amperes full scale, with 10^{-15} amperes resolution. Combination of fast, pushbutton self-standardization plus temperature stabilized feedback assembly provide the 1035's ultra high accuracy.

CHECK THESE ADDITIONAL BARGAINS.

A CMC Model 614 Preset Multi-function counter that normally sells for $1300 on sale for only $595; Rutherford Models B-7B, B-7D, and B-7F Pulse Generators slashed from $875 for B & D models and $895 for F model to $449, $465, and $495 respectively; and the Rutherford Portable Pulse Generators Models B-14 and B-15 slashed from $475 and $525 to $249 and $299.

PLUS THESE SPECIAL PACKAGE DEALS.

If you purchase a combination package of many of the instruments that are on sale, you also earn additional bonus discounts. Example: 904 on sale for $969. 931 on sale for $645. Buy them as a package for only $1495! Ask for further details.

DYNASCIENCES — Counters • Digital Voltmeters • Picoammeters • Pulse Generators

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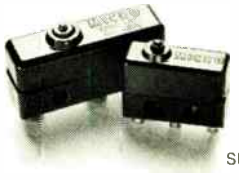
Everything's subminiature except their capacity.


Shown actual size.

Our subminiature switches may be tiny, but there's nothing small about their electrical capacity, long life expectancy, or application versatility.

Our SM series, for example, has a switching capability to 10 amps, bifurcated gold contacts for high reliability and a wide choice of integral or auxiliary actuators. Available are several terminal styles, including new flat quick-connects. To meet your other design needs, there's now a sealed version of the SM.

And if that's not enough, our smallest snap-action switch—the 1SX series—combines precision operation and long life in a 1 gram package. Plus it offers most of the features found in the SM.

For more information, call your MICRO SWITCH Branch Office or Authorized Distributor (Yellow Pages, "Switches, Electric"). Or write for Catalog 50.

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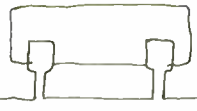

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We've done it again . . . We found a need and filled it. The 640-1 completely Solid State SerenDIP* Relay is the result.

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Use it for Analog and Transducer Signal Switching, Programmable Gains for Operational Amplifiers, Lamp Drivers, and Modulators and Demodulators!

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Laser beams point at fast printer applications

Impact units face challenge from laser-based copying, character generator, and typesetting systems work

Impact printers are the medium for the message in high-speed computer centers, but they're about to be challenged by a new class of character-generating devices using lasers. In fact, laser-based devices are being readied for a host of printing tasks: recording computer output directly on microfilm, copying documents, nonimpact printing, photo-typesetting, and digital data storage on film.

Only one company, Datalight Inc., a subsidiary of Andersen Laboratories, Bloomfield, Conn., so far has announced it has a laser-beam character generator ready for business applications. But others are busy, including the Zenith Research Radio Corp., subsidiary of Zenith Radio, which recently showed off a developmental laser beam character generator. And the Copymatics Manufacturing division of Saxon Industries, Miami Lakes, Fla., is hard at work on an office copier, while Bell Telephone Laboratories, Murray Hill, N.J., reportedly is working on a microfilm recorder and photo-typesetter. The microfilm recorder is being designed to operate over telephone lines.

Datalight's system, named Datawrite, is to be sold to original equipment manufacturers and, depending on the laser-sensitive recording medium, can be engineered into a variety of systems. It writes alphanumerics and graphics or digital words from computer data. In a "computer-output-on-microfilm" mode, it can record in a page format of 136 characters by 64 lines at a throughput rate of four pages per second. This rate translates to a figure as high as 50,000 characters per second, faster than any real-time computer output, says Walter A. Crofut, vice president at the Laser Systems division. In addition, the number of lines per page is instantaneously programable for any fixed number up to 80, with reduction ratios of either 25× or 42×. At the higher reduction, 30,000 lines can be written per minute. The systems can also be expanded to an 82× reduction and an eight-page-per-second throughput.

The system uses a low-power, 3-milliwatt helium-neon laser for its light source and an acousto-optic modulator to deflect the beam and form the characters. These are written by a single beam moving vertically downward through a seven-dot-high by five-dot-wide matrix. The beam is turned off as it moves upward on its return from the bottom of one vertical row of dots to the top of the next. A mechanical scanning device is used to position the beam from character to character across the page. An acousto-optic modulator, developed about six years ago in connection with classified military work at Datalight's parent Andersen Laboratories, is used to deflect the laser beam and modulate it on and off. In fact, the laser beam character generator was developed as a result of a decision to find new uses for the modulator, Crofut reveals. In a microfilm recording mode, the laser beam is intense enough to expose dry, rather than wet film, speeding up the complete recording process, he explains.

A different writing technique is used by Zenith. Although the laser beam is also deflected in an acousto-optic modulator, it is also broken up in the modulator into seven vertically separated beams. This is done by applying signals, controlled by the computer output from seven discrete rf oscillators to the modulator. And each laser beam can be turned on and off individually.

Like the Datalight system, Zenith's relies on a character made up of a seven-by-five dot matrix. But each character is written by the seven beams sweeping horizontally across the page to be printed. The result of using completely electronic deflection is a staggeringly high writing rate—up to 420,000 characters per second, says Zenith's George Hrbek. A total of 133 characters can be written per line width, and this can be the width of a microfiche or of a teletypewriter page, he continues.

In a recent demonstration, Zenith used its system to print out, on dry-process recording paper, the information carried over a United Press International news ticker. This taxed the system hardly at all, says Hrbek; the ticker operates at a speed of only six characters per second.

Firmly committed to a laser-writing system is Copymatics. The company has contracted with Holobeam, Paramus, N.J., to develop the

writing mechanism and inking system for an office copier that will use ordinary nonphotographic paper and regular ink. Says a spokesman, "You won't be able to tell between the original and the copy."

Commercial electronics

TI calculator chip bids to make a wave

Texas Instruments finally got around to announcing its calculator on a chip [*Electronics*, Nov. 23, 1970, p. 83], and it looks like it could have a profound impact on the MOS/LSI calculator chip market beyond its quantity price of under $20.

Though it's not the first one-chip calculator circuit [*Electronics*, Feb. 1, p. 19], the big 230-by-230-mil chip, intended for personal calculators, is the first standard product that's programable with a single mask step. TI can provide almost any combination of the eight-digit, three-register functions being offered—something no device maker appears to be offering now.

Marketing a calculator chip as a standard part that can be quickly and cheaply tailored to a manufacturer's needs may be the shrewdest move yet in this fast-moving industry. The usual approach is to work privately with a single customer on captive circuits.

If TI is ahead of the field in producing a programable single chip, the rest of the MOS/LSI makers can't be far behind. North American Rockwell Microelectronics Co., for example, says it has a "matrix of functions included in every conceivable one- or two-chip consumer or industrial calculator in various degrees of completion." And a final mask change is all that is required to complete a given function, says Charles Kovac, vice president.

TI has been talking to customers for nearly a year on the new chip and was expected to announce it in May. The Dallas firm denies it had any problems getting into production. But Kovac, for example, says that two of the customers TI reportedly has for this chip—Bowmar Instruments and Eldorado—should have been on stream last February with the TI chip in their machines. And they are just now getting into volume production.

The Dallas company apparently waited until its production lines were on stream before it publicly announced the part. It already is shipping at the rate of several thousands a month and will step it up to the tens of thousands a month in October, says Daniel Baudouin, TI's MOS standard products program manager.

And these customers are not small makers trying to get into the business without paying for a custom line, Baudouin points out. "Two of the largest U.S. calculator manufacturers are buying our chips," he says, and "four of the top Japanese companies are announcing new machines using the TI chip."

One U.S. company that's building a four-function machine with the TI chip is Eldorado Electrodata Corp. The Concord, Calif., firm says it has signed an agreement with Spiegel Inc. to supply the machine. The Chicago mail order house will carry the calculator in its winter catalog under the "Argyle" name; price is expected to be under $200.

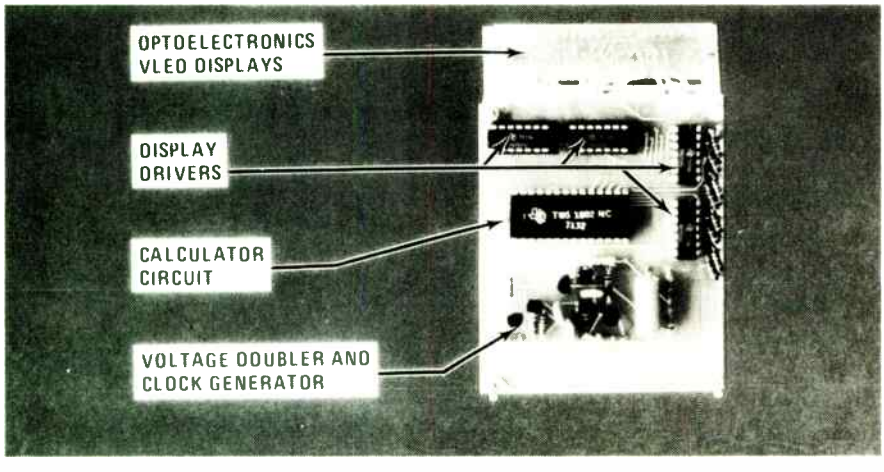
TI says it is selling the single-chip calculator circuit for under $20, but reports are that the price quoted on big orders already in the $12 to $14 range. Other calculator chip makers say that their multichip sets already are competitive with TI's single-chip price but many are hard at work on single-chip designs. Many industry officials feel the only way to the magic $100 retail price tag for calculators—the point at which they feel it will turn into a consumer product, thus creating a much larger market—is the single chip calculator.

In any case, TI's programable chip is impressive for its simplicity and variety of functions offered. It contains a 3,520-bit ROM, a 182-bit RAM, a decimal arithmetic logic unit, control circuits, timing, and output decoders. To get the best yields possible, TI stayed with standard P/MOS processing. Baudouin claims that yields already are high despite the chip's large size. TI's method for programing is another cost-cutter—functional variations of the basic circuit can be made by changing the final photomask step. This takes only six weeks for simple functional changes (like plus or minus) and only two months for a major change—against nine months to a year to develop most custom lines. And any or all of the circuit components can be mask programed—the control, program, timer, data, and drive output.

The chip is housed in a 28-pin plastic dual in-line package. Used in a calculator, it needs only a simple switch matrix keyboard (decoding and bouncing are done on chip), a drive buffer for a LED display (probably no buffer for liquid crystals), and digit interface and a clock generator.

Another unique feature of the TI

Little wonder. TI's calculator on a chip—package in center—is expected to cause a stir.



chip is its expandable layout design, which allows circuit power to be expanded to perform other than simple calculator functions. Called a host chip, the current calculator chip will form the basis of other IC's which can be adapted to more complex calculators and even small computers. Even the present chip, simple as it appears, can be expanded.

Government

DOT wants big boost for rail, highway systems

Development of sensors, data links, and control-system computers for highway and high-speed rail systems will be growth areas for electronics in the '70s. And proponents of new avionics for vertical and short takeoff and landing aircraft (VTOL/STOL) will have to content themselves with extended research and development efforts during the remainder of the decade.

That's the message contained in a massive analysis by the Department of Transportation of congestion problems within the heavily-populated Northeast Corridor, which extends from Boston to Washington. The three-volume, five-year study, which draws on both government and industry analyses, was delivered in mid-September by DOT Secretary John Volpe to the Congress. With it were strong recommendations for both short- and long-term programs to head off increased transportation congestion in the Northeast, including a call for immediate investment of $460 million to improve high-speed rail systems in the region plus another $160 million for highway system improvements. In addition, a heavy investment in diversified transportation technology R&D is required now in order to make decisions by 1976 on "next-generation" systems needed for the 1980s, Volpe said.

The DOT secretary was careful to outline to Congress that the Nixon Administration recommendations for the region "are not to be construed as legislative proposals," though they will need appropriations for implementation by the department. Unofficial comments in Washington suggest that the President now is considering a DOT request for a major increase of "several hundred million dollars" in its fiscal 1973 budget, to be delivered to Congress in January.

For the remainder of this decade, DOT wants to improve existing high-speed rail systems in the corridor. Of the $460 million required to make the improved system operational in three years, the share for electronic car controls and improved switching systems is unofficially estimated to run as high as $40 to $45 million.

In the same time frame, the DOT report calls for an investment of about $80 million for early implementation of a real-time highway information system as a high-priority goal. While Federal sources say the system for the corridor would not require the complex level of electronics in DOT's electronic route guidance system killed by Congress more than a year ago [*Electronics*, June 8, 1970, p. 69], the new information system is expected to draw on the R&D effort for continuous acquisition of data on traffic flows by roadside sensors, data transmission to analysis centers to determine optimal intercity routes, and communication of information to drivers by radio or freeway-sized roadside display panels. Vehicle sensors, the study said, could draw on radar, infrared, magnetic, or sonic technology.

Work also should begin now on an intercity information system for the corridor anticipated to cost $50 million for capital equipment. Additionally estimates for an advanced freeway surveillance and ramp-metering control system run to $30 million more.

Short-haul air traffic in the Northeast Corridor using STOL and VTOL "is not considered practical" in the 1970s, according to the study, because of insufficient cost data on terminal and air traffic control systems as well as unresolved "environmental considerations" essentially dealing with "noise, air pollution, and safety."

Computers

RCA drops out of computer production

To RCA's Computer Systems division employees, the company's abrupt decision to withdraw from the general purpose computer business was as shocking as it was to the rest of the computer world. Completely in the dark were executives just transferred from Cherry Hill, N.J., to the new Marlboro, Mass., headquarters, those still overseeing the construction of the $35 million Marlboro complex, and the engineers who had developed new additions to the computer line, including a new small computer.

The big question, of course, is what will happen to the computer business with RCA throwing in the towel? Gaining the most will likely be IBM Corp., the Armonk, N.Y., giant which already has over two-thirds of the business. RCA was committed to gaining the number two position—a 10% market share—largely by replacing IBM computers already installed.

RCA's dollar share of the market was estimated by Arthur D. Little to be about 3.8% at the end of 1970. And sales, if not deliveries, were picking up. By 1975, Little estimated, RCA's share of market could have been in the 5% to 9% range.

"I doubt that any of the other computer firms will pick up much from RCA's account lists," says a Little spokesman. "Managers know that IBM will stay in business but will harbor suspicions about everyone else from Honeywell on down. RCA not only has hurt itself, but made every other large mainframe maker suspect except the one they were out to profit from—IBM."

He feels that although RCA must now write off $250 million and affect as many as 10,000 employees with its decision, just as much impact will be felt in other mainframe firms. "Just as cadres of data processing experts were becoming able to advise their companies on the price-performance advantages of computers other than IBM's, this has

happened—giving both the cadres and the independent [non-IBM] mainframe makers a black eye."

Faulty cost projections may have been at the root of RCA's decision. Committed to becoming number two, top management may have failed to realize how much money and time would be involved.

In pulling out, RCA said the price was simply too high for it to continue in the computer business. "The hell of it is that we didn't think we were doing that badly," says one RCA executive at Marlboro. "We knew all our sales would be hard, but we were slowly beginning to gain a foothold among customers who formerly would buy only IBM gear."

What RCA will do with its mainframe computer operation is unclear. The company says it would sell or otherwise dispose of it, but the company reportedly has already been trying hard to sell the operation. It does plan to continue in "specialized data communications systems and specially designed business systems." These markets, however, are felt by many to be as tough a market as the one it decided to leave Sept. 17.

Optoelectronics

Fairchild joins 256-diode optical scanner club

Perhaps the most crucial component in optical character recognition and facsimile equipment is the sensing array: it must have enough sensors to provide sharp resolution plus a scanning mechanism integrated on the chip. Oddly enough, only two American optoelectronic component makers have been able to meet those requirements. Reticon Corp. of Mountain View, Calif., says it has shipped samples of its 256-element self-scanner and will soon be in volume production [*Electronics*, Sept. 13, p. 25], and now Fairchild Semiconductor has come in with its version—also a 256-diode linear array—to complement its 96- and 128-element models.

Like Reticon's, the Fairchild chip scans the diode array with a matrix of MOS shift register counter stages—a four-tier arrangement that yields the maximum number of shift register elements per linear direction of array. This is necessary because the photodiode sensors are on 1-mil centers, making the total length of the array only about 0.25 inch.

It has a 1-megahertz scan rate, but experiments indicate that operation up to 5 MHz and above is possible. Such speeds should go a long way toward satisfying makers of OCR equipment—one Fairchild customer is Recognition Equipment Corp. of Dallas—who feel they need that kind of zippy scanning for such proposed systems as a postal reader.

Fairchild designed its sensor for minimum noise conditions, also a strong OCR requirement. The device presently has a 35:1 signal-to-noise ratio, which is the noise of the clock.

Conceptually, adding tiers of shift registers would allow even higher packing densities, but because of the close spacing of the photodiodes the chip may already be metal-limited. The sensors have been placed close to the edge of the chip, and the chip has been designed with a precision interface that permits arrays to be close together—an arrangement that could lead to a hybrid technique Fairchild calls the bilinear array.

Fairchild envisions an array of linear sensors staggered by only a few thousandths of an inch. Such spacing could lead to an infrared mapper in which many 256-element chips would be combined with appropriate sampling circuitry and relatively few leads would be needed per array.

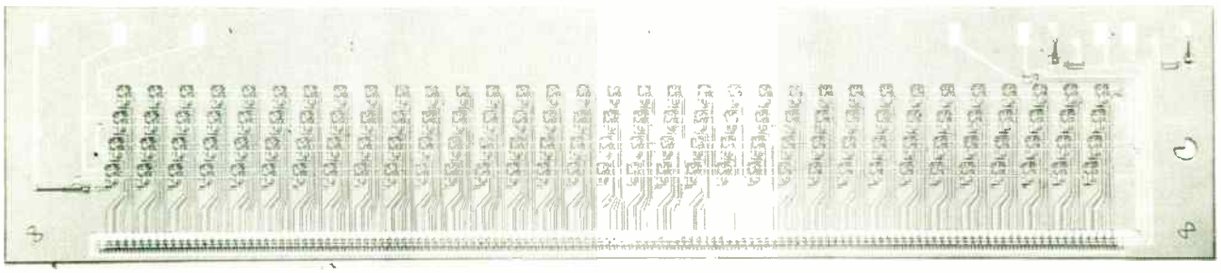
Memories

AMI primed for speed with 1103-type part

"When you're in a race and you get out in front, don't look back, just run like hell. Now that we've got the first 150-nanosecond 1103 memory in production, we're going to run with it." That's the word from Warren C. Wheeler, senior vice president and general manager of American Micro-systems Inc. The reason for his ebullience: AMI has licked the problems of making an 1103-type 1,024-bit random access MOS memory with an access time of 150 nanoseconds and a cycle time of 250 ns [*Electronics*, June 21, p. 29].

According to Wheeler, AMI can produce 5 million bits worth of 150-nanosecond memory in October. This will increase to 10 million bits in November, 25 million bits in December, "and by the first quarter of 1972," he notes, "we'll be producing 100 million bits each month." AMI, like Intel and the other 1103 memory producers, has been trying to build parts that meet Intel's original 150-nanosecond spec. "Speed by itself was not the major problem," says Zvi Grinfas, senior member of the technical staff at AMI; rather, it

On the line. Fairchild's self-scanning 256-diode device has 1-megahertz scan rate, but has reached 5 MHz in the laboratory.



was "in making a memory chip that was compatible with systems designed around the Intel spec."

With the AMI part, called the S-2103, "and a clever systems design," a memory can be built with a 250 ns access time and a 500 ns cycle time, Grinfas says, the specs that Data General was shooting for in its semiconductor memory.

Wheeler points out that "It's easier to start from scratch with a specific customer in designing a new 150-nanosecond part than it is to work with a set spec." AMI has the high-speed part designed, he says, and "from here a 2,048 is as easy as turning on the machine and if I thought it was in our best interest to do so, I could build a 4,096-bit, 200-nanosecond RAM in six months—all I'd need is a contract."

But Wheeler questions whether it would be wise to use today's technology to produce a 4,096-bit part instead of waiting six to nine months and make a better one with a new or improved technology. And what may be even more significant, he questions whether the semiconductor memory market is going to be for standard or custom products. "Now that we've got the 150-nanosecond part and can build it in volume," he says, "we have to wait and see what the market will do."

Employment

New grads suffer unemployment burden . . .

Bearing the brunt of the current unemployment crisis in engineering seems to be the lot of the under-30 generation of EEs, with this year's graduates hit hardest. In a survey of 144 college placement offices to be published this year by the Engineers Joint Council, 11% of this year's EEs and 9% of all engineers had no job offers or firm plans at the time they received bachelor's degrees—more than double the 4% in the same predicament at the time of graduation in 1970. Less than 1% of all engineering graduates were uncommitted at graduation in 1966–69.

How this year's grads fared

	BS		MS		Ph.D.	
	EEs	Total engrs	EEs	Total engrs	EEs	Total engrs
Accepted employment	51%	52%	66%	63%	87%	84%
Considering job offers	3	3	2	2	3	3
To grad school	20	20	21	21	3	3
Military service	14	14	7	8	2	3
Other plans	2	2	3	3	2	4
No job offers or plans	11	9	2	2	2	4

"Yet I can't feel that the EE graduating class is in serious trouble," says John Alden, director of manpower activities for the council and executive secretary of the Engineering Manpower Commission. There are some indications that this oversupply of newly graduated EEs may work itself out. "We're getting reports back of substantial decreases in freshman engineering classes, and of increasing attrition in the upper classes," Alden continues. "The supply, at least for the immediate future, is almost static."

But it's precisely that decline in science-engineering enrollments, with the abrupt leveling off of Federal support of R&D, that is creating a partial vacuum in the two largest markets for Ph.D.s—academia and R&D. New data from the National Research Council shows that the job opportunity curve for newly graduated Ph.D.s continues to fall—2.6% of new engineering doctorates were jobless or working at jobs they were overqualified for, up from last year's 1%. On the brighter side, the report concludes that "in spite of the emergence of large numbers of new doctorate recipients each year"—and U.S. Office of Education statistics show the number of Ph.D.s awarded in engineering skyrocketed in the sixties, with employers sopping up annual increases averaging 17%—"the economy has found room for almost all recent recipients of the doctorate."

Whether the excess can continue to be absorbed remains to be seen. "Faculty members have tended to produce Ph.D.s in their own image, with a minimum of thought as to the needs of the industrial sector of the job market," Stanford University Vice-President Frederick E. Terman contends. "Yet the industrial sector must be depended upon to provide jobs for the bulk of the Ph.D.s in the decade ahead."

. . . yet forecasts predict EE deficit

While the immediate prospects for an expanding science-engineering job market remain bleak, almost all manpower observers agree that the current surplus of engineering personnel eventually will become a deficit, although they don't agree when.

Wallace R. Brode, representative of the American Association for the Advancement of Science to the Scientific Manpower Commission, predicts that the surplus of engineers that developed between 1968 and 1970 will peak at perhaps a 10% surplus by 1983, and then begin tapering off to an eventual shortage by 1987, "and possibly earlier, depending on our technological growth rate." Brode's projections, which run through 2025, assume that the supply of scientists and engineers remains the same, fixed percentage of all 22-year-olds—a constant proportion since 1958. His projections are admittedly conservative—a 1970 Engineers Joint Council study indicated shortages of engineers again by 1975. But EJC admits that it is rethinking its prediction in the light of recent developments, such as a change in the U.S. Bureau

Electronics review

of Labor Statistics demand figures.

"In the long run," Brode continues, "it will be the exceptional situation in which the supply of scientists and engineers exceeds the demand, since the population is expected to stabilize, and thus sets limits on the supply."

The long-term outlook for Ph.D.s is not quite so bright as that for the more flexible younger engineers. Even the most cautious estimates project as many doctorates from 1971 to 1980 as have been granted by American colleges since the first Ph.D. in engineering, together with the changing job market for Ph.D.s, will create a serious oversupply by 1980—a surplus estimated by the National Science Foundation to be more than 40% over the projected utilization.

Consumer electronics

RCA fights to increase its color-TV lead

RCA has launched a three-pronged attack to gain the edge in consumer products against stiff competition from the Japanese and U.S. firms using off-shore production. In addition to exploiting materials technology, particularly ceramic substrates, the company is buying and developing new automated assembly and testing equipment. It's also getting into what it calls "vertical integration"—making use of in-house facilities for manufacturing products from the ground up.

Ceramic substrates really are the key element in process automation because of their adaptability to automated assembly and high reliability. Robert A. Schieber, operations vice president for consumer products, says "By going to ceramic, we can make circuits for the same price as conventional printed circuits are made in Taiwan, but ours are more reliable."

Schieber also points out that his company doesn't just assemble TV sets, but manufactures them." At the huge Bloomington, Ind., plant near Indianapolis, the alumina for the ceramic substrates is mixed and baked, modules are stamped out, conductive inks are applied, resistors and capacitors screened on and the circuits are built up, and inserted into four of RCA's solid-state color TV sets. RCA also makes its own deflection yokes, ferrites, and even the wood cabinets.

Right now, four of the 12 plug-in modules comprising all the circuitry for a solid state color TV set are ceramic, and Schieber expects that eventually all circuits could go ceramic. Two major problems yet to be solved are the lack of high-voltage transistors, and the development of conductive inks that can withstand high voltages.

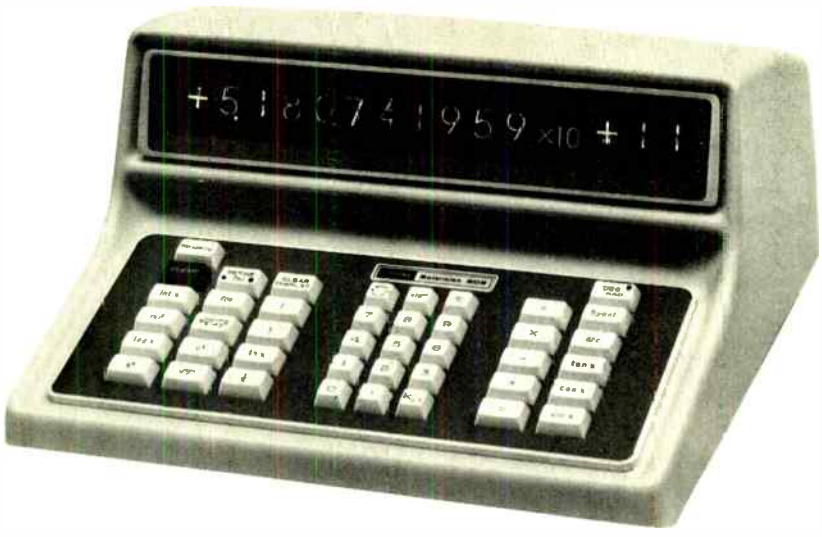
Whether or not RCA's $5 million facility for producing ceramic devices will be instrumental in stemming the flow of TV sets from Japan into the American market remains to be seen. But with RCA's new Bloomington plant producing 10,000 sets a day—half of them color TV—the effect could be felt by next year. Then it will be seen whether RCA can increase its lead as the largest color TV supplier.

Components

Multiplier has sealed-in resistor for safety

Voltage multipliers are widely used in high-voltage power supplies applications, including lasers, cathode ray tubes, and night-vision image intensifiers. Voltage going into the multiplier might range from 200 to 6,000 volts and be stepped up to 25,000 V or more. But one problem was that a bleeder resistor had to be used outside the multiplier to drain away built up high-voltage charges so that workers handling the power wouldn't be endangered. This arrangement precluded potting of the resistor, thereby sealing all the high-voltage connections inside the multiplier.

A new kind of high-voltage resistor developed by Semtech Corp. of Newbury Park, Calif., solves the problem. Harvey Stump, Semtech's



COMPARE CALCULATORS!

If you're looking for a programmable calculator, ask these questions:

YES NO

☐ ☐ Can you write equations directly on the keyboard in mathematical form, bypassing computer languages?

☐ ☐ Is correct algebraic hierarchy automatically observed in performing all functions? Press 2 X 3 + 4 X 5 =. Do you get the correct result (26) instead of 50?

☐ ☐ Will it solve complicated problems and still be easy enough to operate without special training?

☐ ☐ Is every function and program clearly and uniquely defined by the key sequence (without modification by toggle or rotary switches)?

☐ ☐ Does it have individual left and right parentheses keys that allow you to solve directly expressions such as: $((a+b) - c \div d) \times (f-g) = ?$

YES NO

☐ ☐ Does it have a true *equals* key to display partial sums or total results immediately?

☐ ☐ After a questionable procedure, does operation continue using the best available data? (With an unmistakable indicator showing an assumption was made?)

☐ ☐ Is 10 significant-figure accuracy maintained after repetitive sequences such as $\ln x - e^x - \ln x - e^x \ldots .$?

☐ ☐ Are there a sufficient number of stored constants (26 or 100) that are separate and independent from the program steps?

☐ ☐ When data such as $6378.388125 \times 10^{-13}$ are entered, does the data appear correctly, or as $6.378388125 \times 10^{-13}$?

YES NO

☐ ☐ Does it have hard-wired x^y, $\sqrt{x^2 + y^2 + z^2 + \ldots}$, trigonometric, hyperbolic and other functions?

☐ ☐ Can you write, store and recall constants and equalities through direct and indirect addressing?

☐ ☐ Does it have simple key access to a wide range of peripherals including a 5120-step programmer, printer, X-Y plotter and TTY interface?

☐ ☐ Will the calculator serve as the heart of a data acquisition system or minicomputer for on-line data processing?

☐ ☐ Can you get prompt, reliable factory service?

☐ ☐ Is the basic calculator priced at no more than $3200?

☐ ☐ Is it still a money-saver if you add on the "cost of learning" for the people who will operate it?

Every answer is yes for one calculator...

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High-voltage DC power transmission and control problems are now under study at Hughes' Malibu, Calif. research laboratory. The original research currently being conducted on DC converter valves and circuit breakers stems from the company's earlier ion-propulsion research for NASA. The Electrical Research Council, which represents America's private and public utilities, is partially funding the development of the Hughes DC breaker.

Electric power specialists from 13 countries, who were attending a CIGRE conference in Los Angeles on AC-DC converting equipment, reviewed the work in progress during a visit to the Hughes laboratory recently.

A hand-held, wide-angle optical transceiver that provides clear, secure communications up to three miles has been developed by Santa Barbara Research Center, a Hughes subsidiary. It resembles a binocular, weighs only four pounds including the rechargeable battery, and can be reliably operated after minutes of instruction. It was designed as a low cost walkie-talkie in line-of-site communications applications, such as ship-to-ship, ship-to-shore, helicopter-to-ground, and land-based operations. Other optical communicator designs provide secure communications over ranges up to 15 miles.

More than a million hours in space without a failure is the record to date of the traveling wave tubes built by Hughes for all the Syncom, Intelsat, ATS, TACSAT, Mariner, and Lunar Orbiter satellites and the Surveyor and Apollo spacecraft. Though the Syncom II satellite was designed for a six-month experiment, its TWT is still operable after eight years. The TWT for Canada's Anik I domestic synchronous communications satellite is expected to operate for more than 12 years.

The first tri-service validation of an Air Force contractor's program performance measurement system was won by Hughes recently on the cost-schedule control system for the Maverick missile program. Maverick -- a TV-guided air-to-ground missile -- is being developed under a "total package procurement" contract. It has completed flight tests by Hughes and is now in USAF's Category II flight test.

Hughes needs Systems Engineers for systems design of training simulators. Requirements: BSEE, U.S. citizenship, and a minimum of 10 years experience in the design of systems involving digital computers, displays, and solid-state circuitry. Experience in training simulators desired but not mandatory. Please write: Mr. R. J. Waldron, Hughes Aircraft Co., Field Service & Support Div., P.O. Box 90515, Los Angeles, CA 90009. An equal opportunity M/F employer.

Thermal emission from the planets Venus and Mercury will be measured by infrared radiometers built by Santa Barbara Research Center during the 1973 Mariner fly-by mission. The data will enable scientists to determine the thermal structure and cloud-top temperatures on Venus and the surface temperatures on both the day and night sides of Mercury. SBRC is building the instruments for NASA under the direction of Jet Propulsion Laboratory.

president, believes he's come up with the solution in a ceramic high-voltage resistor that's much like a coil spring. Instead of having the resistive ink coated on what ends up as a continuous ceramic substrate with several "turns" of ink, Semtech applies the ink to the ceramic substrate and then saws through the substrate, leaving a helical resistor with nothing between the turns or "lands." This design makes the resistor flexible so that it expands and contracts when the voltage multiplier is potted.

Semtech engineers previously had tried to put conventional precision, glass-encapsulated, high-voltage resistors inside the multipliers they make, but the different coefficients of expansion of the glass and potting compound caused the glass to break when the potting compound cured. The glass-encapsulated, high-voltage resistors also aren't able to handle much more than 10,000 v, which isn't high enough for some of Semtech's voltage multiplier applications. Tubular ceramic resistors rated at well over 100,000 v are available, but they might be 18 inches long—too big to put inside the multiplier and protect handlers from high voltage.

There are some side benefits that Stump thinks can be traced to his new design, although he insists that he's not a resistor authority, and Semtech's measurement equipment isn't optimized for resistor evaluation. "But we've measured a three-quarter-inch-long resistor with 25,000 v on it, which is equivalent to about 30,000 v per inch, and we got the same resistance value as we did when we put only 2% to 3% of that voltage on it," Stump observes.

This suggests that there's virtually no voltage coefficient of resistance—a change in resistance value with a change in applied voltage. This hasn't been the case with conventional high-voltage resistors, Stump says, and constitutes a detrimental feature. He thinks the Semtech design has done away with the leakage or voltage gradient between turns of the conventional high-voltage resistors, caused, he feels, by a surface effect between the turns on the continuous ceramic substrate. In the Semtech device, once encapsulated, the potting compound fills in between the turns on the resistor. The potting compound is a homogenuous bulk instead of a surface, and Stump believes the bulk effect negates what little leakage may occur in the Semtech resistor.

It's his opinion, too, that the surface effect that's responsible for leakage in conventional high-voltage resistors is what causes noise in those devices. By virtually eliminating the leakage, Semtech has practically done away with noise, which should make the resistor attractive for instrumentation applications.

Stump's intention initially is to make the flexible resistors for Semtech's own voltage multipliers.

For the record

Heart aid. A demonstration prototype of a hospital surveillance system which has the potential to monitor every patient's heart functions in a more efficient, effective, and less costly manner than those now in operation in intensive-care units has just been installed at Mount Zion Hospital in San Francisco. Lockheed Aircraft Service Co., Ontario, Calif., built and helped develop the system. Three wires, attached to a patient's chest, are hooked to a small bedside monitor, which then is linked to a central console as well as an oscilloscope and an EKG printout. If a patient's heart malfunctions, the console signals the alarm with a chime and a flashing red light over his panel. Then the nurse switches on the single oscilloscope and EKG printout for that patient and by looking at the tracings, she can determine rapidly the extent of the problem.

New light path. A fiberoptic light guide called Crofon IRX is said to "greatly improve" the infrared transmission from light-emitting diodes, such as those made of gallium arsenide. Manufactured by E.I. du Pont, the fiber is a continuous filament 5 mils in diameter. Quadri Corp. of Phoenix says it will use the fibers in its computer memory.

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Washington Newsletter

September 27, 1971

White House names Magruder to draft '72 technology drive

A new set of technological "game plans" designed to cut unemployment in aerospace and electronics is being pulled together for President Nixon by his newest aide, William A. Magruder, former project officer for the Department of Transportation's defunct supersonic transport. From Magruder's efforts as special counsel to the Domestic Council, the President will put together a major program to lay before Congress in January. Its aim will be to spur industrial innovation through tax and antitrust plans as well as programs to cure domestic ills with technology.

Though Magruder's appointment was disclosed in mid-September, he has been working on the project since late spring, shortly after the President had discussed unemployment with aerospace leaders and requested a list of technological priorities from them. Due on Magruder's desk by Oct. 1 are plans for employing electronics and other technologies on communications, social and ecological needs. Coincidentally, White House science adviser Edward E. David is drafting an identical plan.

Army to prepare RFPs for new laser program . . .

The Army plans initial funding of "several million dollars" before the end of the year of a major program called LDSS for Laser Designator Seeker Systems, but has yet to publish requests for proposals. Management of the effort, which will probably have one prime contractor, will be split evenly between the Electronics Command, Fort Monmouth, N.J., and the Missile Command, Huntsville, Ala.

The electronics command will be responsible for the development of hand-held laser rangefinders and target designators, to be used by forward area troops as a guide to artillery. Rangefinder/target designators, probably neodymium-YAG operating at 20 pulses per second, would be used in the rangefinder mode with conventional ordnance, while target designators—including a 10-p/s model with that function only—would operate with shells and helicopter-launched missiles equipped with optical seekers. Huntsville's missile command will oversee the LDSS program's helicopter-borne hardware requirements.

. . . as part of major $28 million weapons project

The LDSS program is one segment of a larger, five-part optical weapons project on which the Army wants to spend $28 million this fiscal year, but which is still subject to some criticism. It's said, for example, that the new Hellfire missile that would operate with LDSS would duplicate the Navy's Bulldog and some Air Force programs. Nevertheless, the Army is confident of Congress's approval, particularly after its successful demonstration of the concept using Little John missiles and Texas Instruments equipment at White Sands Missile Range earlier this year [*Electronics*, March 15, p. 54]. Other components of the Army program include artillery shells equipped with optical seekers, and radar area correlation guidance for terminal bombing of "submissiles," a totally new concept.

Space failures linked to Soviet cooperation

The extraordinary willingness of the U.S.S.R. to share its civilian space program data with the United States [*Electronics*, Sept. 13, p. 40] puzzled some Government space officials until they learned from military space communications monitors that both Russian Mars probes have stopped transmitting.

Washington Newsletter

The presumed Soviet failures are the fourth this year and, along with the crash of its lunar lander Luna 18 on the moon in September, raise to three the number believed attributable to failure of communications systems. **Communications is also the area to which the Russians assigned 10 of their 18-man delegation in the first round of U.S.-Soviet space cooperation talks.**

DOT focuses on automated highway travel after 1985

Research on dual-mode transportation—vehicles that operate under their own power on existing roads or automatically over a guideway system—is now being concentrated in the Department of Transportation's office of systems engineering, with components drawn from DOT's high-speed rail, highway, and urban mass transit groups. Although the department doesn't foresee a sizeable dual-mode system in operation before 1985, its recent report on Northeast Corridor transportation [see p. 25] predicts that future travelers will find today's concept of highway travel obsolete.

DOT is now looking for companies to research dual-mode systems, develop specifications for hardware, and perform cost-benefit analyses. **"We expect to proceed within a year or two with specific system development," says Robert Maxwell, the office's assistant director, "and we envision an urban demonstration system shortly after that."**

Military academy for medicine could boost technology

Medical electronics could get a significant push from the creation of a new Uniformed Services University of Health Sciences, a military medical school similar to the other services academies at West Point, N.Y., Annapolis, Md., and Colorado Springs, Colo. The project, estimated to cost $101 million over 10 years, is a long-time dream of Rep. F. Edward Hebert (D., La.), chairman of the powerful House Armed Services Committee. **A bill to locate the new academy within 25 miles of Washington is now in the hearing stage,** and has strong Pentagon support.

Senate to weigh dissolution of industry giants

Legislation aimed at splitting up the long established giants in concentrated industries will be introduced in a few weeks by Sen. Philip Hart (D., Mich.), head of the Senate antitrust and monopoly legislation subcommittee. The lack of price competition is the root of inflation, Hart says, and the alternative is wage and price controls forever.

Targets of Hart's bill are likely to be the highly concentrated industries named in early September in a report of the House antitrust subcommittee. **Included in the list were manufacturers of computing and related machines, aircraft, telephone apparatus, and cathode ray tubes.**

Addenda

Albert C. Hall, vice president of Martin-Marietta and chairman of the Defense Intelligence Agency's science advisory committee, is being touted as top candidate for Assistant Secretary of Defense for Intelligence, one of two new assistant secretaries that DOD chief Melvin Laird wants authorized by Congress [*Electronics,* March 15, p. 53]. . . . **GTE Sylvania Electric Products has pulled down an $8.9 million Army contract for the first lot of 18 sets of AN/TIC-38(V) switches,** originally proposed as an interim Tri-Tax switch [*Electronics,* June 21, p. 31]. . . . Application of phased-array radar techniques to an advanced Air Force airborne warning control system (Awacs) is being studied by Hughes Aircraft and Westinghouse Electric under two $500,000 contracts.

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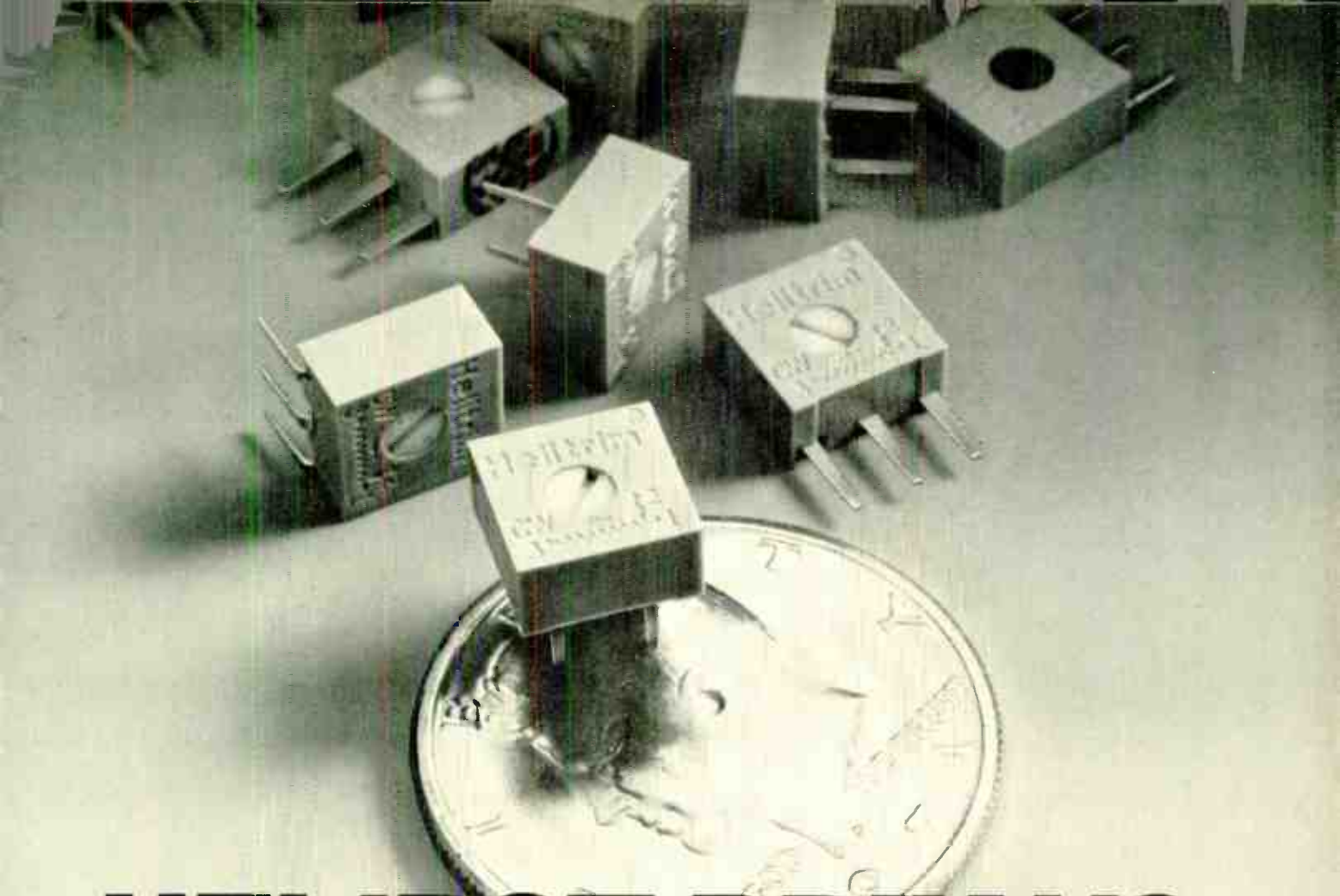

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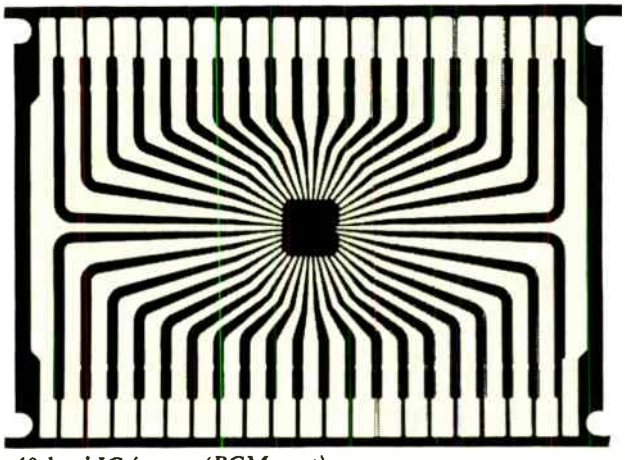

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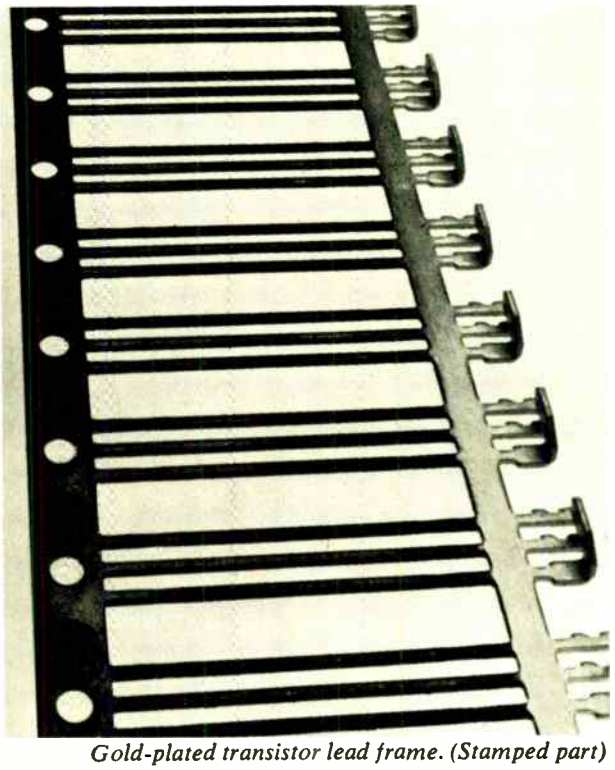

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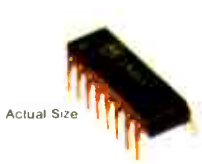

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Circle 42 on reader service card

Technical articles

Two-way cable TV paves the road to the wired city: p. 44

When it enters the city, two-way cable TV will have to abandon rural simplicities or fail to fulfill the promise of the wired city concept. Five authors look beyond the FCC's latest stand to discuss the markets two-way TV systems will open up, the need for systematic planning, the equipment required, and the involvement of computer technology.

The cover: The printed circuit board meets the manhole cover as electronic two-way cable TV prepares to go under the streets and into the homes of tomorrow's wired city.

Electronic thermometers give fast clinical temperature readings: p. 56

Medical personnel have more important things to do than wait around for the three minutes or longer required for a reading on a clinical mercury thermometer. Doctor's little helper, says author Larry Hunter, is the electronic thermometer that gives an accurate reading in 20 seconds; it measures the rate of temperature change and then uses it to extrapolate a temperature-vs-time curve to come up with a fast, steady state oral reading.

Optinet will see you through from design to marketing: p. 64

Introducing a new electronic product involves more than just design and analysis—the limits of conventional computer-aided design programs. Now there's Optinet, says author Robert Hall; it's a total software package that goes far beyond design and analysis to be used to control and adjust production runs and expedite marketing procedures, too.

Engineers of America, unite! p. 72

That's the consensus of respondents to a poll in the Aug. 2 issue. Asked if they favored formation of a new national group of engineers, our readers overwhelmingly voted yes, with 56% backing a professional organization along the lines of the AMA and another 22% calling for a union. Those in favor of the professional organization stressed performance standards and status issues as much as job security, while the union advocates mentioned the need for a strong bargaining agent with company management. Also high on the list of EES' priorities were licensing of engineers and portable pensions.

And in the next issue. . .

Minicomputer aims for big-computer jobs . . . computer modeling for zener diodes . . . Impatt diodes fit millimeter wave applications . . . multilayer pc boards for phased arrays . . . bit-error rate detector goes digital.

Stringing the wired city: two-way TV descends from blue sky to real world

Cable TV is getting set to enter the big cities in a big way; bidirectional services promise a raft of new services, and eventually the home screen will become a data terminal

by Gerald M. Walker, *Consumer editor*

☐ How are you going to keep CATV down on the farm now that it's seen the city? The answer is, you can't, although the regulatory ban on entering the 100 top U.S. markets has been long in lifting, and it may be one to three years before the FCC's formula permitting this move finally gets in gear.

The aim in expanding cable into urban centers is far different from CATV's original goal of boosting weak over-the-air broadcast signals for the TV-deprived countryside. For populous areas, which may have up to seven vhf channels vying for their attention, this aspect has less appeal. Instead, the "wired city," the name now given to the dream of cable in metropolitan land, refers to the wide range of broadband communications services that coaxial cable can carry into the home aside from the networks' wasteland offerings. Most radically, the wired city opens up the possibility for two-way communications between subscriber and a central processor, itself made possible by a coax's capacity to handle up to 40 channels.

Yet CATV has been embroiled in regulatory hassles in Washington for so long it's easy to forget that the wired-city vision is also clouded by operational problems. The first is how to implement two-way communications—whether with bidirectional versions of one wire systems, with complete two-wire systems, or with a combination. Another problem is the relatively limited ability of CATV operators to generate the software for all the non-network channels piped to subscribers. A third is deciding what type of subscriber terminals will best do the job of interacting with the cablecaster.

More staggering is the job of planning a new, complex communications system for services as diverse as two-way education, two-way security alarms, and standard one-way entertainment. Such a system will involve purchase of transmission, distribution, and program origination equipment along with computers or time-sharing arrangements, hard-copy peripherals, and special meter-reading sensors and couplers. Over $2 billion will be spent on CATV equipment during the '70s, predicts the market research company, Frost & Sullivan Inc., New York.

By 1975, the firm estimates, signal processing equipment will be worth $15 million a year, distribution gear will reach $76 million annually, cable, $60 million; and converters, $30 million. Another research firm, Arthur D. Little Inc. of Boston, predicts that in 1976 $240 million will be spent on signal processing equipment, amplifiers, bridges, line extenders, individual customer "drops", and television set converters. And by 1980, Frost & Sullivan adds, CATV operators will invest at least $410 million in hardware compared to the less than $100 million laid out in 1970. In short, the experts agree that the wired city presents a profitable vista to equipment and cable suppliers.

An indication of the wired city's potential demand for two-way system equipment is appearing in the handful of test systems running now. The first trials have generally been in CATV's traditionally strong, nonmetropolitan areas, but this fall the first big-city programs will go on line. By the end of the year evaluation of two-way burglar alarms, meter reading, shopping by TV, and on-demand special information, computer-aided instruction, and other forms of home education will be in full swing. But as of now there are bewildering arguments over which two-way services to pursue. For the long term, obviously, the most sensible move would be to install bidirectional systems with capacity to provide the entire range of services, even if only one or two can be afforded at the beginning.

Cost versus profit potential is the prime concern of the operator. On the other hand, the local government with franchising power may stipulate certain community services, such as neighborhood program origination, as a prerequisite for signing the cable agreement. (After a period of relatively easy franchising, communities are getting more and more demanding in awarding CATV contracts.)

Adding to the confusion is a numbers game on cost per service now in full swing. But until the industry fully evaluates the experience gained on the trial systems, the figures flying around on investment and revenue are rather uncertain. For example, a recent Arthur D. Little estimate of the investment per subscriber required by a 20,000-terminal system to provide full two-way capability drew substantial criticism from cable men attending the National Cable Television Association convention (*Electronics*, July 19, p. 27). Little put the figure for upgrading frequency-division multiplexed systems now used for one-way transmission at $255 to $285 per subscriber and $380 each for a 24-channel space-division multiplexed system. Critics said the frequency-division multiplexed estimates were too high and the space-division multiplexed projection, too low.

The numbers game is also blurring the picture inside the subscriber's home. For example, meter-reading instruments can be installed for as little as $15, say manufacturers, and would automatically provide a utility with information for which cablecasters might expect to charge $1.25 to $2.50 a month per meter. Critics say meter reading won't work unless there is virtual saturation, and besides the sensors cost too much. For the cable caster who wants to go into the alarm business, security systems manufacturers estimate that a complete fire-burglar installation would cost a subscriber $150 to $200 and that the CATV operator could charge $2 to $3 a month for the service.

Though operators are puzzling over the relatively low-cost ancillary services in the offing, the real blockbuster is completely interactive audio communications, which is particularly desirable for education. Public-minded money founts such as Ford, Markle, and Sloan Foundations have invested considerable amounts in planning for education in the wired city. One plan calls for a kind of interactive Sesame Street, in which kids could send replies via pushbutton terminals to questions posed on the home screen and find out immediately if their answers were correct. Like Sesame Street, it appears that much of educational CATV may have to run on public grants, this time over leased channels.

So while cable operators and equipment manufacturers are juggling the costs and profits of the wired city, it's clear that city governments, community groups, and educators will be important factors in shaping the programs and services in this new communications medium. With the many forces pulling and tugging to get in on the action, the real challenge seems to be not the technical capability to perform the many wonders promised, but the vast systems complexity that confronts any massive urban project. Whether the existing breed of cable entrepreneur is up to the task or whether it will take a new breed of systems-oriented technocrats will be seen in the next few years.

As FCC Chairman Dean Burch told cable operators, CATV's potential is not limited just to what the commission may or may not require. He pointed out, "I stress again that what principally is involved is your definition of your own industry—and your response, minimal or generous, tunnel-visioned or imaginative—to the opportunity." If the cable interests seek maximum public service, he added, "then you can count on a response the equal of your own effort." □

Understanding cable-ese

The typical CATV operation consists of reception, headend, and distribution facilities, each representing a distinct equipment market. The major components of each facility are:

- Reception: directional antennas and microwave receivers mounted on high towers and connected by cable to the signal processing center.
- Headend: a building in the vicinity of the tower containing electronic equipment to convert, modify and modulate signals prior to distribution; in use are channel amplifiers, frequency converters, modulators, filters, and power supplies and current controls.
- Distribution: signal amplifiers to maintain signal strength, power supplies to provide and regulate voltage for transmitting signals, directional couplers and taps to run cable from distribution line to "drop" line on the subscriber's property, and wall plate outlets and impedance transformers for each TV set that will match the 75-ohm unbalanced impedance of the cable to the 300-ohm balanced load presented by the TV set.
- Converters: a supplementary device inserted between CATV cable and the input to the TV set, that expands channel capacity beyond the standard 12 vhf broadcast stations by utilizing unused channels.

The full exploitation of the wired city's potential requires a systems approach

by William F. Mason, *The Mitre Corp., McLean, Va.*

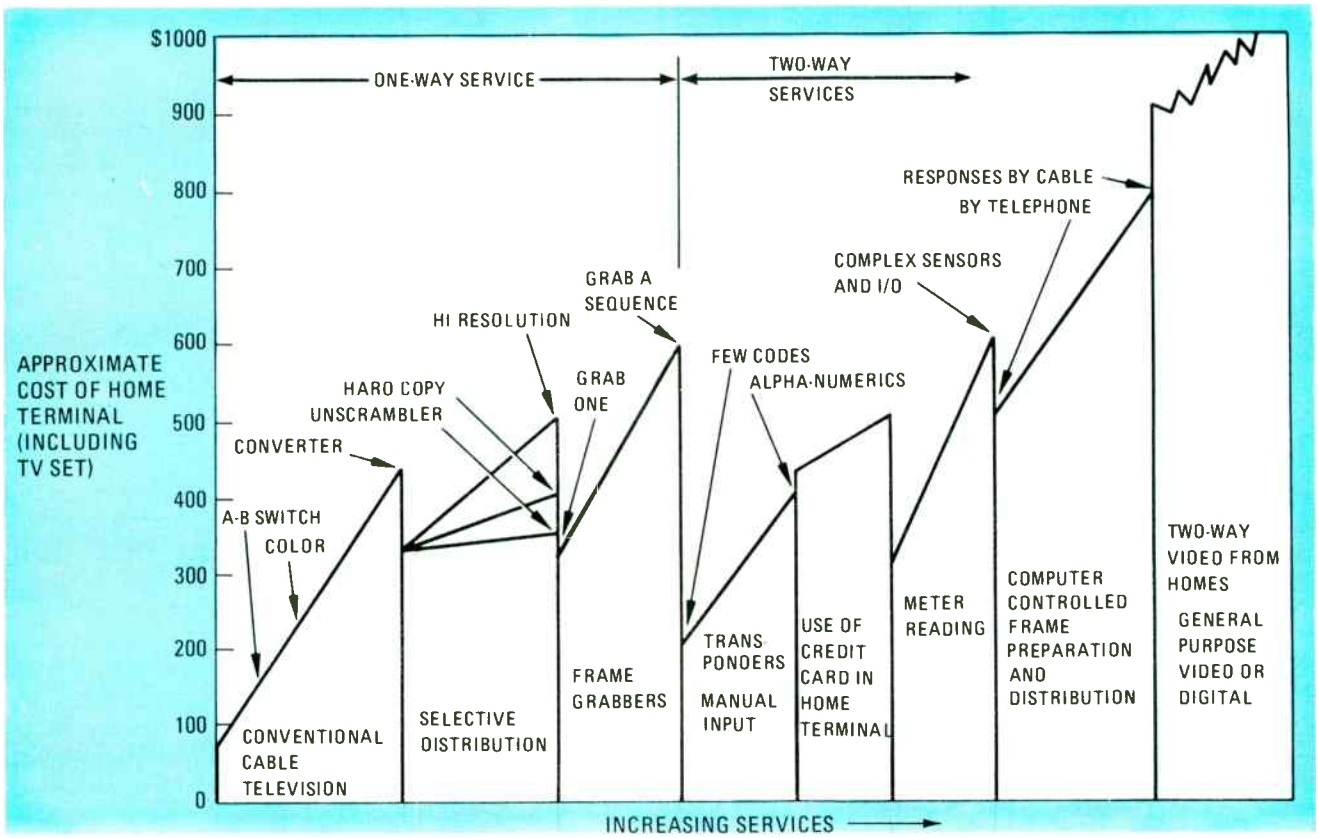
□ Once cable is strung in the top 100 markets,[1] it will be too late for our major cities to have serious second thoughts about the design of their TV communications systems. Those designs will be determined by decisions taken today. But the full promise of the "wired city" concept will never be realized without a systems approach—and that is unlikely to come from either local government or the cable companies.

On the one hand, city planners and decision-makers have a desperate need for additional revenue, while on the other, cable operators and their equipment suppliers are interested in the profits from cable systems. Meanwhile, the public is only interested in conventional TV and is essentially unaware that its long-range interests are not best served by the agreements the two groups are apt to make.

Generally a cable franchise petition offers no more than a promise that the system will provide the city with new income and be flexible enough to incorporate new services as soon as they prove economically viable. No commitment is made to divert any part of profit into public services. The city fathers, acutely aware of their immediate problems and in need of funds to help solve them, may be inclined toward the best proposition they can get in terms of immediate and continuous revenues, even if it amounts to a tax in the form of higher than necessary subscriber charges. This in itself would not be all bad, if whatever the city purchased with franchise funds were more important than the long-term services that a well designed cable system could provide. However, before the city can make an intelligent decision, it must be made aware of the potential benefits of the sophisticated system.

The cable system operator is also biased. Without a firm system obligation, he will implement the most profitable areas. He would hardly go voluntarily into parts of the city where he might lose money. In addition, he is not apt to put profits back into service or system improvements when his stockholders much prefer dividends.

The equipment manufacturer is subject to similar



1. TV menu. Starting with conventional cable programing, all these services will eventually become available on CATV.

economic forces. No matter what cable service he is trying to sell or is asked to consider, some adaptation of his basic equipment line will be used to provide it. It's essential to take an open and thoughtful look at the operational ramifications of any decision. A burglar or fire alarm system, for example, shouldn't be considered independently of its impact on police and fire department procedures and organization. Since there are many such considerations, clearly a systems approach to the evaluation of a cable system is necessary.

The complexities of a wired-city system may require a public organization to manage the franchise. Though this idea might infuriate cable operators, it might insure lower rates, more services, and higher profits. If bureaucratic considerations make public management impractical, a nonprofit group should be set up. Such an organization might also control the urge to convert profits into stockholder's dividends and instead circulate funds back into equipment, service development, and other system improvements.

An urban environment, of course, is very different from the rural one in which CATV grew up. What does this change mean to the cable system planner? Fortunately, the high cost of installing cable in the city is offset by the population density: the installation cost per household is about $100, or about the same as it is outside the city.

One factor holding back cable in the cities is that people there usually have relatively good off-the-air television reception. In addition, large sectors of the city have low-income populations to whom $5 to $7 per month is too much to pay simply for an improvement in signal quality. Lower subscriber rates would help, but the long-term answer is to use the cable system to provide for the telecommunications needs of the city as a whole. By replacing the present hodge-podge of special systems in an integrated and synergistic fashion, the cable system is more likely to obtain the revenue base from which the longer-term interest of both the public and the cable industry can be served.

For cable systems offer two brands of service, one to the homes of the individual subscriber and the other to the city as an operating entity. As part of a large cable system study, eight "technical categories" have been defined. For each category, Fig. 1 gives a range of prices for various home terminals, including the cost of the television set. The important point about the services shown in Fig. 1 is that the single, basic equipment configuration needed for any one service will provide for all the other services in the same category.

The larger view. In other words, planners should consider the entire family of services that can be provided by any proposed equipment configuration, so that a burglar alarm system would be designed in conjunction with a fire alarm system and a meter-reading system.

As operating entities, cities have many communication needs. They already have police and fire call-box systems, and are starting to implement computer-controlled traffic-light systems,[2-3,4-5,6] automatic vehicle-locating systems,[7-8,9] and cellular communications systems.[10,11] All these could be part of a cable network, since a good cable system provides links to every street intersection.

In addition, the city's educational institutions could benefit from interactive cable TV. Banks and other commercial institutions are interested in better communi-

cations between their own branches. The medical community is just beginning to tie hospital and other facilities together so that both digital and video information can be exchanged rapidly.

Cable television services are usually classified as one-way or two-way. The conventional one-way service simply offers more channels. In urban centers, however, as many as seven of the twelve vhf channel positions may be already occupied by strong off-the-air signals. Set-top converters are therefore used to convert all of the cable's channels to one of the TV set's unused channels, making perhaps 20 to 30 additional channels made available per cable installation. Dual cable installations double this potential, but require an A-B switch to skip from one cable to the other.

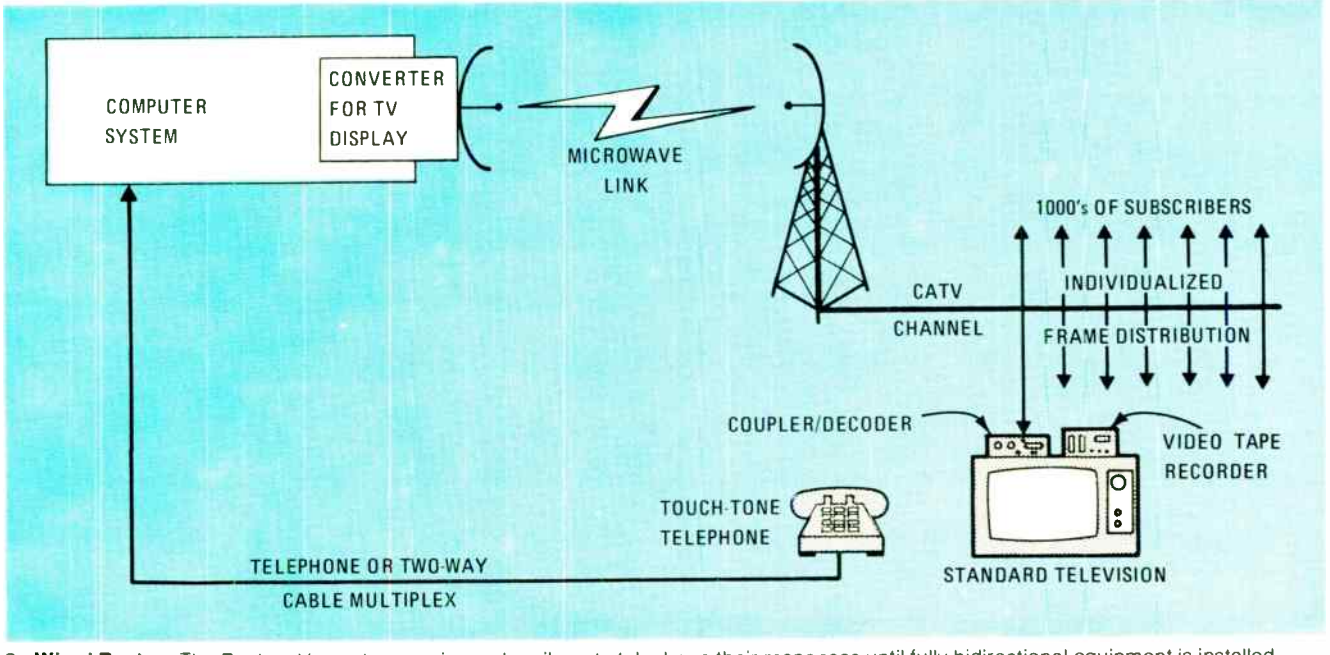
Two-way specialties. New kinds of services have been discussed for one-way systems, such as hard-copy printout of material provided over TV channels and special distribution networks. These networks could also provide programing for specified subscribers. For example, the medical community may pick up televised surgery with high-resolution (1,000-line) receivers on 10-MHz channels. There are also "unscramble" systems generally associated with pay TV. These enable the cablecaster to unscramble programs for those subscribers who pay an extra fee, and to leave them scrambled for the others. All of these services and equipment are now operational possibilities, and they have one thing in common—they are designed to capture a specific market and don't take system considerations into account.

Two-way services make use of a transponder-like terminal in the home that returns information to the transmitting or headend point. Generally, two-way systems use the frequencies above 54 MHz for signal distribution from the homes to the headend. Almost all the new system concepts use a polling technique, allowing the central (headend) computer to retrieve the information selectively from each terminal on the system and to keep track of the whole network. Thus the subscriber could vote for a girl in a beauty contest, choose items from a retail catalog, or play a game by pushing buttons on a home terminal and waiting for the central computer to interrogate his terminal to record the information. It's easy to see how such a home terminal is capable of providing digital codes for relaying fire alarms, burglar alarms, meter readings and the like.

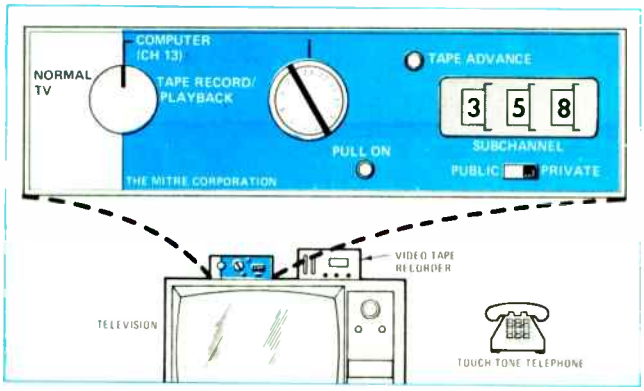
Each of these systems would of course require its own unique set of sensors within the home which would then be tied into the encoding box (coupler) for relay to the central computer. But, though it's already possible to buy devices that permit the pushbutton voting functions, none of these capabilities is in general operation today', indicating that none of these services by itself is economically attractive. The longer this situation stands, the harder it will be to overcome CATV operators' prejudices concerning the economics of programs like these.

There is another, entirely different, possibility that has not been discussed. While cable itself has increased the number of available channels, there is also a system that permits the cable operator to supply up to 600 different services every 10 seconds on each channel, creating a whole new family of possibilities for home services. This is the basis of a demonstration system set up in Reston, Va. [*Electronics*, July 19, p. 29].

Cable operators refer to every untried capability as blue-sky, and do very little experimentation with what aerospace engineers would consider rather straightforward two-way cable possibilities. It was to gain experience with the technical and operational problems associated with new home-terminal concepts that Mitre has installed six demonstration home terminals in Reston, a new town located about 25 miles from Washington, D.C. The town is completely cabled by the Reston Transmission Co., which provides the necessary TV channel and part of the microwave relay link between a computer facility located in McLean, Va., and the Reston headend 10 miles away (Fig. 3).



2. Wired Reston. The Reston, Va., setup requires subscribers to telephone their responses until fully bidirectional equipment is installed.



3. Pick-a-channel. Heart of the Mitre terminal configuration is coupler/decoder which brings in channels, controls the VTR.

The demonstration currently being run with this configuration includes both one- and two-way services. For the one-way service, the computer generates 600 different TV frames of information in every 10-second period, each with its own digital identification. These 600 frames are sent over the microwave line through the Reston cable system to all subscribers on channel 13. Any home on the Reston system can view this channel in its "raw" form, with hundreds of different pictures racing past at 60 per second on the TV screen. The demonstration sites, however, are equipped with coupler-decoders, called "brown boxes" (Fig. 4), which enable the subscriber to select any frame he wants. The selected frame is passed to a video tape recorder, which records it in one-sixtieth of a second and immediately plays it back in the next one-sixtieth of a second on the subscriber's TV screen. Using its stop action mode the VTR refreshes the picture on the screen until the viewer selects a new frame. A 263-line picture repeated twice is used to obtain standard 525-line pictures, unlike the process used in broadcast TV, in which two interlaced fields are normally transmitted.

So much capacity is available in this mode of operation that every cable subscriber in Reston could be provided with a continuous and personal report of his own particular stock portfolio, updated by the local ticker-tape system so that he can see it whenever he wishes and need not sort through a complete stock listing. Of course this capability would mean that a particular frame be dedicated to a particular person and that he would have to be charged for such services, but there are plenty of frames and channels available with room to expand. Other Reston viewers might be more interested in racing results, ball-game scores, skiing and fishing conditions, local announcements, or the 28 other community information services offered.

Computer-aided homework. The two-way service at Reston allows the home subscriber to perform mathematical calculations on the computer or take computer-aided instruction. Because Reston does not have a two-way system cable at present, the Touchtone telephone provides the link between the subscriber's home and the computer, but the basic design parallels a full-capacity, two-way cable system.

To use it, the subscriber sets his brown-box switch to the private mode, and telephones the computer, which automatically identifies him. In the private mode, the brown box uses its own unique address, something like a personal telephone number. The computer responds with a frame of information directed to this particular address and telling the subscriber that three types of services are available. The subscriber, using the Touch-tone buttons, selects the type of service he desires from the three offered: one that involves search through a file structure, another for computer calculations, and a third for interactive education.

In the first category, Reston community services, for example, allows the viewer to select a list of activities that interest him and to sort sequentially through the files to get information on meetings, people to contact, etc. The home calculator allows him to add, mutiply, subtract, divide, take square roots, raise to powers, and store portions of computations for later retrieval; he enters figures with the telephone buttons and gets a read-out on the screen, as well as instructions on what codes to enter to get the calculations he wants. The interactive selections include two courses in computer-aided instruction in mathematics.

Package deal. The Reston demonstration has not attempted to duplicate any of the services already being commercially demonstrated by other companies. It uses only commercially available equipment, and melds services so that the cost of the package is more attractive than the sum of the costs of individual services.

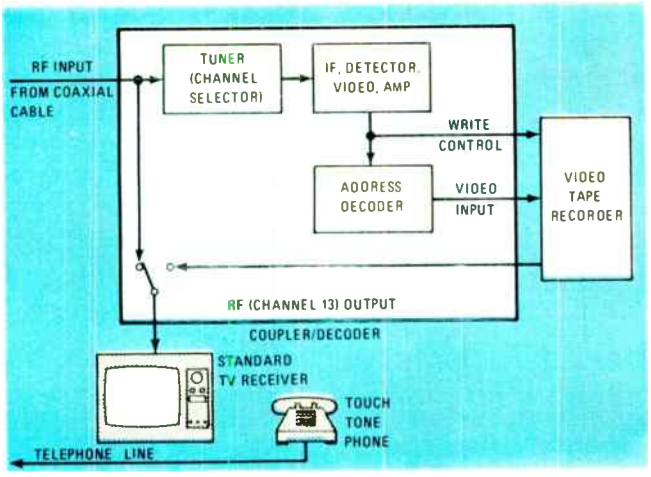
Each of the three types of two-way services was selected to show a capability of the computer that might lead to other ideas. For example, the file search program could be applied to searching for information in any encyclopedia or directory, while the calculator program shows the computer can perform functions such as maintaining a checking account balance or preparing utilities bills and recording payments made by credit card codes.

Other possibilities for interactive TV are numerous, and the cost could be very reasonable. An hour of console time to each household could cost less than 30¢, according to Mitre estimates. Monthly rental of the terminal, including the VTR, would be $30 to $40, unless the subscriber already owned the video tape recorder.

All the Reston capabilities could be implemented right now. Most of the current commercial-equipment experiments concern sending devices that could be added to home terminals, and several alarm systems and polling concepts have been developed, too. But few companies apart from Mitre are experimenting with systems that use the computer to distribute as well as to gather information.

The heart of distribution capabilities is the frame grabber. Because the general unavailability of such devices encourages people to think that only special terminals can interact with a computer, Mitre assembled the TV display from a commercial video tape recorder and some extra circuitry to enable it to record and play on a one-frame basis. The decoding of the addresses on each of the frames sent out the by computer can be done with the brown box (Fig. 5), which is the only unique part of the home terminal.

The brown box looks at all television frames and selects those of interest to the subscriber for transfer to the tape recorder. It contains a conventional TV tuner, an i-f



4. Inside the box. The coupler/decoder uses standard components, proving home terminals need not be expensive.

5. Interactive. A Reston viewer dials computer for local information, interactive instruction, or calculator services.

strip, a detector, a video amplifier, a digital decoder, and circuitry to gate the VTR switch to the record mode and back again to the playback mode after the frame is recorded. The particular frame code that the brown box looks for is selected by a set of octal switches on the front panel. In addition, the box has a hardwired code of its own, so that when the public-private switch is set on the private position, the box records only frames addressed to its particular code number. (Normal TV can be viewed by switching the left-hand knob, which bypasses the brown box).

Besides the hardware expense, the cost of software is a major consideration for interactive television. A software package is expensive when not broadly used. But if it can serve thousands of subscribers over a long period, it becomes a trivial expense. In addition, the system described here has a very simple set of programs to provide dozens of services. Even the disk calculator capability took one man only a few days to develop.

Nevertheless, though the community services are not costly to program, educational material is. The interactive TV idea, unfortunately will not gain widespread appeal unless a great many interesting courses and entertaining games courses become available. And while it is not the cable operators' direct responsibility to develop these programs, it would certainly serve their purpose to invest in the production of such interactive courses produced by others. Naturally local, state, and Federal money will also become available for producing educational material for schools, home education, vocational training and so on, and some private foundations are already supporting the development of new ideas that cable systems could incorporate. Meanwhile, fundamental interactive capabilities can be justified commercially on the basis of the kinds of services put into the Reston demonstration.

Before these possibilities become actualities, however, the cable industry as a whole must recognize that these new two-way services are not fanciful projections. Cable operators must also look at systems of services rather than equipment brochures, and cities must be encouraged to make franchise arrangements that will benefit the entire community on a long-range basis.

A cable system would not replace a city's existing communications plant immediately, but a long-range plan would phase in cable capabilities whether there is need to replace a part of it. But because of the magnitude of the undertaking, no commercial interest can be expected to develop as complete a system as needed.

The technical considerations are straightforward, so it is up to the technical community to articulate the possibilities in a way that social scientists, educators, politicians, and the public can understand. This approach is essential to attain the full potential of the wired-city. □

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A cablecaster discusses what services can be obtained from different two-way systems

by Hubert J. Schlafly, *TelePrompTer Corp., New York, N.Y*

□ Broadband systems offering a wide range of new services will be the most significant development in social communications since Samuel Morse first transmitted codes over wires. Virtual real-time contact and interaction with large numbers of citizens in their homes and places of business, the takeover of municipal services, and the enlarged access to information as well as entertainment will result, and will affect every facet of daily life.

Central to the emergence of this new medium is coaxial cable's ability to carry a multitude of channels. Of equal importance is the fact that the cable doesn't care which way the information flows, whether from headend to subscriber or from subscriber back to the headend. Nor does it care whether the traffic is video or voice or digital data.

While the concept might seem to compete with the telephone, there is a distinctive difference. Telephone is a dedicated wire system, with a comparatively narrow bandwidth that links any user to any other user at any location through elaborately equipped, multiple switching centers. The person who captures a telephone circuit can occupy it as efficiently or inefficiently as he wants, for as long as he chooses to pay for it. Broadband cable, on the other hand, is a giant party line, linking all of many thousands of outlets, on which time-sharing and/or channel-sharing is possible by means of terminal control.

The tremendous bandwidths—200, 250, 300 megahertz into each connective outlet..are suited for frequency-division multiplex systems in either one or two directions on the cable. Each individual subscriber or outlet terminal can have a unique digital address for communication with a central control point. But this communication will be disciplined communication, in that controlled times for machine language transmissions will provide almost real-time service to numerous outlet locations—even present operating hardware could make inquiries into 10,000 homes and get responses once every second. In addition, in at least 20% of those homes individual hard-copy messages could be deposited at a rate of about 100 words a minute, although such a service is not yet operating anywhere commercially.

What kinds of question can you ask 10,000 subscribers? You can ask, "Is there an emergency in your home? Do you have a fire, or need medical assistance, or is the fuel in your oil tank low?" You can ask if the home has an electricity failure and then determine if a repairman should be sent to fix it. If no response at all comes, an emergency or a cable failure exists and needs investigation.

Other questions with answers. You can also ask, "Is your television set on? If so, what channel are you watching?" On an educational program the live instructor can tell immediately who has his set turned on, who is watching the program, and—because he can issue such commands as, "Anybody paying attention, please push number one on his keyboard"—how well or badly his class is concentrating.

It means a tremendous opportunity for merchandising goods, not only those displayed on television, but also direct mail or catalog offerings. A simple, six-digit catalog number can describe any of a million articles. When punched into a home terminal keyboard, this number can be transmitted to a central location where it will be collected by a computer that already knows who you are, where you live, and what your credit rating is. The computer can send that information to the merchant, who will deliver the item directly to your home. He won't have to worry about invoices because there will probably be a credit guarantee, with payment simply an item on the monthly cable bill.

Types of two-way service

In addition to the usual line-up of cablecasting news and weather, CATV operators will be able to offer the wired city such completely new, two-way services as:

- household services: security, surveillance, and alarm; banking at home; shopping at home; in-home printout of newspaper and other data; electronic mail delivery; special interest programs played on order; and opinion polling.
- business: data retrieval; computer time-sharing; document reproduction; remote meter-reading; market testing; and credit card validation.
- education: computer-aided instruction; data retrieval; and centralized library services.
- government: fire and burglar detection; picture and fingerprint record retrieval; remote "line-up" of suspects; interconnection between agencies; and traffic control.

Basically, such data transmission services in the home can be performed by a computerized interrogation-response system working in conjunction with visual and aural displays and records. It benefits from the speed, memory capacity, and processing potential of third-generation computers. It is served by a cable transmission system that considers a one or two megabit data rate as a loafing assignment, to be tucked away in some unused corner of its normal bandpass.

On a cable communications system capable of handling high-speed data, each digital address identifies a given subscriber's terminal and the people associated with it. The computer, which has memorized this address, uniquely associates the address with these people, their physical location, and possibly other pertinent data that will be permitted the data banks. The terminal at this location is told its own address, a unique series of pulses. It is capable of opening the line to none of the addresses the computer sends out on the system, except its own.

The computer follows the address with an instruction, also in digital form, which the terminal accepts or interprets and forwards to some associated cooperative device within the home. Replies, which also can be digital, return to the computer over the same cable but on a different "upstream" frequency. The home terminal design objective is to keep the cost of the basic subscriber's unit in the range of other home appliance prices, though some of the associated equipment like the hard-copy printer or alarm sensors naturally represent additional cost.

The cable in a CATV net is inherently bidirectional, so if proper equipment is used, information can be sent from any point on the network, back to the headend and re-transmitted in the opposite direction to the "downstream" distribution. Though a second cable could carry the upstream information, a single cable can carry information simultaneously in both directions if the two transmissions are at different frequencies. The bidirectional amplifiers must be capable of rejecting those frequencies not intended for their proper direction. If this protection were not provided, the amplifier

output would feed back to its own input, and the circuits oscillate uncontrollably. (The suggestion has also been made that a second cable be used for that part of the network which involves amplifiers, and that upstream transmissions on a single cable be made through passive devices only.)

Because directional protection is required, a "gate" using cross-over filters is necessary. A cross-over filter is a splitter, with one group of frequencies going through one half and another group through the other. Any frequency that is not in the downstream band is usable for upstream transmissions, provided a suitable separation filter is available. Since expanding cable services contemplate using the "midband" and the "superband," as well as the low and high frequencies allocated to vhf broadcast frequencies, the obvious space remaining for upstream traffic on a single cable is the portion of the spectrum below channel 2 (54 MHz.)

Some operators, however, are considering dedicating a complete second cable system to upstream traffic, thus buying additional upstream capacity and avoiding the cross-over problems. This raises the question of how much information must travel upstream. But if it is narrowband, for example, as the FCC suggests, "at least the capacity equivalent to a single 4-kHz message channel," the problem is considerably eased.

A better option. A 4-kHz bandwidth would allow one-voice communication or perhaps narrowband telemetry. But it would not be much harder to provide a full 6-MHz upstream band that would, for example, permit a television program to be inserted anywhere in the system and sent back to the headend. There it could be recorded, or immediately converted to a downstream channel and distributed to all subscribers. Such a channel could be used for voice channels or data channels on a time-sharing basis, and would add to the system's flexibility by allowing remote originations anywhere within the cable area to be returned to the headend and instantly distributed throughout the full network.

Theoretically, the full 54 MHz, or nine TV channels, could be placed in the sub-band below downstream channel 2. In practice, however, the upstream transmission must be separated from the downstream band by 20 or 30 MHz, to prevent the cost of a cross-over filter with suitable phase and amplitude characteristics from becoming unreasonable.

Similarly, to simplify upstream amplifier and equalization problems, the low end of this upstream spectrum should probably not use the base band from dc up to 5 or 10 MHz. If an upstream band from 6 to 30 MHz is provided, this leaves 24 MHz, or the equivalent of four upstream TV channels.

Such equipment may still be costly to build and install, but is well within the state of the art. In fact almost every manufacturer now offers equipment like this for sale (although few yet quote a firm delivery date), and some operators are installing it for cautious tests, to discover what passive components have to be replaced, what ambient or system interferences will be encountered, what the upstream transmission does to the downstream signals, and what installation (retrofit) problems will arise.

In addition, this pioneering requires good system control to maintain normal customer service during the tests. One problem encountered is the upstream amplifier noise from parallel feeders, an effect not present in the downstream direction. The tests so far performed haven't been on a large enough scale to indicate the size of this problem or suggest what might be the most practical solution.

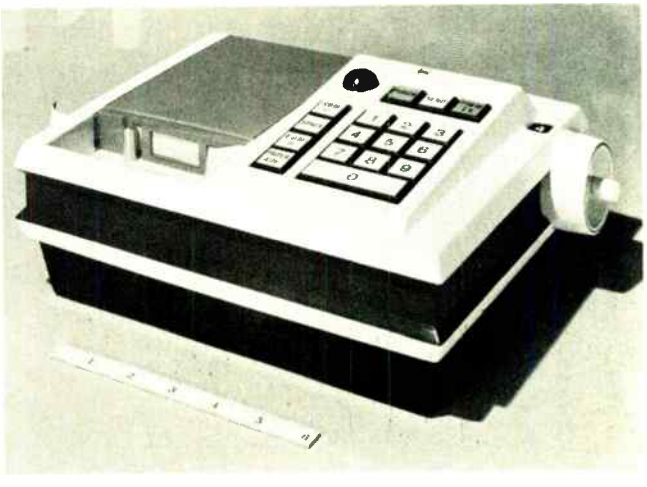
Some manufacturers are incorporating the two-way cross-over filters and amplifiers in one package with new, extended-band downstream amplifiers—either as permanent circuits or as plug-in modules. This is fine for new systems, but many operators will want to salvage as much of their existing downstream plant as possible. To evaluate the feasibility of retrofitting an existing single-cable plant, this year TelePrompTer has been conducting a series of engineering tests in the CATV system in Los Gatos, Calif., a medium-sized community that's typical of many other communities south of San Francisco and that has a good cross-section of people, including educators, engineers, industrial workers, retired elderly, and tradespeople.

The cable system is comparatively new, and has push-pull amplifiers that provide a transmission band from 54 MHz to 260 MHz. It carries 18 channels of television programing, plus the fm band, and has room to expand because the subscribers have all been provided with a 25-channel selector mounted in a remote-control box. The system was retrofitted for two-way communication over 3.9 miles, with cross-over filters and subchannel amplifiers designed for upstream transmission in the band from 5 to 35 MHz.

This series of tests, now nearly concluded, will be followed by the next phase of the test program, an entirely new dual-trunk and partially dual-feeder system at El Segundo, Calif.

Because it obviously will be more satisfactory—and more economical—to provide two-way services at the outset rather than later on, TelePrompTer has adopted a policy calling for dual-cable trunk and partial dual-cable feeder for all new construction and major rebuilding. Many similar tests are now under way or contemplated by cable operators and by manufacturers of hardware. □

6. Home and back. This subscriber's terminal, built for a two-way system, is being tried by TelePrompTer in California.



Whether two-way systems transmit over one or two cables, they'll do best when linked to computers

by Joseph D. Romasco, *Jerrold Electronics Corp., Philadelphia, Pa.*

☐ The plans for CATV's future derive directly from the current state of the art in cable distribution systems. In a standard cable system, signals are received on a large mast antenna, are supplied to the headend of the cable system, and prepared for amplification on the trunk distribution line. They leave the trunk stations, are reamplified by line extender amplifiers, pass through a broadband flexitap and are delivered through a signal splitter and a 75-ohm transformer to subscribers' television sets.

This type of distribution system can carry 30 video channels in the forward direction. To transmit in both directions on a single cable (Fig. 7), it's necessary to insert high/low split bandpass filters in the trunk and line extender stations, which also accommodate both forward and return signal amplifiers. Signals above 54 MHz are sent forward through the highpass side of the filter, and are blocked by the lowpass side. Conversely, signals in the 5- to 30-MHz range pass in the reverse direction through the lowpass filters, and are blocked by the highpass side.

In more detail, the forward signals distributed as entertainment channels flow to a distribution feeder filter and are routed through the highpass filter to the line extender and forward amplifiers to the broadband tap. Return signals from the tap are routed by the lowpass filters and return amplifiers back through broadband feedermaker and another lowpass filter into a broadband coupler to the return signal trunk.

In the system proposed in Fig. 7, video signals in the forward direction are split into two streams. The first enters a top-of-the-set converter and provides a selection of up to 30 video channels through a standard television tuner, while the second proceeds to an alphanumeric terminal. Experiments have already shown it's relatively easy to modify standard, off-the-shelf, computer alphanumeric terminals to respond to a part of the forward spectrum reserved for data.

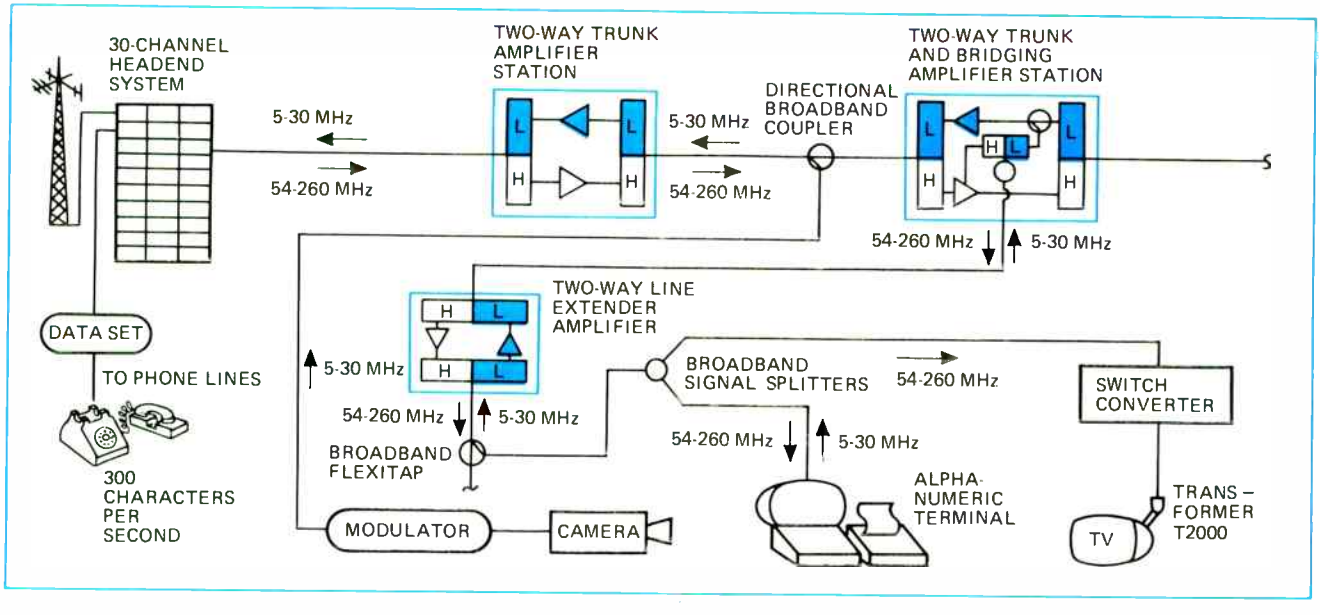
The same modification—a data set—allows data to be transmitted in a portion of the return bandwidth. This data passes through the lowpass sides of the two-way line extenders to the return spectrum of the trunk and back to the headend, which could be interfaced to a minicomputer or, through a data set and phone lines, to a remotely located, time-shared computer. Messages from either the data set or a minicomputer go back through the headend and pass in the forward direction to the terminal.

Figure 8 is a schematic of a two-way distribution system. Signals supplied by the camera are fed back to the trunk and proceed to the headend, where they are rerouted on a forward entertainment channel. The same video picture could be entered through the broadband tap and returned through the lowpass side of the line extender amplifier, pass back through the trunk line to the headend, and then be rerouted on the forward spectrum as an entertainment channel.

Although switch converters are available off the shelf, an economical alphanumeric terminal has yet to be developed for use in a consumer-oriented CATV system. But the problem is definitely one of economic feasibility, not of technical capability.

Many major markets will require the alternative of greatly increased channel capabilities and the unique capabilities of dual-trunk and dual-feeder systems offered by the type of system shown in Fig. 8. A dual-trunk and -feeder system is a total communication system made up of a single-trunk and single-feeder system superimposed on the two-way system represented in Fig. 8 by Cable B.

7. Singles only. This single-trunk, single-feeder, bidirectional system uses standard equipment, and can be installed in a one-way network.



Cable B operates analogously to the cable in Fig. 7, except that the frequency spectrum is split by a guard band between 108 MHz and 160 MHz, allowing for up to 12 video channels and data in the return direction from 5 to 108 MHz, and up to 14 entertainment channels and data in the forward direction. Such an alternative frequency allocation permits up to 12 channels on the Cable A termination points, plus 7 channels of entertainment on the B termination point, for a total of 19 channels of entertainment without use of a switch converter. With a switch converter, up to 44 channels are available—30 on Cable A, plus 14 on Cable B. Signals from the 160- to 260-MHz range travel on Cable B (the two-way portion of the system) through the two-way trunk station and line extenders to the broadband tap, and are split to feed either the Cable B termination point in the subscriber's home or an alphanumeric terminal, when it becomes available.

Signal route. Data from the terminals return in the 5- to 30-MHz band back to the headend. From there, return signals go either to a remote time-shared computer through a data set or directly to a minicomputer. Likewise, data from either computer travels in the forward direction (and a portion of the forward spectrum) through the distribution system to the alphanumeric terminals. A 6-MHz video band can carry up to one million characters per second.

With the exception of the alphanumeric terminal and the data set, the two-way communications systems that have been described here are composed of standard off-the-shelf items, and point to an important step that must be taken as CATV becomes an integral part of a broadband communication system. That step is the interface with digital technology because the existence of a CATV system with two-way capability creates the opportunity of harnessing computer technology for information services.

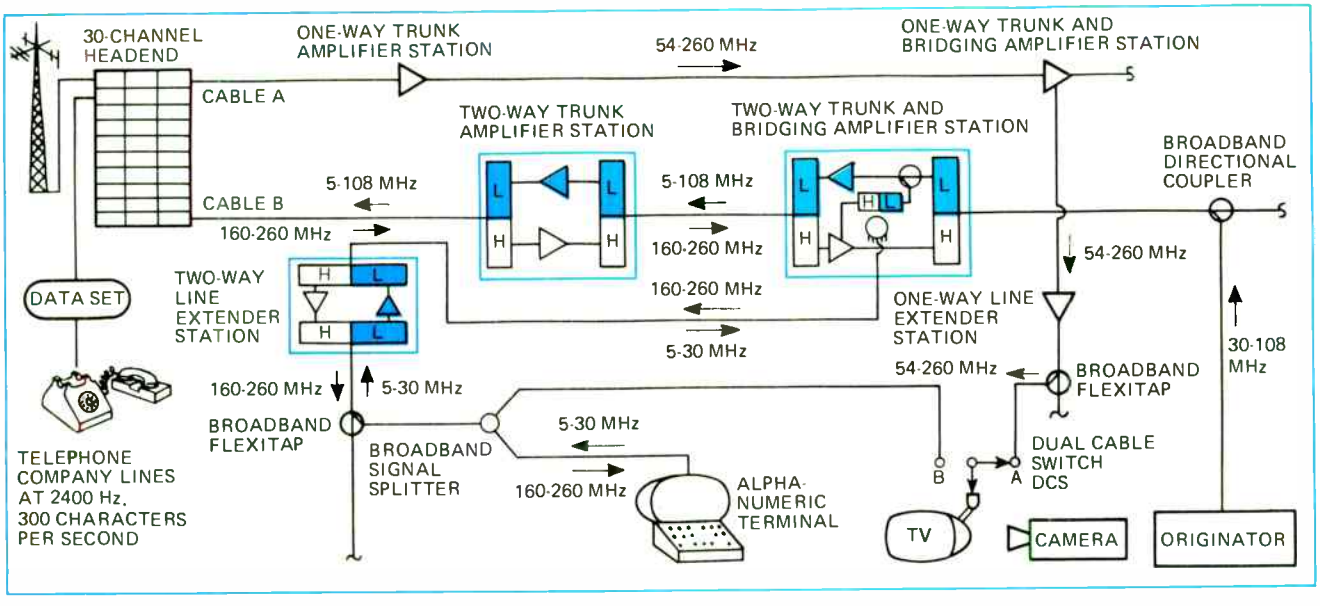
These two technologies—broadband communications and computer data handling—must converge for the promise of cable in the wired city to be completely fulfilled. The chief benefit this combination offers is feedback from or dialogue with subscribers. That feedback might be as simple as a digital impulse indicating a consumer preference in a market research project. But a more intriguing possibility is the use of a two-way cable system and a computer for information delivery systems, specifically for education, where it could cause considerable rethinking of the method and structure of the conventional class room.

Certainly one of the most serious problems facing major cities in the United States today is the ever-rising cost of the school system—and the evolution of cable systems could help improve its effectiveness. A school room of the future, containing various activity groupings, could use two-way cable communication in several ways. For instance, a student-sequenced TV monitor could present material to a group of students, each with a simplified alphanumeric terminal or pushbutton pad at his disposal. The TV monitor would display material in the programed instructional mode, a frame at a time, in standard video format from an educational video tape recorder/player. Responses either from individual students or the collective group on a statistical basis would serve to trigger or sequence the next frame.

Alternatively, a work station could make audio information available to each student over a head set. Some 15 channels of audio information can be delivered on a standard 6-MHz video bandwidth. The student would sit at a station, tune to the instructional audio program he needs, and repeat it as often as necessary. A programed TV monitor to provide private circuit presentations is a third use for CATV in the class room. This receiver would carry programs of a more general nature, with or without interactive instruction.

All the support and facilities required to manage such an information delivery system could be centralized in a single "magnet" school. In this application, a minicomputer would receive responses from student-controlled terminals, sequence the VTRs, and produce programing on demand, while ordinary film-clips and slide

8. Dual version. In this dual-trunk, dual-feeder, two-way system, Cable A transmits forward only, Cable B bidirectionally.



carousels would present static information. As an added benefit, the individual home would also have access to the school programs.

This school system is a microcosm of the two-way systems that should eventually be established in major metropolitan areas. They, too, will be the result of the convergence of broadband communications technology with computer technology, and produce altogether different and more versatile networks than the CATV systems of today. □

Economically viable two-way systems are possible with time-division multiplexing

by Donald G. Chandler, *Electronic Industrial Engineering Inc., North Hollywood, Calif.*

□ Two-way cable television is a technical reality, no longer a way-out dream, that is well on the road to national application in the "wired city." By now there are no technological limitations to accomplishing all the applications of a bidirectional, broadband communications system that have long been talked about.

If any kind of limitation still exists, it lies in the economic viability of the two-way system for the cable operator and/or channel lessor. It's important, therefore, to look at present bidirectional equipment and the tradeoffs required in an economical system. This necessitates an evaluation of some of the hardware contributing to the overall costs of the two-way link, or specifically the amplifiers and home terminals.

For the last 19 months, evaluation of a single-wire, two-way system has been under way at EIE on a laboratory basis, using an eight-amplifier, bidirectional CATV distribution system. By November there will be at least 10 subscribers on a field pilot system, and an additional 200 are expected by the spring of 1972. Simultaneously, a 24-amplifier, dual-cable distribution system with computer control at the headend has been set up in the EIE laboratory.

The primary difference between these two-way systems and the standard CATV distribution systems is their inclusion of bidirectional amplifiers. Such amplifiers pass the frequency band of 50 to 260 MHz in the forward (downstream) direction and 10 to 30 MHz in the reverse (upstream) direction, permitting two-way communication on one cable. Essentially, each unit is two amplifiers in one housing, isolated by filters but using the same cable into and out of the amplifiers. (A two-cable, frequency-division multiplexed system would simply double this arrangement rather than allot one cable each to forward and reverse communication.)

The single most important factor in making this bidirectional broadband communication system viable is the ability to assign a unique address to each subscriber in the system. This is done with a time-division multiplexed scheme, shown in Fig. 9 along with a modulation scheme and data rates for information transfer.

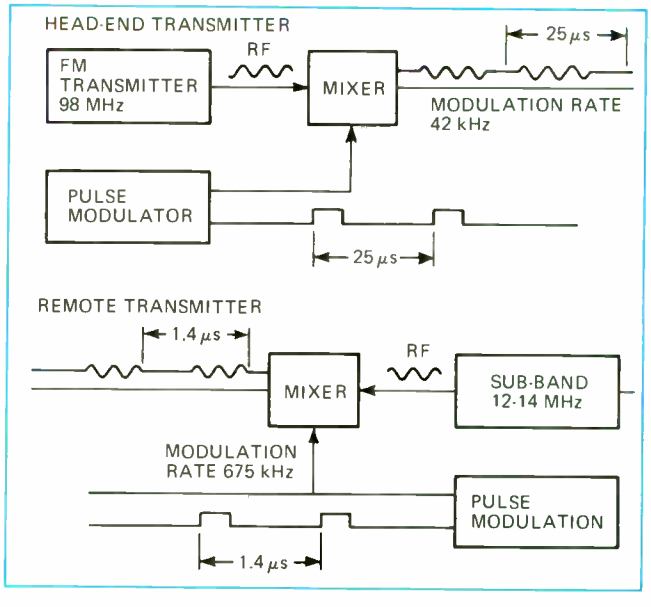
The data rate of transfer in the reverse direction is about 16 times higher than that in the forward direction because addressing the subscriber takes very little time and therefore uses less bandwidth. The control and monitor, located at the headend, is capable of addressing 30,000 subscribers in less than 30 seconds, each subscriber having an address of 15 bits plus a parity bit. A single fm channel is used for this interrogation in the forward direction, and the sub-band of 12 to 14 MHz is used in the reverse direction. The capability permits data to be transferred from the subscriber to the control monitor center upon demand.

In the plan, the control center is at the CATV headend, but in practice it could be anywhere along the line. Alternatively, there could be a number of centers, each with its own distinct transmitter and receiver frequencies, in effect forming a frequency time-division multiplexed scheme. This variation will be important in setting up industrial security systems that need a number of control points.

To understand the interrogation and response procedure, it's best to divide the operation into two blocks—channel monitor headend (Fig. 10) and channel monitor remote unit (Fig. 11). Upon manual or computer command, a frequency-modulated, 200-kHz digital code emanates from the channel monitor headend. The subscriber location with its unique address detects the code, and the remote unit starts the response cycle.

A total of 128 data bits is available: 15 bits and one parity bit for location; 15 bits for command bit status; 24 bits for channel monitor (on a 24-channel system); and 73 bits for other data such as meter, burglar, and fire alarms, opinion polling, and shopping. Once data has been transferred, the storage unit is reset, and the next subscriber position is ready for interrogation. In addition to receiving data from the subscriber location(s), up to 15 commands can be originated from the headend, for example, remotely connecting and disconnecting subscribers, energizing functions such as video surveillance and various kinds of alarm system.

9. Back and forth. A time-division multiplexed design transfers information on single cable from (top) and to (bottom) the computer.



It's important to note that in this design the transmitter and receiver in the channel monitor remote unit, together with the related logic functions, are located outside the subscriber's home on the transmission pole. One transponder services four subscribers on a time-sharing basis, so that when one location is being interrogated and responding, the other three are automatically blocked out.

4-in-1 benefits. This arrangement offers three advantages to the cable operator. First, it simplifies the terminal required inside the subscriber's house—only a switch closure terminal device is needed. Second, letting four subscribers time-share one transmitter/receiver unit is more economical than providing one for each subscriber. It's also much easier to carry out maintenance with the unit outside the home and so more accessible to the cable owner than units inside the home. Finally, with remote location of the transponder unit, the entire system becomes more secure from noise generated at the subscriber's end. For industrial and commercial alarm systems this means that an intruder would not be able to jam a CATV system by using a noise generator at an on-site terminal.

Bidirectional CATV offers another advantage in security systems because it can combine a number of video surveillance camera locations on a single coaxial cable distribution system. This promises greater capacity than a closed circuit TV setup can generally handle.

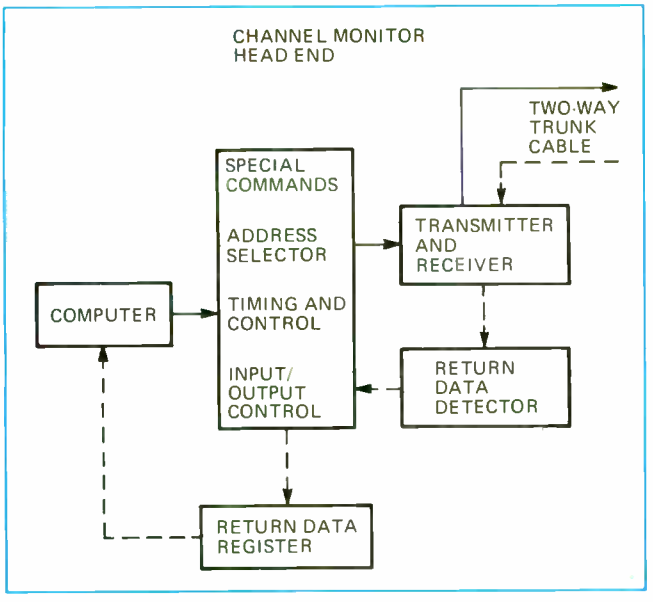
In such a surveillance plan, a camera and optional audio installation can be placed in up to 10,000 locations and interrogated every 60 seconds by a data control unit, which will display from an indicator the location of any unit whose intrusion alarm has been activated. At this point the monitor operator may select that location to be displayed on a live monitor by using an address selection and indicator unit. During the time he is displaying this location live, the data control unit continues its scan of all locations and, if it detects an alarm, once more registers it on the indicator.

A single-frame picture is also displayed on one of a group of auxiliary single-frame monitors and updated on a single-frame basis at any interval between 5 and 60 seconds. At any time, the operator may shift the activity on the live monitor to a single-frame monitor and pick up the location shown on a single-frame monitor on his live screen. This system is also capable of remotely monitoring intrusion or other alarms without video. Under these conditions an alarm indicator is used which, when the remote device is activated, displays all pertinent information such as address, type of device triggered, and the time it was triggered.

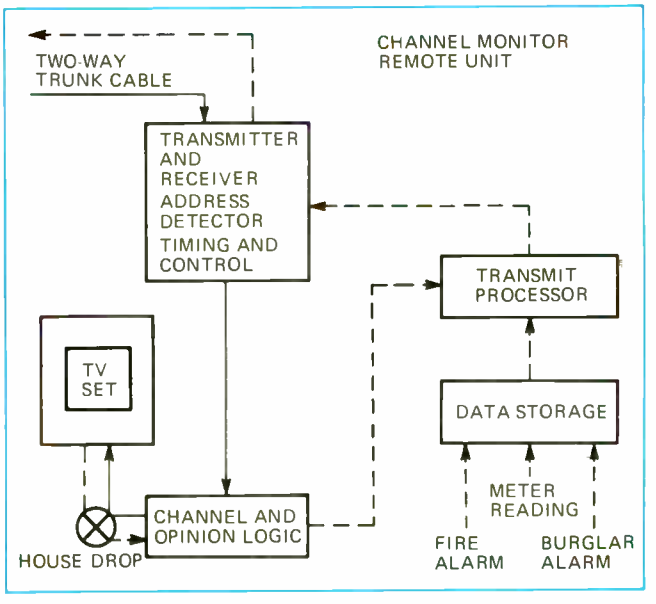
Only one channel is required to implement this type of surveillance system. As for costs, by using the bidirectional, time-division multiplexing approach described earlier, it's estimated that two-way communications, not including cameras and monitors, can be installed for about $300 per subscriber compared to $100 to $150 for conventional cable. However, while today's operator is able to charge on an average $5 a month per subscriber, the services provided by two-way will justify rates of $15 to $25 a month. And besides the industrial and commercial users some 50% of home subscribers are expected to opt for a security system at $7.50 more a month each.

Although the technology exists to accomplish the services promised by the wired city, the ability to market the new two-way communications, including interactive programing, is still a big question mark. It's quite possible that different selling organizations will emerge, leasing channels and terminals from CATV owners, and marketing security, meter-reading, and other two-way services to industrial, commercial, government, and consumer users. A key factor is that two-way communication has opened up industrial, commercial, and government markets to CATV that did not exist at all for the one-way broadcast importation activities. It remains to be seen how these new markets will be integrated with the wired city. □

10. At the CATV operator's end. Data sent to subscribers (solid line) and returned by them (dotted line) pass through same control.



11. Polling place. Transmitter/receiver, plus control logic, handles incoming (solid line) and returning (dotted line) signals.



Electronic thermometers make short work of oral temperature readings

By measuring the rate of temperature change and then extrapolating a temperature-vs-time curve, electronic instruments require only 20 seconds to give a reading that usually takes 3 minutes or more

by Larry L. Hunter, *LaBarge Inc., St. Louis, Mo.*

☐ Whether it makes the difference between a life saved or lost, or just for speeding nurses and doctors on their rounds, time is a valuable commodity in hospitals. A novel electronic thermometer promises to save plenty of time by cutting the three-minute-or-longer waiting period required for a reading on conventional glass-and-mercury fever thermometers down to a few seconds. And the electronic unit is more accurate, too.

Electronic temperature measurement is straightforward enough—if time is no consideration. It commonly involves placing a sensor (usually a thermistor) near or on the object, waiting until its output stops changing, and then measuring and converting the output to a reading. But the electronic thermometer shown in Fig. 1 drastically reduces the waiting time for the sensor output to stop changing: it measures the rate of change and then extrapolates the temperature-vs-time curve to come up with a steady state value within 20 seconds. While this extrapolation technique has been used in aerospace situations to analyze transient data from rockets under test, this electronic thermometer marks the first time it's been used in medicine.

In use. Most of the circuitry for the battery-powered thermometer is housed in a plastic case the size of a pack of cigarettes. Connected to the case via a thin cable is a sensor assembly. Temperature is determined by placing the sensor, which has a small thermistor at its tip and is covered by a disposable sterile sheath, in the patient's mouth. Within about 20 seconds a red light on the instrument's front face turns on, indicating that the meter is displaying the temperature.

The design is based on the principle that when an object much smaller than the human body and initally at room temperature is placed inside the mouth, the object's temperature will rise exponentially toward the oral temperature. When the thermometer's sensor is placed in the mouth, its temperature T will be described by:

$$T = T_{ss} - (T_{ss} - T_i)\, e^{kt}$$

where is T_{ss} is the oral temperature, T_i is the initial sensor temperature, and k is the thermal time constant of the sensor (defined as the time required for T to reach 63.2% of T).

The thermometer, in effect, plots this equation to determine T_{ss}. Inside the plastic case is a timing circuit connected to the sensor. The timer permits the instrument to sample sensor temperature for 15 seconds after T passes a predetermined threshold level—below 95°F. At that time, the sensor temperature T_m is multiplied by a scaling factor to determine T_{ss}.

Figure 2 illustrates why just one scaling factor is needed for a clinical thermometer. Plotted are the sensor response curves for the worst-case limits of human tissue temperature (95° and 106°F) and the mean temperature (98.6°F). For each curve T_m is given by:

$$T_{m1} = b_1\,(106)$$
$$T_{m2} = b_2\,(98.6$$

and

$$T_{m3} = b_3\,(95)$$

It happens that b_1, b_2, and b_3 are very nearly equal. When they are approximated by a single scaling factor,

1. Temperature-taker. The electronic thermometer's meter is much easier to read than the scale on glass clinical instruments. The indicator in the center, a light-emitting diode, comes on when the patient's correct oral temperature is ready to be read.

Drawdown and error

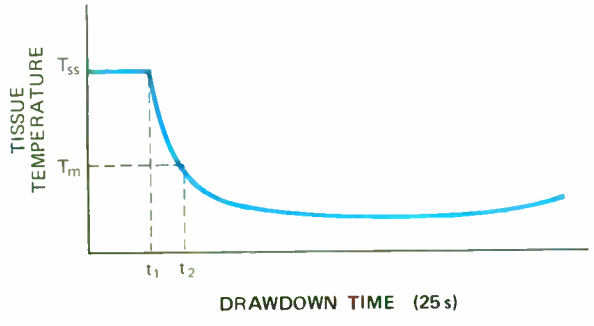
In drawdown, insertion of a thermometer causes a sudden lowering of tissue temperature surrounding the instrument's sensor. As shown in the figure, drawdown occurs within a few seconds, while recovery takes several minutes.

This can be too long a delay in a clinical situation. Compensating circuitry is needed to eliminate this inaccuracy; otherwise, the rate at which sensor temperature approaches body temperature will depend on the sensor's initial temperature.

Drawdown results from a thermal energy flow between objects of different temperature. When they come into contact, the energy flows from the warmer to the colder until both are at the same temperature. In the case of the human body and a small sensor, there's only a sudden, localized cooling around it, because the body's own mass is very much greater than that of the sensor and because the body generates its own thermal energy to maintain its temperature.

Measurements of drawdown for various sensor temperatures show that for an initial sensor temperature of 75 F and an initial tissue temperature of 98.6 F, the average drawdown time constant is 25 seconds, while recovery time is at least five minutes.

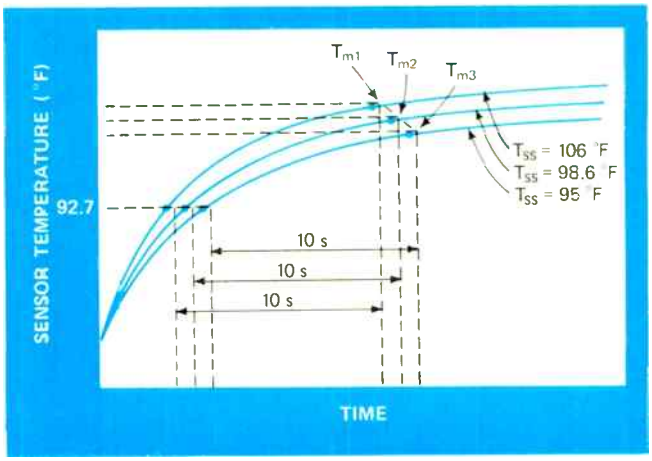
Fortunately, it's possible to compensate for drawdown. When a family of curves like the one in the figure is plotted for various initial tissue temperatures (T_{ss}, T_m), it can be shown that the amount of drawdown—defined as the initial temperature minus the tissue temperatures at the end of the electronic thermometer's 15-second cycle (t_1-t^2)—is directly proportional to the initial temperature. Thus, a positive temperature-coefficient resistor integral with the sensor assembly compensates for drawdown.



b, the worst-case error is only about 0.1 F. Assuming the constant of proportionality is b, then $T = bT_{ss}$ or $T_{ss} = T/b$. The sensor's temperature thus can be sampled at this point (t_m) and electronically converted to a current using linear amplification at a gain of 1/b. The resulting current is a direct analog of the patient's temperature (T_{ss}).

The measurement process begins when the sensor is removed from its receptacle on the back of the instrument case. This closes the two switches in series with the batteries, applying power to the circuit.

As shown in Fig. 3, the sensor is attached to a bridge whose output goes to both a zero-crossing detector and a sample-and-hold circuit. Upon contacting the mouth, the thermistor in the sensor tip responds, unbalancing the bridge. When the sensor response passes 0 volt—the



2. Response. Sensor responds as function of time; curves represent worst-case limits and mean value of 98.6 F. Sensor temperature rises exponentially toward steady state value equal to oral temperature. After 92.7°F, sensor output is measured and multiplied by scaling factor to produce signal corresponding to oral temperature.

bridge balance point that corresponds to the threshold temperature—the detector switches, turning on the 15-second timer and connecting the output of the sample-and-hold circuit to the instrument's meter. Meanwhile, the timer's output closes the switch between the bridge and the sample-and-hold circuit. The sensor output then is connected via the bridge and the sample-and-hold circuit to the meter. After 15 seconds, the timer turns off, disconnecting the sample-and-hold circuit from the bridge and turning on the read lamp, a light-emitting diode. The temperature displayed by the meter equals T_{ss}. The sample-and-hold circuit maintains this reading for at least 7 seconds after the read light comes on.

The battery cut-off circuit continuously monitors the power supply for low output. If either the positive or negative battery voltage drops below a predetermined level at which accuracy could be degraded, the thermometer automatically turns off and cannot be used again until the batteries are replaced.

The instrument's sensor consists of a thermistor mounted in the tip along with a positive-temperature-coefficient resistor. This resistor compensates the total sensor assembly for its drawdown effect (see "Drawdown and error," p. 57), as well as for any effects of the sensor's initial temperature on the thermistor.

The bridge consists of a zero-adjustment potentiometer R_1 and resistors R_2, R_3, and R_4. Battery voltage to the bridge is regulated by zener diodes D_1 and D_2. Operational amplifier A_1, located at the bridge's output, provides a gain of 5 as well as high input impedance to protect the bridge from loading effects.

A_1's output passes through sample switch Q_1 to charge hold capacitor C_1 at the input of hold amplifier A_2. Like A_1, it's an op amp, but it's connected in a voltage-follower configuration to give very high input impedance and low output impedance at a voltage gain of 1. A_2 drives a series combination of potentiometer R_6, the meter, meter switch Q_2, and scaling resistor R_8.

A_1's output also goes to A_3, an open-loop amp that provides the zero-crossing detection. A_3's positive input terminal is referenced to ground so that its output is

positive when A_1's output is below ground and negative when for A_1's output is above ground.

When A_3 switches to its negative state, Q_2 turns on, allowing positive current to flow through the meter. Before it goes negative, A_3's output is more positive than the cathode of diode D_3, so that A_3 clamps the voltage across C_2, the timing capacitor. When A_3's output swings negative, C_2 charges through R_7 and R_8. When the junction of C_2 and R_8 reaches the reference voltage of A_4, the amplifier switches to a positive output, lighting the read lamp. A_4's output also turns off Q_1, maintaining the meter reading; the transistor's charge is sufficient to hold a constant current for a minimum of 7 seconds.

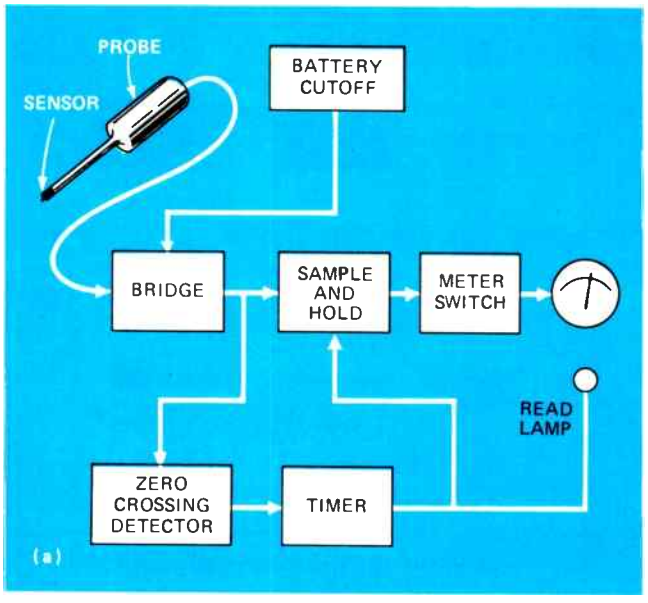
Battery testing. Amplifiers A_5 and A_6 are the heart of the battery test circuit. A_5, the positive battery monitor, is connected in open-loop fashion as a voltage comparator. Two resistive voltage dividers are connected to its inputs. R_9 and R_{10} form the divider for the positive terminal, R_{11} and R_{12} for the negative terminals. When the positive battery voltage drops enough to cause the negative terminal to fall below the reference level set by D_1 on the positive terminal, the amplifier's output swings positive and applies voltage between R_3 and R_4. The resulting imbalance effectively shuts off the bridge, and the thermometer with it. No output is possible until battery voltage rises above the reference level.

The negative monitor works the same way, except that the reference voltage from D_2 is applied to A_6's negative input terminal so that the output from A_6 is also positive for a low battery. Diodes D_4 and D_5 isolate the outputs of A_5 and A_6 from each other.

The circuit's accuracy vis-a-vis glass thermometer was verified through a series of laboratory tests on more than 1,000 human subjects. In one test, temperatures were measured using both a precision electronic standard (0.05°F accuracy) and a clinical mercury thermometer to establish the quantitative deviation of the clinical thermometer readings from the subject's true temperature as gauged by the electronic instrument. Testing was performed by taking the electronic steady state temperature first and waiting until drawdown and recovery were very nearly completed inside the patient's mouth before the clinical thermometer was used. The results, shown in Fig. 4(a), indicate that the clinical thermometers in this sampling tended to read high.

In another test, electronic thermometers were used in a hospital on a day-to-day basis for a month. In order to plot the statistical distribution of a large number of measurements, readings were taken at random, with some temperatures read with the glass thermometers and others with the electronic units. These results, presented in Fig. 4(b) show a much smoother distribution for the electronic thermometer. The peaks for the clinical thermometer at 98.0°F and 98.6° are probably the result of rounding off due to the difficulty of reading temperatures in the "normal" range on the glass thermometer. This is no problem with the electronic unit.

Although these two tests proved the inherent accuracy of the electronic unit, the real significance of the results is that readings for each type are fairly closely correlated. Thus, doctors and nurses do not have to adapt to a new scale when using the electronic thermometer. □



3. How it does it. Colored sectors in schematic (b) (right) correspond to those in block diagram (a) (above). The electronic thermometer uses op amps to scale sensor signal (A_1, A_2, A_3), detect zero crossing (A_3) and time (A_4), and check batteries (A_5, A_6).

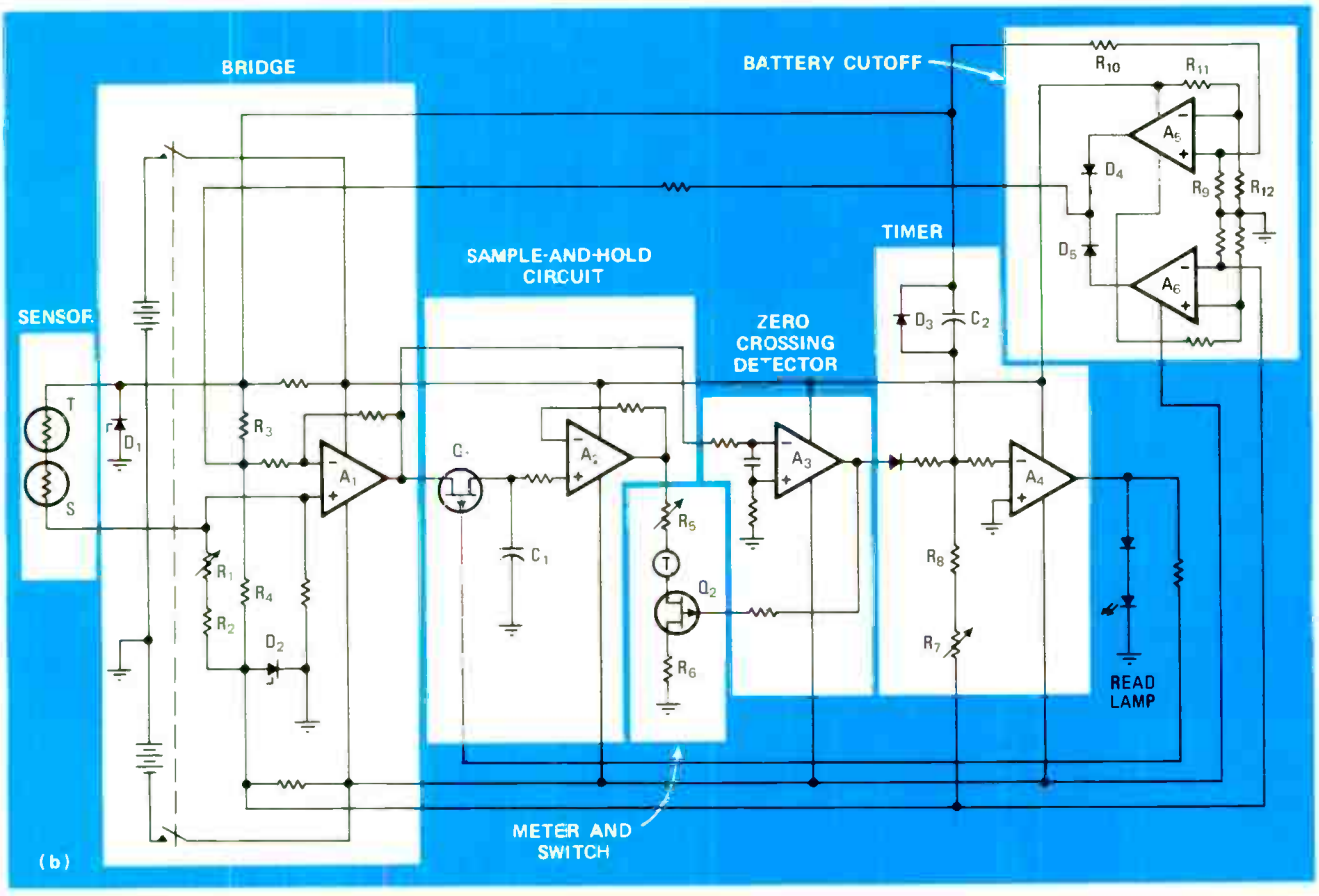
Why an electronic thermometer?

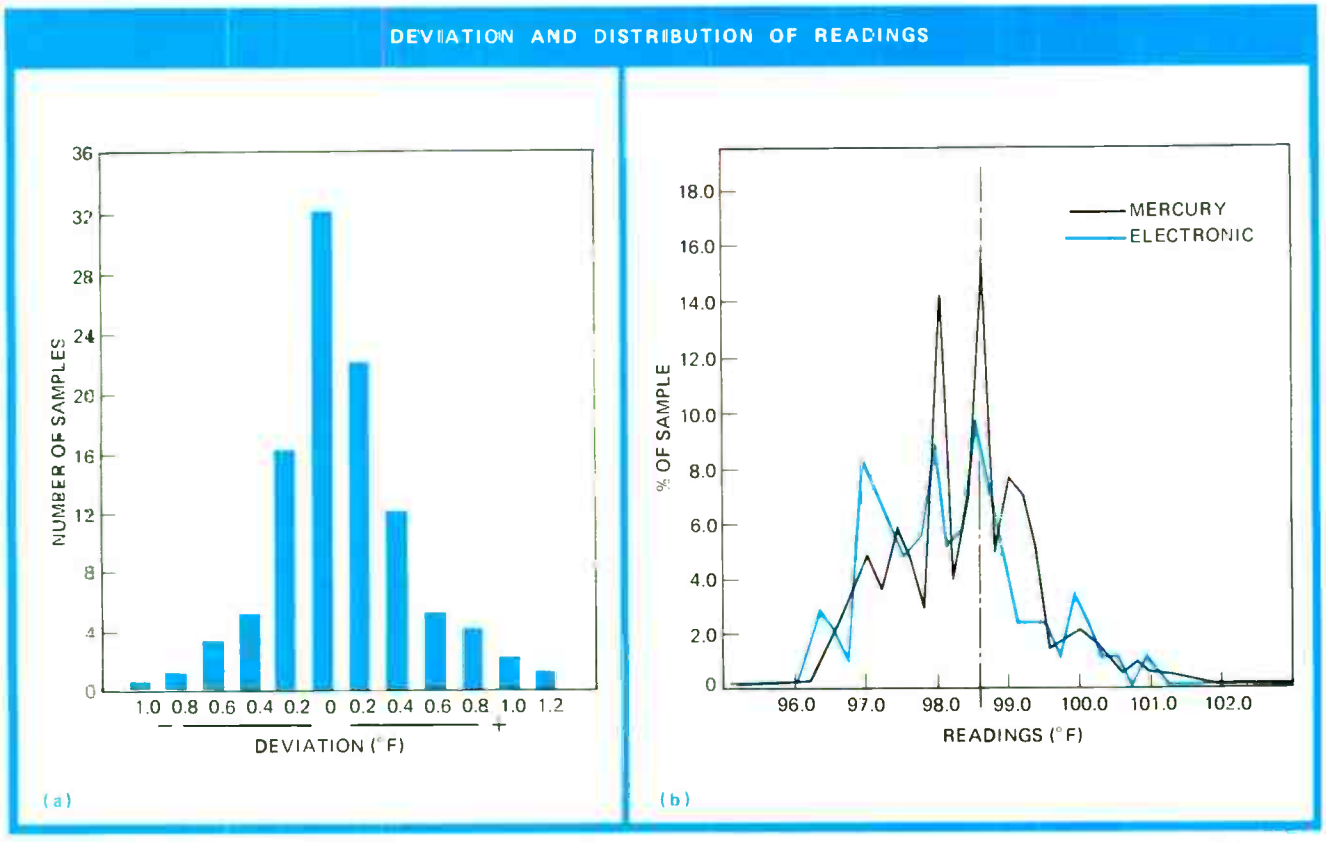
Does it pay to replace cheap, reliable glass clinical thermometers with an electronic instrument that sells for upwards of $100 and requires periodic battery changes? The answer, say the companies that are offering the electronic thermometers, is yes. Hospitals can save time and money by using their products, they say.

Temperatures are taken in a matter of seconds, not minutes. And the cost per temperature check, surprisingly, is a lot lower. Ray Mohrman, vice president at LaBarge Instruments Inc., St. Louis, says that when the cost of sterilization and replacement is included, it costs up to 8 cents to take a temperature with a glass thermometer. With the LaBarge unit, which will be lent to the hospital, requiring only the expense of the disposable sterile sheaths, the figure is closer to 3.5 cents per temperature. Mohrman predicts that the total market for the thermometers will hit $15 million, followed up by an annual $45 million market for sheaths.

At present, over two dozen companies, most of them tiny, are offering some type of electronic thermometer. The most successful at this early date has been Ivac Corp. of San Diego. The firm already has made large sales to several hospitals. That electronic thermometers are being taken seriously is demonstrated in Ivac's marketing agreement with pharmaceutical giant Parke, Davis & Co.

Several types of designs were tried when companies first started tinkering with electronic thermometers. But the configuration that seems to be gaining acceptance is the one Ivac and LaBarge are using—a thermistor packaged in a long, thin probe that's connected to a handheld measuring instrument. A slight variation is used by Medictech Energy and Environmental Corp. of Danvers, Mass. That small firm uses a completely disposable probe. Medictech expects to be marketing its thermometer through another large drug house, Chesebrough-Ponds Inc. —Owen Doyle





4. Side by side. In tests that produced (a), temperatures of 211 patients were measured initially with electronic unit and then with glass instrument. Glass units tended to read slightly higher than electronic thermometer; mean deviation was 0.3°. In (b), readings with two instruments were taken on random basis to plot temperature distribution as measured by each type. Electronic unit shows smoother distribution. Actually, readings correlate fairly closely, so that medical personnel need not adapt to new scale to obtain accurate readings.

Designer's casebook

One-shot makes fast trigger out of slow input pulse

by Raymond J. Manco
Foxboro Co., East Bridgewater, Mass.

In addition to being insensitive to transients, a hybrid monostable multivibrator can trigger high-speed integrated circuit flip-flops with either a slowly rising or slowly falling pulse of an input. The triggering device may be a logic circuit, a relay, a toggle switch, or a momentary-contact pushbutton switch. The one-shot can even be made variable by adding a biasing resistor.

Most IC flip-flops require transient-free trigger pulses with fast rise times. The circuits shown in (a) and (b) generate a pulse whose rise time is 10 to 100 nanoseconds and whose duration is 10 microseconds. Rise time for the trigger input can be 10 ns to 10 milliseconds.

The one-shot configuration of (a) should be used when the input is a slowly rising pulse. It is triggered by the leading edge of the input pulse, which turns on transistor Q_1. Gate G_1 is then enabled, and transistor Q_2 switches on. Feedback from Q_2's collector to G_1's input keeps the gate high whenever Q_2 is on so transients in the input trigger do not influence the one-shot.

Gate G_2, which is enabled by Q_2, shapes the monostable's output pulse for triggering a high-speed TTL micrologic bistable, like the 9001 J-K flip-flop shown.

If the flip-flop being triggered requires a negative-going pulse, the output of G_2 can be inverted with a third type 9002 NAND gate. Trailing-edge triggering also can be implemented with series 54/74 TTL ICs, as illustrated in (b), or with DTL gates.

The circuit action of (b) is similar to that of (a), although a relay contact provides the input trigger pulse. The input pulse's trailing edge enables the first NAND gate, which turns on the transistor. A feedback loop again keeps the gate on while the transistor conducts. Two more NAND gates, one shaping and the other for inverting the pulse, result in a negative spike input for the SN54L72 J-K master-slave flip-flop.

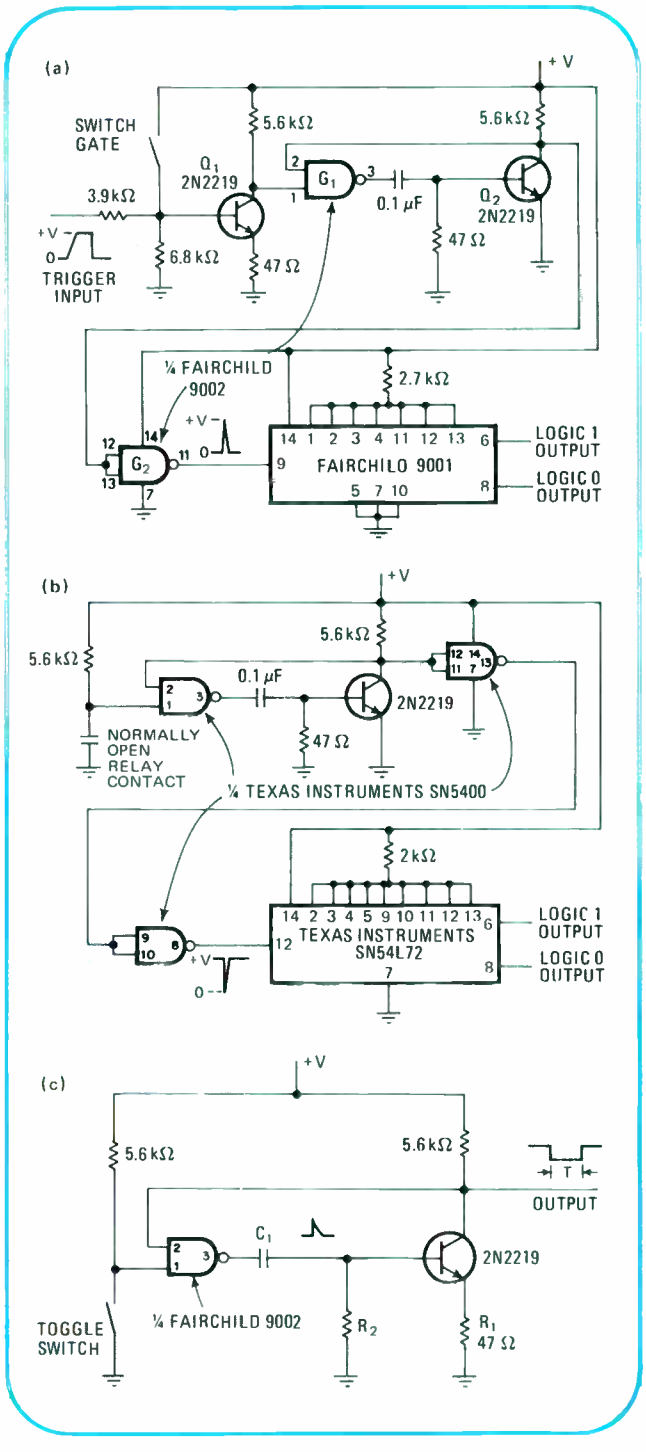
The circuit of (c) shows how output pulse width can be expanded from 10μs to 25 ms. This variable oneshot requires a toggle switch input, one NAND gate, and one transistor with feedback to the gate. Adding R_1 (47 ohms) between the transistor's emitter and ground causes the transistor's input resistance, R_i, to be greater than R_2, or:

$R_i = \beta R_1$ where β is transistor current gain. Output pulse width becomes:

$T = 5\,C_1\,R_2\,R_1/(R_2 + R_1)$

Resistor R_2 can range from 10 ohms to 100 kilohms, and capacitor C_1 from 0.1 microfarad to 1 μF.

Pulse shaper. Hybrid one-shot uses NAND gates and a transistor to deliver sharp positive-going or negative-going spike from slowly rising pulse (a) or slowly falling pulse (b). Input transients do not affect output triggering because of feedback from transistor to preceding gate. Adding a resistor to transistor's emitter loop, as shown in (c), permits output pulse width to be varied.



FET supply tests bipolar current gain

by James B. Marshino
CTS Microelectronics Inc., Lafayette, Ind.

With just a simple, variable constant-current source, it's easy to measure direct current gain for a bipolar transistor with better than 1% accuracy. The source controls both collector and base currents with only four active devices—a differential operational amplifier, two field effect transistors, and a diode. In addition, the circuit also can be used for go/no-go testing with slight modification. Approximate parts cost is about $10.

When power is first applied, Q_1 is on, Q_2 is off, and the bipolar transistor is also off because no base current can flow. As current through R_1 increases, voltage at the noninverting input of comparator A_1 rises.

The threshold voltage of A_1, which is determined by R_2 and the setting of potentiometer R_3, fixes the bipolar's collector-emitter junction potential. When the bipolar's collector voltage approaches A_1's threshold, the amplifier switches and its output goes low.

This decreases the gate-source voltage of Q_1, thus limiting the flow of current through diode D_1 and decreasing the voltage across resistor R_4. FET Q_2 now turns on and operates in its active region. Since the time constant of R_4 and C_1 is large, Q_2 sees these components as a constant voltage source.

A small constant current, then, flows in the base loop of the bipolar being tested, turning that device on. Because the base current (I_B) is constant, the transistor's collector current (I_C) is also constant, permitting accurate determination of current gain.

The magnitude of I_B can be measured directly with a voltmeter by reading the voltage across resistor R_5 (V_{R5}):

$$I_B = V_{R5}/R_5$$

Transistor collector-emitter voltage (V_{CE}) and I_C are determined from the manufacturer's data sheet:

$$-V_{CC} = V_{CE} + R_1 I_C$$

where $-V_{CC}$ is the collector supply voltage. Or I_C can be measured directly by using the voltage across resistor R_1. The dc current gain (h_{FE}) becomes just a matter of division:

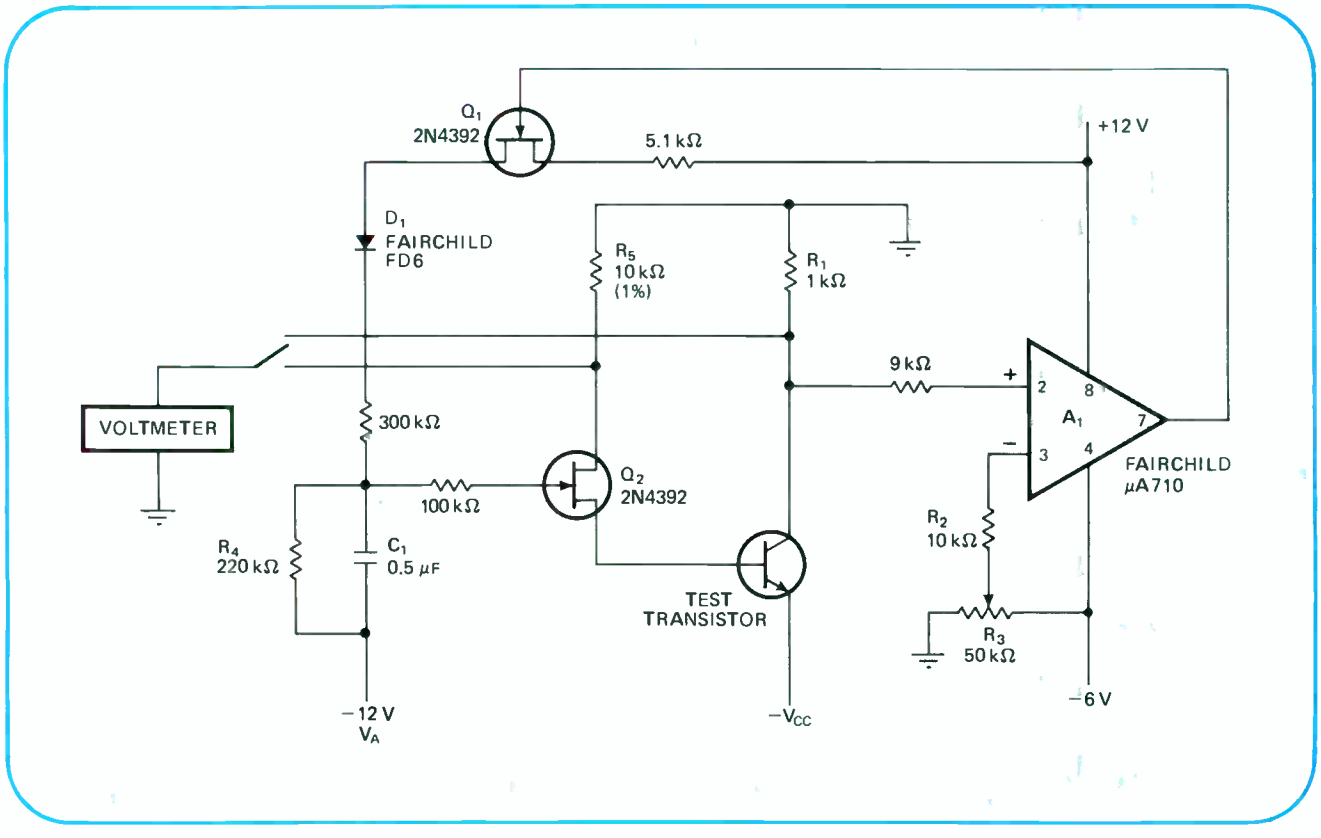
$$h_{FE} = I_C/I_B$$

To use the circuit as a go/no-go tester, replace the voltmeter with a Fairchild type μA711 dual limit detector. Increased measurement accuracy can be obtained by putting an operational amplifier between the circuit and the detector.

The test circuit illustrated is for an npn transistor. One caution should be observed: the V_A supply must be more negative than the $-V_{CC}$ supply to keep Q_2's gate-source junction reverse-biased.

To check a pnp transistor, supply polarities must be reversed and p-channel FETs used.

Measuring current gain. Amplifier A_1, and FETs Q_1 and Q_2 form constant-current supply for testing h_{FE} of bipolar transistor. When bipolar's collector voltage approaches A_1's variable threshold, A_1 goes low, decreasing current through D_1. Constant voltage provided by large R_1C_1 time constant also drops so that Q_2 conducts. Bipolar now turns on with controlled constant I_B and I_C, which are measured with a voltmeter.



Feedback pot extends multivibrator duty cycle

by Michael J. Shah
University of Wisconsin, Madison, Wis.

It's easy to design an astable multivibrator that has a variable duty cycle of 1% to 99%. Just put a pair of diodes and a linear potentiometer in a feedback loop to the inverting input of a differential operational amplifier and add a positive feedback resistor for regenerative action. The configuration requires only one timing capacitor and features good temperature stability. Moreover, variation in duty cycle is nearly independent of repetition rate. The op amp performs as a comparator, switching from one state to another when its input voltages are equal.

Let e_o be the astable's output voltage, e_1 the voltage at the comparator's inverting input, and e_2 the voltage at the non-inverting input. When e_o is the maximum output voltage (V_{SAT}) of the op amp, where V_{SAT} approximately equals $V_{CC} - 0.5$, diode D_1 is forward-biased, and diode D_2 is reverse-biased. Timing capacitor C_1 is charging towards V_{SAT} through D_1, KR_1 and R_2. (K is a constant whose minimum value is 0 and maximum value is 1.)

As can be seen from the circuit diagram of (a), e_2 is determined by voltage division across R_3 and R_4:

$$e_2 = R_4 V_{SAT}/(R_3 + R_4) = V_{SAT}/2$$

since $R_3 = R_4 = 100$ kilohms. When e_1 reaches $V_{SAT}/2$ at time t_1 (due to the charge across C_1), the comparator switches, bringing e_o from V_{SAT} to $-V_{SAT}$. Diode D_2 becomes forward-biased, and diode D_1 reverse-biased.

The capacitor now charges towards $-V_{SAT}$ through D_2, $(1 - K) R_1$, and R_2. Voltage e_2 is again determined by voltage division across R_3 and R_4:

$$e_2 = R_4(-V_{SAT})/(R_3 + R_4) = -V_{SAT}/2$$

When C_1 discharges sufficiently to make e_1 equal to $-V_{SAT}/2$ at time $t_1 + t_2$, the comparator switches back to V_{SAT}, C_1 begins to charge, and the cycle repeats. Resistor R_2 provides a positive feedback function for regeneration of the astable's cycle.

The equation for the on time, T_1, is:

$$T_1 = (KR_1 + R_2)\, C_1 \ln\left[\frac{V_{SAT} - V_{D1} + V_{SAT}/2}{V_{SAT} - V_{D1} - V_{SAT}/2}\right]$$

where V_{D1} is the voltage drop across diode D_1. The expression for the off time, T_2, becomes:

$$T_2 = [(1 - K) R_1 + R_2]\, C_1 \ln\left[\frac{V_{SAT} - V_{D2} + V_{SAT}/2}{V_{SAT} - V_{D2} - V_{SAT}/2}\right]$$

where V_{D2} is the voltage drop across diode D_2.

Duty cycle, D, for the astable is:

$$D = T_1/(T_1 + T_2) = (KR_1 + R_2)/(R_1 + 2R_2)$$

Minimum duty cycle occurs when K = 0:

$$D_{min} = R_2/(R_1 + 2R_2)$$

which approximately equals 1% for $R_1 = 250$ kilohms and $R_2 = 2$ kilohms. Maximum duty cycle is obtained when K = 1:

$$D_{max} = (R_1 + R_2)/(R_1 + 2R_2)$$

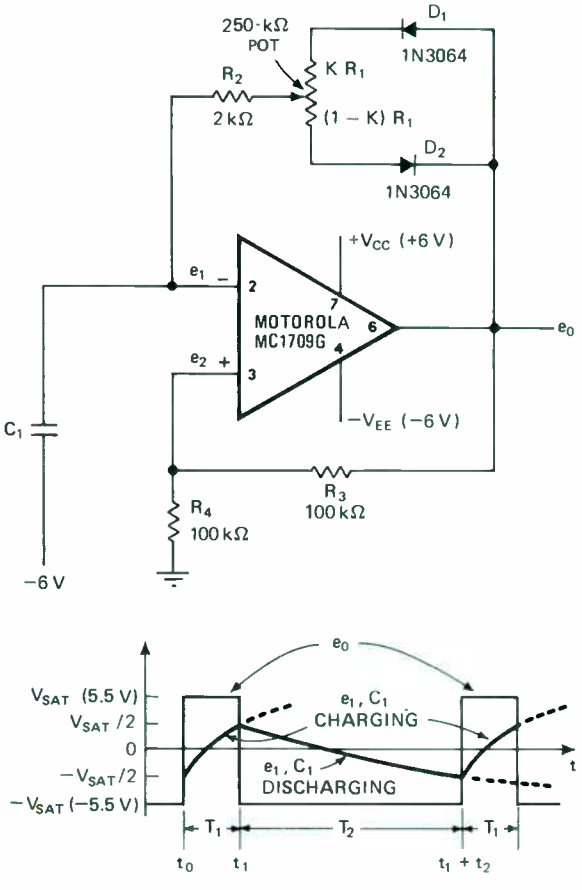
which approximately equals 99% for the given resistor values.

Table (b) shows circuit performance for various values of capacitor C_1.

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

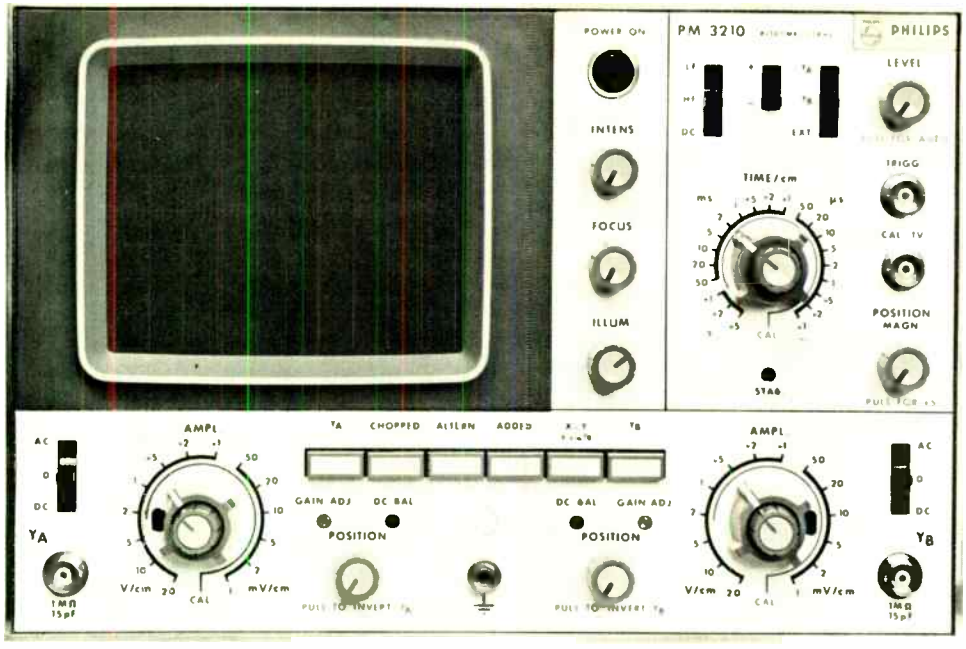
Variable astable. Pot in comparator's feedback loop permits adjustment of astable's duty cycle over almost 100% range. When comparator output is high, D_1 conducts, D_2 is off, and C_1 charges until e equals e_2. Then comparator output goes low, D_1 opens; D_2 shorts so that C_1 discharges. When e_1 is the same as e_2, the comparator switches again, and the cycle repeats. Sample data is shown in (b).

(a) VARIABLE-DUTY-CYCLE ASTABLE



(b) PERFORMANCE DATA

C_1 (μF)	$(T_1)_{min}$ (μs)	$T_1 + T_2$ (ms)	FREQUENCY (Hz)
0.0027	7	0.6	1,670
0.01	21.3	2.1	464
0.056	128	13	76.6
0.1	212	21.7	46.1
0.33	690	70.9	14.1
1	2,130	218	4.6



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Optinet guides electronic products from design through marketing

Software system goes beyond usual optimization and analysis functions of CAD programs—helping users develop a prototype, control production, and dramatically expedite marketing procedures

by Robert Hall, *Dean Hall Associates Inc., Los Altos, Calif*

☐ The various people involved in designing, building, and selling electronic equipment have various requirements—the engineers want to optimize design, the production staff aims for maximum efficiency, and the marketing men seek to reach the right customer. Now they have a software package that can satisfy all of their goals. Called Optinet, the program can be used to optimize circuit designs, keep track of production controls, and expedite marketing procedures.

Optinet includes a full set of computational facilities and uses them to perform modeling with variable parameters. Also provided is storage for models, solutions, and intermediate results, as well as commercial product data. Another feature is a dial-up access capability that brings the system to manufacturers and customers.

The software package is available through National CSS Inc., Stamford, Conn., and Sunnyvale, Calif. By next March, other time-sharing services are expected to offer the program.

Optinet generally requires a large computer facility on the order of the IBM 360/67. The program is written in Fortran 4. Though Optinet is one of the fastest and least-expensive analysis programs available, design analysis itself is not always the highest-priority consideration when introducing a new product. With its sensitivity analysis, worst-case diagnosis, production modeling, and market data capabilities, Optinet can cut costs and time involved in the critical process of transferring the product to the production and marketing stages.

Optinet is designed for devices, components, and subsystems that can be described in terms of piecewise-linear ac models. Additional modeling capability is added regularly so that the system will be able to handle dc, nonlinear and transient calculations sometime next year.

A closer look. Modeling with Optinet is straightforward. Networks are broken down into subnetworks, sections, and elements. A catalog of more than 75 elementary sections provides easy access to lumped, distributed, active, passive, analytical, numerical, and hypothetical models. Up to 15 networks can be defined simultaneously, each with its own frequency range and performance requirements, permitting modeling of piecewise-linear and multistate networks. A total of 15 elements in these networks may be identified as the variable parameters of the model.

Basically, Optinet requires three types of files—network, frequency, and performance—to solve an analysis problem. They are numbered to correspond to each other; for example, files N1, F1, and P1 form a set, as do files N2, F2, and P2. Up to 15 complete file sets are available. The network file gives the circuit description, the frequency file lists the frequencies of interest within a design band, and the performance file defines circuit requirements.

Data files (30 in all) are independent of the other files and contain values of frequency-dependent circuit elements or circuit specifications, which are defined in either a network or performance file. These data files can be used anywhere in the analysis.

A variable file is required for design, because the user must specify the circuit elements he is willing to vary to meet desired performance specifications. This file allows either a circuit element as called out in a network file or a circuit parameter as specified by a performance file to become a variable. Limits and nominal values for the variables are established by the file, which can contain up to 15 lines.

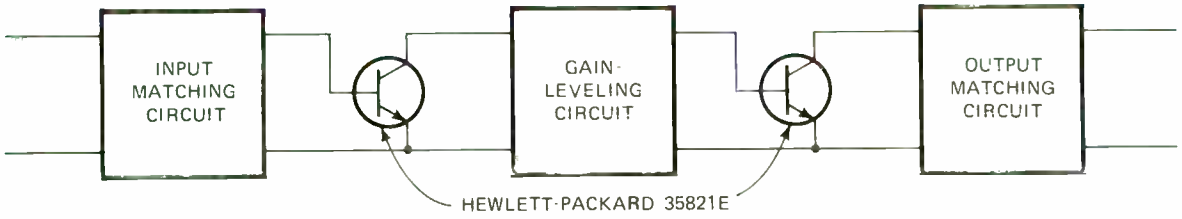
A criterion file is also required for Optinet's design capability and can have up to 15 lines. The criterion file defines a function that represents best circuit performance. The function usually has one form for performance optimization and another for worst-case analysis. For example, an optimization criterion could be a function whose minimum value represents best performance, while a worst-case criterion could be a function that goes to zero if desired specifications are not met.

Optinet provides a sensitivity analysis capability, too. It can vary individual parameters by any desired percentage and print the resulting variations of the performance requirements. A trace capability lets the user plot frequency-dependent performance as a function of a variable parameter over its entire range.

Ample storage facilities are another feature: up to 15 complete problem groups can be saved in a private disk area. When a problem group is retrieved, the contents of all files are reset exactly as they were when the problem group was saved. The problem then may be continued from the last result.

Information for use by multiple subscribers may be stored in read-only files for general access. The contents are retrieved by code names supplied along with the information at the time it is stored. These names also can

(a) AMPLIFIER BLOCK DIAGRAM



(b) TRANSISTOR CHARACTERIZATION

```
FORWARD NETWORK  2
AVERAGE VALUES

     GM      DB   = 6.49855
     R       OHM  = 19.0001
     X       OHM  = 10.2284
     RHM          = .470606

MAXIMUM VALUES

     GM      DB   = 9.39645 AT F = 1.6   GHZ
     R       OHM  = 20.2859 AT F = 3     GHZ
     X       OHM  = 16.3528 AT F = 3     GHZ
     RHM          = .48 AT F = 2.39999    GHZ

MINIMUM VALUES

     GM      DB   = 4.02790 AT F = 3     GHZ
     R       OHM  = 18.17 AT F = 1.6     GHZ
     X       OHM  = 4.14764 AT F = 1.6   GHZ
     RHM          = .469999 AT F = 2.1    GHZ
```

```
REVERSE NETWORK  5
AVERAGE VALUES

     GM      DB   = -19.0961
     R       OHM  = 39.0471
     X       OHM  = -46.3705
     RHM          = .482

MAXIMUM VALUES

     GM      DB   = -17.4579 AT F = 3    GHZ
     R       OHM  = 52.4157 AT F = 1.6   GHZ
     X       OHM  = -40.3198 AT F = 3    GHZ
     RHM          = .520001 AT F = 3     GHZ

MINIMUM VALUES

     GM      DB   = -21.2096 AT F = 1.6  GHZ
     R       OHM  = 28.2906 AT F = 3     GHZ
     X       OHM  = -52.9682 AT F = 1.6  GHZ
     RHM          = .46 AT F = 1.7       GHZ
```

1. Desired amplifier. Transistorized microwave amplifier (a) must supply gain of 12 decibels ± 1 dB and have 50-ohm input and output impedances from 1.6 to 3 GHz. Due to transistor transmission characteristics, gain-leveling and matching circuits can be separated. Important transistor properties are tabulated in (b) for forward and reverse performance.

be stored in a directory that can be printed out during any Optinet session.

The program uses a time-shared computer system primarily because it is the best choice of communications. Through time-sharing, Optinet can rapidly service scattered users by providing mutual access to models and performance criteria.

Furthermore, Optinet offers a number of convenience facilities. For example, it controls the cost of computation. Total dollar expenditure is reported on demand, and estimates of the cost of computation are available before the computation is run.

Information and diagnostics keyed to the current state of the problem may be obtained by typing "?". Successively deeper explanations are given when "?" is typed again. Also included is an adaptive editor to speed the flow of information, manage files, and adjust to the user's style.

Design example. How Optinet works is best illustrated by following a hypothetical project from design through marketing, and restricting the example to four basic areas: design, interpretation of measured data, production control, and marketing.

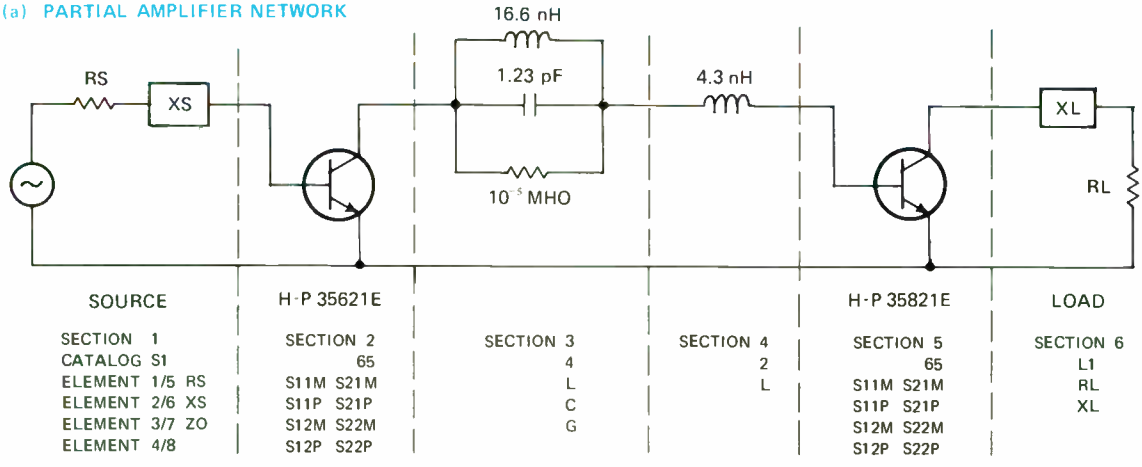
Suppose the desired product is a broadband amplifier that uses microwave transistors. Its specifications are: a minimum gain of 12 decibels with a flatness of ± 1 dB; a center frequency band of 2 to 2.5 gigahertz; a total bandwidth of 1.6 to 3 GHz; a minimal number of stages; and 50-ohm input and output impedances, with maximum reflection coefficients of 0.2.

Data on a suitable transistor is prestored in the Optinet public data file by the device's manufacturer. Using Hewlett-Packard's type 35821E transistor for this example, it is characterized in the file by S parameters at 15 volts and 15 milliamperes over a frequency range of 100 to 4,500 megahertz.

The major transistor design problems are gain variation and mismatched input and output impedances. Since this particular transistor has low reverse transmission, gain-leveling and matching circuits can be separated as shown in Fig. 1(a). Transistor properties relevant to the problem are computed from S parameters stored in the public file, as shown in Fig. 1(b).

Optinet describes the transistor for both forward (input) and reverse (output) characteristics. Average, maximum, and minimum values are tabulated for gain magnitude (GM), resistance (R), reactance (X), and reflection coefficient (RHM). Also noted is the frequency at which the value occurs as well as its units callout. For example, maximum input resistance is 20.2859 ohms at 3 GHz, while minimum output resistance is 28.2906 ohms at 3 GHz.

(a) PARTIAL AMPLIFIER NETWORK



(b) NETWORK FILE

M2

SECTION	CATALOG	ELEMENT1/5	ELEMENT2/6	ELEMENT3/7	ELEMENT4/8
1	S1	50	0	50	
2	65	1C1D9	1C2D10	1C3D11	1C4D12
		1C5D13	1C6D14	1C7D15	1C8D16
3	4	16.6C12	1.23C9	1E-5	
4	2	4.3C10			
5	65	1D9	1D10	1D11	1D12
		1D13	1D14	1D15	1D16
6	L1	50	0		

(c) FREQUENCY FILE

F2

LINE	FREQUENCY
1	1.6
2	1.7
3	1.8
4	1.9
5	2
6	2.1
7	2.2
8	2.3
9	2.39999
10	2.49999
11	2.59999
12	2.69999
13	2.79999
14	2.89999
15	3

DATA FILE

D13

LINE	DATA
1	2.95
2	2.8
3	2.62
4	2.54
5	2.37
6	2.3
7	2.15
8	2.08
9	1.98
10	1.91
11	1.86
12	1.77
13	1.73
14	1.63
15	1.59

(d) VARIABLE FILE

V

LINE	COMMON	NEG-BOUND	POS-BOUND	VALUE
1	9	1	2	1.23
2	10	2	6	4.3
3	11	11	13	12
4	12	10	20	16.0

(e) PERFORMANCE FILE

P2

LINE	MEASURE	FORM	WEIGHT	REFERENCE	COMPARE
1	GM	PLOT	10	12C11	SO
2	R	D1			
3	X	D2			

(f) CRITERION FILE

C

LINE	OPERATOR	SOURCES
1	SUM	P2

2. Gain-shaper. Partial amplifier (a) is described by its network file (b). Frequency file (c) sets test frequencies in operating band, while data file shows corresponding values of transistor gain. Variable file (d) establishes specification limits, performance file (e) defines amplifier gain requirements, and criterion file (f) optimizes gain flatness.

Of the several procedures that could be used to design the amplifier with Optinet, a very direct one is to first ignore input and output matching (since about the same amount of gain is lost across the entire band due to mismatching), and find approximate element values for an interstage circuit that provides adequate control over gain slope. Next, amplifier input and output impedances are computed and approximate element values for 50-ohm matching networks are found. Finally, the complete circuit is assembled, overall performance criteria are defined, and optimization is used to adjust the various element values for best performance.

The data in Fig. 1(b) indicates that the transistor's maximum input resistance and minimum output resistance nearly match at the high end of the operating frequency band if a series inductance is used to balance out reactance. It can also be seen that the gain rolloff, from a maximum of 9.4 dB at 1.6 GHz to a minimum of 4 dB at 3 GHz, is about 6 dB per octave.

Since there are two transistors, approximately 12 dB of gain rolloff must be introduced at the low end to flatten amplifier gain response. Thus, at least three reactive elements are needed to increase the gain control circuit's reactance slope. Values will be chosen to provide the flattest and highest gain within the operating band.

Figure (2a) illustrates a partial amplifier design and

Fig. 2(b) is its description. The network is partitioned into sections that correspond to lines in the network file and elementary sections in Optinet's catalog of subcircuits. Elementary sections are represented by mnemonics (like S1 and L1) or numbers in the catalog.

The mnemonics are listed in the CATALOG column of network file N2 to indicate which sections are needed. Certain element values are required to complete the section description. For example, Fig. 2(a) shows that section 1 contains a voltage source (S1), described by a source resistance (RS), a reactance (XS), and a characteristic impedance (ZO). These elements are assigned appropriate numerical values each time they are used, as done on the first line of the network file.

Eight S parameters are required to completely describe each transistor's performance at any frequency. The S parameters are complex numbers forming a 2-by-2 matrix, and are represented by mnemonics S11M through S22P (M is for magnitude, P for phase). The double-number designation fixes the S parameter's row and column location in the matrix. For instance, S11M is the magnitude of the S parameter in the first row and first column of the matrix; S21P is the phase of the S parameter in the second row and first column of the matrix. Because each transistor is described by identical S parameters, only one set of eight must be stored; these values go into data files D9 through D16.

Also included is a master numbering system for the circuit elements. Every network file has four ELEMENT columns, differentiated by numbers 1/5, 2/6, 3/7, and 4/8. A number is assigned to each element in a network section. For any single section, Optinet can accept up to eight elements, the maximum required to completely describe any network section. From the network file of Fig. 2(b), it can be seen that section 2 comprises elements 1 and 5 (1C1D9 and 1C5D13) through elements 4 and 8 (1C4D12 and 1C8D16).

Section 3 of the partial amplifier calls for catalog subcircuit number 4, which is a parallel inductance (L), capacitance (C), and conductance (G). Because the conductance merely accounts for minor parasitic losses, it is specified as $10\nu^{5}$ (noted as 1E-5 in Fortran) mho.

Program files. Network elements may be made variable and/or frequency-dependent. Figure 2(c) shows a frequency file; it gives the frequency points to be evaluated and the data file for S21M. The latter represents the variation of element S21M over the frequency range called for in frequency file F2. Whenever network performance is computed, the appropriate gain for S21M is chosen from data file D13. If the frequency of interest is 2 GHz on line 5 of the frequency file, corresponding gain is 2.37 on line 5 of the data file.

If an element value is stored in one of 25 special locations, called common storage locations, it can be used for several elements in a network and/or it can be made a variable parameter. To be stored in one of these locations, a flag designated by a mnemonic C1 through C25 must immediately follow the element's numerical value. Element values stored in this way act as multipliers.

Data files can be treated similarly. If data files are called out as shown for the eight S parameters (1C1 through 1C8) in line 2 of network file N2, the element value is the number stored in the selected common location multiplied by the appropriate data file entry.

The variable file of Fig. 2(d) specifies a set of variable parameters whose values are to be adjusted for best performance: up to 15 numbers of a maximum of 25 stored in common locations C1 to C25 can become variables. These are listed (by number) in the COMMON column. A range for each variable must be defined by listing its lower limit (NEG-BOUND) and upper limit (POSBOUND). Nominal variable values are called out in the VALUE column.

Variable file V presents the data for amplifier gain and the passive gain-leveling circuit elements shown in Fig. 2(a). Line 1 calls for the 1.23-picofarad capacitor stored in common location C9, line 2 the 4.3-nanohenry inductor in C10, and line 4 the 16.6-nH inductor in C12. Line 3 stores amplifier gain in common location C11 and confines its value to 12 ± 1 dB. Storage locations for gain-control elements are also noted in the network file.

Values of variables may be assigned or changed by making an appropriate entry in the variable file, as well as in any file where the common location is referenced. Variables are required for all of Optinet's higher computing functions, such as sensitivity analysis and optimization. During optimization, any changes in variable parameter values are readily examined by printing the variable file.

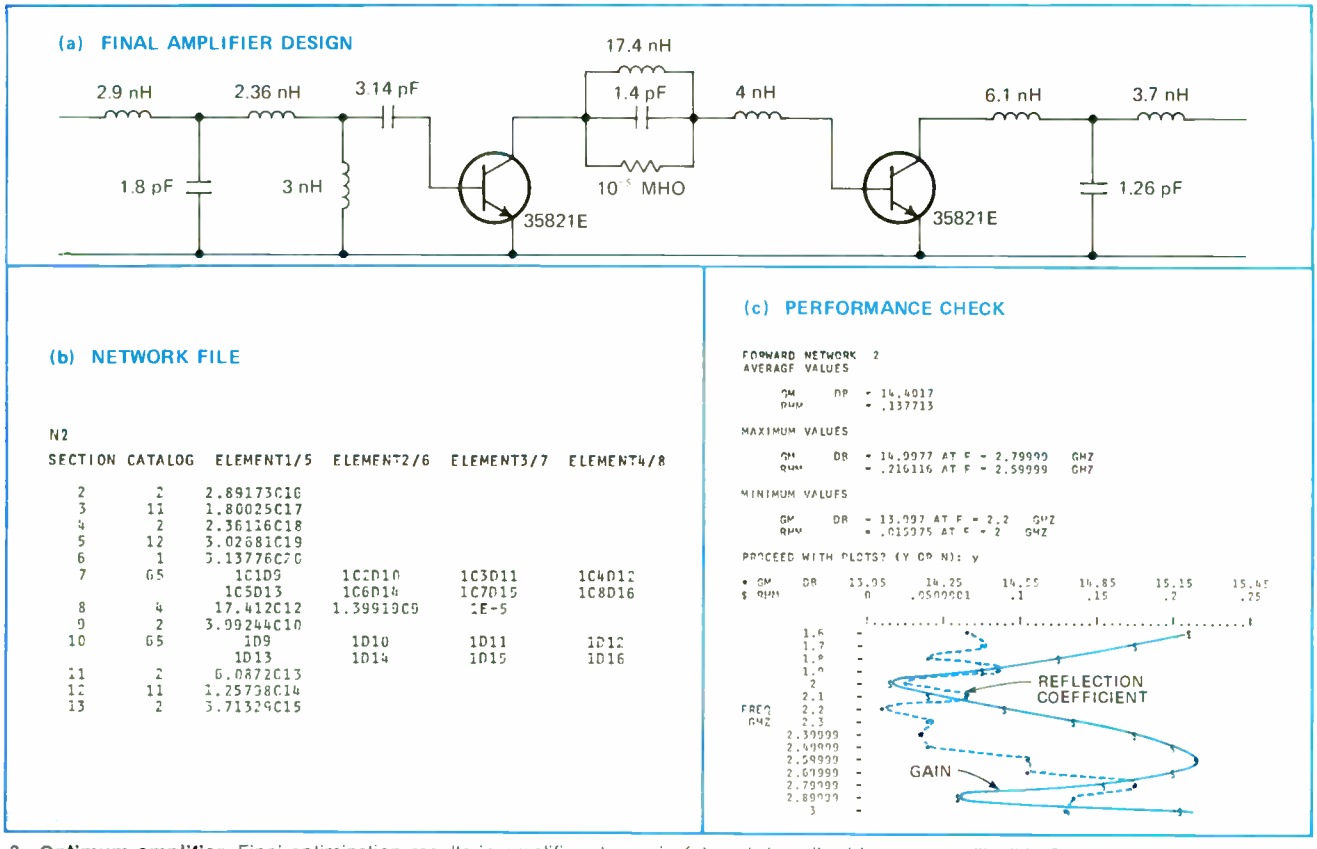
The performance file of Fig. 2(e) defines the proposed network's performance requirements. Line 1, for instance, requests the gain magnitude (GM) to be presented in the form of a plot versus frequency whenever the network is analyzed. The REFERENCE column cites the nominal value of the variable of interest (gain magnitude in this case) and its storage location. A callout of 12C11, for example, refers to the variable listed on line 3 of the variable file; its nominal value is 12 and it's stored in common location C11.

The gain affects the criterion function because its weight is positive (not zero). Weight value is assigned by the user and reflects the relative importance of the quantity being computed.

Two other factors influence the weight value. One is the magnitude of the quantity, and the other is how often it is computed during a run. Gain, for example, is computed 15 times (because of the 15 frequencies in the band) and has a high value of 10 to 15 dB. Reflection coefficient, however, is found only once in the band and has a low value of 0.1 to 0.2. To make these two quantities approximately equal in importance, the user could assign a weight of 1 to the gain and a weight of 1,500 to the reflection coefficient.

Since gain is specified as a point-by-point measure (PLOT) in performance file P2, it contributes a value to the criterion function at each point in the operating frequency band. This value is the WEIGHT (10) multiplied by the square (SQ) of the difference between the gain magnitude and the reference. The COMPARE column in the performance file indicates what mathematical operation should be carried out.

Minimizing the criterion value, WEIGHT $(GM\text{-}REF)^2$, will bring the gain closer to the reference at each point in the band. Since the reference is a variable parameter, an optimization search can adjust it to a value that gives the flattest gain curve.



3. Optimum amplifier. Final optimization results in amplifier shown in (a) and described by network file (b). Optinet can also predict performance of finished amplifier. Performance check (c) notes that minimum gain is 14 dB at 2.2 GHz, and maximum input reflection coefficient is 0.22 at 2.6 GHz. Gain and reflection coefficients are plotted.

For optimization, only the first line of performance file P2 is used, because the other lines have no weights. When an analysis is run, the network gain magnitude is plotted, and network input resistance (R) and reactance (X) are automatically computed and stored in files D1 and D2 for use in solving the input matching problem.

The criterion file of Fig. 2(f) gives the final requirements for a function whose minimum represents best performance. Contributions from one or more performance files can be combined to create the criterion function in the way specified by the OPERATOR column. Possible operators are sum (SUM), maximum (MAX), and product (PRO). Sum and maximum are generally used for design purposes, while product is usually listed for worst-case analysis. Performance files to be combined to form the criterion function are listed in the SOURCES column.

First-order design. Now that the Optinet files needed for a solution are established, the amplifier design problem can be run. Figure 2 contains all the files needed to establish an interstage gain control circuit.

Next, an output matching network can be found by computing input and output impedances across the operating band. The complete first-order design is then optimized to produce the best performance.

The final amplifier design, its network file, and a final performance check are shown in Fig. 3. As indicated in Fig. 3(c), the amplifier's maximum reflection coefficient does not quite meet desired specifications: its value is 0.216 at 2.6 GHz. Minimum gain, however, exceeds the original design objective with a value of about 14 dB at 2.2 GHz. To improve the reflection coefficient, another computer run would be necessary and some degradation permitted in gain performance.

With the initial part of the product design finished, the time and expense incurred thus far can be examined. Slightly more than 24 engineering hours in addition to seven hours on a time-shared terminal are required. A reasonable time-and-cost estimate for the entire design task is about a week of engineering time and around $300 to $700 for computer time, including the investigation of alternative circuits.

The design is not complete until sensitivity and worst-case performance are checked. Optinet's sensitivity analysis indicates the change in network performance as each variable circuit element is individually increased by some small amount. Worst-case analysis predicts circuit performance if all the variables are changed simultaneously. For this amplifier, the key performance specifications are minimum gain and maximum input reflection coefficient.

For sensitivity analysis, these two performance measures are called for by altering performance file P2 as shown in Fig. 4(a). The variables to be changed are the gain and circuit elements whose optimized values are indicated for the amplifier of Fig. 3(a). Nominal value of each variable will be increased by 1%.

Figure 4(b) illustrates the results of the analysis (potentially troublesome areas are surrounded by boxes). Nominal values of gain and reflection coefficient are printed, along with the incremental change that occurs in these quantities when a given variable is increased.

Numbers 1 through 11 correspond to the variables listed on the same-number lines in the variable file.

A 1% increase in variable 1, the 1.4-pF capacitor in Fig. 3(a), causes a 0.003 increase in the reflection coefficient and a 0.07-dB increase in the gain. For this design example, an increase in any variable causing more than a 1% change in a performance measure is considered potentially troublesome. Therefore, any increment greater than 0.002 in the reflection coefficient and greater than 0.14 in gain is surrounded by a box in Fig. 4(b). (Note that gain performance never goes out of specification; taken as a whole, the amplifier design is satisfactory.)

The cost of sensitivity analysis is usually nominal (under $10 in this case). The analysis not only pinpoints the elements that may need to be adjusted in the final design but also helps to define acceptable tolerances on other elements. And it could be useful to overdesign a circuit by using more than the minimum number of circuit elements, thereby reducing all of their sensitivities.

Worst-case analysis is the next step. Optinet can determine what specifications will not be met, at what frequencies in the band, as well as for what combinations of component values and value tolerances. The necessary files are given in Fig. 5(a); these must be used along with the network file of Fig. 3(b).

Worst-case analysis. For the amplifier example, the worst-case criterion function must go to zero if the desired specifications are not met at any point in the band. The variables in the variable file are normalized values of the eight S parameters that characterize each transistor. The boundary values shown reflect a ±10% tolerance as specified by the manufacturer.

Performance file P2 places an upper bound (UB) on minimum gain to assure that the first term in the criterion function will be 0 if the gain falls below 13 dB. Line 2 of the file sets a lower bound (LB) for the maximum reflection coefficient to make certain that the second term of the criterion function is 0 if the maximum reflection coefficient in the band exceeds 0.33. The product operator (PRO) in the criterion file sets the criterion function equal to the product of the terms in file P2.

When the worst-case performance objectives defined by the performance file are exceeded, Optinet terminates the search and prints the results as shown in Fig. 5(b). The normalized S parameters that cause worst-case performance are listed in the VALUE column of a new variable file. (Note that none of the worst-case S parameter values exceed their specified tolerance.)

According to the analysis, the reflection coefficient will be 0.346 at 3 GHz and, therefore, not within specification. Minimum gain, however, stays within design objectives—its value is 13.9 dB at 1.8 GHz. Worst-case analysis always identifies the frequency with the poorest performance.

When the limit for the maximum reflection coefficient is changed to 0.5, gain variation is emphasized. Running through worst-case analysis again yields the results shown in Fig. 7(c) and a different set of S-parameter values. Gain will be just over 13 dB at 2.2 GHz and still within specification. Reflection coefficient also meets the desired limit with a value of 0.346 at 3 GHz. Cost for this worst-case analysis is about $55.

(a) PERFORMANCE FILE FOR SENSITIVITY ANALYSIS

```
P2
 LINE   MEASURE   FORM    WEIGHT     REFERENCE   COMPARE
   1      GM       MIN
   2      RHM      MAX
```

(b) SENSITIVITY ANALYSIS RESULTS

```
FORWARD NETWORK   2
    PERFORMANCE            INCREMENT DUE TO 1% CHANGE IN VARIABLE
PARAMETER     VALUE            1            2            3            4

MAX   RHM     .216116     .00329638    .00355709        0      5.02765E-4
MIN   GM      13.997      .070467      .0462922         0       .0151348

    PERFORMANCE            INCREMENT DUE TO 1% CHANGE IN VARIABLE
PARAMETER     VALUE            5            6            7            8

MAX   RHM     .216116     .00141782  1.80125E-4   -7.512E-4    .00443208
MIN   GM      13.997      .00505447   .00344276  -.00498772  -.00276947

    PERFORMANCE            INCREMENT DUE TO 1% CHANGE IN VARIABLE
PARAMETER     VALUE            9            10           11

MAX   RHM     .216116     .00186241  8.47638E-4    .00172377
MIN   GM      13.997     -.00534058   .00244141  -.00295639
```

4. Sensitivity analysis. Performance of final amplifier is checked for sensitivity to changes in individual variables. A 1% increase in each variable is introduced separately. Performance file (a) indicates that gain and reflection coefficient should be tested. Results in (b) have possible trouble spots noted with a box.

The worst-case performance study indicates the S parameters that should be avoided at specific frequencies for acceptable amplifier performance. Variations in transistor parameters generally are compensated for by adjusting circuit elements, and Optinet can determine appropriate ranges and parameters.

Another application for the Optinet system is interpretation of measured data. The program can determine the values of the variable model parameters that provide the best fit between computer and measured data. Using this feature requires that a bench model of the Optinet-designed amplifier be built and tested.

Because of tolerance ranges in purchased components, it's highly unlikely that the test data for the prototype will accurately match predicted performance. But Optinet accepts the measured performance data and finds the new variable values needed to make measured performance match the computed. The program indicates those parts of the circuit responsible for any discrepancy and notes corrective action required.

Implementing this Optinet feature involves using the same files that are employed for design. However, the measured data is stored in data files to establish amplifier performance for each frequency in the band. These data files are then listed in the REFERENCE column of a performance file. Optinet will automatically adjust circuit element values to achieve the best match for the reference (measured) data. The user then can determine those elements that require adjustment and by what amount.

Production modeling. Transferring a product from development to production usually causes many problems. Some can be reduced or even eliminated if both an Optinet model and prototype are available to production personnel.

A study of the prototype quickly shows what tolerance must be held and what performance changes occur, with certain circuit element variations. As pilot

(a) FILES DEFINING WORST-CASE ANALYSIS

```
V
 LINE   COMMON   NEG-BOUND   POS-BOUND    VALUE
   1        1         .9         1.1        1
   2        2         .9         1.1        1
   3        3         .9         1.1        1
   4        4         .9         1.1        1
   5        5         .9         1.1        1
   6        6         .9         1.1        1
   7        7         .9         1.1        1
   8        8         .9         1.1        1

P2
 LINE  MEASURE  FORM  WEIGHT  REFERENCE  COMPARE
   1     GM      MIN      1        13        UB
   2     RHM     MAX    100       .33        LB

C
 LINE  OPERATOR  SOURCES
   1     PRO      P2
```

(b) WORST-CASE ANALYSIS RESULTS

```
V
 LINE   COMMON   NEG-BOUND   POS-BOUND    VALUE
   1        1         .9         1.1     .999343
   2        2         .9         1.1     .945808
   3        3         .9         1.1     1.0627
   4        4         .9         1.1     .949363
   5        5         .9         1.1     .990322
   6        6         .9         1.1     .920838
   7        7         .9         1.1     1.02744
   8        8         .9         1.1     1.04963

FORWARD NETWORK  2
MAXIMUM VALUES

      RHM          = .346239 AT F = 3    GHZ

MINIMUM VALUES

      GM      DB   = 13.9353 AT F = 1.8   GHZ
```

(c) MODIFIED WORST-CASE ANALYSIS

```
V
 LINE   COMMON   NEG-BOUND   POS-BOUND    VALUE
   1        1         .9         1.1     1.04318
   2        2         .9         1.1     .915946
   3        3         .9         1.1     1.07918
   4        4         .9         1.1     1.03349
   5        5         .9         1.1     .912443
   6        6         .9         1.1     .904025
   7        7         .9         1.1     1.00344
   8        8         .9         1.1     .921671

FORWARD NETWORK  2
MAXIMUM VALUES

      RHM          = .324711 AT F = 3    GHZ

MINIMUM VALUES

      GM      DB   = 13.0834 AT F = 2.2   GHZ
```

5. Worst-case analysis. If all circuit variables are changed at the same time, amplifier performance can be checked for worst-case conditions. Files (a) define worst-case gain (GM) and reflection coefficient (RHM) when transistor S parameters are varied by ± 10%. Printouts (b) and (c) show results.

models are built and checked. Optinet can interpret test data for the adjustment of the production process to provide target performance. Optinet also can even continuously monitor production so that drifts can be corrected before the product goes out of specification.

Optinet also can compensate for variations in state-of-the-art components that may be the only devices available for a given production run. With an Optinet production model of the whole product, data on the doubtful parts can be entered into the program. Optinet then will investigate the corrective action possible through controlled changes in other circuit parameters.

Another consideration in production modeling is answering requests for quotations that involve some deviation from standard performance. It may be difficult to determine quickly whether these special specifications can be met on the production line. With Optinet, the special specifications can be used in the optimization routine. Knowing the best values for the elements and the best performance obtainable can greatly improve bidding accuracy and production planning.

Marketing. The final step in developing a new product is marketing. Through its public data file, Optinet can make this task easier, as well as reduce time and expense for both seller and buyer. Since the program is available through a time-shared network, any subscriber has easy dial-up access to the public file and, therefore, to the Optinet product model. A potential customer can explore the properties of the product or even run through a complete design, as was done here with the Hewlett-Packard transistor.

Instead of spending months exchanging samples, building prototypes, and trying to agree on mutually acceptable product performance, the manufacturer and his customer can trim this exploratory period to a matter of weeks. Costs, too, are dramatically reduced because less engineering time is needed.

Suppose a conventional sample-and-build period is about three months. Engineering costs, including support and overhead expenses, normally would be about $10,500. Optinet could reduce the time factor to two weeks, dropping engineering costs down to $1,750. Adding about $700 for computer time brings the total expenditure to $2,450, a significant saving.

Since Optinet's public data file has the same capacity as its working file, there is ample space to store product data, frequency ranges, performance properties, and component tolerances. The amplifier example could be represented explicitly by its network file description. Or the circuit's two-port performance may be given in terms of S parameters or any other equivalent numerical description.

If an Optinet subscriber already has a model in his private files, it can be transferred to the public disk without charge and stored for $10 to $20 per month. The public file can be updated from subscribers' private files at any time.

As the Optinet system grows in scope, the catalog of products in its public data file also will grow. It should be remembered, however, that the program's most up-to-date source of product information is its directory, which can be listed simply by giving a command during an Optinet terminal session. □

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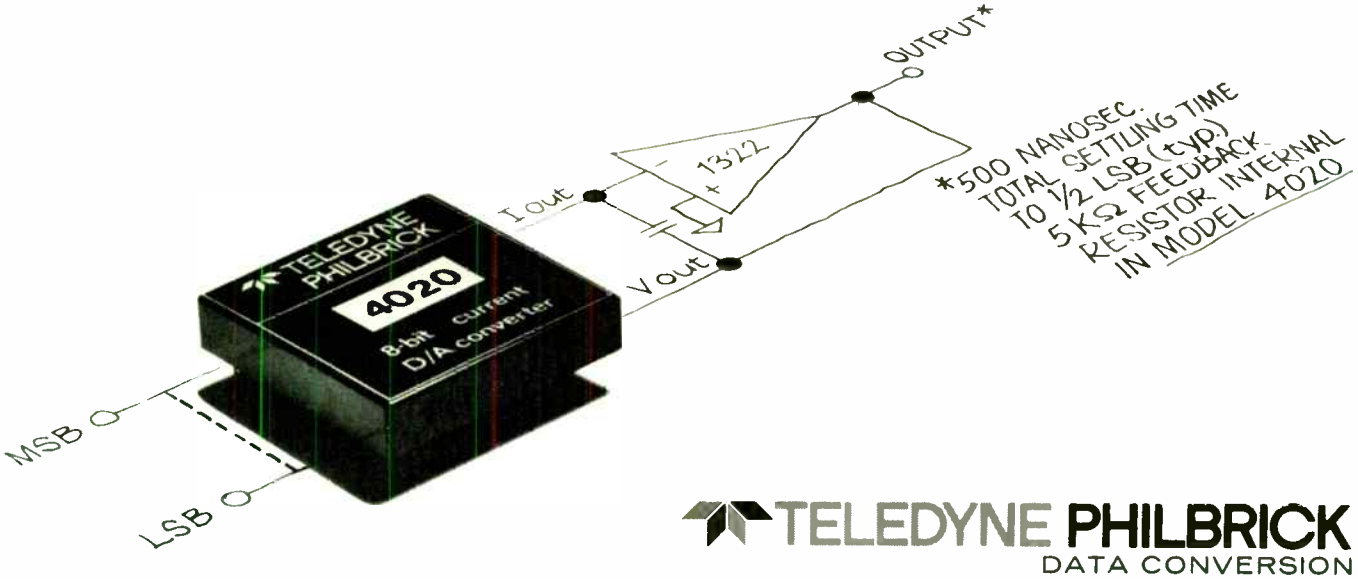

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Circle 71 on reader service card 71

Up the organization, say EEs responding to poll

Concerned with job security, pensions, and their status as engineers, our readers overwhelmingly favored forming a new national group; but they strongly preferred a professional organization to a union

☐ By a substantial majority, electronics engineers favor formation of a new professional association, similar to the American Medical Association, or a trade union in order to win career benefits and improve their position in American society. According to results of an *Electronics* questionnaire, 78% of respondents to a ballot presented in the Aug. 2 issue supported the concept of a national organization—56% for a professional association, 22% for a trade union.

Based on comments received with these ballots, feelings are running high on the union issue. It's apparent that both the current attitude toward lack of job security and the fuzzy role of the engineer in society have heavily affected the results: there was no clear-cut agreement on whether professional standing is worth more than a secure paycheck.

For example, the most-mentioned reason for setting up a new association was that such a group would represent engineers in a professional manner, influencing standards of performance and status—the EE's public image—as much as to provide job security. On the other hand, the reasons most mentioned in favor of a trade union were the need for a strong bargaining agent with company management and the possibility of improving pensions and other income benefits.

As a 36-year-old Bostonian put it, "A strong association of engineers which dictates its desires to Government, industry, and the educational institutions is the only chance for a dying profession. If the supply of engineers were halved and my monetary compensation were doubled, I would be very happy to pay $1,000 annual dues to an association that maintains a lower supply of engineers and a greater demand. I would also attend a national meeting at my own expense. Then engineers would start becoming professional, earning the respect of society and industry in the process."

More equivocal in his support, an EE from California commented, "The only valid argument against a trade union for engineers is that a professional organization patterned after the AMA is better. Engineers, based on their training and educational background, should strive to attain the professional privileges enjoyed by doctors and lawyers. We can never hope to attain such status without a powerful professional organization. Unions do not reek of professionalism; the AMA does."

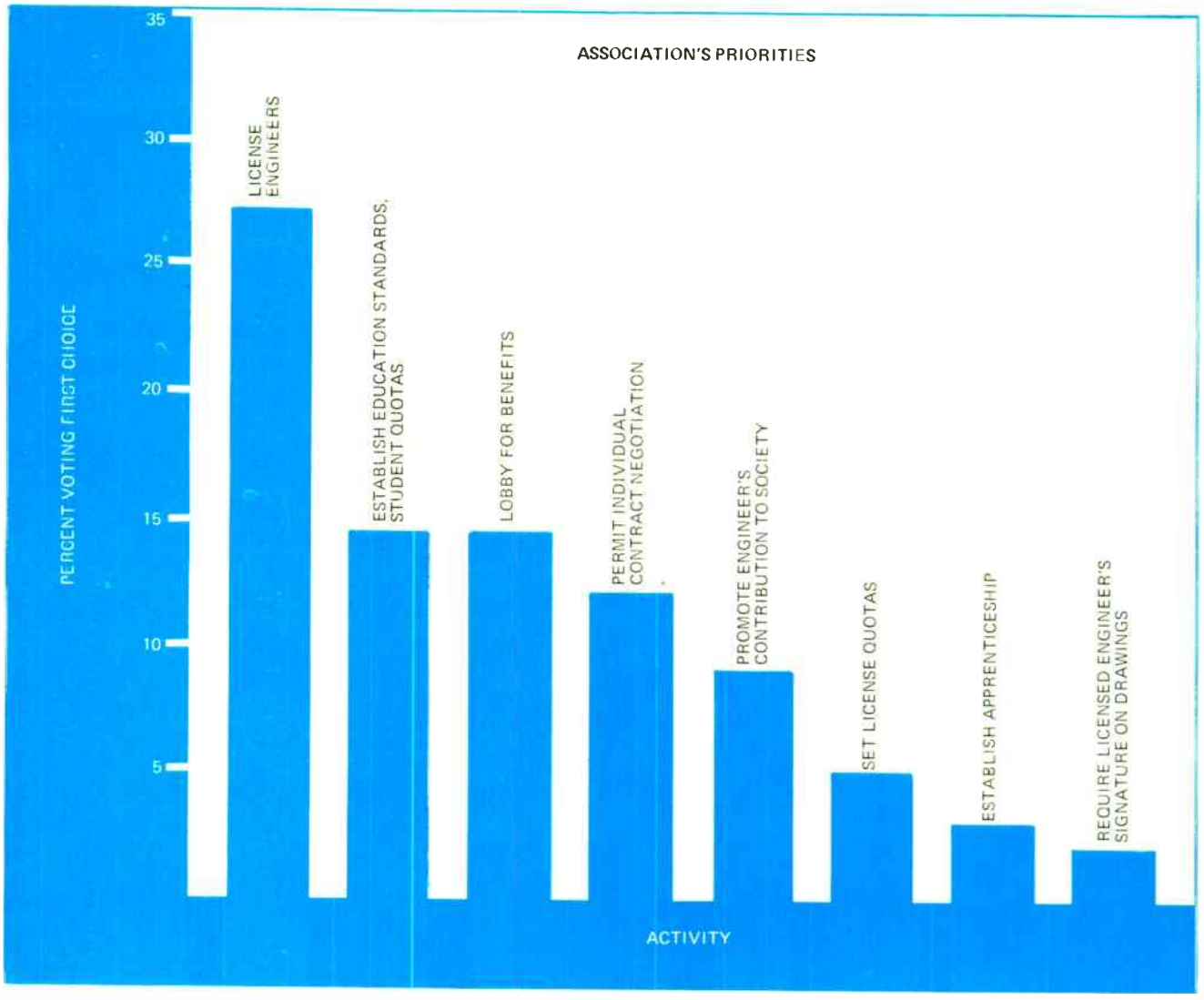
Significantly, the tenor of the pro-union arguments stressed job benefits even at the cost of disregarding the engineer's professional image. Though just 22% of those who voted for some form of organization favored unions, it represents a view of the career strongly influenced by layoffs, recession, inflation, and heavy competition for jobs in most electronics centers—as well as a completely different self-appraisal for EEs. "Professionalism is bunk—no engineer can be a professional if he works for somebody else," noted a 60-year-old design engineer from Los Angeles. This view is typical of this type of thinking.

An engineering manager from Pennsylvania wrote: "It is time we face the fact that except in a few instances, such as consultants, we engineers are not professionals in the same sense as doctors and lawyers. When you have 50, 100, or 1,000 engineers working for a company, you can consider them as nothing more than very high-level technicians doing a job which in many instances seems less important to the company than a good secretary. The engineer has no control over working conditions or his own personal interests except that he can work late as long as he is in on time in the morning."

"The only answer," noted an unemployed 36-year-old BSEE in Southern California, "is to unionize—the coal miners, musicians, truck drivers, and longshoremen did. We are not better than they are—we would just like to pull even with them."

Unions: yes or no. The *Electronics* poll, which presented the arguments for and against unions and asked readers to express their opinions, also included a slot to register anti-organization feelings. By far the most prevalent reason presented by the 22% who were opposed to both an association and a union was that these groups limit or inhibit individual achievement, career planning, and promotional progress.

The anti-unionists stressed professionalism and career satisfaction as prime motivations for engineers. As a 31-year-old communications systems EE put it, "The days of the individualist, rugged or not-so-rugged, engineer or otherwise, are not over. Any economy will have its ups and downs. During a down, companies lay off engineers, not because they want to discriminate against the engineering profession, but because the unpleasant realities of what is supposed to be a free-enterprise system dictate such action. In the event that a given engineer is laid off, the fact that he is an engineer should mean he has enough brains, backbone, and motivation



to solve his problem without running to a union for help."

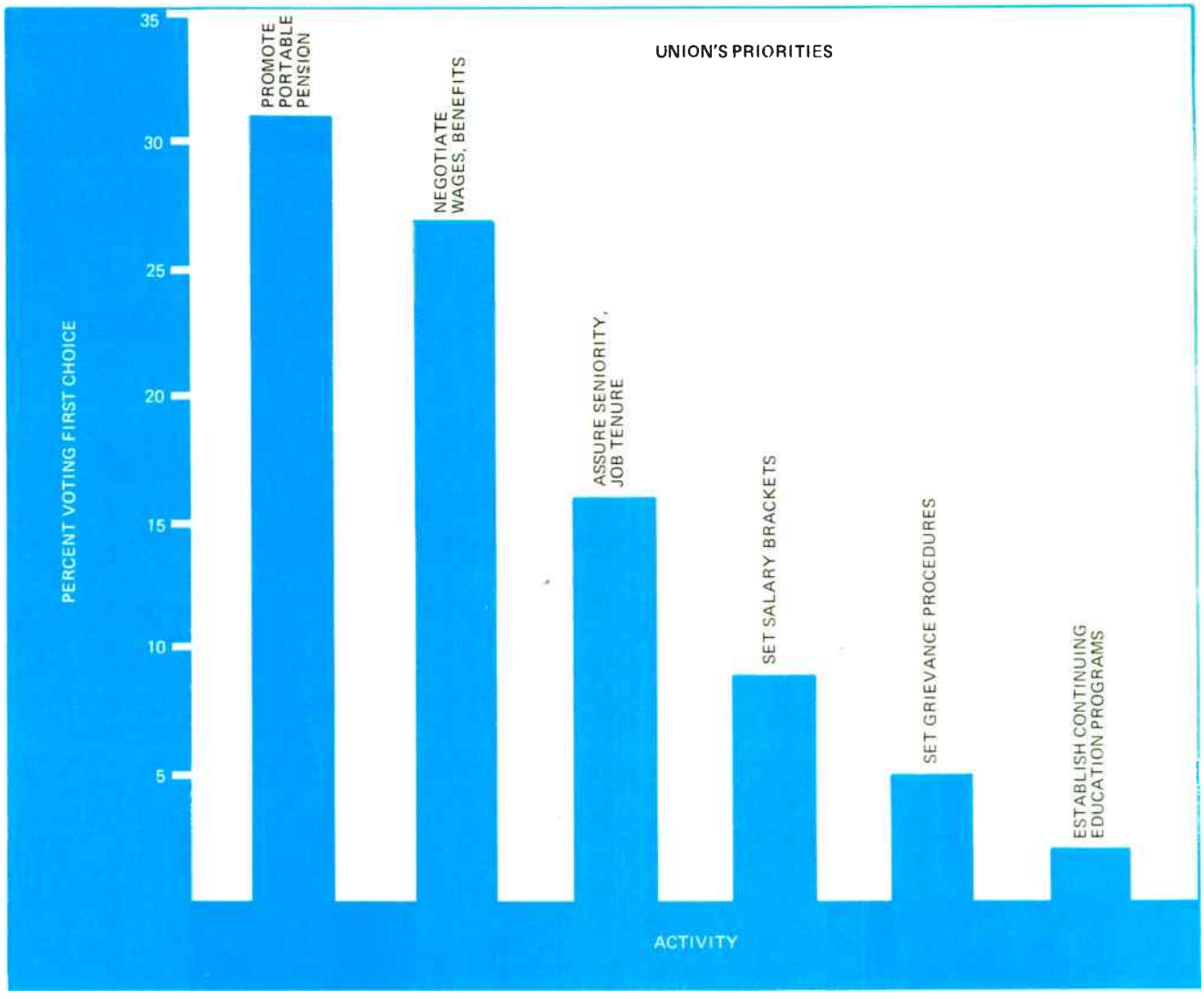
Among the many young engineers against unions (see "Over-30 militants," p. 75), a 29-year-old senior engineer from Florida, stated: "The primary effect of either a union or an association would be to align engineers with the long list of those demanding something for nothing to the detriment of the profession, the engineers, and society."

"The very idea that a man will obtain a salary increase, not because his productivity has increased but because he absolutely refuses to work until the salary is increased, is revolting, to say the least," asserted a 23-year-old EE in his first year of engineering. "If I did not have a pride in my own ability and confidence, I would not have become an engineer," he added.

Standing between these strong attitudes on professionalism vs trade unions is the not-so-silent majority hoping to obtain the financial and psychic rewards of both through an association. Those voting for an association were asked to list eight activities or goals in order of importance for a new national group. Most of the objectives listed (Fig. 1) would clamp some sort of control on the engineering career. Among these, the most popular, with 27% first-choice nominations, was requiring national licensing of practicing engineers. While not as far up the list of top priorities, lobbying in Washington for engineering job benefits, sponsoring a national advertising campaign to inform the public about engineering, and working with universities to set educational standards and enrollment received a high number of mentions.

Though EEs favored licensing of practicing engineers, the idea of establishing apprenticeships for beginning engineers prior to licensing was among the least-popular goals of an association. Similarly unpopular was the suggestion that all design drawings be signed by the licensed engineer responsible for their creation.

On the whole, the ballots reveal that EEs want a group that is interested in promoting the engineer to the outside world as much as promoting his individual career, but draw the line on restricting the number of engineers on the job market. "How would we feel if the United States ended up a third-rate power in technology as a result of a scarcity of engineers which was promoted by a successful association?" a Houston, Tex., EE asked. The idea of a quota system for EEs was distasteful to many who pointed to the American Medical Association's role in controlling the number of MDs as contributing to a national health crisis today.



Among the six choices for a trade union's activities (Fig. 2), promoting a portable pension plan received the highest percentage of first-choice votes and the greatest number of total mentions. Negotiating wages and employee benefits was close behind in first-choice selections, followed somewhat distantly by insuring seniority and job tenure.

EEs placed union-sponsored continuous education last on the list of priorities. And the opportunity to take complaints against a company's procedures to a formal grievance committee also drew little support.

While job tenure and seniority was not the top priority, many EEs mentioned layoffs as the big impetus interest in a union. A disgruntled group leader for an Ohio OEM firm demanded, "We need a full-blown union with strike power to save the engineering profession from more and more intimidation from exploiting companies and loss of engineers to trades that pay more per hour." He signed these comments "Ex-aerospace engineer now an underpaid technical slave."

A majority of respondents favoring an association thought that the IEEE should take the lead in organizing it: 53% said yes to this idea, 34% voted no, and 8% did not answer. However, reactions to the IEEE's positions were rarely lukewarm.

"The IEEE is the only organization in the right position to organize an association but they have shirked responsibility too long," a New York engineer complained. "They [IEEE] had better do it before the teamsters do," a Californian warned.

On the negative side, engineers charged that because the IEEE is slanted toward electronics industry management and is dominated by academics, it is not a good focal point for an association. The more critical condemned the institute for not taking enough interest in the welfare of its members.

A number of returns suggested that the National Association of Professional Engineers is better equipped to organize engineers, as well as promote engineering interests in Washington, than is the IEEE. Still others suggested that an engineers' association become a joint effort of all disciplines—electrical, chemical, mechanical, civil—rather than an EE-only club.

A Ph.D. in electrical engineering complained that the IEEE should be more aggressive, but contains "many highly technical, nonaggressive people." His own aggressive suggestion: "How about a two-day, nationwide job boycott to show the importance of engineers?"

Though other such outright demands for job action were few, the unmistakeable mood of the majority of re-

Who voted

Though the issue was unionization, engineering managers dominated the responses with 44% of the total questionnaire returns. In this group were chief engineers, directors of R&D, and project or program managers.

Design engineers were the second-highest responding group, but way down at 14% of the total. The rest were scattered among systems, applications, test, and production engineers.

Respondents to the union issue tended to be experienced EEs. The predominant age group was 31 to 35 with 26%, followed by 26-30 with 22% and 36-40 with 16%. A majority of respondents, 51%, have graduate degrees. And the average experience in engineering is 13 years.

Space, missiles, and aircraft companies (13%) along with communications and radar manufacturers (12%) dominate the list of electronics firms represented with 25% of the total, reflecting the importance of the union issue to hard-hit engineers for Government contractors. Geographic preponderance went to California with 24% of the returns; New York, 10%, and Massachusetts and New Jersey, 7% each, followed.

spondents was militant, even among EEs with managerial titles and Ph.D.s in R&D positions. Among the many lengthy analyses included with the return ballots, that of a 48-year-old EE now teaching college in Colorado was particularly poignant: "Engineers are the brains of the country, but they do not have guts," he wrote. "Engineers, if you are meek and mild and if you can go on taking a beating time after time, please do something for your daughters and sons, who might like to become engineers and have to face the same humiliating and uncertain life that we have. If injustice is done to engineers, individuals cannot take action. The only way to success is by organized, united action."

Along the same line, an engineer for a CRT display firm in New England called for more visibility for EEs. "The next engineering era should include more person-to-person contact, more company exposure, and a greater public profile," he proposed. "Too often the engineer has been pushed aside while management and sales get the recognition, the exposure, and the rewards. Typically, the only reward an engineer gets is a pat on the head by the management, his own self-gratification, and a chance to pour on the coals again on another project—burning out a product and himself."

This EE, along with many others, suggested that engineers are neither blue-collar nor management. Therefore, engineers should begin setting up individual contracts with companies for their services, he felt. "This would create some interesting problems, but would not be impossible to overcome."

Although the ballot made a distinction between union and association goals, a number of EEs indicated an interest in combining some of the job-security objectives of a union with the status-building approach of the professional association.

For example, an unemployed BSEE from Pennsylvania posited: "The increasing institutionalism of our society generates for the individual engineer a sense of frustration, not unlike that of other disadvantaged minorities, who see themselves as pawns in the socio-politico-economic moves of organized interests.

"I believe that a professional association, similar to the American Association of University Professors rather than to the AMA, would be a constructive step toward presenting the professional concerns of salaried electronics engineers. Such an association should direct itself not to parochial protectionism, which is common to both the union and the AMA-style association proposals, but to the wider, enlightened interests of both our profession and of society.

"We should seek to reduce the disproportionate economic incentives of the 'use-and-discard' theory of engineering employment, not defy them behind barriers of seniority and quotas. The portable pension and continuing education programs are constructive steps in this direction. With the rapidly changing technology and short technical half-life of the working engineer, benefits might accrue to both him and his employer by the recognition of the professional sabbatical as a valid element of his professional employment. Periodic maintenance and improvement are no less applicable to experienced and capable personnel than to an employer's capital equipment."

In a less-profound vein, a 45-year-old Connecticut EE probably captured the intensity of most feelings when he pleaded, "Call it anything, anything at all—association, union, or even prostitution, but please, for the sake of all the yellow-degree engineers like me, do it. You will be surprised how fast it will grow and the support it will get from the engineer." □

Over-30 militants

If organizing a union or association is a surprisingly radical endeavor for EEs, even more surprising is that the sentiment is being led not by the youth, but by the over-30s group.

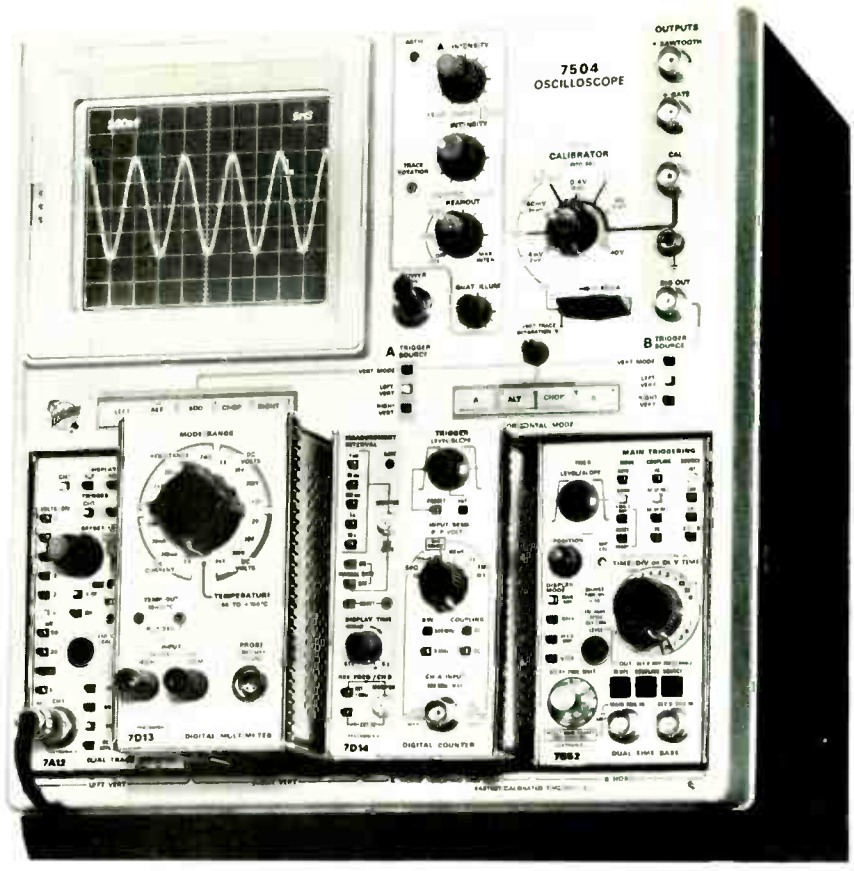
The 31-to-40-year-olds submitting opinion ballots voted 28% for a union, almost 55% for a professional association, and under 18% against any organization. A more conservative under-30 group voted 15% for union, 56% for association, and 29% against any national group. The over-41 respondents voted 22% for union, 5% for association, and 21% against both.

Youth's commitment to the status quo was reflected more strikingly in the comments in which the strongest arguments against unions and for "rugged individualism" came from EEs in their 20s.

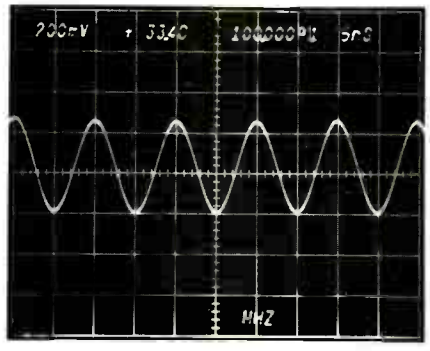
And how do students feel? Milton H. Crothers, associate professor, Department of Electrical Engineering, University of Illinois, Urbana, sent in ballots from some students in his Electronics 2 class. There was hardly much radicalism in this EE-to-be-group: one voted for a union, one for either a union or association, three for association, three for association but against union, and one against either an association or union. Six of the nine favored IEEE leadership in setting up an engineering organization.

Crothers, 50, faces a partial generation gap with his students: he voted for an association, against a union, and half-heartedly for IEEE leadership.

push in the two center plug-ins and . . .



have an oscilloscope that digitally measures: frequency, resistance, current, voltage, and temperature. You still retain all normal scope features such as delaying sweep and dual trace. The CRT display at right is just one of many measurements possible with a scope/DMM/counter combination.



The output of an oscillator is displayed and its frequency is simultaneously correlated against changes in temperature.

The 7D13 Digital Multimeter has 3 1/2-digit readout. It measures DC voltages to 1000 V with an accuracy of ±0.1%, ±1 count; DC current to 2 A; resistance to 2 MΩ; and temperature from −55°C to +150°C.

The 7D13 input can be floated up to 1.5 kV above chassis potential. This allows considerable flexibility in measuring parameters that have a high common-mode voltage. A unique probe is supplied for measuring both voltage and temperature.

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The counter's Schmitt trigger circuit output can be displayed directly on the CRT. This gives a picture of the actual triggering point, thus, many signals that are difficult to trigger on with other counters are now measured with greater reliability.

The 7D14 will determine ratios from 0 to 10^{-5} and totalize from 0 to 10^{8}. The delayed sweep from the oscilloscope can drive the counter gate. By doing this, signals are displayed on the CRT with the ones being counted intensified.

For complete information on these exciting plug-ins, contact your nearby Tektronix field engineer or write: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

Prices of instruments shown: 7504 90-MHz Oscilloscope $2100, 7A12 Dual-Trace Amplifier $900, 7B52 Dual Time Base $950, 7D13 Digital Multimeter $560, 7D14 Digital Counter $1400. The 7D13 and 7D14 are compatible with all 7000-Series mainframes except the new 7403N.

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Decision delayed on laser systems

The Air Force will brassboard two competing, 1-gigabit-per-second, space communications systems since the paper studies seem inconclusive

by Stephen Wm. Fields, San Francisco bureau manager

November is the deadline for submission of two paper studies on a 1-gigabit-per-second, laser communications system, for use with an Air Force data relay satellite. But the rules for deciding between them have changed. When the six-month, $150,000 study contracts were let in May to Lockheed Missiles and Space Co. and the McDonnell Douglas Astronautics Co. [*Electronics*, May 10, p. 48], the plan was for the Avionics Laboratory at Wright Patterson Air Force Base, Dayton, Ohio, the program director, to study both proposals and then have a brassboard made of the one selected. But during the last few weeks, a decision has been made to brassboard both systems by July of next year, compare their performance, and only then judge which way to go.

Over the past several months, researchers from both Lockheed and McDonnell Douglas have given many papers describing various aspects of their respective systems. At some point the papers usually comment on the competing technique and how it is inferior. Some of these criticisms concern power consumption, system weight, noise figures, and implementation. But, though some importance may be attached to each of these points, Capt. Dale Barry, deputy program manager at the Avionics Lab, says that most important is "a system that is flexible and one that is flyable; and so we are now going out on contract for components for both systems."

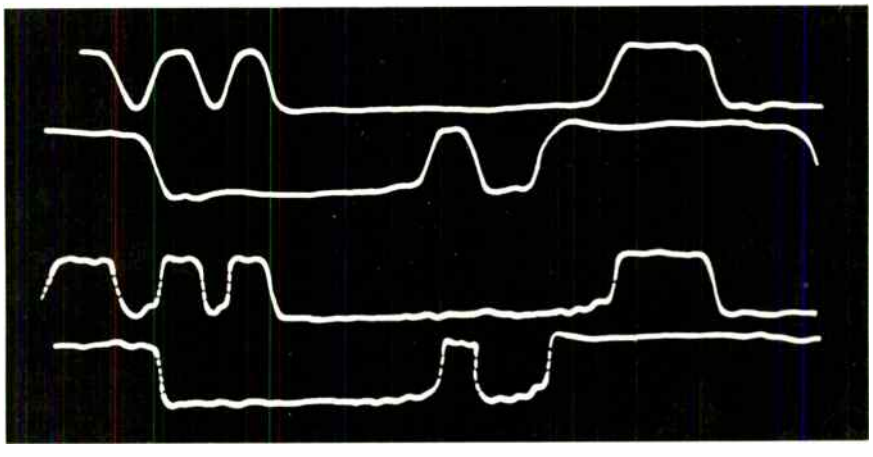
Each system is designed around a neodymium YAG laser, which offers high performance as well as small size. Such lasers, however, work at 1.06 microns, a wavelength where available detectors are not very sensitive. As a result, two to three watts of laser power is required to assure satisfactory signal reception and an error rate of less than one in a million bits. At 0.53 micron, however, sensitive detectors are available, and with them only 0.25 watt of laser power would be required for low error reception. Consequently, frequency doubling will probably be employed.

The difference between the two systems is in how the laser is operated and modulated. The Lockheed approach is to operate the laser in the continuous wave mode, with an optical filter placed in the laser cavity to select a single output frequency. This frequency is then doubled to 0.53 micron and is polarization-modulated by a phase-modulated microwave subcarrier. "This modulation format was chosen because it is well suited for use in space applications where high communications efficiency (data bits per received photon) and simplicity of on-board processing equipment are essential," says Romayne F. Whitmer, laboratory manager at Lockheed's Electronic Sciences Laboratory, where the laser work is being done.

The modulator is a microwave, octave-band type that uses a lithium-niobate electro-optic crystal and is driven by a 1.5-gigahertz, constant-amplitude signal. This digitally modulated signal is generated by deriving two microwave carriers derived from a 1.5-GHz oscillator and individually phase-modulating them with two independent 0.5-Gb/second data streams.

Advantages. An important feature of this method of modulation is that, apart from switching transients, the rf power input to the electro-optic modulator remains more or less constant, regardless of the particular digital sequences being transmitted. Therefore, unlike baseband modulation, which is used by McDonnell Douglas' mode-locked system, this method avoids

Ins and outs. Scope traces of two simultaneous 0.5 Gbit/s data streams in Lockheed single-frequency laser system compare data fed to biphase modulators (top) with output streams.



the possibility of problems with variable rf heating of the electro-optic crystal, and the rapid changes of birefringence associated with them.

At the receiver, a wideband photodetector recovers the microwave subcarrier modulation from the laser beam. The subcarrier is then amplified and fed to two balanced synchronous detectors, which also receive inputs from a phase-locked oscillator.

Another advantage is that the two 0.5-Gb/second data streams don't have to be synchronized because each biphase carrier component is modulated and demodulated independently.

In a mode-locked laser communications system, such as the one proposed by McDonnell Douglas, the laser output is gated at a precise rate to produce a single output pulse. The advantage in this type of system is that since the receiver can be gated to the same pulse frequency as the transmitter, "background noise can be reduced, and thus the signal-to-noise ratio is higher, or the transmitted power required for the same signal-to-noise ratio is lower, than that of a single-frequency system such as Lockheed's," states Allen L. Furfine, manager, advanced electronics techniques at McDonnell Douglas. The company figures that if the two systems were operated at the same power level, the McDonnell Douglas system would have a signal-to-noise ratio that was 6 decibels greater than the Lockheed system.

Impractical. However, Lockheed's Whitmer counters by saying the 6-dB figure is an ideal case. "In theory," he says, "if the two systems are operated side by side in the complete absence of background noise and at 100% modulation, then there would be a 6-dB advantage to the McDonnell Douglas approach. But in practice, you don't have 100% modulation, and there is always some background noise present. And under these real-life conditions, their 6-dB advantage is reduced to about 1 dB because the mode-locked system degrades more rapidly than the single-frequency system under actual space conditions."

But a McDonnell Douglas spokesman says that while Whitmer's statement may be true, "it has not been proven. And since the only numbers that can be agreed upon are the theoretical limits, then it is perfectly correct to use them. Even if they don't apply in real life, they are the only accurate comparison." They are accurate, however, only as long as the same base numbers were employed in the original calculations—and the chances of this are slim.

The disadvantage of a mode-locked system is that the digital information also has to be locked to the pulse rate, so that the data rate of different streams has to be a function of the pulse rate of the laser. For example, in a 1-Gb/second system with two streams, each would have to be 500 megabits per second. With four streams, each would have to be 250 megabits per second, or one could be 500 megabits and two could be 250 megabits. But with a single-frequency system, there is no restriction at all on the data streams.

Versatility. Whitmer says, not only has Lockheed achieved single-frequency operation with a YAG laser, but it has also built a satisfactory frequency-doubling device. And, when both systems are brassboarded and operating side by side in July, the McDonnell Douglas' slight power or noise figure advantage may be overshadowed by the fact that the Lockheed system can be used with almost any type of communications system without having to synchronize the data to a fixed rate. McDonnell Douglas claims that this, too, can be overcome, with additional circuitry.

Capt. Barry concludes, "This is a program that is tied to a calendar 1975 launch, and while we want high technology in a state-of-the-art system [state of the art 1971-1972], we are going to be sure the technology can support a working, flexible system." Barry says that neither system is favored, "and that the decision is not going to be based on a dB number or a power or weight number (although these certainly will be considered). It is going to be based on how easily we can get the system up and running, and on the link analysis. It's really too early to say which system has the advantage. Both will have to be built and operated side by side. □

Communications

TV 'ghosts' haunt Trade Center

Port Authority now says its twin towers aren't interfering with TV, but angry broadcasters insist it keep promise to relocate antennas

By Alfred Rosenblatt, New York bureau manager

In an abrupt turnabout, the Port of New York Authority now says interference with television transmission in the New York City area caused by reflections from the twin 110-story towers of its giant World Trade Center won't be so bad after all. In fact, in a petition to the Federal Communications Commission, the authority says it may not even be necessary to relocate the TV broadcasting facilities from the Empire State Building to its towers.

But the authority, which usually has its own way around the Greater New York area, is in for a fight. A broadcasters' committee, consisting of representatives of the nine TV stations transmitting from the Empire State Building, say the Trade Center buildings are interfering—and plenty.

The Port Authority's about-face is in striking contrast to the position taken about five years ago, when the World Trade Center was in the proposal stage. At that time, at least three independent engineering consulting firms agreed that reflections from the center's towers traveling through Manhattan, the Bronx, and into the city's suburbs would cause objectionable double-image interference ("ghosts") with TV pictures. To overcome opposition to the center's construction by broadcasters and certain elected officials, the Port Authority agreed to relocate the broadcasters' TV transmitters to its towers. At 1,350 feet, they are the tallest buildings in the world—some 100 feet higher than the previous record-holder, the Empire State Building.

An additional complication is that the two uhf stations in the Philadelphia area also are opposed to the New York stations moving their transmitters. Since the World Trade Center is three miles south of the Empire State Building—and three miles closer to Philadelphia—the Philadelphia stations contend that their viewers would be able to tune into the New York stations, at their expense. The New York broadcasters' committee feels that, since viewer antennas will be oriented toward Philadelphia, any net improvement in bringing in New York stations would be inconsequential.

The broadcasters' group points out that while it has actually gone into the field to make interference measurements, the Port Authority has relied on theoretical calculations made by engineering consultants. In addition, the authority relied on a telephone poll of viewers to ascertain the extent of interference—a rather unscientific procedure since the set owner might have thought the voice on the phone was out to sell him a new antenna, comments one broadcaster.

The broadcasters' latest measurements were made in August—when the aluminum outer skin of one tower had been attached as high as the 106th floor—at some 75 locations in the northern part of the Greater New York area. Objectionable interference, set when the ratio of the reflected signal to the direct signal exceeded 8%, varied widely among the channels. For example, there was none for channel 9, but on channels 2, 31, and 47, there was objectionable interference at roughly half the locations.

But more important, the interference got worse as the Trade Center buildings grew. Back in March, for example, when the aluminum skin was only at the 82nd floor, there was no objectionable interference for channel 2 at any of the locations. But interference worsened as the tower neared completion. Paradoxically, there was also some improvement, but it was negligible: Channel 31 was interfered with at 68.7% of the test sites back in March, but at only 51.3% in August. However, the broadcasters committee, led by Otis Freeman, vice president of engineering at channel 11 (WPIX-Inc.), fear the interference will get much worse as the second tower is completed and its outer skin is fitted into place.

Nullification. As the broadcasters ready their reply to the FCC, the interesting question is why the Port Authority changed its mind. It probably would rather not incur the cost of moving the transmitters. Fortuitously, it found through its engineering consultants that many tall office buildings erected in mid-Manhattan since the earlier studies of 1965-67 are nullifying the reflected signals going to the northern New York City area.

In addition, the Port Authority's consultants seem to be figuring things differently than they did before. Atlantic Research in Alexandria, Va., for example, finds interference reduced from the values it calculated five years before. The reason according to latest report: "The factors fundamentally involved in the . . . reflection phenomena are [being] examined in greater detail and in greater depth." Mathematical assumptions have been avoided "at the expense of more extensive computations." And the interference won't bother anyone at all, it says. □

Companies

Pertec tries a little kindness

Peripherals maker gives employees carpeted assembly areas, year-end vacation, and planned recreation to increase satisfaction—and profits

by Lawrence Curran, Los Angeles bureau manager

Fancy lobbies and luxurious offices often are danger signals to visitors of a company just getting started. Most successful companies made it by starting with a minimum of amenities. However, a Santa Ana, Calif., computer peripherals maker thinks it has a better idea—spending money to create top working conditions in the beginning. And so far this unorthodox approach seems to be paying off.

While the emphasis isn't on offices or the lobby, visitors to Pertec Business Systems are shocked to discover that the firm's assembly area has wall-to-wall carpeting—the same type used in its administrative offices. And some also question the use of top-quality Linemaster assembly benches and $20 soldering irons instead of $6 versions.

Carpeting and top-of-the-line equipment aren't the only things the firm is doing to make its employees happy—and hopefully achieve more efficiency and less turnover. There's piped-in music in the assembly area, free coffee, a paid year-end holiday from noon on Christmas Eve through Jan. 1, and even a plush women's rest room, with carpeting, large mirrors, comfortable sofas, and vanity tables. "We feel we've taken an unorthodox and progressive approach to manufacturing and the working environment," says Loren D. Huweiler, vice president for manufacturing.

Each employee is rated every two weeks on quantity and quality of production, attitude, and attendance. The statistics Pertec Business Systems has generated to date show that the attrition rate is 5% lower than the industry average, and the overall employee efficiency is 10% to 15% higher than usual, measured against motion and time-movement standards. Michael De Nicola, manager of production and manufacturing engineering, says this means that his employees perform to within 80% or 85% of the standard, vs the more common 70% to 75%.

Growth of the two-year-old company also seems to back up this approach: the parent Pertec Corp. has been profitable throughout its four years, reports Robert Kleist, president of the 200-employee producer of key-data entry and computer-output microfilm equipment. Sales reached $21.3 million in the fiscal year ended June 30, with Pertec Business Systems accounting for $12.5 million.

Returns. "We feel that, putting people in the proper environment costs very little," says Huweiler. In fact, Pertec Business Systems officials have calculated that the "frills"—the extras over and above what most other firms provide—cost the company 1.25 cents per employee hour, figured over 10 years and using a 200-employee base.

The company's computer-ouput microfilm equipment is marketed under the Pertec Business Systems name now that the product line made by Peripheral Technology Inc., another Pertec Corp. subsidiary, has been acquired and moved under the roof at Santa Ana. In the other product area, Kleist says Pertec has become the number-two supplier of key data-entry equipment. The varied product line for handling keyboard data-entry and business data processing is all sold to Singer-Friden, under terms of a long-duration contract.

That contract helped Pertec to do the thorough planning job on the 40,000-square-foot facility that included careful consideration of its people, and also to closely integrate design and manufacturing. "A long-term contract with an OEM allowed us to take a more orderly look at how we should proceed," Huweiler says. "We put a lot of emphasis on being at the state of the art in the production area. Manufacturing people were involved at the outset on the key data-entry equipment, so producibility was closely considered from the outset."

The company began as Peripheral Business Equipment Inc. in a 2,000-ft² building in January 1969. A year later, during the first month of production for key-data entry equipment, the operation was moved to an 8,000 ft² facility. The present site was occupied in July 1970. De Nicola has equipped the facility with automated component-insertion equipment for both axial-lead and dual in-line packaged parts, and he's arranged the facility for smooth assembly flow.

Icing. He believes it's important to provide variety for his assemblers. It prevents monotony, which could have a negative effect on quality, and it also permits cross-training so that one worker can do many jobs—they're normally rotated from one task to another each week. He also provides three minutes (five minutes on Fridays) at the end of the work day for cleaning of work stations. "We want them to feel that this isn't just a place where they drop in in the morning and drop out at night. We encourage them to make their areas as clean as they'd like to have them when they return," De Nicola says. □

International

Africa to get its own phone system

By 1975 an independent network worth possibly $1 billion will have replaced out-dated imperial systems of routing intra-African calls through Europe

After years of complaints from Africans that they couldn't speak with their neighbors directly without going through London, Paris or Brussels, and sometimes through all three capitals of the former empires, the world's largest continent will soon get its own, completely independent, telephone network—by 1975 according to present plans. In the process of setting up the Pan-African system, much of the antiquated and worn-out equipment of the national networks will be replaced with new, automatic equipment, and telephone rates will be cut drastically. This new market should mean about $1 billion of sales for Western equipment manufacturers, who are already well entrenched in most African countries.

The creation of the 8,700-mile network will follow the completion of the U.N.-financed pre-investment survey now in progress and the specification of required links and switching equipment. All but 16% of the $2.325 million survey is being paid for by the United Nations Development Program; the 41 participating national administrations are contributing the balance. Estimates of the amount of investment in telecommunications hardware range from the U.N. development program's unofficial figure of $80 million for the West African portion of the network alone, to $1 billion or more for all 41 national networks. Most of it will be financed either by the World Bank or its African affiliate, the African Development Bank.

The dependence of most of the participating countries on Western European switching services is evident from the fact that, as recently as 1968, 380 out of 832 intra-African telephone routes still passed through Europe. In other words, more than a decade after gaining their independence, 42 African countries still depend upon switching centers in London, Paris and Brussels for nearly half of their international calls within Africa.

The complete survey actually consists of nine regional surveys, which include four of the densely populated West African subregion, three of Central Africa, and one each of North and East Africa. Each regional survey consists of a detailed, on-the-spot examination of existing, planned, and required links within the territory served by the region's national administrations in order to ensure that they will interface with one another when the Pan African telephone network is brought into life.

Contractors. The first two contracts let by the U.N.'s specialized agency for telecommunications, the International Telecommunications Union, were announced last March, and went to a Norwegian group of consultants, Norconsult, which has been active in much of East and North Africa during the past decade, and Britain's Preece, Cardew and Rider, which is currently engineering a troposcatter system in New Guinea. Norconsult is surveying Northeastern Africa under a $152,000 contract while the British firm has a $123,750 contract for Southeastern Africa.

Last July, the ITU signed a $285,500 contract with Canada's Acres Intertel Ltd. for two sub-regional surveys in West Africa, covering eight countries. Two or three additional consultant firms are expected to be signed up by the end of the year for the remaining regional surveys. All those recruited or about to be recruited for the project come from a list of 18 firms drawn up by the ITU earlier this year.

The consultant firms have two technical tasks:

- To determine the siting of relay and terminal stations for radio systems, they must perform land profile surveys; reconnoiter the area chosen for the station; carry out topographical surveys, optical tests to check line-of-sight paths, and

Direct. By 1975 Africans should have their own modern telephone network.

Probing the news

propagation tests; determine transmission power, height and type of antenna, reception margins and prepare equipment specifications, for example.

- For cable or overhead line systems, they must survey the route and determine the characteristics of the conductors; work out design and placement; establish the siting and specifications of terminals and repeaters; and prepare specifications for the line and its equipment.

In both cases, the firms also have to specify the multiplex terminal required, decide whether it is to be manual or automatic, draw up a list of the circuits or groups of circuits to be created, and specify how they can be incorporated and routed in the national networks.

The surveys' economic component mainly consists of estimating how much it will cost to buy the required equipment; to install, operate and maintain the networks; and train and pay personnel. It will also estimate how much income the networks should earn annually.

Specs. The intention is to provide each of the 41 African administrations involved with complete specifications for a national system. The first report, from Norconsult, is expected to be ready next October. It will cover the Northeastern African subregion. Equipment specifications will be written throughout the winter, and the first call for hardware bids will be made before next spring. Equipment orders should be placed before the end of 1972. Once the reports have been completed, the ITU will discuss them with each government before equipment specifications are written.

Reports for the other subregions will be received by the ITU every few months starting late this year, and the same procedure will be followed in preparing specs and calling for bids. "Without being overoptimistic, we consider that this vast and badly wanted Pan-African network should be an accomplished fact by 1975," notes the ITU's Secretary-General, M. Mili.

Most of the new network will consist of broadband microwave systems. Switching equipment will be of the crossbar type, replacing many of the electromechanical Strowger systems now in service. (Electronics exchanges are not envisaged since few African telephone administrations have the qualified technicians required for their maintenance and servicing.) Over 90% of the links being covered by the survey will require some type of new equipment, including the improvement of overhead lines and the expansion of low-capacity, narrowband radio systems into higher-capacity, broadband ones. The balance will require general upgrading and increased capacity. Little of the new equipment is expected to be of the reed relay type. PCM techniques for heavy traffic circuits and other links are being considered.

A few of the new links foreseen will be of low capacity, i.e., 12 to 24 channels, operating in the 450- to 900-megahertz range. Most of the radio relay systems comprising the network, will be medium- and high-capacity microwave links with 300 to 960 channels, operating in the 2-, 4-, and 6-gigahertz bands.

The survey is limited to terrestrial links because satellite communications are still very much in a state of flux in Africa. Though at least seven national administrations have stations planned or under construction, little exists in the way of a coordinated timetable for their entry into operation. In any case, a recent ITU policy statement contends that the advent of satellite communications in the future still does not alter basic routing principles. Moreover, a satellite network will still require an operational terrestrial network in order to be fully effective.

The Pan-African survey will probably be followed by a flood of requests for additional ITU assistance in expanding and upgrading of the African nations' training facilities in order to meet the new personnel requirements imposed by the advanced equipment. Manufacturers of telecommunications training equipment, testing and measurement instruments and related gear stand to benefit, since each of the ITU's present 11 training projects in Africa are spending $300,000 to $500,000 on equipment alone. The equipment component of future projects is likely to be even higher. □

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Companies

Harris looks sharp in civvies

Semiconductor firm profits in hard-hit market by applying military expertise to selected high-performance linear, logic, memory ICs

by Alfred Rosenblatt, New York bureau manager, and Laurence Altman, Solid State editor

The natural thing for a military-oriented semiconductor house to do in a dwindling market is to search for new industrial and commercial business. The problem, of course, is to do it without plunging disastrously into the red.

One company making this move successfully is the Harris Semiconductor division of Harris-Intertype Corp. in Melbourne, Fla., on the Atlantic coast near Cape Kennedy. For years a high-technology supplier of high-reliability and radiation-resistant semiconductors and integrated circuits for missile, space, and classified Government programs, Harris has over the past three years not only dramatically revamped its mix of military and nonmilitary business but has stayed profitable and grown handsomely in the process. And it has done so while the rest of the semiconductor industry has, with few exceptions, faltered badly.

Hard work. In eight years Sorchych went from the bottom to president at Harris.

Some figures are indicative of what has happened, especially since January 1968, when Donald R. Sorchych took over at Harris Semiconductor as vice president and general manager. In the fiscal year that ended June 30 1968, 85% of Harris' business was with the military; for the fiscal year that ended last June 30 this figure had dropped to 40%, with the remaining 60% coming from new industrial and commercial fields. Further, employment has risen threefold to about 1,000 people, Sorchych points out. And sales for the latest fiscal year, estimated by industry sources at about $30 million, jumped 30% over the year before.

The company's game plan seems simple. "It's profitability that counts, not who manufactures the most lines," asserts Sorchych. Accordingly, he insists on keeping his company a "damn selective supplier of ICs," relying heavily on high-performance products, derived from military oriented programs, that can command a premium price.

Selectivity. "The mainstream TTL and DTL circuits are not for us," he says. "Their prices have eroded far too much and we have no intention of buying our way into this business." Harris' selectivity, however, isn't as restrictive as it sounds—the company's product planners and designers have considerable leeway in broad areas of linear, digital logic, and memory ICs. Some 20 new products will be introduced this fiscal year. And where it "makes sense," Harris will second-source products to "fill out" its line.

One of the early examples of Harris' high-performance philosophy came in December 1967, when the company introduced what it claimed was the first fully compensated IC operational amplifier. It also introduced, about a year and a half ago, the first programable read-only memory (PROM) using MOS technology. And last January, Harris developed a low-cost bipolar 16-key keyboard encoder on a chip.

But despite this activity, the product push from Harris is really only beginning. Perhaps the most significant new memory product is a soon-to-be-announced random access 1,024-bit unit that could be the first to use complementary MOS processing. The device will be priced competitively with the silicon gate 1103 type that's become an industry standard. Ordinarily, a C/MOS RAM would be much more expensive than a silicon gate p-channel MOS unit because twice as many steps would be needed in its manufacture. However, Harris has modified the conventional junction-isolated C/MOS technique to reduce the number of process steps, asserts David Uimari, digital product marketing manager. "Performance will be up while cost will remain the same as silicon gate circuits," he claims. Harris' knowhow here derives from its long experience in the military market making dielectrically isolated C/MOS devices.

For the new RAM, the performance goals are high indeed. Access time will be less than 200 nanose-

conds on a chip 60% smaller than conventional silicon gate units. The small size should increase yields, helping to keep costs competitive.

Also in the digital memory area is Harris' new work on bipolar isolation techniques, which should lead to high levels of bipolar memory integration. Similar but not identical to the Fairchild Isoplanar process, Harris' method involves replacing active junction isolation with passive oxide isolation so that storage elements can be placed closer together. With these new isolation methods Uimari envisions ultradense 1,024-bit bipolar RAMs typically operating at 60-nanosecond switching speeds.

Another area of interest to Harris in the bipolar sector is emitter-coupled logic for computers. Harris is now looking at ways to modify standard military-derived designs for commercial applications. The aim is to lower the power dissipation to 10 to 15 milliwatts per gate and achieve competitive speed-power ratios. Other digital endeavors involve interface circuits, including such devices as diode matrices and receiver/transmitter interfaces.

Complementing Harris' new digital work is its thrust into commercial linear circuits. Already on the market is a dielectrically-isolated C/MOS multiplexer [*Electronics*, Aug. 16, p. 139] which gives eight channels of high-speed, low-leakage multiplexing.

Coming are such products as programable operational amplifiers to serve as linear building blocks, four-channel op amps with field effect transistor front ends, phase-lock circuits, chopper-stabilized amplifiers, and high-frequency, high-slew-rate op amps in the 50–100-MHz, 1-kilovolt-per-microsecond range for high-speed data handling. And very shortly Harris will be getting into the analog-to-digital converter market by melding two six-bit current sources and one 12-bit ladder into a 12-bit a-d converter. □

Sorchych's success story

Since taking over at Harris Semiconductor in January, 1968, Dan Sorchych has managed to succeed despite the difficult times that have overtaken his industry. While most other semiconductor companies found things tough, vice president and general manager Sorchych has achieved steady growth.

At first glance, Sorchych appears something of a maverick. An avid hunter and fisherman, he likes to drive to his office behind the wheel of a $5,000 jeep sporting a motorized winch on its front bumper. Complete with air conditioning and stereo, it's just right for a quick trip out into the miles of flat snake and game-infected marshland not far from his plant.

But Sorchych's sportsman's instinct comes tempered with an instinct for hard work. He literally worked his way up from the bottom of Harris' engineering ranks to the top in less than eight years, beginning with the old Radiation Inc. organization in 1960 with a BEE from the University of Illinois, and also four years in the Navy specializing in aviation electronics.

He began at Radiation Inc. by working on airborne telemetry systems and in 1966 he was picked to lead a circuit engineering group in Radiation's Physical Electronics department, the lead group developing the firm's IC technology. Its forte became dielectrically isolated ICs and high-reliability semiconductor products.

Sorchych soon became director of engineering for the department, which became Radiation's Microelectronics division, and then was named vice president and general manager. In September 1970, his organization became Harris Semiconductor division of the Harris-Intertype Corp.; the latter acbquired Radiation Inc. some years before.

The tall, blue-eyed, and greying Sorchych relies heavily on tight market planning with frequent feedback on how goals are being met. And he is clearly out to keep his company growing. Military business for important missile, space, and classified programs is likely to continue as a strong income base. He has also lined up a formidable group of sales reps around the country to sell his products, a new approach for the company. And he will be pushing his products planners and designers for a host of new high-technology products, banking heavily on the expertise attained in years of military effort.

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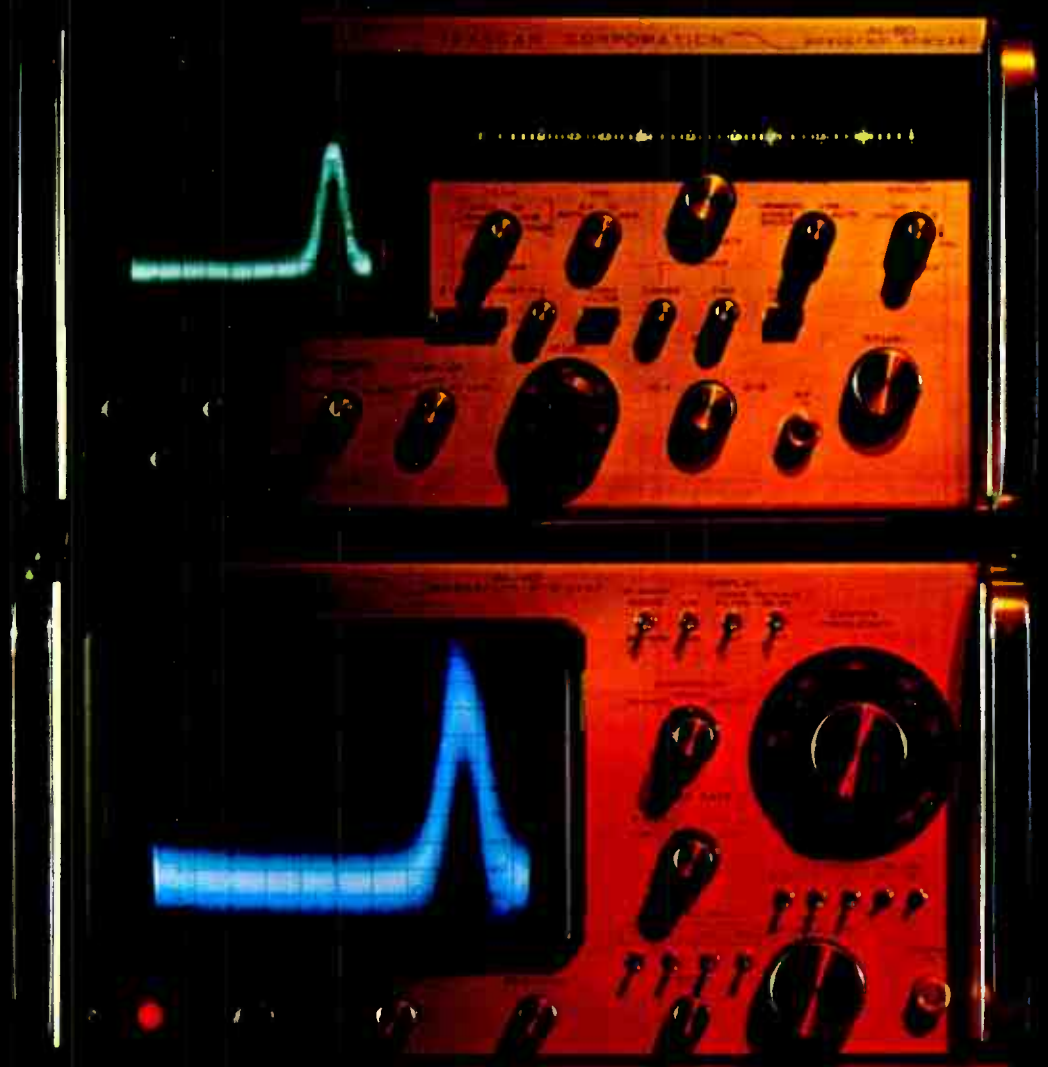

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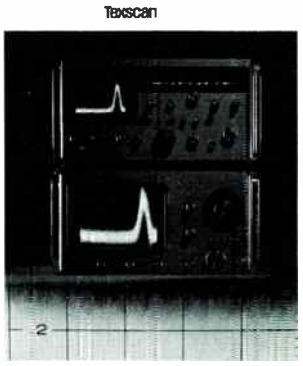

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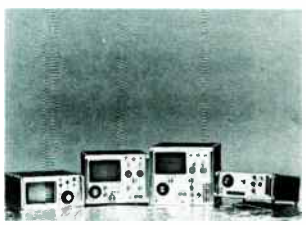

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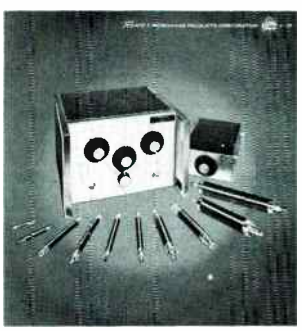

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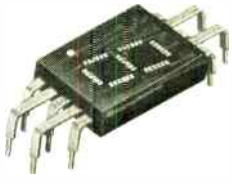

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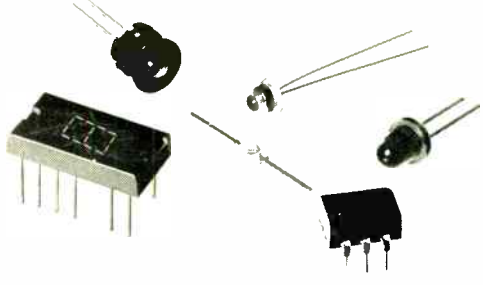

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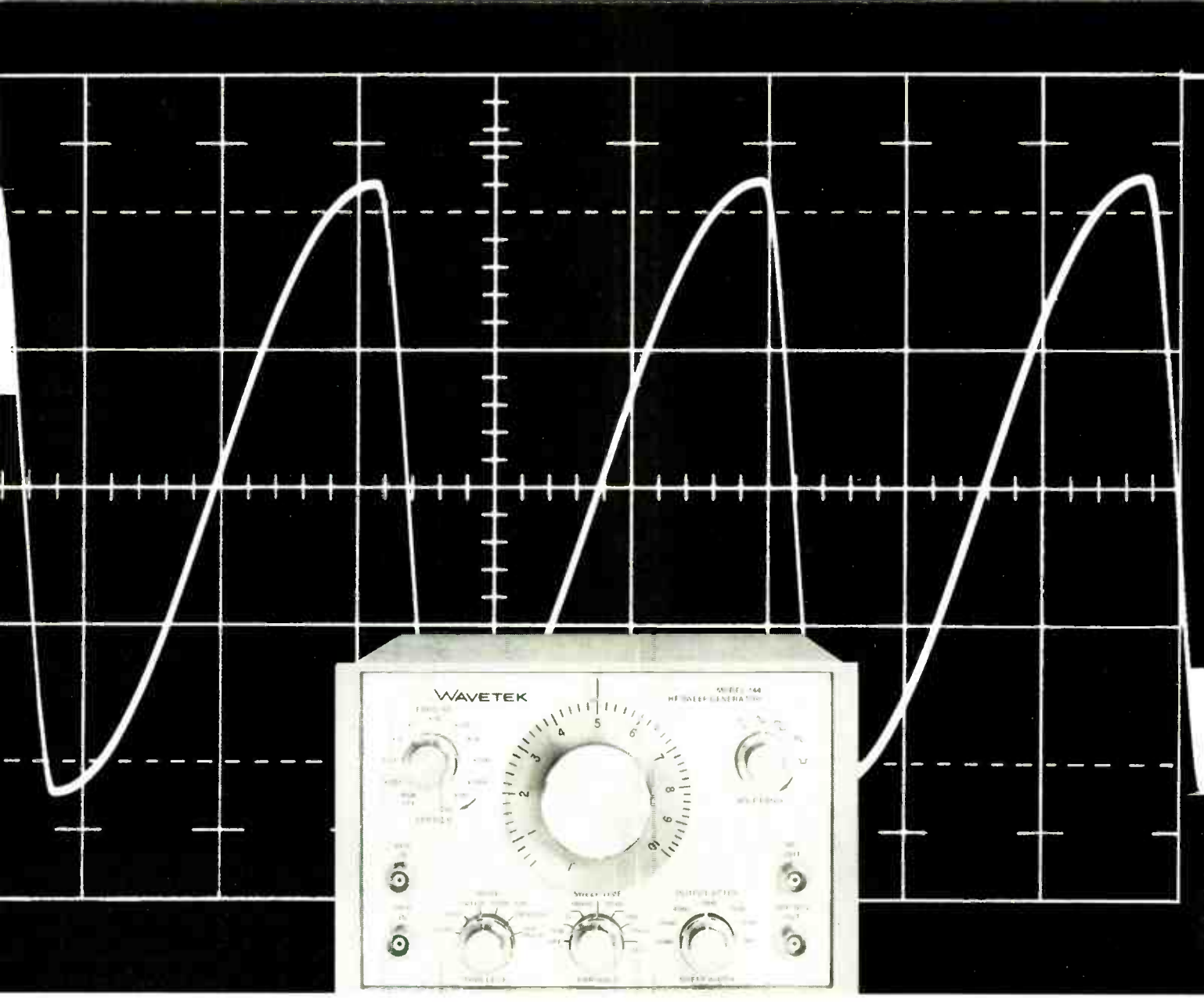

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System automates production tests of instruments

By Stephen Wm. Fields, San Francisco bureau manager

Multi-access computer and programable fixture provide broad range of measurements, calibrations

Two years ago when the John Fluke Manufacturing Co. entered the digital voltmeter business, automatic test systems tailored to production checkout of instrumentation were not readily available. The Seattle company developed such a system and became its own first customer last January when it automated its DVM test stations. Now the company is marketing the system [*Electronics*, Sept. 13, p. 25].

Designated the Terminal/10, it differs from broad-capability automatic test systems that sell in the $200,000 range in three principal respects: a typical configuration will sell for about $75,000 plus computer, it can be controlled by a multi-use computer, and a universal, programable test fixture available as an option eliminates the need for individual fixtures for each unit under test.

Unlike the large, serial, do-all test systems, a multitest-station Terminal/10 system provides parallel access to the computer and performs a variety of tasks.

Says Richard W. van Saun, chief engineer at Fluke: "One terminal could be used for precision voltmeter calibration or verification, another for analog circuit-card testing, and at a third test terminal, program development could be in progress. And because all of the terminals use the same central computer, it's easier to justify some expensive peripherals such as a line printer and a disk storage unit." Terminal/10 requires no modifications to the computer, so other peripherals such as a teletypewriter or CRT keyboard terminal can be used with the same computer for problem solving.

A basic Terminal/10 system has three main elements: the control element or computer (a PDP-11 or equivalent machine) and a CRT terminal; the analog element, mostly Fluke instruments; and the unit under test, which could be anything from components to finished instrument assemblies. These three elements are tied together by two types of interfaces—the control-to-analog instrument interface is the Fluke 1100A interface processor, and the analog-to-unit-under-test interface is the Fluke 1200A and 1200B switch matrix units.

According to John Fluke Jr., senior design engineer at the company, "The minimum computer for a single-user system would be a PDP-8 or PDP-11 with 4k of core. Programs for Terminal/10 are written in DEC Basic. This was chosen for its ease of use and its compatibility—a program written in single-user DEC Basic also can be employed on an eight-user, core-based system or even a disk-supported system. So when a Terminal/10 user updates his system, his old programs are still good." Fluke adds that "we don't spend time monkeying around with the software; DEC has taken care of that. We concentrate on handling analog signals."

The Fluke 1100A interface processor connects to the computer through an asynchronous data channel. It meets the RS232B or C hardware standard and communicates in character and bit serial ASCII. Connected to the 1100A is the CRT terminal (the Fluke 1300A), the various analog instruments, and an auxiliary keyboard. The latter can make testing and control of the testing a simple five-button operation.

The John Fluke Manufacturing Co. Inc., P.O. Box 7428, Seattle, Wash. 98133 [338]

On line. Terminal/10 shown in one of many configurations—as a production test system.

Packaging and production

LSI tester offers 20-MHz clock rate

Flexible system checks MOS, bipolar memories and logic; handles devices with up to 64 input-output connections

While a 5- to 8-megahertz clock rate may be good enough for testing today's MOS/LSI devices, semiconductor manufacturers agree that they will need 10 to 15 MHz tomorrow. Anticipating this requirement, Tektronix Inc. is invading the computer-controlled test field with a system that offers a 20-MHz rate—on each of four phases.

The system, called the S-3160, was designed with another prime requisite in mind—flexibility. Even today's LSI memories and complex logic arrays, such as calculator circuits, require a combination of techniques because of extremes in both test pattern length and word rate. Even the same device may require a different test routine, depending on which manufacturer made it. This complicates things for the user doing incoming inspection because he has to change tests from vendor to vendor.

According to H. Allen Zimmerman, program manager at Tektronix, "The longest patterns (1-2 million words) for random access memory testing can be generated rapidly in hardware under microprogram control. The fastest patterns (10-15-MHz word rate) for shift register and high-speed logic testing can be stored in LSI buffer memories and delivered to the device under test in bursts. Patterns with intermediate length and speed requirements for complex logic testing can be generated either by software or hardware algorithm or retrieved from mass storage and delivered directly to the device under test."

The Tektronix S-3160 has been organized to accomplish all these modes of exercising for both devices and circuit cards, he says.

The S-3160 performs parametric, functional, and dynamic tests on all types of MOS and bipolar shift registers, RAMs, ROMs, and complex logic arrays. The system configuration includes a two-bay rack, a separate graphic computer terminal, and test station. Devices with up to 64 pins may be tested with input-output facilities at each pin. Devices with up to 128 pins may be tested by splitting the input-output connections.

Functional (truth-table) tests are conducted with a high-speed driver and dual strobed comparators for each pin. A four-phase clock serves four pins. Maximum clock-cycle repetition rate is 20 MHz, and clock transition timing is programed in 5-nanosecond increments.

On the fly. A 20-MHz LSI memory (a 1,024-bit shift register) at each pin stores data patterns and address sequences for input forcing or mask and expected-data patterns for output comparison. Testing can be terminated when the first error is committed or output data may be stored on the fly for subsequent analysis or display; 1,024 bits per pin can be chained at adjacent pins for greater pattern length.

Dynamic (timing) tests are conducted on a one-shot basis using either strobed-comparator or level-crossing techniques. Comparator and data-drive strobes may be positioned anywhere in the clock cycle in 1-nanosecond increments. Time between level crossings at any pair of pins can be measured from 1 millisecond to less than 1 nanosecond with 100-picosecond resolution. Strobed-comparator tests can be performed at rates up to 20 MHz, level-crossing tests at up to 250 per second. Two oscilloscope outputs are provided. Using repetitive test loops, the drive or output signal at each pin can be observed with 2-nanosecond rise time.

Parametric dc tests are performed either during a slow-speed functional test using driver/comparator techniques or individually using the dc measurement subsystem. The former technique allows functional initialization and go/no-go tests at several pins simultaneously; the latter technique affords greater accuracy and a wider measurement range. Driver/comparator tests can be performed at rates up to 10 kilohertz, subsystem measurements at up to 250 per second.

Driver on card. The pin electronics for the 64-pin version of the S-3160 consists of 64 cards, of which 60 are input/975075 cards. Each has a driver, a dual comparator, and four sample and hold circuits—one for high drive level, one for low drive level and one each for high and low comparison level. The other four cards are a combination clock driver and power driver. Each card has a 1,024 bit memory associated with it; these actually are made up of four 256-bit shift registers multiplexed to get the 20-MHz data rate.

The S-3160 is controlled by a Digital Equipment Corp. PDP-11 with 8k of core and a 65k disk. Standard peripherals are a Tektronix graphic computer terminal and a Remex high-speed paper tape reader/punch.

The standard S-3160 configuration provides one 1803 test station with a manual test fixture. Options include wafer prober, auto handler, environmental handler, and circuit-board test fixtures—fully interfaced. Up to four 1803s can be time-shared on a single system. A 64-pin S-3160 tester will sell for about $175,000.

Tektronix Inc., Box 500, Beaverton, Ore. 97005 [339]

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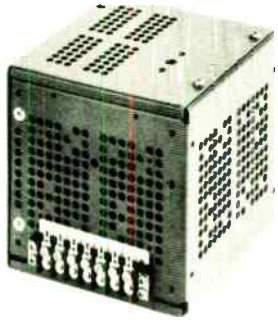
5 volts, 7.4 amps



Other single output models available in 6, 12 and 15 V.

The LX Series is also available in 3, B and C packages in 12 single and dual output, wide range and fixed voltage models with ratings up to 15 V, up to 9 A.

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The DAC-12QZ inherits its performance from our top-of-the-line converters, and it owes its low price to new production techniques we've developed. Result: there is nothing like it for the money.

There *is* a less expensive converter in our line — the $29, 10-bit DAC-10Z we introduced last month. And there are some other nasty surprises for our competition coming up. For example, the ADC-8S to be announced next month. Its low price will doubtless change your buying habits — like using one ADC-8S per channel instead of multiplexing an expensive ADC.

Meanwhile send for detailed information. And if you want an evaluation sample of the DAC-12QZ or the DAC-10Z just call, or write us on your letterhead. Both are in full production and we have lots in stock. Analog Devices, Inc., Norwood, Mass. 02062, (617) 329-4700.

ANALOG DEVICES

Circle 94 on reader service card

Components

DIP converts power for MOS

On-board unit also shifts TTL voltage levels to ECL, eliminating extra supplies

MOS read-only memories, random access memories, and shift registers are widespread in systems that consist mostly of standard TTL or DTL bipolar logic. Also widespread are resultant power supply problems that are at least an annoyance, and can be a real headache. TTL and DTL operate from + 5 volts, while MOS usually requires at least one different voltage, say −15 V, and often requires two voltages that aren't readily available. Likewise, many linear integrated circuits require ± 12 V supplies, and ECL often operates from about −5 V. As with MOS, use of these components in a TTL system creates power problems.

A Texas company, Reliability Inc., has a solution with a DIP-sized dc-to-dc converter that accepts + 5 V input from the system supply and puts out one or two voltages in the desired range. The company's V-Pac power supply fits on a pc board, and takes up little more space then the familiar 24-pin DIP. This eliminates the necessity for bulky extra power supplies and the additional wiring they require.

The V-Pac is a potted assembly measuring 1.3 inches long, 0.6 in. wide and 0.38 in. high. It conforms to the standard 24-pin DIP configuration (600 mils between rows and 100 mils between adjacent pins). This permits mounting the units directly on pc boards with reflow soldering, or using standard solder or wirewrap sockets. It also permits mounting the unit near the IC without any worry about extra leads from the pc connector.

The units include side-exiting pins to facilitate in-circuit testing, a ⅜-in. body height for pc-board-mounted applications where the boards must plug into racks on ½-in. centers, and short-circuit protection. All V-Pac units are given a 168-hour burn-in prior to final test.

Standard V-Pac units available include single-voltage sources and dual-voltage sources. Single-voltage units are the VP12, supplying −12 V at 80 milliamperes, and the VP5, supplying −5V at 160 mA. Dual voltage units are the VP 14/14, supplying +14 and −14 V at 70 mA, and the VP 12/12, supplying +12 and −12 V at 80 mA. Special voltages or combination of voltages between −30 and +30 V can be supplied for volume users.

Short-circuit protection in V-Pac components is self-recovering in 70 microseconds. Normal temperature range is from 0/; C to +70/: C, with expanded temperature range units available on special order. Turn-on voltage tracks the +5 V supply with a maximum of 20 microseconds lag. Turn-off voltage lag depends on circuit loading. Single-quantity price for the single-voltage units is $36, and for the dual-voltage units, $44.50.

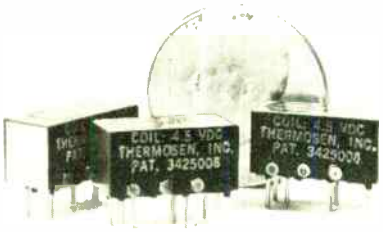
Reliability Inc., 5510 Greenbriar, Houston, Texas 77005 [341]

Component briefs

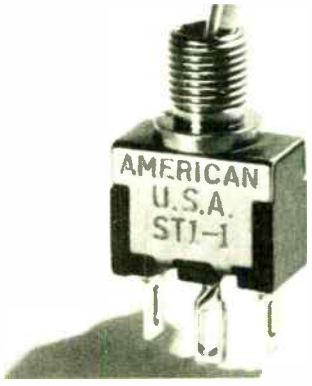
Reed switch. RI-20 microminiature unit is for use by manufacturers of relays, keyboards, and control systems. Reliability test programs have shown a failure rate of less than 10^{-9}

over more than ten million operations at MOS and TTL load levels. Price is 20 cents in lots of 100,000. Amperex Electronics Corp., Hicksville, New York, 11802 [348]

Relay. Type D3A multireed unit is for use in three-wire multiplexing systems. It measures 0.4 by 0.4 by 0.8 in., and can be either mounted on a pc board or plugged in. Two signal-carrying contacts and one guard contact are incorporated. Operating characteristics allow the signal to be used more rapidly after the first contact closure, providing higher scanning rates. Low-level life is greater than one billion operations. Thermosen Inc., 375 Fairfield Ave., Stamford, Conn. 06904 [347]



Toggle switches. Series ST1-1 single-pole, double-throw units are for ac and dc loading conditions. They are flame-resistant, have high arc resistance, and their terminals

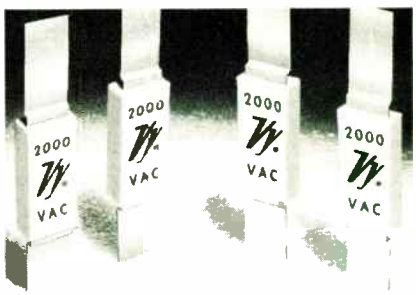


accept three No. 18 AWG wires. The center terminal hole is oriented for wiring accessibility. American Switch Corp., 24 Mill Lane, Arlington, Mass. 02174 [343]

Optical encoder. Rotaswitch 860 is 1.5 in. in diameter and 1.2 in. long, uses a light emitting diode as the light source. Rotating disk made of Photoplast offers freedom from oscillation, permits close mask-to-disk tolerances. Clean output signal is available as a sine or square wave, at various pulse rates. Standard rates range to 1,000 pulses per shaft-revolution, and higher values are

available. Standard version is priced at $125 with quantity discounts. Disc Instruments Inc., 2701 S. Halliday St., Santa Ana, Calif. [344]

Capacitors. Series VY 87 porcelain devices feature current ratings of up to 13 amperes and voltage ratings to 2,000 vac and 500 vdcw. Capacitance range is 10 to 1,000 picofa-



rads, and temperature coefficient is 105 ±25 ppm/°C. Minimum Q is 2,000 at 1 MHz, operating within the range of -55 to +125°C. Vitramon Inc., Box 544, Bridgeport, Conn. 06601 [345]

Clock oscillator. Low-profile device called the CO-231L drives 10 TTL loads at any frequency in the 200 kHz to 30 MHz range, operating from 5 vdc. Stability is better than ±0.0025% over 0 to 70°C, and the 0.3-in. unit permits close spacing between pc boards. Price for one to four pieces is $80 to $90 depending on frequency, and less than $20 in quantity. Options include two models with higher stability. Delivery time is 1-4 weeks. Vectron Laboratories Inc., 121 Water St., Norwalk, Conn. 06854 [346]

Subassemblies

Digital recorder shuns audio sins

Drive system outside cassette eliminates tape damage, poor guidance, tension variations

With few exceptions, cassette recorders aimed at digital applications have been upgraded audio versions. Because the cassette itself is used for tape guidance, the user sometimes must deal with such problems as poor tape guidance, tape edge damage, and reel-to-reel tension variation, that lead to tape wear and resultant loss of data reliability. Upgraded audio cassettes also use pinch rollers and belt drives, which must be replaced too often to suit digital recording users.

Memodyne Corp. of Newton Upper Falls, Mass., introduced a digital cassette earlier this year [*Electronics*, July 5, p. 87] that records data bit by bit with a 120-bit-per-inch packing density. The latest entry is the model 240, a character-by-character recorder from the Instruments Division of Bell and Howell's Electronics and Instruments group.

Peter Howes, a project engineer in the group which has several years experience in instrumentation tape recording says that tape tension can be controlled in digital cassettes the way it is in large tape transports. This led to the design of a drive system completely outside the cassette, leaving the cassette as a mere tape holder, and eliminating reliability problems.

A loop of tape is pulled from the cassette by a "snatcher" system, as Bell & Howell calls it. The two Teflon-coated fingers that acquire the tape from the cassette after it's locked into place in the holder pull it above a ramp and over the external capstan, then lower it around the capstan. This action automatically positions the tape loop in relation to the capstan, a precision guide, the magnetic head, and two guide rollers just outside the cassette.

Strain gages just below these guide rollers sense tape tension, holding it to a maximum of 1.5 oz at all times, and a tachometer provides servo control of the capstan to sense rotational speed. With this combination, it doesn't make any difference which reel of the cassette is fuller; the gage readings are amplified, determining how much tension exists at those points, and the appropriate reel motor on either side is controlled. Pinch rollers often exert transient tensions up to 8 oz on audio cassettes.

E. Michael Perkins, program manager for peripheral products, looks for the added life contributed by the design to make the model 240 attractive for computer peripheral applications ranging from key-to-tape units with no buffers to CRT terminals. He also expects it to find use among minicomputer users for program-loading and data processing.

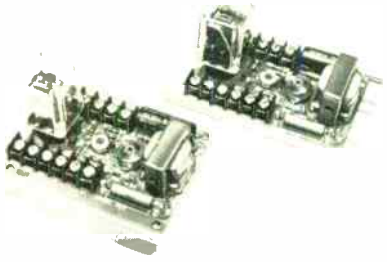
Howes says the design can be improved to permit writing and reading at 50 in./s but for now, the unit will be specified at any speed between 2 and 20 in./s with read-after-write capability at any speed between those two. Recording density is 800 bits per inch per track, and storage capacity is 2.8 million bits per track at 800 b/in. on a 300-ft cassette. At 2 in./s, start and stop times are 15 and 10 milliseconds, respectively. At 20 in./s, the unit gets up to speed in 30 milliseconds and stops in the same time. Error rate is 1 bit in 10^7 "after hundreds of passes," Howes says.

Price is approximately $500 for more than 1,000 units; single-unit price is $1,150. The model 240 is in production and small quantities can be delivered in 30 days.

Instruments Division, Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif. 91109 [381]

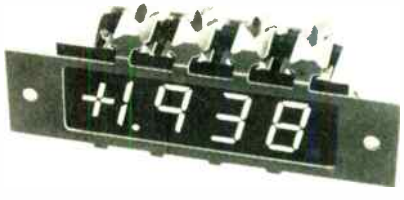
Subassembly briefs

Photocell amplifier. Control Trak model PCT is for use with most photocells and thermistors. Features include adjustable setpoint and time delay, which is intrinsically 15 milliseconds. Time delay can be increased by attaching a capacitor to two turret terminals, and the control



can be wired for either light- or dark-energized operation. Price in 100-lots is $18.25 each. Delivery is from stock. Curtis Development & Mfg. Co., 3250 N. 33d St., Milwaukee, Wis. 53216 [383]

Segment display. Miniature seven-bar device series 1040 provides ½-in. display in a single-plane configuration, and optimum reading is from a distance of 12 feet. A choice of five colors is offered, and standard-based lamps delivering 4 mil-



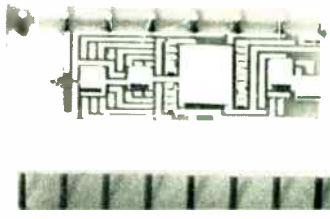
lion hours of life at 3.5 V, 60 mA are used. Applications include instrumentation, calculators. Price is $11.31 per digit/decoder. Industrial Electronic Engineers Inc., 7720-40 Lemon Ave., Van Nuys, Calif. 91405 [384]

Operational amplifier. Model A520 fast-inverting op amp offers high open loop gain and low input offset voltage drift. It has a bipolar transistor input stage with less than 20 nA

input current and uses feedforward circuitry to achieve a 100-MHz gain bandwidth product and 300 V/μs slew rate. The output can deliver ±20 mA load current and is short-circuit-protected. Intronics Inc., 57 Chapel St., Newton, Mass. [385]

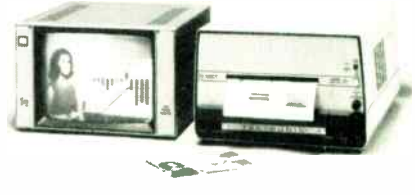
Multiplexer. High-speed, eight-channel MOSFET analog device includes channel-to-channel switching time of less than 100 ns. Designated the model 625, it provides a settling time of less than 400 ns when used with the company's FST-160 op amp. Throughput rate when used with the FST-160 and a model 251 A nine-bit a-d converter is 200 kHz. Price is $155. Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890 [386]

Converter. Model MN325 achieves a slew rate of 0.1μs and a settling time of 100 ns and is housed in a 16-pin DIP. The 10-bit device is for use with external operational amplifiers and the package includes mono-



lithic switching networks, a thin-film resistor network, and internal reference. Price is $69 for one to 24 units, and $49 in 100-lots. Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. 01604 [388]

Storage monitor. Half-rack-width unit with 2-MHz-bandwidth X-Y amplifiers provides displays of alphanumeric and graphics information from computers and other data transmission systems. Designated the model 603, it has information storage rates of at least 200,000 dots per second and a viewing time of at least one hour. Price is $1,100. Tektronix Inc., P.O. Box 500, Beaverton, Oregon 97005 [389]



Packaging and production

IC sockets resist wear

Contacts grip narrow sides of dual in-line packages, providing higher pressure

One of the giants of the semiconductor industry, Texas Instruments Incorporated, is aiming for a giant share also of the IC socket market. TI's hopes ride in part on a new line with closed- and open-entry contacts, wire-wrap or solder tails, removable top covers, and contact construction that promises more resistance to wear plus better contact pressure.

The contacts grip the narrow sides of dual in-line package leads instead of gripping the wide edges as most other connectors do. For the same force exerted by the contact spring, contact pressure will be higher because the area of contact will be smaller. The higher pressure will give lower resistance and will more easily break through any oxides or films on the DIP lead.

Another advantage of the side-gripping feature, the company says, is that the contact is more tolerant of twisted leads that are spread. These tend to damage other types of connectors.

The contacts can easily be removed by using a tool similar to a spring-loaded Starret center punch, generally used to form an indentation for drilling a hole. Instead of its sharp point, a small cylinder can be installed to surround the wire-wrap tail and push out the contact. Although the barbed arrowhead (see sketch below) might tear the connector housing a little, the glass-filled nylon is resilient and even cold-flows a bit, minimizing the damage.

TI engineers say that contacts removed and replaced as many as five times retained the required seven to eight pounds retention force.

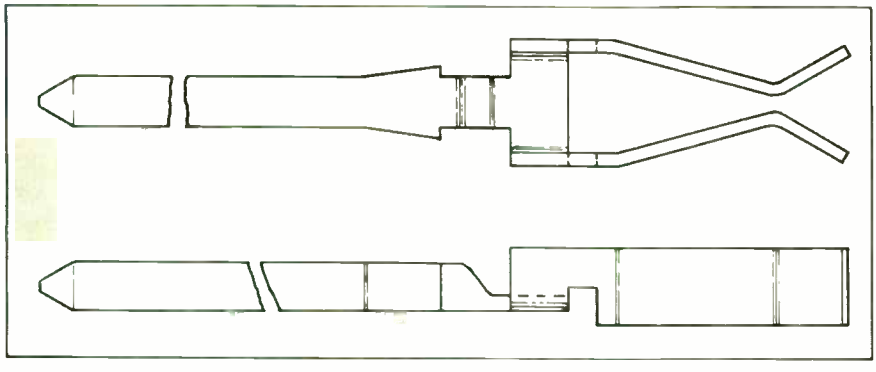
Sockets in the new line have from eight to 40 contacts, with either plating or TI's gold stripe contact, in which gold is clad to the material before the contact is cut from the strip. (TI's Attleboro, Mass. plant specializes in clad metal technology and is a supplier of the clad metals used in U.S. coins.)

The sockets are also available with removable covers to allow conversion from closed entry to open entry.

Price of a 40-pin socket with wire-wrap tails ranges from 90 cents to $2.85, depending on plating and quantity. A 14-pin socket would cost from 25 to 67 cents each. Delivery is from stock.

Texas Instruments Connector Products Dept., Attleboro, Mass. 02703 [391]

Two views. Narrow opening, at right in top sketch, grips edge of IC package lead



Sequencer-taper aimed at smaller production runs

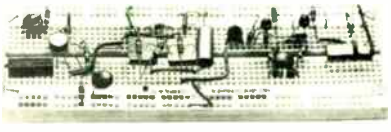
Machines that perform automatic insertion of axial-lead components have been available for a long time, but equipment to set up the devices by placing them on a taped reel in the proper sequence have been relatively expensive—in five figures. Now there's a sequencer-taper that costs less than $5,000.

Universal Instruments Corp.'s 2523, called the Bantam, is designed for the manufacturer who has a pantograph insertion machine; it operates at the same rate—up to 2,000 components an hour. Larger sequencer-tapers, selling in the $25,000 to $40,000 range, have been geared to faster equipment. The Bantam has a rotary feed input and can handle up to 84 different components, fed from 42 dual-compartment bins that rotate into position whenever the operator presses the foot pedal. The stations are programed with washers that fit over pins—each foot-pedal signal causes the bins to rotate to the position of the next washer. The operator then takes a component in each hand and places them in a fixture. The machine then moves the components up a ramp to be applied to the tape.

Universal Instruments Corp., 137 E. Frederick St., Binghamton, N.Y. 13902 [392]

Production briefs

Universal component socket. A No. 4 mounting screw is all that is needed to breadboard circuits with the EL socket, and the unit can be insulated for use on conducting or metal surfaces by using vinyl tape. Components can be connected with



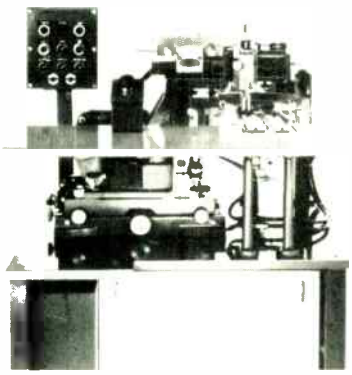
#22 to #26 gauge solid wire and no patch cords are required. Each terminal has five tie points. Price is $18. EL Instruments Inc., 61 First St., Derby, Conn. 06418 [397]

Photo resist spinner. Model HR300 coats substrates up to 3 ¾ in. in diameter. It is semiautomatically tray-loaded, and four spindle spin-

New products

ner heads operate simultaneously. Production rate including 15-second spin time is typically more than 550 wafers per hour. Speed is variable from 500 to 10,000 rpm and acceleration is adjustable from 200 ms to 1.2 s. Headway Research Inc., 3713 Forest Lane, Garland, Texas 75042 [393]

Screen printers. Models 756 and 786 for thick film hybrid circuit manufacture have a 1s cycle, and production rate of up to 3,000 ceramic substrates per hour. The machines offer in-line transport systems. The model 756 takes screens or masks up



to 5-by-5 in. and prints ceramic substrates up to 2 in. square. The 786 accepts masks or screens up to 8-by-10 in. and prints as large as 5 in. square. Precision Systems Co., U.S. Highway 22, Somerville, N.J. 08876 [396]

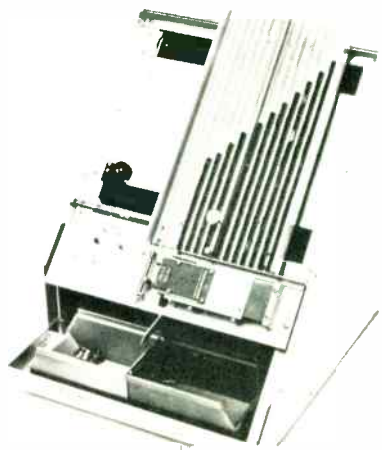
Circuit board ovens. Units plug into 240 V or use natural or propane gas. They have fused quartz radiant elements mounted in metal housings with fiberglass insulation. SCR modulating temperature control is from 100 to 450 F, and conveyors move from ½ to 8 feet per minute. Recirculating air system is supplied. Cleveland Process Corp., Tungsten Rd., Cleveland, Ohio [399]

Microcircuit duplicator. CR series mercury-arc illuminator provides high light-collecting efficiency and illumination uniformity equal to 5% over the full object (or mask) plane.

The unit, available for a 60-, 70-, or 80-mm diameter field, is based on the Kohler microscope illumination principle. Tropel Inc., 52 West Ave., Fairport, N.Y. 14450 [400]

Component spacers. Called Remov-A-Pads, devices temporarily protect, locate, space, mount, and reinforce transistors, ICs, capacitors, potentiometers, and other components. They are noncorrosive, nonconductive, nontoxic, and strong enough for automatic feeding. Units are placed between components and board, providing space for air circulation. Not affected by soldering temperature, they leave no residue. Dynaloy Inc., 7 Great Meadow Lane, Hanover, N.J. [398]

IC handler. Unit called Dip-O-Mat handles all dual in-line packaged circuits, relays and networks with up to 20 leads on 0.300-in. centers. The contact device is interchangeable for MSI and LSI circuits with 0.500- and 0.600-in. centers. Micro Electronic Systems Inc., 30 Lawson Lane, Ridgefield, Conn. [394]



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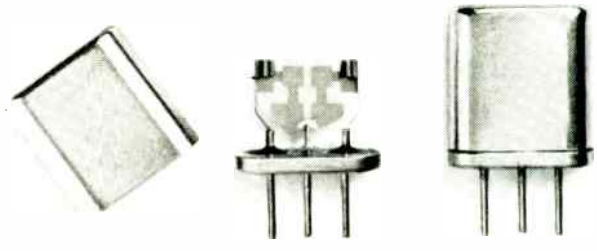
MOTOROLA



Data handling

Mini tackles special jobs

Large-machine-like design is aimed at communications, control, interactive systems

"We're not trying to be another Digital Equipment Corp or Data General," says Allen Shapiro, president of Omnus Computer Corp., a Santa Ana, Calif., minicomputer firm organized about 18 months ago and now ready with its Omnus 1. "Our niche will be where others aren't serving the market," he says, citing special applications in communications, process control and interactive systems. And the Omnus minicomputer costs more than the PDP-11, Nova 1200, or Varian's 620, though all are 16-bit machines.

Shapiro describes the Omnus 1 as a versatile minicomputer with architecture approaching that of much larger machines. Key design features include the input-output system, the way registers and cores are used interchangeably in a multi-environment machine, and a capability for accepting external instructions or external microprograming from a control memory.

The system's "dynamic I/O processing" allows simplicity in programing because a single-word instruction not only performs the data transfer but at the same time operates on it. Shapiro says the functional interchangeability of registers and cores is "somewhat unique" in a multi-environment machine—one that can select a set of general-purpose registers independently without disturbing the central processor.

He further adds that the external microprograming is difficult to accomplish in a machine as versatile as the Omnus 1 at a reasonable price. "But we've found a way to put the external control memory on the universal bus to allow us to add instructions, emulate other machines, or build custom data channels." He says many external control memories can be hung on the universal bus, called the Omni-Buss, with a priority system deciding which device has control of the machine.

The Omni-Buss's 5-megahertz (200-nanosecond) clock rate allows full advantage to be taken of high-speed read-only or scratchpad memories that can be added to it as options, over and above the machine's standard 4,096-word-by-16-bit core memory.

Shapiro claims the Omnus 1 offers 45% faster throughput than most competitive computers. For example, it can proceed from an interrupt and, while saving the old environment, go to a new set of registers, store data away and test for the end address in 20 microseconds.

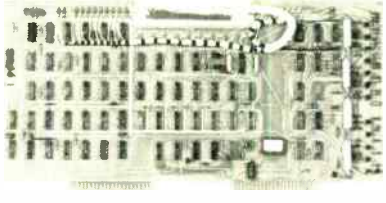
The Omnus 1 has 32 levels of priority interrupt, a power fail and automatic restart feature, 2,049 general-purpose registers organized as 256 pages of 8 registers each, more than 1,000 instructions (or more than 10,000 hardware-wired instructions if general register address modes are counted), and direct memory access for up to 16 devices attached to the universal bus.

The rack-mountable console with 4,096 words of core memory sells for $6,100. With a Teletype controller, autoloader plus reset, autoload and interrupt keyboard functions, the price is $6,500. Adding a Teletype puts the price at $8,700.

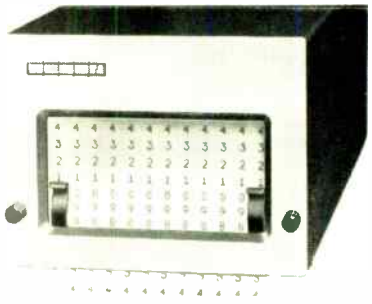
Omnus Computer Corp., 1538 E. Chestnut St., Santa Ana, Calif. 92701 [361]

Data handling briefs

Magnetic tape formatter. Unit is for use with most continuous digital recorders, provides almost all computer-compatible system functions for seven- and nine-track tapes. Features include a write clock, check character, and ability to address four tape transports. Price is $400 in quantity. Digi-Data Corp., 4315 Baltimore Ave., Bladensburg, Md. 20710 [365]

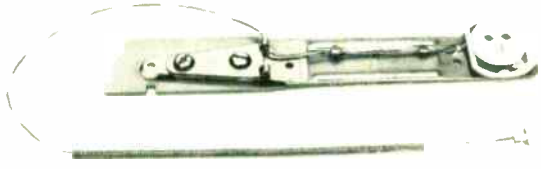


Digital line printer. Series A0501 is for low-speed data acquisition and recording. Device accepts mixed inputs, BCD, pulse train, or a combination of both; and uses an ink car-



tridge instead of ribbon. Print speed is up to 5 lines per second over 4 to 12 columns. Hecon Corp., 31 Park Rd., New Shrewsbury, N.J. 07724 [364]

Flying head assembly. The model ERW-306301 is for use with disk pack drives and records 200 tracks per inch. It consists of a read/write section, straddle erase, and mounting arm. The assembly is available

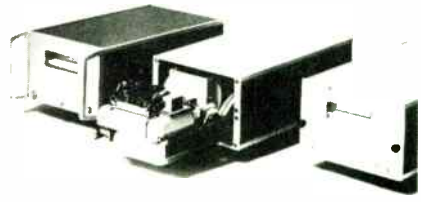


in either a ramp load or torsion-arm load configuration. The unit operates at a packing density of 2,200 bits per inch and a disk speed of 2,400 rpm. Applied Magnetics Corp., 75 Robin Hill Rd., Goleta, Calif. 93017 [367]

Privacy unit. Model CTS 110 Secre/Data is designed to prevent unauthorized use of time-shared facilities. The unit can operate in line synchronously, in full duplex mode, at any rate up to 1 megabit per second, independent of code format. Asynchronously, it can be switch-selected to accept and deliver 5-, 6-, 7-, or 8-element codes at a choice of

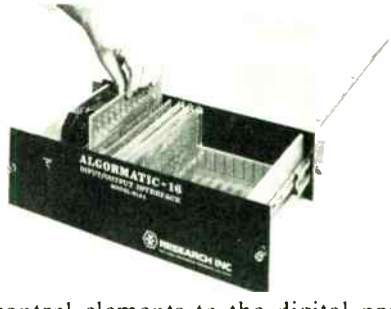
any four rates. Price is from $400 to $1,595 depending upon requirements. Com/Tech Systems Inc., 120-30 Jamaica Ave., Richmond Hill, N.Y. 11418 [363]

Digital printer. Model DM 400 operates at three lines per second. It is capable of printing data from three different sources on up to 21 columns. The print drum has 16 positions per column and can print 50 different characters and numbers.



Functions include: floating decimal point, zero suppression, column or channel blanking, data storage, 10-line decimal input, and positive or negative signal logic. The entire print mechanism is slide-mounted and can be replaced in 30 seconds. Price is $895 for 10 columns of printout. Keltron Corp., 225 Crescent St., Waltham, Mass. [366]

Interface unit. Designed as a traffic point for computerized process control systems, model 812-1 I/O unit provides the interconnections of standard direct digital control devices, such as operator's control panels, input multiplexers, and final



control elements to the digital processor. Unit offers buffering of 12 address bits and 12 data bits. Priority system allows high-speed devices to take care of quick updating. Research Inc., Box 24064, Minneapolis, Minn. [370]

Semiconductors

Chip op amp is easy to use

Monolithic unit offers drift of under 1 μV/°C and can drive load up to 1,000 pF

The gap between discrete and monolithic op amps is narrowed by Analog Devices' introduction of its AD504L linear ICs. The firm claims that not only is its AD504L the first monolithic to combine less than 1

microvolt drift per degree centrigrade with the ability to drive up to 1,000 picofarads of load capacitance—an amount that would make many other units oscillate—but it also has fully protected inputs, and offers single-capacitor frequency compensation.

Analog says the design is brand new, not a rehash of the 741, 725 or similar families. A key goal has been ease of use. Single-capacitor frequency compensation obviates the need for stabilizing networks, and along with them does away with the risk of added error. So does the 504L's output capability; the 1,000-pF drive capability makes series output resistors and their associated loss of some dc accuracy unnecessary.

Analog is aiming the 504L at low level applications—precision measurements, low level transducer preamps, stable voltage sources, and buffers for passive circuits. Some of these applications may break new ground for monolithics at the expense of discrete op amps. Engineering vice president M.A. Maidique notes that Analog's own discrete model 183 "is challenged on a spec-for-spec basis" by the 504L.

The 504L's open loop gain is greater than one million, and common mode rejection is typically 140 decibels. Voltage offset is less than a millivolt and trims to zero. Turn-on temperature performance is good, with the device reaching spec in less than 2 minutes in free air, and faster in a heat sink. A 50° sudden change in ambient temperature is handled within 30 seconds, and without hysteresis, it's claimed.

Physical and circuit design has made these specifications and temperature performance possible. The basic circuit uses a protected differential input followed by a pnp Darlington gain stage with a current source load. A follower stage then drives a protected push-pull output. The input combines advantages of Darlington and differential input configurations and opens the possibility of future superbeta 504s.

Not only are thin film resistors used—deposited on top of the passivation layer near the input stage for thermal stability—but each transistor is placed so that it has a complement relative to the "thermal center of mass" of the chip. For example, temperature variations caused by changing power dissipations in the output stage will be "communicated" along the axis and affect the input stage symmetrically.

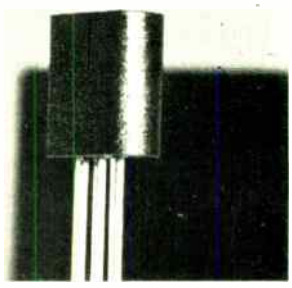
J and K models of the 504 are also available with slightly less glamorous specs, and all three chip types are being delivered off the shelf. Evaluation-lot prices are $21 for the 504J, $30 for the 504K, and $36 for 504L. In lots of 100-999, the respective prices drop to $14, $20, and $24.

Analog Devices Inc., Route 1 Industrial Park, Box 280, Norwood, Mass. 02062 [411]

Semiconductor briefs

High voltage diodes. Miniature units offer a maximum reverse current of 2 nanoamperes at PIV ratings from 1,000 to 4,000 V and a continuous forward current of 20 mA. Maximum capacitance is 1 picofarad at 0 V. Applications include multiplying circuits that require high efficiency and low battery drain. Scientific Components Inc., 350 Hurst St., Linden, N.J. 07036 [414]

Silicon controlled rectifier. Series 2N5060-64 plastic units are for low-cost industrial applications. Packaging is in a TO-92 case with a special epoxy compound providing moisture resistance and good thermal temperature without deforma-



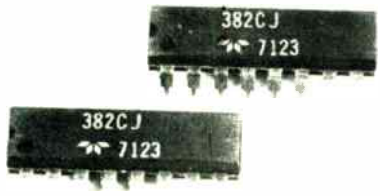
tion. Devices are available in voltage ratings up to 200 V, with maximum ratings of 0.8-A forward current, rms; 6-A surge current, 8 ms; and 200 μA gate sensitivity. Price is as low as 37 cents in 1,000 quantities. Unitrode Corp., 37 Newbury St., Boston, Mass. 02116 [415]

Silicon voltage regulators. Zeners offer low dynamic impedance, and can be operated at a low bias current. Nominal voltage is from 30 to 120 V for 1-, 3-, and 5-watt appli-

cations. They are designed for communications, aerospace, and industrial power electronics. Semtech Corp., 652 Mitchell Rd., Newbury Park, Calif. [417]

Decoder/driver. Model 382 offers over 4-V typical noise immunity and 70-V output characteristics. The device decodes BCD 1248 code and drives Nixie or similar indicator tubes requiring 7-mA or lower cath-

New products

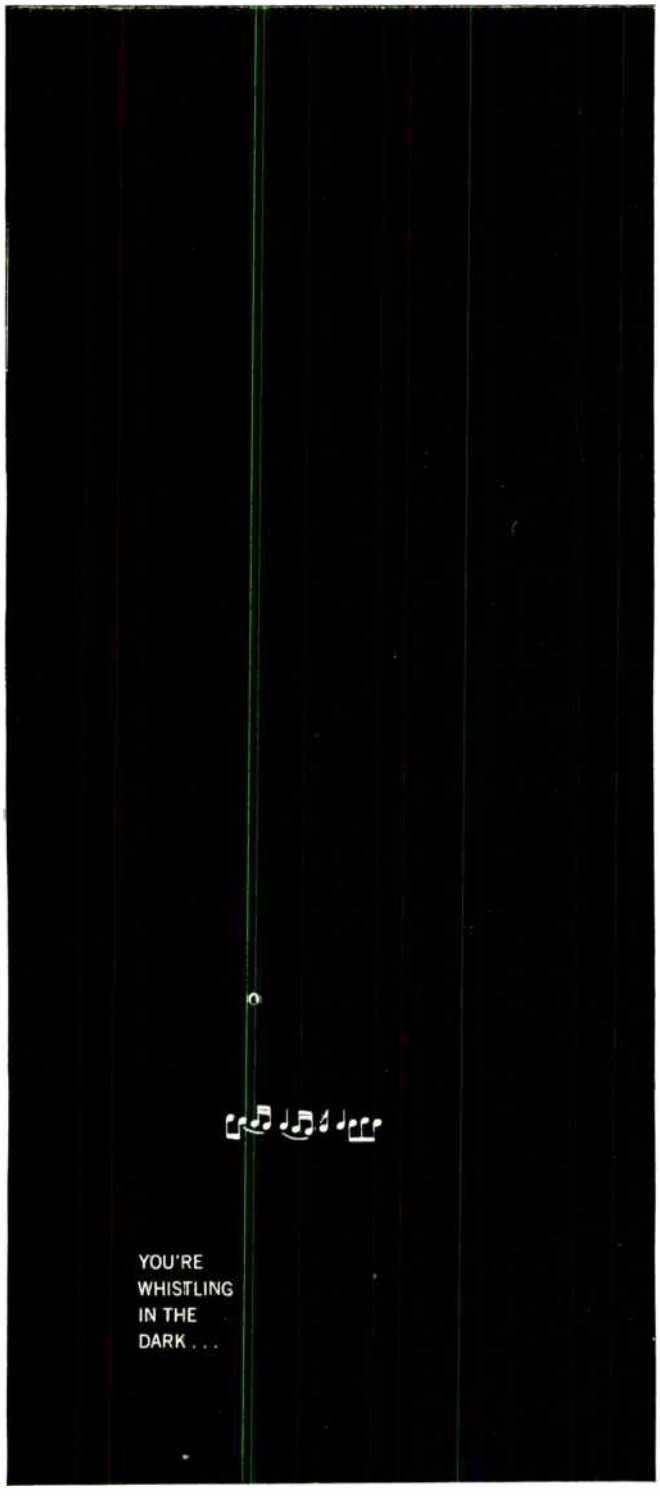


ode current. Price is $6 each in quantities of 100 to 999. Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94040 [419]

Silicon bridge rectifiers. High-voltage miniature devices for a variety of power-supply jobs are chassis-mounted and fully insulated. They feature a PIV of 1,000 to 6,000 V rated at 50 mA, and true rms voltage is 700 to 4,200 V. Cycle surge is 20 A with an average forward drop at rated current from 4 to 10 V. Dimensions are ¾ by ¾ x ¼ in. Terminals are solder lugs. Codi Semiconductor Div., Computer Diode Corp., Pollitt Drive South, Fair Lawn, N.J. 07410 [416]

Op amp. Model FST-160 A/B is a differential FET-input unit that can settle to 0.01% of full scale (±10 V) within 0.6 ms maximum when used as follower amplifier. Minimum common mode rejection ratio is 20,000, and it slews at 100 V per ms.

Other features include a minimum gain bandwidth product of 30 MHz, full power response of 1.5 MHz, minimum gain of 1,000. The 160 can be used as a differential amplifier or a programable buffer. Price is $49 for the A and $55 for the B. Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. [420]



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Test conditions and typical values at 25°C

Core type		18PH2*	18PH4	18PH5	18PH6
I_f	(mA)	213	425	500	580
I_p	(mA)	130	259	305	354
V_1	(mV)	11	31.4	35	39
V_Z	(mV)	1.2	6.8	6.0	6.2
t_p	(ns)	230	142	136	123
t_s	(ns)	490	290	270	230

* With this core, wired in a 2D configuration and used under asymmetrical drive conditions, read/write switching times of 150/300 ns can be obtained, applying read-, write- and digit currents of about 440, 220 and 110 mA respectively

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SEPTEMBER 1971

Adult education: variety that's in tune with the times

On six separate evenings this fall, an assortment of professional men, executives retirees—and some wives—will file into a lecture room at Manhattan's New York University to learn from experts how to assemble an art collection that one might call "great." At Duquesne in Pittsburgh, a similar group will be taking a scholarly view of the obscenity issue in movies. And at Wisconsin, Rutgers, Michigan State, and elsewhere, adult classes will be discovering how to apply "encounter group dynamics" to solve human relationships. They'll review problems that can crop up anywhere from the office to the yacht.

These after-hours scholars are merely a few of the estimated 368,000 adult Americans many with advanced degrees and some with none, who are flocking to the extension courses now being offered at local colleges and universities in every part of the country. The enrollees have more than tripled since 1958, and the courses—once narrowly limited in scope—now run the gamut from the mechanics of investing with a neighborhood broker to the play of power politics among nations. "People," says a professor who teaches these non-campus students at the University of Missouri, "are getting a desire to upgrade, outreach, and self-renew, to reawaken interests that were alive in their undergraduate days."

Enrollment in nearly any U S city with a campus or state university branch has been made easy. Since few of the courses offer academic credit, no diplomas or transcripts are required, and grades take a back seat. Sessions are short (usually two hours a week for 10 to 13 weeks), and the courses are mostly inexpensive, ranging $25 to $90.

PERSONAL BUSINESS
Like all McGraw-Hill publications, is written for a select audience. It is devoted entirely to your personal interests and activities as an aid to better management of your time and money

A prime motive for enrolling is professional advancement. Businessmen, for instance, realizing that their managerial effectiveness rests largely on their ability to communicate, sign up at schools such as Rutgers, NYU, Brigham Young, and the Univ. of California at Berkeley which offer courses in effective oral communications. Bad writers can get help at places like Hunter and Duquesne, two of several which list courses in writing business letters, reports and memoranda. The psychological approach, via encounter-group dynamics, often aims at leading and motivating others. Thus, "Human Relations in Management" is taught at Wisconsin, Arizona, Rutgers, Michigan State, NYU, and the Rochester Institute of Technology.

Computers becoming as important as they are in every-day dealings, courses in the basic lingo of data processing are drawing crowds at many schools, from Georgetown to UCLA. Business public relations gets full treatment at Hunter, Brigham Young and elsewhere, and some schools also tailor special courses (as at the University of Arizona) to meet the needs of club and association leaders. And speed-reading, a communications skill much envied in an age of

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mounting printed material, is listed in many catalogues, among them those of Chicago, Wisconsin, Virginia, Colorado, Hunter, Duquesne, Michigan State, Rutgers and NYU.

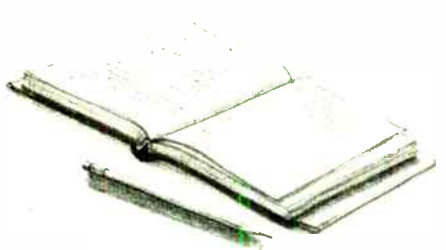
With private investment now demanding closer attention and caution, extension courses in financial matters are beginning to abound. Virginia, Colorado, Arizona, Duquesne, Michigan State, and Northwestern, for instance, all offer advanced courses on the stock market. Arizona also runs classes on mutual funds, NYU courses examine the new real estate investment trusts (REITs), and Wisconsin, among other universities, gives guidance on family estate and financial planning.

Most non-lawyers find legal terminology a stumbling block, so the basics are being taught to businessmen at Virginia, NYU, and Purdue. With broader strokes, a weekend seminar at Wisconsin is tackling "Justice in America", and at Minnesota a class of non-campus students are pinpointing their interest on "Legal Problems for Veterans and their Families".

Virtually every university with a continuing-education program these days is listing several courses on the social and ecological issues that are commanding the headlines. Pollution and ecology are important courses at Chicago, Massachusetts, Wisconsin, Minnesota, Northwestern, Georgetown, and Rochester, just as they are at the New School for Social Research in New York. Some, like those at Minnesota, Chicago, and Rutgers, take a generalized view of urban affairs, while others narrow the field. Wisconsin, for one, offers a extension course on "The Modern City Learns to Live with Organized Labor".

Population growth commands the attention of after-hours classes at Minnesota, and the question of civil authority is raised at Duquesne, in a course entitled, "Cops, Courts and Freedom". Increasing drug abuse has prompted Michigan State, Harvard, and many others to schedule classes on the subject, while the less publicized but nonetheless critical problem of venereal disease is a major concern of courses at Wisconsin and NYU.

Counter-culture movements, particularly those linking youth to revolution, are getting close attention this fall from extension students at colleges in Manhattan. And the establishment is getting some scrutiny, too, as in a course of "Crime in Business and the FBI" being offered at Rochester.



The "black studies" boom on U. S. campuses has reached the extension crowd as well. NYU offers a "Standard History of Black People", while a course at Wisconsin concentrates on black literature. Rutgers and the New School this fall are examining the black experience through art, music and drama.

As citizens of a shrinking world, extension students are also seeking to deepen their understanding of international politics. Minnesota, for example, lists several major courses in this area: "Problems of the '70s, American Foreign Policy and International Politics", "The Arms Race", and "The New Europe". The Middle East gets special attention at the University of Massachusetts, while NYU and others are predicting a large enrollment for new courses on China.

The rising U. S. interest in culture has also fed the back-to-school movement. Classes in the contemporary theater gather rapt audiences at campuses from Wisconsin to Hunter. An equally intense group at Wisconsin pores over recent American novels, while at Rutgers the alienated hero of contemporary fiction gets a going-over. Avante garde poetry is the meat of other back-to-school adults at the University of Colorado.

Film, the only art form the 20th Century can claim as its own, is also rising on this fall's extension-course curriculum. Some courses, such as those listed at the New School, Colorado, and Minnesota, treat it as art. Others, as at NYU and Purdue, teach it as a technique in courses aimed at amateurs who want to polish their moviemaking. Some go all out. At NYU, for example, the extension students get to exchange views with such film luminaries as Otto Preminger, David Susskind, and critic John Simon.

One of the main attractions of extension study is that it is not all heavy-going. On the lighter side, there is NYU's course on art collecting. For genealogy buffs, there is "Your Family Tree" and the like at Purdue, Michigan State and Arizona. And for those with wanderlust, Purdue, for one, lists "The Hows and Whats of European Travel".

Another virtue is its availability. A post card or phone call to nearly any state university, private or community college in your neighborhood will bring forth a catalogue or listing of courses that can open up a whole new world in which to flex your intellectual curiosity—with no harm done if you don't happen to make the dean's list.

A can't-lose fund? Yes, with insurance

Imagine a mutual fund that can only go up. That is the idea behind a new form of insurance that provides a floor but no ceiling for a long-term investor.

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On a $10,000 investment, for example, the 10-year premium comes to $600, and the administrative charge totals $120—or $72 a year. At the end of 10 years, if the value of the mutual fund investment falls below $10,720, the insurance makes up the difference. The shareholder gets price-drop protection.

Behind this new idea in fund merchandising is the fact that mutual fund sales have slumped since 1970 when the stockmarket broke. The first to try the insurance idea is Fairfield Fund, a $58-million growth fund underwritten by New York's National Securities & Research Corp. But it won't be long before other funds offer similar protection.

The idea originated in Britain in 1956, and finally got off the ground here when Philadelphia's I.M.F. (Insured Mutual Fund) Services, Inc., worked out a plan for the Harleyville (Pa.) Mutual Insurance Co. The plan, which the Fairfield Fund is using, is available today in 35 states. Harleyville is seeking authority in such prime market areas as California, Texas, and New York.

For the mutual fund buyer, there is security—and for the insurer there is, of course, the comforting fact that it is almost impossible to find a 10-year period in the past 30 years when the funds did not go up.

At the season's end: tieing up a smart deal for a used boat

"A lot of people who could afford to own and maintain big boats have suddenly found they can't," said the old hand at Northrop & Johnson, the yacht brokerage firm. "They're fighting bad investments and slow business—so we expect this fall to be even better for the boat buyer than last year when so many first rate used boats were unloaded."

The pattern holds pretty much from marina to marina, coast to coast, and it applies to boats in the broad $2,500 to $25,000 range, but with more expensive craft going at the softer prices. It isn't exactly a season of sacrifice sales (as predicted last spring). But this fall, shopping the boat yards will uncover some smart buys and bargains. And there is more to it than the economic climate. It is easier to shop for a boat in the fall. The pace is more leisurely and relaxed at a boatyard than in springtime when everybody is fitting out for the new season—and first-time buyers are bidding up the prices.

Prices are generally about 10% to 20% lower in autumn than in springtime, according to top-rate boat people such as Sparkman & Stephens, the design and selling firm, and shopping the yards proves the point. The price break holds especially for medium-size boats in the $5,000 to $15,000 range. There is more floating stock to choose from in this bracket, making for a buyer's market; and beyond this, used boat dealers are usually anxious to unload stock before the winter lay-up season sets in.

A potential buyer—even if he has had experience with a small boat and is upgrading—ought to mull over the idea of a fall purchase much as an old hand will mull over the "feel" of a 10-year-old wooden hull. If he is a novice, he should keep in mind that a used boat is not at all like a used car. A boat, if properly maintained, can actually improve with age. "All kinds of kinks you find in a new boat can be straightened out," says a Marblehead, Mass., boat owner of many years. "And when you buy an old boat, it won't really be all old if it's been well maintained by a good owner. It'll have a lot of newness in everything from improved electronics to a redesigned galley."

Another old hand at seamanship who sails in summer out of Boothbay Harbor, Me., nails down the philosophy of used boat buying in saltier terms: "When you go looking—if you're serious—you'll see hundreds of older boats from 10 to 40 years old. Some are sturdy, honest, and will give years more service at minimum cost. Others are all gloss and fresh paint and gleaming brightwork—they've just been dolled up for a fast sale and will cost cash at every turn."

So, for most people, a used boat buy becomes a case of the closest inspection. But handle it right, and the reward can come in terms of pleasure on the water—and in dollars, as well. In a typical transaction at a California marina, a small but excellently maintained cabin cruiser that was new in 1965 was sold two years ago for $14,000. The boat had originally cost $24,000. The sale was typical because a new model boat, as a rule, will depreciate 15% to 25% the first year, 10% more the second year, and about 5% the third. The second owner, who paid $14,000, used the cruiser for two years, decided to upgrade, and had no trouble finding a willing third owner—at $14,000.

The third owner picked up a fine buy, despite the fact that he faces a winter storage lay-up at about $500, and an engine overhaul at about $500 more.

Besides a lot of waterfront searching, there are two prime rules for the average boatsman who figures on laying out a sizable piece of cash. One is to buy through a reliable broker (whose 10% commission is paid by the seller). The other is to hire a good "surveyor" for boat inspection before paying a dime.

A top-rank yacht broker supplies two things: listings of boats on the market, and advice. And though it is true that he gets his 10% from the seller, his long-range success depends on reliability in the market. Boat people are, by and large, a close-knit and talkative fraternity, and the dealer who pushes fancy paint jobs and sodden hulls soon gets cut adrift from 10% commissions on second-hand boat sales.

"If you get the feeling of a fast sales pitch," warns a long-time member of a Connecticut yacht club, "—then you had

John Groth

better move along to another man." Nationally known brokers such as Sparkman & Stephens, Northrop & Johnson (New York), Bertram (Miami), John Alden (Boston), and Joseph Stephens and David Fraser (Los Angeles area) are known for their fair dealings. Unhappily, though, there are fast operators to contend with. One good way to seek out the best broker in your area is to contact the commodore of the nearest yacht club. He will likely have ample information on local and regional brokers. He may even know of a club member who wants to sell a good boat—and if you buy this way, the seller avoids the 10% commission and may pass part of it along to you.

In all cases ("even if your cousin is the yacht club commodore," notes a Nyack, N. Y., boatsman), a buyer should employ the services of a surveyor. The used-boat idea falls apart, of course, if a "lemon" is picked from the boat yard. A small fortune in big repairs can be lost, or even the whole investment if the boat proves to be dangerously unsound. The surveyor will make a close inspection of the craft down to the finest detail (and paying for this kind of advice isn't a bad idea even for a new boat purchase). The qualified surveyor, a licensed marine inspector, will usually be a member of the National Assn. of Marine Surveyors, Inc., and will charge from $2.50 to $3.50 per foot for boat inspection (measured by deck length, not waterline).

Surveyors, in great demand for commercial work, can be hard to find for small boat inspection. But boatyard inquiries usually will turn up a good man willing to do private work, oftentimes on weekends. For a used boat, a haul-out for inspection is almost a must, since the possibility of dry rot and unrepaired damage below the waterline is always present. At most yards, the owner pays about $2 to $2.50 an hour while the boat is mounted on a repair scaffold—assuming an average-size pleasure cruiser, or sailing craft.

Above all, a buyer should sail the boat before making a deal. Chartering for a week is one sensible way. It is a way to learn the "feel" of the boat in the water—and about one's own personal reaction under sailing conditions. Charter costs vary. A 24-footer, for example, may run $300 or so a week without a crew—and another $150 with a captain aboard, to play it safe.

Charm, progress abide in harmony in sunny San Diego

The charm of California's oldest city has been neatly described by author-columnist Neil Morgan: "What you find in San Diego now is what you thought was California but isn't anymore . . . There is much to hope for in a community that splurges to protect open spaces and playgrounds, that hides its freeways in canyons, uses harbor fill to create garden islands, and plants trees and sows California poppy seed from helicopters."

San Diego is that miracle of American cities, a pleasant place that has experienced rapid growth without the usual ugliness. It remains a city of easy living. It is blessed by a gentle climate with an average temperature of 71.2 degrees. It is always green, abloom with flowers, and cooled by ocean breezes. Even in the hottest spells, San Diegans need a blanket for comfortable sleeping.

Thanks to an enlightened city government and citizenry, San Diego has become a major playground of the West. There are 70 miles of splendid beaches, and two great bays—San Diego and Mission. The atmosphere is rarely tainted by smog, the beaches are clean, the water unpolluted.

It is a seafaring city, a place of exquisite sunsets, soft lights glimmering on the water at dusk; of tuna fishermen mending their nets along the embarcadero; of the grey whale passing off Point Loma enroute to Scammons Lagoon, a breeding ground 450 miles south in Baja California; of Sea World, a vast oceanarium on Mission Bay where the Theater of the Sea offers performances by penguins, dolphins, and Shamu, the captive killer whale.

If New Orleans is "the city that care forgot," San Diego is America's Tivoli. The phrase comes from travel writer Richard Joseph, a frequent San Diego visitor. Joseph was delighted to discover that San Diego, like Copenhagen, is built around a lovely park. Tivoli in San Diego is Balboa Park, 1,400 acres of greenery in the heart of the city.

One of the attractions is the Children's Zoo, where the kids can touch the animals. And there is no zoo in the world quite like the San Diego Zoo, where only a few of the 5,000 mammals, birds, and reptiles are caged. Nearly all are allowed to roam about within 128 fenced acres, and are permitted at least an illusion of freedom.

San Diego is the quietest of California's large cities, and perhaps the safest. It is essentially conservative in most of its attitudes. It played a decisive role in winning California for Richard Nixon in 1968, and reelecting Gov. Ronald Reagan in 1970. The affluent are drawn by its fine hotels, restaurants, and a variety of pleasures. At the new Westgate hotel one can obtain a suite complete with a butler and a Rolls-Royce. Other top hotel names are Sea Lodge at La Jolla, del Coronado, and Royal Inn at the Wharf.

The Star of the Sea Room on the wharf is one of America's truly superior seafood restaurants. And a favorite of San Diegans is Casa di Baffi (House of the Handlebars) where a delightful little man, George Pernicano, displays his $50,000 moustache (it's insured with Lloyds) and presides over a first-rate steak and chop house.

Del Mar, nearby, is where the racing crowd vacations. There is also racing just across the border in Tijuana, a mere 20 minutes away. If wicked cities could be rated, Tijuana would have to be one of the top five. (Prostitution flourishes openly, and the night club acts on Aveinda Revolucion are gamy.)

But Tijuana also offers such delights as horse and dog racing at Caliente, plus bullfighting, jai alai—and bakeries which make some of the world's tastiest breads and rolls.

The pleasures of San Diego take on an artistic tone, too. The city holds an annual Shakespeare festival at the Old Globe Theater in Balboa Park, starlight operas and musicals at the Zoo, and the San Diego Symphony and the San Diego Opera Company hold forth at the Civic Theater.

One of San Diego's finest features is Mission Bay Park, an extraordinary aquatic playground with 27 miles of shoreline, a milieu for water skiers, boatmen, swimmers, and fishermen. There is surfing at Windandsea or Sunset Cliffs, casting for sea trout in Mission Bay, trolling for marlin or albacore off the nearby Coronado Islands, dozing in the sun at La Jolla Cove, and dining and dancing on two islands dredged from San Diego Bay—Shelter and Harbor islands.

Though the population approaches 800,000, and the metropolitan area (San Diego County) is up to 1.3-million, San Diego is still a bright and shiny place. It has had population explosion without fallout.

For a long time, the community was divided between those who sought to hide it from the rest of the world and those who advocated "progress" by courting industry. The result was a happy compromise. San Diego grew dramatically, but it largely attracted light industry. It became a "think tank" of impressive dimensions, with half a dozen campuses and such scientific centers as the Salk Institute. So today most of San Diego's smoke comes from the pipes of its scientists and professors.

Bottlenose dolphin do their amazing capers at San Diego's Sea World lagoon.

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End of a revolution: the beginning of a saner era

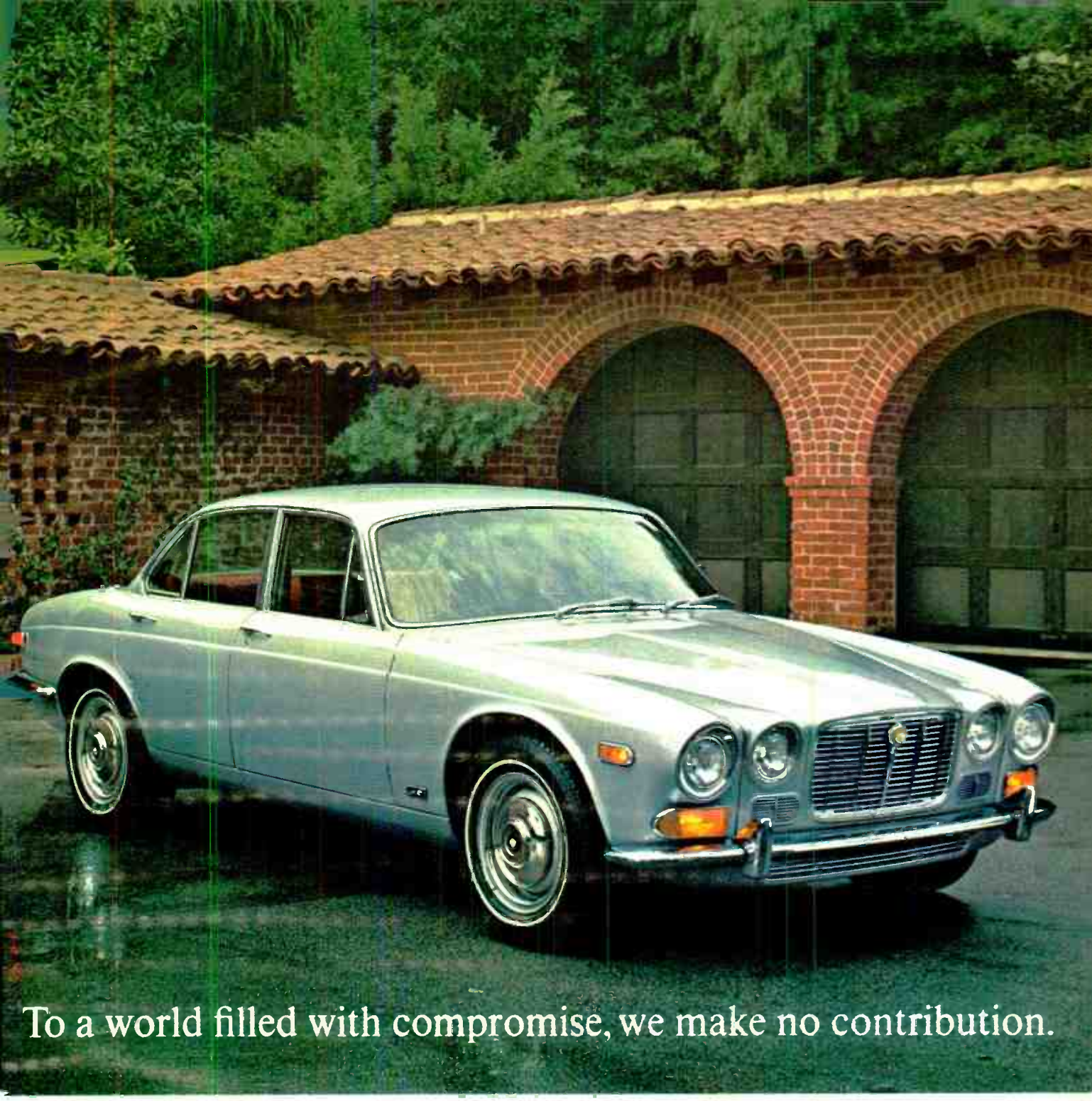
The men's fashion revolution in the late sixties ushered in a period of far-out designs and downright silly styles like the Nehru jacket, Edwardian coats, velvet suits and the look of the 30's. But the brash revolt scared away the customers. Suit sales dropped from 22 million in 1969 to 15 million last year. In reaction, manufacturers are returning to moderation and restraint. "What we are in is a phase of fashion that might well be called current classicism—a concept of true masculinity with a touch of elegance," says a leading observer of the scene.

This fall the wide look is in. Everything is wide: lapels, ties (4-4½ in.), flaps on suit coat pockets, cuffs, and belt loops. Jackets are shaped, with the waist nipped in and an extra long center vent. The single breasted business suit is stronger than ever, mostly with two buttons. The most popular fabrics are in subtle checks, glen plaids, modest stripes, and muted colors. Tans and light browns are in style, but the newest fall color is aubergine, a shade that runs from deep maroon to plum.

The suit (picture) is from Earl of Litchfield at $125. Austin Reed, a division of Hart Schaffner & Marx, makes a good-looking solid light tan suit, also two-button, single breasted. It is shaped with wide lapels and has deep side vents and large buttoned scalloped pocket flaps.

Probably the biggest news in men's wear is the development of the knitted suit to replace the traditional woven one. Even sports jackets will follow this trend. The knits are ideal for travel because they are crushproof and retain their shape and press even after rugged abuse. There are shortcomings, too. They don't keep out the wind in winter and have an uncomfortable feel in very hot weather. But after being introduced

This businessman travels to meetings in a company plane. Dark navy pinstripe suit by Earl of Litchfield, $125. Shirt, $20, and tie, $10, by Oleg Cassini. Muskrat hat by Dobbs, $30; camel's hair topcoat by Bert Paley, $150; by Johnston & Murphy shoes, $42.50.



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Matching its uncompromising performance is the quality of its interior. Hand-cut leather upholstery sets the tone. And following through are such amenities as a hand-rubbed burled walnut fascia, an impressively organized easy-to-monitor instrumentation system, lavishly contoured reclinable front seats, and the positive comfort of flow-through ventilation.

The performance, the refinement, everything about the XJ6: definitively, uncompromisingly Jaguar. Not surprisingly, the XJ6 has been named by *Road Test Magazine* as "The 1971 Car of the Year." Surprisingly, it costs less than $7,500*.

For the name of your nearest Jaguar dealer and for information about overseas delivery, dial (800) 631-1971 except in New Jersey where the number is (800) 962-2803. Calls are toll-free.

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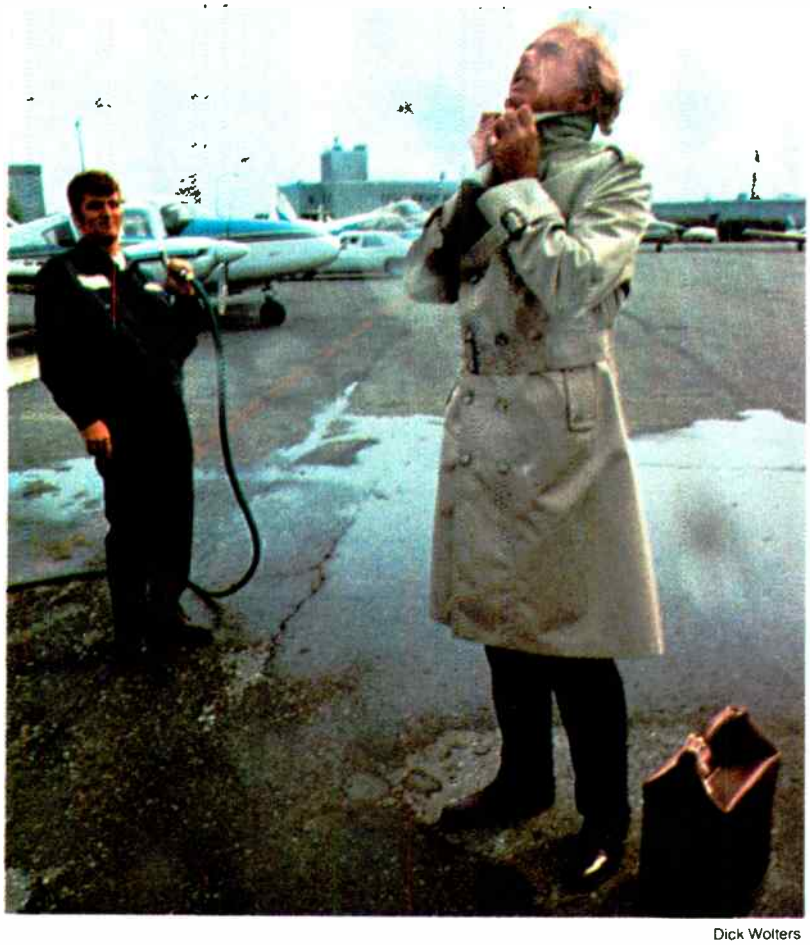
*Manufacturer's suggested retail price. Transportation charges, dealer preparation, state and local taxes, if any, not included. Whitewalls optional extra.



Dick Wolters

Raincoat by Cortefiel de Espana, $90.

Suit, shirt, tie by Oscar de la Renta (After Six).

last year, the knit suit will make a big splash this year, though they are likely to be in short supply—there are not enough double-knit knitting machines.

The most durable knit is of polyester fiber. There are blends of wool and polyester, but trousers made of this mix tend to bag at the knees.

Sports coats for fall have many design features of the suits: shaped, single-breasted, two-button. But they will feature belted backs. The fabrics have a heavier look with many tweeds, checks, glen plaids and herringbones. Here there is no restraint in color, but again, aubergine and shades of light brown are most evident. Models by Stanley Blacker, Clubman and Botany 500, among others, cost $50 to $55.

Dress slacks in many colors and patterns, some of them wild, feature a slight "gentleman's" flare and pockets western-styled with openings on the waist rather than at the side. Many are self belted. Nostalgia note: Knickers have returned as a fashion trend in sports pants.

White shirts, long off the fashion scene, are returning in textured fabrics, white-on-white, though some whites have stripes and geometric prints and bold patterned shirts are still to be seen. Many are double-buttoned and French cuffed, and some shirts with long collar points are being buttoned down once again. Even the expensive brands are going to permanent press because laundry prices have climbed so high. And shirt prices themselves have soared. Even popular-priced brands are offering products up to $12.

The return to sensibility is marked in the overcoat department. A stylish yet practical model is a camel's hair and wool storm coat with alpaca collar, body and sleeve linings (picture). It is double-breasted, with an all-around belt, imported leather buttons and an extremely long center vent in the back, which makes for comfortable seating. From Bert Paley, at $150, it is light but warm. Businessmen will find it good for both travel and stadium wear. Another stylish outercoat is from Stanley Blacker, in aubergine corduroy. It has big patch pockets, an all-around belt and a white sherpa collar ($85).

Fall shoes will feature more boots and two-tones, many with buckles. The pointed toe is replaced by a square toe, and the patent-leather look is in for both business and casual wear ($25 to $50).

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BOOKS

STAMPS FOR INVESTMENT
BY KENNETH R. LAKE
STEIN & DAY, $6.95

Like numismatics, stamp collecting is the sort of hobby to which one can devote two or 20 hours a week and in which one can spend from $5 a week to $20,000 a year. Either way, stamps *do* have a marketable value, so Kenneth R. Lake's *Stamps for Investment* is good reading for both beginner and specialist. One of the few recent books to deal with the appreciation potential of stamp collecting, this volume suggests that you can turn the hobby into a way to put the children through college, better the return on securities investment, or pay income taxes.

Forty-one years ago, a $2.60 stamp was issued. Today it is worth about $300. And if you were fortunate enough to buy four of them in a block from the corner of a stamp sheet, your $10.40 investment would now be worth approximately $2,250. Such success stories indicate the possibilities. But what about the $5 stamp also issued in 1930 that now is worth only $3.50? Or the dozens of 20-year-old stamps—still available in quantity—that now command less than face value? Fortunately for prospective investors, however, Lake is less concerned with such numbers than he is with "how things happen, why the market functions as it does, and what is likely to happen in years to come."

Above all, of course, he stresses that philatelics is an enjoyable hobby. But to maximize that enjoyment, the collector must be able to recognize many things. For instance, Lake notes that such factors as national patriotism, economic instability, overinvestment, changes in postal policy, and a bevy of other imponderables can quickly result in a loss of confidence in an issuing country's stamps. On the other hand, "a small, philatelically clean country, with a genuine postal need for its stamps and with small but carefully controlled printings, will provide the most satisfactory long-term investment."

At least once, Lake touches on the stamps or postal policy of over 100 nations. And while he never really sermonizes at length about stamps, he cautions that "irresponsible investment, based on irrational prejudices, misinformation, or ignorance, can have severe repercussions on the image of both the (stamp) trade and hobby, and its effect on the pocketbook of the unwary investor can be catastrophic."

OVERCOMING DRUGS
BY D.B. LOURIA, M.D.
MCGRAW-HILL, $6.95

No subject has so captured the American imagination in the last few years as has drug use. Between parents and their children, doctors and their patients, and social workers and their "cases," drug use and abuse now seems to almost dominate the conversation. In *Overcoming Drugs*, noted physician Donald B. Louria offers some comprehensive programming for dealing with the narcotics problem and gives some practical advice to parents anxious to discuss drug use with their kids—or, perhaps, who have been forced to because the child already is a user.

Dr. Louria is well-qualified for his editorial task. The author of many articles, he currently is president of the New York State Council on Drug Addiction. In his program for parents, he expands on five basic tenets in dealing with the offspring: don't panic, educate yourself, learn to communicate, evaluate the problem, be able to follow through. In the prevention of drug abuse, for instance, it helps a great deal if the child has a healthy sense of identification with a parent—and this means open, two-way communication.

Louria tells his readers to use this "formula" method to help determine the severity of the problem: Consider the type of drug (mild or severe), the kind of use (transient or chronic), and the child's personality (healthy or unhealthy). In each of the three categories, give a lesser drug, limited use, and a healthy personality a value of one each; give a severe ("hard") drug and chronic use a value of two each, and an unhealthy personality a score of three. If the total score is three or four, the child probably has a mild to moderate problem. Five indicates one of intermediate severity, and anything higher, a most severe problem.

"We owe (our children) more than monumental indifference to the ephemeral or permanent harmful consequences of promiscuous drug use," Louria says. Indeed, he obviously feels that physician involvement is necessary, too, especially when his relationship with the family is of long standing.

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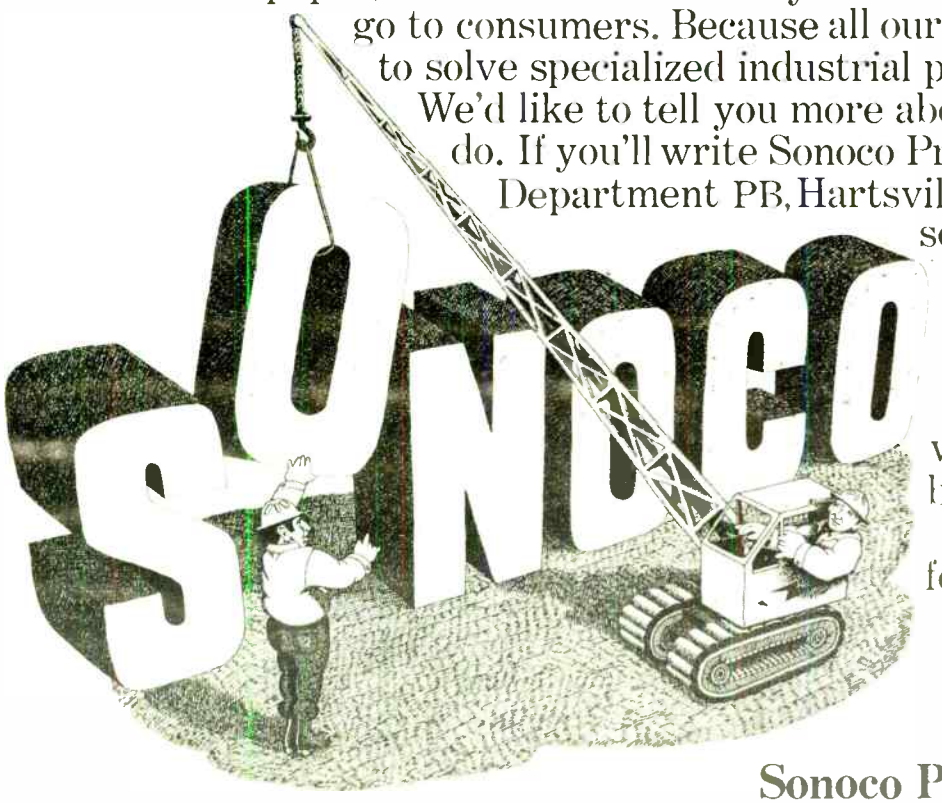

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Brilliant October: nature's best show

From the White Mountains to the Ozarks, October is the month when autumn's foliage is most brilliant. It is also a month with a choice of three-day holidays (Columbus Day, Oct. 11, and Veterans Day, Oct. 25). There's time now to plan one or another of several foliage tours recommended this year.

New Hampshire's color should peak between Oct. 3 and 15. One way to enjoy it is to meander north on Route 10 to Hanover, N. H., where the Hopkins Center of Performing Arts at Dartmouth College offers concerts and theater year-round. About 50 miles north is Sugar Hill, overlooking Franconia Notch, where The Homestead is a favorite stopping place. Route 116, south, enters the White Mountain National Forest, where Lost River Reservation and Kinsman Notch are pleasant for scenic walks. Among hotels are the Franconia and Mittersill Alpine inns, and for dining, Lovett's-by-Lafayette Brook.

Bucks County, Pennsylvania, is also an October color scene. The Pennsylvania Dutch countryside, restored Hopewell Village (where Revolutionary cannon were forged), and Hawk Mountain Bird Sanctuary are particularly colorful in the early weeks of the month. And for typically hearty Dutch fare, local travelers favor the Chartlesville Hotel.

Ashe County in northwestern North Carolina is another mid-October beauty spot. A scenic drive along the Blue Ridge Parkway leads into West Jefferson, N. C., departure point for the annual Autumn Leaf Train Excursion Oct. 10 to Galax, Va., and back. For rustic dining and lodging, there are the Hound Ears and Cliff Dwellers inns, among others in the area.

The Flaming Fall Review in the Ozark Mountains runs from Oct. 15 to Nov. 5. Mountain View, Ark., is a vacation spot where the White River offers excellent trout fishing as well as foliage vistas, and the Bull Shoals lakes are an unpolluted mecca for scuba divers. Hotels such as Crow Barns, Gastons and Baybreeze serve the traveler.

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Tax write-offs: club dues to vandalism loss

If you return to the family homestead after summer vacation and find that some unruly kids—or more vicious types—have ransacked your house and caused damage, there's no question about picking up a tax deduction for any uninsured damage you uncover. The first $100 worth is nondeductible, of course. But the point is that pure vandalism loss is deductible, and you needn't show that costly items were stolen. Any kind of forced entry calls for a police report, and photos of items broken will nail down your case. . . . The non-claim: What happens when a man who is insured avoids making insurance claims for minor casualty losses because he fears "spoiling" his record and having his premium raised? Can he get by with taking tax deductions for such items? Most probably not, according to a Tax Court case (assuming his 1040 is examined). Note: If it's an auto accident case and gets even fleeting publicity, the insurer may pick up the news anyway.

Good records are the safest way to support any tax deduction. But lately, charitable donations have been getting softer treatment at the hands of the Tax Court. In a recent case, taxpayer claimed $890 for such items as church, Red Cross and United Fund but lacked proof. IRS gave taxpayer a hard time and disallowed the $890 but the court drew a generous line, at $625. Note that the Tax Court now has a highly simplified procedure, if the tax in dispute is under $1,000. . . . Club dues: If your country or city club dues are way up (as many are), you may want to do a greater percentage of business or professional entertaining at the club—and thus get past the 50%-business-use rule that produces dues deductions.

Cycling: the spoke and chain are "in"

The Complete Book of Bicycling is by Eugene A. Sloane, a freelance writer and geared-up cycling enthusiast. Bikes—which enable you to view fall foliage as you've never quite viewed it—have come a long way since the first wooden version of 150 years ago, and Sloane describes this miraculously efficient sports-health machine in myriad ways. He tells you what to look for in a bike, how to condition yourself to ride it, how to service it, and where to ride it. He touches cycling for health (with some very sensible rules), touring and camping, and safety. Also he lists bike clubs, and even outstanding shops. To be really in the groove, you need a 10-speeder. All about the new "in" sport in 342 pages (Trident, $9.95).

A wintertime junket to Hawaii is fine, especially if you go to an "outer" island—and make plans way ahead. An offbeat idea is to double up with friends and share the rental of a private house in the islands. They come in all sizes and on all beach fronts from Maui to Kauai (write to Properties International, 2201 Filbert St., San Francisco 94123). . . . *Rand McNally's Travel Guide for Servicemen* is a needed book, packed with practical detail; by Joseph K. Taussig III, Capt. USMC Res. (paperback $2.95). . . . The American Express hotel and car rental reservation phone number (800-AE 8-5000) will now connect you with a vastly expanded list of locations (over 3,000). Hotels reach from the Pierre in New York to London's Churchill to the excellent Okura in Tokyo; there's no charge, and if you've an Amexco card, reservations are confirmed. . . . The impressive new John F. Kennedy Center for the Performing Arts, on the Potomac in Washington, opening Sept. 8, offers a cascade of talent ranging from Leonard Bernstein to Diahann Carroll to dramatist Harold Pinter. First splurge of activity runs two weeks (write to the Center, 726 Jackson Place, N.W., Washington, D.C.).

Private label

In their *How to Eat Better for Less Money*, James Beard and Sam Aaron suggest that you mix a fifth of Smith's Glenlivet or Grant's Glenfiddich with six fifths of a low price blended Scotch. Since Glenlivet and Glenfiddich are all-malt, robust-flavored Scotches, you get a superior result at considerably less money. Idea is to refill the seven bottles and affix your private label.

International Newsletter

September 27, 1971

Siemens finds new radiation-hardening technique...

A new approach to radiation hardening that improves the radiation resistance of silicon transistors by factors of up to 100 has been developed at Siemens AG's Erlangen laboratories. The method, in which the semiconductors are subjected to high doses of electron bombardment and heat treatment at 200 to 250°C, differs markedly from conventional processes that replace silicon oxide and silicon nitride layers with other passivation layers. **Siemens notes that since its technique is applicable to off-the-shelf devices, costs of developing special transistors for space applications can be dramatically reduced.** Siemens researchers say the transistors are not degraded during the treatment, and that gain is the same after processing as before.

...but faces loss in RCA pullout

Siemens probably will be hit hard by RCA's abrupt withdrawal from the large mainframe computer business [see p. 25]. Siemens had been in a strong number-two position in the German computer industry behind IBM, and had been moving up steadily on the strength of its licensing agreements with RCA. **Though Siemens was making its own ICs and assembling its mainframes in house, it probably was dependent on RCA to some extent for new products and software development.** RCA chief Robert Sarnoff says there are no potential buyers for RCA's computer operations now. But it's possible that Siemens would be interested in getting hold of whatever new products and software would benefit it, as well as picking up some parts inventory at low prices.

The silver lining in this cloud is that Siemens actually could become top dog in the RCA relationship. With the world's largest analog and digital communications systems business outside the U.S., Siemens may become the source of some of RCA's data communications gear.

Toshiba shows point-of-sale gear...

Toshiba has gotten a head start on other Japanese companies by unveiling that nation's first retail point-of-sale unit. Sales are scheduled to start in March or April, closing about 100 to 200 per month. **The company says price will be less than $3,000, against about twice that for NCR's unit—the only other point-of-sale machine in Japan.**

The bar-coded pattern on the label slated for use with the Toshiba machine has an up-to-eight-digit item number and an up-to-six-digit price configuration. Since the label is printed only in black, price and size of the wand can be kept down. Toshiba says these features more than outweigh the disadvantage of having fewer digits than the more-expensive, three-color NCR label. A keyboard also is included to handle noncoded labels. **The Toshiba machine produces a record on cassette tape as well as a paper journal tape and receipt.**

...and develops improved material for liquid crystals

Meanwhile, Toshiba's R&D center has developed a new liquid crystal material that it says will operate over a wider temperature range than previous substances. **Three materials developed in the current project operated with extremely high stability over −17 to +51°C, −6 to +65°C, and +3 to +79°C.**

The new material also features low-voltage, low-power operation. **A requirement of 10 to 50 volts, and several hundred microwatts per**

square centimeter, make it useful for direct drive by ICs in calculators, electronic watches, and similar applications, the firm says. Contrast is 60 to 1, higher than for most other liquid crystal materials. Response time is 10 to 20 milliseconds, and life now exceeds 10,000 hours.

Sperry Rand plans German computer

Convinced of a big need for such equipment in West Germany, Sperry Rand GmbH has announced a medium-class computer tailored specifically to that country's market demands. **The computer, designated Univac 9380, ranges in performance between the company's models 9300 and 9400 and will rent for $7,000 to $17,000 a month depending on system configuration.** Its basic capacity of 64 kilobytes can be expanded to 128 kilobytes. Moreover, with external mass memories, data banks with a capacity of more than 2 million bytes can be built up. The 9380, built at Sperry Rand's Frankfurt plant, initially will be marketed in West Germany only. Deliveries start in spring.

British, French broaden activities in EDP market

Britain's Computer Technology Ltd. is crossing the English Channel this fall to invade Europe with its Modular 1 and Satellite 1 systems. **The firm opened a Paris office this month and will move into Brussels, Geneva, and a yet-undetermined city in West Germany within the next few months.**

Meanwhile, Engins Matra, the French aerospace firm, has created a new data processing division to market the multikeyboard systems of General Computer Systems and the optical reader devices of Scan-Data Corp. in Europe. **If Matra's plunge into data processing is successful, the firm plans to develop and sell its own equipment in Europe.**

German firms get slim pickings from Phantom buy

West German electronics sources now believe that country's avionics makers won't significantly participate in equipping the 175 Phantom F-4F planes the Bonn defense ministry recently ordered in the United States. **The major share of the $230 million earmarked for subcontracts with the domestic industry will go to Motoren- und Turbinen GmbH, a power plant manufacturer.** And with airframe makers likely to get most of the rest, little will be left for electronics producers. The only German avionics maker that can count on substantial Phantom business is Litton Technische Werke Freiburg (Litef), itself a member of the U.S. Litton group. Litef has been assured a $14 million contract for LN 12 inertial navigation systems for the 175 Phantoms. Costing roughly $80,000 each, they will be built at Freiburg under license to Litton in the U.S.; other avionics houses will get only service contracts.

The latest word from Eole: oops!

A good part of the Franco-American Eole meteorological satellite program went up in smoke when **an erroneous telecommand destroyed 72 of the high-flying balloons over Argentina.** The French ground control operator accidentally coded the destroy signal instead of the interrogation signal that would have triggered the Eole satellite to start pinpointing the location of the transponders carried in the drifting balloons [*Electronics,* International Newsletter, July 19]. By the time the sequential destruction mechanism was stopped, only 69 balloons remained aloft; another 231 now must be launched before the full scope of the experiment can be carried out. "At least now we know the destructor mechanism is functioning," observed a French space agency spokesman.

Digital ICs control German color TV receivers

TTL circuits plus varactors provide fully electronic station selection in sets introduced at Berlin show

For all their applications in industrial and commercial equipment, digital techniques have found little work in consumer electronic products. They have been limited to some higher-priced uhf radios for automatic station search and in remote control systems for model boats and airplanes.

Now, with several digital integrated circuits in its latest color TV sets, West Germany's Grundig Werke GmbH has thrown the home entertainment market wide open to digital techniques. Prospects are that other European set makers will follow suit and apply digital techniques even in lower-priced, black-and-white TV receivers.

The digital ICs Grundig is using, off-the-shelf transistor-transistor-logic circuits, are turning up in the company's Color 4050 and Color 3055 receivers. In these two models, the TTL devices are performing jobs that are perhaps as noteworthy as is the first entry of digital ICs into television sets. Together with varactor tuning diodes, they help provide fully electronic and automatic station selection without any moving parts involved in the process. In the Color 3055, stations are selected by merely touching a numbered plate on the receiver's front panel. In the other, selection is by remote control based on ultrasonic principles.

The two new Grundig receivers had their public debut at this month's radio exhibition in West Berlin. The firm already has geared production lines for mass fabrication of the new sets, with large-series runs just starting. First units should show up at German retailers next month at a price "not significantly higher than that for comparable color sets without the electronic program selection feature," according to the firm. TTL circuits eventually will be tapped for the same jobs in black-and-white sets.

Step by step. For automatic program selection, the new sets use a binary counter and a decoder/driver, which make a step-by-step switching device for switching between seven preselected programs. The counter is made up of a series of flip-flops whose binary content is converted by the decoder/driver into decimal values for program indication on the set.

If the receiver is tuned to program 1, the counter stores a binary number and a certain output transistor would be conducting. This puts a potential on cathode 1 of the cold-cathode indicator tube on the front panel, causing it to indicate program 1. At the same time, a pair of transistors in the tuning circuit conduct to apply a preset voltage to the varactor diodes and to the range-switching diodes in the tuner.

If, in program switching, a microphone-derived command signal is fed to the counter input, the counter will jump to the next-higher binary number, whereupon another output transistor in the decoder/driver is turned on. This causes program 2 to be indicated on the tube. At the same time another pair of transistors becomes conductive, applying a voltage that is preset to a value that is appropriate for program 2.

More logic. In the touch-controlled model, the TTL logic circuitry is slightly more extensive and constitutes what Grundig terms a program computer. In addition to the binary counter and the decoder/driver, this computer incorporates a NAND-gate circuit and a multiplexer. Program selection is by touching one of seven metalized and numbered plates on the receiver's front panel.

When one of the selection plates is touched, a hum voltage is produced from which a command signal is derived for the counter. The multiplexer circuit then compares this input signal with the counter's binary state. With the NAND-gate circuit, the counter's position is sampled at the 50-hertz line-frequency rate until a position is found which corresponds to the number of the selected program. At that instant, the signal feed to the counter automatically stops, and a lamp behind the appropriate selection plate lights up.

West Germany

Gunn-effect amplifiers yield gains up to 32 dB

By using gallium arsenide as the basic material and by exploiting the Gunn effect, researchers at West Germany's AEG-Telefunken have succeeded in making experimental

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two-port amplifiers yielding gains of up to 32 dB at frequencies between 400 megahertz and 4 gigahertz in pulsed operation.

Once perfected, such devices should find wide use as traveling-wave amplifiers, as input stages in high-frequency applications, and in phased-array antenna systems as output amplifiers. Furthermore, they could be used as the switching elements in a number of different logic circuits.

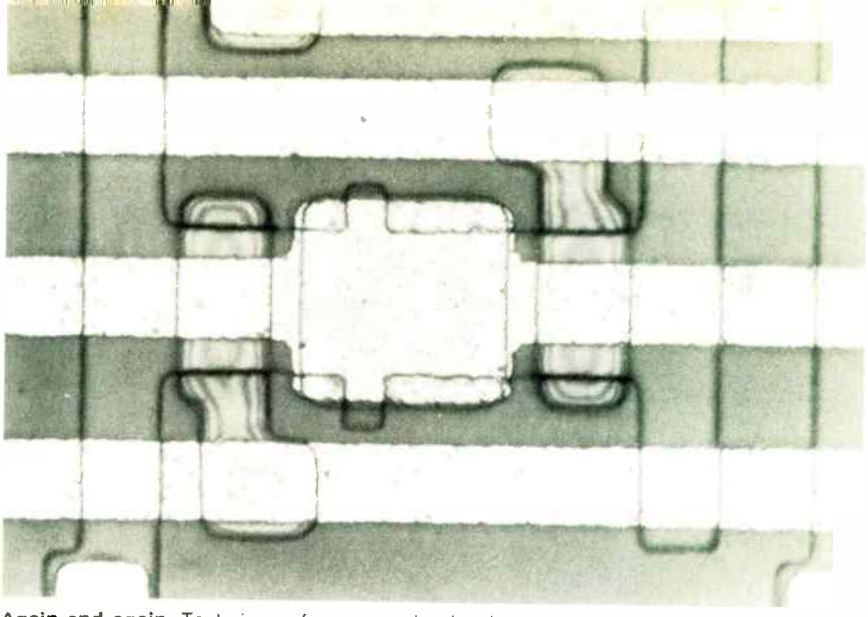
Similar work is being carried out by Japanese firms and by RCA and others in the United States. But the AEG-Telefunken people say that the performance characteristics of their device are the best obtained so far. In particular, constant high-gain values are obtained over the whole 400 MHz-to-4-GHz range without any appreciable falloff over that 10-to-1 range. In addition, output power levels of between 100 milliwatts (below 700 MHz) and 0.1 mW at 4 mW GHz have been obtained, the AEG-Telfunken men report.

The new device, being developed at the company's research institute in Ulm, exploits the negative differential electron mobility that occurs in gallium arsenide when such material is subjected to high electric-field strengths. This mobility causes the periodic variations in density of the electrons drifting through the element to increase in the direction of drift. In the opposite direction, the density variations are damped. Such variations, or space-charge waves, are kicked into excitation by the signal which is to be amplified and which is applied at the cathode by means of a suitable coupling electrode. Signal conversion from its electrostatic to electromagnetic form takes place at the anode.

Japan

MOS memories can be reprogramed electrically. . .

Japanese researchers have developed prototypes of MOS memories that are the closest yet to the goal of nonvolatile, electrically reprogramable MOS memories fabricated with present technology. This is one step ahead of the Famos memory [*Electronics*, May 10, p. 91], which can be electrically programed but which cannot be electrically erased. The need to remove a Famos memory from equipment before erasure by X rays seriously limits its utility.



Again and again. Technique of reprograming involves two gates in a two-layer structure. Device is turned on by charging the floating gate, and erased by pulsing overlay gate.

An Electrotechnical Laboratory team, composed of Yasuo Tarui, Yutaka Hayashi, and Kiyoko Nagai has worked out the theory for two types of devices, and has fabricated one of them. Both devices build on the Famos structure, but include physical effects not utilized by the developers of Famos.

The Famos memory device uses a p-channel MOS transistor with a floating gate in each memory cell. As fabricated, there is no charge on the gate and the transistor is off. A large negative voltage applied to the drain causes an avalanche breakdown between the drain and substrate, and hot electrons are injected into the oxide overlying the junction and accumulate on the gate. Electrons injected into the oxide layer are accelerated toward the gate because capacitive division of the applied voltage makes the gate positive with respect to the drain.

Although operation of the Famos memory is based exclusively on injection of hot electrons into the silicon dioxide layer, it is also possible to inject hot holes. This effect can be used to erase a memory or used for writing. However, it is harder to inject a hot hole into the oxide than it is to inject a hot electron and this must be taken into account when selecting channel polarity and device structure.

Avalanche injection is not the only method. Hot electrons can be injected into the oxide from the inversion region that forms the channel during normal operation. This mode of operation is achieved in n-channel MOS transistors with the gate biased positively to form a conductive channel between the source and drain, and the drain connected to a still-positive power supply.

In this mode of operation, the gate is biased positively with respect to the channel in the region between the source and the channel pinch-off point. Some of the electrons traveling through the channel become hot electrons in the constricted channel just before they reach the pinchoff point, and the field between the gate and the channel through the oxide layer accelerates these electrons toward the gate. The Japanese group operated commercially available n-channel transistors in this manner and confirmed that current flows through the oxide layer to the gate.

Thus it should be possible to fabricate an electrically reprogramable MOS memory by using an n-channel structure with two gates in a two-layer configuration. One gate would be a floating gate similar to that used in the Famos memory, and would extend from a point slightly overlapping the source to a point over the channel near the drain. The second gate would be over the first gate, be insulated from it, and extend from the edge of the floating

gate over the source to a point over the drain.

Normally the channel would be off. It can be turned on in a manner analagous to the original Famos—a positive voltage applied to the drain causes an avalanche breakdown, and holes from the base are injected into the gate. This charge can be erased by operating the transistor in the inversion mode—a positive voltage is applied to the uppermost gate, and hot electrons from the channel injected into the oxide discharge the floating gate.

The team has also designed and fabricated another type of reprogramable memory based on a p-channel MOS transistor with a p^+n^+ structure under the floating gate at the source. In this structure the floating gate extends to a point over the drain. A second gate overlies the floating gate. To turn the transistor on, the floating gate is charged by applying a high negative voltage to the drain and a zero voltage to the gate. Electrons accumulate on the floating gate.

The memory is erased by applying a high negative voltage to the source and at the same time applying a large negative voltage to the gate overlying the floating gate. The source-substrate field intensity is greatest on the side of the junction between the p^+ extension of the source and the n^+ diffusion. An avalanche breakdown occurs in the p region, and hot holes are injected into the oxide under the influence of the negative voltage on the second gate. Many of these holes travel to the floating gate where they cancel the accumulated electrons and erase the memory.

. . . and fabricated with simpler structure

A funny thing happened to a Japanese research group that started to develop a high-voltage MOS display driver. They ended up developing a basic technique for fabricating programable MOS memories, which can be reprogramed after being erased with X rays. Now this group at the Research and Development Center of Toshiba has been augmented with more people, and is hard at work developing the memory into a commercial product.

While working with the high-voltage transistors, the group discovered that, during avalanche breakdown at the drain junction, the avalanche voltage gradually drifts to higher values—a result that has also been reported by others. The group found that the increase in avalanche breakdown voltage is caused by charging of the gate oxide by carriers injected during the avalanche breakdown. For p-channel transistors, the carriers are electrons.

The charged gate oxide induces carriers of the opposite polarity on the semiconductor surface under the gate oxide. For a p-channel transistor with gate oxide charged with electrons, the carriers induced in the channel region immediately adjacent to the drain are holes, and that portion of the channel is effectively turned on. Further work has shown that the portion of the channel turned on has a length in the order of 1 micron. Thus if MOS transistors are fabricated with a channel length of 2 microns or less, and avalanche breakdown is induced at both the drain and source junctions, a normally off transistor can be changed to a normally on transistor—which constitutes electrical programing.

The exact mechanism by which the charge is trapped in the oxide is not known, but Toshiba researchers say the effect is both reproducible and stable. Extrapolation of the decay of charge storage at a holding temperature of 200° C shows that the time required for the charge to decay to half its initial value is in excess of 100 years.

The Toshiba memory can be erased by X radiation in the same manner as the Famos memory transistors. But work done at Toshiba indicates that a Famos-type memory can only be erased a limited number of times because of radiation damage. A positive bias applied to the gates of the memory transistors greatly reduces the amount of radiation needed and in effect eliminates radiation damage.

For applications where electrical reprograming is necessary, Toshiba men are working on a p-channel stacked gate MOS with one floating gate and a second overlying gate with a lead attached. Because this memory is programed by the charge on its floating gate, it is not necessary to use the narrow channel width required when the charge is trapped in the oxide.

This memory is programed by applying a negative voltage to both the source and drain to induce avalanche breakdown at both of these junctions. At the same time, a positive voltage is applied to the second gate to increase the injection of electrons into the oxide. Electrons that accumulate on the floating gate turn the transistor on.

To electrically erase, a negative voltage is again applied to the source and drain to induce avalanche breakdown. This time, a more negative voltage is applied to the second gate to increase the injection of holes into the oxide. Holes reaching the floating gate neutralize the electrons and erase the memory.

The Toshiba men, Yoshiyuki Takeishi, Hisashi Hara, Tai Sato, Kazunori Ouchi, and Hiroyuki Tango, will present a paper on these memories at the IEEE International Electron Devices Meeting next month in Washington.

Great Britain

Seeing infrared at room temperature with TGS

Most commercial infrared imagers use a point detector, usually indium antimonide, and scan both horizontal and vertical axes mechanically, using complicated arrangements of prisms and mirrors. In England, Rank Precision Industries Ltd. has improved the principle by using a vertical 10-element detector array so that a 120-line picture is obtained with only a dozen mechanical horizontal scans. However, Rank still uses indium antimonide, which has to be cooled to 77 K.

The new generation of imagers is

coming along and will deal at least partially with both snags. A leading sensor candidate is the pyroelectric detector, using such materials as triglycine sulphate. TGS could be used as target material in an infrared vidicon, as proposed by English Electric Valve Co. [*Electronics*, Electronics International, Nov. 9, 1970], or for a linear detector array as long as one picture axis, so that mechanical scanning is needed in only one direction. Work at Plessey Co.'s Caswell Labs on long TGS arrays integrated with signal processing circuitry was described in detail at last week's Infrared Techniques Conference, held at Reading University.

The Plessey team, led by Harold Blackburn, has built a TGS array of 128 elements, mounted on a glass substrate with MOS amplifiers and signal sampling circuitry. Each element will produce one horizontal line of a 128-line picture, coupled to a single horizontal scanning mirror providing an image the same height as the array and feeding all the elements simultaneously. Turning the simultaneous feed into a sequential vertical scan is the function of the sampling system, which in turn synchronizes with a mechanical chopper that is positioned in front of the array.

A picture is built up of 128 elements down one side of the screen, from top to bottom, followed by another 128 in each adjacent column. The development system uses 100 columns and a 2-second frame rate, giving 50 chops per second. But this would be speeded up in a production system.

Apart from its scan function, the chopper is essential with TGS, which gives an output only when its temperature is changing. It's necessary to alternately heat and cool the detectors. The signal is very small and TGS, a very high impedance material, must have an amplifier very close to each detector. The detectors are about 16 by 20 mils thick. The back face is covered with a single electrode and attached to the glass with a conducting resin. The individual electrode on the front face of each detector is thin-film nichrome, which is effectively transparent to infrared.

Each detector electrode is wire bonded to an MOS amplifier, which is no more than 10 mils wide and integrated in packs of eight. The TGS output signal feeds the gate of a small-area MOS amplifier coupled to a large-aspect-ratio MOS transistor acting as a load resistor. Normally such a high-impedance preamplifier requires a high-value resistor to set the bias point, but this is expensive and too large for integration. Instead, Blackburn has connected a feedback transistor between gate and drain of the amplifying transistor. The feedback transistor turns on very slightly whenever leakage in the detector and amplifying transistor tend to shift the bias point, and it passes sufficient current to counterbalance the leakage. He says this works quite well at the low signal levels involved. The preamplifier has an input capacitance of less than 1 picofarad, a voltage gain of 2.7, and an input resistance greater than 10^{11} ohms, reduced to 10^{9} ohms at the output by including a source follower stage.

On the same chip is the sampling circuitry. A 128-bit parallel output shift register samples each amplifier output in turn, producing a serial waveform. The samples are taken at peak heating and peak cooling, 128 hot peaks followed by 128 cold peaks. Each value is converted off the chip into a 10-bit word, to remove errors arising from inevitable variations in offset voltage and gain in the separate amplifiers. Essentially, this is done by basing the picture signals not on the absolute output of each amplifier but on the difference between the hot and cold states in each amplifier: hence differences between amplifiers become irrelevant.

The 10-bit word is spread over parallel stages of 10 128-bit shift registers. Thus a stored cold signal value is coming out of the far end of the registers at the same time as the following hot signal for the same detector is coming out of the a-d converter. It's a simple matter to take one from the other. Blackburn says that when offset variation over the 128 detectors is 1 volt, the digital technique will reduce the resulting error to the equivalent of 1 millivolt, for a 1,000-to-1 improvement in resolution.

Eastern Europe

Comecon plans joint efforts in computers, control

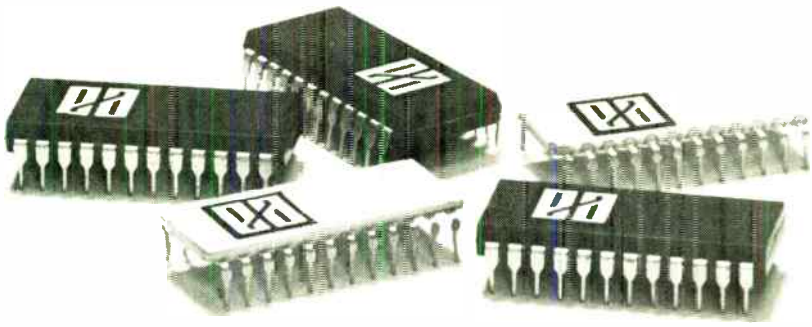
Member countries of Comecon, the Eastern European common market, are embarking on a program to "deepen and expand" their cooperation in computer technology and the development of program- and information-compatible control systems as well as other electronic systems.

Details of the program were not available. Reports from Soviet sources in Moscow said only that the object of the computer plan was development of "an automatic communications system for the transmission of all kinds of information." Specialization will apply to the manufacture of instruments, machine parts, and semiconductors.

In the new five year plan (1971-1975), member countries also plan to push "work to improve the apparatus in color television and to spread it in the countries of the community as well as to launch the large-scale production of color picture tubes." Moreover, the reports said, Comecon countries will develop an air traffic control system with emphasis on cooperating and specializing in the manufacture of the components of the system. During the next five years, there also will be an expansion in the area of measuring instruments.

The program is a long-range one, however, and Soviet sources admit it is designed for a "stage-by-stage realization over a period of 15 to 20 years." Western observers in Moscow see that as an admission that more intensified development is needed before a unified Comecon-wide production network will work in the field of electronics.

Western firms are being urged to participate, although details are not available on how to do so.



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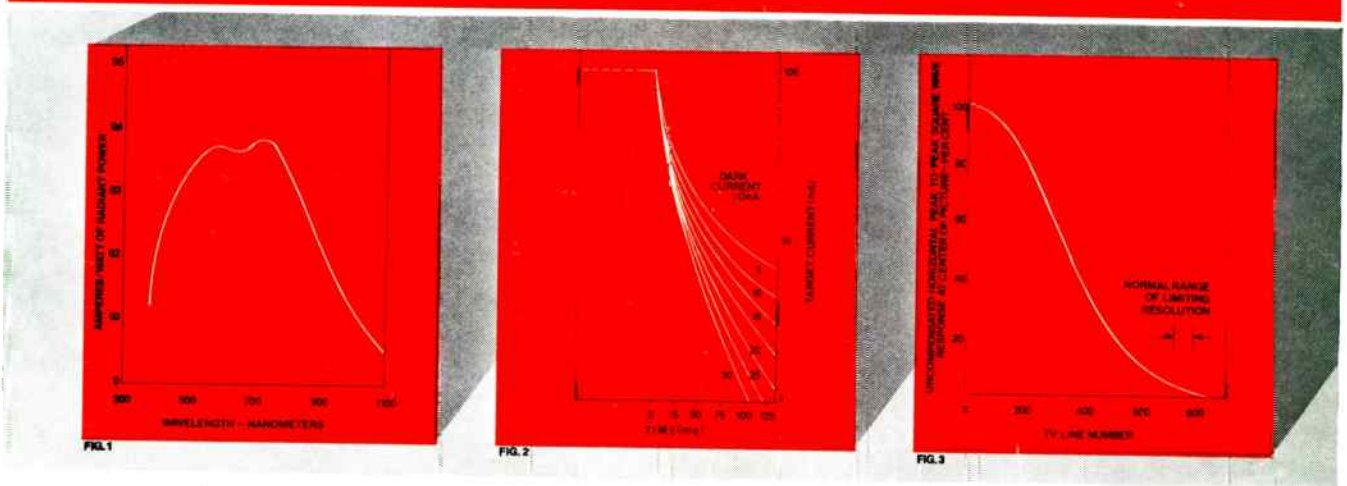

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