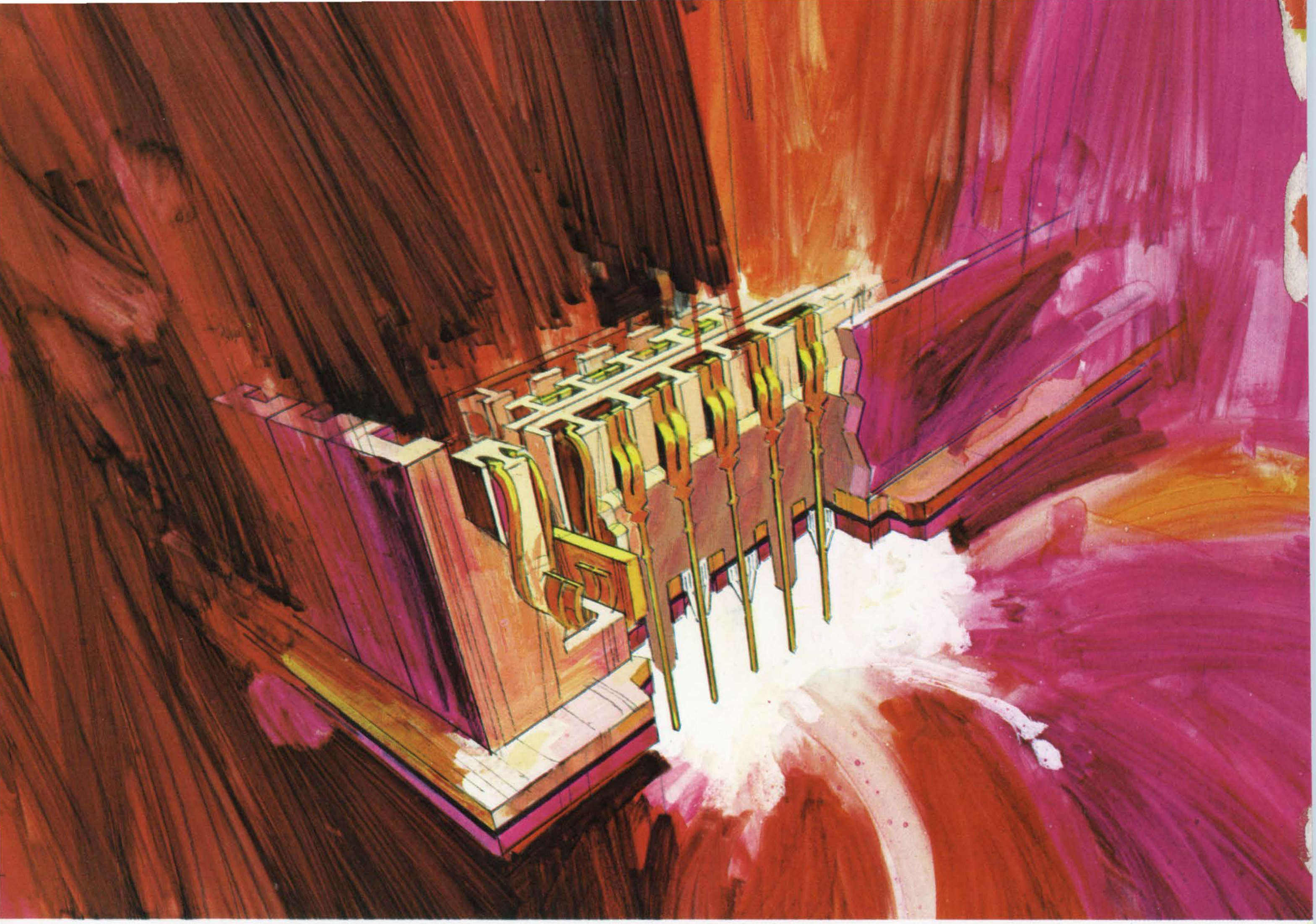
Electronic Design

VOL. 18 NO. 9

FOR ENGINEERS AND ENGINEERING MANAGERS

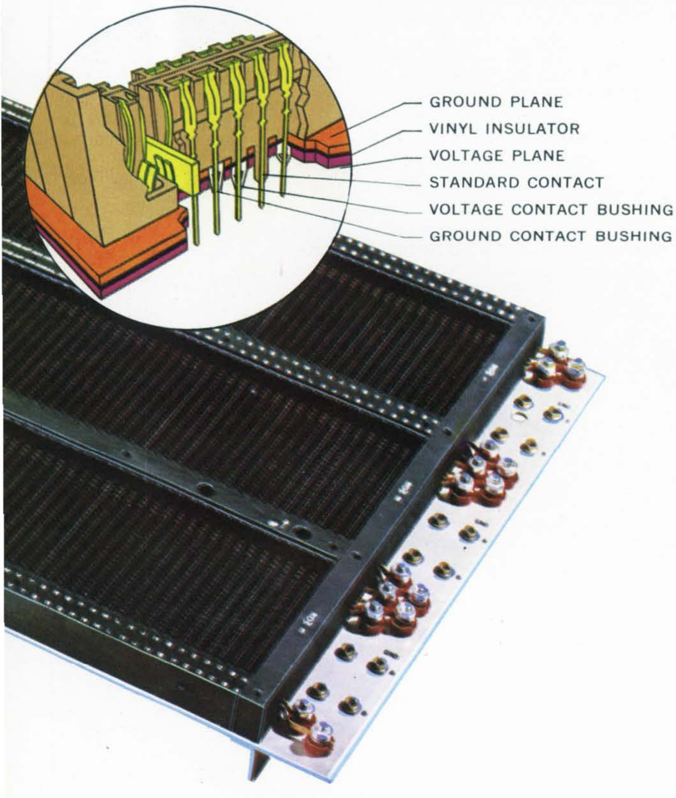
APRIL 26, 1970

Minicomputers: The new success story of the industry. Low cost, small size, rugged construction and adaptability are the reasons behind the sudden burst of new applications. Automatic test lines, laboratory data logging, hospital care and scientific computations are just a few. For details, see this report starting on page C6.



IMITATED—BUT NOT EQUALLED.

CINCH BACK PLANE CONNECTOR SYSTEM



Today, most back plane connector systems are being modified to include features first developed by Cinch. But only the Cinch back plane was designed to incorporate these innovations as basic design considerations, not modifications of already existing devices.

Cinch design leadership produced the *first* back plane connector system with these important features:

1. Replaceable buss bars that permit removal and replacement of bussing contacts.
2. Easily replaceable voltage plane and ground contacts, including bussing.
3. Precision monoblock insulators that eliminate modular construction.
4. Cantilevered, preloaded contacts.

Cinch didn't stop with the product. Special design molded styrofoam carriers completely eliminated damage during transit.

Combined with cost reducing techniques of selective gold plating, simultaneous insertion of contact rows and a unique method of terminal positioning, these features result in the most efficient and most economical back plane connectors system you can buy.

For information on this or other Cinch interconnection devices, contact your local Cinch Electronics Group office or write to Cinch Manufacturing Company, 1501 Morse Avenue, Elk Grove Village, Illinois 60007.

C-6914

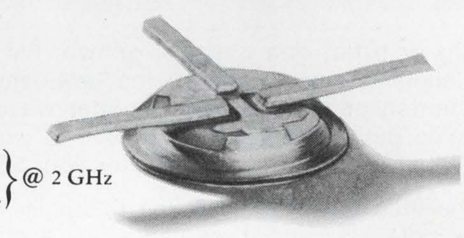
CINCH

INFORMATION RETRIEVAL NUMBER 242

CINCH DIVISIONS OF TRW INC., CINCH MANUFACTURING, CINCH-GRAPHIK, CINCH-MONADNOCK AND CINCH-NULINE

Microwave transistors, $49 and less.

They're as good as anything twice the price.



Typical 35803 B/E performance:
as oscillator: 100 mW @ 4 GHz
as amplifier: 50 mW output, 8 dB gain, 4.5 dB noise figure @ 2 GHz

For all you designers who've been paying $90 and up to $150 for *high quality* transistors, Hewlett-Packard has good news: volume microwave transistors at low prices. The prices are so low because we make more of these devices than anybody else in the world (we use them ourselves in the instrumentation we sell).

All transistors are 100% tested at microwave frequencies and HP process control assures high uniformity from device to device. With such consistent quality, you can design your circuits around their performance with confidence.

Typical 35806 B/E performance:
as oscillator: 40 mW @ 4 GHz
as amplifier: 50 mW output, 9.5 dB gain, 5.2 dB noise figure @ 2 GHz

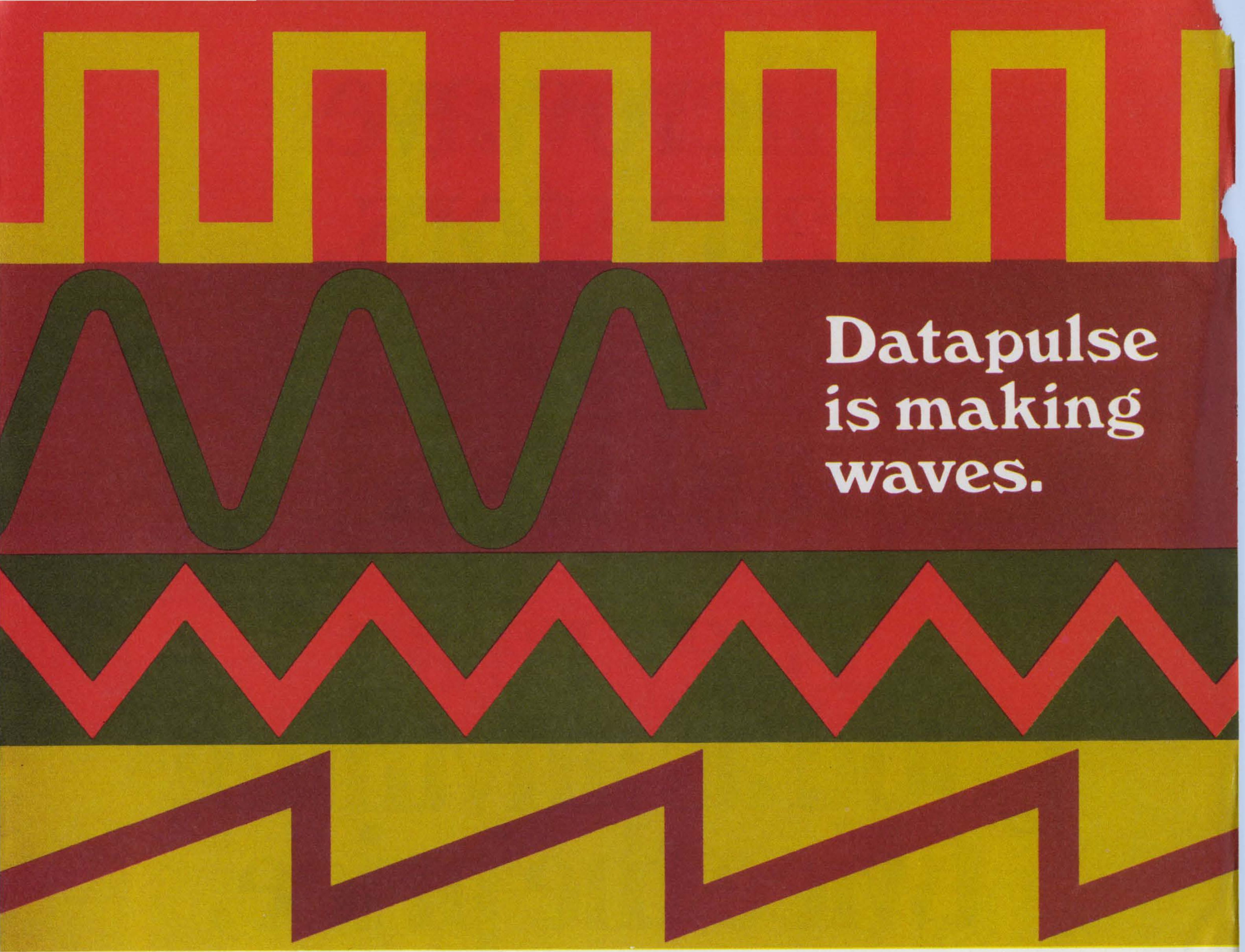
Evaluate HP's microwave transistors. In 1 to 99 quantities, they'll cost you $49 each for some types and just $45 for the others. Or if you want fully RF tested chips instead of packages, they're $15 each. Compare their performance to anything else you can buy. They're as good as anything twice the price.

Let your local HP field engineer fill you in on all the specs on all our microwave transistors. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

04009

INFORMATION RETRIEVAL NUMBER 2



Datapulse is making waves.

Big or little, one channel or two, FM or AM, square, triangular, sine or swept, the new family of Datapulse function generators makes better waves. What's more, we've put a couple of new ideas to work in the design so that you get more for your $$$.

The little beauty on top, the Datapulse Model 401, sells for only $395 and gives you a dial accuracy of one percent (that's about twice as good as the competition). Frequency is 0.02 Hz to 2 MHz, and sine distortion is only 0.25 percent in the audio range. Square-wave rise time is a fast 40 nanoseconds. To handle low levels, we give you 80 db dynamic amplitude range.

You can field calibrate the 401 with a screwdriver, and we give you a calibrated 1V p-p square wave out for scope work. A switchable 40 db attenuator and your choice of 50 or 600 ohms output impedence further simplifies your life. You get 1000:1 voltage control, too.

The other unit, the one with all the buttons, bells and whistles, is the elegant and sophisticated Model 410. It takes up where the 401 leaves off.

Frequency is 0.0002 Hz to 2 MHz. Dial accuracy is 1%. Uniquely among function generators, the 410 allows you to both AM and FM outputs for an extra dimension in wave generation. A built-in triggerable sweep generator gives complete flexibility using either or both of the independently controllable 40V p-p output channels to generate sine, square, triangle, sawtooth, and swept waves. Price is a modest $995.

To arrange a demonstration or obtain more data, contact your local S-D man. Or address Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, California 90230. Phone (213) 836-6100.

DATAPULSE
DIVISION

SYSTRON DONNER

VOL. 18 NO. 9

Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 26, 1970

NEWS

TECHNOLOGY

PRODUCTS

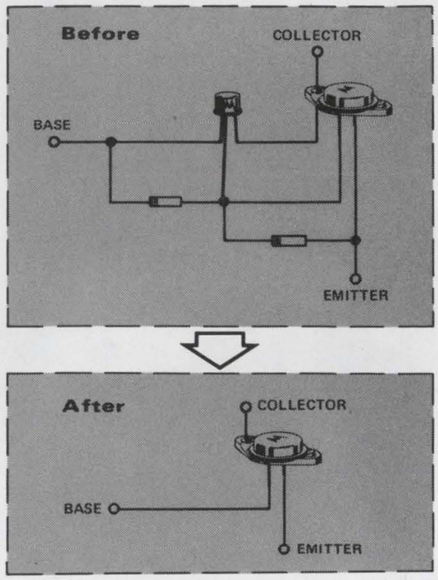
Departments

Cover photo: Courtesy of Data General Corp., Southboro, Mass.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York, N.Y. 10022. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N.Y. 81,801 copies this issue.

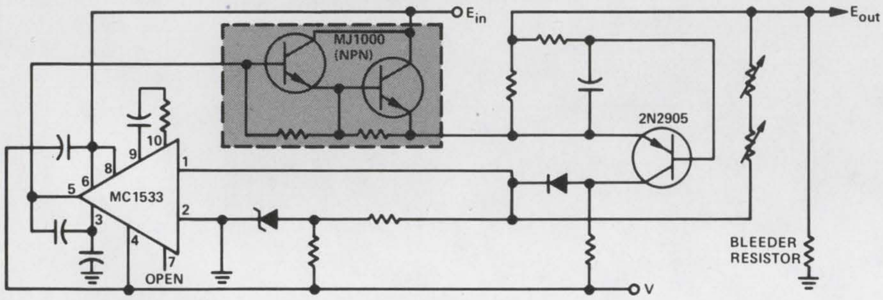
Compress Your Costs. Cut space and heat sinking needs, assembly time and components because the driver device is now on the same heat sink as the output unit. Reliability rises, too.

DARLINGTONS SIMPLIFY!



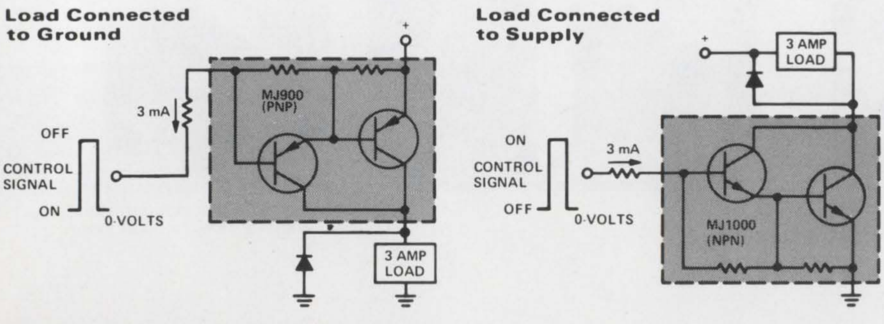
Up Op Amp Power. No separate, discrete driver transistor needed now — it's all there on one monolithic, EpiBase* power chip: driver transistor, output device and base-emitter resistors.

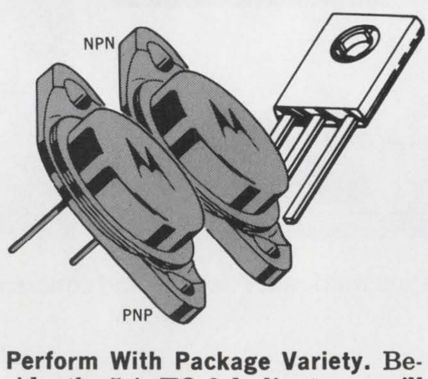
VOLTAGE REGULATOR



Power Darlingtons

DC STATIC SWITCHES





Put In Either Polarity. Positive or negative-based systems are possible with your choice of either PNP or NPN devices that can also be used as complements in audio amplifiers.

Perform With Package Variety. Besides the 5 A, TO-3 darlington, you'll soon have your choice of Thermopad plastic packages 77 and 90 — two sizes of case economy that will further reduce design costs.

—where the priceless ingredient is care!

All toroids look alike.

Our PULSE-RATED™ toroids really are alike.

We developed the concept of *pulse rated* toroids to eliminate tedious selection problems. Now we've developed new materials. Fully proven. Component tested. So you get guaranteed performance over a temperature range of 0° to 60° C.

Pulse-rated toroids not only simplify your selection process, they practically eliminate scrap. So you get 100% yield in your pulse transformer production.

Specifications provided for every *pulse-rated* toroid include pulse inductance, volt-microsecond product, and temperature behavior under pulse conditions.

Parylene-coated *pulse-rated* toroids in sizes and specifications to suit your design requirements are now available for off-the-shelf delivery. Want some? We welcome the opportunity to send you samples. And hot-off-the-press spec sheets. And to consult with you about your design problems. Write Indiana General, Electronic Products, Keasbey, N. J. 08832.

indiana general

a division of Electronic Memories & Magnetics Corporation

INFORMATION RETRIEVAL NUMBER 8

INFORMATION RETRIEVAL NUMBER 9 ►

INTRODUCING

The instrument that obsoletes systems.

Simple idea. But someone had to think of it first. We did. We took all the elements of a digital data acquisition system and designed them as plug-in modules. Then we put them all in a box—*one box.* Result: the system became a single instrument.

So what? Cimron's new 8000 Series Digital Data Acquisition System is the first major departure in design concept since the advent of analog-to-digital converters. This new instrument optimizes the digital system. It offers the greatest range of inputs, speed, and recording capability obtainable—*all at a price no system can match.* Cimron's measuring instruments will meet any accuracy and resolution requirement.

Modules in the single small 50-lb box include scanners, comparators, programmers, serializers, digital clock. No cables. No redundant components. Eliminates noisy ground loop problems. The housing contains a time shared readout, common power supply, and front panel controls. The DAS 8000 is easily expandable and computer compatible.

Cimron *customer concern* again brings you a new instrument for solving the most stringent and complex measurement problems at the lowest cost per channel. For details on the DAS 8000, write: Cimron, Dept. D-137, 1152 Morena, San Diego, California 92110.

CIMRON

LEAR SIEGLER, INC. / CIMRON DIVISION


Bodine helps copiers/duplicators stay sharp, quick, reliable
Small. Quiet. Run reliably in long, hard, heavy-duty usage. Bodine fractional horsepower drive systems meet the needs of copier-duplicator operations. Bodine designs and builds exceptional performance and service-life into every drive and control unit. For they have a reputation to live up to: *Yours!* This means fewer callbacks. Fewer field service problems. Power that meets the dependability standards you've engineered into your product.
Whatever your product—copier, duplicator, business machine, instrumentation—specify Bodine fhp drives and controls. Over 3,500 standard specifications to choose from. Bodine also builds custom fhp drives and controls to meet design requirements. Our engineers will gladly help pinpoint the right one for your application. Write for bulletin. Bodine Electric Company, 2500 W. Bradley Place, Chicago, Ill. 60618.
Bodine Motors Wear Out—It Just Takes Longer
BODINE
BODINE MOTORS/GEARMOTORS
SPEED CONTROLS

Designer's Calendar

MAY 1970

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

For further information on meetings, use Information Retrieval Card.

May 11-14
International Microwave Symposium (Newport Beach, Calif.) Sponsor: IEEE. R. H. DuHamel, Granger Assoc., 1601 California Ave., Palo Alto, Calif. 94304.

CIRCLE NO. 317

May 13-15
Electronic Components Conference (Washington, D. C.) Sponsors: IEEE, EIA. Darnall Burks, Sprague Electric Co., Marshall St., N. Adams, Mass. 01247.

CIRCLE NO. 318

May 18-20
Aerospace Electronics Conference (NAECON), (Dayton, Ohio) Sponsor: IEEE. IEEE Dayton Office, 124 E. Monument Ave., Dayton, Ohio 45402.

CIRCLE NO. 319

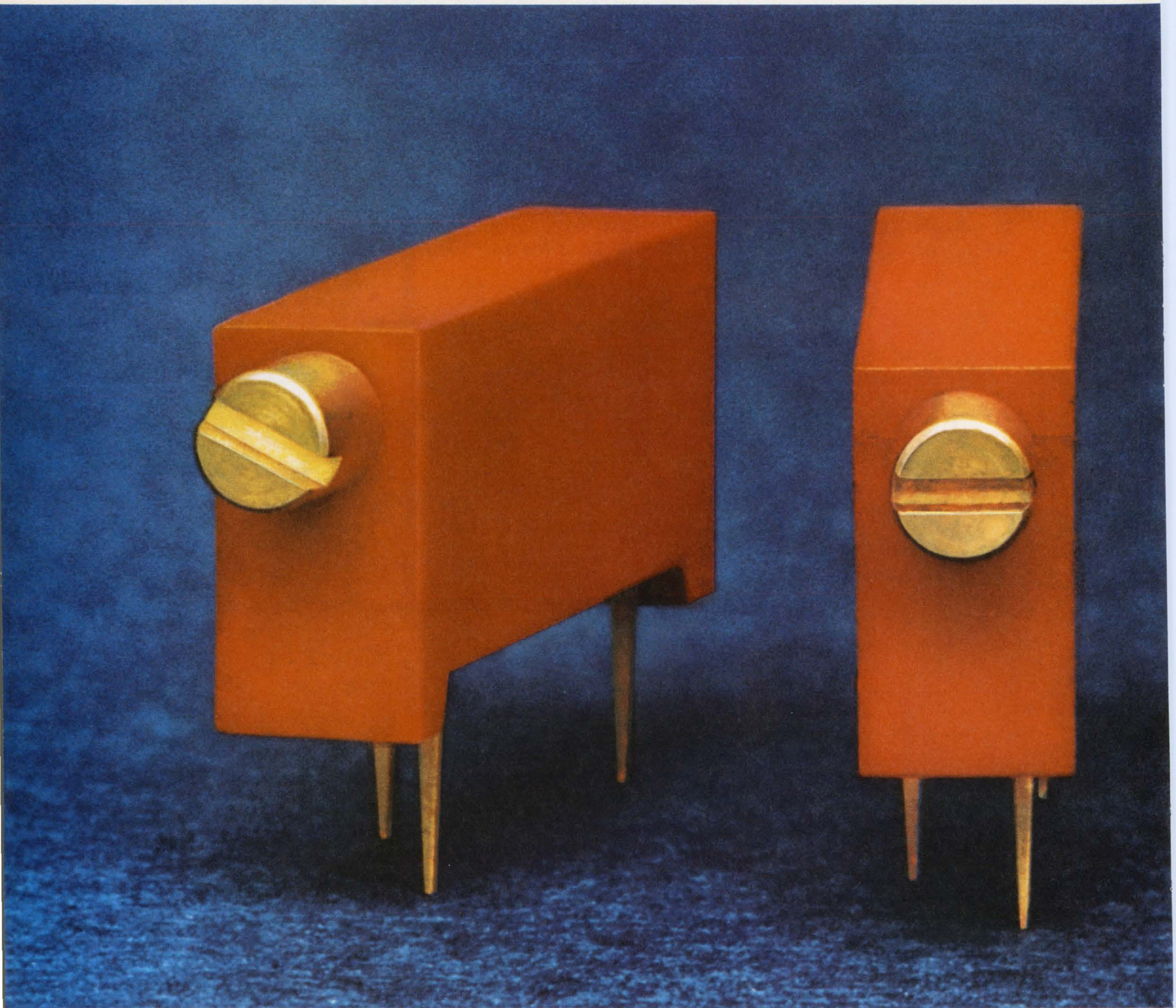
May 19-21
Power Sources Symposium (Atlantic City, N. J.) Sponsors: U. S. Army Electronics Command, et al. Power Sources Division, U. S. Army Electronics Command, Fort Monmouth, N. J. 07703.

CIRCLE NO. 320

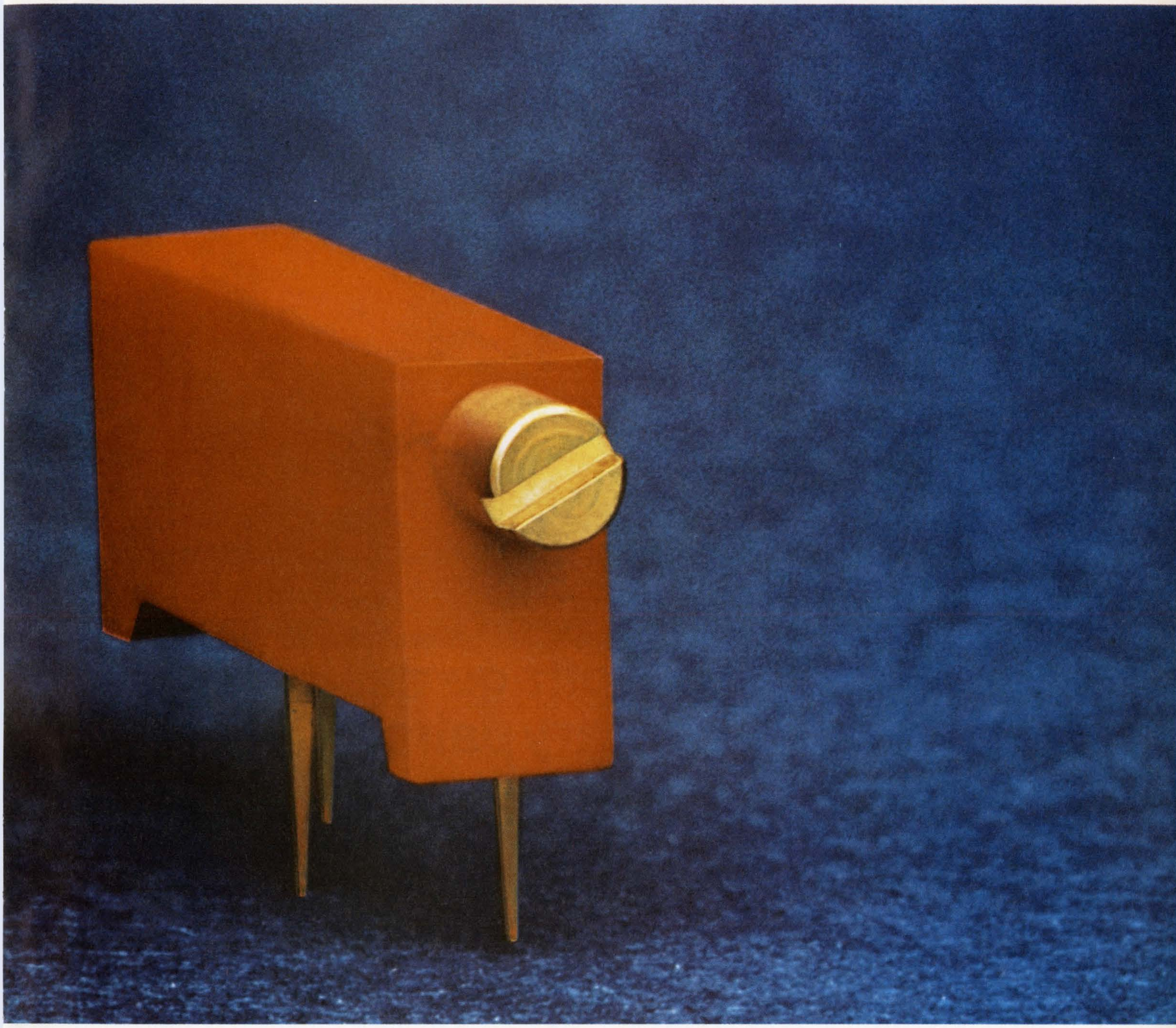
May 26-28
Society for Information Display Symposium (New York City) Sponsor: Society for Information Display. Bernard J. Lechner, RCA Laboratories, Princeton, N. J. 08540.

CIRCLE NO. 321

Film-Mets? Wirewounds? Or Cermets?



What our extra choice means to you.



Have symmetry reflected

in your high-voltage designs with complementary pairs from RCA

Here's news for designers who have been waiting for high-voltage complements. RCA announces the TA7410, a new high-voltage silicon power transistor which extends the capability of RCA's whole new generation of p-n-p/n-p-n devices.

Featuring high-breakdown voltages and fast-switching, the TA7410 will be one of the most important transistors in a wide range of commercial, industrial, and military circuits... especially those using complementary pairs.

With new advantages from complementary high-voltage pairs you can:

- ☐ Obtain low output impedance at both + and − terminals with symmetrical series regulators
- ☐ Eliminate the destructive effects of leakage inductance in push-pull inverters
- ☐ Design line-operated, complementary linear amplifiers
- ☐ Create new complementary high-voltage switching inverters.

TA7410 is a p-n-p complement of the well-accepted 2N3585. Its companion type, TA7719, is a complement to 2N3584. TA7410 features a V_{CEO} of −300 V while TA7719 has a V_{CEO} of −250 V. Both are realistically specified for minimum betas of 20 at 1 A, and feature rise and fall times of 0.6 μs maximum.

Let TA7410 and TA7719 complement your designs with their compact hermetically-sealed TO-66 packages. They represent the newest in a series of high-voltage complementary pairs that started with the 2N3440/2N5415—the industry's first such units (in hermetic TO-5 packages).

For more information, consult your local RCA Representative or your RCA Distributor. For technical data, write: RCA Electronic Components, Commercial Engineering, Section IG4-2/UT9, Harrison, N.J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA

INFORMATION RETRIEVAL NUMBER 13

INFORMATION RETRIEVAL NUMBER 247 ▶

THE WAVEMAKERS

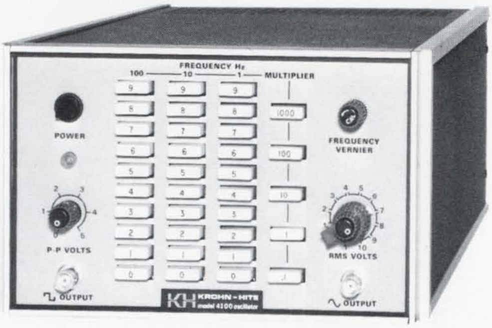
KROHN-HITE MODEL 4200, 10 Hz TO 10MHz, TEST OSCILLATOR

- **Frequency Range: 10 Hz to 10 Mhz**
- **Power Output: ½ watt**
- **Maximum Output: 10 volts rms**
- **Frequency Response: 0.025 db**
- **Harmonic Distortion: 0.1%**
- **Frequency Accuracy: 2%**
- **Internal Impedance: 50 ohms**
- **Auxiliary Output**
- **External Synchronization**
- **Amplitude Stability: 0.02%**

A low priced, solid state laboratory or production signal source featuring unusual flatness and ease of operation normally found in instruments selling at twice the price. The high power output signal of the Model 4200 delivers full voltage to the load over the entire frequency range. An infinite resolution dial and push-button multiplier provide rapid and continuous frequency tuning. In short, the Model 4200 is a broad range, versatile test oscillator destined to set new standards in performance and value.

KROHN-HITE MODEL 4100A, 0.01 Hz TO 1 MHz PUSH-BUTTON OSCILLATOR

- **Frequency Range: 0.01 Hz to 1 MHz**
- **Power Output: ½ watt**
- **Harmonic Distortion: 0.02%**
- **Frequency Accuracy: 0.5%**
- **Amplitude Stability: 0.002%**
- **Frequency Response: ±0.05 db**
- **Internal Impedance: 50 ohms**
- **Square Wave Risetime: 20 ns**
- **External Synchronization**



A medium priced, solid state, general purpose Oscillator that produces sine and square waves simultaneously from 0.01 Hz to 1 MHz with ½ watt of power into 50 ohms. Frequency calibration is within ±0.5% and push-button tuning permits ±0.1% frequency repeatability. 50 ohm internal impedance minimizes output voltage drop due to loading, specifically at higher frequencies where unavoidable capacitive loading limits the usefulness of higher impedance oscillators. The Model 4100A is an ideal laboratory and production instrument for a variety of applications where outstanding performance offers increased measurement speed and accuracy.

Yes, Krohn-Hite, the leader in variable filters, is fast becoming a leader in oscillators. Krohn-Hite has designed and manufactured a complete line of signal generating equipment to meet and, in many cases, exceed your project requirements. Each offers high performance features that you'd normally expect to cost a great deal more. Here's a brief rundown of the soon-to-be famous, never-to-be forgotten Krohn-Hite line. For further information on any of the instruments or complete details on our challenging Free Trial offer, simply fill in the attatched postpaid reply card. We guarantee an answer by return mail.

OSCILLATORS

Frequency Range	Osc. Model*	Freq. Acc. %	Power (mw)	Impedance (ohms)	VRMS (Open Circuit)	Quad. Output	Add'l. Wave-Forms	Freq. Resp. (db)	Dist. %	Approx. Ship. Wt. lbs/kgs	Price
0.001 Hz to 100 kHz	4024	0.5	125	200/600	10	Yes	⎍ ⊓	0.01	0.01	24/11	$1200
0.001 Hz to 100 kHz	4025	0.1	125	200/600	10	Yes	⎍ ⊓	0.01	0.01	24/11	$1950
0.01 Hz to 1 MHz	4100A	0.5	500	50	10		⎍	0.05	0.02	21/10	$ 550
0.1 Hz to 100 kHz	4000	0.5	125	200/600	10	Yes	⎍	0.01	0.01	18/9	$ 850
0.1 Hz to 100 kHz	4001	0.1	125	200/600	10	Yes	⎍	0.01	0.01	18/9	$1450
10 Hz to 10 MHz	4200	2	500	50	10		∼ (FIXED)	0.025	0.1	21/10	$ 350

*Add suffix "R" for rack mounting.

PROGRAMMABLE OSCILLATORS

Frequency Range	Osc. Model	Freq. Acc. %	Max. Volts	Output Impedance	Dist.	Square Wave	Prog. Amp.	Approx. Ship. Wt. lbs/kgs	Price
0.1 Hz to 100 kHz	4030R	0.5	10 RMS	200/600	0.01%	optional	optional	27/13	$1495
0.1 Hz to 100 kHz	4031R	0.1	10 RMS	200/600	0.01%	optional	optional	27/13	$2145
0.1 Hz to 1 MHz	4131R	0.1	10 RMS	50	0.02%	yes	no	30/15	$1375
0.1 Hz to 1 MHz	4141R	0.1	10 RMS	50	0.02%	yes	yes	30/15	$1585
1 Hz to 1 MHz	4130R	0.5	10 RMS	50	0.02%	yes	no	27/13	$1075
1 Hz to 1 MHz	4140R	0.5	10 RMS	50	0.02%	yes	yes	27/13	$1285

☐ Yes, I accept your challenge to try the fabulous Model 4200 Test Oscillator. Send me complete details at once.

☐ Send me complete specifications on Model(s): ____________________

☐ Send me a copy of the complete K-H Catalog.

☐ Wow! You've aroused my interest and I can't wait. Please have your representative call me for an appointment.

NAME ______________________________ TITLE ______________

COMPANY ____

DIVISION __________________________ PHONE ______________

STREET ____

CITY ______________________ STATE ____________ ZIP ________

Here's your chance to put Krohn-Hite, the Wavemakers, to work for you. Accept our challenge and you'll never settle for less. Just fill in the attached post-paid card and we'll see that you get all the details on the Krohn-Hite Free Trial Offer by return mail. Then, you too can be a wavemaker.

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Printed in U.S.A.

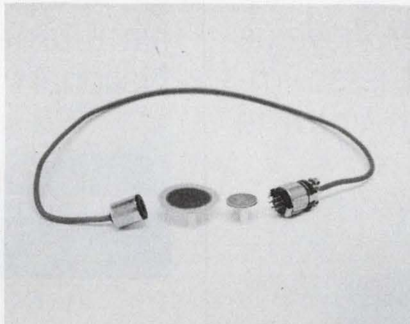
Highlighting
THE ISSUE

"The minicomputer industry is the fastest-growing segment of the fastest-growing business in the world."

This statement by the director of marketing of a minicomputer manufacturer—Allen Z. Kluchman of Data General Corp., Southboro, Mass.—sums up the impact of an idea that has been kicked around in the computer industry for six or seven years but only began to bear fruit two years ago.

The minicomputer's name comes from its small size, but its most significant feature is its relatively low cost. And the list of its applications is endless.

PAGE C6



A new incremental optical encoder with a remote reflective disc controls speed digitally without adding mass. It eliminates the need for shaft couplings and extra bearings.

The device consists of two separate parts: a thin reflective plastic count track disc and a small electro-optical pickup head. The user simply cements the disc on the rotating surface to be monitored.

PAGE 97

Not many people in the country have heard of Item 807 of the United States Tariff Code. But by summer it may be as common in the language as "Taft-Hartley" or "ABM."

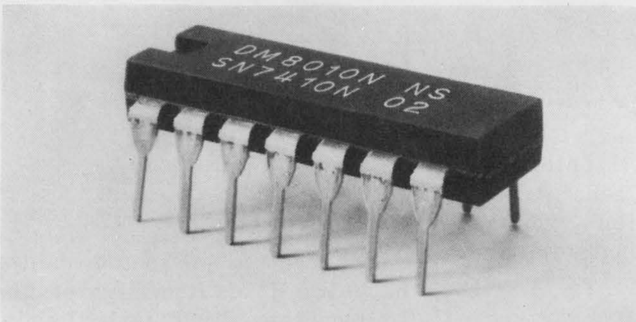
The Tariff Commission will open hearings in May at its Washington headquarters, and the inherent fireworks in these sessions will likely get them national attention. Labor wants the tariff item repealed; industry insists that it be retained.

What is Item 807? And why has it stirred such a fuss? Full details are contained in the story on

PAGE 24

Why National Semiconductor buys Teradyne J259's by the dozen

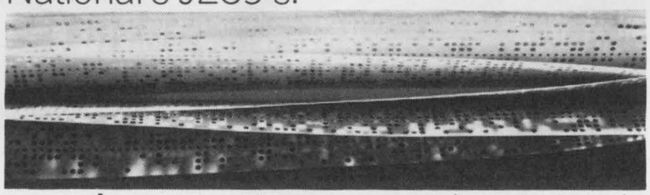
National Semiconductor can trace its considerable success as an IC manufacturer to many factors. One of the most important is the productivity of its testing facility, built around a lineup of 12 Teradyne J259 computer-operated test systems. "The Teradyne systems," according to Jeff Kalb, National's TTL product manager, "give us the economy of testing that is so important to profitable high-volume production."



National, along with most other major IC producers, has found that the J259 boosts productivity in many ways. No other test system, for example, gives its user as much multiplexing freedom as does the J259, which lets National leverage its investment by making each J259 support several test stations doing several different jobs.

Reliability is another all-important key to productivity. National experiences minimal downtime with its J259's. This is as it should be; we design and build our equipment to work shift after shift, year after year, in *industrial* use. Teradyne systems are right at home on production lines like National's, where the workload is heavy and continuous. And operation never has to be interrupted for calibration; the J259 has no calibration adjustments.

The J259's great versatility is also put to good use at National. The same systems that test wafers and packages also generate the distribution and end-of-life data that engineers need to control production processes and ensure high device reliability. Production, engineering, QC, and final test – all share simultaneously in the benefits from National's J259's.



A computer-operated system is only as good as its software, which in the case of the J259 is the best there is. National's J259's are orchestrated by Teradyne-supplied master operating programs for datalogging, classification, and evaluation. As Teradyne updates and improves its software, National is kept fully informed.

National's array of J259's handle the testing of its digital IC's smoothly and economically. For its linear-IC testing, National has turned to Teradyne's J263 computer-operated linear-IC test system.

Teradyne's J259 makes sense to National Semiconductor. If you're in the business of testing circuits – integrated or otherwise – it makes sense to find out more about the J259. Just use reader service card or write to Teradyne, 183 Essex St., Boston, Mass.

Teradyne makes sense.

News Scope

U.S. technology stars at 20-nation Paris show

Paris

The biggest electronics show in the world—the Salon des Composants Electroniques, held in Paris, April 3 to 8—drew 784 companies from 20 countries, but it was American technology that dominated.

This was particularly apparent in the field of advanced semiconductors. Several European companies, however, have developed linear ICs, MOS memories and high-speed thyristors that look remarkably like their counterparts developed by General Electric, Texas Instruments and RCA.

The Soviet Union, Hungary and East Germany were on hand, and their presence stirred animated speculation about a huge potential electronics market and supplier: Eastern Europe. The problem here is trade restrictions. One French executive for an American company put it this way: "Eastern Europe is like a beautiful woman who wants to get married, but one must first obtain a medical certificate to talk with her."

The Russian exhibits, which overshadowed those brought by Hungary and East Germany, included 40 types of ICs, some with 1340 MOS devices on a chip; DTL and RTL devices; FETs, linear ICs, hybrid LSI circuits, gallium arsenide light-emitting diodes and a rack full of passive components that the exhibitor described as "the best in the world."

Representatives of American companies at the show said that business is booming. Motorola reported it had grown 80% last year and looked for growth of 100% this year. Fairchild, Texas Instruments, RCA and General Instruments are also firmly established on the Continent.

The European giants at the show were Philips and Siemens. A number of European concerns have added new lines of ICs, particularly for industrial and consumer markets. Among these are RTC and Sescosem in Paris and Ates Componenti Elettronici in Milan.

Missing at this year's exhibition was the wide range of instrumentation equipment that had been displayed in the past. Components and materials were spread over 65,000 square feet of the Hall Monumental of the Parc des Expositions, while instruments occupied hardly a tenth of that area. The reason given for the cutback in instrument displays was competition from other electronics shows: the Hanover Fair at the end of this month, the Mesacura Show in Paris late in May and the Electronica Show in Munich in November.

JOHN N. KESSLER

Israelis double electronics output

The electronics industry in Israel is growing at a phenomenal rate. In 1969 the output doubled over that of the previous two years, hitting $71.4-million. And this did not include the output of enterprises belonging to the entertainment sector, such as television sets and radio receivers. Nor did it include those plants that belong directly to the defense establishment.

Israeli electronic products include radio transmitters for both civilian and military application, radar, control systems, electro-optical equipment, medical electronics, cables and wires, burglar and fire-alarm systems, computers and components.

Recently announced was production of microcircuits on silicon wafers by the engineering department of the Technion, Israel's technical university.

A further boost to Israeli industry may come if the European Common Market gives Israel a 45 per cent preferential customs treatment that she is now requesting. Israel feels entitled to this because she is "such a good Common Market customer," a Government official explained.

Among the foreign concerns that have invested in the Israeli electronics industry in the last few years are Motorola, Monsanto, Zenith, American Electronics Laboratories, J. F. D. Electronics, General Telephone & Electronics, and the Vishay Corp.

$71-million in computers ordered by Government

NASA and the Dept. of Defense have announced plans to spend upward of $71-million for new computers.

NASA intends to spend $63-million during the next fiscal year for data-processing equipment. Both large and small-scale machines are included, with the small machines to be used for real-time data acquisition in the testing of systems.

The Defense Dept. is buying over $8-million in computer equipment from Honeywell. It is to be used in a digital communications system for the Defense Contract Administration.

Computers to sort mail at 210 post offices

Now that the American public has learned to address letters with ZIP codes—75% of the letters that enter U. S. post offices now bear them—the Post Office Department is going to install 210 computers and sorting machines in post offices in 136 cities.

Built by General American Transportation Corp., Niles, Ill., the 210 computers will cost $11.4-million.

The system will enable a postal operator to sort mail merely by glancing at the zip code on a letter as it flashes by and pressing a ZIP-coded keyboard. The keyboard will feed the information to a computer, which will tell a 15-ton sort-

News Scope CONTINUED

ing machine which of 277 destination bins the letter goes to. Twelve operators will be able to sort up to 36,000 letters an hour at an estimated savings of $13.5-million a year in labor.

Study finds Omega flaws, but Navy isn't worried

A number of major design problems need to be solved before the Navy's Omega navigation system is ready for transoceanic use by civil airlines. This is the conclusion reached in a study made for the Federal Aviation Administration by the Radio Science Laboratory of Willow Run Laboratories.

The Willow Run Center, a unit of the University of Michigan's Institute of Science and Technology completed the study last fall, but the findings were released only recently.

Omega is a very-low-frequency navigation system that, with only eight ground stations, is designed to provide position information to Omega receivers anywhere in the world—in aircraft, ships or submarines. Civilian as well as military vehicles can use the system. Omega is a step beyond Loran-C because of its greater range, fewer number of ground stations and ability to be received in submarines.

The Navy, which began development of the worldwide network in 1958, doesn't share the apprehension expressed in the report. It says the design problems are all being solved.

"It's hard, of course, to demonstrate what the complete eight-station system will do, with only four stations in operation," Omega's project manager, Capt. James Burke, told ELECTRONIC DESIGN. "But, all in all, the system is working well."

The last station in the network is scheduled to be completed, at the latest, by early 1973.

A major problem, according to the Willow Run report, is position ambiguity. The receiver may show an aircraft's exact position in relation to two position lanes—but without making it clear which two lanes in the vast grid system are being displayed.

Other problems include: lack of a fully automatic receiver to perform the complete coordinate transformation and lane-resolution functions, and the possibility of losing tracking capability during periods of precipitation static—noise made by the impact of small particles, particularly ice crystals, upon the surfaces of aircraft.

The Navy says the ambiguity problem has been partly cleared up by a receiver built by Northrup; it uses three frequencies instead of only one.

And the problem of precipitation static, the FAA says, may have been solved by abandoning an E-field antenna for a ferrite loop type developed by the Pickard and Burns Div. of Continental Electronics Manufacturing Co. in Dallas.

Electron beam transfers color video tape to film

Color images from video tape can now be transferred directly to film without going through tedious, expensive procedures, the 3M Co., St. Paul, Minn., announced at the National Association of Broadcasters Convention in Chicago on April 5.

Development of the new system, which 3M calls Chromabeam, means that high-quality video tape can now be mass-produced at low cost.

The technique dispenses with the kinescope, which requires color film; it uses, instead, less expensive slow-speed, fine-grain black-and-white film to produce three color separation negatives. The film, which is commercial grade, is exposed by electron beam.

Color registration is assured inherently because all images are recorded by the same beam on the same film. The film exposed to the beam is processed into a separation master. The final color print on color film is obtained from the master by using color filters and the color separation negatives.

Low-cost tape copying developed in Japan

A new method for duplicating video, as well as audio, tapes at high speed and low cost has been developed by Matsushita Electric Corp. of Kadoma, Japan. The company's two-inch video-tape printer eliminates the usual head-to-head method of tape duplication. It works with either color or black-and-white tape.

A conventional tape and a special master tape, their magnetic surfaces facing each other, are tightly wound together onto a single reel. A transfer electric field is applied to the reel for a few minutes. The tapes are then unwound onto their respective reels.

Matsushita reports this method provides excellent duplicate tapes without harm to the quality of the master tape, even after thousands of applications.

Besides its use as a video tape printer, the new unit can also duplicate audio and computer tapes, as well as the popular 1/4-inch cassette tapes.

2 new minicomputers to be shown at SJCC

At least two manufacturers of minicomputers have developed new models and plan to put them on public display for the first time at the Spring Joint Computer Conference in Atlantic City, N. J., May 5-7.

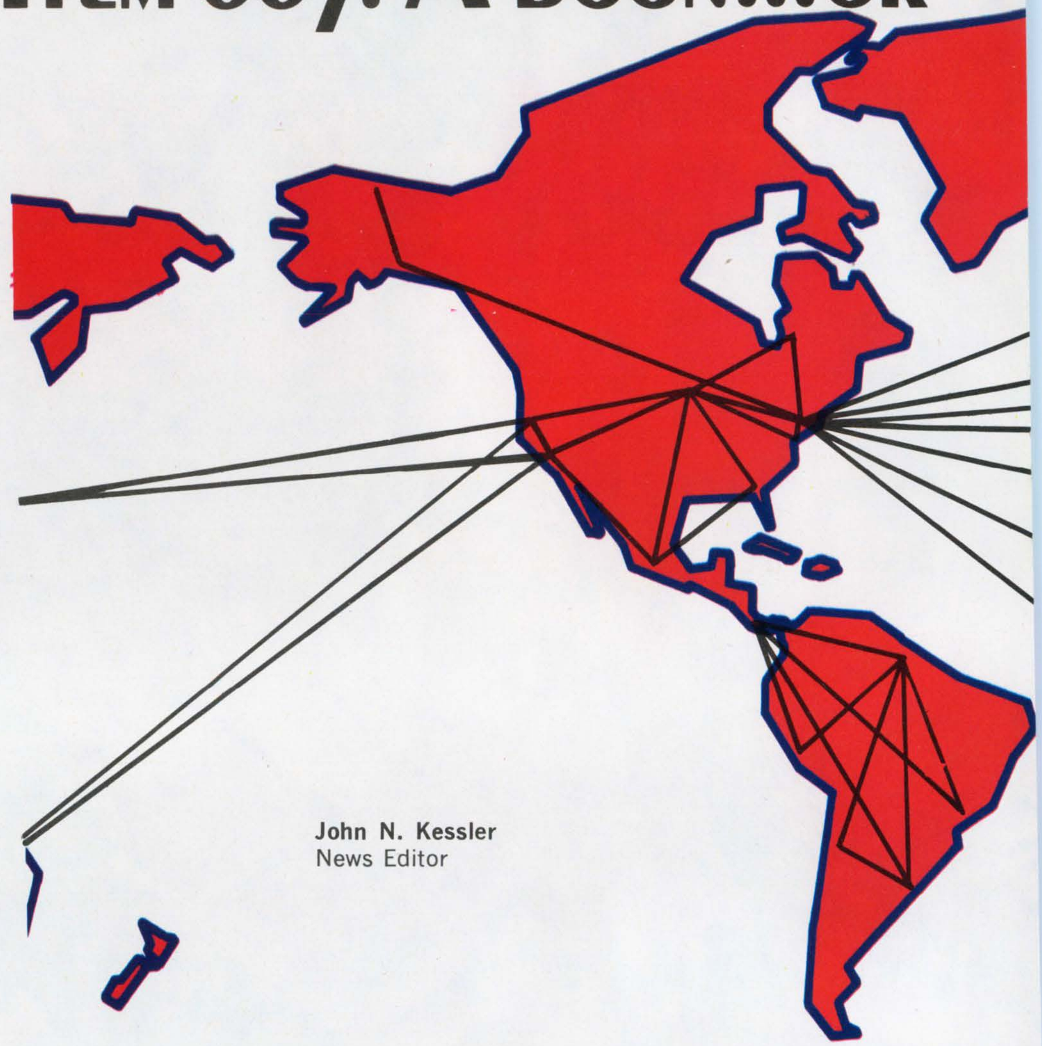
The two companies are Varian Data Machines, Irvine, Calif., and General Automation, Orange, Calif.

Varian's entry is the 620/f, a high-speed version of the company's line of 620 minicomputers. The 620/f has a cycle time of 750 ns, which qualifies it as one of the fastest minis. A typical speed today is 1000 ns.

The new General Automation model is the SPC-16, the company's first 16-bit-word minicomputer. With a cycle time of 960 ns, it joins the established 8-bit SPC-12.

This activity among minicomputer manufacturers is indicative of the current status of the computer industry. Sales of small machines are good; those of the larger ones are lagging.

Item 807: A boon...or



John N. Kessler
News Editor

Not many people in the country have heard of Item 807 of the United States Tariff Code. But by summer "Item 807" may be as common in the language as "747 jumbo jet," "Taft-Hartley" or "ABM."

Item 807 is being extolled by major electronics companies as a boon to the industry and the national economy.

Item 807 is being denounced by organized labor as a threat to job security and a drain on the U.S. balance of payments.

The United States Tariff Commission, at the request of President Nixon, will open hearings May 5 at its headquarters in Washington on the merits and drawbacks of Item 807, and the inherent fireworks in these sessions will likely get them national attention. Labor wants the tariff item repealed; industry insists that it be retained. The President has called for recommendations by the Tariff Commission no later than Aug. 31.

An exemption in duty

What is Item 807 of the Tariff Code? And why has it stirred such a fuss?

Simply put, the Tariff Code item provides that when U. S. components are sent to a foreign country and assembled there by any company into a product, the product may be imported into the United States exempt from duty. Duty is paid only on the "value added" by foreign labor.

Both complete products—such as television sets—and parts of complete products—circuits, say—come under Item 807. Anything for which an assembly operation takes place can be imported under the tariff item. The only requirement is that the import contain American goods.

It need not even be 100% American goods in the import. A company abroad may, for example, build a television set or a circuit with 55% foreign goods and 45% American; it receives an 807 tariff break on the 45% of the import that is American-made.

Under Item 807, American electronics companies have sent components to assembly plants abroad, where labor is cheaper. They have had radios, television sets and other consumer products assembled there and have imported and sold the finished products in this country at considerable savings in labor.

Under Item 807, American semiconductor companies and other makers of electronic parts, have moved a portion of their operations overseas. By using part foreign goods and part American, they have assembled their circuits and other components, imported them into the United States and received an 807 tariff break.

Last year, the Tariff Commission reports, the average television set imported under Item 807 consisted of 60% foreign parts and 40% American. If that trend holds, the importer of such a set valued at $200 will pay this year a tariff of only $8.40, as opposed to $14 for a comparable 100% foreign-made set—a neat saving if the company imports 100,000 units of only the one finished product. A concern importing several such products and parts under Item 807 could save upward of a million dollars.

Besides such obvious gains for business, what other benefits does 807 yield? Supporters of the tariff item, including the Electronic Industries Association, cite these broad advantages:

- It helps stimulate the export of American components to foreign assembly plants.
- It's good for world trade and enables American companies to compete more successfully with cheaper foreign products.
- It protects American jobs in the long run, by encouraging U.S. companies to buy at least part of their components in this country. If 807 were repealed, the argument runs, U.S. companies might be tempted to buy all of their parts overseas.

But the AFL-CIO sees Item 807 this way:

bust for electronics?

■ Technological knowledge, production and jobs are being exported overseas, and American labor is being hurt as a result.

■ The item encourages the import of foreign goods, and thus is a negative factor in the balance-of-payments ledger.

■ It forces the American electronics industry to become increasingly dependent on Government contracts and subsidies to survive in this country, and the Government is engaged in cutting back on this commitment at present.

In 1968—the last year for which complete figures are available—the total value of goods imported into the United States under Item 807 amounted to about $1.4-billion, according to the Tariff Commission. Of this total, the value of consumer electronics, components, ferrite-core memories and other electrical equipment was $269-million. This did not include scientific and technical instruments, such as oscilloscopes and voltmeters, which amounted to another $13-million.

Of the $268-million in electronics $109-million represented U.S. components shipped out of the country and assembled overseas. Importers paid duty on the balance —$159-million, which covered components purchased overseas and the labor costs of assembling the product.

Battle lines are drawn

Industry's view at the May 5 hearings on the controversial tariff item will be spearheaded by the special counsel to the EIA, Alfred R. McCauley of Graubard, Moskovitz & McCauley, Washington, D.C., and by Prof. Robert B. Stobaugh of the Harvard Business School. Nathaniel Goldfinger, director of the research department of the AFL-CIO, will probably lead the presentation of labor's position.

McCauley denies that U. S. workers are losing jobs heavily as a result of Item 807.

"Employment," he told ELECTRONIC DESIGN, "is up each year in the electronics industry." And he cites EIA figures, based on U. S. Dept. of Labor statistics, as follows.

Year	Workers in Electronics
1966	1,080,000
1967	1,084,000
1968	1,110,000
1969 (Sept.)	1,147,000

Moreover there is no great rush by American companies to use cheap labor in underdeveloped countries, McCauley says. He states that of the $1.4-billion in total goods shipped into the U. S. under Item 807 in 1968, $1.1-billion came from labor in developed areas, such as Canada and Europe.

The consequences of repealing 807 "would be bad for the United States, bad for foreign trade, bad even for U.S. labor," McCauley contends.

Goldfinger has a different view of the statistics. In a statement on U. S. trade policy before the Joint Economic Committee of the AFL-CIO, Goldfinger said on March 18:

"Offset by defense contracts, over-all U. S. employment in the [electronics] industry thus far has tended to show improvement, but in consumer electronic products, TV sets, radios, etc., the trend has been to substitute foreign production for U.S. production at the expense of U. S. jobs."

Goldfinger asserts that thousands of workers in electronics are confronted by "import-related job losses and production cutbacks as defense contracts decline."

McCauley says, however, that if 807 is repealed, U. S. companies would purchase even more of their parts from foreign sources because there would no longer be any tariff incentive to use American components. "The purchase of components, from overseas companies," he adds, "would displace American labor who now make such components."

ELECTRONIC DESIGN has obtained a list showing 31 foreign electronic companies doing business on Taiwan as of June, 1968. Nearly all of the firms are American, and the total employment for 22 of these concerns comes to 12,014; there are no figures for the nine other companies.

According to the April 10, 1969

Item 807, *(continued)*

issue of *IUE News,* a publication of the International Union of Electrical, Radio and Machine Workers:

"A study of wage rates showed that 70% of the Taiwanese electrical workers make less than 10 cents per hour. Including fringe benefits, the average wage paid by and American employer was found to be 11 to 15 cents. The minimum work week is 48 hours."

Another list dated 1968 shows there are about 35 U. S. electronic plants in Mexico, employing 2,717 workers at about $2.50 a day.

Abe Morgenstern, research director for the IUE, has told this magazine that he is less concerned about present shipments of goods under 807 than about future trends.

Electronics exports from Taiwan, he says, will shoot from $60-million in 1968 to $500-million in 1972. About 650,000 black and white TV sets were exported from Taiwan to the U. S. in 1969—an increase of 80% over the year before, according to Morgenstern.

"General Instrument," he says "is making 75,000 tuners a week in Taiwan, but they just closed their plants in the U.S. and laid off 3000 to 4000 workers." And, he says, "the same is true with Zenith, Admiral and others."

In the January 17, 1969 issue of *IUE News,* the union states: "The effect of imports on IUE's members was pointed up dramatically when Westinghouse laid off 600 employees at its Metuchen, N.J., plant just three weeks before Christmas. The company said it was curtailing production of television sets and stereo phonographs in favor of importing them from abroad—probably Japan."

Despite the fact that employment in the electronics industry has been increasing, Morgenstern argues, the increases have been in defense-related areas. "What the electronics industry is doing now," he says, "is shipping non-defense production overseas."

Employment in components, TV and radio has gone down by 45,000 jobs in the last three years, according to Morgenstern.

Nonetheless, when ELECTRONIC DESIGN checked with National Semiconductor in San Ysidro, Calif., that company stated that its employment in the U. S. had increased significantly over the last three years. But it would not cite specific figures.

The importers' views

To get the importers' views on the consequences of repeal of 807, ELECTRONIC DESIGN queried General Electric, National Semiconductor, RCA, Zenith, Radio Corp., Fairchild Camera and Instrument, Control Data, Admiral, and Texas Instruments.

The total value of goods imported into the United States in 1968 under Item 807 amounted to about $1.4 billion, according to the Tariff Commission. Of this total, the value of consumer electronics, components, ferrite-core memories and other electrical equipment was $269-million.

Big companies affected

Major electronics companies doing business under Tariff Item 807, according to the Electronic Industries Association, include the following:

Bendix Corp.
Control Data Corp.
Motorola, Inc.
Fairchild Camera & Instrument Corp.
Texas Instruments, Inc.
Arvin Industries, Inc.
Corning Glass Works, Signetics Corp.
CTS Corp.
General Electric
General Instrument Corp.
RCA
The Magnavox Co.
North American Rockwell Corp.
Philco-Ford Corp.
Sylvania Corp., Semiconductor Div.
TRW, Inc.

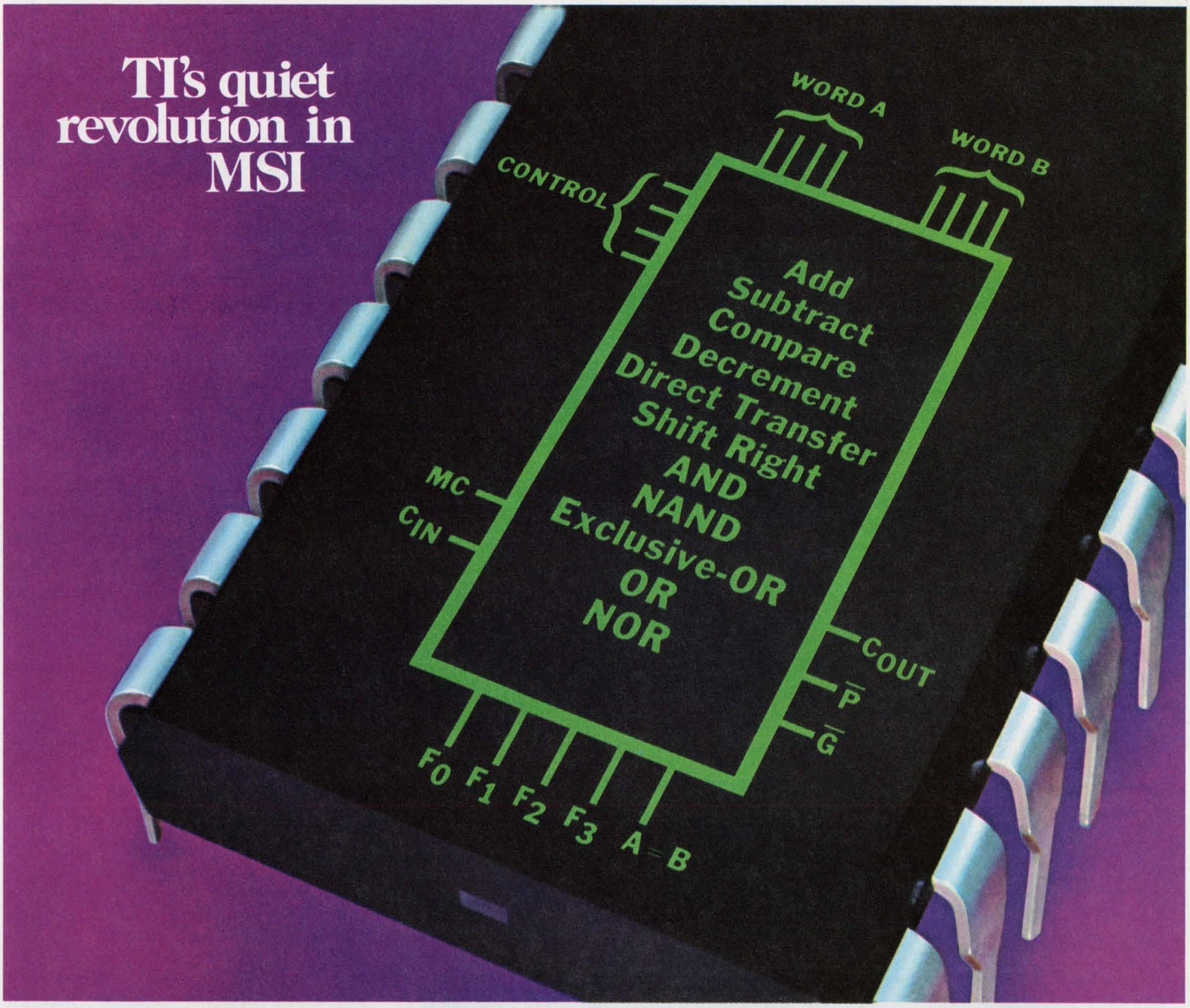
A spokesman for Admiral said his company was no longer concerned because it had transferred all production and assembly of items formerly imported under 807 to overseas operations. Texas Instruments released a statement that said:

"Repeal of Item 807 would bring about the anomaly of placing duty on American-made goods, and since the same duty rate would be applied to cheaper foreign-made goods, the end result would be to encourage greater use of foreign-made piece parts and components in goods manufactured overseas and destined for U. S. markets."

There were no "on the record" comments from the other companies.

While national trade policy may seem remote from the hearings on 807, the final decision on this issue will affect the economic structure of hundreds of electronic firms, and nearly all of the big ones.

The marketing manager for a large semiconductor manufacturer, who asked not to be named, told ELECTRONIC DESIGN that the "imposition of additional duty is *not* the principle at stake here; we think it is healthy to take advantage of the world as a whole in making decisions as to how to manufacture and sell, since we are in world competition." ■■



CPU in a 24-pin package:
TI's new SN54/74181 arithmetic logic unit.

Equivalent to 75 TTL gates, TI's new MSI arithmetic logic unit is the closest thing yet to a 4-bit CPU in a package.

The SN54/74181 performs 16 arithmetic binary manipulations on two 4-bit words—including add, subtract, compare, decrement, direct transfer and shift right. It will also perform all possible 16 logic functions of two Boolean variables—including AND, NAND, exclusive-OR, OR and NOR. It's the most complex arithmetic integrated circuit available today.

As for speed, four SN54/74181s can be teamed with one new SN54/74182 carry look-ahead generator to add/subtract two 16-bit words in 36 ns typ.

All of which means that with TI's Series 54/74 MSI, the arithmetic section of your processor has more built-in versatility and flexibility for higher level performance. Economically.

In 100-999 quantities, the dual-in-line plastic SN74181 is \$16.50; the SN74182, \$3.63.

Of course, digital processors can be built with small-scale integrated devices. But as many as 25 may be necessary to duplicate all the performance of just one SN54/74181.

To get your CPU under way this new way, you should have the 184-page supplement to our TTL catalog. Circle 249 on the Reader Service Card or write Texas Instruments Incorporated, P.O. Box 5012, M.S. 308, Dallas, Texas 75222. Or your authorized TI Distributor has copies.

TEXAS INSTRUMENTS
INCORPORATED

It's time to consider CW chemical lasers

High-efficiency, compact, inexpensive units are still under development, but no longer mere curiosities

David N. Kaye
West Coast Editor

Cw (continuous-wave) chemical lasers have progressed to a point where they are no longer merely laboratory curiosities but can be thought of in terms of future applications. These applications will fall in any area that requires a compact, efficient, inexpensive, high-power laser.

Some of the applications may include power transmission and long-distance communications in space; military field uses where a convenient source of electrical power is not available; industrial applications where small size is important—and potentially as a trigger for nuclear fusion.

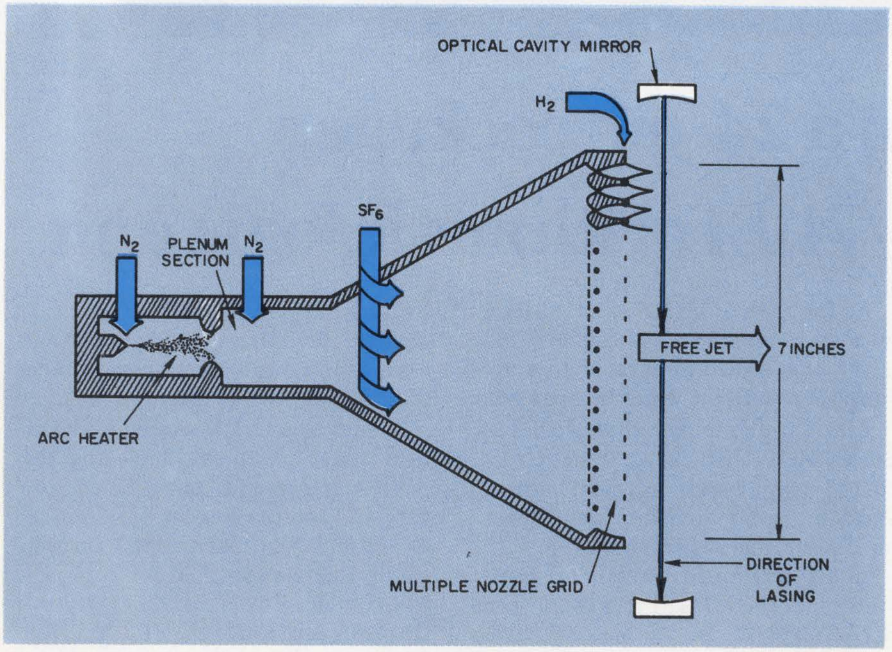
On May 9, 1969, the first cw chemical laser was developed at Aerospace Corp. in El Segundo, Calif., by a team that included Dr. Theodore A. Jacobs, head of the Aerophysics Dept., Dr. Harold Mirels, head of the Aerodynamics and Heat Transfer Dept. and Dr. Donald L. Spencer, manager of the Heat Transfer Section.

According to Dr. Jacobs, powers in excess of 630 W have now been obtained. When the cw laser first operated, the team got less than 1 W from it. Radiation is in the 2.6 to 2.9-micron region.

One of the major features of this type of laser is its high efficiency. Dr. Jacobs points out, "The efficiency of conversion of chemical energy to laser energy is 12% at the present time." Most other types of lasers have efficiencies on the order of 2% or less.

"Arc-heated nitrogen is used," says Dr. Jacobs, "to partly or completely dissociate sulfur fluoride (SF_6) in order to create fluorine (F) atoms (see diagram). The gas is expanded and forced through a nozzle to form a supersonic jet of F atoms. Hydrogen is diffused into the jet. The reaction creates vibrationally excited hydrogen fluoride (HF*) which is made to lase in an optical cavity."

Vibrationally excited hydrogen fluoride has both a vibrational and a rotational state. In the optical cavity, HF* reacts with a photon—arising spontaneously from the noise in the cavity—and changes its state. The vibrational level decreases by one, and the rotational level increases by one. This change in state gives off energy in the form of laser light. Each time the HF* changes state, a different frequency of light is given off. The most significant wavelengths noted so far have been 2.640, 2.707, 2.795, and 2.871 microns.



Cw chemical lasing can be achieved through the above scheme. Sulfur fluoride is injected into hot nitrogen, causing the fluorine to separate out. Hydrogen is mixed with the fluorine atoms to create vibrationally excited hydrogen fluoride. The hydrogen fluoride passes through an optical cavity at supersonic speed and changes state, causing lasing in the cavity. Light is given off at 2.6 to 2.9 microns.

Small cavity, high power

Two 2-inch diameter gold-coated beryllium-copper mirrors located approximately 40 inches apart make up the laser cavity. Various mirror radii in the range of 85 inches or more are used. The supersonic jet of HF*, however, flows only through 7 inches of the cavity. In order to get an equivalent amount of power out of a CO_2 laser, the cavity would have to be more than 10 feet long.

Limitations on the efficiency of the laser come primarily in two areas. The major loss is due to the fact that heat, as well as light, is given off when HF* changes state. Second, is the loss due to the cavity itself.

The arc heater is not included in the efficiency calculations. Other more efficient means will be used in the future, such as combustion and regenerative heating.

Development of the laser is supported under a contract from the Air Force Space and Missiles Systems Organization. ■■

A hospital data system designed by an MD

Physician-engineer offers electronic prescription for medical men suffering from computer phobia

Elizabeth de Atley
West Coast Editor

How would you design a medical information system that a doctor would be willing to use? Most doctors hate to type and don't want to learn even a simple program language like BASIC. They are perfectly satisfied with present methods of recording medical information on hospital patients.

Most doctors just scrawl their prescriptions in the patient's record book and give it to a nurse to decipher. From these scrawls, she must prepare lists of special diets for three meals a day, lists of medications to be given at different hours, requisitions for the pharmacy and laboratory, medical reports, etc. A computer might do the job more efficiently. But would a doctor use it?

Should such user idiosyncracies affect the choice of computer memory? Is hard copy necessary, and if so, how much?

Dr. William Chapman of the Palo Alto (Calif.) Medical Clinic who is both an internist and an electronics engineer has been asking himself questions like these for years. He has worked as a consultant for Lockheed Missiles & Space Co., Sunnyvale, Calif., on a regional time-shared medical information system that is not yet operational, and last June he formed his own company, Spectra Medical Systems, Inc., to assemble the hardware and design the software for an information system of his own. ELECTRONIC DESIGN asked him four questions:

1. What is the need for such a system?

2. Why haven't such systems been built before?

3. What criteria did you follow in selecting the hardware?

4. In what areas do you think technological advances are necessary to optimize future systems?

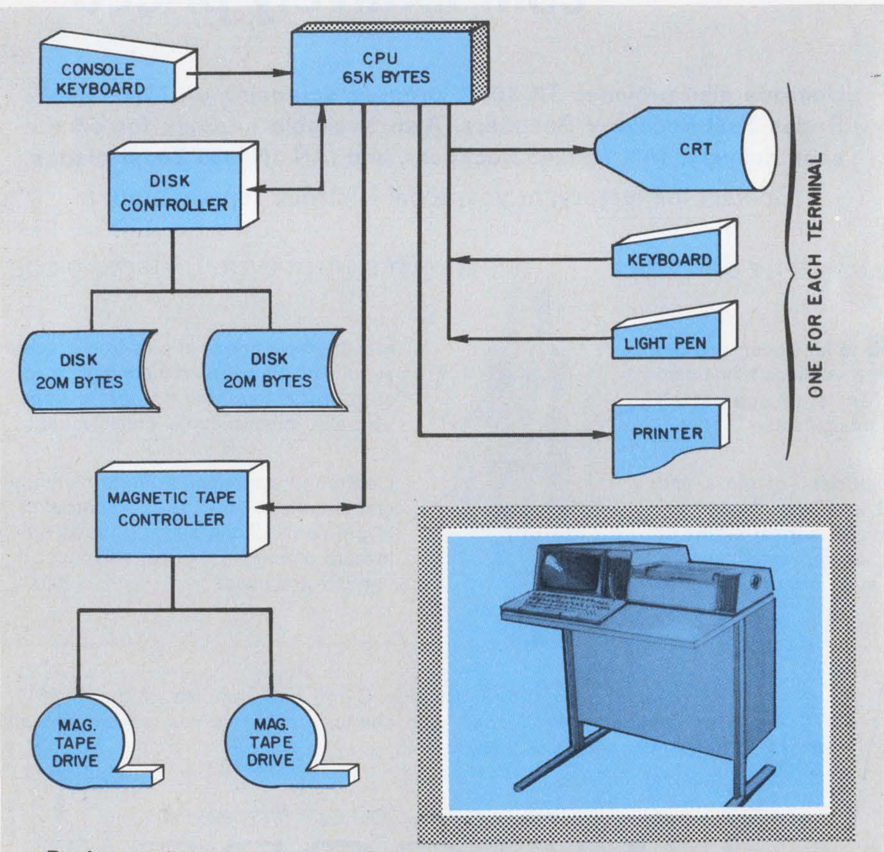
His answers are summarized here.

1. Who needs one?

The need for such a medical computer information system, says Dr. Chapman, is urgent. In fact, he says, 25% of the total operating budget of the average hospital goes to pay for the handling and sorting of medical information by nurses. Most of this work, he points out, could be done by a computer system that would cost only 3% of the total operating budget. Furthermore, with a shortage of nurses, the need becomes critical. Some hospitals have had to close down entire wings, he says, because they couldn't afford to hire nurses to staff them.

2. Why no system before?

People have been talking about medical information systems for at least 10 years, Dr. Chapman says, and a number of companies have worked on them, but it wasn't until last January that a system—manufactured by National Data Communications Inc., Dallas, Tex.—was finally completed and put on the market. Why were none of the earlier systems successful? Partly because of a lack of communication between hospital personnel and systems analysts, Dr. Chapman says, and partly because of the



Basic requirements for the Spectra Medical System are shown in the block diagram. The magnetic tape will duplicate information on the disc file and will also be used to store records of patients who have left the hospital. An artist's conception is shown above.

Spend seven fun-filled days with your very own minicomputer.

Just call the nearest Honeywell office listed below. Tell a sales representative you'd like to borrow an H112 Minicomputer. Within a few days you'll have the basic under-$5K 12-bit H112: 4K core memory, control logic, power supply, and drawer.

For the next seven days, the H112 will be yours almost free – just for a $50 handling charge.

Run through a few demonstration programs. Study the modular design that makes it easy to add another 4K of our memory, μ-PAC logic modules, A/D converters, or digital subsystems. It's that flexible. Pick out the options you need. Plug them in. No repackaging. No need to engineer your own interfaces.

In a week you'll have learned a lot about the H112 Controller/Computer. Its fast execution times. Effective memory utilization. Advantages of a data word with greater width.

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The Other Computer Company:

Honeywell

(**MD designer,** *continued*)

wrong choice of computer. Most of the systems used a large computer like the 360/40, because at the time nothing else was available. Unfortunately, Dr. Chapman notes, such large computers are complex and difficult to program. Furthermore their biggest asset, their large core memory, is not needed in a medical information system. A small "midi" or minicomputer, combined with fast-access disc storage, can do the job more efficiently, Dr. Chapman contends. To support this view, he points out that the National Data Communications System, which beat all the others to the marketplace, uses a Honeywell 516 computer. Called REACH, the system sells for about $8 per hospital bed per day. Although REACH is basically an excellent system, Dr. Chapman says, he believes his company will produce a better one at half the price.

3. What are hardware criteria?

For the doctor who hates to type, ease of data entry is the most important criterion. It almost has to be, Dr. Chapman says, in the form of displays on a CRT screen—displays that query the doctor and allow him to respond by pointing.

The system being designed by Spectra, Dr. Chapman reports, will work as follows:

"The doctor sits down at the terminal, identifies himself by typing in a code designation, and a list of his patients appears on the screen. He selects one with the light pen, and the display then changes to an index of possible orders, followed by the question, 'What order do you want to write?'

"The doctor points to the order he wants—let's say it's a medicine order. The question, 'What letter does it start with?' then appears, followed by an alphabet. If he points to the letter A, the display then says, "Here are all the drugs that start with A,' and it lists them, together with the recommended dosage. He points to one, or types it in if it is not listed.

William Chapman, MD, company president and an engineer.

"Each time the display changes, the first two lines indicate what went before, so that if the doctor is interrupted, he can quickly see where he left off. When he has completed all the orders, he pushes the 'review' button and the orders are listed on the screen. He can change something by pointing to it, pushing an 'erase' key and typing in the correction. When he is satisfied, he pushes the 'enter' button and puts it into the computer, which then prepares the reports the nurses need to take care of their patients and distributes requisitions throughout the hospital."

Fast-access disc essential

The key to this system, Dr. Chapman says, is large-storage capability and fast access to it. "You've got to be able to change the display at each terminal at least once a second," he says. "Otherwise, the procedure will be too slow. That means that if you've got 30 terminals in the hospital, you've got to have a disc-access time of no more than 30 ms."

On the other hand, Dr. Chapman points out, a powerful central-processing unit is not required just to sequence and format the displays and sort the data. The programs controlling these operations are short compared with those that control a mathematical problem, such as a matrix inversion. Therefore the core can be small.

The computer chosen for the Spectra Medical System is an EMR "midi" computer, with 65K bytes of core, and a Burroughs fixed-head disc file containing 40 million bytes. The computer and disc together cost about $250,000, Dr. Chapman says, compared with about $1-million for a 360/40 and a standard IBM disc system. Storage can be added to the disc in the Spectra system in increments of 10 million bytes without having to reprogram the computer. The access time to the disc—that is, the length of time it takes to locate the area of the disc where the data for a particular display is stored —is 20 ms.

Dr. Chapman points out that a small computer with very high-speed access time to a supplementary disc is much easier to program than a large computer with a big core, but slower, disc access.

"If we had chosen a 360/40 computer," the physician-engineer says, "we would have to do more things in parallel, because the disc-access time of a standard IBM disc system is only one-fourth as fast. We wouldn't have had time to complete each disc access before starting another operation. That makes for more complicated programming, and therefore a much longer down time if the system breaks down."

Dr. Chapman estimates that if the Spectra system breaks down, it will be possible to repair it in two hours or less. He feels that this will not seriously disrupt the operations of a hospital, since the system will produce hard copy of all information. During the down time, doctors and nurses can refer to this hard copy and keep interim records on paper, which they will enter into the computer when the system is functioning again.

Data entry by light pen

The system will use Computer Communication, Inc., terminals with CRT, light pen and keyboard. The light pen will be modified, so that when the doctor points at a spot on the screen that spot lights up, telling him where the system thinks he is pointing. This illuminated area will follow the pen as the doctor moves it about the screen, giving him instant feedback as to where he is pointing. This will be accomplished, according to Dr. Edward E. Heller, also a physician

(**MD designer,** *continued*)

and vice president of Spectra, by electronics in the light pen that will sense the instantaneous presence of the electron beam and and compute the location of the spot from the time it takes the beam to travel in a raster scan from position zero to that spot. When the doctor is satisfied that he is pointing where he wants to point, he pushes a button and enters the information into the computer.

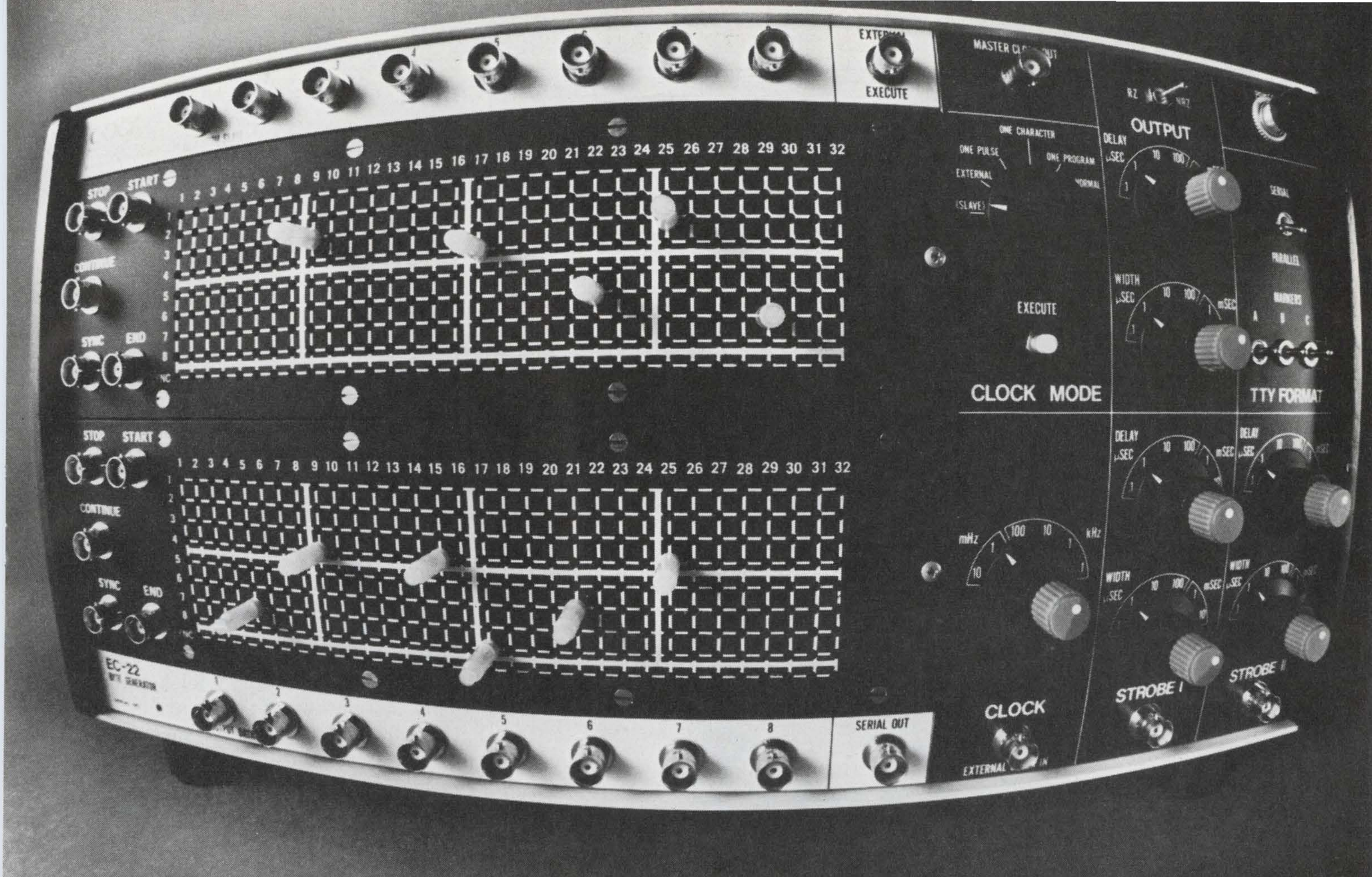
In other light-pen systems, Dr. Heller says, the user must push two buttons—one to light the screen and show him where he is aiming, and another to enter the information into the computer. However, Dr. Heller feels this is a needlessly tedious operation for the doctor.

4. What advances are needed?

As for technological advances that Dr. Chapman would like to see in hardware for this application, he points to these areas:

- Better mass storage—that is, lower price, faster access and greater size.
- Cheaper interface electronics between the computer and the TV terminal. "Between the computer and the TV screen at each terminal," says Dr. Chapman, "there is about $10,000 worth of equipment—controllers, multiplexers, etc. There may be anywhere from 20 to 35 terminals in the system. So if the interface cost could come down, it would make a big difference in the system cost."

Dr. Heller points out that as mass storage gets better and cheaper, the terminals will have to improve to take advantage of it. He visualizes a portable system in an attaché case, complete with some kind of flat TV screen and a light pen for entry. This would eliminate the need for a printer at every terminal, since the doctor could carry the terminal about with him and call up the patient's records from the central computer whenever he needed them. ■■



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Considering what the EC-22 does for only $2,500, it's a steal. Get in touch with us today, and we'll tell you how the EC-22 can help make your job a whole lot easier. It's nice to be needed. Call Bill Noren, collect.

Adar Associates, Inc., 85 Bolton St., Cambridge, Mass. 02140. (617) 492-7110.

Computer terminal uses photochromic CRT

The latest entry into the growing computer graphics display field is a time-sharing terminal that contains a new cathode-ray tube using photochromic glass as the storage and display medium. Called the 904, the device is made by Corning Data Systems, Raleigh, N.C.

Photochromic glasses, developed by the company, darken when exposed to ultraviolet light and erase (regain transparency) when exposed to red light.

The electron beam in the CRT is converted into ultraviolet light. This activates pinpoint areas of the tube's photochromic faceplate, fixing an image that is retained until it is erased by the operator. The image retention of the photochromic glass enables image storage without need for the associated refresh electronics and circuitry of conventional CRTs.

The image on the photochromic faceplate is then projected through a lens system onto the display screen.

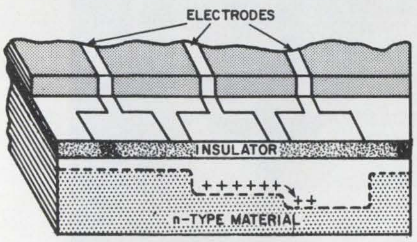
The 904 interactive graphic computer terminal, which was recently unveiled in New York, com-

Interactive display terminal from Corning contains a photochromic CRT. A superimposed slide is shown on the screen.

bines graphic and alphanumeric display, and contains a built-in electrostatic hard-copy device and a system for superimposing slide data over computer-generated information.

The display screen has a capacity of 4608 alphanumeric characters arranged in 64 lines of 72 characters each. ■■

New devices developed at Bell Labs



Scientists at Bell Telephone Laboratories have developed a new class of semiconductor devices that, they say, could perform many of the functions of more complex integrated circuits at lower cost.

Called Charge Coupled Devices (CCDs), the circuit is a three-layer structure (see diagram) consisting of a metal conductor, a layer of silicon dioxide and a base of homogeneous silicon semiconductor.

As described, the CCD creates and stores minority carriers, in a spatially defined depletion region—called a potential well—at the surface of the semiconductor. In this case, minority carriers are holes at the semiconductor-insulator interface of an n-type semiconductor.

This charge, or minority carrier, is then moved about the surface of the semiconductor by moving the potential well. It is detected and measured at some location.

Bell Laboratories' scientists produce and move the potential wells with voltages applied to an array of electrodes formed on the insulator-semiconductor layers.

The CCDs are expected to find application as shift registers and imaging devices. ■■

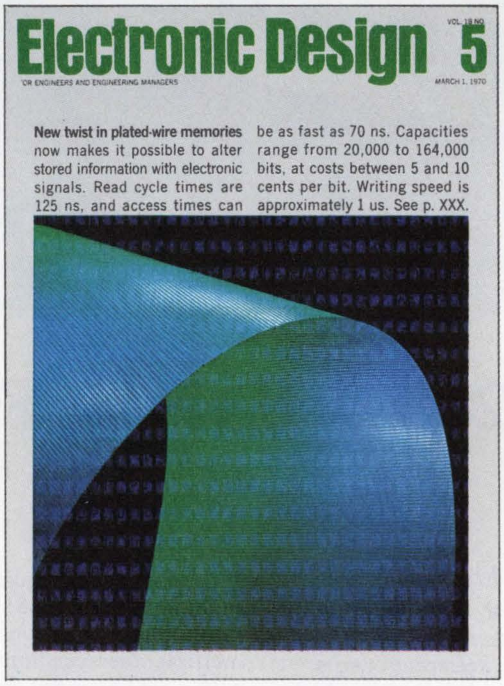
The more complicated it seems...

The simpler it gets... CONCENTRATE!

FROM 4 TO 85 MAGAZINES In May, 1953, only *four* magazines appeared with basic listings in SRDS's newly created section 40—"Electronic Engineering." They were *Electronic Design, Electronic Equipment, Electronics,* and *Tele Tech.* Now media buyers are confronted with 85 publications under this heading. Confusing? To say the least. Of course, the 13,706 advertising pages placed in the electronic press last year were mostly divided among the top publications. But even so, making the correct media choice has become a difficult problem.

THE SHAKEOUT TO COME Today there simply aren't enough advertising pages to go around. In the last 3 years, only three magazines increased their total pages (one of the gainers is *Electronic Design).* The other five lost ground, some drastically. One or two may fall by the wayside this year. There is nothing unusual about such a shakeout. It has occurred in other industries. *There is great duplication of effort among the publications* which tends to complicate rather than simplify the advertiser's problem.

CONCENTRATE—BUT WHERE? To reach most engineering prospects most efficiently, advertising should be *concentrated* in the strongest publications. The fewer publications you use, the more impact you will get in those publications. But how do you decide *which* publications to concentrate *in?*



WHAT IS REALLY NEEDED is a "Simmons" type study in the electronics field—not to determine a simple winner, but to illuminate real differences and strengths. *Electronic Design* has long urged that such a study be undertaken. In the meantime, there *is* something you can do to make your buying a more enlightened process. *You can make your own readership studies work harder!* They can tell you what *combination of magazines to use for optimum efficiency in reaching your market.*

BEGIN WITH YOUR READERSHIP STUDIES Circulation doesn't buy—*readers* buy. For this reason, many electronics manufacturers have conducted their own studies of magazine readership over their own customer and prospect lists. Although it is good to find out which publications are best read—it is even better to go one step farther and explore *duplication* of readership. A list of publications ranked by "Read Most"—while valuable for selecting a first book—can be misleading in choosing the second or third book for your schedule.

WHAT DUPLICATION STUDIES REVEAL When you conduct your own readership study, it will tell you which publication gives you the most reach in your market. This is your *basic* book. (In over 90% of all such independent studies this publication is *Electronic Design.) It may be that Electronic Design, alone, provides the best means of reaching most prospects at optimum cost.* However, if budget permits, the next step is to extend market coverage as efficiently as possible. Let us assume *Electronic Design* gives you 68% of the market. The next best read book gives 48%. However, if duplication is analyzed, the publication to add is not the runner-up in readership, *it is the publication that adds the most unduplicated readers.* It might be the second or it might be the seventh in terms of "read most" — *only your duplication studies will tell you for sure.*

ELECTRONIC DESIGN WILL HELP In addition to sharing the cost of your readership study, *Electronic Design* now makes it easy for you to analyze duplication! On request, we will send you a set of cards with complete instructions for your computer service. The program takes no more than a minute of computer time; you can tabulate your studies faster, more accurately, and with much more information resulting. You *can* untangle the media puzzle! In the EOEM, marketing *begins* with *Design.*

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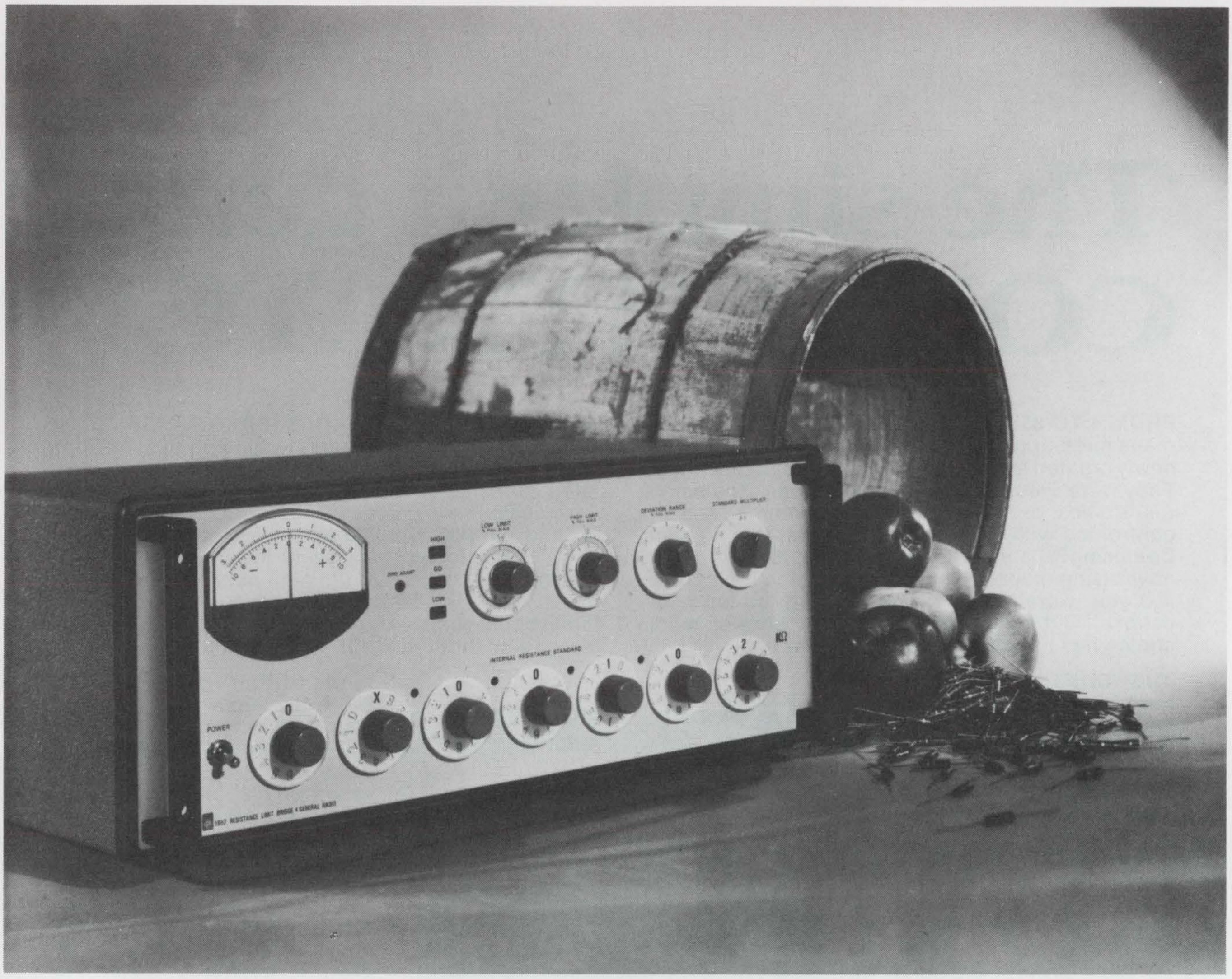

Washington Report

Postal strike viewed as boost for automation

The recent postal strike may help speed the automation of the postal system, according to Harold Faught, Assistant Postmaster General for Research and Engineering. The public is now aware of the Post Office's problems and the need for reform, he says.

To automate the system that now sometimes requires several days to move a letter across town will cost approximately $500-million a year for the next several years, says a spokesman for the Post Office Research and Engineering Bureau. The new equipment would include large quantities of optical character readers, computers and memory units.

'Sickness' in air traffic control disputed

Present air traffic control equipment is "dangerously inadequate," a spokesman for the Professional Air Traffic Controllers Organization said during the union's "sick-out." But Sen. Howard Cannon (D-Nev.), vice chairman of the Senate Aviation Subcommittee, is unimpressed by the accusation, according to one of the Senator's aides.

The PATCO sick-out is "strictly a power play for more control over personnel policy, such as transfers and overtime," the Senator's spokesman said. "The complaint about 'inadequate air traffic control equipment' is a camouflage."

A total of $2.5-billion for new air traffic control equipment is provided over the next 10 years in the Senate's version of the Aviation Facilities and Expansion Act of 1970. "And PATCO knows this," Senator Cannon's spokesman said.

The controllers' union, in reply to this, says it hasn't been told how the $2.5-billion will be spent.

A partial answer to this, however, is provided in a recently issued study by an Air Traffic Control Advisory Committee appointed by Secretary of Transportation John Volpe. In general, the study calls for greater automation for the semi-automated "third generation" of air traffic control equipment that the Federal Aviation Administration is now planning to install. The System, the study concluded, should display such information as weather and wind shifts, blocked runways, aircraft emergencies and equipment failure; it should automatically take into account any of these situations in directing traffic.

Study finds defense profits are low

Defense contractor profits are considerably lower than profits made by comparable industrial manufacturers, according to a study financed by the Pentagon. In fact, profit pressure is encouraging larger companies to avoid defense work and go into the production of goods for civilian markets, says the Logistics Management Institute, Sumner, Md., which made the study.

A spokesman for Senator William Proxmire (D-Wis.), a perennial critic of defense spending, said the Senator would have to study the institute survey before commenting.

Based on 1968 figures the institute found that the average before-tax profits on defense sales were 3.9%, against 7.6% on contractors' commercial sales and 9.3% earned by all-commercial durable-goods manufacturers. Profit on sales actually realized by the defense industry under price-competitive Pentagon contracts averaged 2%. Profits on sales under "cost-plus-fixed-fee" contracts averaged 4.2%; under "cost-plus-incentive-fee" contracts, 5%; under "firm-fixed-price" contracts, 3.3%. As a percentage of total capital investment, major defense companies earned 12.8% before taxes on defense business, against 16.3% on nondefense business and 19.5% netted by durable-goods manufacturers.

Data processors to be exempt from FCC rule

The Federal Communications Commission has proposed that the data-processing industry be allowed to use communications between customers without Government regulation. The reason—that such computer services will flourish best in a competitive environment.

The commission has also proposed that communications common carriers with annual operating revenues of $1-million or more be allowed to sell data-processing services.

Interested parties are invited to comment on the proposal by May 18.

Air Force races Navy for air-to-air missile

The Air Force has awarded contracts to three companies to begin parallel studies for an air-to-air missile that could eventually bring in billions of dollars—or could be discarded. Called AIM-82, the short-range missile, to be used by fighters for close-in dog fights, will eventually be compared with a similar study by the Navy called Agile. One will be bought by both services and the other one scrapped.

The $1.5-million, 90-day definition-phase contracts for AIM-82 are held by General Dynamics/Pomona, Hughes Aircraft, and Philco-Ford. The Agile work is in-house at the Naval Ordnance Test Station, China Lake, Calif.

FCC waits for industry's satellite ideas

The Federal Communications Commission is waiting for industry to come up with concepts for a domestic communications satellite system that would best serve the public. After all the proposals have been submitted, the commission will resolve such issues as these: How many systems should be authorized? (The White House has said it favors competitive systems.) Who should own them? Should the satellites be dedicated to one use or required to carry all major types of communications?

Besides proposals, the FCC has asked for comments on whether or not AT&T should be allowed to enter the domestic satellite field. Some contenders for the network have argued that AT&T is so big it would smother competition.

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Totally visual indication of operation. It's Cutler-Hammer's new illuminated Rockette Switch. Another example of how we go just a little further to meet your design and functional needs.

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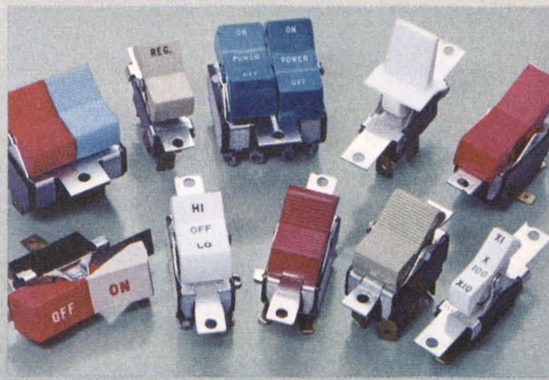

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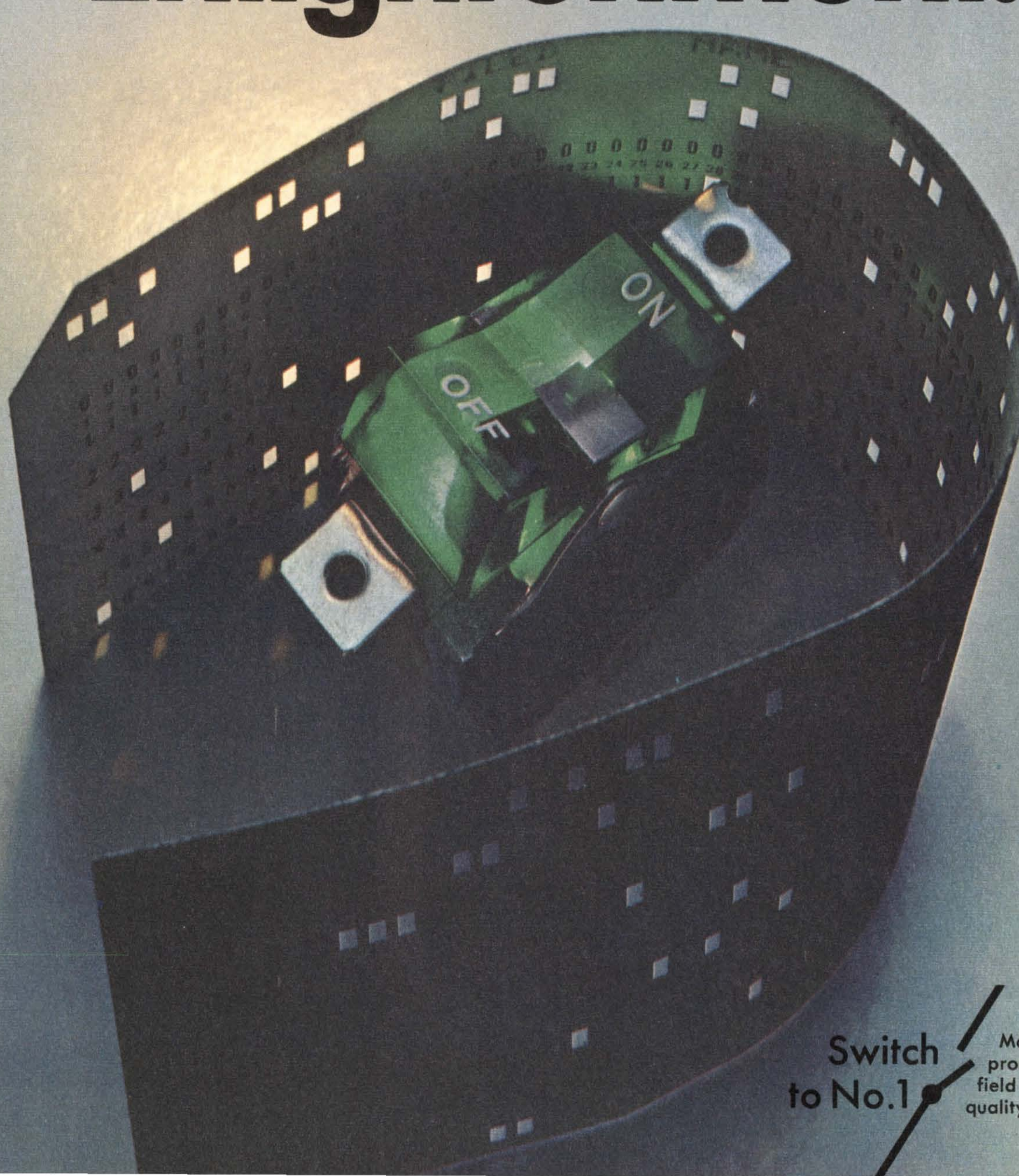

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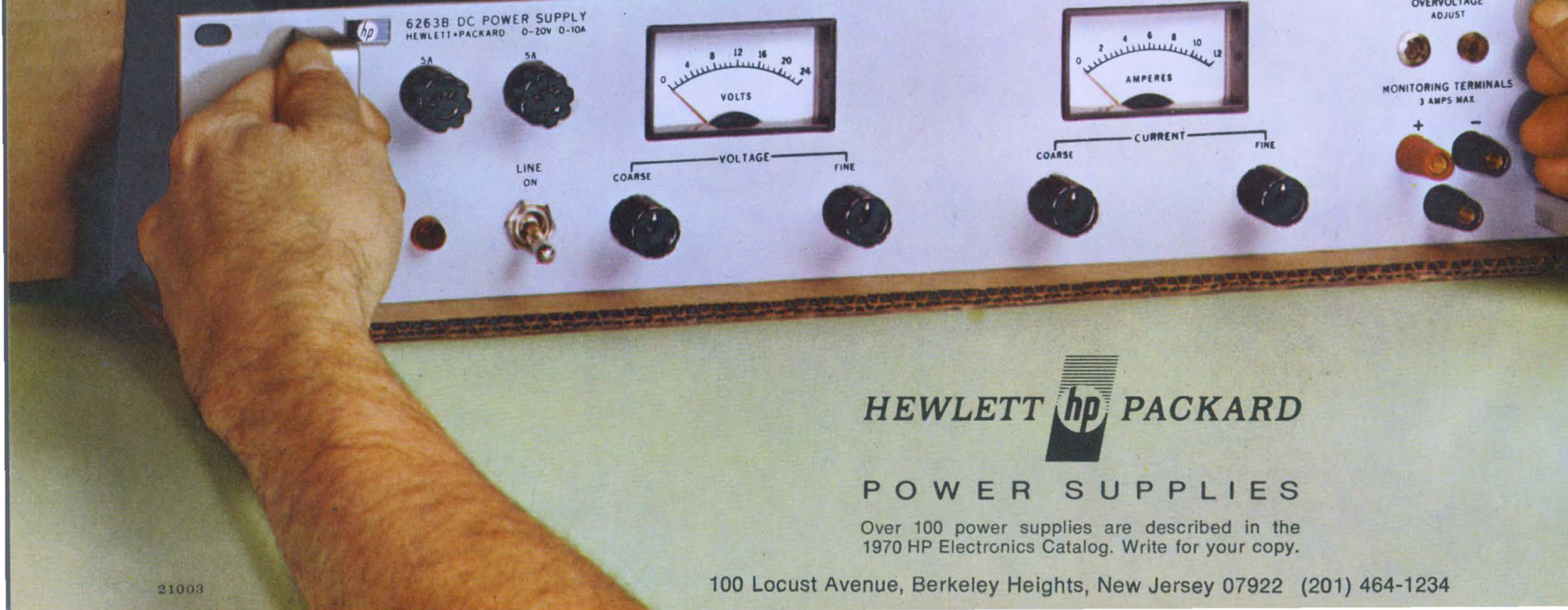

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Letters

It's not all right—engineering, that is

The following letter is in response to one that appeared in the March 15, 1970, issue (ED 6) titled, "Today's youth 'ideal'? He calls them 'fools.'" The writer of that letter reacted violently to our editorial in the Dec. 6, 1969, issue (ED 25) about the negative thoughts "idealistic" youth has about the engineering community. He said that if today's youth is idealistic, then its ideals are certainly completely rotten.

Sir:

Violent reaction, huh, Jack. What's your defense? Not idealistic? Probably no more nor less than any other generation, except that this one is doing something about it. You may not feel the need to justify engineering, but it certainly needs it.

The man in the street confuses science and technology, but it doesn't make too much difference —both have enjoyed the status of something holy for too long. Perhaps it's easier for scientists, but engineers had better start asking "why" instead of simply "how."

In case you haven't noticed, Jack, we're suffocating from our own pollution. Today's idealist—sloppy looking, pot-smoking, long-haired, etc.—didn't make this mess. He hasn't been here that long. He is doing us a favor, Jack, by bringing to the attention of everyone something we should have taken care of years ago.

Spanking won't do a thing to solve the problem. It might help you, but it won't cure him. You haven't seen anything yet, Jack, so stick around.

J. F. Hinds

Andover, Mass.

What a computer hasn't got—a head

Most stories about computers—mini to maxi—concentrate on what they can do and how they can do it better than a man can. But in gathering material for his special report on minicomputers (p. C6), Computers Editor Milton Lowenstein (see photo) found an area where men can outperform computers at their reputedly most efficient job—repetitive tasks.

The idea came out during a conversation with Cloyd Marvin, vice president of marketing, for Four-Phase Systems, Cupertino, Calif. Marvin pointed out that layouts for his company's LSI artwork for semiconductor memories are always made by men. Computers—so far—are too expensive for the work. A single cell of random-access memory requires several complex superimposed masks. Each cell is then repeated hundreds or thousands of times, depending on the circuit being built. The memory needed for a program to perform this task, using computer-aided design, is so large that the average in-house or time-shared computer is not equal to the demand.

A man, however, can recognize a pattern, and he can suppress details while performing the over-all layout. Later, he can add the fine details. So memory in a machine isn't everything—as long as man has a head.

What would repeal of 807 mean to you?

What started off as a brief preview of a Tariff Commission hearing in Washington, in May, became a story with enormous implications for the industry. At the hearing, arguments will be presented by industry and labor on the hotly debated Item 807 of the U. S. Tariff Code. Under it, products made from American components but assembled in a foreign country are exempt from duty when imported back into the States; duty is paid only on the "value added" by foreign labor. If the item is repealed, the Electronic Industries Association says, imported electronic products will cost more in the U. S., American-owned plants abroad will use cheaper foreign instead of American-made components, and competition with Japan will stiffen.

News Editor John Kessler interviewed such sources as Alfred R. McCauley, special counsel to the EIA, and Abe Morgenstern, research director of the International Union of Electrical Radio and Machine Workers. The story begins on p. 24.

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The new lil' Ubiq®, the smallest real-time spectrum analyzer for on-line frequency measurements of noise, vibration, and underwater signals.

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Frequency accuracy	digital marker calibrated to .2%	.5% read from display
Oscilloscope display, chart recording, and X-Y plotting	yes	yes
Single frequency select	with digital switches	with 10-turn dial
Companion averager	dual 500-pt.	single 200-pt.
Height	12½"	7"
Rack mounting	yes	yes


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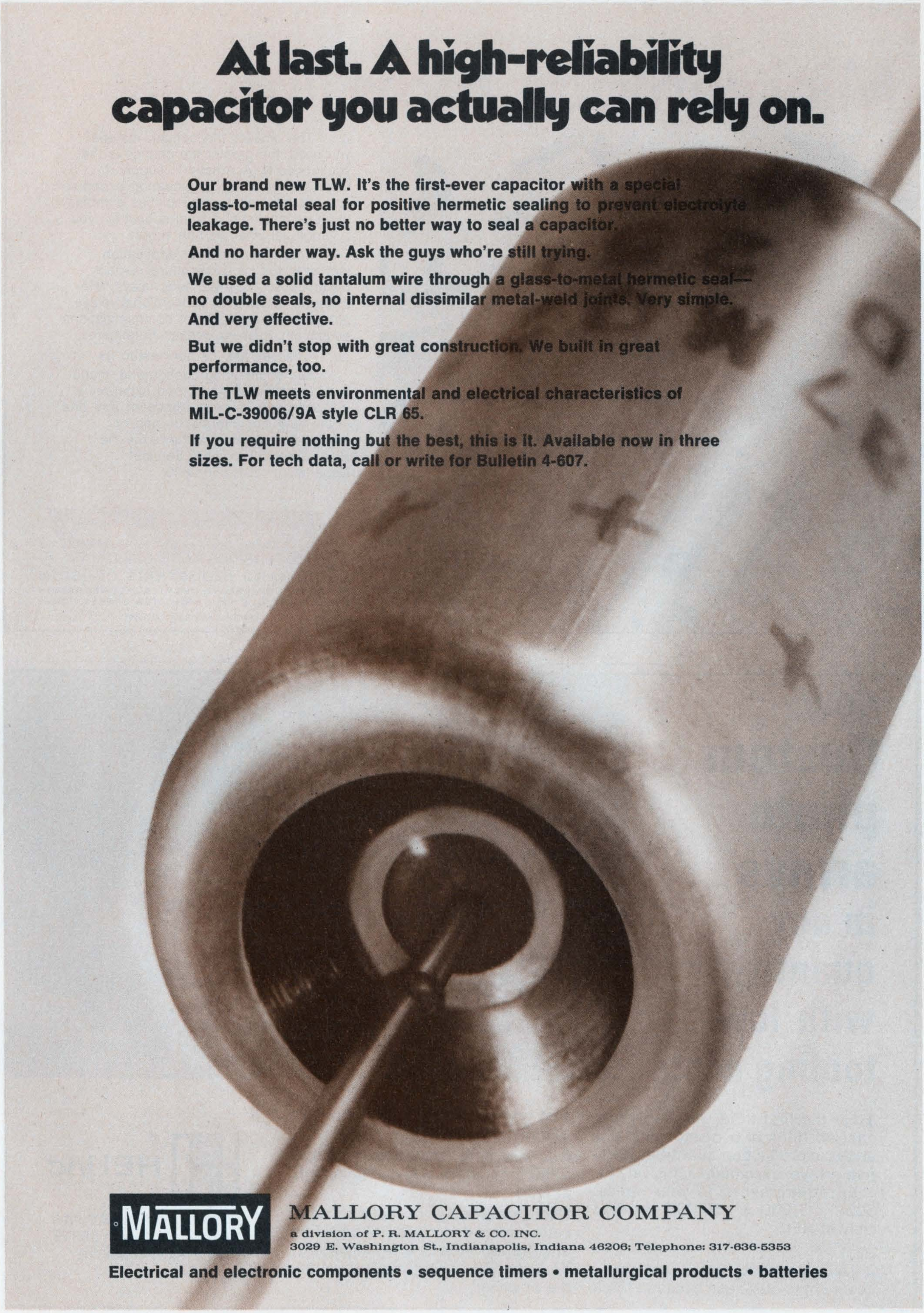

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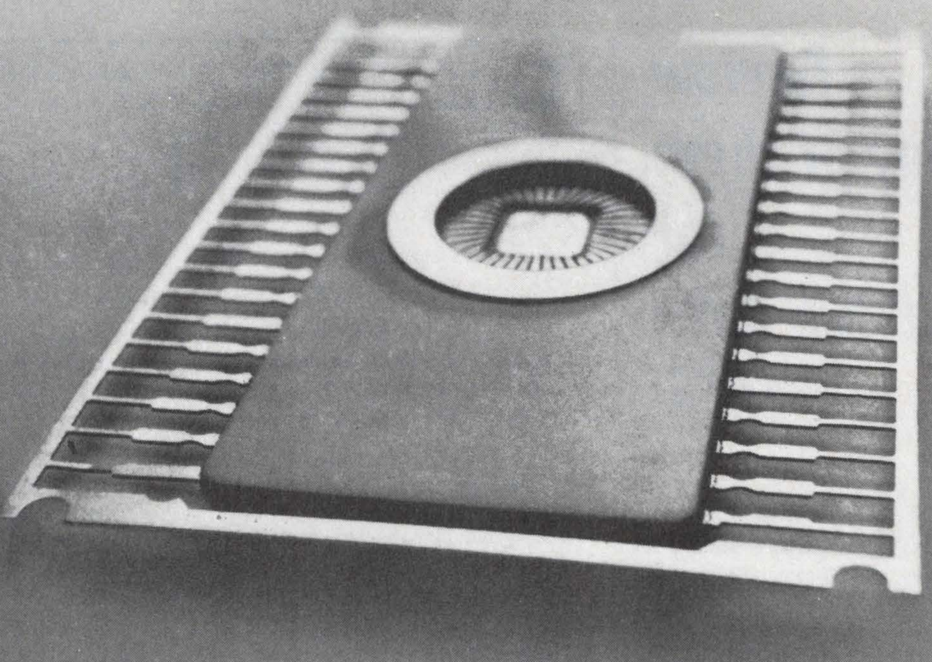
Sylvania introduces a new 40-lead, glass-ceramic, sandwich-type, unitized, hermetically sealable large scale integrated circuit package.

(whew.)



Here is the first glass-ceramic package in the IC major leagues. And that, friends, marks the beginning of the end of the LSI package shortage. *Write to: Sylvania Precision Materials, Parts Division, Warren, Pa. 16365. Or telephone: 814-723-2000. Ask for Bill Williamson.*

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A complete and concise survey of the entire field of microelectronics providing practical and professional ideas from the pages of *Electronic Design*. Almost 90 important studies cover all aspects or this rapidly expanding technology—basic integrated circuit components, thick and thin film, reliability, black-boxing, etc. Valuable data charts on more than 500 devices, a list of manufacturers, and a full bibliography insure the book's usefulness. 320 pages, 8½ x 11 illustrated, clothbound.

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MICROWAVE SYSTEMS PLANNING
Kenneth L. Dumas and Leo G. Sands

Designed for managers and engineers, this book defines and explains in a semi-technical manner the important criteria involved in the planning, engineering, and installation of microwave communications equipment. Covers point-to-point FM systems beginning with frequency, wave theory and propagation, and following through to hardware theory and the practical aspects of establishing a microwave path with a high probability of good performance. 152 pages, 6 x 9, illustrated, clothbound.

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Bringing together the various modern, or network-synthesis methods in filter design, this book enables the engineer to achieve practical design more easily. Extensive tables of numerical data preclude much of the difficulties in design. Covers lowpass, highpass, simplified and refined designs, bandstop, attenuation, equalizers, linear-phase and delay equalizers, measurement techniques, etc. 182 pages, 5½ x 8⅛, illustrated, clothbound.

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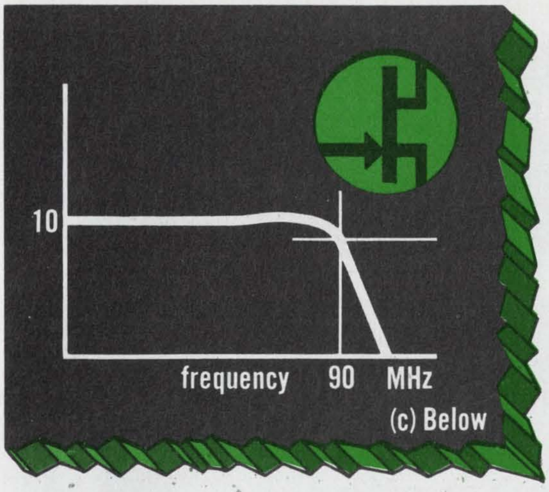

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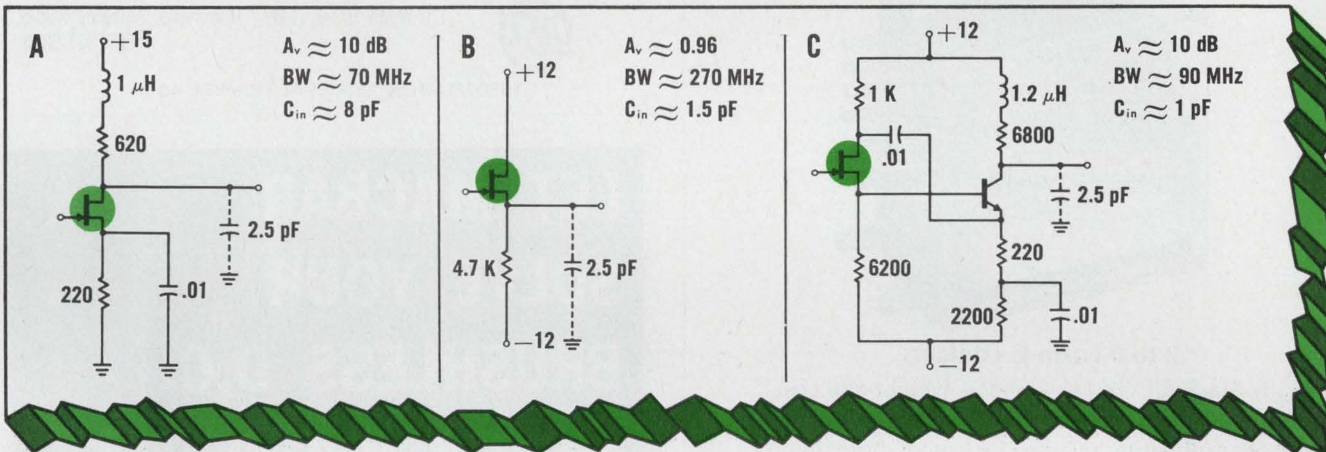

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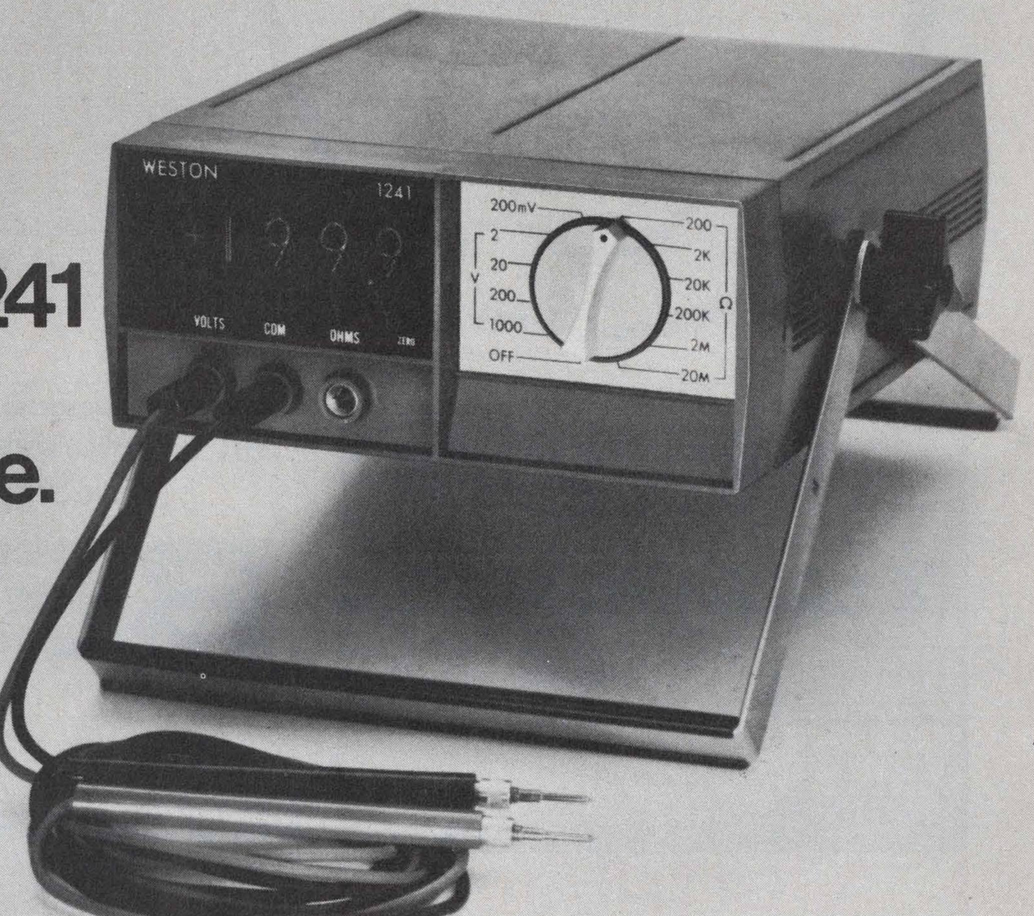

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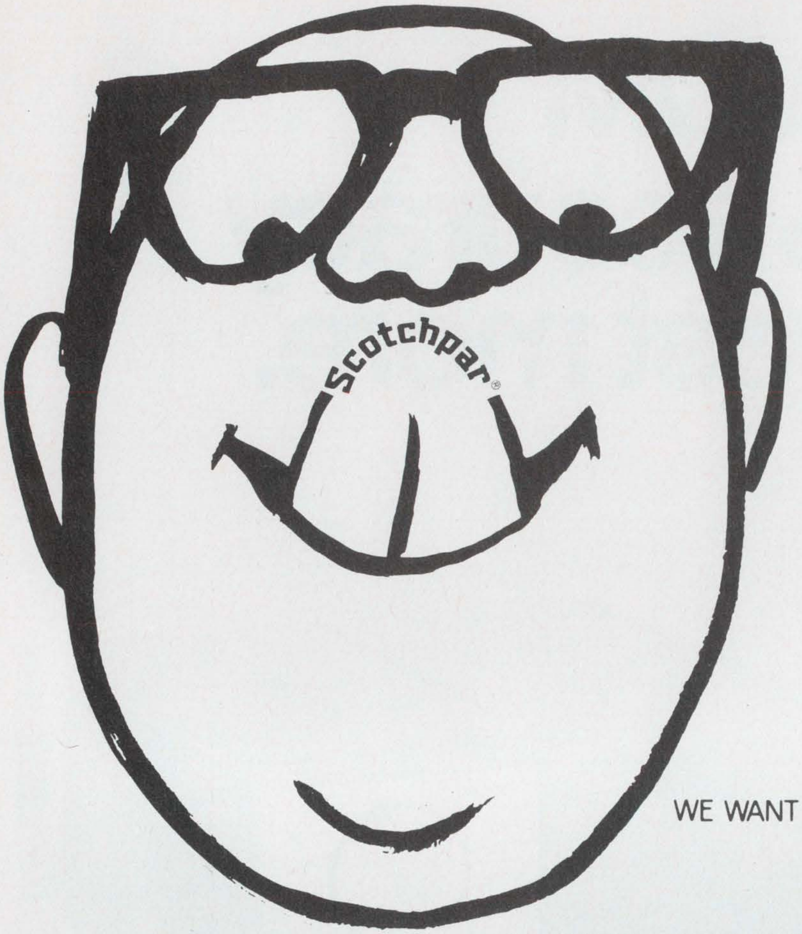

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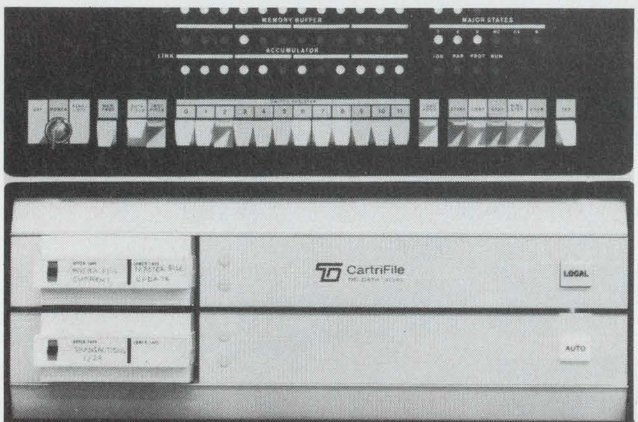

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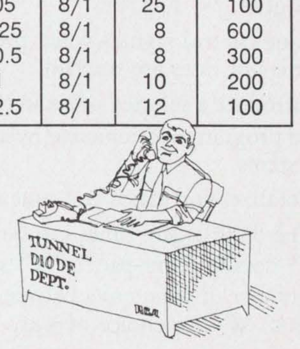
40562	9	11	6/1	25	900
40563	18	22	6/1	30	600
40564	45	55	6/1	40	350
40565	90	110	6/1	40	150
40566	4.75	5.25	8/1	15	1200
40567	9.5	10.5	8/1	15	600
40568	19	21	8/1	20	400
40569	47.5	52.5	8/1	25	200
40570	95	105	8/1	25	100
40571	4.75	5.25	8/1	8	600
40572	9.5	10.5	8/1	8	300
40573	19	21	8/1	10	200
40574	47.5	52.5	8/1	12	100



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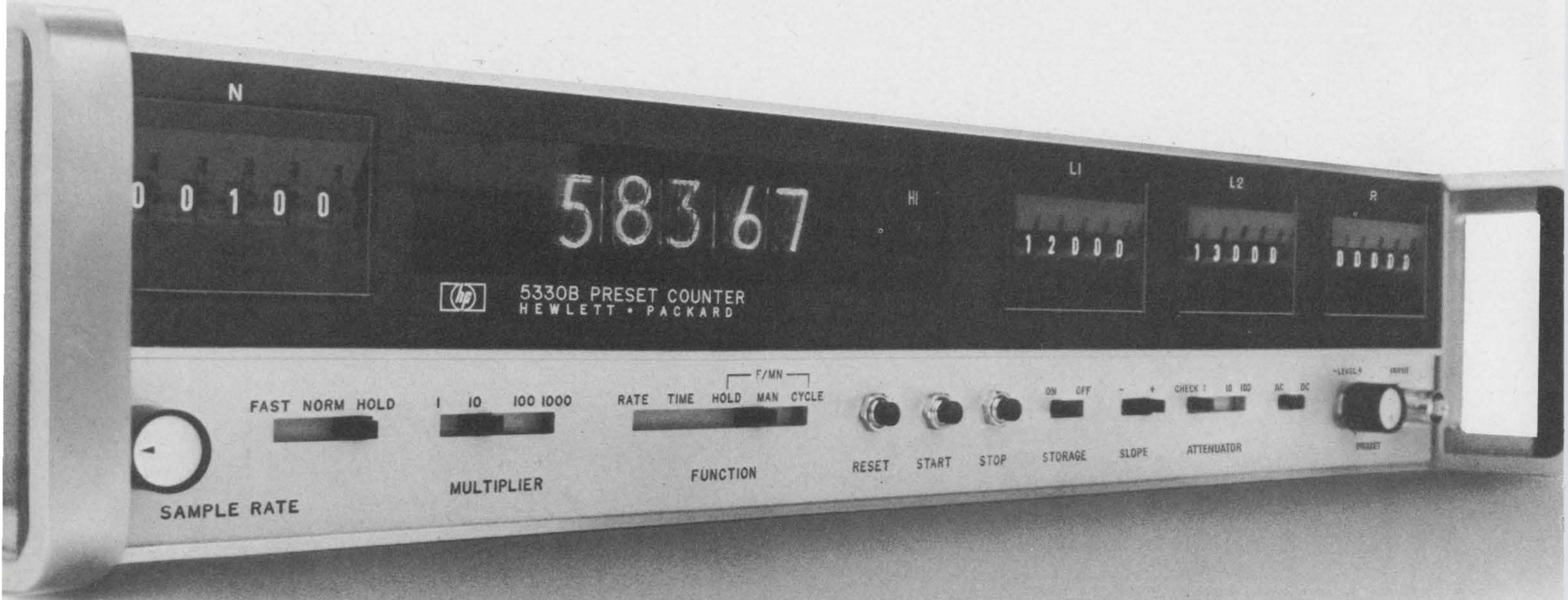

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All four of these functions can be remotely preset. It's also the first preset counter to offer an anti-noise option. This rejects high frequency noise that might mask low-frequency data.

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If the 5330B is too versatile for you, the 5330A should be just right. It does slightly less (without limits, but zero offset option available), and costs slightly less.

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New York Office
850 Third Ave.
New York, N.Y., 10022
(212) 751-5530

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P.O. Box 272
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San Francisco
Elizabeth de Atley
2051 Wellesley St. (Suite D)
Palo Alto, Calif. 94306
(415) 321-7348

Los Angeles
David Kaye
2930 Imperial Highway
Inglewood, Calif. 90303
(213) 757-0183

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Art
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EDITORIAL

The industry can help solve postal chaos

Labor trouble is not the only problem facing the U. S. Post Office Dept. A headache of major proportions is the evergrowing volume of mail that must be handled each day by the nation's 32,000 postal offices. This year, nearly 82 billion pieces of mail will be processed. The New York City post office alone deals with 35 million pieces of mail daily, more for instance, than all of Belgium handles.

Despite a budget of $7.13 billion and 725,000 workers, the Government's largest civilian agency is gradually cracking under the strain. The fact is that the American postal service is slower and less reliable than those of many other nations—even some underdeveloped ones.

In 1968 the President's Commission on Postal Organization, headed by former AT&T chairman Frederick R. Kappel, declared that each year the Post Office "slips farther behind the rest of the economy in service and in efficiency." The commission found that mail handling has changed little in the past century. Last May, President Nixon said: "Total reform of the nation's postal system is absolutely essential."

With the recent strike still haunting the Government, it appears that this long-awaited reform will finally take place. Modernizing this Model-T monolith will require billions of dollars to be spent over many years and will utilize the technological skills of the nation's scientists and engineers—a sort of postal "Project Apollo."

The Post Office has in recent years begun to employ several sophisticated systems to speed up the handling and processing of mail. Optical scanners are being used to sort and cancel letters. Machines are being developed to read zip code numbers and extensive use is made of computers, primarily for administrative and payroll purposes.

Nevertheless, only a tiny portion of the enormous resources and skills of the electronics industry has been brought to bear on the problems of the Post Office.

We believe that, first and foremost, the postal system's deteriorating and archaic approaches to both moving the mail and administering the organization need to be overhauled. And we also believe that electronics technology will play an increasingly important role in postal reform.

RALPH DOBRINER

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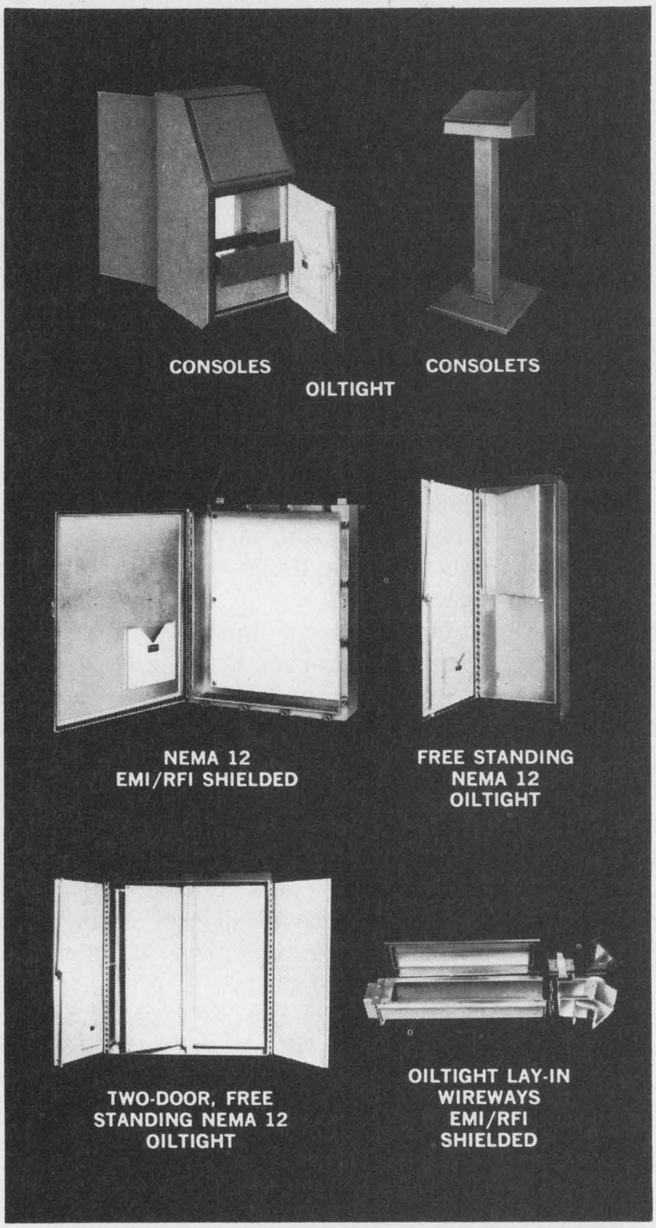

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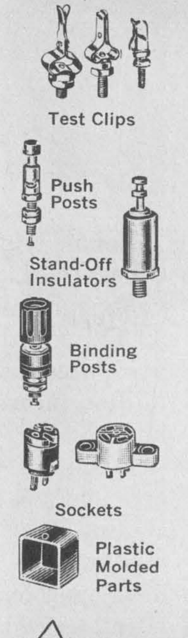

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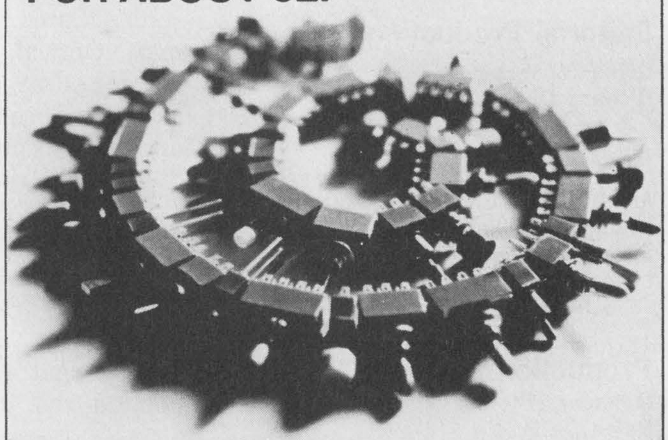

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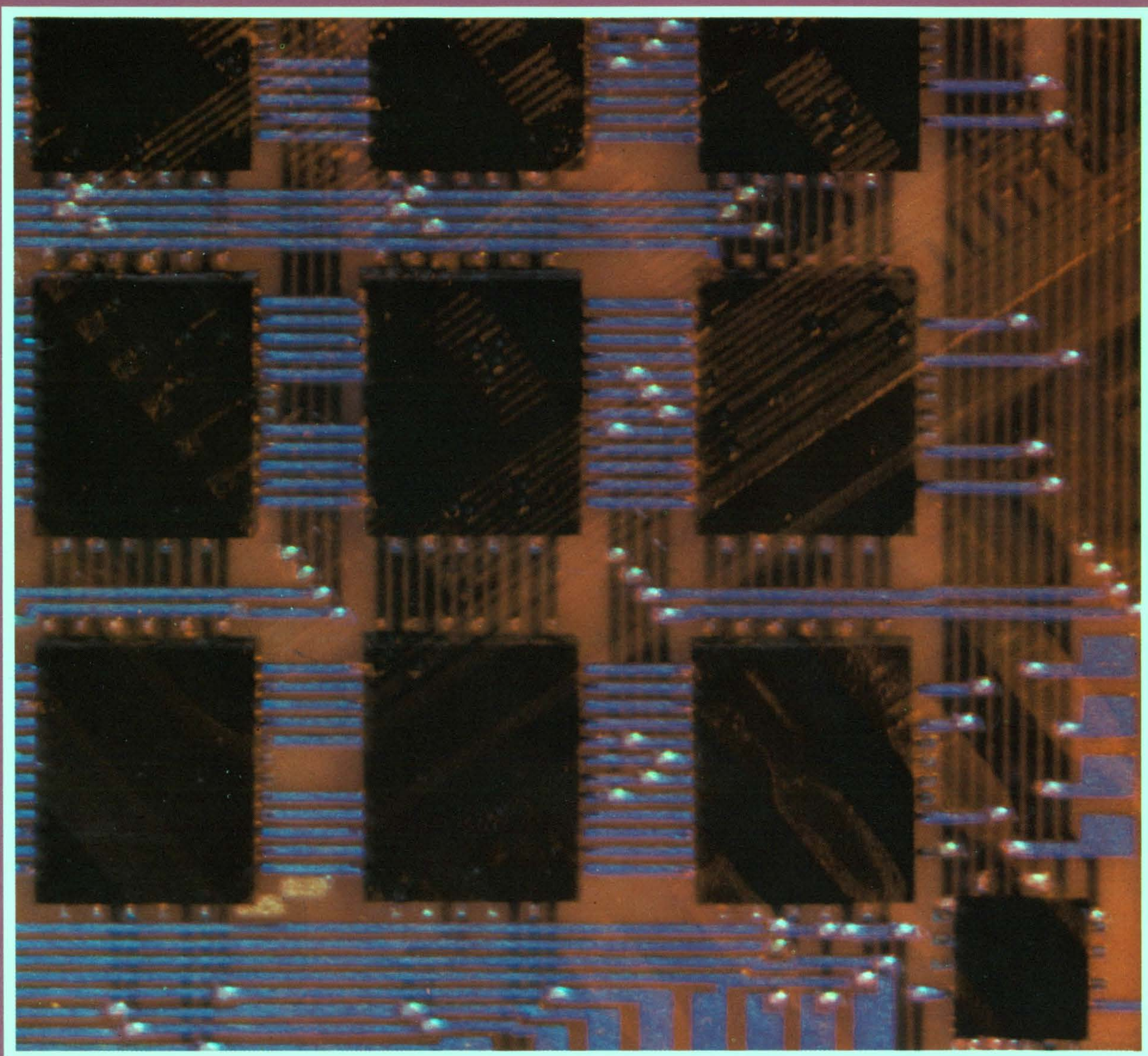

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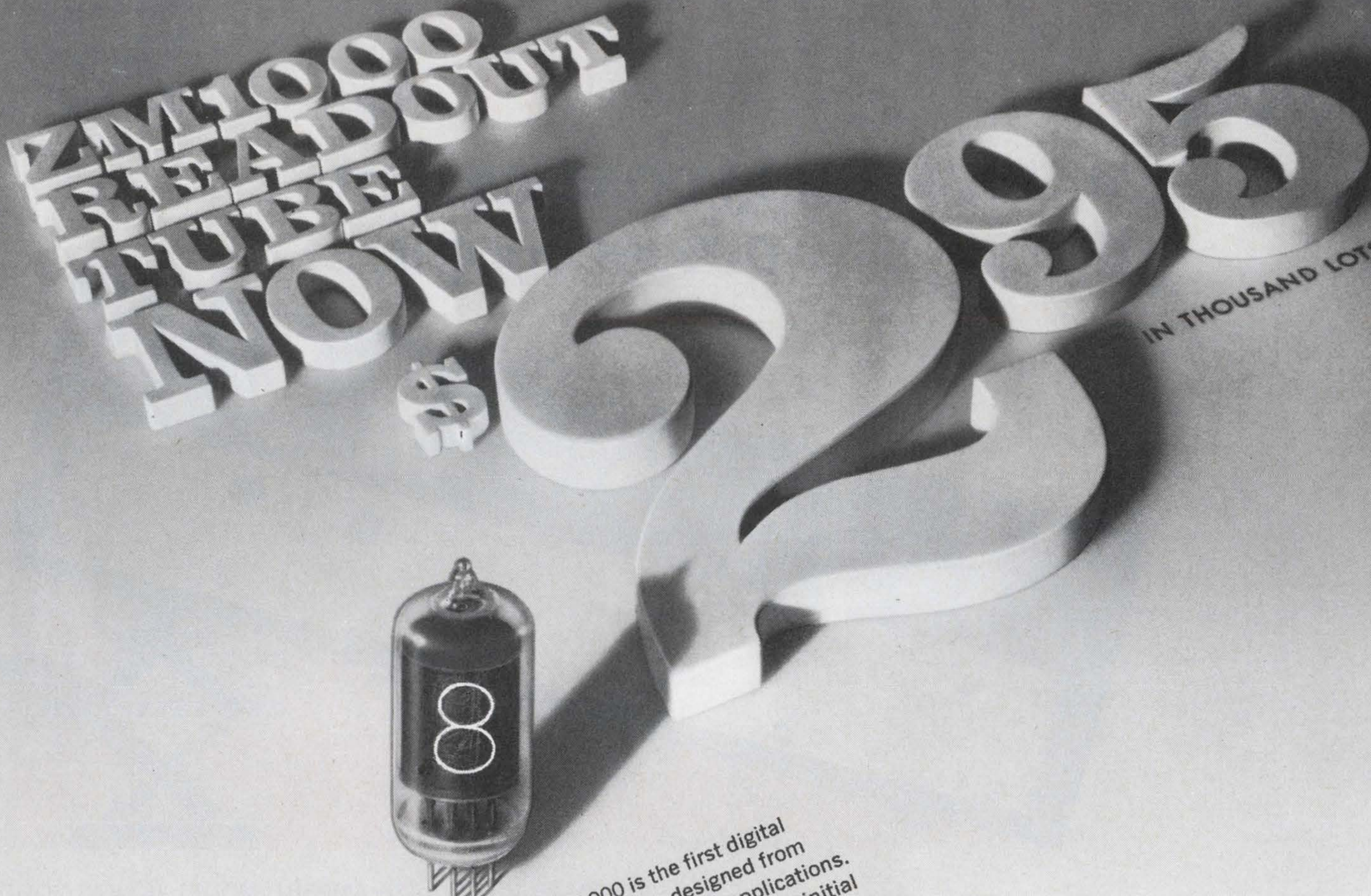
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1970 Spring Joint Computer Conference

special report

by **Milton J. Lowenstein,** Technical Editor

Cover courtesy of Computer Microtechnology, Inc., Sunnyvale, Calif. shows a 40%-bit read/write hybrid semiconductor memory.

The minicomputer: machine with

"The minicomputer industry is the fastest-growing segment of the fastest-growing business in the world."

This statement by the director of marketing of a minicomputer manufacturer—Allen Z. Kluchman of Data General Corp., Southboro, Mass.—sums up the impact of an idea that has been kicked around in the computer industry for six or seven years but only began to bear fruit two years ago.

The minicomputer's name comes from its small size, but its most significant feature is its relatively low cost. Doubling its physical size probably would not affect the rising sales curve drastically; doubling its price would have a strong adverse effect. All of the applications, therefore, reflect the fact that it can penetrate markets never before entered by computers.

The computer industry is now turning out its third generation of large machines. Today's minicomputer has the computing power of the first-generation Univac I, but it is rapidly growing beyond that benchmark. New developments in large-scale integration (LSI) of semiconductors, either already here or just over the horizon, will accelerate that growth.

The applications of the minicomputer run the gamut of the computer business:[1,2] It is used alone to solve scientific and engineering problems. It gives the small businessman the ability to automate his payroll, billing and inventory-control operations. It is used to control the operations of process industries and manufacturing plants. It replaces hard-wired logic in switching systems. It performs as a data concentrator for data-communications systems. It operates test lines in manufacturing and reads, records and reduces data for engineers in development laboratories. It maintains the medical and financial records of patients in hospitals.

The list is endless. In the words of one manufacturer: "The market grows with each inquiry from a prospective customer."

Some of the minicomputers are general-purpose and can be adapted to any number of different applications. These machines give up some computing power and speed for their flexibility, but the big demand for them, and consequently the longer production runs and higher sales, make it possible to cut prices.

Other minicomputers are aimed at specific markets and are more specialized. These machines have higher performance and probably higher initial costs.

Some of these generalizations do not take into account the cost of peripheral equipment, which makes the minicomputer a computing system. They are impressions gained from talking to many manufacturers, however.

Electronic engineers have three areas of contact with the minicomputer. They are the design of the machine, its component parts and its peripheral equipment; the use of the machine as an adjunct to other engineering endeavors, such as problem-solving or as a laboratory tool; and the engineering of applications for customers who have a specific task to perform. All include hardware and software design.

For an engineer to perform these functions, he must be aware of the characteristics and limitations of the machines.

Let us, therefore, take a look at some of the many possibilities. The engineer is probably most familiar with computers used to aid in the design of circuits and equipment.[3] Can the minicomputer operate in this area?

A challenge to time-sharing

Here it is a question of minicomputers vs commercial time-sharing services, and the stand that one takes depends strongly on the speaker's affiliation. The user's point of view is "show me." The time-sharing service or the manufacturer of computers for use in commercial time-sharing has little but disdain for the minicomputer. The minicomputer manufacturer echoes Eliza Doolittle: "Just you wait. . . ."

The issue, of course, is how to get more computing power for the dollar. The time-sharing service is weighted down by the cost of communication lines, over which it has no control, and terminal charges while the user is on-line but not computing. These two costs can amount to half or more of the total charge for the use of a time-shared computer.

The big machines that the commercial services offer, however, can do a great deal of com-

an endless future

Glossary of common computer terms

Byte. A group of bits, usually 4 to 8 that form a sub-unit of information. A word may contain one or more bytes.

Central processing unit (CPU). The arithmetic and control portions of a computer.

Compiler. A computer program that prepares a machine language program from subroutines written in other programming languages.

Cycle time. The time required to complete one loop. It is the basic time unit of computer operation.

Direct memory access. Direct communication between memory and peripherals. In computers where this is not inherent, a device that bypasses the CPU.

Firmware. Programs or instructions stored in read-only memories; analogous to software in a hardware form.

Hard copy. Computer output in a form that can be saved—for example, printout on paper is hard copy; display on a cathode-ray tube is not.

Hardware: The physical components of a computer.

Interface. A connection between a computer and some other device that either transmits to or receives information from the computer. Interfaces must provide information in a form compatible with computer's needs.

Interrupt. A break in the flow of a program that permits the program to be resumed at a later time. The source of the break may be internal or external.

Language, assembly. A computer language that has a one-to-one correspondence with an assembly program, which directs the computer to operate on a symbolic language program to produce a machine language program.

Language, higher order. A programming language that is independent of the computer. It usually resembles natural languages and requires a compiler for translation into machine language. FORTRAN and ALGOL are examples.

Language, machine. A programming language used directly by a machine. It includes machine addresses and operation codes. It is the end result of compiling a source language program.

Macroprogram. A computer program written as a sequence of instructions in a source language.

Main frame. The central processing unit of a computer plus the input/output unit and the random-access and read-only memories. The mainframe is the computer without peripherals.

Microprogram. A computer program written in the most basic instructions or subcommands that the computer is capable of executing; commonly it is stored in a read-only memory.

Multiprogramming. A method by which many programs can be operated on within the same time span. The programs are overlapped or interleaved. This technique is the basis for time-shared operation.

Operating system. The totality of software that describes the methods by which data is processed to obtain a desired result.

Peripheral. A device through which the computer communicates to the outside world. The term may also include auxiliary memories, such as tape, disc and drum.

Random-access memory (RAM). A memory that can be written into or read by locating any address in which data is stored.

Read-only memory (ROM). A memory in which the information is stored at the time of manufacture. The information is available at any time, but it can be modified only with difficulty.

Software. The programs and instructions for a computer.

Word length. The number of bits in a sequence that is treated as a unit and that can be stored in one computer location. Longer words imply higher precision and more intricate instructions.

puting that the minicomputers cannot. The reason: the very large memories that the big machines have. Complex programs cannot be stored in small memories. Richard McNair, computer scientist of XDS, El Segundo, Calif., a supplier of computers to many time-sharing services, refers to this when discussing computer-aided design (CAD) for circuit programs. He says: "The size of the programs that are being used in CAD are such that the minis cannot handle the number of program statements required. CIRC dc has 7000 statements, and CIRC ac and SCEPTRE have over 15,000. Some things can perhaps be put on a minicomputer instead of in commercial time-sharing, but I don't know what. I think that time-sharing can do most CAD better."

XDS's manager of product marketing, Lawrence Israel, has a different reason for believing that minis pose no serious competitive problem for time-sharing services. He says: "The running costs of a self-contained in-house computing system—including maintenance, setting up and choosing auxiliary and peripheral equipment—have an adverse effect on cash flow that use of a time-sharing service does not."

Israel also points out that time-sharing services supply more than just time on a computer. They are large suppliers of software to their customers. The user of an in-house computer system must either buy or supply his own software. Israel foresees minicomputers restricted to data communications, control and laboratory system applications.

Time-shared minicomputers offered

Three of the largest manufacturers of minicomputers see few restrictions on the use of their machines. They are Digital Equipment Corp. of Maynard, Mass.; Hewlett-Packard, Palo Alto, Calif., and Varian Data Machines, Newport Beach, Calif. Both Digital Equipment and Hewlett-Packard now offer minicomputers for inhouse computing applications, and Varian is planning to offer one shortly. These systems adopt one feature of their competitors: they are interactive time-shared computers. Usually as many as eight remote terminals can be linked to one minicomputer central processing unit.

Minicomputer manufacturers refute the antimini arguments one by one. The minicomputer manufacturer can choose, set up and maintain a system for a user. The system can be leased, so that the customer need not make a capital investment. The manufacturer can make software available—perhaps not free, but neither is a time-sharing service's software strictly free either. Time-sharing service charges include the cost of software. The only objection that the minicomputer manufacturer cannot answer is that the computing capability and memory size offered by the time-sharing services is larger.

But in one respect the minicomputer can outperform the time-sharing service, according to Zvonko Fazarinc, an engineer with Hewlett-Packard. He does not design computers, but he does have one available for his use in designing test equipment.

Fazarinc dismisses the small memory as of little importance. His machine has a 16,000-word memory, but he believes that 8000 words are sufficient for most jobs. He concedes that SCEPTRE needs over 15,000 source statements, but he says that SCEPTRE has general-purpose capabilities to make it useful for a wide variety of problems. Fazarinc's circuits have restricted requirements and can be designed with much smaller programs. He says: "We make the program as big as the circuit requires."

A typical problem—the design of a Schmitt-trigger—was run by Fazarinc in CIRCUS, SCEPTRE, SYSCAP and on his mini. The running times were 80, 85, 30 and 35 seconds, respectively—this in spite of the fact that the big programs ran on machines that could multiply 500 times as fast as the minicomputer.

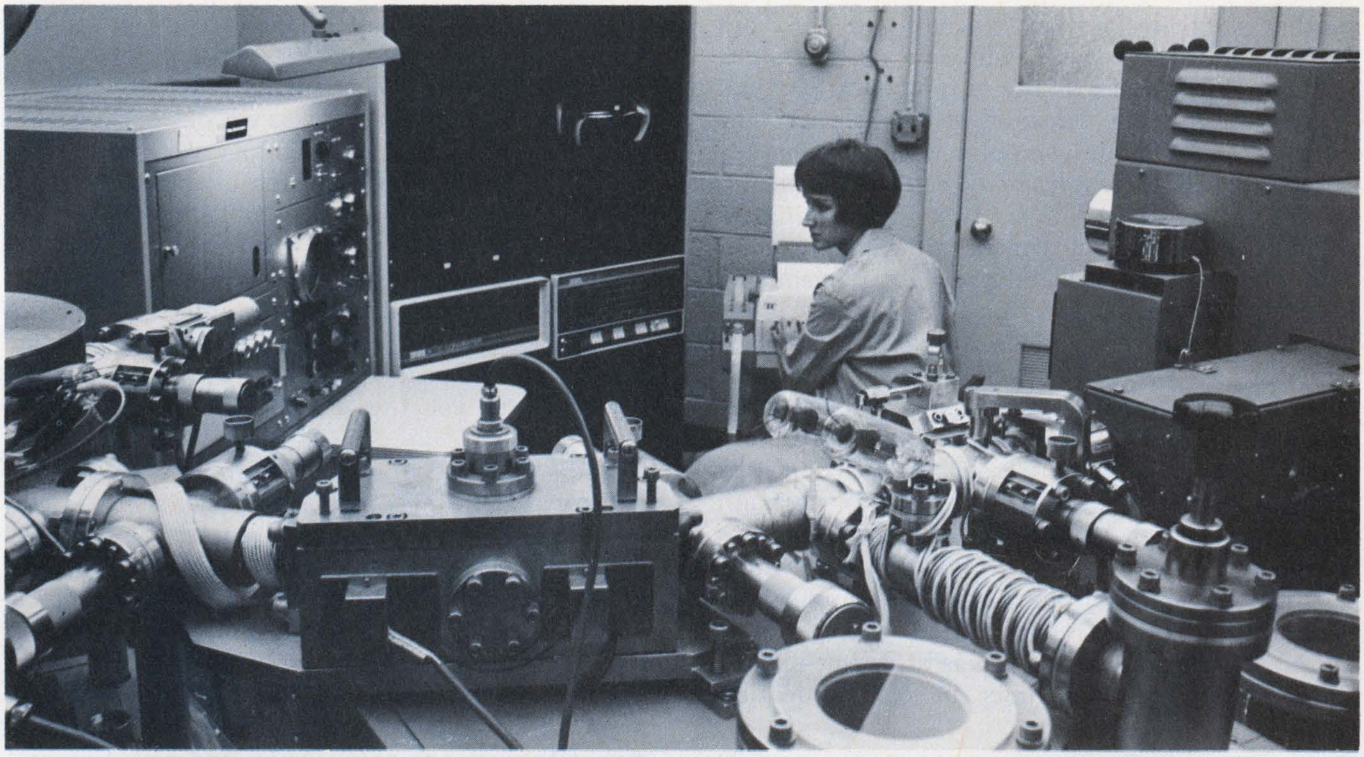
Up-to-date software needed

Another disadvantage of the time-sharing services' CAD programs, according to Fazarinc, is that they are obsolete. They are being maintained on-line only because nothing better is available. Fazarinc calls them obsolete because they are all linear programs with limited nonlinear capabilities. He thinks that the engineer with a nonlinear problem is better equipped to solve it if he has his own minicomputer at hand and can try out his own programs. Fazarinc says:

"Linear circuit analysis by computer is a waste of time. It has been done over and over again. If a circuit-analysis program can't do nonlinear problems, it is useless."

Fazarinc is particularly in favor of a minicomputer terminal dedicated to serving one engineer at a time. This permits the use of a program as a substitute for an actual circuit on a laboratory bench. The dedicated computer allows the engineer to study his circuit in depth; to examine its performance at any point. A plotter, or a device as simple as a strip-chart recorder, can be attached to the computer to make hard copies. The low cost of the minicomputer makes such dedicated operation possible.

It is likely that these two strongly opposing opinions—that minicomputers cannot design effectively, on the one hand, and that they will displace commercial time-sharing services, on



Mass spectrometer measurements are run in a laboratory environment under the control of a minicomputer.

The use of semi-skilled personnel foreshadows similar applications in the field.

the other—overstate the case for and against the in-house, stand-alone minicomputer. The future will probably see some compromise in marketing positions.

A projection by the Diebold Group, Inc., a New York management consulting concern, indicates that another rapidly growing segment of the computer industry over the next five years will be in information services. This category includes time-sharing services as a significant component. Diebold says that there is room for both the time-sharing and minicomputers to grow here.

On the lower level of capabilities, the desk-top calculator enters as a possible competitor of the minicomputer. Some programmable desk-top calculators have a degree of sophistication that approaches that of the minicomputer. But the price does, too—and that is the kicker. The most elaborate desk-top calculators, which are completely self-contained machines (they require no auxiliary equipment to perform their functions, however limited), can be installed on an engineer's desk for about $5000. The addition of such frills as a printout and a plotter can double this figure. A time-shared minicomputing system with eight terminals can be installed for $25,000 to $50,000. Each terminal costs as little as $3000 and is, therefore, competitive with the desk-top calculator.

The likelihood is that the winner in this particular showdown will be the mini. Sophisticated desk-top calculators will be forced to become either more simple (and cheaper) or more elaborate—until they, too, are minicomputers.

The problem-solving minicomputer will carve out a niche for itself between the successors of the adding machine on one side and sophisticated commercial time-sharing services on the other. It is likely that none of the three manufacturing categories will suffer too badly in this competition, because each will grow in its own area as the market expands.

Minicomputers to concentrate data

Communication of data over leased telephone lines is very expensive. It is, in fact, one of the major cost items in the use of commercial time-sharing systems. One reason for the high cost is that most user terminals are standard teletype or electric typewriters that operate at low data rates. The ordinary voice-grade telephone line is capable of transmitting data considerably faster than the average terminal can handle it.

Other factors enter into the cost of using telephone lines in time-sharing. Users operate in an on-line mode when, in reality, they are only pondering their next step. A user who is attempting to decipher the computer's diagnostic statement while on-line is wasting valuable telephone time. High-speed terminals can transmit data more rapidly, but they cannot speed up the operator of the terminal.

Because of these considerations, the minicomputer will become a partner of time-sharing in another way: as a data concentrator for both the user and the service. The concept is simple. Use a minicomputer at the output of a terminal to store data being transmitted by the user. The memory in the minicomputer thus becomes a fairly large buffer storage. When all of the information has been delivered by the terminal to the minicomputer, the central time-shared computer can be accessed and the data transmitted at high speed in a brief time. The process is reversed for data transmisison from the central computer.

When a time-shared computer user has many terminals at one site, the technique is even more useful. The user in this case can be connected continuously to the central computer through only one data line. All of the terminals feed into the buffer storage in the minicomputer, which in turn transmits the data over the single line. In addition to the computations being time-shared, the data transmission is also time-shared with a consequent savings in communication costs.

First used in laboratories

The earliest applications of minicomputers were in the development laboratory, where the ability of the machine to digest large stores of data was of special interest.[4,5] Engineers and scientists were among the first to conceive of the possibilities of small computers, and they provided the impetus that led to the development of the minicomputer.

At first, the computer was used to record data and to perform elementary operations on it. As the technique became more elaborate, the minicomputer was required to perform at higher and higher levels, until the current capabilities were reached. Now, engineering measurements that require many days or weeks of conventional data-taking by technicians and computation by engineers can be completed in hours.

The key to the technique is to make use of measuring instruments as peripherals to the minicomputer. The instruments must either have computer-compatible digital outputs, or, if they are analog instruments, they must have a suitable analog/digital converter as an interface to the computer.

Interactive experiments made possible

One unique consequence of the minicomputer in the laboratory is the practicality of interaction between the engineer and the experiment. The computer is operated on-line. The results of an experiment are available in real time, so the experimenter can return to the set-up, modify it and obtain new results—all in less time than it previously had taken to copy down the readings of the instruments.

The practicality of using a minicomputer in the laboratory to perform as an on-line controller for the taking of data and as a computer for the reduction of data depends on many factors. They include the kind of data being taken and the speed at which it is read; the amount of computation needed to reduce the data to usable form; the need for modification of experimental set-ups as the experiment proceeds; and the quality and quantity of hardware and software necessary to get the experiment going in the first place.

The applications of the technique cover the electromagnetic spectrum and then some. Conventional electrical measurements—including voltage, time and frequency responses, spectrum analysis and the like—are commonplace. More abstruse applications include pulse-height measurements in high-energy physics, nuclear magnetic resonance, laser and maser phenomena and mass spectrometers. On the less sophisticated end of the list, the engineering and scientific applications merge with those of the test line and the factory. As older techniques become more familiar, they are adopted by the production department and new, sophisticated devices replace them in the science laboratories.

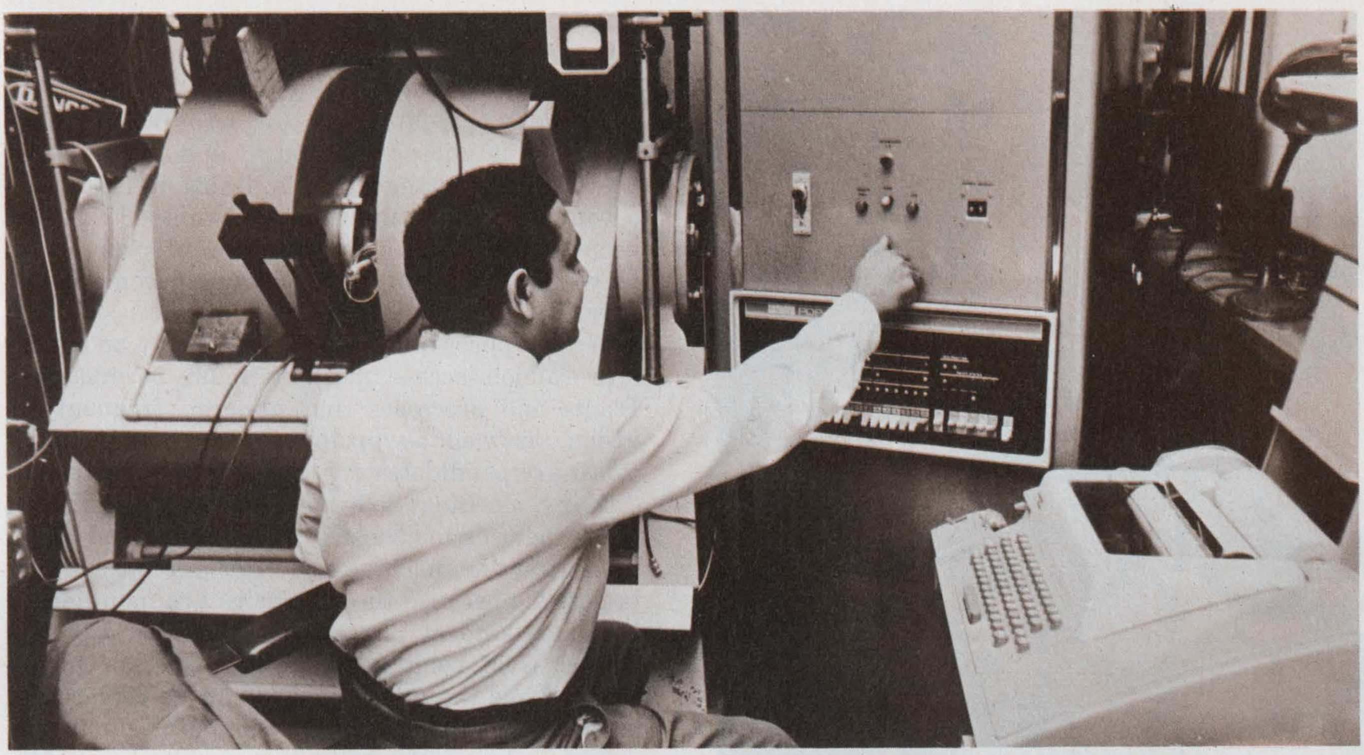
Hard-wired logic replaced

Hard-wired logic has been used for many years in many forms. Before logic terminology became common and before electrical engineers were aware of Boolean algebra, designs embodying these techniques were created with relays. One such application was an automatic elevator control. Later hard-wired circuits followed in the wake of electronic technology: vacuum tubes, thyratrons, semiconductor diodes, transistors.

There are three basic operations in hard-wired logic: interlocking, sequencing and selection. All of these can be performed with minicomputers. The sensing elements, whether they be switches, photoelectric devices, proximity devices or any other detector, become the peripheral devices for the computer. The interconnection of the logic that determines the mode of operation becomes either a computer program (software) or a microprogrammed read-only memory (firmware).

Minicomputer cuts design costs

The major reason for using a minicomputer to replace hard-wired logic is a reduction in cost. Each job requiring hard-wired logic is unique. The traditional approach has been to design the logic circuits—a process that requires the atten-



Nuclear magnetic resonance studies are being done with the aid of a PDP-8/L minicomputer by Dr. Garg of the National Research Council, Ottawa, Can. The resonance chamber in which magnetic and rf fields act on the sample is the large cylindrical device which is shown on Dr. Garg's left.

tion of engineers and draftsmen. Then it is necessary to procure the material, design and fabricate circuit cards, wiring and racks, and to manufacture and test the resulting product. The costs in this process can be considerable, even with relatively simple systems, because of the high labor skills involved.

Until the prices of minicomputers dropped to their present levels, the use of a computer as an alternative to hard-wired logic was not even considered. Now, however, it is possible to eliminate all of the labor costs of the design and manufacturing phases by using a computer. This does not imply that the use of the computer is free. There is the little matter of programming, either micro or macro, which erode a considerable portion of the savings. In some cases, it may cost more to program a computer than to design and build hard-wired logic. But the computer brings additional benefits.

One serious problem in the use of hard-wired logic is that the processes to be controlled are rarely specified fully at the time the logic is being designed. The engineers must make some assumptions that become part of the design. If the assumptions are not consistent, or if the process itself changes after the logic is designed, the logic must be modified after it is built. Such modification requires more engineering time, more documentation and rewiring, and this can easily double the cost of the original design.

But with a computer program, the modifications are made to the software, and this is a much simpler, and less costly and less time-consuming operation.

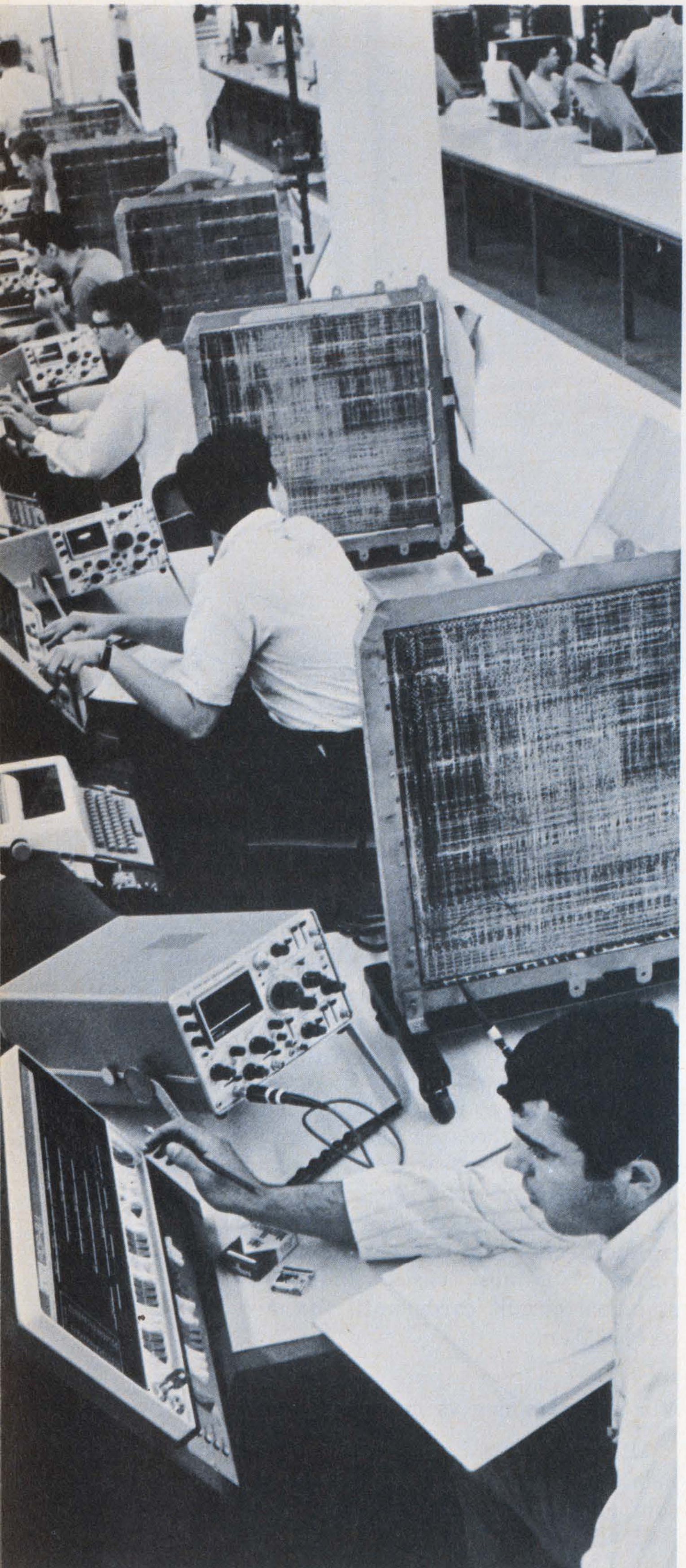
After the control system is put into operation —in a chemical plant, say—the plant may find it necessary to alter its operations. With the minicomputer, the alteration can be made by modifying the software again. With wired-in logic, the hardware must be ripped out and completely redesigned.

Maintainability is also improved with use of the computer, because the machine is a standardized component with a recognized maintenance procedure. The repair and maintenance of hard-wired logic requires the attention of a trained technician. Computer repairs can be performed, in most cases, simply by replacing standard circuit cards until the device is again in operation.

Microprogramming vs macroprogramming

Minicomputers designed to be used as replacements for hard-wired logic are usually called controllers. These machines are typically organized with 8-bit word length and either random-access memories (RAM) or a combination of random access and read-only memories (ROM). The 8-bit word and the ROM are factors in making minicomputer controllers the lowest priced main frames in computer catalogs.

When a read-only memory is specified, the



Minicomputers are used to test minicomputer subassemblies at the Digital Equipment Corp., Maynard, Mass. Besides performing all the tests, a hard copy of the results becomes part of the documentation of each part. The Digital plant now probably has the higest concentration of test minicomputers everywhere.

user is accepting some limitation on the flexibility of the machine in exchange for a saving in initial cost. However, complete flexibility is not usually a requirement for a controller. Since the ROM is microprogrammed and is not easily accessible for change, it is a desirable feature in a controller when unauthorized tampering must be prevented. The microprogram, of course, can be revised at any time should this become necessary.

If macroprogramming is necessary, an extensive random-access memory must be included. Plants and processes that undergo frequent revision, as well as protoypes for new installations, are candidates for computers with RAMs.

Many machines are now on the market that allow the user to choose between RAM and ROM, even after the machine has been purchased. This is possible because the memories are mounted on the same kind of plug-in circuit cards that give this class of computer a high degree of modularity. Thus the memory card can be replaced at a fraction of the cost of the computer should the original choice of memory prove to be wrong.

Minicomputers invade the factory

Minicomputers are about to become standard equipment in the modern factory.[6,7] By replacing hard-wired logic, they can function as machine and process controllers. They can also exercise supervisory control over a series of machines and processes. Probably the most significant new application is in running test lines[8] at both the incoming inspection and final test points.

The use of computers in factories is expanding into smaller and smaller plants. These applications involve the control of inventory, cost and labor units. Minicomputers can perform the entire function in small factories and can feed information into central computers in larger factories.

Numerical control has been another expanding area of computer use in manufacturing. Until recently, only large computers were available, so machine tools had to be controlled in groups to take advantage of the computer's capacity. Now the smaller machines allow integral computers to be installed on machine tools, with an important improvement in flexibility of use.

Computers test other computers

One of the most interesting minicomputer applications got its start not long ago when Digital Equipment Corp. began to use its own products to test its output. The Digital plant now probably has the highest concentration of test minicomputers anywhere.

Every stage of manufacturing is tied to a computer test line. Logic modules are tested through all of their functions in a small fraction of the time that the same job would take if done manually. As an added plus, a hard copy of the test results is immediately available for each module. If the unit passes, the printout is a record of the test; if it doesn't pass, the printout describes the repairs that are needed.

At higher levels of assembly, the computer-controlled test line performs similar, but more involved functions. Final test of virtually all minicomputers of any manufacture is now carried out by a companion unit. Programs are written to exercise all computer functions and to supervise environmental testing, since repeated heat soaks are a standard procedure in the quality-assurance procedure.

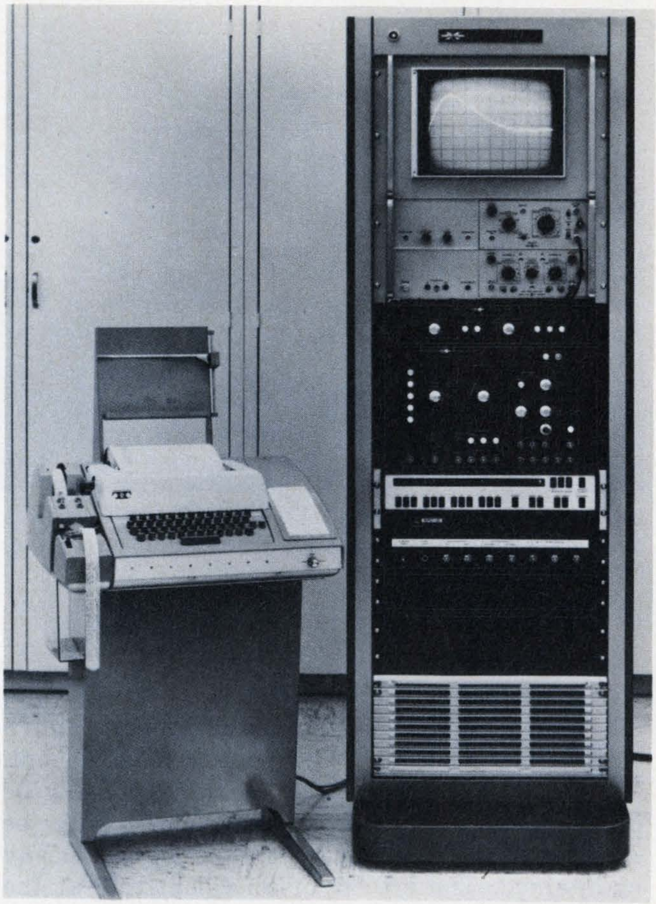
Manufacturers of other products also rely on automated test lines. Steel mills that produce tinplated sheets for cans use sensors connected to minicomputers to detect flaws in the plating. A large roll of finished sheet cannot be scrapped because of a few pin holes in the surface; neither can the flawed material be used for tin cans. The solution is to mark each flaw with paint as it is detected, so it can be removed at the canning plant. Simultaneously a printout of the location of each flaw is made by the computer. The printout becomes a permanent record of the roll of sheet and is attached to it when it is shipped. The record is also useful as a check on the plating process itself.

Test and manufacturing can be combined, as in an installation described by Computer Automation, Inc., Newport Beach, Calif. The controlled process is the trimming of a resistor to a high tolerance. The resistance is measured and fed into the minicomputer, which in turn controls a laser beam that burns away resistor material in precisely controlled increments. The process continues until the resistor meets the required tolerance.

Instant trouble-shooting possible

Diagnosis and repair of defective equipment is another related application. General Automation, Inc., Orange, Calif., has some computers attached to microphones and spectrum analyzers to monitor the performance of machinery. The computer performs a frequency scan and determines the spectrum of the sound. A defective part like a dry bearing has a different spectrum from a good one. This technique is capable of wide use (see "Curing Engine Failures Before They Occur," ED 7, April 1, 1970, p. 30).

The auto industry is toying with the idea of using minicomputers in its service organizations to speed the repair of cars and to help overcome the shortage of trained mechanics. The ingenuity of engineers in adapting sensing instruments to interface with minicomputers will rapidly expand this area of application.



Spectrum analyses are carried out in real time and the results can be obtained on the graphic display or on hard copy from the Teletype. The minicomputer is the SPC-12 manufactured by General Automation, Anaheim, Calif., and installed by Spectral Dynamics Corp.

'Family trees' can be built

Closely related to both factory operation and data concentration is the use of hierarchies of computers to oversee intricate operations.[9] The minicomputer, because of its small size, low cost and ruggedness, is installed at the lowest level of the hierarchy. It can control the unit operations of a plant. It can also be installed as a data concentrator for time-shared terminals. The minicomputers then communicate with a larger time-shared computer that performs computations and data reduction. This machine may also issue production orders to the computers in charge of unit operations. A larger central data processing computer is the highest level in a plant. All financial, production and cost data finally arrive at this machine for disposition. Thus the entire record-keeping and operational supervision of a large plant can be kept under the constant surveillance of one or more computers and data processors.

Instant evaluation of an experimental potato picker is done by a minicomputer at the Institute of Agriculture, Edinburgh, Scotland.

The ability of hierarchal computer control to display this omniscience has important ramifications for all levels of corporate management. Lower management's functions will probably be diluted, while higher management will be strengthened. Over-all control will be more easily maintained. The effects of miscalculation at the higher levels of decision may, however, prove more damaging.

A boon to hospital care

As engineers move away from the military aerospace area, they will begin to find employment in unfamiliar fields. One of these that possesses a world of electronic riches is the hospital. The minicomputer will increasingly demand more and more electronic expertise in the hospital.

Hospital use of computers is expected to be one of the major growth areas. The reasons are much the same as those in other applications: greater demands for service and fewer trained personnel to provide it. Typical uses for minicomputers in hospitals are in patient care and clinical applications. Further in the future are data retrieval and diagnosis.

Patient care requires the use of sensors interfaced with the computer. A typical installation[10] makes use of blood-pressure instruments, thermometers, respiration and pulse-rate transducers, as well as more elaborate devices like electrocardiographs and electroencephalographs. These instruments feed signals to a minicomputer that has a display unit at a nurse's station. Alarm levels can be set for each patient, to alert the nures to an impending crisis. Periodic printouts of each patient's readings provide a hard copy for the physician and replace the familiar and traditional hospital chart.

Medications and dosages can be programmed into the computer to remind the nurse at proper intervals. (A serious problem in some hospitals is incorrect or improper dosage administered by overworked nurses.) With more equipment, the computer can take over control of some types of therapy. Temperature can be maintained; artificial kidney dialysis and certain types of intravenous infusion can be controlled. The list can go on and on.

Minicomputers make all of this possible by being available at low cost. They can be divided among hospital floors in large urban medical centers, and they can be used with equal ease in small rural or suburban hospitals. The engineer may become as important an employee in the future hospital as the medical doctor is now.

End user vs OEM

The design of a computer control is a problem in system engineering. This simple fact has touched off one of the most intense debates in the minicomputer industry. The thesis is: Resolved, control systems are to be sold through OEM (original equipment manufacturer) channels. Manufacturers have taken positions ranging from the affirmative to the equivocal to the negative, with varying degrees of intensity. A look into the background of the thesis can be instructive.

A computer by itself can perform no useful function. At the minimum, it must have input and output devices properly interfaced and system software that directs it to operate. The average user of a control system is not a sophisticated computer engineer. He is, more likely, a man who wants a job done at minimum cost and maximum effectiveness and who does not care who or what does the job.

The minicomputer manufacturer, at this stage in the development of the industry, is relatively small but innovative. His financial resources, with some significant exceptions, are limited. He has no facilities for manufacturing peripheral equipment, and he has only a small staff capable of writing extensive programs.

A gap therefore exists between the user and the manufacturer that complicates the interchange of information. This gap is bridged by the OEM. The original equipment manufacturer supplies complete operational control systems to the user; he buys the computer from one source and the peripherals from others. He also provides the specialized software and instruction of personnel that is needed by the user.

The OEM performs one more very important task. He broadens the market, by bringing computer control to the attention of prospective users who would otherwise be ignorant of its advantages to their operations.

Manufacturers stake their claims

The marketing strategy adopted by a minicomputer manufacturer depends very heavily on his financial strength. The giants—Digital Equipment Corp., Hewlett-Packard and Honeywell—profess interest in the user market. The independents, on the other hand, eschew the user and woo the OEM. But the division is not that cut and dried.

Among the giants, Digital Equipment and Honeywell do a sizable business with the OEMs; and some independents are not averse to short-circuiting the OEM if a particularly juicy opportunity should come their way. Only Hewlett-Packard seems to have taken an unequivocal stand in favor of selling to the user, and this because of the unique capabilities that the company has in all areas of computation, instrumentation, interfacing and software.

Main frames are only one aspect

Prospective computer-control customers should not be beguiled by the low prices quoted for minicomputer main frames. A control system consists of the main frame, peripherals, hardware and software interfacing, maintenance and upkeep, and system software. One knowledgeable estimate is that each of the first four items accounts for one-sixth of the system's total cost, and the system software for the remainder. Therefore the typical minicomputer control system costs in the neighborhood of $60,000.

Maintenance and upkeep can present serious problems. No one doubts that peripherals, many with moving parts, can break down, but the reliability of the main frame is a matter of debate. Curiously, the larger manufacturers stress main frame maintenance more heavily than do the smaller ones. This is not because computers made by big companies are less reliable, but because big companies are more likely to have extensive repair facilities.

Maintenance and repair is not a serious problem for a sophisticated user. The design of all minicomputers is modular, with all components mounted on circuit cards. A minimum of instrumentation can localize a failure, and replacement of a card is simple. It is the unsophisticated user who may suffer seriously from a failure. If he bought his system from an OEM, he must rely on the OEM for service if complete satisfaction is to be expected.

One exhuberant exponent of the minicomputer —Data General's director of marketing—remarked recently (conservatively, some in the industry say) that there were 2000 potential applications for the machine. This report has covered about six of them. The others are out there in the field, where inquisitive engineers are busily interfacing small computers to anything that moves.

In the future, there is the possibility of a minicomputer in every kitchen and in every automobile. What is more likely is that the minicomputer will lose its identity as a breadbox-sized device and will be hidden inside of the equipment it controls. The likelihood of this development is based on maturation of the concept of large-scale integration of semiconductors.

Right now, LSI memories are beginning to appear as production items. Memories with 4000 bits on a 1-inch-square chip are now practical. Logic circuits with similar densities are somewhat further off, but they are imminent. LSI will have several effects on the minicomputer (and perhaps also the large computer). It will make all computers much smaller; it will make them cheaper. It may turn the semiconductor manufacturers into computer manufacturers, thereby making them direct competitors of their current customers.

At least one minicomputer manufacturer—General Automation, Inc., of Orange, Calif.—has recognized this threat and has taken steps to hedge its bets. It is selling its computer production as a package with system software; if it is pushed out of the hardware business one day, it will buy the hardware from others and continue to sell software. Others are ignoring the possible threat and staking their futures on the reputations they are developing.

Whatever the future holds for the minicomputer industry, it is certain to be lively, whether from a business[11] or a technical aspect. ■■

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(214) 399-2897

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(215) 644-7316

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Elko Sales
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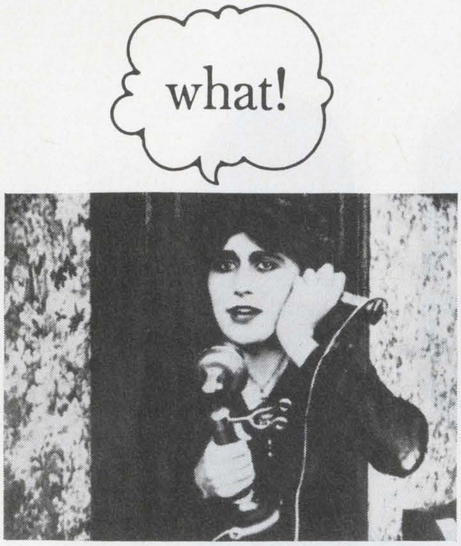
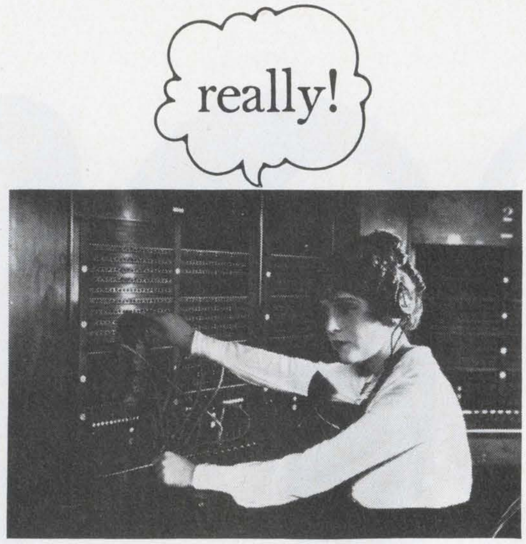
(312) 678-8560
(612) 920-8640

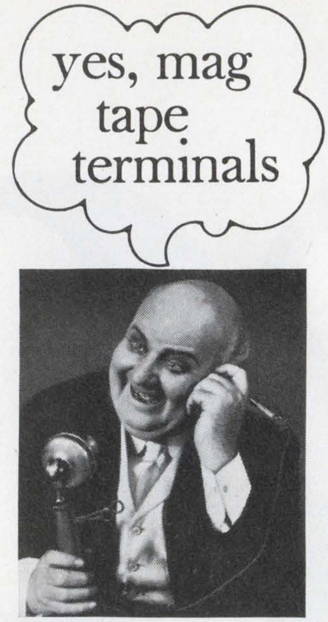
(513) 278-9411
(215) 647-2612

Schley Electronics
(617) 926-0235
(201) 935-2120
(516) 621-0025
(301) 948-0250

INFORMATION RETRIEVAL NUMBER 123





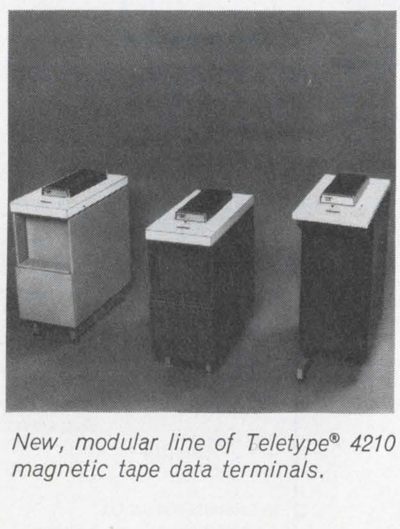


It's true.

After helping a jillion feet of paper tape wind and unwind its way through communications systems everywhere, Teletype announces the addition of magnetic tape data terminals.

There are some basic advantages in both mediums. But as you are well aware, the medium that's right for a system depends a lot on the application criteria.

The new magnetic tape data terminals have many operational features that make life less complicated for the operator.



New, modular line of Teletype® 4210 magnetic tape data terminals.

For example, take a look at the tape cartridge, which was specifically designed for reliability required for data transmission.

Its vital statistics are: 3″ x 3″ x 1″.

It contains 100 feet of ½″ precision magnetic tape.

It will hold 150,000 characters of data, recorded at a density of 125 characters per inch. The equivalent of a 1000 foot roll of paper tape.

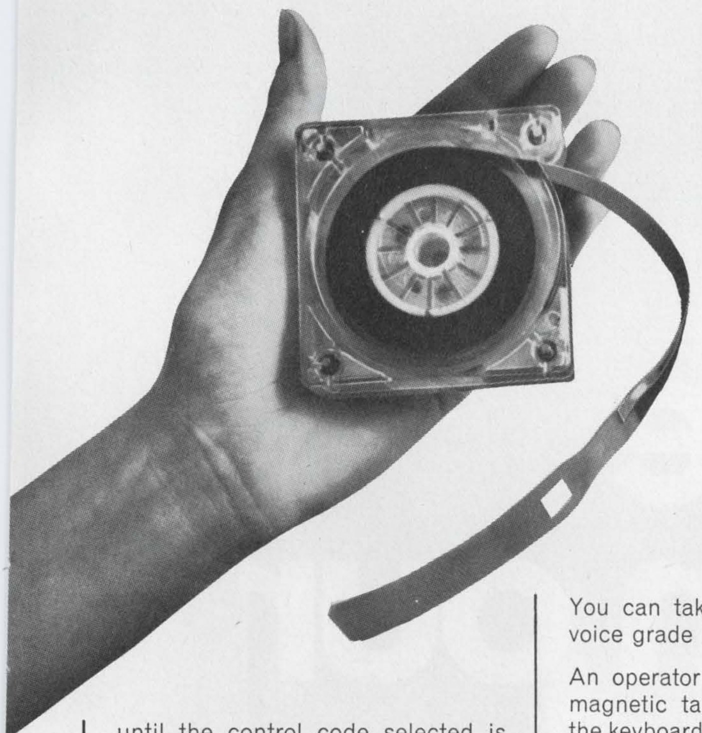
This means that your data is easier to store, easier to handle, easier to work with than ever before. And it's reusable.

DATA COMMUNICATIONS

equipment for on-line, real-time processing

The units have a "fast access" switch which will move tape forward or reverse at a speed of 33 inches per second. A digit counter provides a reference point to help locate various areas of the tape.

Four ASCII control code characters can be recorded in the data format to aid character search operations. When the terminal's "search" button is pressed, tape moves at the rate of 400 characters per second



until the control code selected is detected. Then the terminal stops the tape automatically.

A "single step" switch is also provided which enables you to move the tape forward or backward one character at a time. In editing or correcting tape, you can send a single character using this feature.

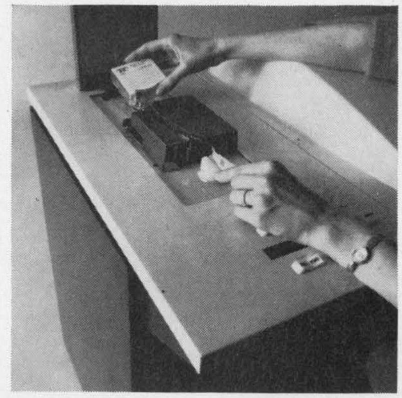
Also magnetic tape adds high speed on-line capability to low speed data terminals.

You can zip data along the line at up to 2400 words per minute. For example: Take a standard speed Teletype keyboard send-receive set, and a typical typist. Add a new magnetic tape unit to this combination and the on-line time savings can pay for the magnetic tape terminal in short order.

You can take better advantage of voice grade line speed capabilities.

An operator can prepare data for magnetic tape transmission using the keyboard terminal in local mode. Then send it on-line via the magnetic tape terminal up to 2400 words per minute.

These new modular magnetic tape data terminals offered by Teletype are perfectly compatible with model 33, model 35, model 37 and Inktronic® keyboard send-receive equipment.



Straight-through threading makes tape loading and unloading exceptionally easy.

They can send or receive at high or low speed. Or can be used independently as stand-alone terminals online.

If you would like to know more about this new line of Teletype magnetic tape data terminals, please write **Teletype Corporation, Dept. 89-15,** 5555 Touhy Avenue, Skokie, Illinois 60076.

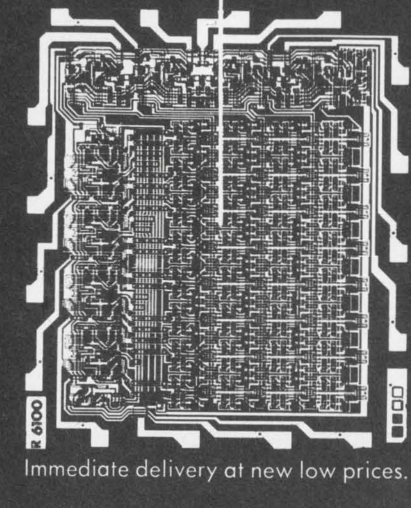
Teletype 4210 magnetic tape data terminal with 37 keyboard send-receive set.

machines that make data move

TELETYPE ®

INFORMATION RETRIEVAL NUMBER 124

We'd like to put in our 64 bits worth.



Immediate delivery at new low prices.

Dynamic range: 10^{-99} to 10^{+99}

Automatic special functions:
a^x, Log_{10}/Log_e, SIN/COS,
SIN^{-1}/COS^{-1}, $x!$, $\frac{1}{x}$,
Radians to Degrees,
Single key Σx, Σx^2, N,
Rectangular to Polar Conversion.

Just plug in
and put it to work.

Weight: Twelve pounds.

sales and service technicians. Monroe men who know everything there is to know about calculators. Because calculators are our only business. That's how we got our name. Monroe. The Calculator Company

A DIVISION OF LITTON INDUSTRIES

550 Central Avenue, Orange, New Jersey 07050

INFORMATION RETRIEVAL NUMBER 126

Product Source Directory

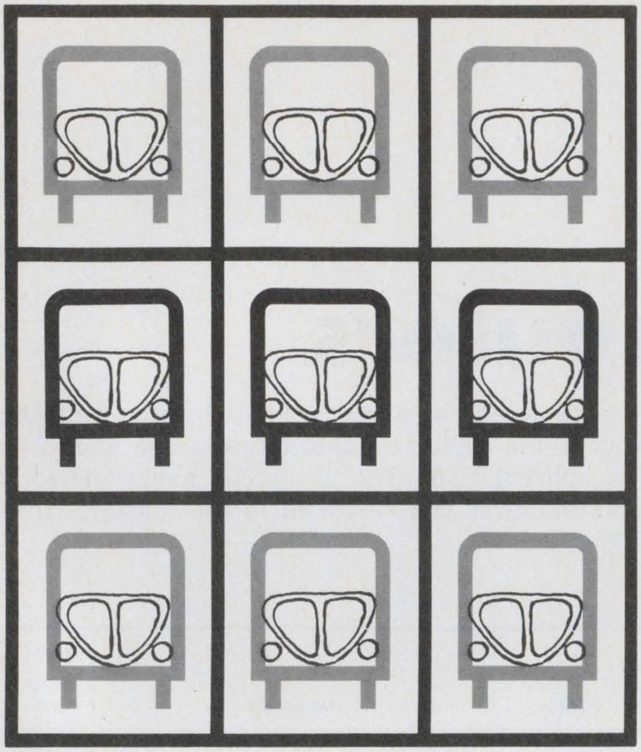
Minicomputers

This Product Source Directory covers Minicomputers.

For each table, the instruments are listed in ascending order of one major parameter, that column being color-coded white. All notes used in this table are in parenthesis and defined at the end of the section. Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the Master Cross Index below.

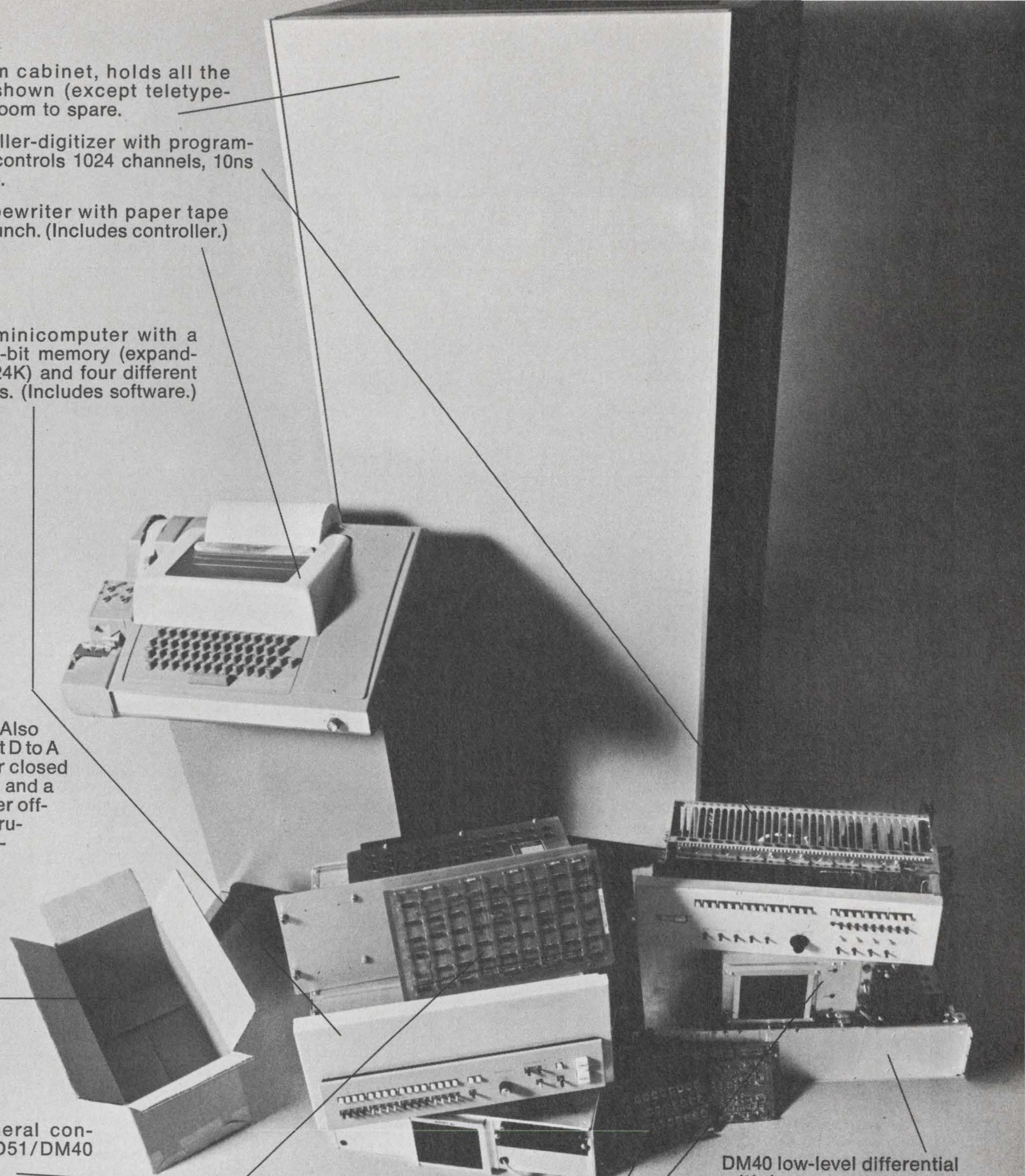
Abbrev.	Company	Reader Service No.
Bendix	Bendix Corp. Navigation & Control Div. Teterboro, N.J. 07608 (201) 288-2000	**443**
Cincinnati	Cincinnati Milling Machine Co. 4701 Marburg Ave. Cincinnati, Ohio 45209 (513) 475-8100	**444**
Clary	Clary Datacomp Systems 404 Junipero Serra Dr. San Gabriel, Calif. 91776 (213) 283-9485	**445**
Comp Systems	Compiler Systems Inc. P.O. Box 366 Ridgefield, Conn. 06877 (203) 438-0488	**446**
Data Gen	Data General Corp. Southboro, Mass. 01772 (617) 485-9100	**447**
Datamate	Datamate Computer Systems Box 3106 Big Spring, Tex. 79720 (915) 267-8766	**448**
DCC	Digital Computer Controls, Inc. 23 Just Rd. Fairfield, N.J. 07006 (201) 227-4861	**449**
DEC	Digital Equipment Corp. 146 Main St. Maynard, Mass. 01754 (617) 897-5111	**450**
DSC	Digital Scientific Corp. 14455 Sorrento Valley Rd. San Diego, Calif. 92121 (714) 453-6050	**451**

Abbrev.	Company	Reader Service No.
Elbit	Elbit Computers Ltd. Elron Inc. 9701 N. Kenton Ave. Skokie, Ill. (312) 676-4860	**452**
EMR	EMR Computer 8001 Bloomington Frwy. Minneapolis, Minn. 55420 (612) 888-9581	**453**
Foto-Mem	Foto-Mem, Inc. 6 Strathmore Rd. Natick, Mass. 01760 (617) 655-4600	**454**
GRI	GRI Computer Corp. 76 Rowe St. Newton, Mass. 02159 (617) 969-7346	**455**
H-P	Hewlett-Packard Co. 11000 Wolfe Rd. Cupertino, Calif. 95014 (408) 257-7000	**456**
Honeywell	Honeywell Div. Computer Control Old Connecticut Path Framingham, Mass. 01701 (617) 879-2600	**457**
Interdata	Interdata Inc. 2 Crescent Pl. Oceanport, N.J. 07757 (201) 229-4040	**458**
Lockheed	Lockheed Electronics Corp. Data Products Div. 6201 E. Randolph Los Angeles, Calif. 90022 (213) 722-6810	**459**
Micro Systems	Micro Systems Technology 644 E. Young St. Santa Ana, Calif. 92705 (714) 540-6730	**460**



Abbrev.	Company	Reader Service No.
Motorola	Motorola Instrumentation & Control Inc. Box 5409 3102 N. 56 St. Phoenix, Ariz. 85010 (602) 959-1000	461
Multidata	Multidata 7300 Polsa Ave. Westminister, Calif. 92683 (714) 892-8347	462
Raytheon	Raytheon Computer 2700 S. Fairview St. Santa Ana, Calif. 92704 (714) 546-7160	463
Redcor	Redcor Corp. P.O. Box 1031 Canoga Park, Calif. 91304 (213) 348-5892	464
ROLM	ROLM Corp. 10925 N. Wolfe Rd. Cupertino, Calif. 95014 (408) 257-6440	465
SCC	Scientific Control Corp. 1215 W. Crosby Rd. Carrollton, Tex. 75006 (214) 242-6555	466
Spiras	Spiras Systems USM Corp. 332 Second Ave. Waltham, Mass. 02154 (617) 891-7300	467
Tempo	Tempo Computers 1550 S. State College Anaheim, Calif. 92803 (714) 633-3660	468
Unicom	Unicom Inc. 1275 Bloomfield Ave. Fairfield, N.J. 07006 (201) 228-1696	469
Unicomp	Unicomp Inc. 18219 Pathenia St. Northridge, Calif. 91324 (213) 886-7722	470
Varian	Varian Data Machines 2722 Michelson Dr. Irvine, Calif. 92664 (714) 833-2400	471
Vari Systems	Varisystems Corp. 207 Newton Rd. Plainview, N.Y. 11803 (516) 293-6515	472
Wang	Wang Laboratories, Inc. 836 North St. Tewksbury, Mass. 01876 (617) 851-7311	473
Xerox	Xerox Data Systems 555 S. Aviation Blvd. El Segundo, Calif. 90245 (213) 772-4511	474

INFORMATION RETRIEVAL NUMBER 130►



YT19 system cabinet, holds all the equipment shown (except teletypewriter) with room to spare.

CD51 controller-digitizer with programmable gain, controls 1024 channels, 10ns aperture time.

TE33 teletypewriter with paper tape reader and punch. (Includes controller.)

CF16 minicomputer with a 4K x 16-bit memory (expandable to 24K) and four different I/O modes. (Includes software.)

Optionally available: MR50 high-level multiplexer and associated channels (approximately $2400 extra), if you want to mix high and low level signals. Also 10, 12 or 15-bit D to A converters for closed loop systems, and a variety of other off-the-shelf instruments and options to solve virtually any data acquisition problem.

PE20 peripheral controller for CD51/DM40 combination.

OP50 multiplexer switch card contains 8 switches with screw terminals. Each DM40 accommodates up to 16 such cards. Switch cards with other terminal types also available.

OP59 power supply for up to eight DM40s.

DM40 low-level differential multiplexer accepts up to 128 input signals (optionally expandable to 1024) in the range ±2.5mV to ±10V full scale, at a rate up to 20kHz, and with a CMR of 120db at DC.

All instruments and interfaces will be cabinet mounted and functionally tested together prior to delivery. If you're in a hurry, call (213) 679-4511, ext. 3668 or 3391.

XDS
Xerox Data Systems
El Segundo, California

The last reason you should buy our data acquisition system is the price: $21,600.

	Manufacturer	Model	Price $	Word Size (bits)	Memory Size (k bits) Min.	Memory Size (k bits) Max.	Memory Cycle Time (μs)	Instruction Set Size (number)	Software Availability	Interfacing Peripherals
MC 1	Bendix	BDX-6200	reg	20	4	16	3	95	yes	gen purpose
	Bendix	BDX-8000	reg	16	4	16	3	108	yes	gen purpose
	Bendix	BDX-9000	reg	16	4	32	3	70	yes	gen purpose
	Cincinnati	CIP/2000	2720	8, 9	0	32	0.22, rom	15μ commands	yes	(1)
	Cincinnati	CIP/2100	6162	8, 9	4	32	0.22, rom	89	yes	(1)
	Clary	404	7450	16	1	65	2	46	assembler	disc, printer, cassette, mag tape
	Comp Systems	CSI-16	10750	16	4	32	1	31	fortran IV (2)	typewriter (2)
	Comp Systems	CSI-24	14950	24	4	8000	1	31	(2)	typewriter (2)
	Data Gen	Nova	7950	16	4	32	2.6	200	fortran IV (3)	teletype (3)
	Data Gen	Super Nova	11700	16	4	32	0.8	200	fortran IV (3)	teletype (3)
MC 2	Datamate	16	14900	16	4	32	1	100	assembler (36)	teletype (36)
	Datamate	70 Processor	3900	16	(35)	(35)	0.6	50	assembler (36)	teletype (36)
	Datamate	70 Controller	5900	16	0.256	words	0.6 (37)	50	assembler (36)	teletype (36)
	Datamate	70 Computer	7900	16	4	32	1.6 (37)	50	assembler (36)	teletype (36)
	DCC	DCC-112	5900	12	4	32	1.2	n/a	fortran (4)	tape, drum disc, inst.
	DEC	PDP15/10	16500	18	4	131072	0.8	(8)	(8)	yes
	DEC	PDP-12A	29900	12	4	32	1.6	42	fortran (7)	yes
	DEC	PDP-11/20	10800	16	4	32	1.2	55	paper tape (6)	line printer (6)
	DEC	PDP-8/L	8500	12	4	8	1.6	8	fortran (5)	(5)
	DEC	PDP-8/I	12800	12	4	32	1.5	8	fortran (5)	(5)
MC 3	DSC	4001	8750	16	4096 1024	458752 4096	0.9 core 0.09 rom	(9)	assembler (10)	paper tape (10)
	Elbit	Elbit 100	4900-7000	12	1	4	2	106	assembler (11)	teletype (11)
	EMR	EMR 6120	7700	16	4	32	1.9	53	assembler (12)	teletype (12)
	Foto-Mem	Centaur 100	3810	4000	4	66	1	78	yes	printer, CRT
	Foto-Mem	Centaur 100	8810	4000	4	66	1	78	yes	disc, teletype
	GRI	909	8250	16	1	32	1.76	156 (basic)	assembler (13)	paper tape (13)
	H-P	2116B	24000	16	8	32	1.6	70	assembler (14)	paper tape (14)
	H-P	2114B	8500	16	4	8	2	70	assembler (14)	paper tape (14)
	Honeywell	DDP-416	reg	16	4	16	0.96	72	assembler (15)	mag tape (15)
	Honeywell	H316	reg	16	4	16	1.6	72	assembler (15)	mag tape (15)
MC 4	Honeywell	H112	reg	12	4	8	1.69	33	assembler (15)	mag tape (15)
	Interdata	13	15100	16	8	65	1.5	64	assembler (16)	teletype (16)
	Interdata	3	8900	16	8	65	1.5	63 (basic)	assembler (16)	teletype (16)
	Interdata	14	17500	16	8	65	0.98	73 (basic)	assembler (16)	teletype (16)
	Interdata	15	26300	16	8	65	0.98	73 (basic)	assembler (16)	teletype (16)
	Interdata	Mod 4 Processor	10900	16	8	65	0.98	72	assembler (16)	teletype (16)
	Lockheed	MAC16	11950	16	4	65	1	72	assembler (17)	teletype (17)
	Micro Systems	Micro 800	3200	16	0	32	1.1	16 (19)	cross assembler & simulator	teletype (18)
	Micro Systems	812	10000	8	4	32	1.1	105	assembler (18)	teletype (18)
	Micro Systems	810	6900	8	4	32	1.1	89	assembler (18)	teletype (18)
MC 5	Motorola	MDP-1000	6900	8	4.096	16.384	2.16	400	assembler (20)	teletype (20)
	Multidata	A	14995	16	4.096	65.536	0.88	163	assembler (21)	teletype (21)
	Raytheon	703	12750	16	4	32	1.75	74	assembler (22)	teletype (22)
	Raytheon	704	9750	16	4	16	1.5	74	assembler (22)	teletype (22)
	Raytheon	706	19000	16	4	32	0.9	74	assembler (22)	teletype (22)
	Redcor	RC-70	14900	16	65.536	524.288	0.86	35	assembler (23)	teletype (23)
	Rolm	1601	20000	16	4	32	2.6	124	assembler (24)	teletype (24)
	SCC	DCT-132	27950	8	2 (words)	4 (words)	2	21	(25)	teletype (25)
	SCC	4700	22500	16	4	64	0.95	144	assembler (26)	printer (26)
	Spiras	SP65	12400	16	4	65	1.8	150	assembler (27)	teletype (27)
MC 6	Tempo	Tempo I	13800	16/18	4	65	0.9	100	assemblers (28)	teletype (28)
	Unicom	CP-8A	1800	8	0.512	32	1.75	40	assembler	teletype (30)
	Unicom	CP-8B	2100	8	0.512	32	1.75	40	assembler	teletype (30)
	Unicom	CP-8C	3950	8	1	32	1.75	50	assembler	teletype (30)
	Unicom	CP-8D	4900	8	ina	1000	1.75	50	assembler	teletype (30)
	Unicomp	Comp-16	9800	16	4	65	0.9	29	assembler (29)	teletype (29)
	Unicomp	Comp-18	10500	18	2	262	0.9	29	assembler (29)	teletype (29)
	Varian	520/i	6000	8	4.096	32.768	1.5	50	assembler (31)	mag tape (31)
	Varian	620/i	9950	16	4.096	32.768	1.8	100	assembler (31)	mag tape (31)
	Varian	R-620/i	16900	16	4.096	32.768	1.8	100	assembler (31)	mag tape (31)
MC 7	Vari Systems	PAC-16-1	3000	16	8	520	1.75	61	assembler	teletype (32)
	Vari Systems	PAC-16-4	3850	16	32	520	1.75	61	assembler	teletype (32)
	Wang	3300	4950	8	4	64	1.6	74	assembler (33)	teletype (33)
	Xerox	CE16	9980	16	4	16	8	126-881	assembler (34)	teletype (34)
	Xerox	CF16	7990	16	4	32	2.6	126-881	assembler (34)	teletype (34)

Notes

1. 4k magnetic core memory, cycle time 1.1μs. Interfacing peripherals, teletype card reader, CRT, paper tape reader/punch, modems, disc memory.
2. Software, algol, basic fortran IV operating systems. Interfacing peripherals, cassette tapes, high speed tape, disc.
3. Software, disc operating systems, algol-60. Interfacing peripherals, magnetic tape, paper tape, disc, card punch, readers, incremental plotters, a-d/d-a converters.
4. Software, basic system, focal.
5. Software, floating point, macro-8, focal, algol, assemblers on-line editor, mathematical function. Peripherals, 25 available plus 6 processor options.
6. Software, assembler, editor, input/output executive math package, utilities. Peripherals, high speed paper tape, teletype, a-d/d-a converter, dc tape.
7. Software, focal conversational calculator, basic utility, mathematical, demonstration and maintenance package.
8. Memory reference instructions, 13 operating, 12 extended arithmetic, 26 input/output transfer, 5 basic. Software termed compact can be upgraded to the monitor based advanced software system by adding options.
9. Capable of emulating other 16 bit-per-word machines such as the IBM 1130 and 1800.
10. Software, simulator plus software available through simulation. Interfacing peripherals, punch and reader, card punch and reader, magnetic tape, disc, drum and x-y plotter.
11. Software, diagnostics, debugging, editing, multiple arithmetic, utility input/output. Peripherals, tape reader, tape punch, magnetic tape, drum, a-d/d-a converter, card reader, printer.
12. Software, real-time monitor, utilities. Peripherals, paper tape, line printer, disc, communications equipment, d-a converters.
13. Software, editor, interpretive math package, utility routines. Peripherals, magnetic tape, disc, drum, card reader, a-d/d-a converters, relays, time clocks, pulse counters.
14. Software, fortran, algol, basic time shared system, disc operating systems, real time. Peripherals, teleprinter, paper tape punch and reader, card reader, 7 or 9 channel magnetic tape, mass storage discs, drums, line printer, plotter, time base generator, data phone interphase, d-a converter, general purpose cards.
15. Software, utility routines, arithmetic subroutine library, I/O library, debugging. Peripherals, mass storage systems, line printer, paper tape reader and punch, card reader.
16. Software, fortran, loaders, math routine, debugging. Peripherals, paper tape, mag tape, card reader, a-d/d-a converters, 360, 1108 interface.
17. Software, fortran, input/output, real time simulator. Peripherals, paper tape, drum, mag tape, card reader, line printer and buffered 10 channel.
18. Software, operating systems (teletype), diagnostics. Peripherals, paper tape, modem, card reader, input/output expander.
19. This is a micro-programmable minicomputer; as such it has no pre-defined instructions.
20. Software, input/output version, fixed point arithmetic, binary load/dump. Peripherals, document reader, high speed printer, communication modems, data recorder, typewriter.
21. Software, operating system, fortran IV. Peripherals, magnetic tape, paper tape, cassette tape, line printer, card reader, disc, plotter, modems.
22. Software, fortran IV, conversational fortran, real time operating system, editor, math library, sort/merge, diagnostics. Peripherals, disc, magnetic tape, card reader and punch, high speed paper tape, plotter, a-d/d-a, line printer.
23. Software, debug, tape edit, fortran IV, magnetic tape and disc operating system. Peripherals, disc, magnetic tape, line printer, card reader, high speed paper tape, communication interfaces, CRT displays.
24. Software, diagnostics, simulation. Peripherals, paper tape, card, line printer, magnetic tape, disc, plotter.
25. Software, emulators for DCT2000, 2780, user 200, 1004. Peripherals, line printer, card reader, communications couplers, CRT display, card punch.
26. Software, fortran IV, real time monitor, utilities. Peripherals, paper tape, cards, magnetic tape, disc packs, fixed head and disc, typewriters.
27. Software, fortran IV, loader, debug; editor, input/output library, math library, diagnostics. Peripherals, paper tape, magnetic tape, analog front end, plotter, printer, disc.
28. Software, fortran IV, operating system, debug, program up-dater, test and maintenance, math library. Peripherals, card punch and reader, paper tape punch and reader, CRT display, drum, disc, a-d/d-a, magnetic tape, line printer.
29. Software, fortran IV, math routines, floating point up to 7 words. Peripherals, card reader and printer, paper tape, magnetic tape, CRT display, modems, disc, printer.
30. Interfacing peripherals, printer, keyboard, alphanumeric display.
31. Software, debug, math, diagnostic, fortran, binary load dump, peripheral drivers. Peripherals, card punch and reader, disc, drum, paper tape punch and reader, plotter, oscilloscope, line printer.
32. Peripherals, disc, SEL810A, printers, librascope, plotter.
33. Software, compiler and executive for time sharing. Peripherals, cassettes, selectric input/output writer.
34. Software, utilities, math package, diagnostics, fortran IV. Peripherals, a-d/d-a, multiplexers, card reader, disc, magnetic and paper tape, modems.
35. Memory size, basic processor is memory independent, can accommodate a wide variety of memory types, includes LS1, read only, core.
36. Software, loader, debug, input/output systems, diagnostics, fortran, math package. Peripherals, paper tape reader and punch, card reader and punch, line printer, mag tape, disc, drum.
37. Cycle time is memory dependent varies upward from 0.6μs.

The Tektronix T4002
graphic computer terminal

Displays high-resolution graphics and alphanumerics
Brings computer access to your desk
Retains the display without high-cost refreshing
Features a Line-Buffer Edit Area on the CRT

When you face the difficult, time-consuming task of analyzing reams of alphanumeric computer print outs, think of *graphics.* Graphics is a format which lends itself to quick, easy, more accurate and complete analysis of data. Don't hamper your decision-making process with reams of alphanumeric print outs when the same data is retrievable faster and easier in clear, concise *graphics.*

The T4002 brings the benefits of local or remote computers to you on an individual basis, in the office, laboratory, production area, or wherever GRAPHIC and alphanumeric computer support serves you best!

The display device of the T4002 is the Direct-View Bistable Storage CRT designed, developed, and manufactured by Tektronix. A few of the more important features of this unique storage CRT are zero flicker, zero drift, and a density of 39 lines of 85 characters each. But most significantly, it retains displays without costly refreshing.

The T4002 saves Central Processing Unit time through operator use of the Line-Buffer Edit Area, where you edit, compose, erase, retype, verify, or delete. Compose a line of data in the Line-Buffer Area; then transmit it at your maximum baud rate, rather than at the slow manual keyboard rate.

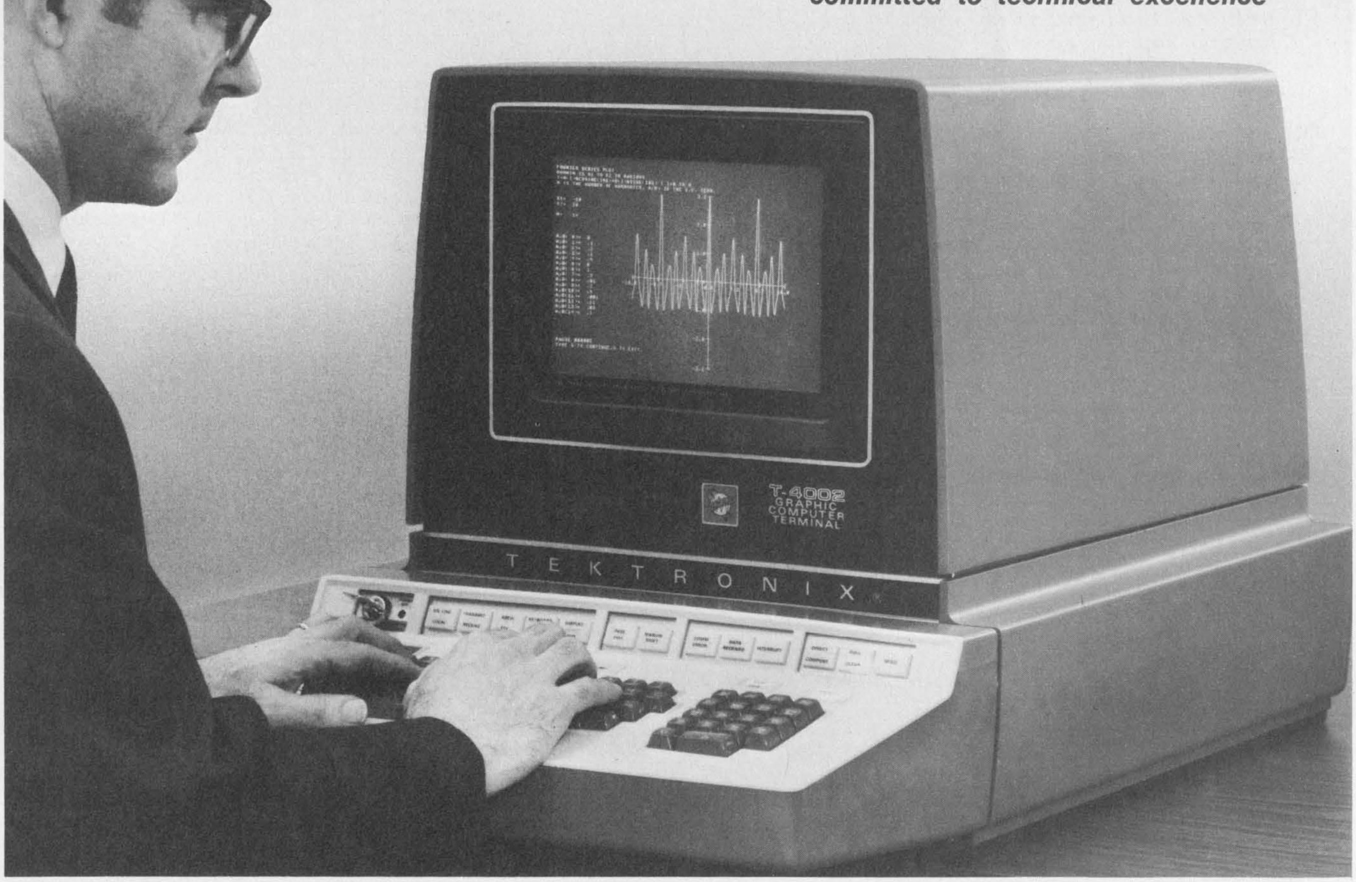
Alphanumeric outputs are displayed at an average rate of 2000 characters per second. Graphic outputs are by any of three programmable modes: Point plot, incremental plot and linear interpolation. The linear interpolate mode draws absolutely addressed vectors in 10 ms or less.

Tektronix has 57 domestic offices located in major cities throughout the United States and 48 foreign offices. For a demonstration or additional information, contact your local office directly. Or call (301) 825-9000 Baltimore; (617) 894-4550 Boston; (415) 326-8500 Palo Alto; or write Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005.

T4002 Graphic Computer Terminal $8,800
U.S. Sales Price FOB Beaverton, Oregon

Call today for a demonstration of the T4002.

Tektronix, Inc.
committed to technical excellence

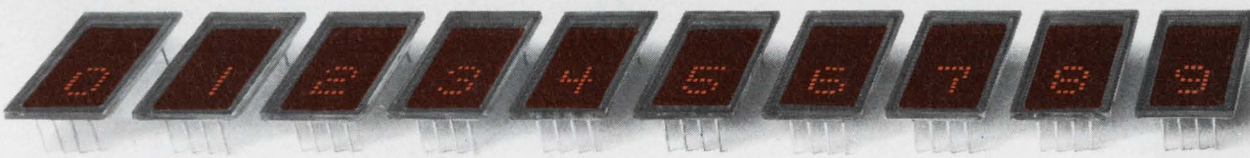


See the T4002 on-line at SJCC Booth 4900

INFORMATION RETRIEVAL NUMBER 131

For $25 what can you expect from a solid-state display?

10 years of brilliant service.



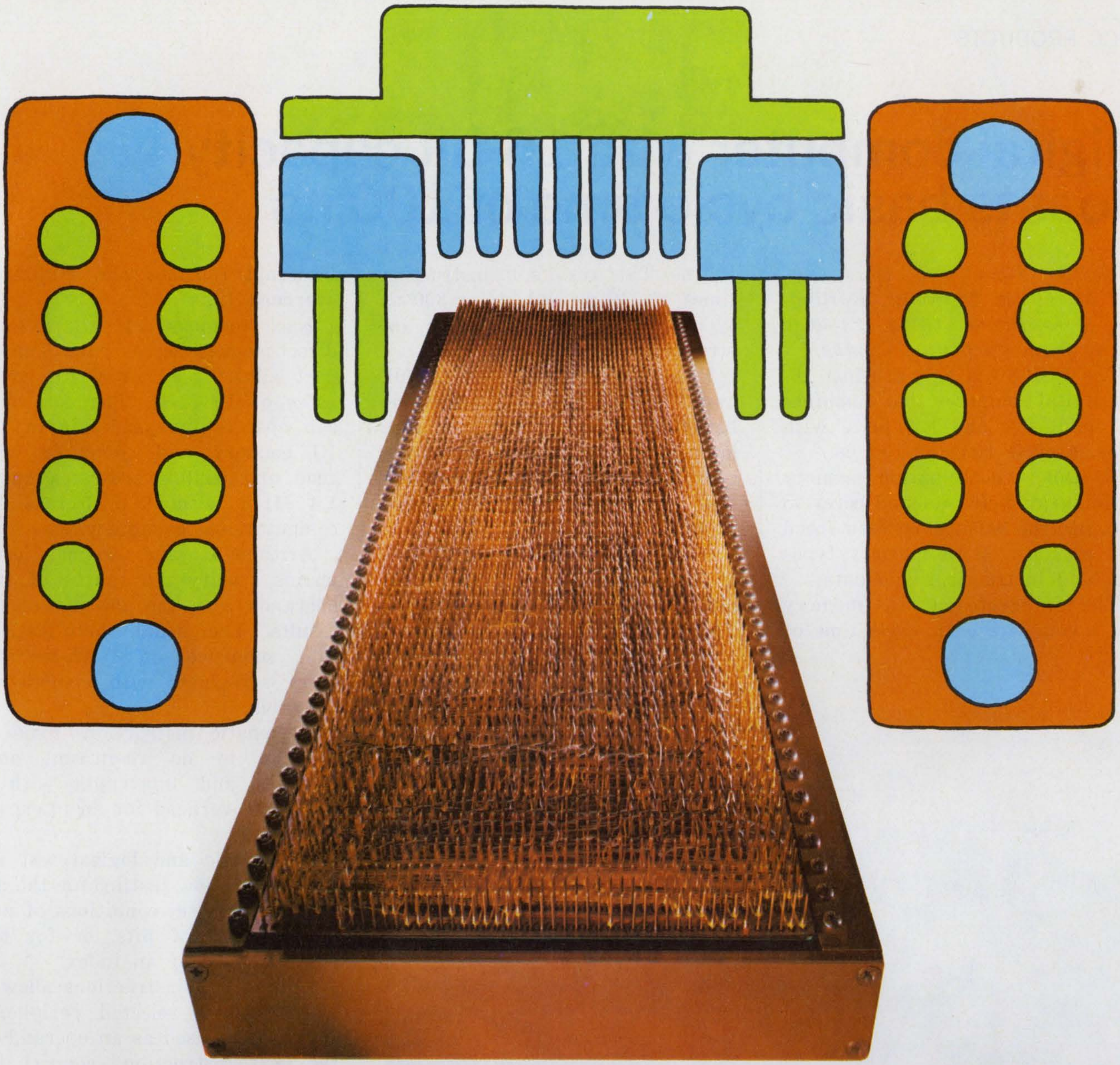
For $25 each in 1 K lots, HP sells you a hermetically sealed, IC-compatible display with on-board decoder-driver. You just plug the module in; it accepts direct 4-line BCD input. You also get a 5 x 7 dot matrix character that prevents ambiguous readings and a parallax-free design in a package that's one inch high and practically flat. It's the brightest display idea since the tube.

HEWLETT hp PACKARD

SOLID STATE DEVICES

Our reliability study shows that the 5082-7000 numeric display glows on for 24 hours a day, 7 days a week for more than 10 years. Ask your HP field engineer for a copy of the study plus volume price quotes on the biggest all-around bargain you can buy in solid-state displays. Or write Hewlett-Packard, Palo Alto, California 94304; Europe 1217 Meyrin-Geneva, Switzerland. 01005

INFORMATION RETRIEVAL NUMBER 134



Winchester Electronics

—their obsession with precision is solving tomorrow's problems today.

Problems—like connectors requiring post true positioning to within a mere .020 of an inch—won't stump Winchester Electronics. They've been making AccurFrame® as close to perfection as modern wire terminating machines demand.

And this fact proves the point: Of the various types of wire terminating connectors, only the HW Series by Winchester Electronics, positioned in AccurFrame, consistently meets the contact true position tolerances required by automatic wire terminating machines.

Now, if that doesn't say something for Winchester Electronics' AccurFrame, perhaps you have a connector requirement that does. Want to take us up on it? Write or call Winchester Electronics, Main Street and Hillside Avenue, Oakville, Conn. 06779.

WINCHESTER ELECTRONICS
DIVISION OF LITTON INDUSTRIES

INFORMATION RETRIEVAL NUMBER 136

Digital computer with 16-bit capacity boasts basic cycle time of 100 ns

Computer Signal Processors, Inc., 209 Middlesex Turnpike, Burlington, Mass. Phone: (617) 272-6020. P&A: from $85,000; 4 months.

The CSP-30 is an ultra-fast 16-bit digital computer that combines its small size and low price with a basic cycle time of 100 ns.

It uses a combination memory of integrated-circuits and cores to optimize the balance between speed and economy. Both memory types can hold instructions and data.

The integrated-circuit memory has a complete basic cycle time of 100 ns. This results in instruction times of 100 ns and up, or 300 ns typically, for over 3 million instructions per second.

The core memory has a full cycle time of 900 ns. But a unique background fetch allows the core latency time to be ignored, so the core can look only 100 ns slower than the IC memory, or only 200 ns in many problems.

A programmer can avail himself of 32 accumulators, of which 14 may be used as index registers. This allows accumulators to quickly interrupt routines and minimizes overhead time.

Each memory has an optional direct-memory-access port. The IC port allows read or write word-rates of 10 MHz. The core port can operate independently of the IC memory and computer with read and write word-rates up to 1.4 MHz, without a decrease in computational capability.

Arithmetic and logical commands specify the source of two operands and the destination of results. The usual three-instruction sequence of fetch-operate-store is replaced with a single instruction.

Automatic instructions make it possible to do re-entrant subroutines and interrupts with a complete overhead for an interrupt of 1.2 μs.

Arithmetic and logical test instructions allow testing for the set or for the re-set conditions of any combinations of bits, or for the relative state of an index.

Unique I/O instructions allow a word from a selected peripheral device to be used as an operand in the next instruction (connect input). They also allow the result of the next instruction to be transferred to a selected output device (connect output).

The I/O subsystem includes both high-speed and party-line channels and provides for externally or program-initiated multiple multi-level priority interrupts. Each channel has status information features that allow simple interfacing with any real-time or conventional peripheral.

A dual-deck magnetic-tape (cassette or cartridge) I/O device and a Teletype KSR 35 are provided with the basic system for simple program entry and off-line storage.

A power-threshold sensor permits major power deviations to cause a program-directed dump of volatile data from the IC to the core memory for later retrieval.

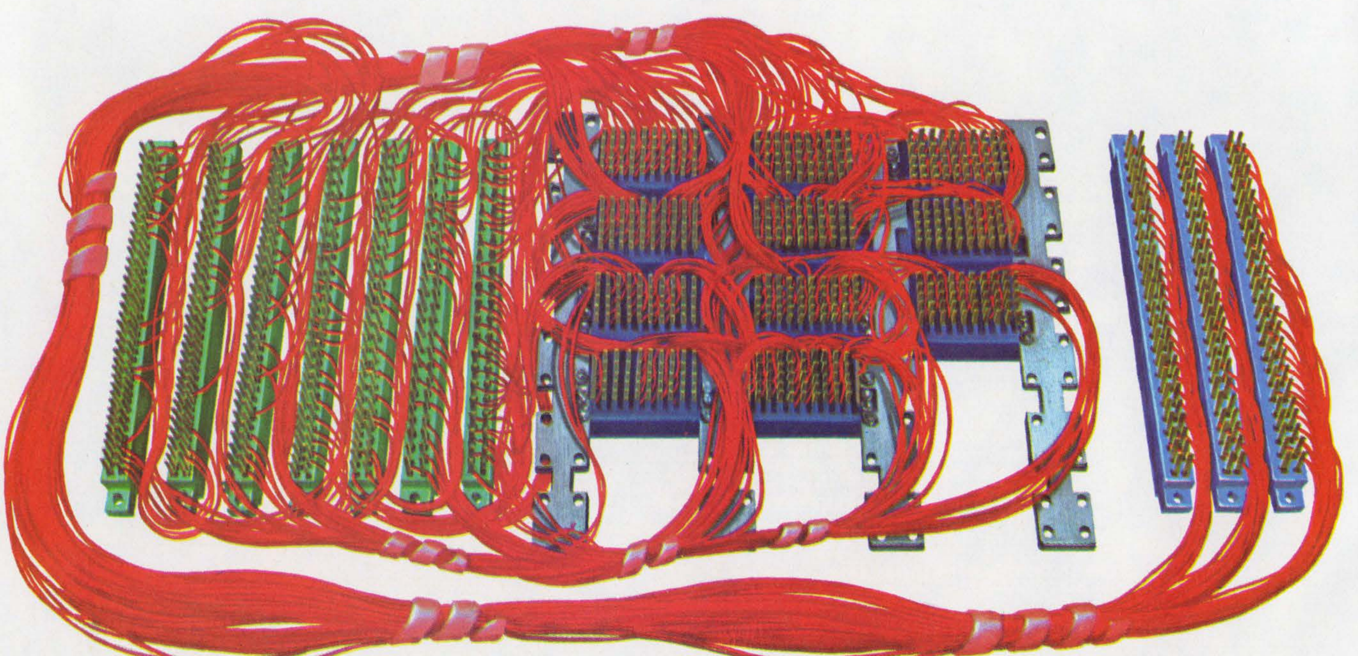
Booth No. 6103 *Circle No. 268*

Using a combination memory of ICs and cores, a new low-cost high-speed 16-bit digital computer features a basic cycle time of 100 ns.

Now there's a pack
Everything includ
plant or ours.

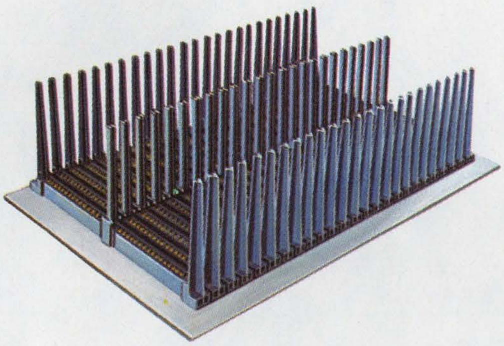
Our plan is whatever you want to make it. It can be everything you need for your panels. Or just some of the things.

We can start serving you at the design stage. Or we can provide components to meet your designs. We can supply all the wiring, too. Our own TERMI-POINT★ point-to-point automatic wiring system that works with solid or stranded wire, and is easily maintainable. Your capital investment to get your panels wired with our method is zero. Whether you wire in your plant or we do it in ours.

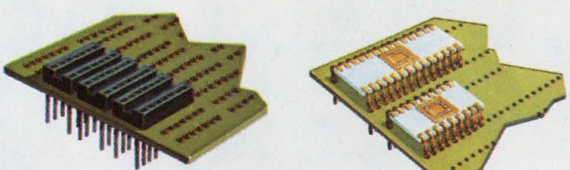


age plan for panels. ing wiring...in your

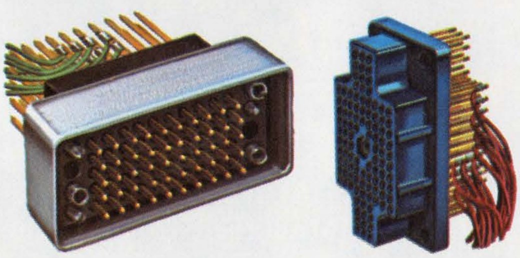
Printed Circuit Connectors. One piece or two piece. In a great variety of sizes that can all be wired automatically on TERMI-POINT or wrap-type posts.



IC Packaging Panels. We can supply header components in a wide variety including Dip Headers, Miniature Spring Sockets, and various IC Sockets. All available with TERMI-POINT, wrap-type or solder posts.



Input/Output Connectors. Both M Series and High Density Rectangular Connectors are available with rear posts for automatic wiring. They can be panel mounted and are obtainable in a host of position sizes. Both are furnished with TERMI-POINT or wrap-type posts.



Your plant or ours. It doesn't really matter which. You can wire with our machines in your plant. Or let us do it for you in our plant. To your specifications, of course.

If you're interested in what else we can do with panels, write for more information to: **Industrial Division, AMP Incorporated, Harrisburg, Pa. 17105.**

See us at booth #5000

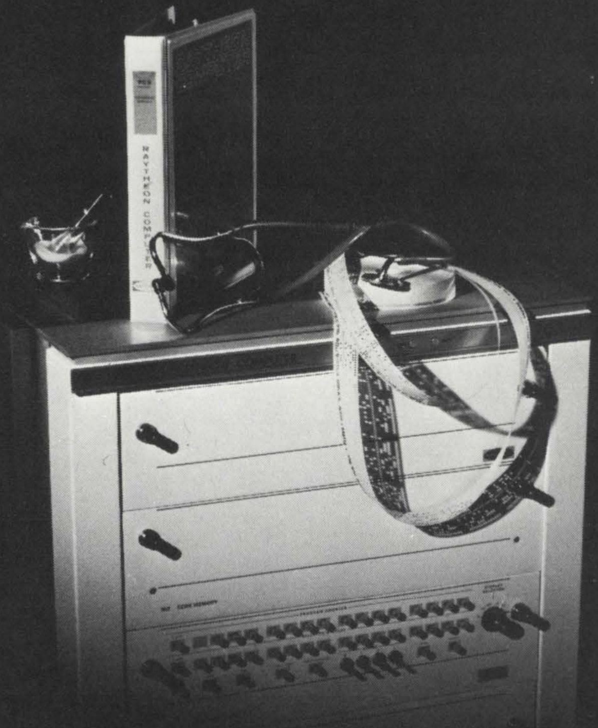
★Trademark of AMP Incorporated

AMP
INCORPORATED

INFORMATION RETRIEVAL NUMBER 138

If you think you need a giant computer for multi-programming, you don't know about Raytheon Computer.

DNA knows.



To get the power of multi-programming without paying the usual premium, Diversified Numeric Applications (DNA) of Minneapolis, Minn., selected one of our 16-bit computers and an auxiliary mass memory for their new Automated Clinical Laboratory System.

Testing has been made faster and more accurate in a versatile system that even allows real-time, on-line system interaction with lab personnel.

You can get the same kind of power into your systems from Raytheon Computer.

Power in hardware. CPU's with cycle times from 900ns to 1.75μs. All with direct I/O to the CPU, 4 addressable registers and 74 instructions. And priced from under $10,000 to $19,000.

More power in the options. Hardware multiply/divide. Direct memory access. An Array Transform Processor. All the standard peripherals. And instant Raytheon Computer interfaces for any non-stardard equipment your system needs.

And powerful software that bumps the Raytheon Computer 16-bit machines into the large computer class when it comes to doing your job.

Executives and monitors for multi-programming and time-sharing systems. Operating systems for mag tape and discs. A 360-compatible superset of FORTRAN IV. Conversational FORTRAN you can run in just 4k of core. And the fastest, most accurate math library in the 16-bit computer class.

In all, over 400 tested, debugged and proven programs and subroutines. All off-the-shelf today.

So write for all the details. Ask for Data File C-183. There isn't a better price/performance story in the industry.

RAYTHEON

Raytheon Computer, 2700 S. Fairview St., Santa Ana, Calif. 92704. Phone 714/ 546-7160.

Desktop $500 data display is self-contained terminal

Hazeltine Corp., Industrial Products Div., Little Neck, N.Y. Phone: (212) 321-2300. P&A: $500; stock.

Incorporating a keyboard input and a CRT monitor in a single compact desktop package, a new display terminal for $500 can present 1760 characters on 32 lines of 55 characters each, or 1998 characters on 27 lines of 74 characters each. In addition, model 1760 offers split-screen capability and full editing features.

Characters have a 5x7 dot matrix structure, and character generation is by means of ON/OFF control of a standard 525-line TV raster. Nominal transmission rate for the new terminal is 110 baud, adjustable to 2400 baud or to below 110 baud.

The 1760's editing capabilities include single character insertion and deletion, as well as the insertion and deletion of full character lines. The character repertoire encompasses 64 standard ASCII upper-case alpha, numeric and special characters, or 96 standard ASCII characters excluding only the lower-case ones.

In addition, selected data transmitted by the computer cannot be modified by the keyboard operator. This data is in the background (protected) and is displayed at a lower intensity than foreground (unprotected) data.

Background and foreground data can also be used to establish fields for use in hardware functions. For example, a tabulation feature allows the cursor to be moved to the first foreground character following the next background field. Only foreground information, which is entered by the operator or is non-protected computer data, can be transmitted from the display.

Additional distinctive advantages of the 1760 include: programmable tabulation, off-line formatting, problem-free interfacing with magnetic-tape and hard-copy system, flicker-free viewing, and fully interactive performance.

Monitors with 9 and 12-in. screens are available.

Booth No. 49012   Circle No. 265

Modular terminal computers talk to any other system

Victor Comptometer Corp., Business Machine Group, 3900 N. Rockwell St., Chicago, Ill. Phone: (312) 539-8210. P&A: $7000 to $100,000; 3 months.

Demonstrating their compatibility with large computers, the series 800 desk-size terminal computers feature the ability to communicate with any other terminal around the country or act as free-standing systems.

They exhibit a unique modularity, large memory capacity, full computer capabilities and fast execution times. Flexibility is afforded with a wide range of peripherals such as cards, paper tape, cassettes, ledger cards and dual-form feed devices.

Beginning with a skeleton mainframe, series 800 components can be added to a simple billing and accounting computer, transforming ing it into a sophisticated on-line terminal or a magnetic ledger-card computer.

The model 820/03 and 820/04 terminals can transceive any set of control characters in any message size or configuration and any five to nine-level code.

Both vertical and longitudinal parity checking are used. Transmission speeds of 50 to 2400 bits per second, in either synchronous or asynchronous modes, are achieved.

By combining a number of series 800 computers with an 820/51 communications control unit and an 820/56 magnetic-tape unit, up to 32 terminals can be interconnected via direct cable or data set.

The model 820/56, under control of the model 820/51, can read and write standard 1/2-in. tape at packing densities of 200, 556 or 800 characters per second.

Each of the 800-series computers can work independently to perform a complete range of business operations. These include billing, payrolls, accounts receivable and payable and inventory control.

The use of terminals saves over half of a computer system's time, since terminals speed up inputs, check data for error before input, and act as back-ups in case of a central computer breakdown.

The series 800's modularity allows systems from $7000 to $100,000 to be formed without the replacement of initial equipment.

The 820/03 terminal can be leased at $200 to $650 per month.

Booth No. 5719 *Circle No. 267*

Time-shared display trims cost per monitor

Data Disc Inc., 1275 California Ave., Palo Alto, Calif. Phone: (415) 326-7602. Price: $2500 per display.

A new time-shared graphic display system drops the per-unit cost to $2500 for each display in a 16-terminal network. Each TV-compatible terminal can display a different picture showing both graphics and alphanumerics on its 512x512-point screen. Over 4000 characters can be presented on each monitor.

Booth No. 111 *Circle No. 260*

Digital metal cassettes ground static charges

Scovill, Auricord Div., 35-41 29th St., Long Island City, N.Y. Phone: (212) 361-7400.

Able to fit any standard cassette machine, series CM metal digital cassettes eliminate static-charge problems because their metal housing acts as a ground to drain off static charges. In addition, the housing ensures precise dimensional stability and contains ball-bearing tape guides for exact tape location and low internal friction. Screw-together construction allows easy access.

Booth No. 50002 *Circle No. 273*

Trounce trimmer troubles

with Dale Industrial and Commercial T-Pots

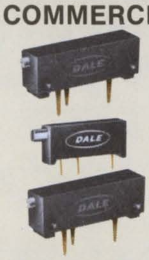
RCA's widely-used Spectra 70 computer is a good example of Dale Trimmers' year-in, year-out dependability. The models shown here are from Dale's 2100 wirewound series...sealed to meet tough RCA immersion requirements. Used in a number of Spectra 70 control and voltage reference applications, they're part of Dale's workhorse line of industrial and commercial trimmers. Nothing fancy...but you get what you need, when you need it—and you can use all you receive. Dale trimmers have a record of less than 1% customer rejection for *all* causes. Join the growing number of trimmer users who've found there's less trouble when you specify Dale.

Call 402—564-3131 for complete information or write for Catalog B.

DALE®

DALE ELECTRONICS, INC.
1300 28th Ave., Columbus, Nebr. 68601
In Canada: Dale Electronics Canada, Ltd.
A subsidiary of The Lionel Corporation

COMMERCIAL GRADE ECONO-TRIM T-POTS



WIREWOUND ELEMENT

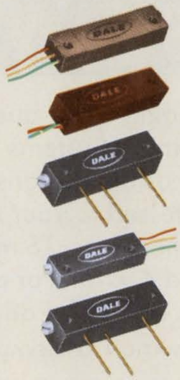
2300 Series: Sealed/Unsealed; 10Ω to 50KΩ, ±10%; 0.5 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

2400 Series: Sealed/Unsealed; 10Ω to 50KΩ, ±10%; 1 watt at 40°C, derated to 0 at 125°C; .31 H x .16 W x .75 L.

FILM ELEMENT

8300 Series: Sealed/Unsealed; 10Ω to 2 Meg., ±10% 100Ω thru 500K, ±20% all other values; .75 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

INDUSTRIAL GRADE T-POTS



WIREWOUND ELEMENT

100, 200, 300 Series: 10Ω to 100KΩ.
100 Series: ±5%; 0.8 watt at 70°C, derated to 0 at 135° C.
200 Series: ±10%; 0.5 watt at 70°C, derated to 0 at 105°C.
300 Series: ±15%; .25 watt at 70°C, derated to 0 at 85°C.
Dimensions: .22 H x .31 W x 1.25 L (also 1.32 L for 100, 200).

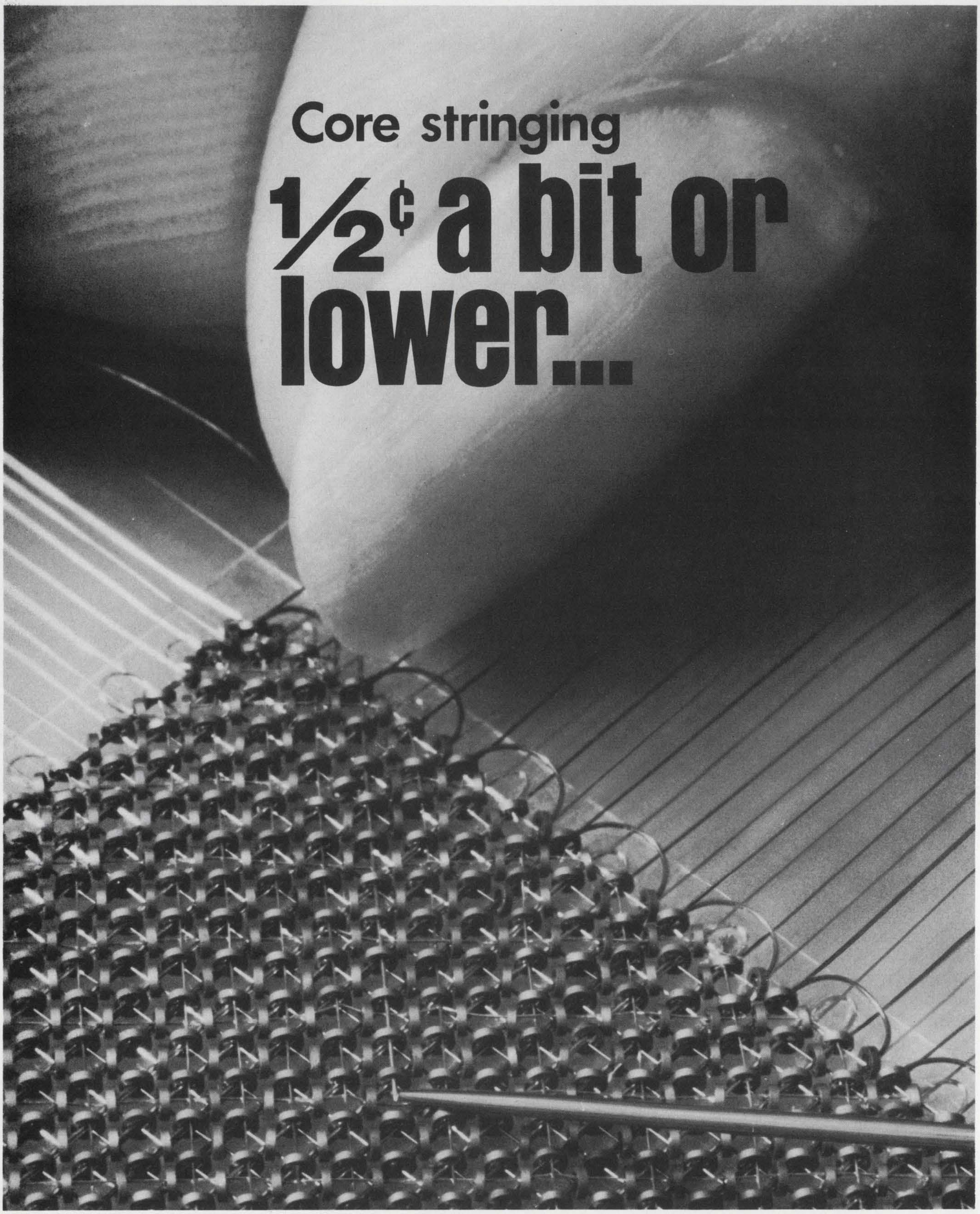
1100 Series: 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 175°C; .28 H x .31 W x 1.25 L.

2100 Series: Industrial counterpart RT-11; 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.

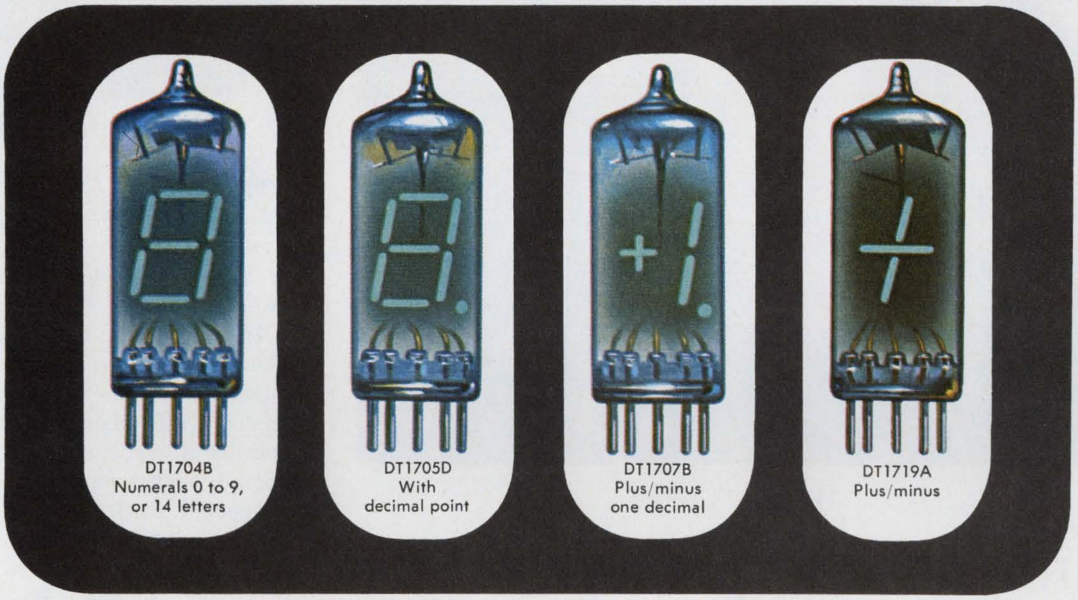
2200 Series: Industrial counterpart RT-10; 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 125°C; .18 H x .32 W x 1.00 L.

FILM ELEMENT

8100 Series: Industrial counterpart RJ-11; 10Ω to 2 Meg., ±10% 100Ω to 500K, ±20% other values; .75 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.

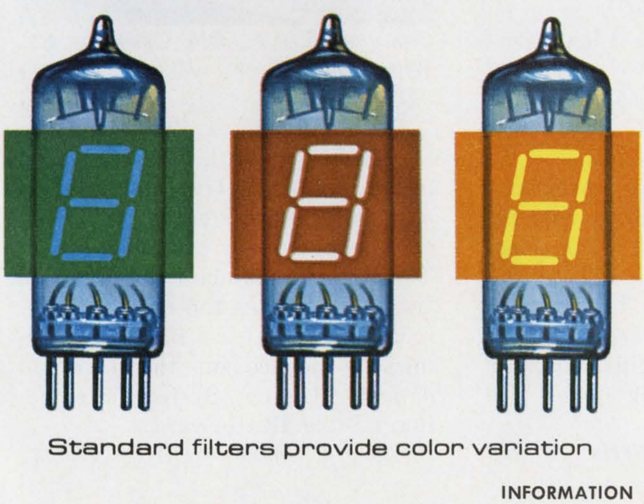

Core stringing
½¢ a bit or lower...

The Tung-Sol® development that created a whole new set of digital display standards



STANDARD CONFIGURATIONS

Low-voltage, low-power drain (25 V and 1.6 V) permits battery-operated applications. Standard miniature tube base. Inexpensive logic/driver requirements. Meets MIL specs. Space-age-type segmented character. Single plane display. Standard alphanumeric, or special symbols. Optimum visibility under ambient light conditions. Common filters provide unlimited color selection for identification, or to heighten contrast. Circuit-board mounting, with solderable-lead option. Write, or phone for detailed technical information and pricing.



Standard filters provide color variation

DIGIVAC S/G T.M.

VACUUM FLUORESCENT DISPLAY

TUNG-SOL DIVISION
WAGNER ELECTRIC CORPORATION
630 W. Mt. Pleasant Avenue
Livingston, N.J. 07039
TWX: 710-994-4865
Phone: (201) 992-1100; (212) 732-5426

INFORMATION RETRIEVAL NUMBER 143

Off-line/on-line printers improve copy and cut costs

Photon, Inc., Computer Graphics Div., 355 Middlesex Ave., Wilmington, Mass. P&A: $69,500, $11,900; 2 months for model 7700.

Two new typographic peripheral printers provide computer data in book-quality printed reports at low costs.

The 7700 (off-line) and the 7445 (off-line/on-line) printers produce completely formatted pages on phototypesetting paper, film or directly on offset masters, ready for production run by any printing process.

Until now, computer centers had to use peripheral line printers that were adequate for limited distribution only, and were limited in producing large volumes of reports for wide circulation.

Furthermore, line printers are usually limited in character design, stilted in format and uneconomical in use of page space.

With the 7700 and 7445 printers, management information systems need not rely on difficult-to-read copies spun out of line printers.

Operating at 300 lines per minute, the 7700 printer offers computer centers a supplementary device that prints readable type directly from a magnetic tape produced by the centers' own computers.

It can mix any two sizes of any two typefaces at any given time. Each typeface offers up to 105 characters consisting of capitals, lower cases, numerals, fractions, punctuation marks, and/or special marks, all in one style.

The 7445 printer is a lower-cost terminal printer that operates at 30 characters per second for on-line operation and 17 characters per second for off-line use.

Optional FORTRAN programs for the 7700 off-line printer enable the user to create additional graphic-arts qualities. These include hyphenless justification, multi-column text arrangements and multi-column justified tab.

Rental and leasing plans are available.

Booth No. 2008 Circle No. 269

CRT display terminal performs at 1200 baud

Computer Displays Inc., 223 Crescent St., Waltham, Mass. Phone: (617) 899-0480. Price: from $7950.

Intentionally designed to look like a teletypewriter to most computers, a new graphic/alphanumeric CRT display terminal can operate at speeds of 1200 bits per second over telephone lines. When connected directly to a computer, the operating speed of model ARDS 100A increases to 50,000 bits per second. Basic cost is $7950; average system price is $10,000.

Booth No. 25003 Circle No. 261

Cassette transport eases error correction

Compucord Inc., 225 Crescent St., Waltham, Mass. Phone: (617) 891-0080.

The Compudette 1200 magnetic tape transport is a cassette-loaded incremental/continuous digital unit that permits error correction on a character-by-character basis. The use of redundant data on two tracks eliminates the need for prerecorded cassettes without requiring dependence on the recorded data for timing. System interfacing is straight-forward.

Booth No. 10005 Circle No. 254

Model SP601 shown actual size.

We make it possible by harnessing the space-saving advantages of the switching regulator—but have pulled its RFI fangs (input and output meet MIL-I-6181).

When you read our data sheet carefully, you'll also find it full of hidden features that other manufacturers would loudly acclaim.

Such as an IC regulating amplifier, automatic overvoltage crowbar, self-resetting automatic overload and short circuit protection, and even 30 ms full-load storage after the input voltage disappears.

Efficiency is so high that the very hottest spot on the heat sink has a rise of only 25°C.

You can actually hold our unit after hours of full-load bench operation without smelling burning flesh!

And is there any other unit you've heard about that will continue to deliver full-load at 71°C.—without derating, heat sinking or forced air cooling.

Single, dual, or triple outputs at voltage levels of 3V to 30V can be provided to your specific needs.

By the way, if you think our $400 price is high, try adding the "optional extras" to anybody else's standard you had in mind.

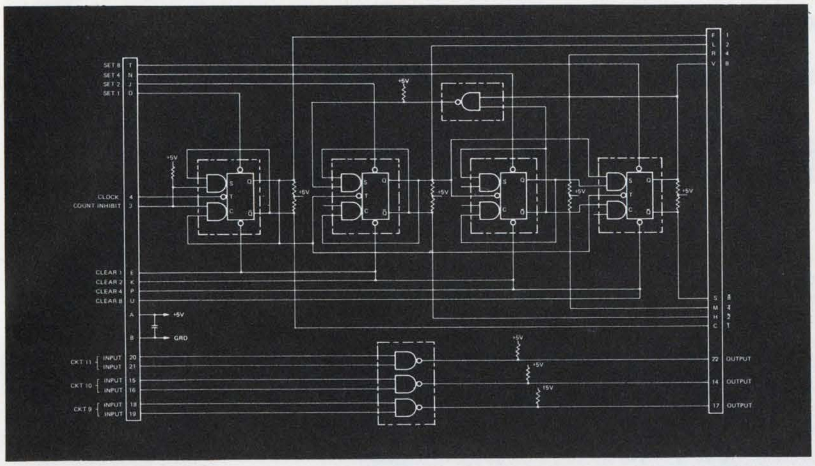
Trio Laboratories, Inc., 80 Dupont Street, Plainview, L. I., N.Y. 11803. Tel.: (516) 681-0400.
TWX: (510) 221-1861.

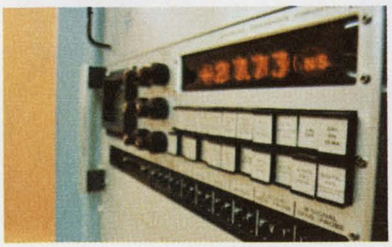
triolab®

Now you can squeeze your 5V/20A power supply down to fit your microcircuitry.

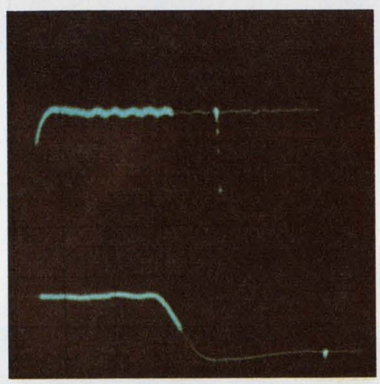
SEE US AT BOOTH 2012 AT THE SPRING JOINT COMPUTER CONFERENCE

INFORMATION RETRIEVAL NUMBER 145





E-H the systematic solution



Whether you need a complete dynamic test system or the ideal components to integrate with your present system, look no further. E-H Research Laboratories, Inc. and its subsidiary, Automated Measurements Corporation, offer you the perfect solution.

For example, the **E-H 1139/1420 programmable timing unit and pulse driver combination** is a new generation in pulse instruments that fits the needs of any systems designer. These two rack-mounted units are so completely programmable that there are no front-panel knobs to twist. They're ideal for any systems applications requiring pulses from 1kHz to 10MHz. And they offer the designer such features as complete waveform control, with programmable width and delay from 10ns to 100μs, amplitude from $\pm$3V to $\pm$10V with programmable attenuation from X1 to X40 and rise and fall times programmable from 5ns to 13μs.

The perfect mate to the E-H 1139/1420 is the **AMC Model 1000 Waveform Analyzer.** The AMC 1000 was designed specifically for programmed systems application. It combines in one compact box the functions of sampling oscilloscope, digital counter and digital voltmeter to provide time and voltage measurements of sampled waveforms. The AMC 1000 is the most advanced instrument of its kind, with features including $\pm$1% time measurements all ranges, fastest measurement rates, 10 remote sampling channels, all solid-state construction, serial-by-character or parallel programming, built-in program memories, stored BCD outputs, built-in floating DVM, and digital readout.

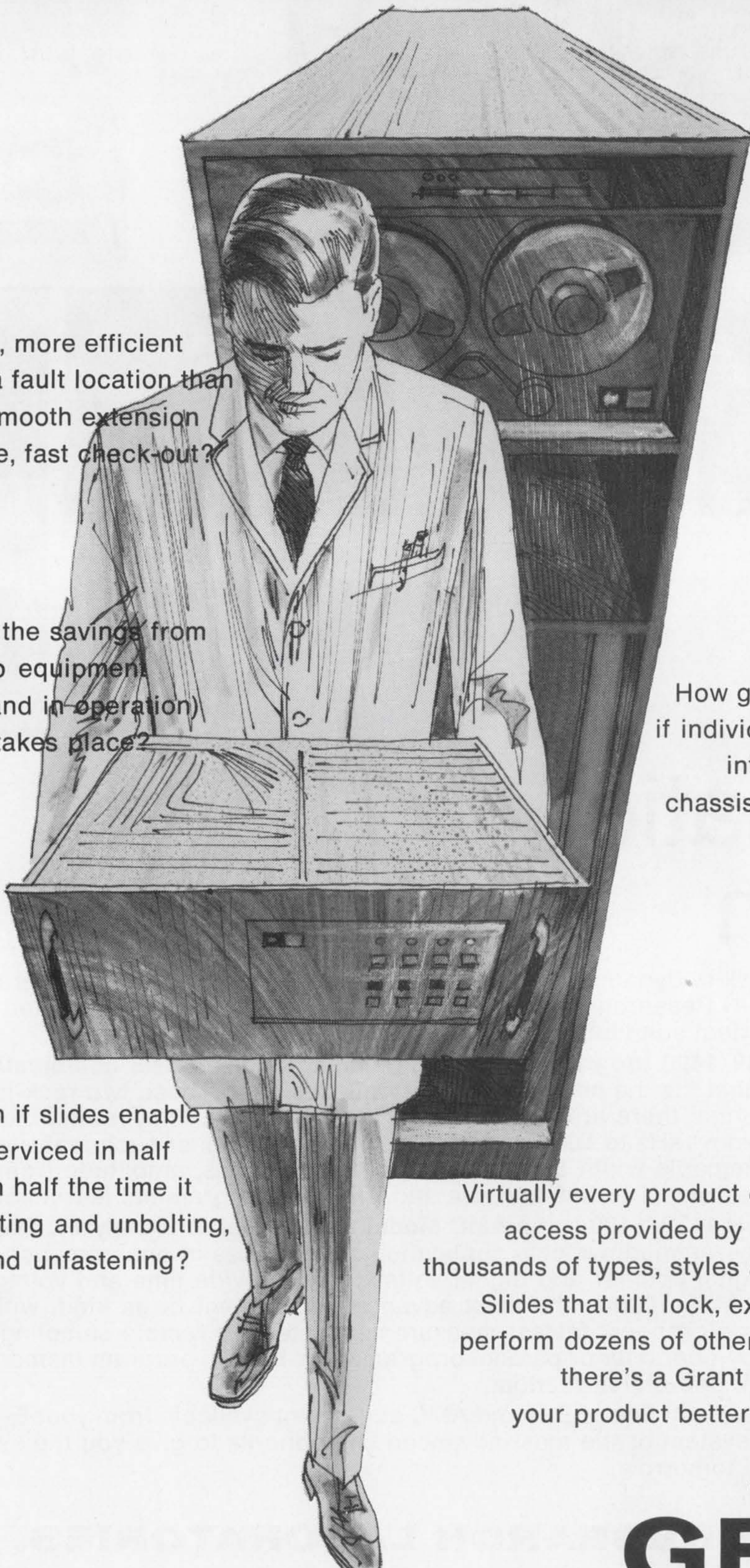
This is just a sample of the broad line of E-H and AMC equipment available from your E-H representative. He can offer you a complete system or the most advanced components to give you the systematic solution to your problems today. And tomorrow.

E-H RESEARCH LABORATORIES, INC.

515 Eleventh Street • Box 1289, Oakland, California 94604 • Phone: (415) 834-3030 • TWX 910-366-7258
In Europe: E-H Research Laboratories (Ned) N.V., Box 1018, Eindhoven, The Netherlands, Telex 51116
In Japan: Iwatsu Electric Company, Ltd., 7-41, 1-Chome Kugayama Suginami-Ku, Tokyo 167, Japan

INFORMATION RETRIEVAL NUMBER 146

So what if Grant Slides save hours of down time?



Is there a quicker, more efficient way to get to a fault location than by immediate and smooth extension of the unit for simple, fast check-out?

Would you guess the savings from being able to keep equipment connected (and in operation) while maintenance takes place?

How great is the value of slides if individual chassis' can be interchanged with similar chassis' in moments?

What's it worth if slides enable equipment to be serviced in half —or less than half the time it ordinarily takes bolting and unbolting, fastening and unfastening?

Virtually every product can use the ready access provided by Grant Slides. There are thousands of types, styles and sizes available. Slides that tilt, lock, extend and lock and perform dozens of other functions. Undoubtedly, there's a Grant Slide that can help make your product better too.

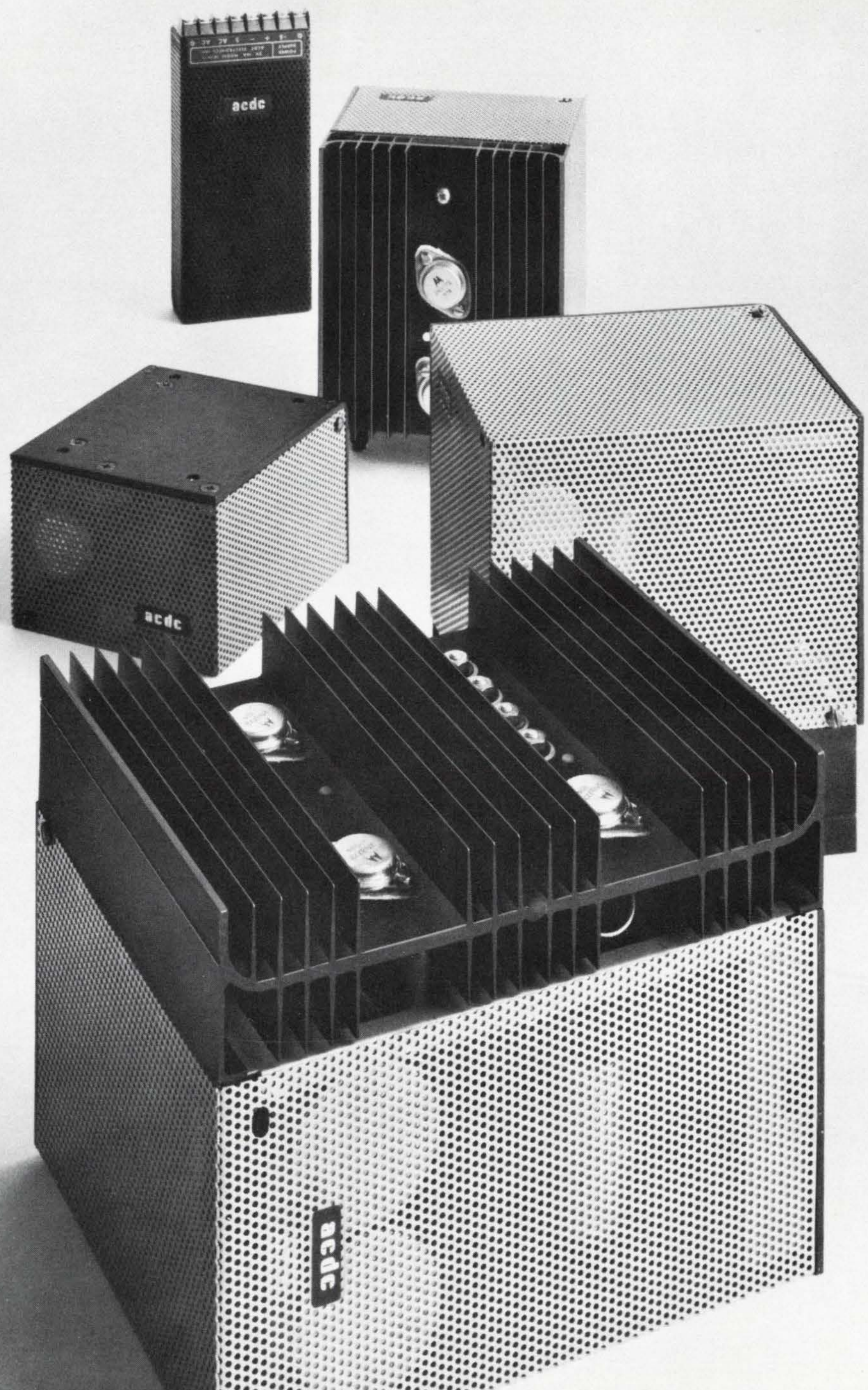
Write for complete data.

GRANT
PULLEY & HARDWARE CORPORATION

EASTERN DIVISION: 21 HIGH STREET, WEST NYACK, NEW YORK 10994
WESTERN DIVISION: 944 LONG BEACH AVE., LOS ANGELES, CALIF. 90021

INFORMATION RETRIEVAL NUMBER 147

acdc electronics inc.



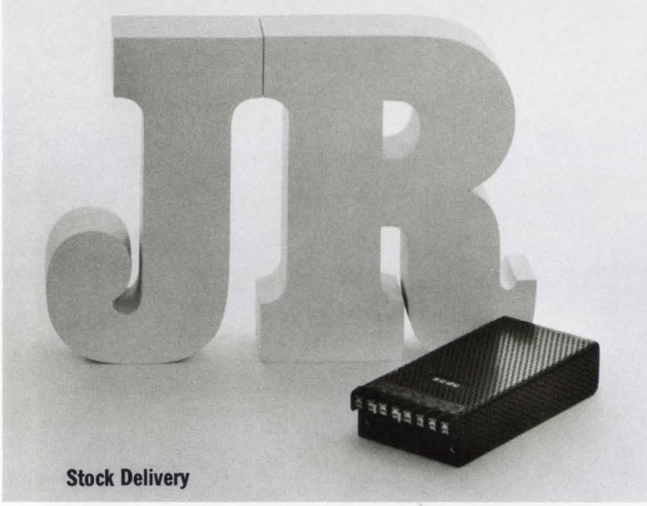
POWER SUPPLIES

ACDC Power Supply Modules

acdc
POWER SUPPLIES

JR — Miniaturized Power Supply Modules

Here's the first precision-regulated DC power supply in a truly miniaturized package. You get AC conversion, isolation, and regulation in a package so slim and light you could actually put five of ours into one of theirs. So you can tuck it into impossible spaces. Yet there's only a modest price differential over conventional units, despite JR's drastically improved efficiency.



Stock Delivery

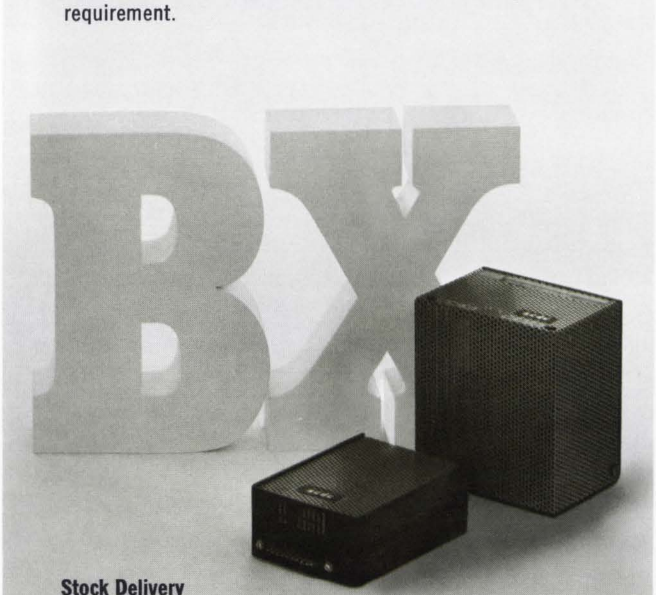
IC — 5V Power Supply Modules for ICs

The application's in the name — if you're in digital ICs, then this unusually complete line of 5VDC power supply modules has been designed especially for you. Performance, too, has been optimized for the end use and we've multi-rated the power output to make IC ideal for you under every possible condition.

Stock Delivery

BX — Precision Power Supply Modules for all Applications

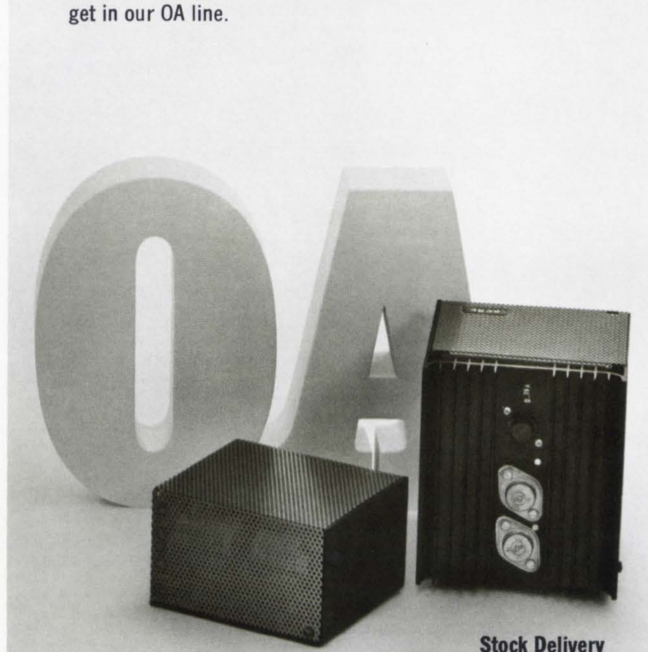
You name it and we'll ship it. From 0 to 28VDC it's off the shelf — higher voltages take just a little longer. When you specify BX, you'll get our best regulated series that's designed to cover every conceivable power supply requirement.



Stock Delivery

OA — Dual Output Power Supply Modules for Op Amps

If you're in op amps, you need power supplies with built-in tracking and long-term stability. That's what you get in our OA line.



Stock Delivery

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General Specifications

acdc POWER SUPPLIES

Stock Delivery

	JR Miniaturized Power Supply	IC Optimized 5V Modules	BX Precision Modules	OA Dual Output Modules
Input	105-125VAC, 47-420Hz, single phase.	105-125VAC, 47-63Hz (usable also to 400Hz — consult **acdc** for derating). All models of 20A and greater are provided with a 105-125/210-250VAC input.		
Output	Voltage range shown in tables on following two pages is continuously variable between limits by externally accessible screwdriver adjustment of multiturn pot. Output is floating — either positive or negative terminal may be grounded. Current: zero to full load as shown in tables.			
Regulation	0.1% +5mV NL-FL. ±0.1% ±5mV for ±10% input variation.	0.05% for line changes of 10%. 0.05% for NL to FL changes.	0.01% or 0.001 volt for line changes of 10%. 0.01% or 0.002 volt for NL to FL changes.	
Ripple	3mV RMS max (120Hz). 25mV P-P (spikes at 50KHz rep. rate).	2mV RMS and 20mV P-P max.	0.5mV or 0.001% max. RMS (whichever is greater).	
Temperature Stability	Typical 10mV for eight hour period after initial warmup.		Maximum 0.1% or 10mV for eight hour period after initial warmup.	
Transient Response	Typically less than 1 msec in response to an NL-FL step.	Output voltage returns to within regulation limits within 50μsec in response to a 50% step change in load current.		
Remote Sensing	Terminals are provided to maintain regulation at the load, compensating for the DC voltage drop in the load cable.			
Remote Voltage Adjustment	Terminals are provided to adjust the output voltage by means of a remote variable resistor. On the wide range models, in addition to being internally adjustable over the full range, remote programming is possible at an accurately adjustable 1000 Θ/V and a separate zero adjustment is provided. Remote voltage adjustment is not provided on dual output models but may be ordered as a special feature.			
Ambient Temperature	Unit must be mounted to allow conductive heatsinking to hold the case temperature below 80°C.	Operating: Full rated output at operating temperatures of 0° to 71°C without forced air or heatsinking. Storage: —55°C to +85°C.		
Mil Specs	The listed catalog models are constructed with the highest quality components and have MTBF ratings in the neighborhood of 50,000 hours per MIL-HDBK-217. **acdc** will also build supplies to meet specific MIL specs such as MIL-E-4158A, MIL-E-16400, MIL-T-21200, and meet environmental requirements such as MIL-E-5400, MIL-E-5272, MIL-E-4970, and RFI specs MIL-I-26600 and MIL-I-6181. **acdc's** own environmental laboratory is able to perform qualification testing when required and is used extensively to prove out designs. In order to provide the most efficient design, customer inquiries are invited, outlining exact specifications and environmental conditions required for the end product.			
Weight	Approx. 1½ lbs.	4 to 83 lbs. Weight for individual models is given in the tables on the following two pages.	1.6 to 46 lbs.	4 to 11 lbs.
Mounting	Fits into 1¾" rack panel assembly.	Unit can be mounted in any position on either one of two sides. Mounting faces have threaded mounting holes.		
Dimensions	H-W-L dimensions for individual models are given in the tables on the following two pages.			
Overload Protection	All models are inherently protected against overload and short circuits of any duration. Except for certain higher voltage units, no fuses or reset buttons are used — automatic recovery is electronically accomplished. On higher voltage units, short circuit protection is furnished by means of an accessible, replaceable fuse.			
Overvoltage Protection (Optional)	A completely independent overvoltage protection module is available and straddles the output terminals. This protection does not depend on the regulating circuitry of the supply. Trip voltage adjustable from 5-30 volts.	Any model, up to 50 volts, can be furnished with overvoltage protection which "crowbars" the output in the event of a rise in the output voltage of 10% or 2 volts (whichever is greater). On dual models, overvoltage protection "crowbars" both voltages to near zero in the event of a rise of one or both of the voltages of 20% or 4 volts (whichever is greater).		
Connector	All cases have barrier strip termination.		Cases A through F are supplied with a solder hook terminal header. Case M1 is furnished with an attached 10 terminal PC edge connector which may be used either as a solder connection or readily removed by the user and mounted in his equipment to provide plug-in convenience. G and H cases have barrier strip termination.	
Construction	Black anodized aluminum case. Unit may be removed from case for complete serviceability.	Modules are constructed of heavy gage aluminum with integral extruded heatsinks; color is black. Removable covers of perforated steel have a light gold enamel finish. Regulating circuitry is mounted on a PC board.		
Output Impedance	(See Regulation and Transient Response).	DC — 1KHz 0.001 R_L or 0.005 ohm max. 1-100KHz 0.005 R_L or 0.3 ohm max (whichever is greater). R_L = rated load.	DC — 1KHz 0.0001 R_L or 0.001 ohm max. 1-10KHz 0.0003 R_L or 0.01 ohm max. 10-100KHz 0.006 R_L or 0.3 ohm max. (whichever is greater). R_L = rated load.	
Temperature Coefficient	0.02%/°C max.	1mV/°C max.	Maximum .015% or 1mV/°C.	

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Specifications | **acdc** POWER SUPPLIES | **Stock Delivery**

JR Miniaturized Power Supply Module

Nominal Output Voltage (VDC)	Output Voltage Range* (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches) H	W	L	Weight approx. (lbs.)	Case Size	Model (Add —1 for Overvoltage Protection)	Quantity	Price (add $30 for OVP)
5	3.0 5.0 5.5 6.0	10 10 9 8	1.375	3.125	6.5	1.5	K1	JR5K10	1-9 10-24 25-49 50-99	$298 291 285 280
15	12 15 18	4.0 4.0 3.0	1.375	3.125	6.5	1.5	K1	JR15K4.0	1-9 10-24 25-49 50-99	$298 291 285 280
25	22 25 30	2.5 2.0 2.0	1.375	3.125	6.5	1.5	K1	JR25K2.0	1-9 10-24 25-49 50-99	$298 291 285 280

*Continuously adjustable

IC 5V Power Supply Module for IC's

Nominal Output Voltage (VDC)	Output Voltage Range (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches) H	W	L	Weight approx. (lbs.)	Case Size	Model (Add —1 for Overvoltage Protection)	Price
5	4.75 to 5.25	2.0 @ 71°C 2.5 @ 55°C 2.7 @ 40°C	5.0	2.5	4.38	4	J1	IC5N2.7	98.00 Add $20 for overvoltage protection
5	4.75 to 5.25	6.2 @ 71°C 8.0 @ 55°C 9.5 @ 40°C	5.0	5.0	5.0	7.5	L1	IC5N9.5	134.00 Add $30 for overvoltage protection
5	4.75 to 5.25	9.2 @ 71°C 11.5 @ 55°C 13.5 @ 40°C	5.0	5.0	7.5	11	N1	IC5N13.5	186.00 Add $30 for overvoltage protection
5	4.75 to 5.25	16.5 @ 71°C 21.5 @ 55°C 25.0 @ 40°C	5.0	5.53	11.0	19	P1	IC5N25	258.00 Add $30 for overvoltage protection
5	4.75 to 5.75	50 @ 71°C 60 @ 55°C 70 @ 40°C	5.25	19.00	14.00	52	S1	IC5N70	529.00 Add $60 for overvoltage protection
5	4.75 to 5.25	75 @ 71°C 90 @ 55°C 100 @ 40°C	5.25	19.00	21.00	83	S2	IC5N100	835.00 Add $85 for overvoltage protection

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Specifications acdc POWER SUPPLIES **Stock Delivery**

BX Precision Power Supply Modules for All Applications

Nominal Output Voltage (VDC)	Output Voltage Range (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches) H	W	L	Weight approx. (lbs.)	Case Size	Model (Add —1 for Overvoltage Protection)	Price
2 through 28 in even voltages	±1 from nominal	0.3	1.88	2.75	4.75	1.6	M1	BX2N0.3 through BX28N0.3	76.00 Add $20 for overvoltage protection
2 through 28 in even voltages	±1 from nominal	1.2	5.00	3.12	4.37	4	A1	BX2N1.2 through BX28N1.2	116.00 Add $20 for overvoltage protection
2 through 28 in even voltages	±1 from nominal	2.5	5.00	4.37	6.00	8	B1	BX2N2.5 through BX28N2.5	137.00 Add $20 for overvoltage protection
2 through 10 in even voltages	±1 from nominal	5.0	5.25	5.00	6.00	11	C1	BX2N5 through BX10N5	184.00 Add $30 for overvoltage protection
12 through 28 in even voltages			5.00	6.87	6.00	14	D1	BX12N5 through BX28N5	
2 through 6 in even voltages	±1 from nominal	10.0	6.50	6.62	8.25	18	E3	BX2N10 through BX6N10	274.00 Add $30 for overvoltage protection
8 through 28 in even voltages			6.50	7.75	8.25	25	F2	BX8N10 through BX28N10	
2 through 14 in even voltages	±1 from nominal	20.00	5.50	8.00	15.00	42	G1	BX2N20 through BX14N20	395.00 Add $30 for overvoltage protection
16 through 28 in even voltages			5.50	9.75	15.00	46	H1	BX16N20 through BX28N20	

For applications requiring 0.5% regulation, see BC series, also available from stock.

OA Dual Output Power Supply Modules for OP Amps

Nominal Output Voltage (VDC)	Output Voltage Range (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches) H	W	L	Weight approx. (lbs.)	Case Size	Model (Add —1 for Overvoltage Protection)	Price
±12	11-13	0.350 @ 71°C 0.425 @ 55°C 0.500 @ 40°C	5.00	2.50	4.38	4	J2	OA12D0.5	119.00 Add $20 for overvoltage protection
±15	14-16							OA15D0.5	
±12	11-13	0.750 @ 71°C 0.900 @ 55°C 1.1 @ 40°C	5.00	3.12	4.37	5	A1	OA12D1.1	149.00 Add $20 for overvoltage protection
±15	14-16							OA15D1.1	
±12	11-13	3.0 @ 71°C 3.5 @ 55°C 3.7 @ 40°C	5.00	5.25	6.00	11	C1	OA12D3.7	195.00 Add $20 for overvoltage protection
±15	14-16							OA15D3.7	

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Other ACDC Power Supply Modules

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POWER SUPPLIES

BC — This series of DC power supply modules has 0.5% regulation. 15 voltage ranges 2 to 28VDC, each available in six current ratings from 300mA to 20A. Available from stock.

0.3A	$ 73.00	5.0A	$178.00
1.2	$111.00	10.0	$265.00
2.5	$132.00	20.0	$384.00

30 to 400VDC Modules — Both the BC (0.5% regulation) and the BX series (0.01% regulation) are offered in 22 voltage ranges to meet 30 to 400VDC precision requirements. The 11 ranges from 30 to 50VDC are available with 0.3, 1.2, 2.5, and 5.0A current ratings. Those from 60 to 100VDC are made with 0.1, 0.4, 0.6, and 1.2A ratings. An additional 0.2A rating is offered in the 100VDC range. The 150, 200, 250, 300, 350, and 400VDC range modules are rated 0.1, 0.2, 0.4, and 0.6A. Prices range from $82.00 to $282.00.

Wide Range Programmable Modules — These unique ACDC modules are adjustable from zero to full output voltage and will deliver rated current at all voltages. A screwdriver makes both the fine and coarse voltage controls easily accessible. May be used with an external programming resistor. In the 0 to 25VDC range, available with 0.1, 0.4, 1.2, and 2.5A ratings. In the 0 to 50VDC range, the ratings are 0.1, 0.2, 0.6, and 1.2A. From $119.00 to $178.00.

Dual Output Modules — ACDC's BX and BC series are also available to meet dual output requirements, in 25 ranges from ± 2 to ± 50VDC. Each range is offered in four current ratings from 300mA to 2.5A. From $154.00 to $275.00.

Warranty

When used within its specified operating environments, ACDC power supplies are unconditionally guaranteed to meet all published specifications for an unlimited length of time. This guarantee covers all parts of the module, including semi-conductors, fuses, and mechanical parts, without regard to the date of purchase or installation. All terms of this guarantee are fully transferable when the power supply is sold as original equipment.

If at any time the power supply is in need of warranty service or calibration it may be returned directly to the factory where, without charge, it will be adjusted to meet its original specifications. ACDC will pay surface freight charges to and from the factory.

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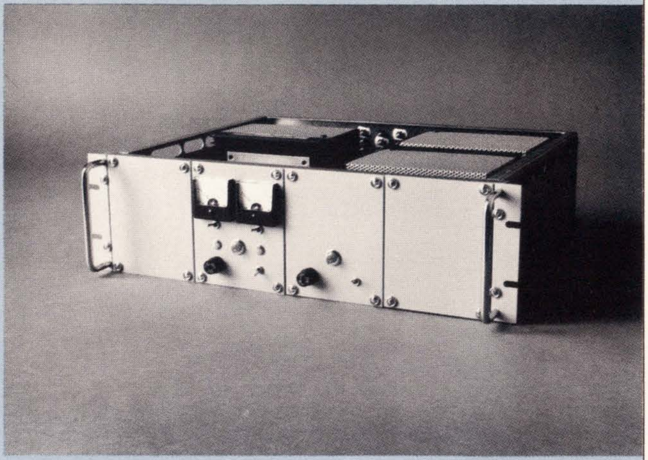
Rack Assemblies

acdc POWER SUPPLIES



New from ACDC! Universal 19″ Rack Adapters for mounting any ACDC power supply. Available in 3½″, 5¼″, or 7″ high and 14″ or 21″ deep. There are no holes to drill, just assemble the power supply mounting plates with the hardware furnished with each Rack Adapter. Front panels are finished in grey enamel and the chassis is cadmium plated. Panel options range from blank front panels to metered control panels.

The 3½″ and 5¼″ Rack Adapters provide an enclosed wire trough located in the center of the chassis. Feed-through barrier strips can be installed on the back panels to simplify cable terminations. Two cable entrance holes are also provided on each Rack Adapter.

The Switch Panels contain Line Switch, Red Pilot Light and a Fuse Holder. The 3½″ Metered Panels provide Line Switch, Red Pilot Light, Fuse Holder, and 1½″ Voltmeter and Ammeter. The 5¼″ and 7″ Metered Panels have in addition two Selector Switches and are designed to monitor two outputs. Buttoned holes allow for customer's installation of remote voltage adjust pots.

When ordering, specify the desired Rack Adapter and specify the number and types of cases which are intended to be accommodated (this provides you with the required special mounting plates and recommended installation drawing shipped free with your order). Choose the desired front panel or panels and possibly a set of slides.

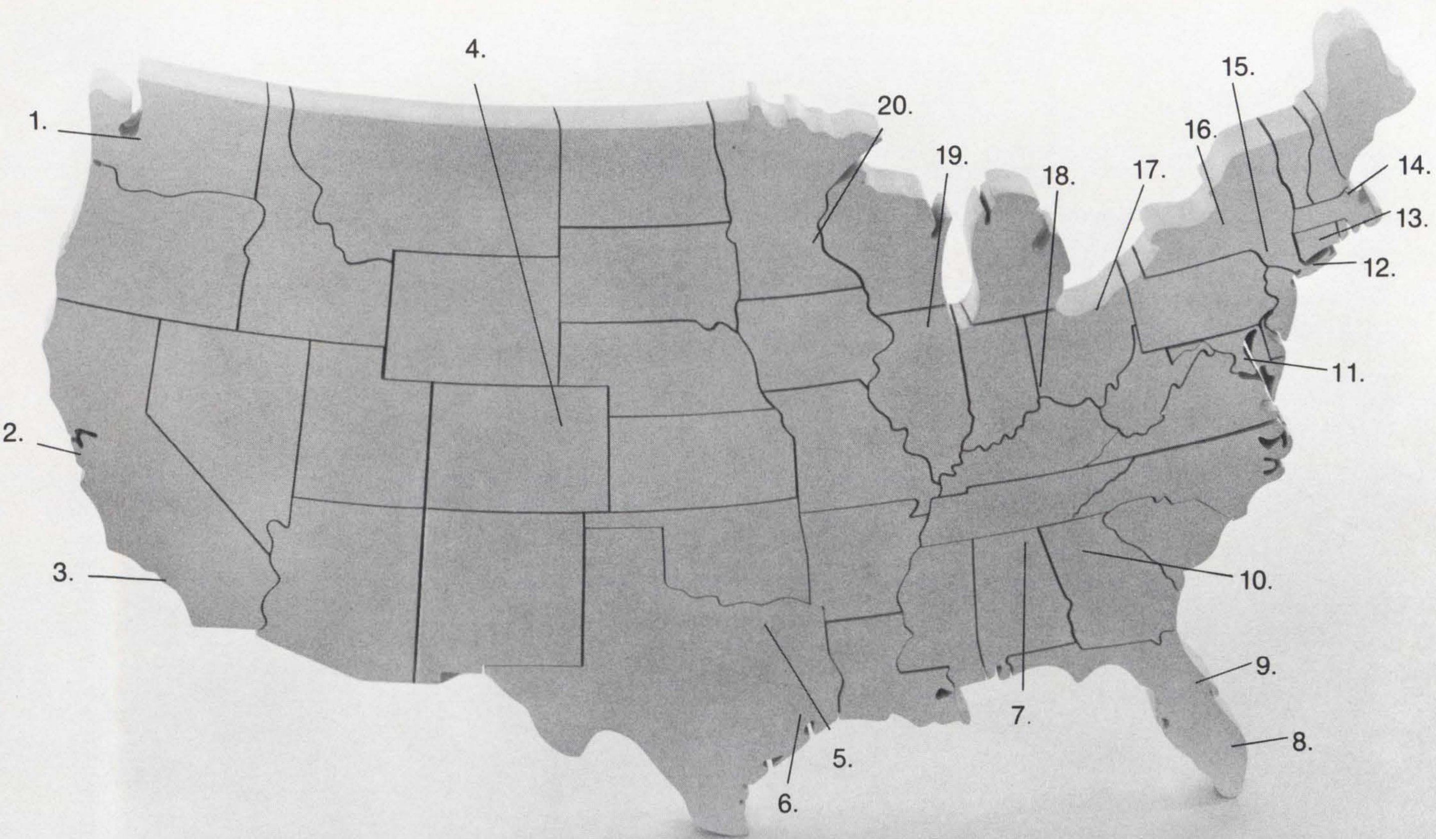
ACDC Case / Rack Chart

The following line-up lists the cases that can be accommodated in each rack adapter. Contact your ACDC representative or the factory for exact total module capacity of each adapter.

3.50″ Rack	5.25″ Rack		7.00″ Rack		
A1	A1	J1	A1	E3	J2
J1	A2	J2	A2	E4	K1
J2	B1	K1	B1	F1	L1
M1	B2	L1	B2	F2	M1
K1	C1	M1	C1	G1	N1
	D1	N1	D1	H1	P1
	D2	P1	D2	J1	

ACDC Case / Rack Chart

	3½″		5¼″		7″	
Basic Rack 14″	RA3X14	$50.00	RA5X14	$50.00	RA7X14	$55.00
Basic Rack 21″	RA3X21	60.00	RA5X21	60.00	RA7X21	65.00
Full Panel	RP3XF	9.00	RP5XF	9.00	RP7XF	9.50
¾ Panel	RP3X3	8.00	RP5X3	8.00	RP7X3	8.50
½ Panel	RP3X2	6.50	RP5X2	6.50	RP7X2	7.00
¼ Panel	RP3X1	5.00	RP5X1	5.00	RP7X1	5.50
Switch Panel (¼)	RP3X1P	18.00	RP5X1P	18.00	RP7X1P	18.00
Metered Panel (¼) (Specify V/A Ranges)	RP3X1M	45.00	RP5X1M	45.00	RP7X1M	45.00
Barrier Strip	RH8	1.90	RH8	1.90	RH8	1.90
Barrier Strip	RH8	1.90	RH10	1.90	RH10	1.90
Chassis Slides (14″)	RS1X14	48.00	RS1X14	48.00	RS1X14	48.00
Chassis Slides (21″)	RS1X21	52.00	RS1X21	52.00	RS1X21	52.00



1. Ruggles Technical Sales
10717 N. E. 4th Street
Bellevue, Washington 98004
Tel: 206-455-2778

2. ACDC Electronics, Inc.
#1 First Street
Los Altos, California 94022
Tel: 415-941-1603
TWX: 910-370-7457

3. ACDC Electronics, Inc.
Oceanside Industrial Center
Oceanside, California 92054
Tel: 714-757-1880
TWX: 910-322-1470

4. Waugaman Associates, Inc.
Suite C, 4643 Wadsworth
Wheatridge, Colorado 80033
Tel: 303-423-1020
TWX: 910-938-0700

5. Roger Martin Associates, Inc.
6211 Denton Drive, Room 103
Dallas, Texas 75235
Tel: 214-358-3704
TWX: 910-861-4200

6. Roger Martin Associates, Inc.
P.O. Box 19291
Houston, Texas 77024
Tel: 713-468-3877
TWX: 910-881-3630

7. Beacon Electronic Associates
3342 Memorial Parkway, S.W.
Huntsville, Alabama 35801
Tel: 205-881-5031

8. Beacon Electronic Associates
651 NE 45 Street
Ft. Lauderdale, Florida 33308
Tel: 305-564-4298

9. Beacon Electronic Associates
540 S. Maitland Avenue
Maitland, Florida
Tel: 305-647-3498

10. Beacon Electronic Associates
2285 Peachtree Road, N.E.
Atlanta, Georgia 30303
Tel: 404-351-3654

11. Sel-Tronics, Inc.
721 Ellsworth Drive
Silver Spring, Maryland 20910
Tel: 301-589-3391

12. Harvey J. Krasner Associates
33 Great Neck Road
Great Neck, New York 11021
Tel: 516-487-0690
TWX: 510-223-0823

13. New England Marketing Assoc.
P.O. Box 151
Branford, Connecticut 06405
Tel: 203-488-7279

14. New England Marketing Assoc.
55 Salem Street
Lynnfield, Massachusetts 01940
Tel: 617-245-9530

15. R. P. Kennedy Company, Inc.
Green Tree Drive North
Hyde Park, New York 12538
Tel: 914-229-2269

16. R. P. Kennedy Company, Inc.
39 Saginaw Drive
Rochester, New York 14623
Tel: 716-271-6322

17. R. G. Sidnell & Co., Inc.
4 Meadowlawn Drive
Mentor, Ohio 44060
Tel: 216-942-3304

18. R. G. Sidnell & Co., Inc.
3300 S. Dixie Drive
Dayton, Ohio 45439
Tel: 513-293-1194

19. R. G. Sidnell & Co., Inc.
6051 Pinecroft
Orchard Lake, Michigan
Tel: 313-851-3518

20. Electro-Products
Griggs-Midway Bldg.
St. Paul, Minnesota 55104
Tel: 612-645-7887

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Novel storage terminal slashes graphics costs

Princeton Electronic Products, Inc., P.O. Box 101, North Brunswick, N.J. Phone: (201) 297-4448. P&A: $3750 or $4250; 6 to 8 wks.

When equipped with the appropriate associated electronics (like a keyboard, vector generator and CRT monitor), a new storage terminal makes low-cost computer graphics terminals a realizable fact. For an approximate system cost of $6000, the model 400 terminal is said to give performance comparable to previous systems selling for $10,000 to $20,000.

For an 800-line display capability, the new storage terminal costs $3750; with 1200-line display capacity, it costs $4250. Prices include the Lithocon silicon-target storage tube (see ED 2, January 18, 1970, page 101, circle no. 250).

Model 400 is also said to claim at least two other firsts. Its 30-MHz video read-and-write bandwidth, which never limits computer data rates, is reported to be the widest recording bandwidth available. In addition, the 400 is thought to be the only storage system, other than a disc, that uses raster scanning, like a TV set, rather than selective (on command) scanning. The new terminal can even be used to convert selective-scan systems to raster-scan ones, thus cutting CRT monitor costs up to 80% and freeing valuable computer time.

Another unique feature of the 400, the ability to subdivide the stored image, allows alphanumeric terminals to offer a scroll effect—displayed lines roll by the viewer. Stored data is not lost, just viewed at different times as one line is added to the bottom of the display and the top line is deleted.

Booth No. 47003 *Circle No. 266*

0625
200V
G.E.
Special Film Foil or
Metalized Film Capacitor
Can be custom designed to
meet customer specifications
69F948G2
Subminiature Tantalum
Wet-slug Capacitor
For highest volumetric
efficiency in industrial
miniature applications
• Voltage range . . Up to 60 VDC
• uf range . . . 3.3 to 450 uf
• Temp. range -55C to 85C
.033 UF
±10%
400 VDC
G.E.
LECTROFILM™-B Polyester
Film Foil Capacitor
Axial leads for use where
size, weight, cost and
reliability offer advantages
over other capacitor types.
• Voltage range . . Up to 200 V
• uf range . . . .0010 to 1 uf
• Temp. range -55C to 125C

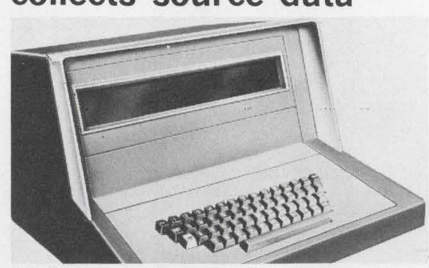
Cassette tape drive writes 9.6 kbits/s

Ampex Corp., 9937 W. Jefferson Blvd., Culver City, Calif. Phone: (213) 836-5000. P&A: $500; 120 days.

Offering a data rate of 9600 bits per second, a new digital cassette tape drive packs up to 350,000 characters on a single standard cassette. The TMC is a serial-by-bit two-track read-after-write unit with a recording speed of 12 inches per second at 800 bits per inch. It provides users with a precision on-line storage device.

Booth No. 3800 Circle No. 256

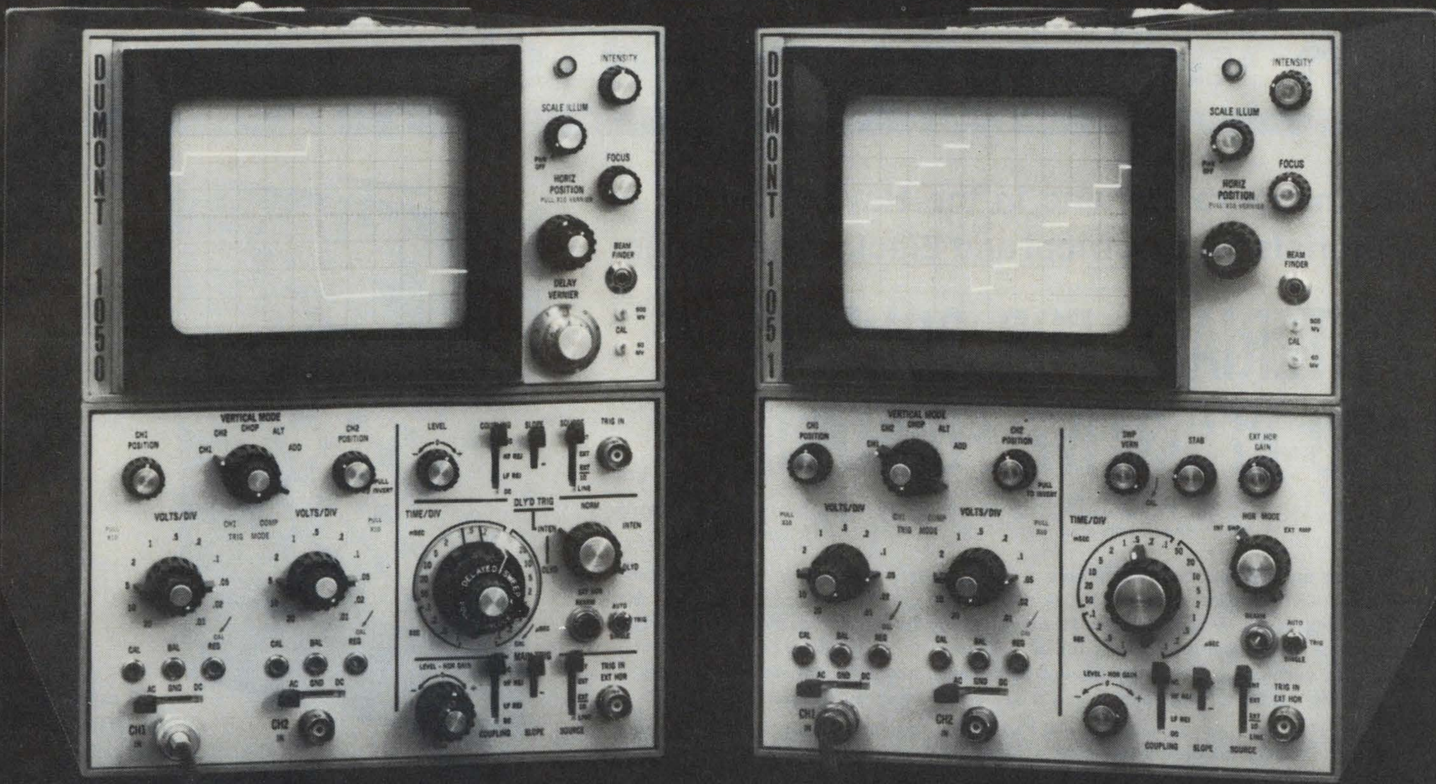
Real-time terminal collects source data



Madatron Corp., sub. of Faradyne Electronics, 110 Route 10, Whippany, N. J. Phone: (201) 887-8874. P&A: $2500; September, 1970.

Called a source data collection device, a new data terminal permits the entry of data at the source, where it is generated, in any entry format. Data is collected in real time and visually verified via an alphanumeric display. Operation can be either on-line or off-line. Sequential visual instructions assure entry format.

Booth No. 49002 Circle No. 264


DUMONT 1050
DUMONT 1051

TOTAL POWER SUPPLY CAPABILITY

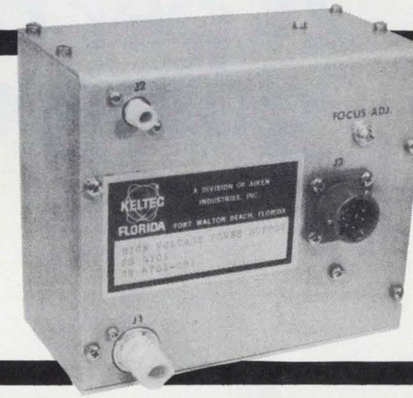

MODEL PS 4613

HIGH POWER TWT POWER SUPPLY

INPUT POWER	115 VAC, 400 cps, 3 phase per Mil-Std-704
OUTPUTS	1. Helix-Cathode: −4000 to −4800 VDC adjustable at 40 ma 2. Collector-Cathode: +2750 to +3250 VDC at 400 ma 3. Filament: 6.3 VAC ±2% at 4.0A (10A turn on surge limiting provided) 4. Focus Anode: +100 to +300 VDC at 1 ma
PROTECTIVE CIRCUITRY	1. Automatic time delay 2. Helix overload protection 3. Thermal overload protection 4. Arc protection (all modes of internal TWT arcing)
ENVIRONMENT	1. Temperature −55°C to +71°C ambient (Mounting surface temperature not to exceed 90°C) 2. Altitude: 50,000 feet 3. Shock, Vibration, Humidity, Explosion: Per Mil-Std-810
WEIGHT	20 lbs. maximum

HIGH VOLTAGE DISPLAY TUBE POWER SUPPLY

INPUT VOLTAGE	28 VDC ±10% @ .5 AMP
OUTPUTS	1. 20KV ±1000 VDC @ 200 $_{u}$A Ripple 20 V Peak to Peak max Load Reg 3% max, full to half load 2. 2.2 KV ±500 VDC adjustable @ 75 $_{u}$A Ripple 2.2 V Peak to Peak max 3. 300 V ±15 VDC @ 10 $_{u}$A Ripple 300 mv Peak to Peak max
SIZE	5.50 x 4.5 x 2.6
WEIGHT	3.3 Lbs max
ENVIRONMENT	MIL-E-5400 Class 2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MODEL PS 4621

MULTI-GRID, LOW NOISE TWT POWER SUPPLY

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WEIGHT	6 Lbs max
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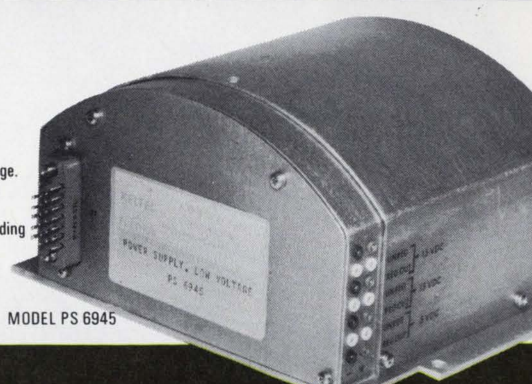
RIPPLE	25 mv Peak to Peak
PROTECTIVE CIRCUITRY	1. Output protection from short circuits for indefinite period without damage. 2. Over voltage—in the event of regulation failure, supplies are terminated in less than 20 microseconds. 3. Overload—supply is protected to prevent damage resulting from overloading in any one of the outputs.
ENVIRONMENT	1. Temperature −55°C to + 71°C 2. Altitude 50,000 feet 3. Shock, Vibration, Humidity and Explosion per MIL-Std-810 4. Electromagnetic Interference per MIL-1-6181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INFORMATION RETRIEVAL NUMBER 153

Key-to-tape station checks written data

International Data Sciences, Inc., 100 Nashua St., Providence, R.I. Phone: (401) 274-5100.

Offering simplified and streamlined operation, the Libra I standalone key-to-tape data station provides a read-after-write check, selective non-verification and a true English display. The system, in its entirety, occupies no more space than a standard keypunch machine.

Booth No. 43001 Circle No. 280

Tape-cartridge terminal stores 150k characters

Teletype Corp., 5555 Touhy Ave., Skokie, Ill. Phone: (312) 676-1000.

Using a compact tape cartridge about the size of a cigarette package, the 4210 magnetic tape data terminal accommodates up to 150,000 characters of information. Because of its high-density data storage (125 characters per inch), the new terminal can operate at slow tape speeds to deliver whisper-quiet performance. A search capability quickly locates specific data blocks on the tape.

Booth No. 1705 Circle No. 253

Digital tape recorder has two drive modes

Datran Corp., 179 West Rocks Rd., Norwalk, Conn. Phone: (203) 847-9669.

The model 8551/8552 digital magnetic tape recorder offers two drive modes—incremental and synchronous. In the incremental mode, data can be written at rates to 1 kHz and at a density of 200, 556 or 800 bits per inch. Incremental reading ranges from 0 to 500 Hz. In the synchronous mode, standard tape speed is 30 inches per second.

Booth No. 6109 Circle No. 250

Computer system multiplies uses

Digital Scientific Corp., 11455 Sorrento Valley Rd., San Diego, Calif. Phone: (714) 453-6050.

Besides being able to emulate instruction sets from other computers, the Meta 4 system can also function as a communications line controller, buffer editor and pre-processor. The unit has a read-only memory with a 90-ns machine cycle instruction execution time and an access time of 40 ns. Core memory cycle time is 900 ns and maximum capacity is 65k 18-bit words.

Booth No. 45004 Circle No. 278

Data couplers/modems customize I/O hook-ups

Anderson Jacobson, Inc., 2235 Mora Dr., Mountain View, Calif., Phone: (415) 968-2400. Price: from $375.

Series 240 couplers, modems and combination coupler/modems allow the time-share equipment user to select the model containing only the outputs and inputs he requires. The output to the switched network complies with tariffs covering acoustic (data-phone compatible) and data-access arrangements. Inputs include the Teletype ASR 33 and/or EIA (RS-232B) device-compatible terminals.

Booth No. 33001 Circle No. 271

Non-impact printer zings 1200 lines/min

Path Computer Equipment, Inc., 65 Commerce Rd., Stamford, Conn. Phone: (203) 348-4244.

A new-impact communications and computer printer produces hard copy at a rate of 1200 single-spaced lines a minute. Model 1200 prints all 96 standard ASCII characters at a rate of 96,000 characters per minute in the 80-character-per-line format or at 158,400 characters per minute in a 132-character version. Characters are synthesized from operator-changeable typographic fonts.

Booth No. 42000   Circle No. 251

Computer entry system optimizes data transfer

Addressograph Multigraph Corp., 1200 Babbitt Rd., Cleveland, Ohio. Phone: (216) 731-8000.

The model 6000 computer entry system features a unique on-line computer entry capability providing optimum data transfer without tape reel handling. It consists of a small electronic memory and control unit, which is time-shared by up to six keyboard data entry and display stations. Data entered simultaneously from the keyboards is stored and can be recalled by any operator.

Booth No. 11001   Circle No. 283

Acoustic coupler has 3 interfaces

Sonex, Inc., I/Onex Div., 20 E. Herman St., Philadelphia, Pa. Phone: (215) 843-6400. P&A: $300; stock to 45 days.

Operating as fast as 300 baud with any standard telephone, a new acoustic coupler offers loop current, EIA and IC logic interfaces as standard provisions. Model 30 uses phase-lock-loop detection to assure error-free communications even in high-noise conditions. Operation may be either half or full duplex.

Booth No. 50007 Circle No. 270

I/O scan converter uses standard TV set

Computer Transceiver Systems, Inc., 317 Route 17, Paramus, N.J. P&A: $1500; 6 wks.

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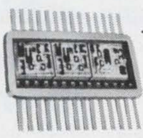

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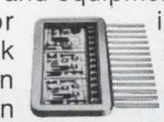

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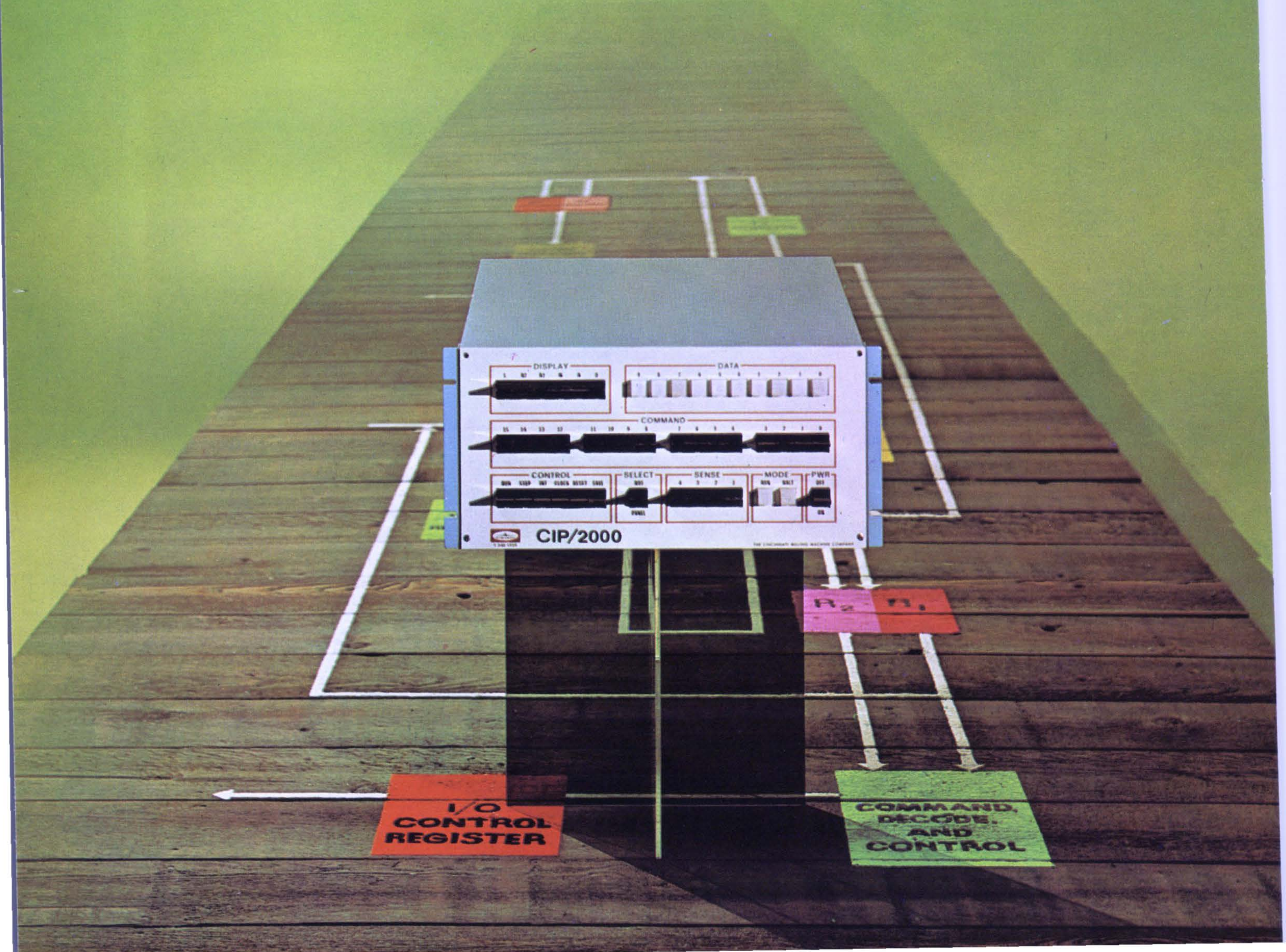


INFORMATION RETRIEVAL NUMBER 51

Speed up the fast Fourier transform

and reduce memory requirements so that a minicomputer can do the whole job.

Designing complex systems is plagued by the fact that the frequency domain is most convenient for linear analysis, while the time domain is ideal for nonlinear analysis. Yet Fourier transformations, both direct and inverse, can be so speeded up by using a digital computer that frequency and time-domain analysis can be used simultaneously. As a result, a great deal of the designer's time is saved.

The fast Fourier transform is the basis for the specialized method to be described—a method that makes a fast technique even faster by recognizing that it contains redundancies that can be removed. The redundancies arise from the fact that most time functions are real while the general form of the transform is complex. The imaginary component of the complex transform can be used to reduce the volume of computations, and a greater number of computations can be accomplished in a given time.

The technique is useful with both large computers and the more limited minicomputers. Machine computations are restricted, of course, to discrete transforms, which have inputs defined only at discrete times and transform values only at discrete frequencies (see box).

Use the Cooley-Tukey algorithm

The fast Fourier transform is a version of the Cooley-Tukey algorithm.[1-6] A program of this algorithm in BASIC is given in Fig. 1. All of the computations involved in the conventional transform technique are performed in the fast transform, but symmetries are used to advantage and repetitions are avoided.

The fast Fourier transform is derived by operating on complex functions, and it is linear. If $f_1(t)$ transforms to $F_1(n)$ and $f_2(t)$ to $F_2(n)$, then $af_1(t) + bf_2(t)$ transforms to $aF_1(n) + bF_2(n)$. But the two time functions can be transformed simultaneously by assigning one of them to be imaginary.

Peter K. Bice, Engineer, Hewlett-Packard Co., Palo Alto, Calif.

Let $f(t) = f_1(t) + jf_2(t)$ where both f_1 and f_2 are real. The transform of $f(t)$ is $F(n) = X(n) + jY(n)$. The real, X, an imaginary, Y, parts can be broken into even and odd parts,

$$F(n) = X_{even}(n) + X_{odd}(n) + jY_{even}(n) + jY_{odd}(n),$$

and the two transforms can be separated, yielding

$$F_1(n) = X_{even}(n) + jY_{odd}(n)$$

and

$$F_2(n) = Y_{even}(n) - jX_{odd}(n)$$

where F_1 and F_2 are the transforms of f_1 and f_2. One operation has given two transforms.

Save by separating time functions

Additional savings can be realized in the specialized method by separating two time functions. Transforms of the two functions can be found simultaneously and then combined to obtain the transform of the original time function.[5]

If, for example, we let $f_1(t)$ be all the even-numbered points in $f(t)$, and $f_2(t)$ all the odd-numbered points, and if there are N points in all, then:

$$\begin{aligned}
F(n) &= \frac{1}{N} \sum_{i=o}^{N-1} f(i)\, e^{\frac{-jin2\pi}{N}} \\
&= \frac{1}{N} \sum_{\text{even } i} f(i)\, e^{\frac{-jin2\pi}{N}} \\
&\quad + \frac{1}{N} \sum_{\text{odd } i} f(i)\, e^{\frac{-jin2\pi}{N}} \\
&= \frac{1}{N} \sum_{k=o}^{-1+N/2} f(2k)\, e^{\frac{-j2kn2\pi}{N}} \\
&\quad + \frac{1}{N} \sum_{k=o}^{-1+N/2} f(2k+1)\, e^{\frac{-j2kn2\pi}{N}} \\
&= \frac{1}{2}\left[\frac{1}{N/2} \sum_{k=o}^{-1+N/2} f(2k)\, e^{\frac{-jkn2\pi}{N/2}}\right] \\
&\quad + \frac{e^{\frac{-jn2\pi}{N}}}{2}\left[\frac{1}{N/2} \sum_{k=o}^{-1+N/2} f(2k+1)\, e^{\frac{-jkn2\pi}{N/2}}\right]
\end{aligned}$$

```
1 DIM X(1024),Y(1024)
100 REM INSERT VALUE OF "G" HERE
110 LET N=2↑G
120 LET P=8*ATN(1)/N
130 FOR I=1 TQ N
140 READ X(I),Y(I)
150 LET X(I)=X(I)/N
160 LET Y(I)=Y(I)/N
170 NEXT I
180 FOR L=0 TO G-1
190 LET G1=2↑(G-L-1)
200 LET M=0
210 FOR I=1 TO 2↑L
220 LET K1=INT(M/G1)
230 GOSUB 530
240 LET Y1=COS(P*K2)
250 LET Y2=-SIN(P*K2)
260 FOR J=1 TO G1
270 LET Y3=X(M+G1+1)*Y1-Y(M+G1+1)*Y2
280 LET Y4=X(M+G1+1)*Y2+Y(M+G1+1)*Y1
290 LET X(M+G1+1)=X(M+1)-Y3
300 LET Y(M+G1+1)=Y(M+1)-Y4
310 LET X(M+1)=X(M+1)+Y3
320 LET Y(M+1)=Y(M+1)+Y4
330 LET M=M+1
340 NEXT J
350 LET M=M+G1
360 NEXT I
370 NEXT L
380 FOR I=0 TO N-1
390 LET K1=I
400 GOSUB 530
410 IF K2>=I THEN 480
420 LET K3=X(I+1)
430 LET X(I+1)=X(K2+1)
440 LET X(K2+1)=K3
450 LET K3=Y(I+1)
460 LET Y(I+1)=Y(K2+1)
470 LET Y(K2+1)=K3
480 NEXT I
490 FOR I=0 TO N-1
500 PRINT I,X(I+1),"+J":Y(I+1)
510 NEXT I
520 GO TO 610
530 LET K2=0
540 FOR K=1 TO G
550 LET K3=K1-2*INT(K1/2)
560 LET K1=INT(K1/2)
570 IF K3=0 THEN 590
580 LET K2=K2+2↑(G-K)
590 NEXT K
600 RETURN
610 END
```

1. **The general fast Fourier** transform program is the starting point for a nonredundant approach. Delete lines 150, 160 and change sign on 250 for inverse transform.

Properties of the Fourier Transform

The form of the discrete Fourier transform is:

$$F(n) = \frac{1}{N} \sum_{i=0}^{N-1} f(i) e^{-jin2\pi/N}$$

and its inverse is

$$f(i) = \sum_{n=0}^{N-1} F(n) e^{+jin2\pi/N}$$

where N is the number of samples of the time function available.

This transform pair has the following properties: if one is substituted into the other, an identity results. F(n) is periodic with period N. Substituting (N+n) for n does not change its value. Thus, N values of f(i) result in N values of F(n) before repetition begins. Also, F(i) is periodic with period N. If N time samples are specified, one period of the transform is described. If the time function is real, the real part of F(n) is even in n:

$$\mathrm{Re}(F(n)) = \mathrm{Re}(F(N\text{-}n))$$

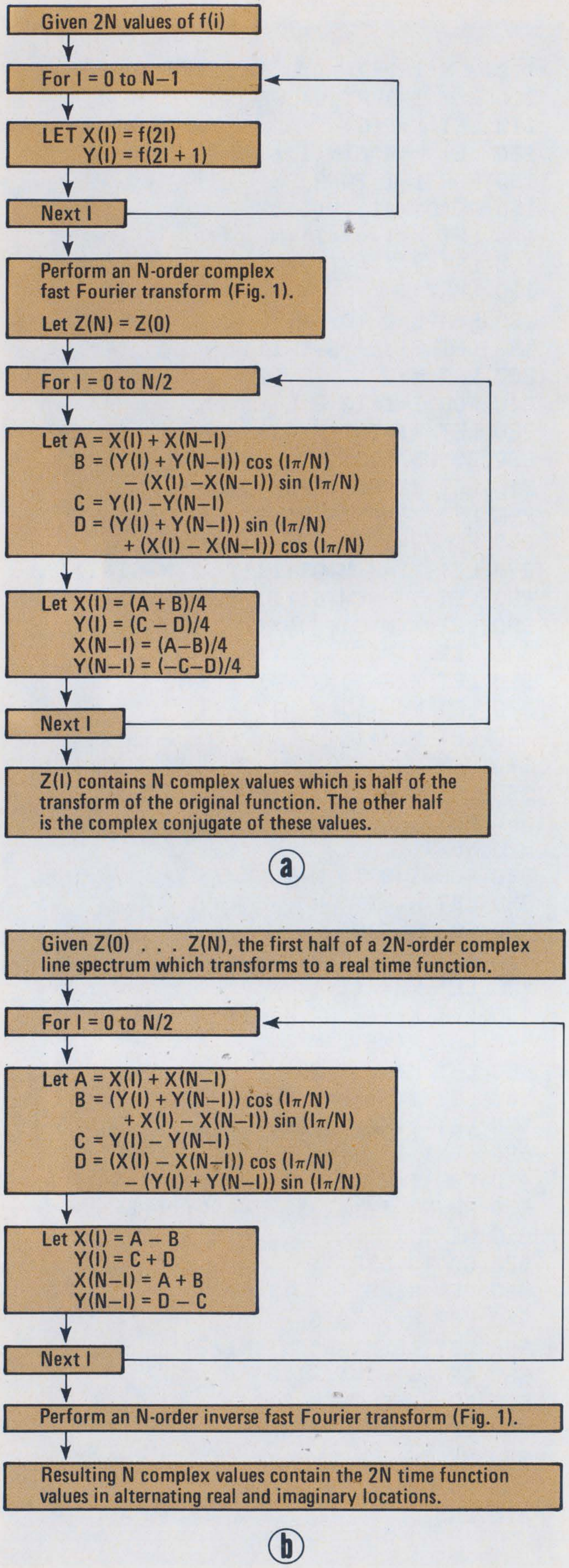
and the imaginary part of F(n) is odd in n:

$$\mathrm{Im}(F(n)) = -\mathrm{Im}(F(N\text{-}n)).$$

The transform and its inverse are very similar. An algorithm for one also performs the other with minor modifications.

For the fast Fourier transform:

1. The number of data points, N, must be a power of 2.
2. Memory must be large enough to store a complex column matrix of N entries.
3. If f(t) is real, $(F(n) = F(N\text{-}n)*$. Thus, half of the resultant complex line spectrum is redundant.
4. The data is read into the complex column matrix and is operated on until the final result is obtained. The transform values must be rearranged into the proper order. The original data is lost.
5. The Cooley-Tukey algorithm requires the change of a number into its image (reverse order of bits). It is done in program steps 530-590 of Fig. 1.

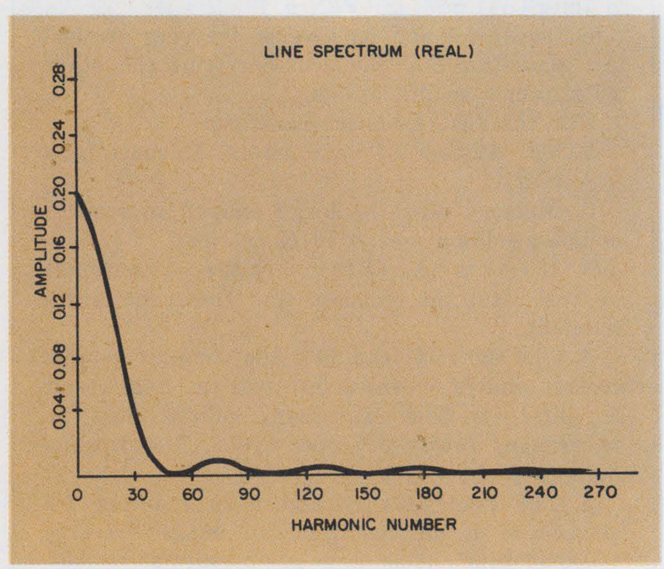


2. **The specialized fast Fourier** transform is obtained from the program of Fig. 1 by using these flow charts. The direct transform from real time to complex frequency is given in (a), and its inverse in (b).

The last quantities are exact N/2-order Fourier transforms for which there exists an algorithm. The memory needed for the computations can be halved by using the specialized transform, because the redundancy inherent in real time functions has been eliminated by performing the two transforms simultaneously.

The flow charts of Fig. 2 show how to modify the fast Fourier transform program to transform a real time function consisting of 2^G samples. The even-numbered samples are treated as the real $f_1(t)$, and the odd-numbered samples as the imaginary $f_2(t)$. The transformation routine is then entered and executed. At its conclusion, the resulting complex line spectrum is resolved into the two spectra, one for each time function. They are then added together as shown above, by adding $F_1(n)$ to $F_2(n)e^{-jn2\pi/N}$. The result is the desired complex line spectrum without the redundancy of negative frequencies.

As an example of what can be accomplished a 128-sample time function was transformed three ways using a Hewlett-Packard 2116B minicomputer. The fast, nonredundant technique, expressly for transforming real time functions,



3. **The real line spectrum** of a triangular wave is plotted from the transform of the time function.

took 46 seconds. The regular fast technique previously described took 87 seconds and required twice as much storage space. The conventional technique, on the other hand, took 16-1/2 minutes and required three times the storage.

Take inverse transforms

The efficiency of the inverse transform (Fig. 2b) can also be improved, but the operations occur in exactly the opposite sequence from those of the direct transform. Begin with a complex F(n) which is nonredundant. Break up the real and imaginary parts into even and odd components and multiply the appropriate pair by $je^{+jn2\pi/N}$. Add the result to the unmultiplied pair of parts, and find the inverse transform of the sum. The result is a column of N/2 complex numbers representing the time function. The real parts are the even-numbered samples and the imaginary parts are the odd-numbered samples..

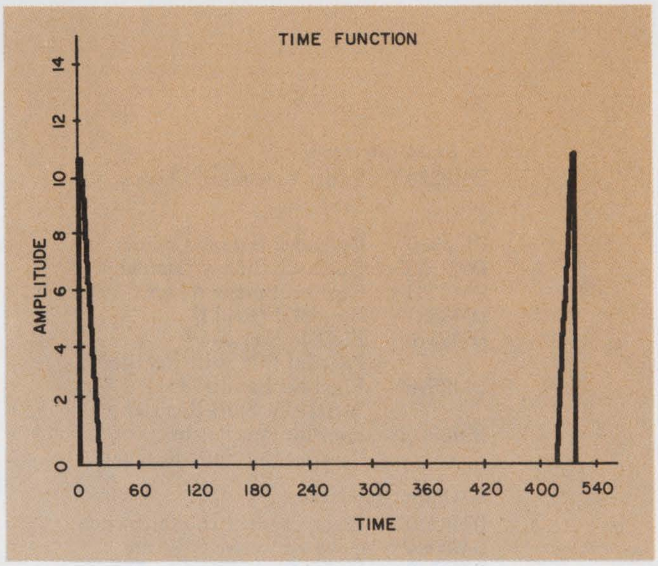
As an example of a fast transform pair, consider a periodic triangular wave with a period of 512 time units, a peak amplitude of 10, and a slope of ±1.

The line spectrum shown in Fig. 3 is the result of this transformation. No harmonics beyond #256 are calculated since they would be redundant. Also, since the time function is even, the imaginary part of the spectrum is zero.

This line spectrum is plugged into the inverse transformation routine. The time function shown in Fig. 4 is the result. In all respects, this function is identical to the original input function, as would be expected of a transform pair. ■■

References:

1. Cooley, J. W. and Tukey, J. W., "An Algorithm for the Machine Calculation of Complex Fourier Series," *Math. of Comput.*, Vol. XIX, April, 1965, pp. 297-301.
2. Haavind, Robert, "The FFT Computer: Designer's Missing Link," *Electronic Design*, Dec. 6, 1967, pp. 25-29.
3. Klahn, Richard and Shively, Richard R., "FFT-Short Cut to Fourier Analysis," *Electronics*, Apr. 15, 1968, pp. 124-129.
4. Bergland, G. D., "A Guided Tour of the Fast Fourier Transform, *IEEE Spectrum*, July 1969, pp. 41-52.
5. Singleton, Richard C., "On Computing the Fast Fourier Transform," *Comm. of the ACM*, Vol. 10, No. 10, Oct., 1967.
6. Brigham, E. O. and Morrow, R. E., "The Fast Fourier Transform," *IEEE Spectrum*, Dec., 1967, pp. 63-70.



4. **The original time function** is synthesized from the inverse transformation of the spectrum in Fig. 3.

Test your retention

Here are questions based on the main points of this article. Their purpose is to help you make sure you have not overlooked any important ideas. You'll find the answers in the article.

1. What is the link between the time and frequency domains?

2. What is the inverse transform of a complex line spectrum?

3. Why is the conventional Fourier transform inefficient when used in a computer program?

4. What is the advantage of a conventional Fourier transform in machine computations?

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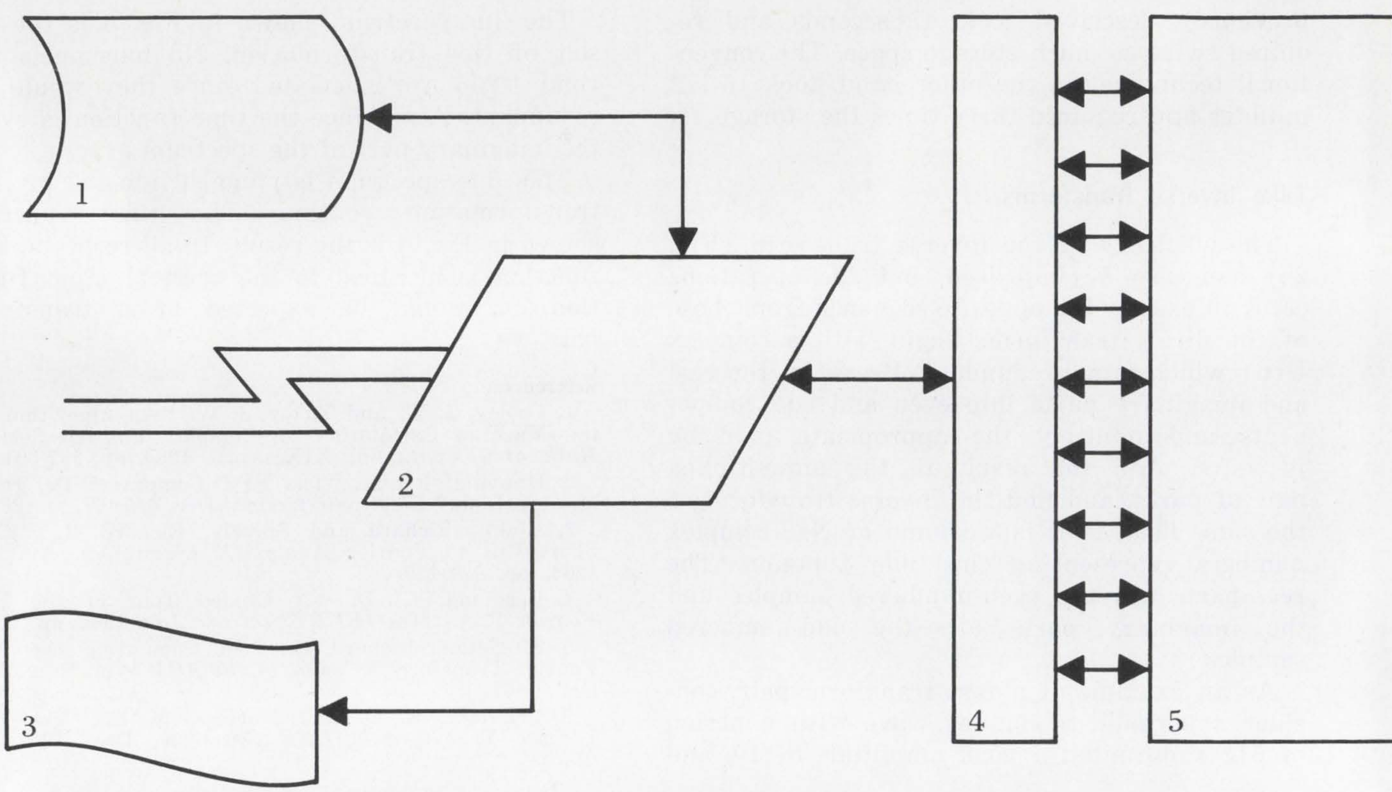

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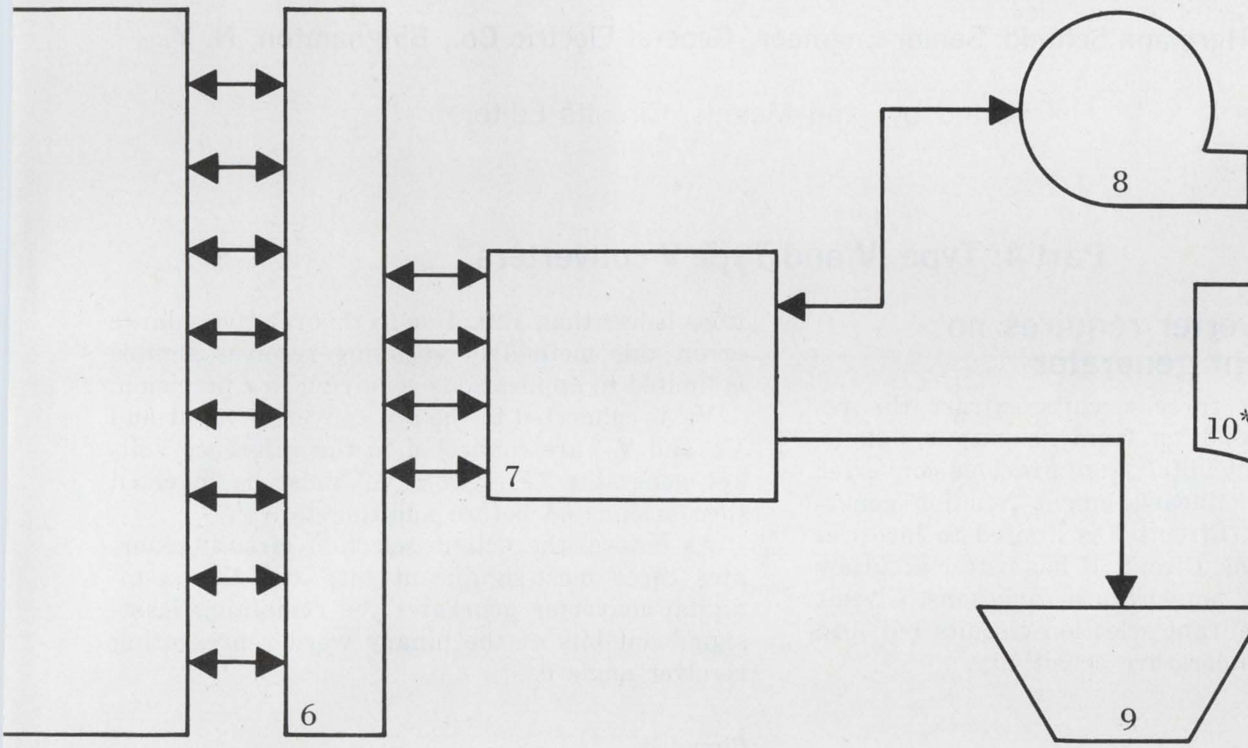

7. Memory

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DM8590N	Eight-bit Parallel-In Serial-Out Shift Register
DM8570N	Eight-bit Serial-In Parallel-Out Shift Register

8. Off Line Storage

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DM8220N	Parity Generator/Checker

9. Display

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INFORMATION RETRIEVAL NUMBER 52

An Electronic Design practical guide for synchro-to-digital converters

Written by: Hermann Schmid, Senior Engineer, General Electric Co., Binghamton, N. Y.

Edited by: Don Mennie, Circuits Editor

Part 4: Type IV and Type V converters

Type IV converter requires no linear-segment generator

The following three circuits extract the resolver angular position from its output signals, V_{Xac} and V_{Yac}, but differ from previous converter designs since no linear-segment function generator is required. Circuit I is limited to low-precision applications. Circuit II has better accuracy but is limited by temperature variations. Circuit III needs no quadrant selection circuits but also suffers from temperature sensitivity.

Circuit I.

This remarkably simple resolver-to-digital-angle converter [22] (Fig. 27) solves the equation

$$\theta = \frac{\sin\,\theta}{\sin\,\theta/\theta} \approx \frac{\sin\,\theta}{\cos\,\theta + \mathrm{K}\sin\,\theta}. \qquad (57)$$

The circuit contains an octant selector, standard analog-to-digital converter and a special reference voltage generator. The special generator combines the selected resolver output signals (V_X' and V_Y') and produces a reference voltage.

$$V_R = V_X' + K\,V_Y' = \cos\theta + K\,\sin\theta. \qquad (58)$$

The difference between θ and its approximation, $\sin\theta/(\cos\theta + K\sin\theta)$, is plotted in Fig. 28 as a function of the angle θ for $K = 0.25$. From zero to 45°, the error between these two functions is less than 1.2°. Due to this relatively large error, this method of encoding resolver signals is limited to applications requiring low precision.

V_X' is connected to the a/d converter input and V_X' and V_Y' are connected to the reference voltage generator (Fig. 27). V_X' must be inverted then attenuated before addition to V_Y'.

As before, the octant selection circuit generates three most-significant bits and the ac-to-digital converter generates the remaining least-significant bits of the binary word representing resolver angle θ.

Circuit II.

Theoretically, a more precise resolver-to-digital angle converter* can be built if the following approximation is used:[23,24]

$$\theta_A \approx 45^\circ + \frac{180^\circ}{\pi}\cdot\frac{\sin(\theta - 45^\circ)}{0.66 + 0.34\cos(\theta - 45^\circ)}. \qquad (59)$$

The error between θ and this approximation is less than one minute of arc (1 part of 21,600) for θ between 0° and 90° (Fig. 29).

Equation 59 must be modified before use since the resolver outputs are $V_X = K\cos\theta$ and $V_Y = K\sin\theta$, whereas the terms required in Eq. 59 are $\sin(\theta - 45^\circ)$ and $\cos(\theta - 45^\circ)$. However, since

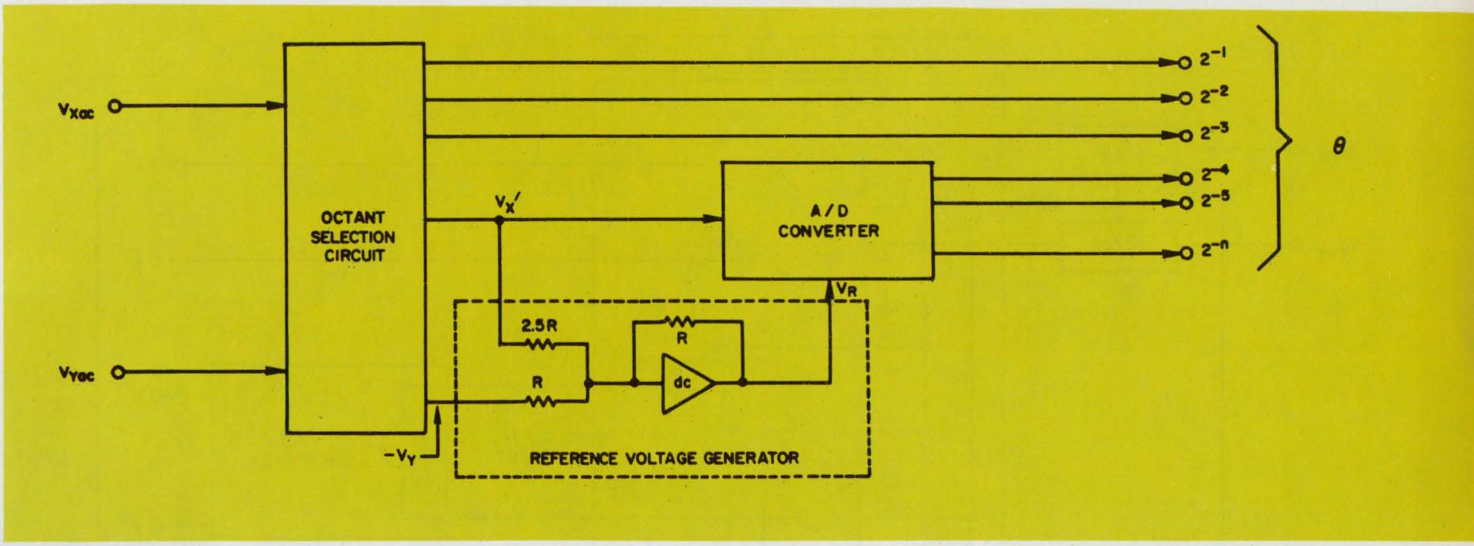
$$\sin(\theta - 45^\circ) = 0.707\,(\sin\theta - \cos\theta) \qquad (60)$$

and

$$\cos(\theta - 45^\circ) = 0.707\,(\cos\theta + \sin\theta), \qquad (61)$$

Eq. 59 can be modified to

* Extracted from "An Electronic Angle Encoder," 1966 National Telemetering Proceedings by permission from G. B. Gilbert, Jr., Towson Laboratories, Inc., Baltimore, Md.



27. **The Type IV converter—Circuit I**—does not need a linear-segment function generator, but large error limits this method of encoding resolver signals to low precision applications.

$$\theta_A 45^\circ + \frac{180}{\pi} \cdot \frac{\sin\theta - \cos\theta}{0.93 + 0.34\,(\sin\theta + \cos\theta)} \cdot \quad (62)$$

It is desirable that the analog-to-digital converter generate digital output signals in the offset-binary form, so that

$$\begin{aligned} +90^\circ &= +\text{ full scale} &&= 1\ 1\ 1 \cdots 1\ 1\ 1 \\ +45^\circ &= \text{half full scale} &&= 1\ 0\ 0 \cdots 0\ 0\ 0 \\ 0^\circ &= -\text{ full scale} &&= 0\ 0\ 0 \cdots 0\ 0\ 0 \end{aligned}$$

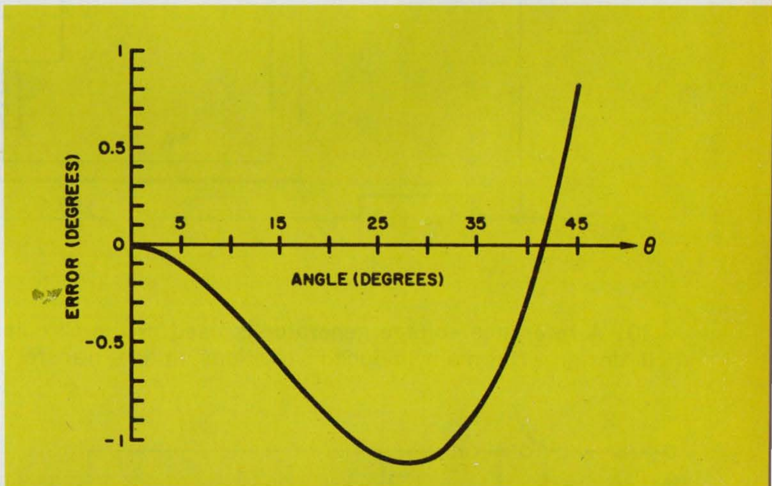
Therefore, the equivalent analog input voltage to the converter must be biased with the equivalent of -45° and normalized by dividing by 45°. Incorporating this into Eq. 62 gives

$$\frac{\theta_A - 45^\circ}{45^\circ} = \frac{\sin\theta - \cos\theta}{0.73 + 0.268\ (\sin\theta + \cos\theta)} \cdot \quad (63)$$

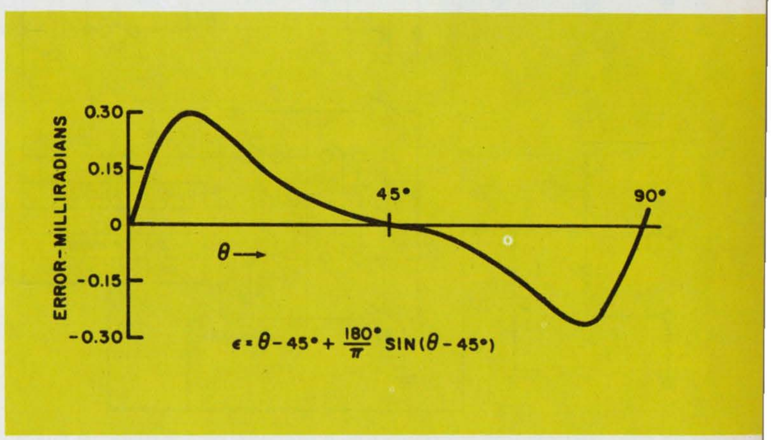
This equation can be implemented in the proposed converter by connecting a voltage to the converter's signal input (proportional to the numerator of Eq. 63) and by connecting a negative voltage to the converter's reference input (proportional to the denominator of Eq. 63). The dc-to-digital converter output is then proportional to the angle θ.

For second, third and fourth-quadrant resolver signals, the polarities of the V_X and V_Y terms in Eq. 63 must be changed to account for resolver output polarity change. This is performed by the quadrant selection circuit. The required V_X and V_Y polarities for generation of the converter-input signal V_S and the reference voltage V_R for the quadrants are:

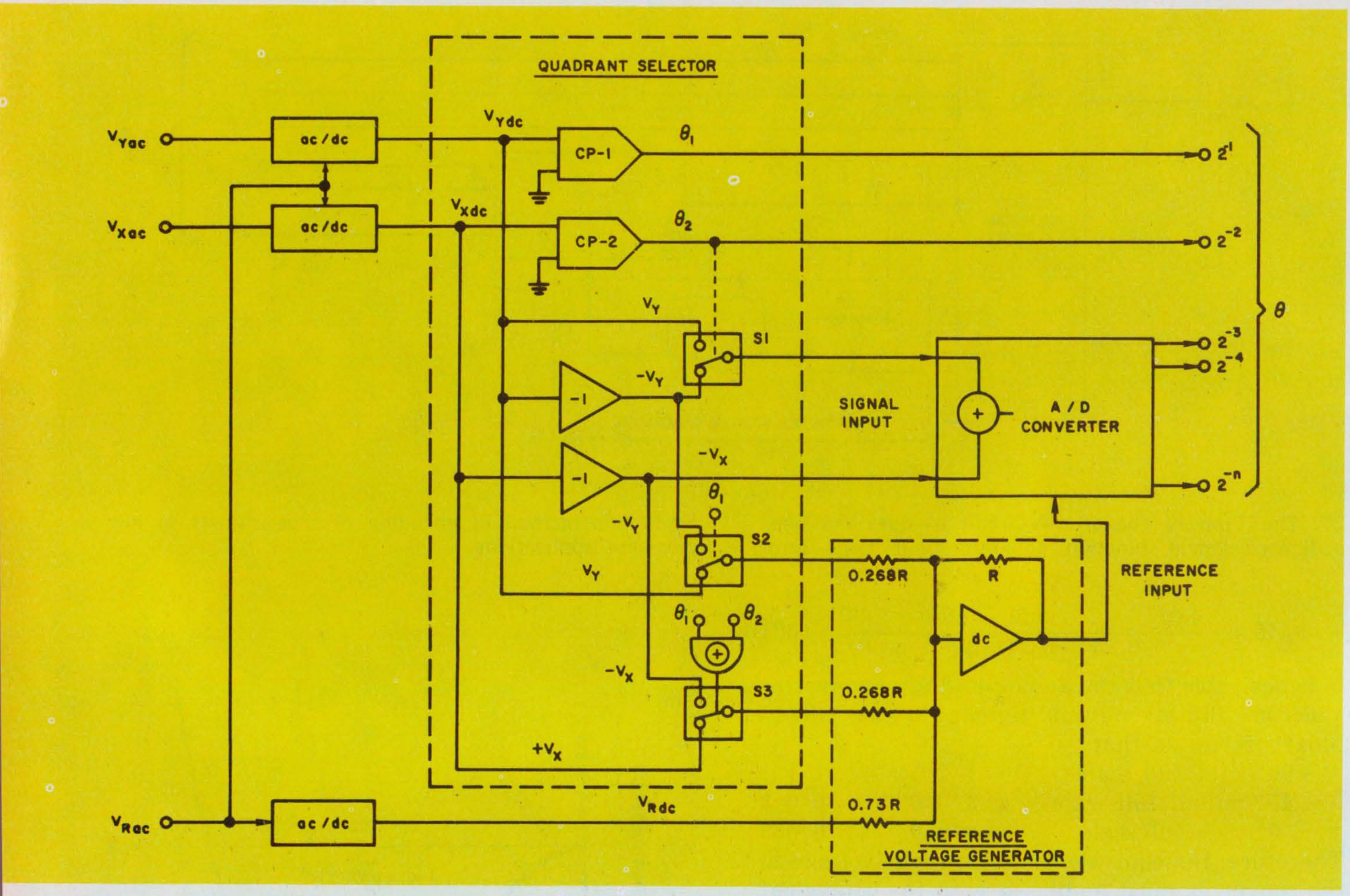
Quadrant	Digital Output 2^{-1}	Digital Output 2^{-2}	Converter Input V_S		Converter Reference V_R	
I	0	0	$+V_Y$	$-V_X$	$+V_Y$	$+V_X$
II	0	1	$-V_Y$	$-V_X$	$+V_Y$	$-V_X$
III	1	0	$+V_Y$	$-V_X$	$-V_Y$	$-V_X$
IV	1	1	$-V_Y$	$-V_X$	$-V_Y$	$+V_X$



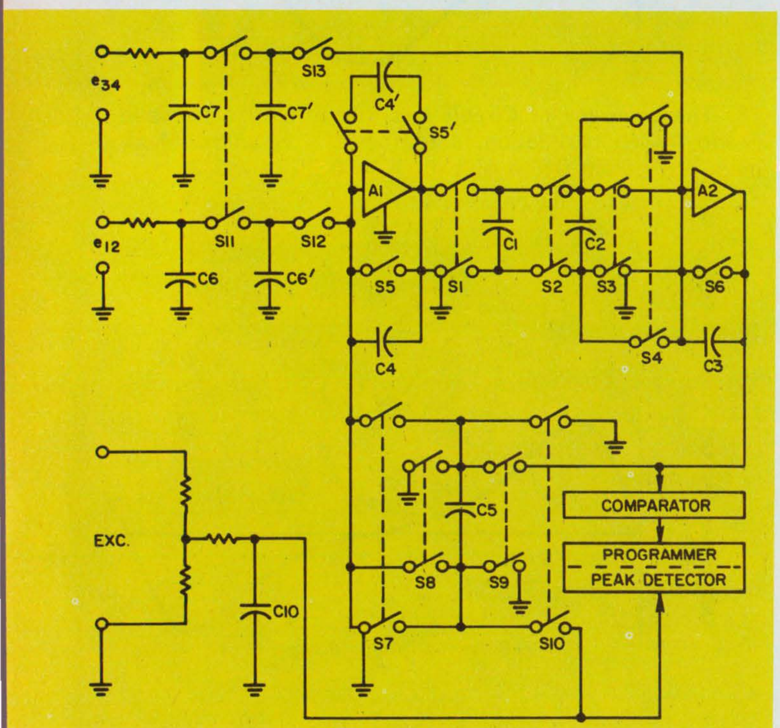
28. **The accuracy of Circuit I** is the difference between θ and its approximation, $\sin\theta/(\cos\theta + K \sin\theta)$. Maximum error from 0° to 45° for K = 0.25 is $<1.2^\circ$



29. **Greater precision is theoretically available** from the Type IV converter—Circuit II. Error between θ and its approximation (Eq. 59) from 0° to 90° is <1.0 minute of arc.



30. **A reference voltage generator** is used in the Circuit II design. Thermally induced variations in the transformation ratio between V_{Rac} and V_{Xac} present a major accuracy problem.



31. **The Type IV converter—Circuit III**—requires stable, precisely related capacitor values. Like Circuit II, this design is accuracy-limited by transformation ratio variations.

Figure 30 illustrates a conventional resolver-to-digital-angle converter using this principle. It is built with three ac to dc converters, a quadrant selector, a standard dc-to-digtal converter and a special-reference voltage generator.

The three ac-to-dc converters generate dc voltages from the resolver output signals, V_{Xac}, V_{Yac}, and from the resolver excitation voltage, V_{Rac}. The quadrant selector accepts bipolar dc voltages V_{Xdc} and V_{Ydc}, and produces the desired combination for the signal and reference inputs of the a/d converter as follows.

The two comparators, CP_1 and CP_2, are connected so that the outputs, θ_1 and θ_2, are ZERO when the inputs, V_{Xdc} and V_{Ydc}, are positive (resolver is in the first quadrant). The comparator outputs θ_1 and θ_2, which are the two most-significant outputs of the resolver-to-digital-angle converter, control the S_1, S_2 and S_3 selector switches. S_1 and S_3 are controlled by θ_2 and S_2 by θ_1. Two conventional operational amplifiers are connected as unity-gain inversion amplifiers to produce $-V_X$ and $-V_Y$. In accordance with the table above, the a/d converter signal input becomes $-V_X$ and $+V_Y$ or $-V_Y$, depending on whether θ_2 is ZERO or ONE, respectively. The inputs to the reference voltage generator are $+V_Y$ when θ_1 is ZERO or $-V_Y$ when θ_1 is ONE, and $+V_X$ when $\theta_1 = \theta_2$ or $-V_X$ when θ_1 is not equal to θ_2.

The converter in Fig. 30 has one serious disadvantage. The voltage representing the factor 0.73 in Eq. 63 (generated directly from V_{Rac}) is not attenuated by the transformation ratio of the resolvers, as are all other voltages. In most resolvers, the transformation ratio between V_{Xac} and V_{Rac}, as well as between V_{Yac} and V_{Rac}, varies as much as 4% initially from unit to unit and as much as 3% over the temperature range. Unit-to-unit variation could be compensated for, but there are no practical circuits to correct thermal variations in the transformation ratio (between −55°C and +85°C).

Circuit III.

A simplified diagram of a complete four-quadrant resolver-to-digital angle converter is given in Fig. 31. This circuit does not require external ac-to-dc converters or quadrant selection circuitry. This design is comprised of a charge-equalizing a/d converter, an input circuit for quadrant selection, conventional comparison and logic circuits and circuitry for generating constants from the reference voltage. A complete description of operation has been published.[24]

The analog portion of this converter comprises 11 precision capacitors, 10 dpst switches, four spst switches and two operational amplifiers. The capacitors must have high stability and precise magnitude ratios, but they need not have tight absolute-value tolerances. The analog voltage switch must display low leakage currents, small feedthrough capacitance, moderate turn-ON and turn-OFF times, and low ON resistance.

The converter design of Fig. 31 has the same disadvantages as the converter of Fig. 30. Neither approach can compensate for resolver transformotion ratio variations.

Type V converter uses harmonic oscillator

Another technique of encoding resolver output signals uses a harmonic oscillator[25] such that initial conditions are made proportional to the amplitude of the resolver output signals, V_X and V_Y. The time required for the oscillator to provide resolver shaft angle information is proportional to the resolver shaft angle magnitude. A resolver-to-digital converter built on this principle[26] is simple, but it has significant accuracy limitations.

In the harmonic oscillator, two integrators and one inverter form a closed loop (Fig. 32). The operation of the oscillator is defined by the differential equation

$$\ddot{X} = -X\frac{R_4/R_3}{R_1C_1R_2C_2} \quad . \qquad (64)$$

Solutions to this differential equation are the two integrator outputs:

$$V_1(t) = E\cos\omega t \qquad (65)$$

$$V_2(t) = E\sin\omega t \qquad (66)$$

where

$$E = \sqrt{(V_{10})^2 + (V_{20})^2}, \text{ and} \qquad (67)$$

$$\omega = 1/\sqrt{R_1C_1R_2C_2} \quad . \qquad (68)$$

V_{10} and V_{20} are the integrating capacitor voltages when $t = 0$ (initial conditions). The oscillator's output amplitude, E, can be controlled by charging C_1 and C_2 to specific values prior to $t = 0$. Note that amplitude is independent of the time constants R_1C_1 and R_2C_2. By contrast, the output frequency is a function of the integrator time constants and is independent of initial conditions.

The two integrator outputs are the X and Y components of an imaginary vector $\bar{R}$, which rotates with the constant velocity $K\omega$. The time, t_θ, required to rotate this vector $\bar{R}$ from its initial position (Fig. 33) to a position where V_Y is zero is directly proportional to the vector angle. Since the angle is $\theta = K\omega t_\theta$ the time is

$$t_\theta = \theta/(K\omega). \qquad (69)$$

The diagram (Fig. 34) shows that the proposed converter is a harmonic oscillator controlled by a 12-bit master counter and a zero detector. Type V converter operation is divided into three modes (Fig. 35) where:

1. During T_1 the initial conditions are set by integrating the rectified resolver output signals, V_{Xdc} and V_{Ydc}.

2. During T_2 the vector $\bar{R}$, represented by its components, V_X and V_Y, is rotated until the output of the second integrator, V_2, crosses zero.

3. During T_3 the two integrators are reset to zero by closing a switch connected across the integration capacitor.

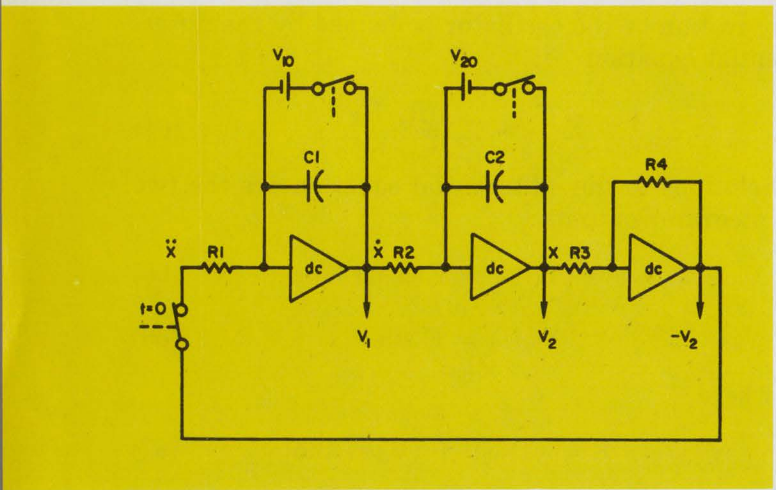
Specifically, the initial conditions, V_{10} and V_{20}, are obtained by connecting V_{Xdc} and V_{Ydc} to the integrators with switches S_1 and S_2 during period T_1. Therefore,

$$V_{10} = -1/(R_1C_1)\int_0^{T_1} V_X dt = (-V_XT_1)/(R_1C_1) \quad (70)$$

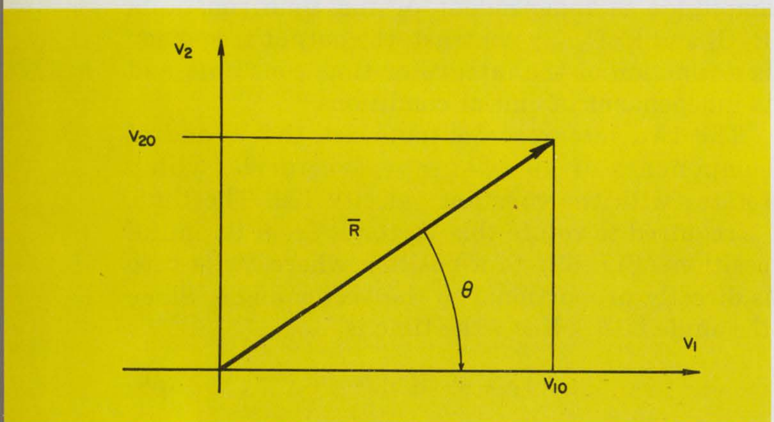
and

$$V_{20} = -1/(R_2C_2)\int_0^{T_1} V_Y dt = (-V_YT_1)/(R_2C_2). \quad (71)$$

During period T_2, the oscillator loop is closed



32. **The harmonic oscillator used in the Type V converter** solves differential equations of the form $\ddot{X} = KX$ (K=constant terms).



33. **The imaginary vector $\bar{R}$** has the two integrating capacitor voltages V_{10} and V_{20} as components. $\bar{R}$ rotates with a constant velocity, $K\omega$.

by placing S_1 and S_2 at position A. The two integrators integrate each other's output, $V_1(t)$ and $-V_2(t)$, defined in Eqs. 65 and 66. Starting with the initial conditions set during T_1

$$V_1(t) = V_{10} - 1/(R_1C_1)\int_0^{t_A} - V_2(t)\,dt \qquad (72)$$

and

$$V_2(t) = V_{20} - 1/(R_2C_2)\int_0^{t_A} V_1(t)\,dt. \qquad (73)$$

Since $V_1(t)$ and $V_2(t)$ are sine and cosine functions, Eq. 73 can be solved for t_A by setting $V_2(t)$ equal to zero

$$V_{20} = 1/(R_2C_2)\int_0^{t_A} \cos\omega t\,dt \qquad (74)$$

Substituting Eq. 71 into Eq. 74 and solving the integral in the latter gives

$$-(V_YT_1)/(R_2C_2) = \sqrt{R_1C_1R_2C_2}/(R_2C_2)\sin\omega\, t_A. \qquad (75)$$

If $R_1C_1 = R_2C_2$, then

$$-\sin\omega t_A = (V_YT_1)/(RC) \qquad (76)$$

which can be verified by examining the waveforms in Fig. 35.

Similarly Eq. 72 can be set equal to the maximum possible value, which is

$$1 = -(V_XT_1)/(R_1C_1) + 1/(R_1C_1)\int_0^{t_A}\sin\omega t\,dt \qquad (77)$$

which can be solved for $\cos\omega t_A$, since

$$1 = -\frac{V_XT_1}{R_1C_1} + 1 - \frac{\sqrt{R_1C_1R_2C_2}}{R_1C_1}\cos\omega t_A \qquad (78)$$

$R_1C_1 = R_2C_2$, hence

$$-\cos\omega t_A = (V_XT_1)/(RC) \qquad (79)$$

Dividing Eq. 76 by 79 gives

$$\tan\omega t_A = V_Y/V_X \qquad (80)$$

or

$$t_A = (1/\omega)\tan^{-1}(V_Y/V_X) \qquad (81)$$

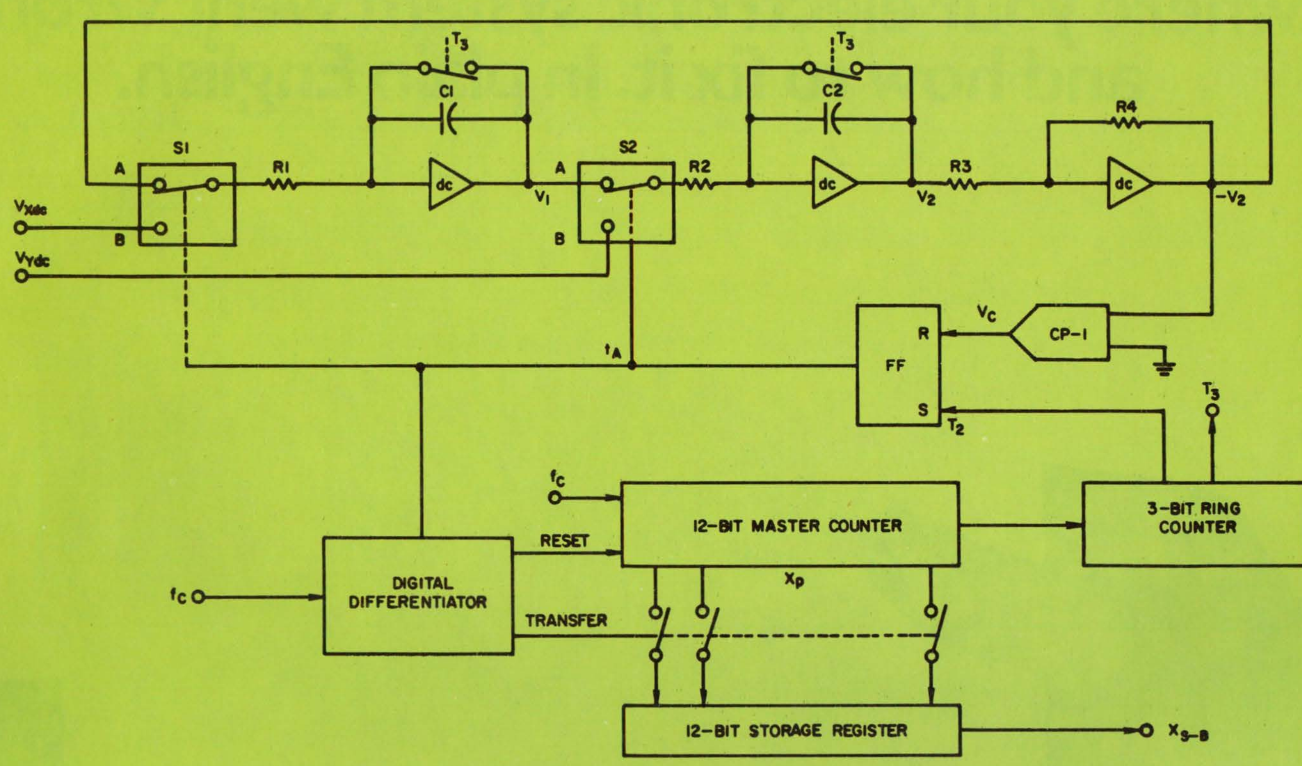
As in any other resolver-to-digital angle converter, t_A is independent of reference voltage. But, unlike other converters, the circuit in Fig. 34 has no reference supply. Signal t_A is also independent of period length $T_1 = 2^n/f_c$, but this provides no advantage since the digital output signal, $X = t_A f_c$, is now a function of clock frequency f_c, which must be stable for good converter accuracy.

Of more concern is circuit dependence on the value and stability of integration time constants R_1C_1 and R_2C_2, since t_A varies with $\sqrt{R_1C_1R_2C_2}$. This means the resistors and capacitors used with the integrators must be precise and stable. Integration time constant dependence poses a severe accuracy limitation for this converter, which overshadows circuit simplicity and low component count.

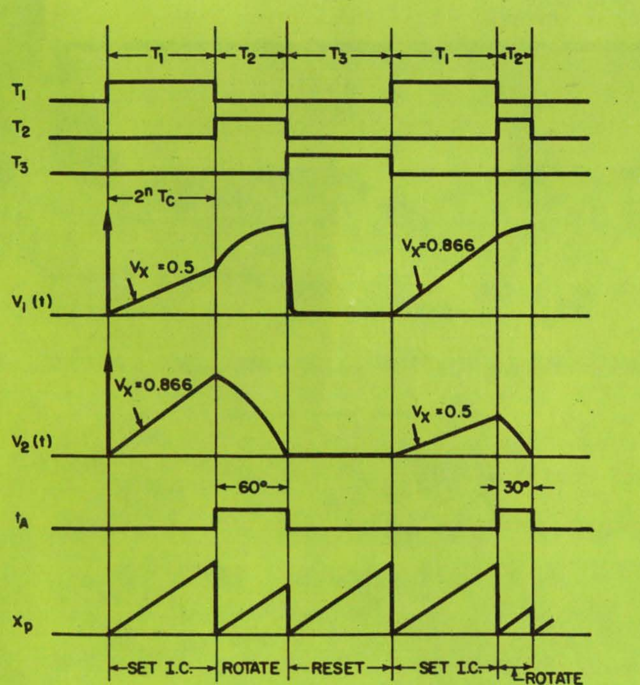
The above description assumes both resolver output signals are positive dc voltages (the resolver angle lies in the first quadrant). The dc signals, V_{Xdc} and V_{Ydc}, obtained from a set of phase-sensitive demodulator outputs, are selected for the first quadrant (per method in Fig. 30). The converter can accept input signals in all four quadrants if a second zero crossing detector is provided and additional logic circuits are employed to assure proper converter operation.

A device similar to that in Fig. 34 is presently sold by Kearfott's Product Division [11, 27] under the trade name TRIGAC. TRIGAC differs from Fig. 34 since it integrates the resolver output signals, V_{Xac} and V_{Yac}, directly for one half the carrier frequency period, thus eliminating the need for phase-sensitive demodulators.

The integrating resistors and capacitors in the



34. **The Type V converter is controlled by a 12-bit master counter.** Integration time constant dependence poses severe accuracy limitations on this design, overshadowing the low component count advantage.



35. **Operation of the Type V converter is divided into three modes.** T_1 sets initial conditions, T_2 rotates vector $\overline{R}$, T_3 resets integration capacitor voltage to zero.

TRIGAC are selected for zero temperature coefficient. The two time constants are trimmed to an accuracy of 0.03% during manufacture. ■ ■

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Part 5: Conclusion

The final section of this Practical Guide for Synchro-to-Digital Converters will appear in our next issue, ED 10, May 10, 1970. This portion will describe the mathematically exact Type VI converter and then discuss multispeed converter design.

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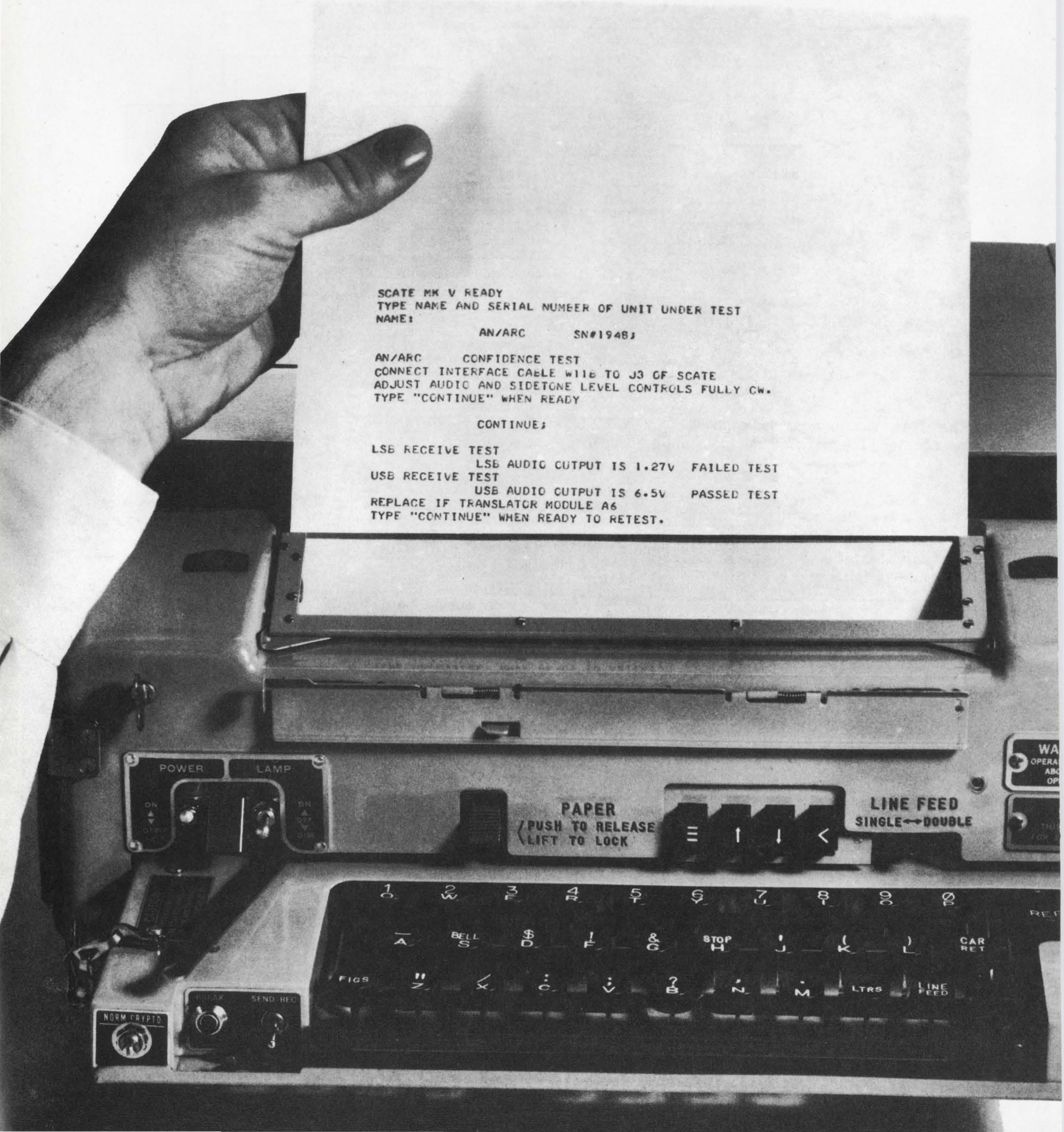

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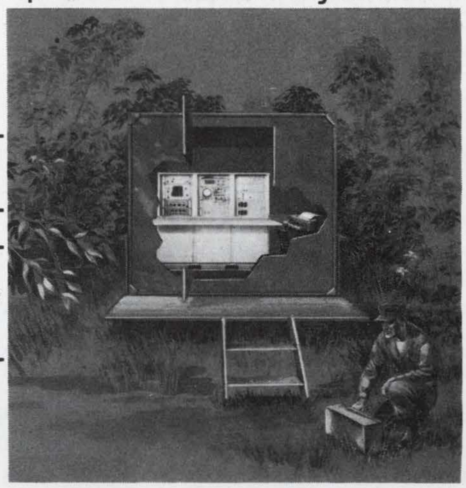

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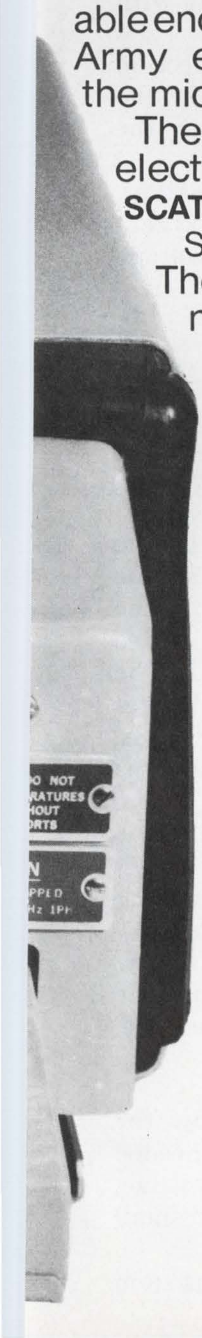

INFORMATION RETRIEVAL NUMBER 53

Choose magnetic deflection for CRT displays that require small spot sizes and large deflection angles. Here are some circuit-design tips.

Magnetic deflection offers several advantages in display-system performance over its electrostatic counterpart, and it should be seriously considered for new display designs.

Of major benefit is the fact that it is inherently incapable of disrupting the beam-shaping process within the CRT. Since beam shaping is an electrostatic process, eliminating the large voltage swings encountered in electrostatic deflection systems allows reduced spot size and thus provides a brighter display.

A second advantage of magnetic deflection is that it provides large deflection angles more easily than an electrostatic system can. This is particularly important with alphanumeric displays because of the demand for ever-larger tube faces in this area.

Magnetic deflection is a current-controlled phenomenon, and this gives it several additional advantages over the voltage-controlled electrostatic approach:

- System reliability is increased because high-voltage component stresses are avoided.
- Since solid-state amplifiers are much more suited to handling large currents than large voltages, the marriage of these amplifiers to magnetic deflection yokes is a happy one.
- Finally, eliminating high voltages means reducing the shock hazard to operating personnel —an important consideration.

Frequency limitation is not a problem

Magnetic deflection works very well at low frequencies. Above about 3 to 5 MHz, however, the resonances of the deflection yoke come into play, making it necessary for the gain of the deflection amplifier-yoke combination to begin rolling off. Otherwise, the feedback loop used to control the yoke current will become unstable.

This frequency limitation is not very important because most display systems—other than high-performance scopes—operate at lower frequencies. Alphanumeric displays, for example, are usually speed-limited by their character generators.

What can be a problem in some demanding alphanumeric display applications is pincushion distortion. This type of distortion is caused by the nonlinear relationship between deflection current and spot deflection distance. It causes the character size and shape to vary somewhat with screen position.

The key parameter in a magnetic deflection system is the magnetic flux generated by the yoke. This is what actually interacts with the electron beam and deflects it.

If the permeability of the yoke is constant, and if resistive losses are ignored, the flux generated by the yoke is related to the voltage across it by

$$E = N\,(d\phi/dt) \qquad (1)$$

where E is the voltage across the yoke, N is the number of turns ϕ is the flux in webers and t is the time in seconds. Clearly, if a voltage step is applied to the yoke, the resulting flux will be a linearly increasing function of time given by $Et = N\phi$.

The assumption that the permeability of the yoke is constant is a good one so long as the maximum deflection current is kept below the saturation value. However, the effective series resistance of the yoke cannot be ignored. The yoke is actually a series R-L circuit that charges exponentially with a time constant $\tau = L/R$, where L is the inductance of the yoke and R is its series resistance.

If a voltage step is applied to a real yoke, therefore, the current will be given by

$$I = (E/R)\;[1 - \exp(-Rt/L)]. \qquad (2)$$

Since the generated flux is proportional to yoke current, it is clear that the flux is not a linear function of time. The resistance causes flux-rate distortion and limits the voltage across the yoke.

Feedback to the rescue

To overcome the distortion caused by the series resistance and to shorten the time needed for the current (flux) to come to its final value, a feedback technique can be employed. A small

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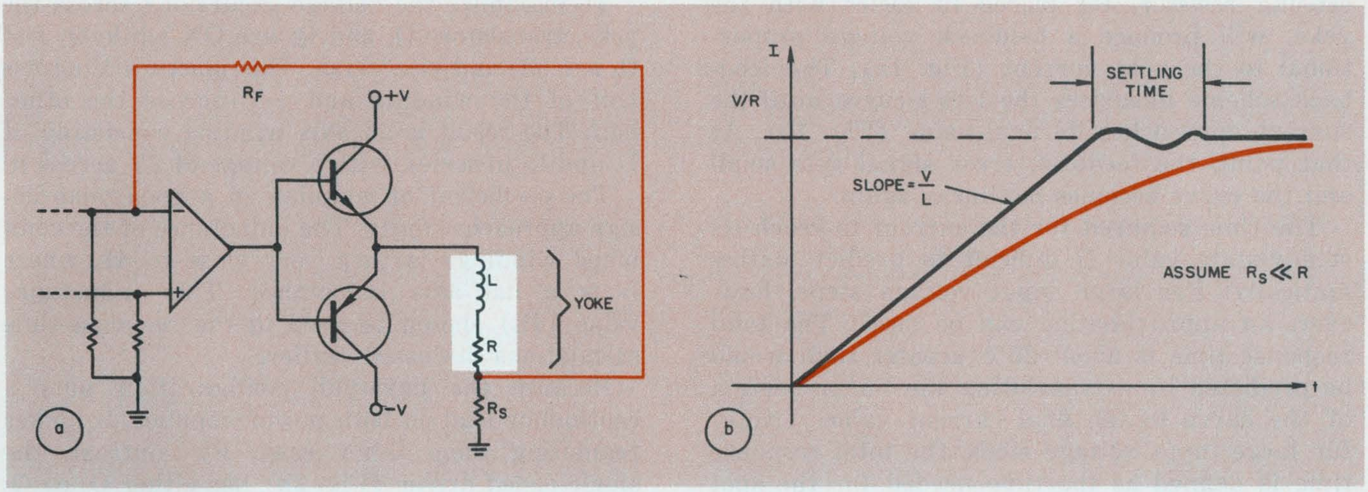
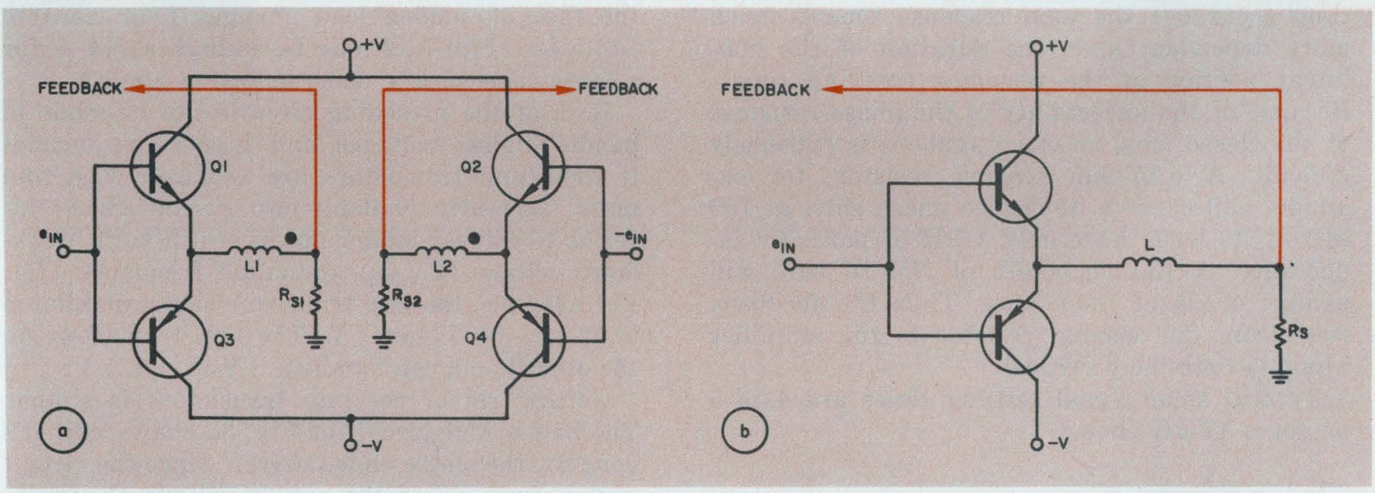
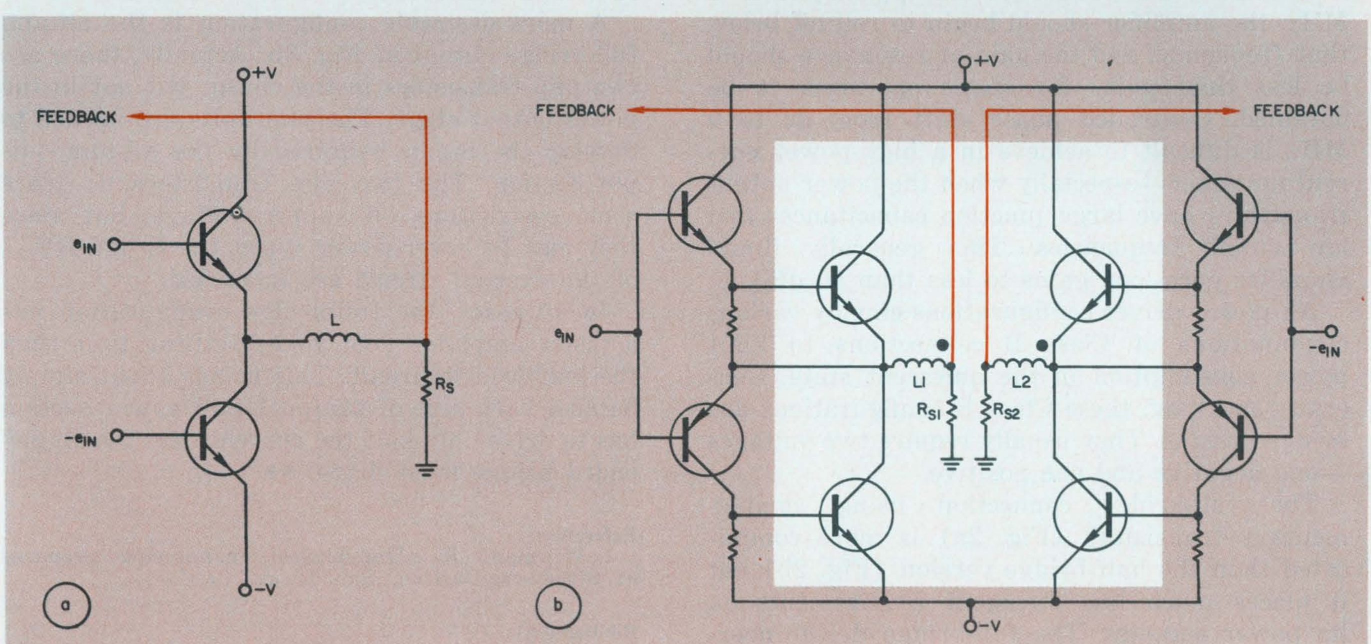
William E. Peterson, Associate Engineer, ITL Research Corp., Northridge, Calif.



1. **Sensing resistor R_S feeds back a signal voltage** proportional to the yoke current (a). The feedback scheme changes the I-vs-t curve (b) from a slowly rising exponential (in color) into an essentially linear curve.



2. **Much less stringent requirements** are placed on the power supply by the full-bridge circuit (a) than by the half-bridge circuit (b). Both circuits suffer from the limitations of the pnp transistors they employ.



3. **These all-npn driver circuits** avoid the drawbacks of the complementary transistor circuits of Fig. 2. The half-bridge configuration (a) is not recommended. The full-bridge circuit (b) is preferred; it does contain two pnp transistors, but they have been kept out of the critical power-output section (highlighted in white).

sensing resistor, R_s, placed in series with the yoke, will produce a feedback voltage proportional to the yoke current (Fig. 1a). The feedback scheme linearizes the I-vs-t curve until the current approaches its final value (Fig. 1b). At that point, the feedback error signal gets small and the curve becomes nonlinear again.

The time required for the current to reach its steady-state value is difficult to predict mathematically. For large input voltage steps, however, an approximation can be used: The total response time is about 25% greater than would be predicted by extrapolating the linear portion of the curve to the final current value. (Note: for large input voltage steps, the total response time is defined as the time needed for the spot to have settled to less than 1% of a screen diameter from its final position.)

For small input signals (requiring 0.1% settling accuracy) the total response time is much more dependent upon the duration of the nonlinear portion of the response (settling time). Because of the uncertainty of the phase response of the closed loop, an exact analysis is extremely difficult. A 0.25-ohm sensing resistor, for example, will cause a 45-degree phase shift at 100 kHz if its leads have only 4 μH of parasitic inductance. A 12-inch length of No. 16 wire will exhibit 4 μH of inductance. Thus the feedback lead from the sensing resistor to the amplifier input is extremely critical.

Typical small-signal settling times are 4 to 6 μs for a 17-μH choke.

Improving the power drive

Because yoke resonances are typically 3 to 5 MHz, the amplifier should begin to roll off below that frequency, and the gain at resonance should be less than unity for stable operation to be obtained. Controlled phase shift from dc to 5 MHz is difficult to achieve in a high-power current amplifier—especially when the power output transistors have large junction capacitances and low cutoff frequencies. This generally limits amplifier open-loop gains to less than 50 dB.[1]

All-power driver configurations employ various combinations of Class B connections to limit power consumption in the quiescent state. Generally speaking, these Class B configurations are bridge designs. They usually require two voltages —one negative and one positive.

The full-bridge connection using complementary transistors (Fig. 2a) is more complicated than the half-bridge version (Fig. 2b) but it places much less stringent requirements on its power supplies. The full-bridge driver operates in push-pull to drive the two halves of the yoke. (Each of the inductors L_1 and L_2 is half of a single axis winding on a push-pull yoke.)

To maximize the voltage excursions across the yoke, transistors Q_1 and Q_4 are ON while Q_2 and Q_3 are off, and vice versa. This places $+V$ across half of the winding and $-V$ across the other half. The result is an axis winding consisting of L_1 and L_2 in series, with a voltage of 2V across it.

The coefficient of coupling in a good yoke design approaches unity. The inductance of the combined windings is then very close to 4L where L is a half-axis inductance. This inductance value (4L) should be used in the response-time calculations discussed earlier.

Because the push-pull configuration puts a continuous load on both power supplies, it makes regulating them fairly easy. By contrast, the single-ended driver (Fig. 2b) has either Q_1 or Q_2 conducting while the other transistor is off. Thus the power supplies for the half-bridge circuit must maintain their voltage regulation even in the face of sudden load changes from zero to full load. (Full load may be as high as 14 A for a large tube with a wide deflection angle.)

Both of the preceding circuits can be made to handle higher voltages and higher frequencies if their pnp transistors are replaced with npn units. Currently available pnp transistors are inferior to corresponding npn types in both breakdown voltage (BV_{CEO}) and cutoff frequency (f_T). For example, the pnp transistor sets a maximum limit of -50 V for $-V$. The npn transistor, on the other hand, can handle a $+V$ of $+125$ V.

Getting rid of the pnp transistors is simple. The half-bridge circuit of Fig. 3a shows how it's done for the single-ended driver. Since the circuit suffers from all of the supply-voltage shortcomings of the complementary half-bridge circuits, it is not recommended.

A more desirable configuration is the all-npn full-bridge circuit of Fig. 3b. Actually, there are two pnp transistors in the circuit but not in the power-output stage. The pnp units are needed to develop the inputs required by the all-npn output section. The two pnp transistors do place some restrictions on supply voltage, but since they may be lower-power types, the f_T and BV_{CEO} of the over-all circuit are increased.

In all cases, the full-bridge configuration has a faster amplifier (not yoke) settling time than the half-bridge circuit. This comes about simply because each side of the push-pull power section has to drive only half the current that the single-ended bridge must drive. ■■

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Papodi, A. E., and Williams, R. M., "Use Magnetic Deflection to Iron out Problems in Display Systems," *Electronic Design*, ED 6, March 15, 1966, pp. 210-215.

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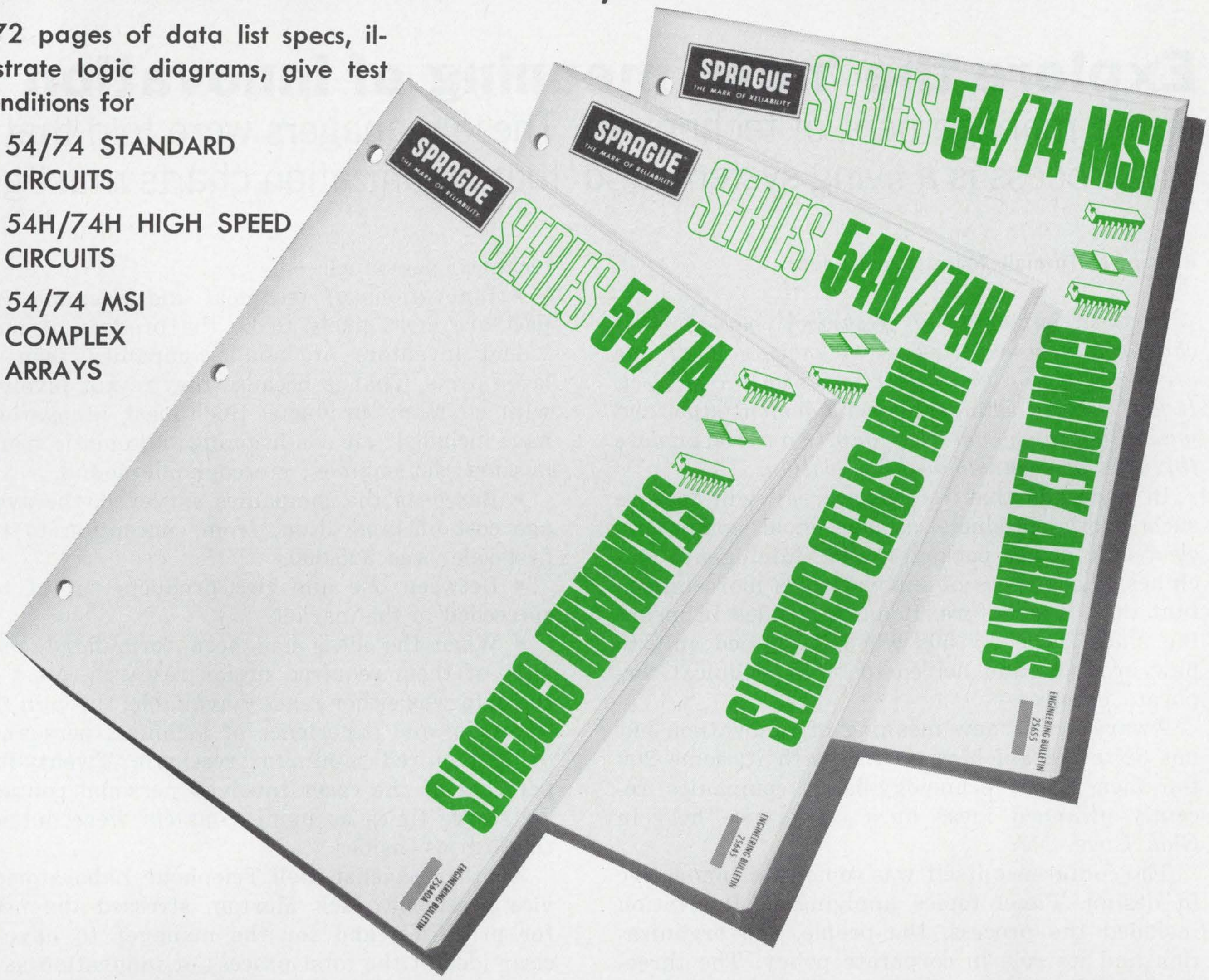

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Explore the 'now' meaning of innovation

in the management of technology. These managers were told that the process is a living system, and that organization charts must go!

Richard L. Turmail, Management Editor

Because methods of technical management change almost as often as technology itself, we are presenting a three-part series on the subject. It has covered changes in management style and managing the generation gap. Now we explore the area of technological innovation.

In a decade that forecasters say will feature such exotic products as household computers, electronic power packages, and "intelligent" machines, the process of innovation is more important than ever before. It has expanded in meaning since the early 50s when it applied only to new products and helped to build technical corporate empires.

Aware of the new meaning of innovation, but not quite certain how to deal with it, some 200 top men from technology-based companies recently swapped ideas at a conference held in Glen Cove, N.Y.

The conference itself was somewhat innovative in design. Panel topics applying to innovation included the process, the people, the organization and its role in corporate policy. The three-day workshop, sponsored by Technology Communication, Inc., was specifically fashioned to feed as much data as possible to those who attended. A closed-circuit video system televised the panelists to meeting rooms occupied by the ten discussion groups. Group leaders used direct phone lines to pose group questions to the panelists. Later, panelists circulated among the various groups to answer further questions.

Guidelines for innovation

Guidelines for the seminar were set by Donald Marquis, director of the Project on Research and Technology, Sloan School of Management, MIT. He defined innovation as "the carrying on of an idea from its inception to the first sale." To establish a background for his subject, Marquis presented survey-based data that included the following observations:

- Only 5% to 10% of the staff of technology-based companies, regardless of size, consists of technical personnel.
- Innovations of technical and economic impact are more likely to be the product of individual inventors or small companies than of large firms. That is because they're not involved with so many products. Such past innovations have included: air conditioning; automatic transmission; jet engines; stereophonic sound.
- Based on the companies surveyed, the average cost of innovation, from conception to the first sale, was $45,000.
- Between one and two products out of ten succeeded in the market.
- When the ideas had been formulated, only 10% of them required major research. Most of the data was either readily available, through the education and experience of technical personnel, or it required minimum research. Twenty-five per cent of the cases involved personal contact, and three times as many contacts were outside the firm as inside.

Another panelist, Bell Telephone Laboratories' vice president, Jack Morton, stressed the need for priorities, and for the manager to have a clear idea of the total process of innovation as it applies to research, production and marketing.

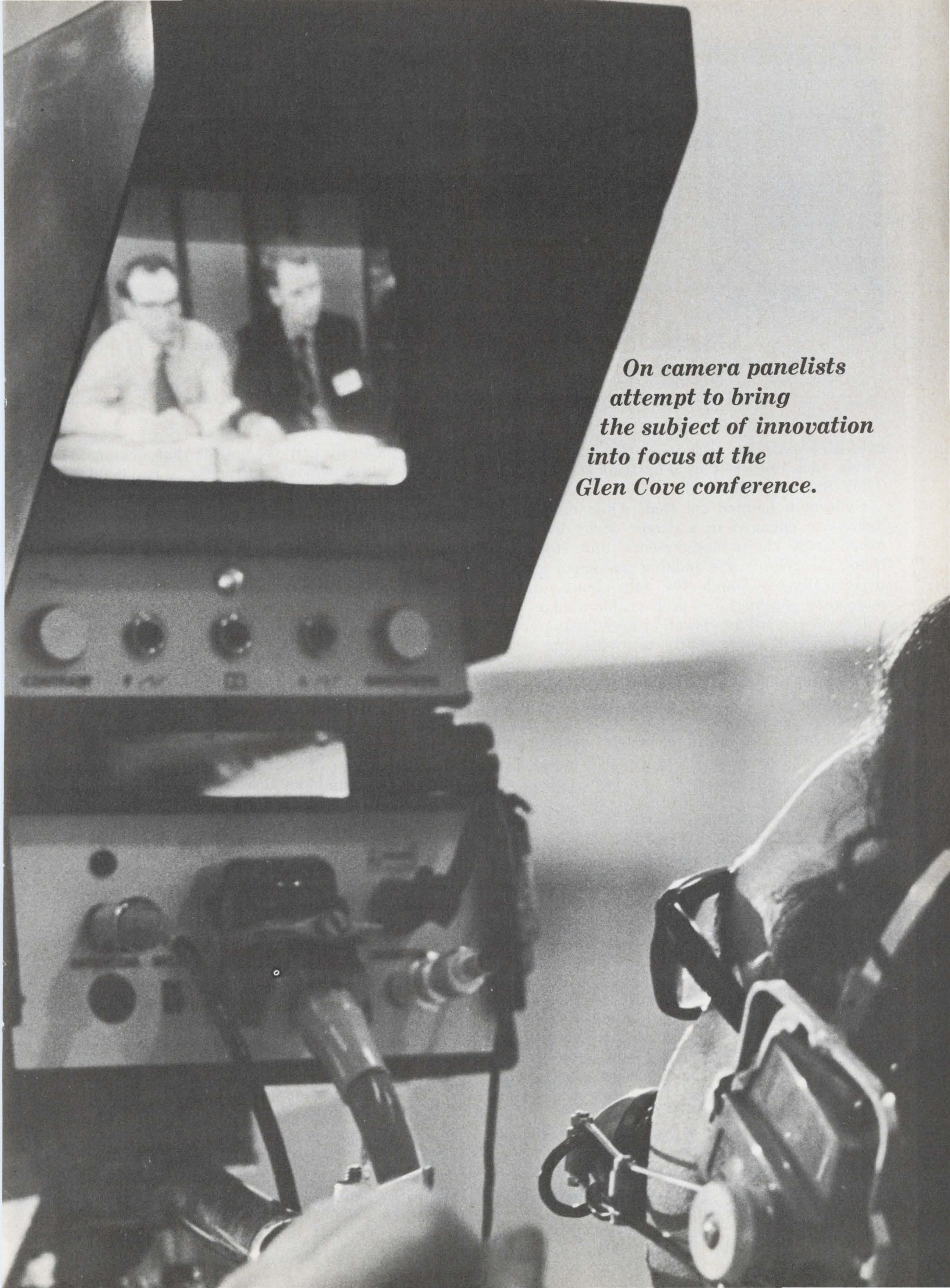
"The tough task," Morton emphasized, "is to get the various specialists to work toward a set of priorities to accomplish a given task. People do not organize themselves automatically into such complex structures. They do not couple and divide the way biological cells do. The manager must organize them."

He said that it is the manager's responsibility to see what specifications are needed, to increase them when required, and to make sure that, as the specializations take place, the parts are better connected.

"Today," Morton said, "we're dealing with a living management system—not a machine system. Organizational charts have to go!"

People are part of innovation

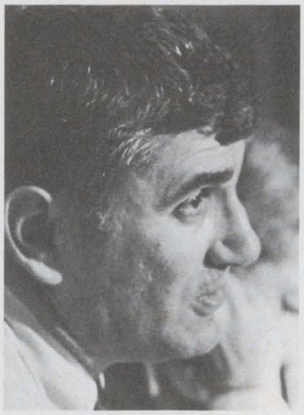
The subject of people as a resource for innovation was discussed at one of the seminar sessions by management consultant Saul Gellerman,



On camera panelists attempt to bring the subject of innovation into focus at the Glen Cove conference.

Hogan

Morton (on camera)



Davis

North

executive recruiter David North, and Sheldon Davis, vice president of industrial relations for TRW Systems, Inc.

Gellerman pointed out that, while most managers are engaged in a career derby involving promotions, choice assignments, and stock options, the criteria for judging managers change periodically. Although the importance of the managers' product or process knowledge and ability to control an operation may fluctuate, the importance of their ability to assess and teach people usually remains constant.

What do today's executives want? They want more authority to act independently at a younger age than ever before.

Concerning technical company employment practices it has been David North's experience that these companies have not been recruiting innovatively. Of every five jobs open in companies seeking recruits, North has discovered that one can be filled within the company; two are either luxuries or obsolete and can be merged with other positions; and two are downright undesirable.

Rounding out the panel on people, Sheldon Davis reported that until recently there had been no technology to implement his company's motivational policies. Now, he said, they are using an emerging technique called "organization development" or "team-building," which in many quarters is referred to as sensitivity training. They call in a consultant to interview members of a project management team about the project, the manager, their co-workers and other related subjects.

"We have found," Davis said, "that the people want to talk to rid themselves of frustrations and job hang-ups. The technique works because when people want to talk, what they have to say is important not only to themselves but to the project. We've noticed that a change of only 5% in a person's attitude as a result of the interviews can make a positive difference in relationships."

It's a game of chance

The panel reporting on technological innovation as a factor in corporate policy included President C. Lester Hogan of Fairchild Camera and Instrument Corp. His own particular expertise in innovation helped to reverse the company's losses of $4,325,000 in 1968 to a profit of $985,000 in 1969. Hogan said recently that the FC&I turnaround was due mostly to management realignment.

Hogan spoke of innovation in the electronics industry in gambling terms. "The rewards that the semiconductor industry offer those who manage it vary with time," Hogan said. "One of our biggest problems is the proper selection of choices open to us in research, in marketing and in production."

He cited the example of Texas Instruments, an electronics company that selected a couple of right cards from its deck to play in the game of transistors back in the 50s. Because it made the right selection from a myriad of choices, TI dominated the transistor industry as no other company has before or since.

But Hogan said the technology is so diffused now that if you call the wrong signals you can reverse your field, run, and catch up."

The planar process (1960) has been the only subsequent fundamental breakthrough. "Fairchild built its entire position on that leap," Hogan said. "Since then," he continued, "we've gone a step at a time. The steps were obvious in 1955. Now we have so many choices open to us that there is no company I know of that has

Marquis (on camera)

Frey

Peterson

Gellerman

either the people or the financial resources to cover all possible bets. So we have returned to very careful selection.

"There is no right choice," Hogan continued. "There's more than one. There must be, however, one set of cards you can play, considering the people and resources you have, that is better than any other set of cards."

As to why the process of innovation is nonexistent or second-rate in many companies, Peter Peterson, president of Bell and Howell Corp., pointed out one reason: many in top management have limited talent in technology, and they become a bit overwhelmed or frightened by high technology input and tend to abdicate and withdraw. Top management has to play a decisive role and not delegate authority to any other function of the business.

Another reason for skimpy innovation, Peterson said, is a shortage of talent.

The probability of finding the ingredients of marketing and technological conceptualism in the same man are pretty low, and yet, he said, "we behave as if we have plenty of such people."

According to Peterson, Bell and Howell brought together the marketing conceptualists with the technological conceptualists and came up with a slide projector that previews what slide is coming up—in case the customer wants to skip a few of lesser quality when showing his Florida vacation.

What are the chances of talent-poor companies recruiting top young talent?

One answer to that question came from the third panel member, Donald Frey, president of General Cable Co. He said he had conducted a survey among college students asking them what they think are the ten most innovative and the ten least innovative of 500 major U.S. companies. He asked the students if they would work for any of the ten least innovative companies, assuming they would be given a $5000 raise.

"By and large," Frey said, "they wouldn't even take an interview with the companies they considered to be noninnovative."

Round-robin questioning

Questions phoned in to this panel by discussion group leaders included the following:

1. How do you spot innovative people?

Peterson: By watching how they react to a given problem. Among ten in a room, the innovative person is the one who works until he comes up with an answer to the problem while the others are still talking about the innovative process. Innovators are where the action is.

2. How do you build company image?

Hogan: It's almost more important to have an innovative image inside your company than outside, so that your creative employees will know there's a chance to air their ideas. It's important to talk about innovative ideas rather than expense accounts when you talk to one of your people. Encourage him. Let him know he has your backing.

3. How do you go about innovation?

Peterson: The way to innovate is to do it instead of talk about it. Avon changed the marketing face of the cosmetic industry by selling door to door to a segment of the market that wanted convenient shopping.

Perhaps the most realistic and possibly prophetic comment about innovation was made by TRW's Sheldon Davis, who said:

"The trouble with improving innovation is that everyone is 'waiting for Godot.' Each one is waiting for someone else to speak up and start doing something. It's incumbent on each manager to do his own talking and his own doing."■■

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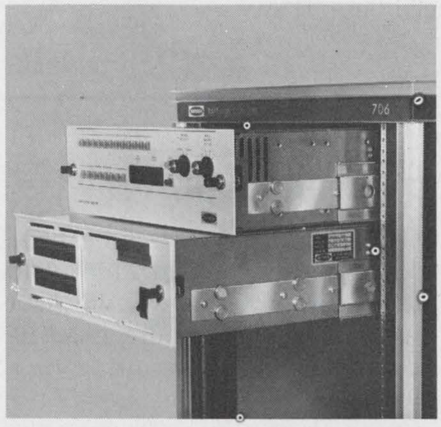
Long, long ago, in the early awakenings amongst the Isles, a happy accident happened.

A grape, then a series of grapes were squashed in such a peculiar way that, fermentation being what it is, someone sensed putting the results in a container would prove of high interest. Thus does history begin.

Bacchus, who established the first really popular excursion trips with his Dionysian Tours to Egypt, India, etc., forthwith then set another record as the world's original wine bottler.

His own person found this endlessly pleasurable and grew to accommodate more of the same. In fact, the Bacchus chassis soon became unstable, unable, even fixed. Or, if you like, utterly stoned, thus making necessary an evolutionary step in package movement so admirably exemplified today by products made for modern markets by the well known firm of Jonathan.

One of the results of Jonathan's great humanitarian interests is movement by the Jonathan Type 110 Ultra Thin Steel Series Precision Full Ball-bearing Slide. In fact, they decided that the bulky balking that was Bacchus' bag is still a problem for electronic chassis slides. Modern packaging concepts demand high capacity, compact design and ruggedness. And solutions for quick disconnect and tilt problems still must be solved. The people at Jonathan have the perfect solution—the Type 110.



The Type 110 is a full ball-bearing steel slide with a heavy duty pivoting mechanism that will easily handle any rated load requirement. It is readily available and inexpensive.

Jonathan's Type 110 is so improved that its smooth action would make the Saturnalia Santa smile with delight.

Others, too, such as Raytheon, who utilize this versatile slide in its 706 Computer, (see photo) an expandable, low-cost processor with large computer capability and compatibility. This newest addition to the Raytheon computer family uses a packaging concept designed for reliability and maintenance ease. Sm-o-o-o-th Jonathan Slides help make it possible. What's your requirement? Detail us your needs, today!

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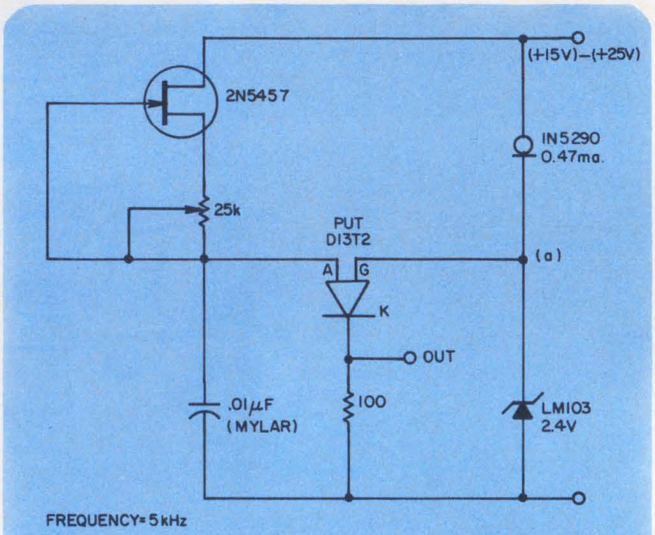
INFORMATION RETRIEVAL NUMBER 56

Programmable design gives gating timer line immunity

Many times in the design of digital systems, a stable and accurate timer is needed for gating functions or counter applications. Often the power supply used has a high ripple content along with poor dc line regulation; therefore, the timer should be immune to output voltage changes from the regulator.

The particular application described here requires a reliable timer for gating information from storage buffers. A D13T2 programmable unijunction transistor (PUT) is used. Along with the PUT, a constant-current diode, feeding an LM103 low-voltage reference diode, and a low goss FET for linearly charging the timing capacitor are selected.

The current diode and LM103 provide the necessary voltage division needed for the PUT. This combination gives the required immunity against line voltage changes. A 20-V line change, for example, will result in less than a 1-mV variation at point (a) of the voltage divider. The FET current source has an output conductance of 10 μmhos (typical). This corresponds to a current stability of 10 μA per volt. For this particular circuit, a 20-V line change produced less than 0.001% deviation in the nominal 5 kHz output frequency.



Programmable unijunction transistor provides gating timer immunity to power-supply variations.

Carl Brogado, Engineering Technician, TEC/Technetics Inc., Boulder, Colo.

VOTE FOR 311

New starting circuit requires little power

Are you looking for a series-regulator starting circuit that does not degrade regulation, has inexpensive parts and draws very little power? You may find your answer here.

Part of a typical series regulator is shown in Fig. 1 with the required starting resistor R_s. Current flows through this resistor into node A, starting and sustaining series regulator operation. The disadvantages are that this arrangement degrades regulation. Since any change in the input voltage is reflected as a change of current into node A. Also, the value of R_s becomes quite small if V_{in} is only 1 or 2 volts above V_{out}, resulting in a large power waste when V_{in} increases.

The starting resistor may be replaced with a constant current source as shown in Fig. 2. This type of circuit requires several volts from the

positive line to node A for proper operation, so V_{in} must always be about 4.5 V greater than V_{out} or the regulator will cease operation.

A new type of starting circuit is shown in Fig. 3. The voltage divider R_1 and R_2 drives current into node B to start the regulator. As soon as the regulator starts, the voltage at node B rises above the voltage at node C, causing D_1 to be back-biased. Q_1 has been changed from an npn transistor to a pnp transistor so that the current now flows out of the base. Consequently, no external current is required to sustain operation of the regulator. This regulator will continue operation even with $V_{in} = V_{out} + 1.5$ V.

The criteria for choosing R_1 and R_2 are as follows:

- Starting: The divider must be capable of supplying a minimum I_s, where

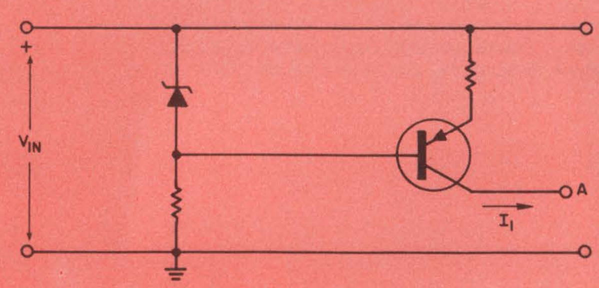
$$I_s = I_{L\,max}/[(H_{fe\,Q1})(H_{fe\,Q2})(H_{fe\,Q3})]$$

when the input voltage is at a minimum and the voltage at C is 1.5 V.

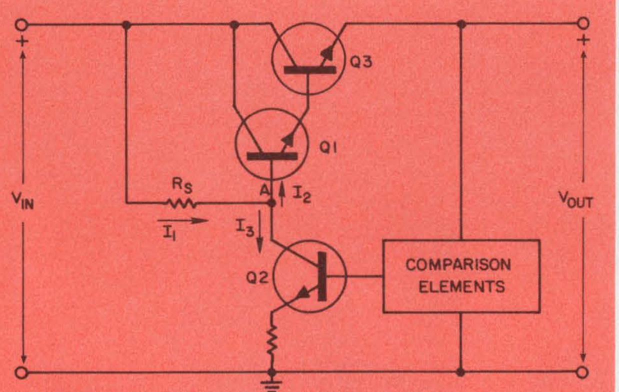
- D_1 kept back-biased: The divider voltage at C must never rise above the normal voltage at B with maximum V_{in}.

Q_2 must have a collector-to-emitter breakdown greater than the maximum V_{in} for proper operation.

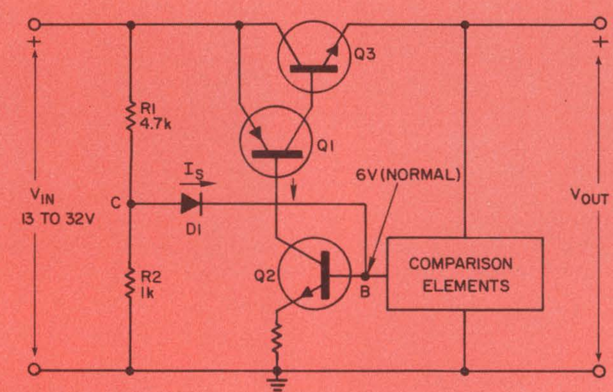
Bernard Doden, Design Engineer, The Magnavox Co., Fort Wayne, Ind. VOTE FOR 312



2. **Replacement** of R_s with a constant source means that V_{in} must be V_{out} + 4.5 V (minimum).



1. **Current flow** for sustained operation is shown by this detail of a typical series regulator.

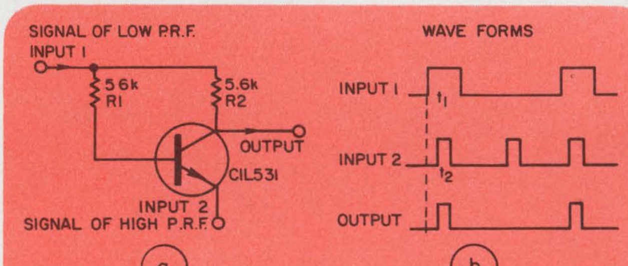


3. **Circuit improvement** allows the regulator to operate properly even with $V_{in} = V_{out} + 1.5$ V.

Single transistor AND gate needs no power supply

Digital systems often require that a high pulse repetition frequency (PRF) signal should appear simultaneously with a low PRF signal. This need is most often satisfied by the use of an AND gate. However, the circuit shown here, needing no power supply and having few components, can serve the same purpose.

The low PRF signal is applied to both the base and the collector terminals of a transistor through resistors R_1 and R_2, respectively. The high PRF signal is applied at the emitter terminal. When the signal at the base and collector is



Single transistor AND gate (a) produces output (b) only when high and low PRF pulses coincide.

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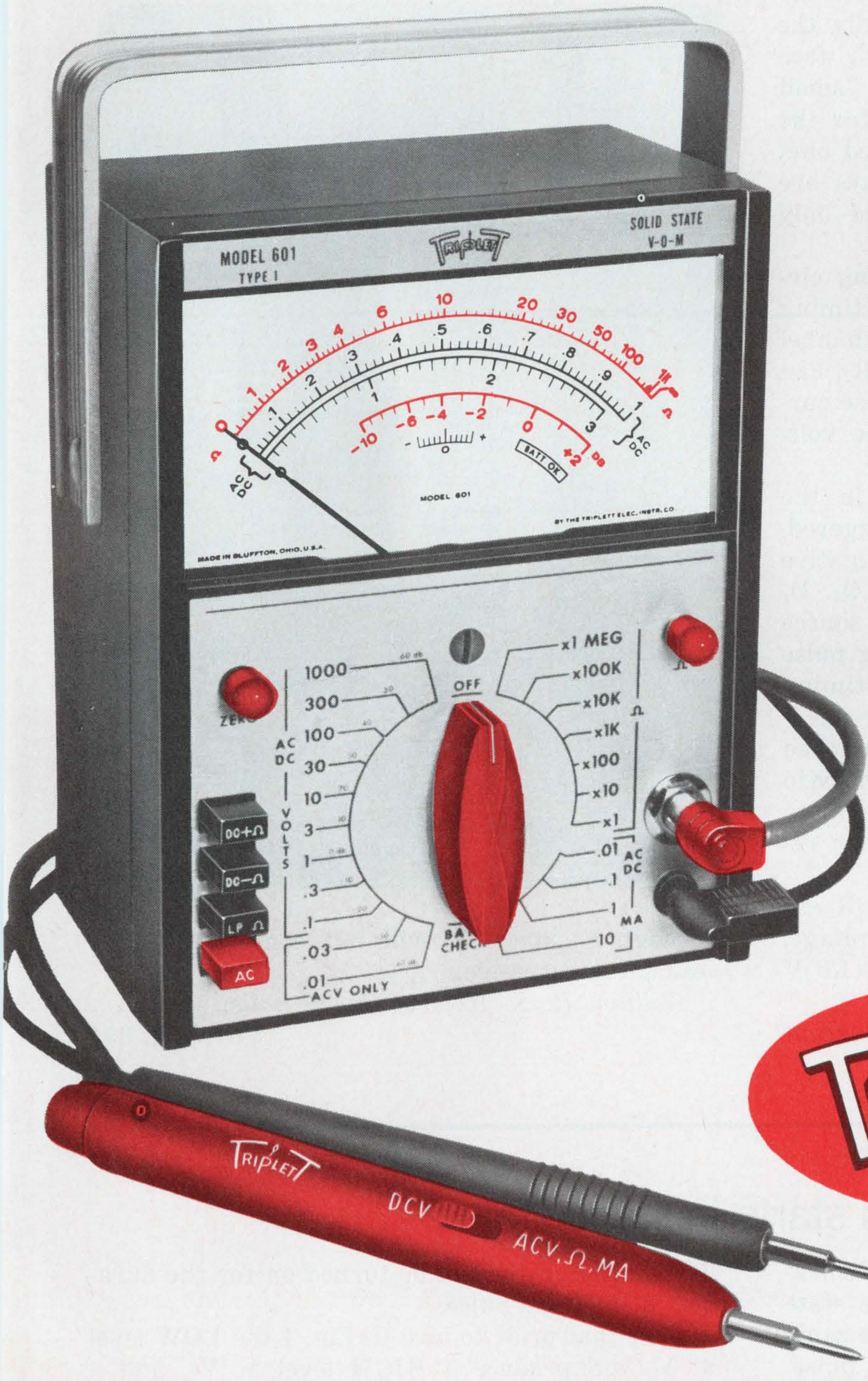

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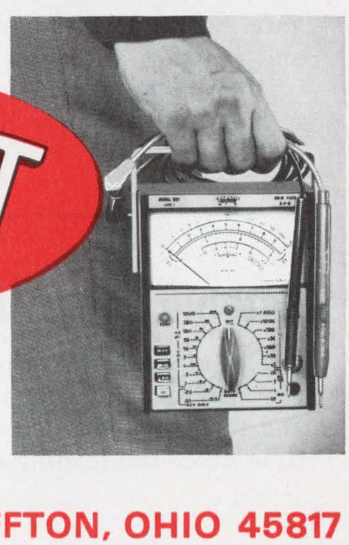

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INFORMATION RETRIEVAL NUMBER 58

at the ONE level, the emitter signal will appear (with about 100-mV offset) at the circuit output. The transistor will be in saturation. In other words, the high PRF emitter signal appears at the circuit output in the presence of a low PRF signal at the base and the collector.

The component values shown have been used successfully.

D. Visweswara Raju, Electronics Engineer, Space Science & Technology Centre, Trivandrum-1, India

VOTE FOR 313

Modified one-shot provides long delay time

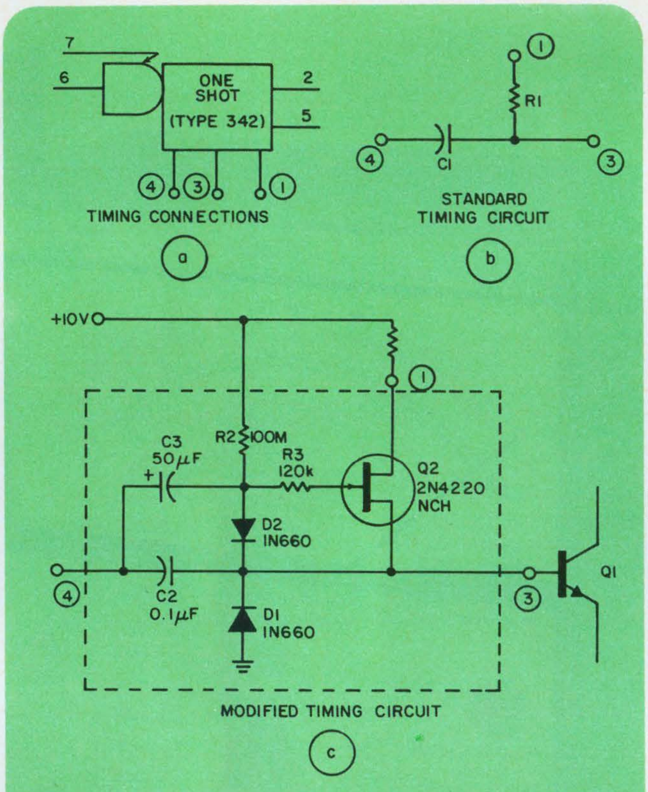
The limiting factor in obtaining a long delay time with conventional one-shots is usually the base current into the ON transistor, Q_1, (see figure). The timing resistor must be small enough to allow sufficient base current for the transistor to be saturated. In this modified one-shot (Amelco 342), 30 to 40-minute delays are obtained. Maximum delay time is limited only by the timing capacitor leakage current.

Essential features of the external timing circuit shown are that the conventional timing resistor, R_1, has been replaced by an n channel FET, and that the new timing resistor, R_2, can be made large since it no longer passes base current but determines the FET gate source voltage.

The modified timing circuit operates in the following manner. When one-shot is triggered, the voltage at pin 4 goes negative. This negative pulse is coupled through C_2 and cuts off Q_1. D_1 clamps the voltage at the base of Q_1 and source of Q_2 to about -0.5 V. The negative-going pulse is also applied to the gate of Q_2 through timing capacitor C_3. Since the source of Q_2 is at -0.5 V and the gate pulse is about 9 V, Q_2 is pinched off and remains so until C_3 charges sufficiently to bring it on. When this occurs, C_2 will begin to charge until Q_1 turns on and the one-shot reverts to its stable state.

The purpose of D_2 is to keep the $C_3/R_2/Q_2$ gate junction from rising to the supply voltage, and it holds this point at approximately $+1.0$ V in the stable state.

The delay time is limited by leakage current through C, since Q_2 will not come on if this leakage is excessive.



Modification allows one-shot (a) to deliver timing delays of about 34 minutes. Standard timing circuit (b) is replaced by n channel FET network (c).

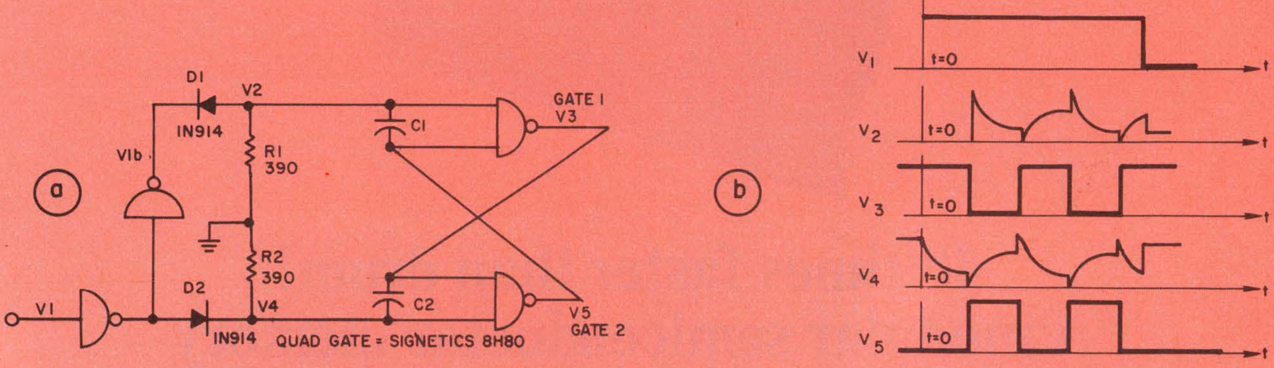
William R. S. Hepler, Great Falls, Va.

VOTE FOR 314

Astable multivibrator always starts in same state

The main features of this astable multivibrator are that it always starts in the same state and its first transition always occurs at the same time after the leading edge of the turn-on pulse. The multivibrator can be turned on for the duration of a single pulse.

Note that prior to t=0 in Fig. 1 the LOW level at V_1 will produce a HIGH level at V_{1a} and a



1. **The oscillation characteristics** of this astable multivibrator are fully predictable.

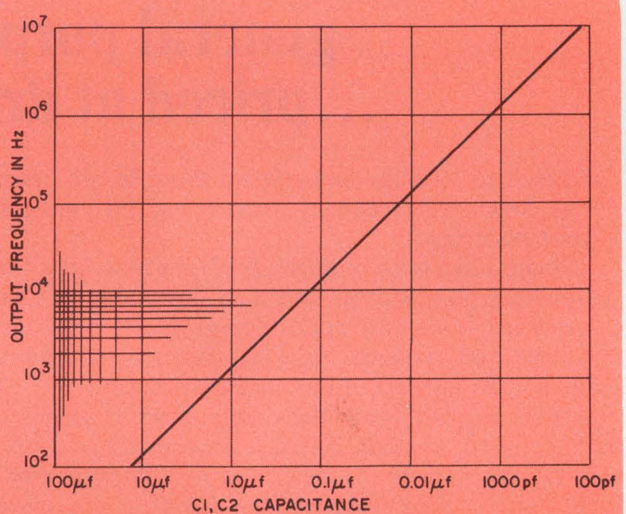
LOW level at V_{1b}. These levels will clamp V_2 and V_4, respectively, negative (LOW) and positive (HIGH). The LOW level at V_2 will cause V_3 to be HIGH. Because of the NAND gate function, this HIGH level combined with the clamped HIGH level at V_4 will cause V_5 to be LOW. Note that under these conditions, no charge is stored in either C_1 or C_2.

A positive pulse or level at V_1 will turn the multivibrator on. When V_1 is driven positive, points V_{1a} and V_{1b} change states. This cuts off diodes D_1 and D_2, thereby removing the clamping voltages from the inputs of the gates (V_2 and V_4). C_2 now begins to charge through R_2, causing the potential at V_4 to decrease exponentially toward ground.

As soon as the V_4 potential has decreased to the switching level of gate 2, the gate 2 output (V_5) goes positive. This causes both inputs of gate 1 to become instantly positive. As a result, V_3 goes LOW. C_1 now charges through R_1, causing the positive voltage at V_2 to decrease exponentially toward ground. As soon as voltage V_2 reaches the switching level of gate 1, the output of this gate (V_3) goes positive, thereby repeating the cycle.

The value of R_1 and R_2 is set at 390 ohms to ensure that capacitors C_1 and C_2 can charge to a potential below the 0.8-V worst-case switching level for the gate used. The Signetics 8H80 quad-gate was selected for this circuit because of its fast rise and fall times and its low output impedance.

The circuit has been tested with various values for C_1 and C_2, and the resulting frequency vs capitance curve is shown in Fig. 2. The maximum operating frequency was 10 MHz. An attempt to determine the minimum frequency was made, but the multivibrator continued to operate properly even at 0.5 Hz. This indicates that the frequency of oscillation may be lowered below 0.5 Hz by using capacitors larger than 1000 μF. It should be noted that the fixed 390-ohm resistors can be replaced with a dual potentiometer to provide some frequency adjustment.



2. **Linear relationship exists** between capacitance and frequency for a wide range of capacitor values.

George S. Krause, Assistant Project Engineer, Bendix, Communications Div., Baltimore, Md.

VOTE FOR 315

LINEAR

One more time:

Fairchild built a reputation on new products, new technology and new applications. Last month we ran the editorial below. It announced another new step for Fairchild. A commitment to do business wherever there's business. First source. Or second. It was a major policy decision for us. So major, in fact, we're repeating the editorial this month.

EDITORIAL

If We Can't Sell You Ours, We'll Sell You Theirs.

For a long time, Fairchild built only linears designed by Fairchild engineers. We didn't think anything else was worth the effort. People said we had an NIH (Not Invented Here) complex. And, they were right.

However, it's been brought forcefully to our attention that a couple other guys in this business know what they're doing. The competition is coming out with some pretty worthwhile linears. Our customers have noticed too, because they're talking to other manufacturers about linears we don't make. They're even talking to sole sourcers!

To keep things even, we've decided to give our wandering customers something they're going to need if they start dealing with a sole source linear maker: A second source. Us. (Just in case the original supplier's factory blows up or they lose the formula or whatever it is that happens when you can't get delivery.)

Starting now, Fairchild is introducing a new line of linears. We call them IT circuits (Invented There). The first two are available today: The LM101 and the MC1495. Soon we'll add the LM101A, MC1496 and the SN7524. Of course, we've given them Fairchild part numbers. Here's a conversion chart:

μA795	Analog Multiplier	MC1495
μA796	Modulator	MC1496
μA748	Operational Amplifier	LM101
μA777	Operational Amplifier	LM101A
μA761	Sense Amplifier	SN7524

There will be other additions to the IT line soon. So be sure you contact your local Fairchild Sales Engineer before you drop a design for lack of a reliable alternate source. Just give him the part number you want and ask him to check the IT line. Farewell NIH.

Introducing the World's First Monolithic J-FET Input Op Amp

Punch-through op amps are obsolete.

Fairchild's new μA740 now offers 150pA (max.) current into either input. While some manufacturers are talking about super beta or punch-through transistors with current gains of 1000, Fairchild technology now makes possible J-FET devices with equivalent betas of over 15,000. And, they're completely compatible with standard monolithic processing.

The μA740 is a simple two-stage design similar to the μA741, but employs J-FET input transistors to obtain extremely low input currents.

μA740 Electrical Performance

Input Current (either input)	150pA max.
Unity Gain Slew Rate	6V/μS
Input Resistance	10^{12} Ohms
Voltage Gain	120dB
Input Offset Current	30pA

The new linear has all the convenience of the μA741: internal frequency compensation for unity gain, input over-voltage protection to either supply, output short circuit protection to ground or either supply, and the absence of "latch-up."

Balanced offset null is easily obtained with a 10KΩ potentiometer and does not affect other parameters.

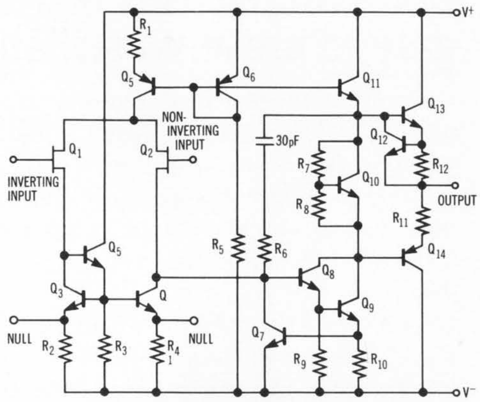
Other μA740 features include a wide common mode range of ± 12 volts, high differential voltage range of ± 30 volts, and wide operating supply range of ± 5V to ± 22V.

The μA740 is directly interchangeable with the μA741, μA748 or μA709.

The new Fairchild device provides circuit designers with superior performance in such applications as active filters, voltage followers, integrators, summing amplifiers, sample and holds, transducer amplifiers and other general-purpose feedback applications.

The μA740 is now available in TO-99 packages (both military and industrial temperature ranges) from any Fairchild Distributor.

Reader Service Number 211



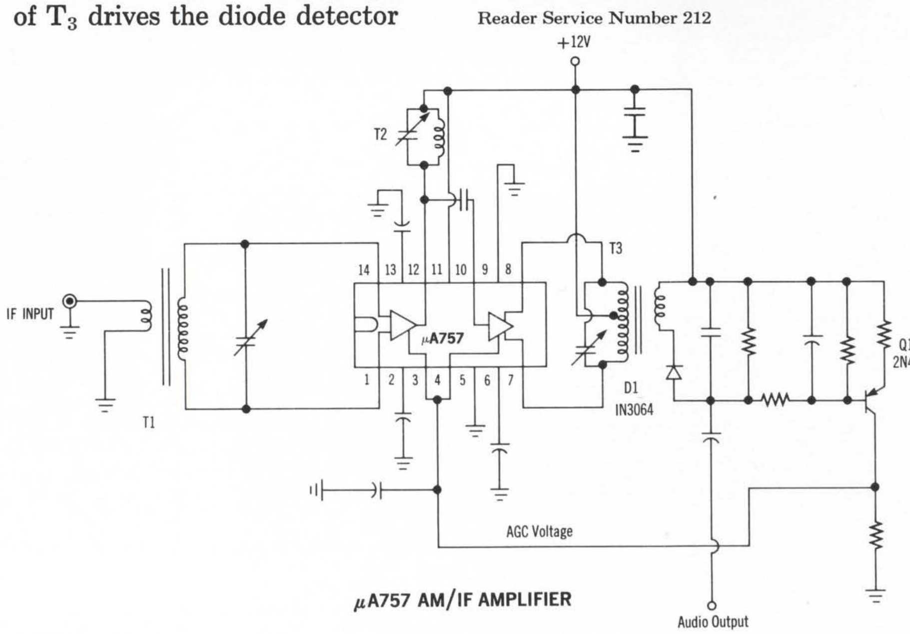
μA740 FET INPUT OP AMP

μA757 Ideal Choice for an AGC-Able AM/IF Amplifier

Fairchild's μA757 can be used very effectively as a high gain, wide AGC range IF amplifier. In this application, the input signal from the generator is matched to the input of the microcircuit with transformer T_1. The output of the 1st section is taken from Pin 12 across a tank circuit which acts as a load impedance. The signal is coupled through a capacitor to the input of the 2nd section, Pin 10. The output of the 2nd section is taken in a push-pull manner with transformer T_3. The secondary of T_3 drives the diode detector from which audio is recovered. Q_1 acts as an AGC signal amplifier to provide gain for the AGC signal from the diode detector.

Voltage gain of the circuit from the input of T_1 to the input of T_3 is typically 80 dB, while the AGC range is typically 70 dB. Input signal handling capability of the microcircuit is typically 300 mV_{RMS} at the input terminals of the microcircuit at full AGC. Stable gain is obtained over a wide temperature range, regardless of AGC setting.

Reader Service Number 212



μA757 AM/IF AMPLIFIER

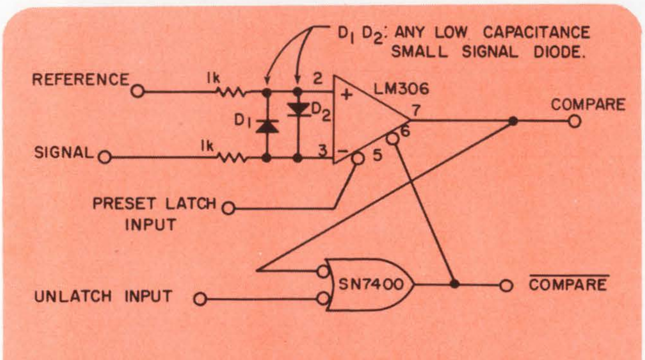
Comparator uses NAND gate to prevent oscillation

Comparators suffer from a common problem of oscillation of the output signal as the input voltage comes to equal the reference input. A method to overcome this oscillation, and to provide logical storage of the comparison, is to form a data latch using the comparator and a NAND gate.

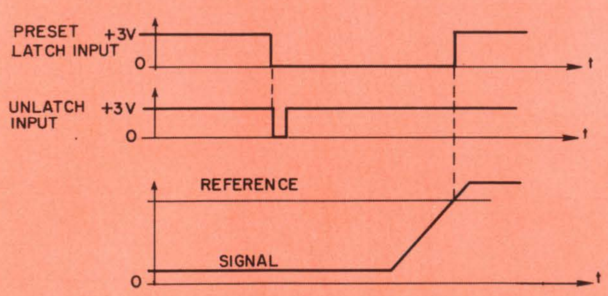
The circuit can be placed in an initial *compared* state by a negative-going pulse on the preset latch input. At the proper time the comparator can be released to function normally by a negative going pulse on the unlatch input. When the signal voltage equals the reference voltage the *compare* output will once again go high and remain in this state until an unlatch pulse is given.

Leonard Halio, Design Engineer, Digital Equipment Corp., Maynard, Mass.

VOTE FOR 316



1. **Comparator/NAND gate will not oscillate** when input signal approaches reference.



2. **Negative pulse** on preset latch and unlatch inputs sets up comparator to detect reference/signal equality.

VOTE! Go through all Idea-for-Design entries, select the best, and circle the appropriate number on the Reader-Service-Card.

SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas-for-Design editor. You will receive $20 for each accepted idea, $30 more if it is voted best-of-issue by our readers. The best-of-issue winners become eligible for the Idea Of the Year award of $1000.

IFD Winner for December 6, 1969
Kingsley P. Roby, Test Engineer, Data-Control Systems, Inc., Danbury, Conn. His Idea "Flip-Flop Measures Frequency Difference Between Two Signals" has been voted the Most Valuable of Issue Award.
Vote for the Best Idea in this Issue.

IFD Winner for December 20, 1969
Peter Lefferson, Senior Engineer, Electronic Communications, Inc., St. Petersburg, Fla. His Idea "Multivoltage Monitor Circuit Uses Only A Single Transistor" has been voted the Most Valuable of Issue Award.
Vote for the Best Idea in this Issue.

IFD Winner for January 4, 1970
Howard Raphael, Design Engineer, Singer Corp., Friden Division, San Leandro, Calif. His Idea "Neon-Bulb Circuit Doubles As Pilot Light and Trouble Light" has been voted the Most Valuable of Issue Award.
Vote for the Best Idea in this Issue.

IFD Winner for January 18, 1970
Saul Ritterman, Assistant Professor, Bronx Community College, N.Y. His Idea "Single Transformer Provides Positive and Negative Voltages" has been voted the Most Valuable of Issue Award.
Vote for the Best Idea in this Issue.

Optical encoder with remote reflective disc controls speed digitally without adding mass

Trump-Ross Industrial Controls, Inc., 265 Boston Rd., Billerica, Mass. Phone: (617) 663-3451. P&A: $35 to $45 in quantity; 4 to 8 wks.

Dubbed a reflective-surface incremental encoder, a new rotary pulse generator provides a digital means of sensing velocity without the conventional shaft coupling, extra bearings and rotating masses associated with previous devices. Essentially, it reduces the amount of moving mass that is required to generate an incremental pulse train without sacrificing acceleration time.

The device consists of two separate parts: a thin (4.5 mils nominal) reflective plastic count track disc, and a small electro-optical pickup head. The user simply cements the disc on the rotating surface to be monitored.

Conventional rotary encoders require the shaft and code disc to be coupled to the rotating member. This results in both mass and torque contributions because of the bearings needed.

On the other hand, the new reflective encoder simply views a pattern on the rotating surface. The mass of this pattern depends on the application—it can be as little as an etched pattern on a reflective surface, or as much as a thin metal disc cemented to the surface.

A standard rotary incremental code pattern is developed over the reflective surface. This pattern is then affixed concentric and perpendicular to the axis of rotation.

The pickup head, which contains a focused light source, projects a mating pattern on the rotary surface pattern. The head is mounted opposite the count track gratings at a distance from the disc that results in a strong reliable signal.

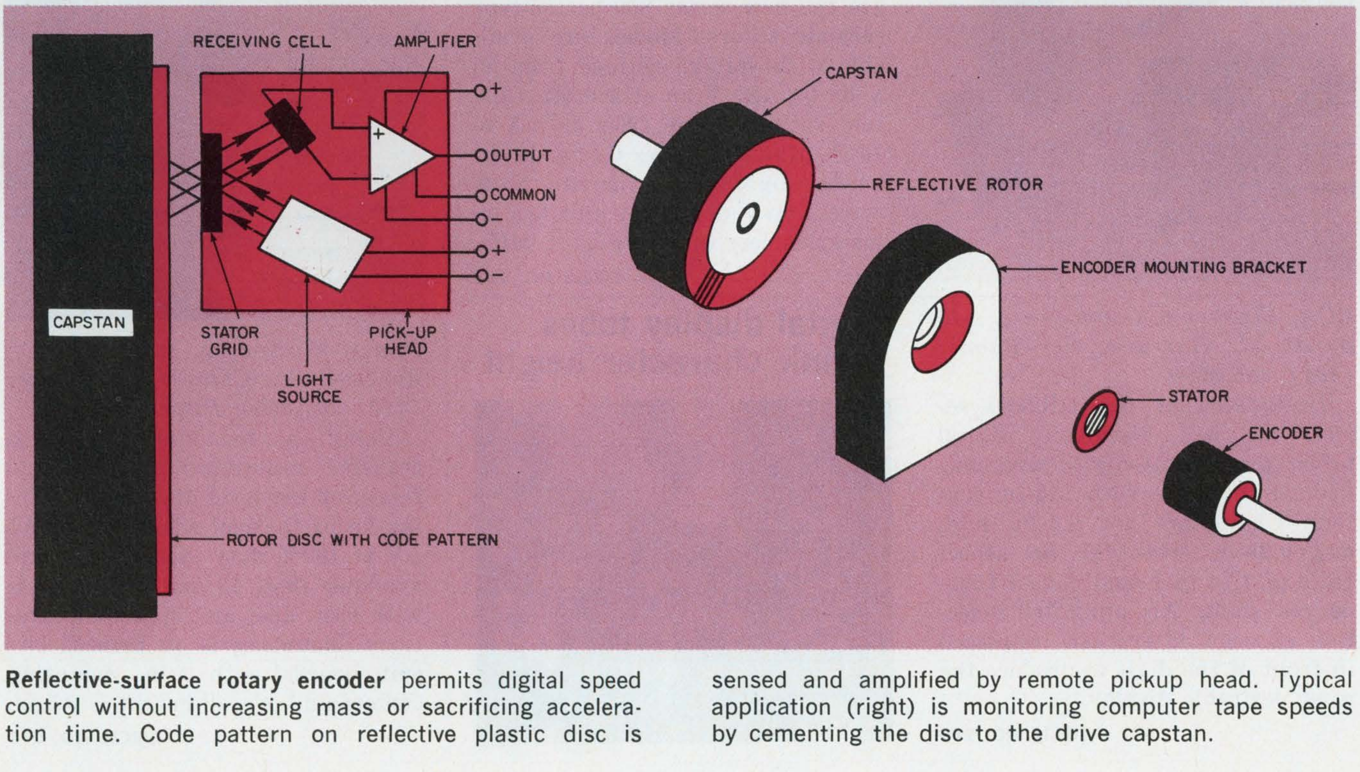
A solid-state opto-electronic element inside the pickup responds to the light-chopping effect produced by the rotary pattern as it passes beneath the head. For many applications, the resultant sinusoidal output signal does not require external amplification.

When the disc has a diameter of 1.5 in., it can generate up to 500 pulses per revolution. Supply voltages of 5 to 15 V dc yield a single-channel sine-wave output that measures 0.4 V peak-to-peak from dc to 50 kHz.

Dimensions for the pickup head are a 5/8-in. diameter and a 3/4-in. length. A slightly longer housing for the pickup allows the addition of an amplifier shaper with a DTL/TTL-compatible output.

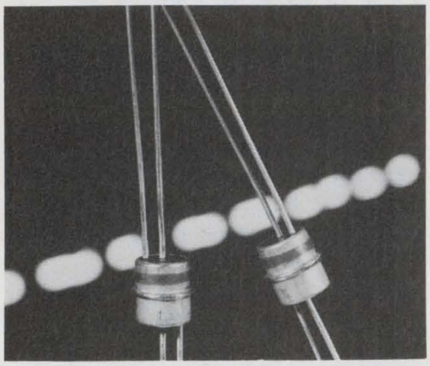
A prime application for the new reflective encoder is in computer tape transports, where the capstan used to drive the tape cannot assume additional mass. Here, the disc is simply cemented directly to the capstan with no sacrifice in acceleration rate.

CIRCLE NO. 285



Reflective-surface rotary encoder permits digital speed control without increasing mass or sacrificing acceleration time. Code pattern on reflective plastic disc is sensed and amplified by remote pickup head. Typical application (right) is monitoring computer tape speeds by cementing the disc to the drive capstan.

High-speed isolators withstand ±1 kV

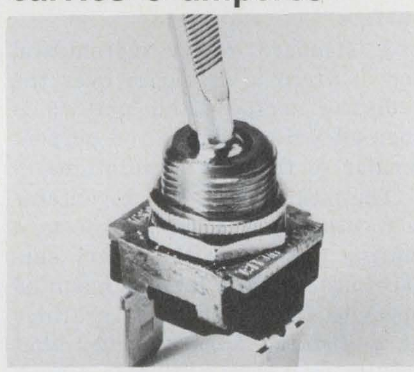


Texas Instruments Inc., Components Group, 13500 N. Central Expressway, Dallas, Tex. Phone: (214) 238-2011. P&A: $6, $10; stock to 2 wks.

Two new solid-state optically-coupled isolators with high-speed switching feature high voltage isolation of ±1 kV. The TIL107 and TIL108 consist each of a gallium arsenide diode light source which is optically coupled to a silicon phototransistor. Both are compatible with TTL/DTL levels.

CIRCLE NO. 286

Small toggle switch carries 6 amperes

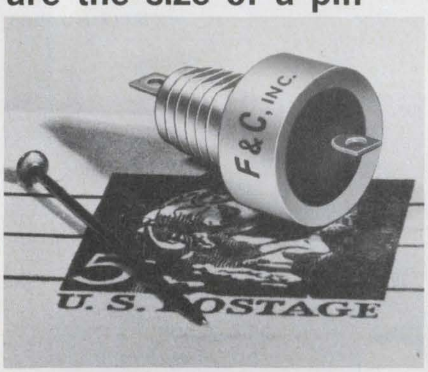


Joseph Pollak Corp., 195 Freeport St., Boston, Mass. Phone: (617) 282-9550.

Available in 192 combinations is a new toggle switch that's smaller than equivalent switches with a current rating of 6 A. It features a one-piece die-cast mounting stem and frame and a high-impact plastic case. Ratings are 6 A at 120 V ac or 3 A at 240 V ac. It is available in spst, spdt, dpst and dpdt configurations. Matching ON/OFF indicator plates are optional.

CIRCLE NO. 287

Button-type filters are the size of a pin

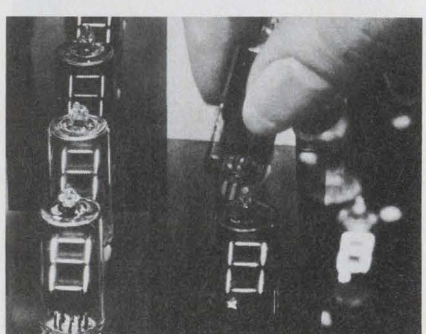


Filters & Capacitors, Inc., 425 N. Fox St., P.O. Box 1272, San Fernando, Calif. Phone: (213) 365-3228. P&A: $12; stock.

No longer than a straight pin are the new series 800 button-type ceramic filters. Models are available with voltage ratings from 50 V dc to 120 V ac at 400 Hz. Current ratings range from 40 mA to 15 A. Units measure 0.4 in. in diameter by 0.17 in. in length. A typical 50-V dc 40-mA unit has an insertion loss of 80 dB at 1 MHz.

CIRCLE NO. 288

Digital display tubes shrink character height

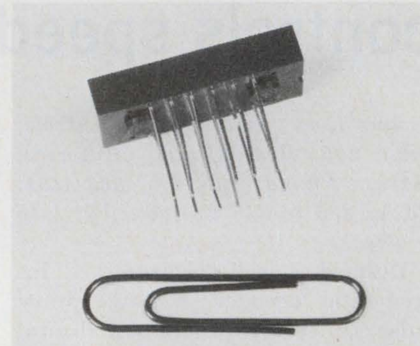


RCA Electronic Components, 415 S. 5th St., Harrison, N.J. Phone: (201) 485-3900.

Designated as the DR2100 series, the new Numitron digital tubes provide 16-digit capability in an 8-in. space with 1/2-in. centers. Characters are 0.4-in. high and 0.23-in. wide for an aspect ratio of 1.74 to 1, and have a four-degree slant. An unlimited selection of color filters can be placed in front of the digit to produce the most desirable display.

CIRCLE NO. 289

Ten-tap DIP delay line features 100-ns delay

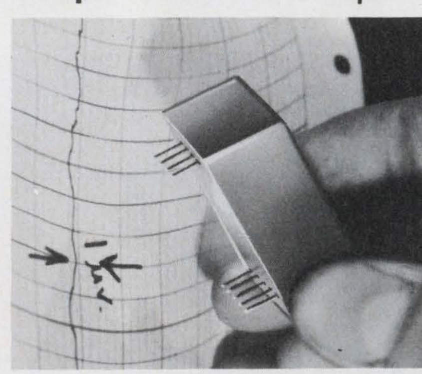


Kappa Networks, Inc., 165 Roosevelt Ave., Carteret, N.J. Phone: (201) 541-4226. P&A: under $10 per 100; stock.

Incorporating ten taps in a dual-in-line package, a new low-cost delay line features an overall delay of 100 ns ±5%. Its maximum rise time is 18 ns, impedance is 200 Ω and attenuation is under 0.3 dB. Temperature coefficient is less than 100 ppm/°C and operating temperature range is −55 to +125°C. The unit is encapsulated in a 1x0.4x0.22 in. epoxy shell.

CIRCLE NO. 290

Low-thermal-drift relay keeps offset to 2.5 μV



James Electronics Inc., 4050 N. Rockwell St., Chicago, Ill. Phone: (312) 463-6500. Price: from $2.

Using a heat-stabilizing and transfer technique, the Milliscan relay for low-level dry-reed switching keeps thermal offsets under 2.5 μV at 100% duty cycles. Units are available in 6, 12 and 24-V models with spst, dpst and 3pst configurations. Mounting is on printed circuit boards with 1-in. mounting centers and overall height is 0.5 in.

CIRCLE NO. 291

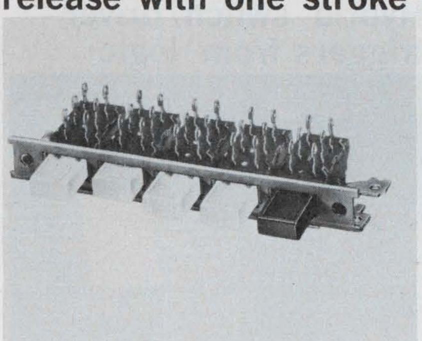
Glass-film-overlay chips up resistor protection

Airco Speer Electronic Components, Niagara Falls, N.Y.

Using a deposited glass film overlay for extra protection are new stable micro-miniature leadless metal-film resistor chips. They feature thick wrap-around gold terminations suitable for eutectic bonding or wire bonding to thin or thick-film conductors. Resistances range from 100 Ω to 50 kΩ. Temperature coefficient of resistance is 25 ppm/°C and size is 75-mils square.

CIRCLE NO. 292

Push-to-lock switches release with one stroke

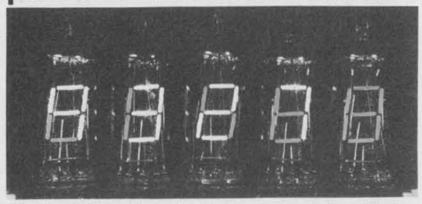


Switchcraft, 5555 N. Elston Ave., Chicago, Ill. Phone: (312) 774-1515.

Offering single switch versions up to 4pdt, the 65000 DW multi-switch assembly has push-lock and push-release features for each pushbutton, plus a common release for all the pushbuttons. The common release function makes the switch ideal for programming applications where it is desirable to release all operated switches simultaneously. This saves an operator valuable time by not having to release each switch individually.

CIRCLE NO. 293

Bipolar decoder/driver powers readout tubes



Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: $11.95 to $15.50.

Hailed as an industry first, a new monolithic bipolar decoder/driver can directly drive seven-segment vacuum fluorescent numerical displays. The MSI 9327 accepts four inputs in 8-4-2-1 binary-coded-decimal format. Two models are available: the 9327A which has a breakdown voltage of 64 V, and the 9327B with a breakdown voltage of 30 V.

CIRCLE NO. 294

Transient suppressors sustain 1500-W surges

General Semiconductor Industries, Inc., 230 W. Fifth St., Tempe, Ariz. Phone: (602) 966-7263. P&A: $3.25; stock.

Capable of dissipating 1500 W of peak power for 1 ms, TransZorb transient voltage suppressors come in voltages from 6.8 to 200 V (JEDEC types 1N5629 through 1N5665A). They can dissipate 10 kW for 10 μs.

CIRCLE NO. 295

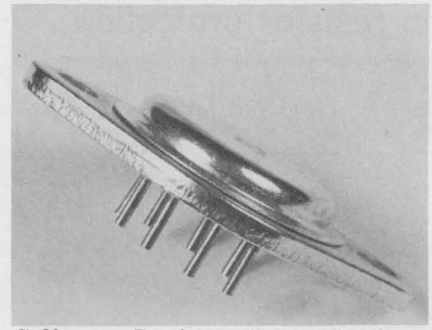
Amplifier chip varies its gain

Silicon General Inc., 7382 Bolsa Ave., Westminster, Calif. Phone: (714) 839-6200. P&A: $4.95; stock.

Featuring variable gain and provision for gating and agc, the the SG1402 linear IC amplifier boasts a frequency response beyond 50 MHz. At 10 V, typical gain is 25 dB and power consumption is just 50 mW. It operates from -55 to $+125$°C.

CIRCLE NO. 296

Dc voltage regulators handle 50 V at 3 A

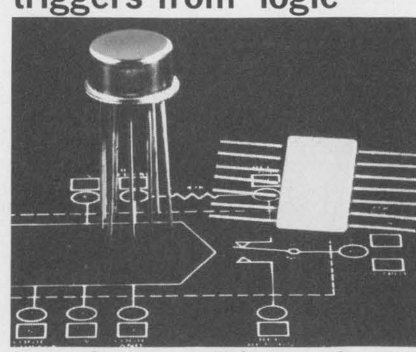


Solitron Devices, Inc., Semiconductor Div., 1177 Blue Heron Blvd., Riviera Beach, Fla. Phone: (305) 848-4311. Availability: stock.

Offering a voltage range of 8 to 50 V with maximum output current of 3 A, a new line of high-power dc voltage regulators features a regulation of 0.5% maximum and 0.05% typical, from no load to a 1-A load. These units are available for positive and negative applications: positive circuits are HCCA 100, 103, 105; negative circuits are HCCA 102, 104 and 106.

CIRCLE NO. 297

Hybrid switch/driver triggers from logic

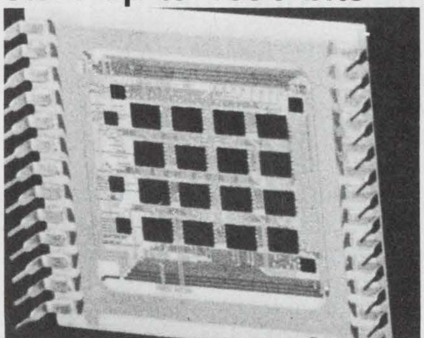


Crystalonics, a Teledyne Co., 147 Sherman St., Cambridge, Mass. Phone: (617) 491-1670. $50 or $60; stock.

The CDA18 hybrid IC is a spdt switch and driver circuit that operates directly from positive logic with a maximum turn-on time of 20 ns. The unit is supplied in a 10-lead TO-100 package or in a 14-lead TO-87 flatpack. Maximum on-resistance is 50 Ω. The new hybrid is intended for use in digital-to-analog converters.

CIRCLE NO. 298

MOS/bipolar memories store up to 4096 bits



Computer Microtechnology Inc., 610 Pastoria, Sunnyvale, Calif. Phone: (408) 736-0300. P&A: $1200; stock.

Combining the best of two worlds, MOS and bipolar technologies, a new line of hybrid read/write random-access memories can store up to 4096 bits, and offers a typical read access time of 150 ns. Ultra-mem series CM2400 multi-chip memory modules also feature a unique package—they use an aluminum beam-lead interconnection system on a dual-level metal-ceramic substrate. This type of construction provides high packing density, low costs, and good reliability.

The MOS/bipolar multi-chip approach simplifies the design of interface circuitry needed to work efficiently with different types of logic families. It also means that level shifting is done internally, yielding additional cost savings and performance optimization.

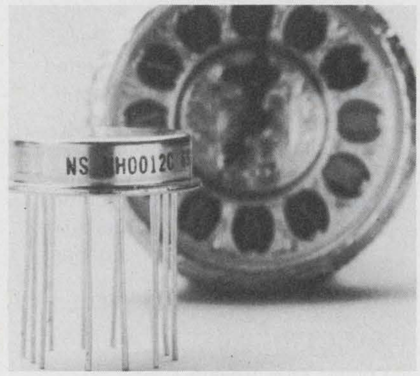
Since the modular package is DIP compatible, it can be assembled with the same techniques used for putting together integrated circuit packages. The housing measures 1.43x1.35 in. and has a seated height of 0.2 in.

Series CM2400 memories consist of up to 16 MOS storage chips and up to six bipolar chips for driving, sensing and output functions. The units are designed for use as buffers, scratchpads and main-frame memories.

Memory configurations can range from 4096 words with one-bit lengths to 1024 words with four-bit lengths. Maximum read cycle time is 600 ns; maximum write cycle time is 600 ns. Input and output signals are TTL.

CIRCLE NO. 299

Hybrid level shifter clocks up to 10 MHz

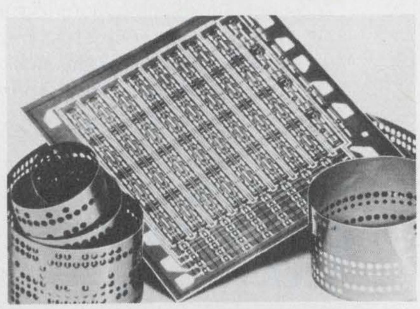


National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. Phone: (408) 245-4320. P&A: $27 or $37.50; stock

With its output swing of 12 to 30 V for driving either low or high-level MOS devices, a new bipolar-to-MOS level shifter can drive MOS shift-register clocks at rates to 10 MHz. Model NH0012 is a hybrid IC designed to be driven by a TTL or DTL line driver or a high-current buffer. Its output is a fixed-width clock pulse with maximum output of 1 A.

CIRCLE NO. 340

MOS memory chip accesses in 400 ns



Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: $13.70; stock.

Featuring a typical access time of 400 ns, a 64-bit MOS random-access memory is said to offer twice the speed of previous larger MOS memories. Organized as 16 words of four bits each, the MC1170L uses four-input binary addressing with full decoding performed on the chip. An enable input is also provided for easy address expansion.

CIRCLE NO. 341

LSI logic arrays are custom devices

Texas Instruments Inc. Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. P&A: $43.50 or $50.70, plus tooling; 90 days.

Combining MOS and bipolar technologies, two LSI circuits are custom-programmed random logic arrays at catalog-device prices. Because their final gate oxide removal mask is custom-programmed during the manufacturing process, the TMX-2000JC and the TMX-2200JC bring small-quantity prices down to $43.50 or $50.70 (less tooling). Both devices provide complexities of 130 equivalent gates, and are fully compatible with TTL and DTL systems.

CIRCLE NO. 342

Power Si rectifiers take 500 A at 2.4 kV

International Rectifier Semiconductor Div., 233 Kansas St., El Segundo, Calif. Phone: (213) 678-6281. P&A: $66 or $102; stock.

Available in both forward and reverse polarities, series 501V silicon rectifiers can carry up to 500 A at repetitive peak reverse voltages as high as 2400 V. Peak surge capability can be either 8000 or 10,000 A, depending on the model. In quantities of 1 to 9, types 501V60B and 501VR60B cost $66 each, while types 501V120 and 501VR120 are $102 each.

CIRCLE NO. 343

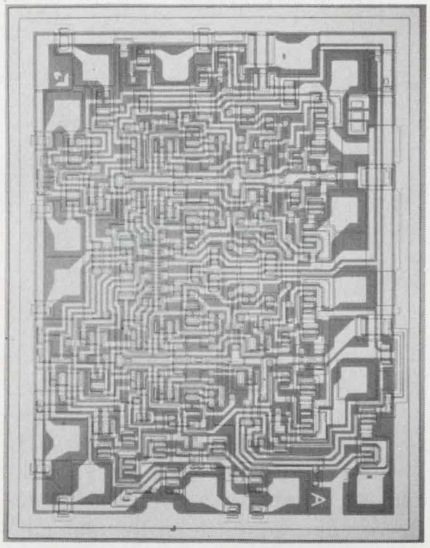
Agc i-f amplifier prevents detuning

Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: $7.30.

Designed for use in AM and FM communications receivers, a new automatic-gain-control i-f amplifier provides high-gain amplification without detuning the external filter circuits. The μA757C is a two-section device.

CIRCLE NO. 344

Commercial-price ICs are 100% MIL-tested



Advanced Micro Devices Inc., 901 Thomspon Pl., Sunnyvale, Calif. Phone: (408) 732-2400. P&A: $5.30 to $16; stock.

Seven new MSI devices that are pin-for-pin replacements of the Fairchild 9300 series are 100% tested to MIL Standard 883 Level B, yet cost the same as conventional commercial units.

This means that the user can benefit from added component reliability due to 100% temperature cycling, baking, hermetic-seal testing and centrifuging, at no extra cost.

Units are also available for operating in the military temperature range of −55 to +125°C at only 50% more in cost.

The devices are the 9300 shift register, the 9301 decoder, the 9304 adder, the 9309 multiplexer, the 9310 decade counter, the 9312 digital multiplexer and the 9316 binary counter.

Circuits in this series of units meet Military Specification 883 Level B, regardless of whether or not they are commercial or military versions.

Discount prices for any 100-unit lot are the same, as long as the lot contains a combination of ten units or more of any particular device.

Prices for military and commercial types, respectively, are $9.75 and $6.05 (9300); $9.35 and $6.25 (9310); $10.25 and $7.50 (9304); $7.95 and $5.30 (9309 and 9312); $16 and $11.75 (9310 and 9316).

CIRCLE NO. 345

Display generator views two functions

MacNeal-Schwendler Corp., 7442 N. Figueroa St., Los Angeles, Calif. Price: $350 to $495.

When used with analog or hybrid computers and an oscilloscope, a new two-variable display generator enables looking at the functions actually stored in the analog function generators, or in the digital computers. These displayed functions may be either a function of two variables or many functions of one variable. The final display can be magnified or stretched.

CIRCLE NO. 346

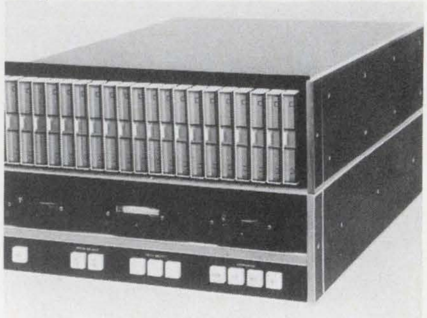
Matched data modules transmit and receive

Plessey Co., Ltd., Components Group, Professional Components Div., Titchfield, Hampshire, England.

Called data modules, matched pairs of transmitters and receivers enable users to construct and completely tailor frequency division multiplexing systems. The transmitters contain an oscillator and filter to give the required output signal. The receivers have an appropriate bandpass filter, together with a discriminator and amplifier; they can drive either relays or logic.

CIRCLE NO. 347

Cassette drive triples storage



Xebec Systems, Inc., Mountain View, Calif.

Intended to increase the capability of minicomputers, the ICU on-line magnetic tape drive system incorporates a compact triple-drive tape cassette unit: one cassette carries the standard software system; a second cassette handles the user's source information; and a third cassette carries the object program. This combined hardware/software system provides the user with increased flexibility and simplified operation.

CIRCLE NO. 348

Microfiche reader is portable unit

Dasa Corp., Information Systems Div., Andover, Mass. Phone: (617) 475-4940. Availability: summer, 1970.

Weighing only 7-1/2 lb and measuring just 13x13x7-1/2 in., the PRM/50 portable microfiche reader features an 8-1/2x11-in. viewing screen and accepts 4x6-in. microfiche with interchangeable grid formats for scanning control. Focusing is constant once set by a fingertip dial. High or low screen illumination is accomplished by a single ON/OFF button. The unit plugs into a standard electrical outlet.

CIRCLE NO. 349

Magnetic tape recorder verifies data entries

Singer Co., Friden Div., San Leandro, Calif. Phone: (415) 357-6800. Price: $7000 or $8000.

The 4301 magnetic data recorder is a stand-alone unit that performs all the functions of a keypunch and of a verifier, but with expanded capabilities. It can be cable-connected to a central pooler or act as one itself when equipped with a pooling adapter. The recorder produces computer-compatible tape with densities of 200, 556 or 800 bits per inch and with either seven or nine tracks.

Booth No. 35002 *Circle No. 350*

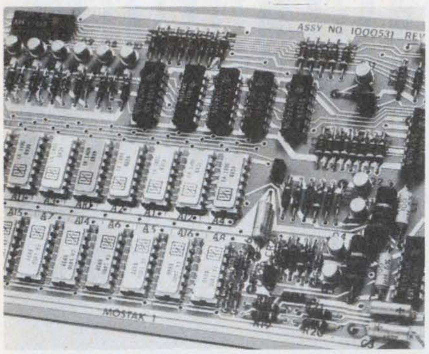
Voice converter calls out data

Instrumentation Systems Inc., 1111 San Mateo N. E., Albuquerque, N.M. Phone: (505) 265-9536. P&A: $795; 30 days.

Datavox I is a digital-to-voice converter that speaks in a clear natural voice to read numbers, and announce the polarity and function (like volts, ohms and frequency) of numerous measurements. The unit can read numbers as English words from 0.00001 to 999.99, and as digits from 0.00001 to 9999.9. A private earphone can be used.

CIRCLE NO. 351

MOS memory card cycles in only 1 μs

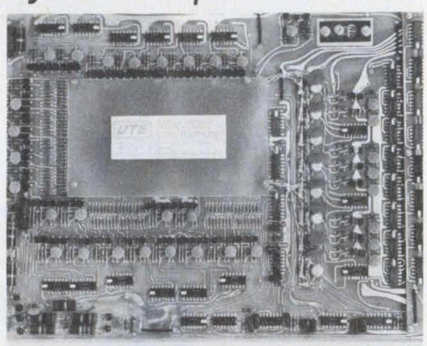


Electronic Arrays, Inc., Systems Div., 9060 Winnetka Ave., Northridge, Calif. Phone: (213) 882-9610. Price: $400.

Employing MOS semiconductors for data storage and address decoding functions, Mostak I read/write memory system features a 1-μs full-cycle time. The unit is a 512-word, four-bit-per-word random-access system with a 0.8-μs read access time. The entire memory is housed on a single board measuring 6-3/4x4-1/4 in.

Booth No. 3008 Circle No. 352

Core memories cycle in 2 μs

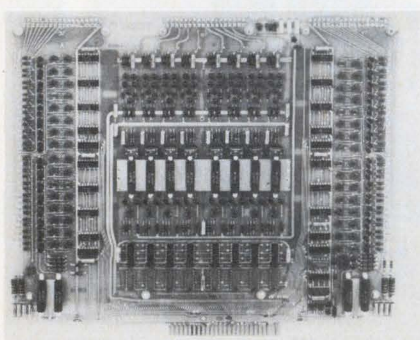


United Telecontrol Electronics, Inc., 3500 Sunset Ave., Asbury Park, N.J. Phone: (201) 988-0400. Price: $500 or $1500.

Two new Mesa 200 core memories offer full-cycle times of 2 μs. The model 5034-1B, which costs $500, is a 1kx8 unit and has an operating temperature range of 0 to 50°C. The model 5036, which costs $1500, is a 4kx18 system with an address register and party-line data registers.

Booth No. 6112 Circle No. 353

Memory cards access in 600 ns

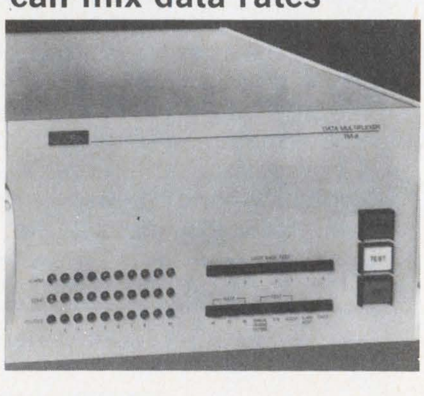


Standard Memories Inc., 15130 Ventura Blvd., Sherman Oaks, Calif. Phone: (213) 788-3010. P&A: $1105 typical; 30 days.

Besides a full-cycle or split-cycle time of 2 μs, Ecom series D memories feature a data access time of 600 ns. The units are available with capacities of 1024, 2048 or 4096 words with 8-bit lengths. In addition, the memories have a single I/O connector and interface directly to DTL circuits. Total power consumption is 52 W.

Booth No. 50016 Circle No. 252

High-speed multiplexer can mix data rates



Codex Corp., 150 Coolidge Ave., Watertown, Mass. Phone: (617) 926-3000. P&A: $4000; 30 days.

A new time-division multiplexer can simultaneously service up to eight terminals of intermixed data speeds from 1200 to 4800 bits per second. Model TM-8 is totally transparent so that EIA-RS232B modem control signals can be passed through it without changes in system operating concepts. In addition, the unit can interface to switched-network modems.

Booth No. 15000 Circle No. 258

Tape cleaner/certifier evaluates all errors

Data Devices Inc., sub. of Data Products Corp., 18360 Topham St., Tarzana, Calif. P&A: $8750; 60 days.

Providing two functions in the same package, the model 7900 tape cleaner/certifier determines whether a reel of tape is computer acceptable, marginal or unacceptable with its dual-error permanent-error and marginal-error counters. Permanent-error level is factory preset, and marginal-error level is selected by the operator.

Booth No. 1000 Circle No. 354

Tape reader rewinds too

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: $3000; 60 days.

Besides reading punched tape at speeds up to 500 characters per second, the model 2758A tape reader/reroller also rewinds the tape so that it's ready to use again immediately. After removing the tape from its clear plastic storage canister, the operator just inserts the tape into the reader, snaps the canister into place, and pushes a button. The tape is read and automatically rerolled into the canister.

CIRCLE NO. 355

Data multiplexers blend 38 channels

Tel-Tech Corp., 9170 Brookville Rd., Silver Spring, Md. Phone: (301) 589-6035.

Designed to transmit multiple low-speed data streams, two new time-division multiplexers can handle up to 38 full-duplex channels of data over a single 3-kHz type 3002 voice-grade circuit. The channels may operate at speeds of 110, 135, 150 or 300 bits per second. Model TTC-3000 is for multi-point networks and permits full contention for channels from remote stations.

Booth No. 4607 *Circle No. 255*

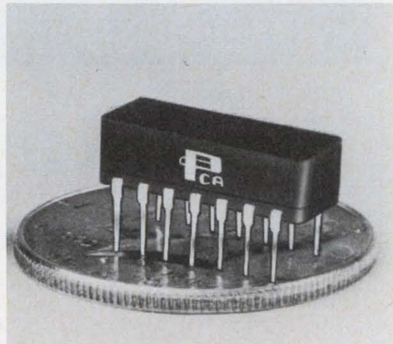
Data multiplexer mixes 88 channels

Rixon Electronics, Inc., sub. of United Utilities, Inc., 2120 Industrial Parkway, Silver Spring, Md. Phone: (301) 622-2121.

Able to handle as many as 88 channels, a new time-division multiplexer can intermix up to four data rates: 300, 150, 134.49 and 110 bits per second. Model TDX-2 is absolutely data transparent and will transmit all combinations of 7 and 8-bit data characters. Status and data quality indicators provide rigorous diagnostic capability.

Booth No. 2103 *Circle No. 263*

Hybrid function modules are multi-circuit DIPs



PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif. Phone: (213) 781-3034. Availability: 2 to 15 wks.

Designed for use in many circuits with various functions are hybrid modules that contain delay lines, pulse transformers, transistors, diodes, resistors and capacitors. They are available in a variety of combinations in 14-pin dual-in-line packages. Modules are 0.78-in. long and 0.27-in. wide with heights varying from 0.18 to 0.3 in.

CIRCLE NO. 356

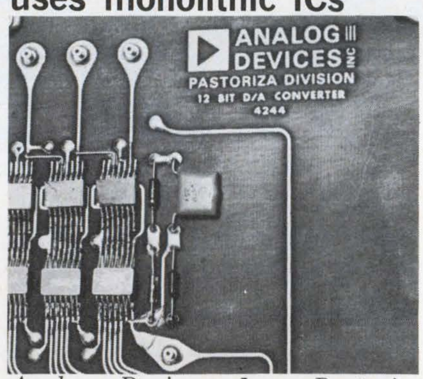
Voltage-source converter doubles output polarity

Delta-X Corp., Box 26733, Houston, Tex.

The Bi-Volter is a new device that accepts a single-polarity voltage and develops voltages of opposite polarity with a stable reference point at any fraction of the input voltage. Load currents of the two output voltages are unimportant as long as the imbalance limitations of the device are met. Maximum input voltage and current imbalance vary by model. Models are available for many input currents and voltages.

CIRCLE NO. 358

D/a 12-bit converter uses monolithic ICs



Analog Devices, Inc., Pastoriza Div., 221 5th St., Cambridge, Mass. Phone: (617) 492-6000. P&A: $191 to $330 for 12 bits.

The new μDac family of thin film monolithic quad switches (AD550) and resistor networks (AD580) and AD582) serve as building blocks for a 12-bit d/a converter with an accuracy of 0.01% ±1/2 the least significant bit. These units can be supplied individually or on PC boards whose layout could be determined by the user at a nominal cost.

CIRCLE NO. 357

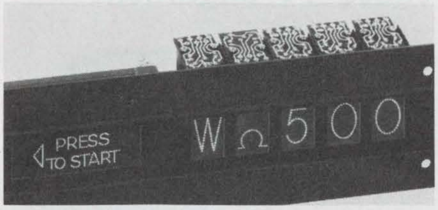
Two-quadrant multiplier reaches 0.1% accuracy

Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. Phone: (617) 272-1522. P&A: $120; stock to 2 wks.

Using the pulse modulation principle, the model 108 two-quadrant multiplier achieves an accuracy of 10 mV out of 10 V. It computes the function XY/10 with an accuracy of 0.1%. Gain versus temperature is 0.005%/°C and offset versus temperature is 50 μV/°C. Bandwidth at −3-dB points is 100 Hz. The unit measures 3.5x2.5x0.825 in.

CIRCLE NO. 359

Legend readout displays digits too



Inter-Market, Inc., 312 Waukegan Rd., Glenview, Ill. Phone: (312) 729-3550. Price: $20 for legend display only.

Displaying up to 12 legends in a window 2-5/8-in. wide and 1-in. high, the M4X legend readout combines with several digital readouts on the same panel. Legends can be engraved in many positions and be coordinated for various messages. The display uses flanged-base T-1-3/4 lamps with 6, 12, 24 or 28-V ratings.

CIRCLE NO. 360

Flatpack power supply powers up to 100 ICs

Elasco-Eastern, Inc., 5 Northwood Rd., Bloomfield, Conn. Phone: (203) 242-0708. P&A: $185; stock to 2 wks.

The IC 5-5A is a flatpack power supply that delivers 5 V dc at 5 A to power up to 100 ICs. It requires less space than conventional units since it measures only 4-5/8 × 3-1/8 × 1-3/8 in. Load and line regulation is held to ±5 mV maximum.

CIRCLE NO. 362

Variable active filters give 3 outputs at once

Varadyne, Inc., 2330 Michigan Ave., Santa Monica, Calif. Phone: (213) 394-0271. P&A: $24.50, $29.35; stock.

The VAF-100 (hybrid) and VAF-200 (PC card) active filters are two series of state-variable units with simultaneous bandpass, low-pass and high-pass outputs. They feature independent frequency, bandwidth and gain adjustments.

CIRCLE NO. 361

Pulse generator drives logic directly

Lear Siegler, Inc., Cimron Div., 1152 Morena Blvd., San Diego, Calif. Phone: (714) 276-3200.

The model 3101 pulse generator provides simultaneous logical complement outputs to eliminate the need for an external inverter when driving IC logic networks. Open-circuit voltage to the network under test is either 0 or 5 V. Rise and fall times are less than 8 ns, and delay and pulse width are continuously variable. Operation mode can be single or double pulse.

CIRCLE NO. 363

Bias supply for $25 eases TV alignment

Sencore, 426 Westgate, Addison, Ill. Phone: (312) 543-7740. Price: $24.95.

Developed primarily for color TV alignment, a new seven-in-one bias supply can be used with any sweep and marker generator, and with either solid-state or tube-type systems. Model BE156, which sells for $24.95, provides three separate 25-V supplies that can be switched positively or negatively. Two of its outputs can be varied from −25 to +25 V, while a third goes from −75 to +25 V.

CIRCLE NO. 365

Analog $160 voltmeter senses down to 82-dBm

Abphot Corp., Instrument Div., 105 W. 27th St., New York, N.Y. Phone: (212) 242-1307. P&A: $160; 1 to 4 wks.

Providing a sensitivity of −82 dBm for only $160, a new analog-readout voltmeter can measure ac signals with amplitudes of 30 μV to 100 V over the frequency range of 10 Hz to 1 MHz. Model 1001 is a solid-state battery-operated instrument with a typical internal noise level of −108 dBm on its 300-μV scale. Input impedance is 1 MΩ.

CIRCLE NO. 364

Digital event counter can be panel-mounted

Digilin Inc., 6533 San Fernando Rd., Glendale, Calif. Phone: (213) 246-8161. Price: $149.

Complete with an internal power supply, a solid-state panel-mounted digital-display event counter makes possible local as well as remote readout of counted or accumulated data. Model 320 is a 3-1/2-digit panel meter that can be located at the sensor or transducer site in high-electrical-noise environments. It can operate at rates as high as 1 MHz.

CIRCLE NO. 366

Ka-band MIC source incorporates afc loop

Texas Instruments Inc., Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. $2400; 60 days.

Designed for use as a signal source or local oscillator from 32 to 33 GHz, a new MIC Ka-band solid-state source includes an automatic-frequency-control loop. Model MIC100 is a microwave thin-film hybrid rf source that meets the environmental requirements of MIL-E-5400 for Class II equipment. This compact unit operates from a 20-V 300-mA power supply.

CIRCLE NO. 367

Microwave mixers use replaceable diodes

Control Data Corp., Boston Space and Defense Systems Div., 400 Border St., East Boston, Mass. Phone: (617) 569-2110. P&A: $1360; 30 to 60 days.

Intended for use in the millimeter-wavelength region, a new family of Schottky-barrier diode mixers features wafer-mounted field-replaceable diodes. Series 965 units are available in each waveguide band from 26.5 to 110 GHz; with rf bandwidths up to 7 GHz at the upper end of the frequency spectrum.

CIRCLE NO. 368

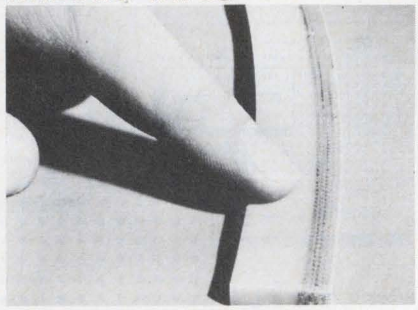
Metalized substrates do microwave work

HRB-Singer, Inc., Science Park, P. O. Box 60, State College, Pa. Phone: (814) 238-4311.

Ceramic metalized substrates for microwave applications are now available in standard sizes and thicknesses. Semiconductor-type cleanliness and procedures allow production of metal films with good adhesion and low insertion loss. Custom metalization and etching of dielectrics, ferrites, and garnets are also possible.

CIRCLE NO. 369

Emi gasketing imbeds wires

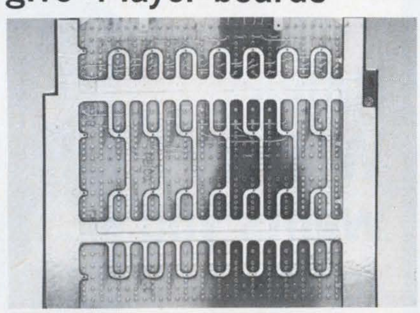


Metex Corp., 970 New Durham Rd., Edison, N.J. Phone: (201) 287-0800.

Developed for emi shielding and pressure-tight sealing of wide flange areas in electronic gear, Combo Polastrip gasketing consists of wire mesh embedded in an elastromeric material. Since the wires are perpendicular to the surface being gasketed, they provide direct current paths for high emi-shielding capabilities. Since the shielding portion is not bonded to, but molded into the pressure seal, the chance of gasket component separation is virtually eliminated.

CIRCLE NO. 370

Flexible circuits give 4-layer boards



Rogers Corp., Rogers, Conn. Phone: (203) 744-9605.

Offering ground and power lines on separate layers, Multi/Bus flexible circuits can become an integral part of a printed circuit board by lamination, transforming a two-layer PC board into a three or four-layer one. The change is reportedly accomplished at a fraction of the fabrication cost of a three or four-layer board. Also the proximity of Multi/Bus to the board and board components results in effective shielding of radiated electrical noise.

CIRCLE NO. 371

Breadboard system stacks together

Heath Co., Benton Harbor, Mich. Phone: (616) 983-3961. Price: $37.50.

Consisting of a small desktop chassis, a power patch card and a component patch card, Stack-n-Patch EU-53A breadboarding system eliminates soldering with on-card connectors that make a tight electrical connection by simple wire insertion. Patching up a design is fast and simple—pick your power supply and connect it to the power patch card, stack the component and power patch cards in the chassis, and then patch components or hook-up wire into the component card.

CIRCLE NO. 372

Semiconductor glass replaces oxide layer

Innotech Corp., 181 Main St., Norwalk, Conn. Phone: (203) 846-2041. P&A: $25 to $55/lb; stock.

IP 650 is a glass that is applied directly to a semiconductor junction rather than on top of an oxide. Substituting a stabilizing glass for the oxide prior to dicing cleans the surface of impurities and prevents migration. Devices are not only gettered but hermetically sealed as well.

CIRCLE NO. 373

Rf connectors telescope together

Sealectro Corp., RF Components Div., 225 Hoyt St., Mamaroneck, N.Y. Phone: (914) 698-5600.

Nanohex microminiature rf connectors feature a telescoping interface to ensure proper mating by first aligning metal bodies, then insulators and then contacts. This permits electrical performance to be maintained over thermal extremes. The units have a typical VSWR of 1.25 from dc to 12.4 GHz when used with 0.056 or 0.07-in.-diameter semi-rigid cable.

CIRCLE NO. 374

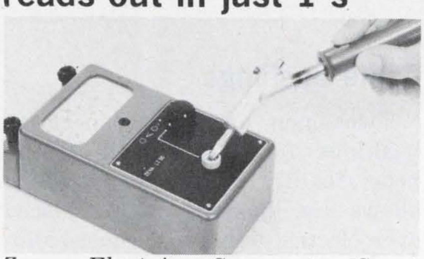
Desoldering kit frees DIP ICs

Eldon Industries, Inc., Ungar Div., Compton, Calif. Phone: (213) 774-5950.

Ideally suited for small printed circuit boards, the Princess 6939 five-piece desoldering kit contains a three-wire grounded handle, an 18-W heat capsule and three specially designed tips. One tip is a slotted bar for releasing up to 16-pin DIP ICs in one operation. Another tip is for use on 0.375-in. TO packages and transistors. The third tip melts and straightens bent tabs and leads.

CIRCLE NO. 375

Benchtop solder meter reads out in just 1 s

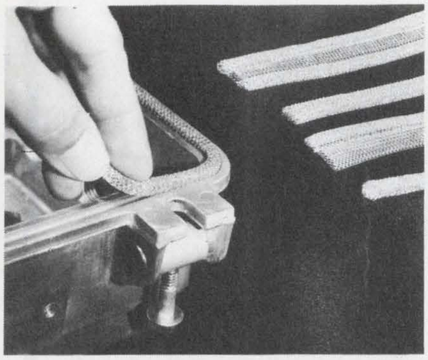


Zeva Electric Corp., 3 Great Meadow Lane, Hanover, N.J. Price: $98.50.

Designed especially for soft soldering applications, a soldering temperature meter gives on-the-spot temperature readings in just one second. Model LT 50 has a wide temperature range of 32 to 932°F, making it useful for measuring soldering irons, pots and baths. The scale is graduated for both Fahrenheit and Centigrade readings. A leather carrying case is optional.

CIRCLE NO. 376

Evaluation Samples



Rfi/emi gaskets

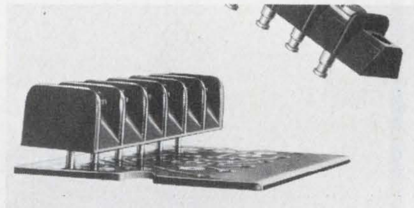
Tecknit strips are resilient, conductive, knitted wire mesh strips used to effectively shield seams and joints in electronic enclosures against emi/rfi. The standard fine wires used to produce this gasketing material are tin-coated copper-clad steel, monel, aluminum and silver-plated brass. The gaskets are generally used on shielding joints that are simple in shape and have a periphery greater than 4-in. Gaskets are available in five different shapes: round, square, rectangular, round with single fin and double core. Total shielding effectiveness up to 120 dB is provided in the frequency range from 1 kHz to 10 GHz. Free samples are available. Technical Wire Products, Inc.

CIRCLE NO. 377

Computerized tag

A sample of a computerized all-weather steel tag designed with a specially compounded coating which is receptive to computer imprinting is available. A special ribbon etches messages into the coating, making the copy as permanent as the steel tag. The tag is then wire-tied to any item. It also can be supplied with a pressure-sensitive backing. The new tags have been subjected to accelerated aging tests duplicating severe outdoor exposure with a predicted life span of at least two years. They can be color-coded for product identification purposes. Impact Label Corp.

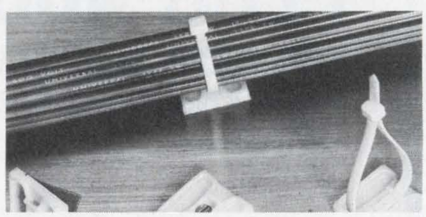
CIRCLE NO. 378



Terminal blocks

Single-screw terminal blocks with attached tin-plated brass lugs and pins are now being offered as free samples. These devices feed through the center of the block allowing the block itself to protect the connection. The pins are made for soldering to a printed circuit board while the lugs have specially shaped ends to which individual wires can be soldered. Lugs and pins are available mounted on either a 15-A 3000-V rms or a 20-A 3400-V rms single-screw block. Blocks are formed from sturdy lightweight phenolic. ETC Inc.

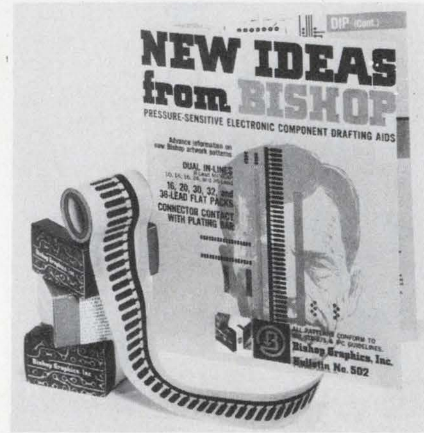
CIRCLE NO. 379



Wiring harness mount

Samples of a new adhesive-backed mount for securing wiring harnesses to virtually any smooth surface for light-duty applications are available. The new ABMS-A mount has a pressure-sensitive adhesive backing with a peel-off paper cover. The inclusion of a countersunk hole permits the mount to be used with a #6 flat-head screw or a 1/8-in. flat-head rivet. The result is a one-hole mount which will not rotate. The adhesive-backed mount is used in conjunction with any miniature, intermediate or standard cable tie to provide a neat, secure harness. It can be mounted to virtually any clean, dry, and smooth surface. Panduit Corp.

CIRCLE NO. 380



Artwork patterns

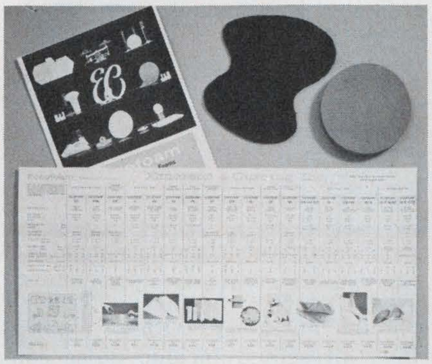
New connector contact patterns, which come in time-saving continuous strips of up to 880 contacts each, are available as free samples. The strips eliminate the old time-consuming method of laying down multiple small segments, allowing the draftsman to count and cut exactly what he needs in a single piece. The connector contacts include a plating bar pattern effecting further time savings by eliminating need for conventional taping. All patterns conform to MIL-STD-275. Bishop Graphics, Inc.

CIRCLE NO. 381

Cable bushings

Two new nylon open/closed bushings for 1/2-in. and 7/8-in. holes feature a split body which allows the bushing to be placed over electric wires and cables, tubing or hose, after installation through panels or housings. When inserted into the proper size hole, a perfect circle and complete insulation barrier is formed. The bushing permits protection of pre-assembled harnesses, control tubes and capillary tubes. A snap-lock feature locks the open/closed bushing to the panel with fingertip pressure and withstands a push-back test of 35 lb. Cost ranges from 95¢ to $2.80 per 100. Free test samples are available. Heyman Manufacturing Co.

CIRCLE NO. 382



Foams chart

Standard plastic and ceramic foams are described and illustrated in a new color chart. Basic materials include polyurethanes, epoxies, phenolics, silicone rubbers, glasses, silica, and other ceramics. Bulk densities range from 2 to 45 lb/ft^3 for the plastic foams and 25 to 68 lb/ft^3 for the inorganic foams. Cell structures available are closed, open, partly closed, and syntactic. Other properties for each foam, listed in a handy table, are color, comprehensive strength, thermal conductivity, water absorption, dielectric constant and loss tangent. Many applications are listed and illustrated including electronic packaging, heat and vibration insulation, lightweight machined parts, and lightweight lenses and antennas for microwaves. Emerson & Cuming, Inc.

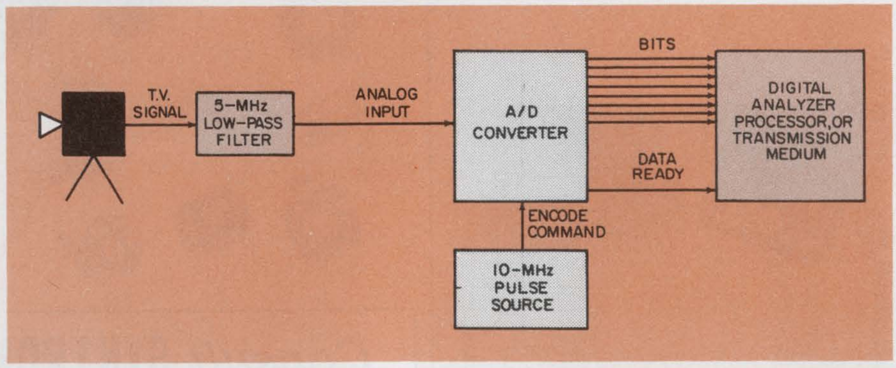
CIRCLE NO. 383

Cable size nomogram

To simplify the selection of cable sizes which must consider voltage drop, current, resistance, length of cable and voltage, two nomograms are available. One is for 115/230-V single-phase systems; the other is for 220/440-V three-phase systems. By using the nomograms, selection can be made quickly and easily by merely coordinating two straight lines across the scales. Prosser Industries, div. of Purex Corp., Ltd.

CIRCLE NO. 384

Application Notes



A/d converter theory

Digitizing color television is just one of the unique applications to be found in a new 22-page booklet entitled "An Introduction to Analog-to-Digital Converters." The technique illustrated above can be implemented with seven-bit binary numbers for full-color high-resolution pictures, or with four bits or less resulting in some loss of color resolution but retention of picture integrity. Other applications presented include pulse contour measurements, and time compression and expansion. In addition, a theoretical discussion covers the basics of a/d converters, their operation, the common codes used, and the various errors in the conversion process. Computer Labs.

CIRCLE NO. 385

High-temperature metal

How to make molybdenum high-temperature resistant is the subject of a four-page brochure. It describes a coating material that protects molybdenum from catastrophic oxidation in the air. A reprint of a recent technical article shows how a silicided diffused coating is produced. A chart lists test results showing how siliciding improves the performance of molybdenum. General Electric Co., Lamp Metals and Components Dept.

CIRCLE NO. 386

Noise measurements

The second edition of the Primer of Plant-Noise Measurement is now available. This revised 24-page booklet features how-to-do-it discussions on making noise measurements consistent with the latest provisions set forth in the Safety and Health Standards of the Walsh-Healey Public Contracts Act. A special section on the measurement of impact noise has been added. General Radio Co.

CIRCLE NO. 387

Stepping-motor glossary

Users of stepping motors who are caught in the middle of a conflict of nomenclatures used by the makers of high-speed steppers and those who make high-torque, low-speed devices can now resolve the problem with a six-page glossary of terms associated with stepping motors. Starting with definitions of three basic types of steppers, based on their method of constructions, the glossary classifies the motors by type of application. A series of terms with definitions are presented. These are arranged sequentially, rather than alphabetically, with each definition building on those preceding it. Among these are such terms as torque, work, total load torque, static torque, dynamic torque, stepping angle, torque angular displacement, detent torque, maximum pulse length, and many others. Although many of the terms also refer to other dynamic systems, the definitions provided in the glossary are specifically related to stepping motors. Heinemann Electric Co.

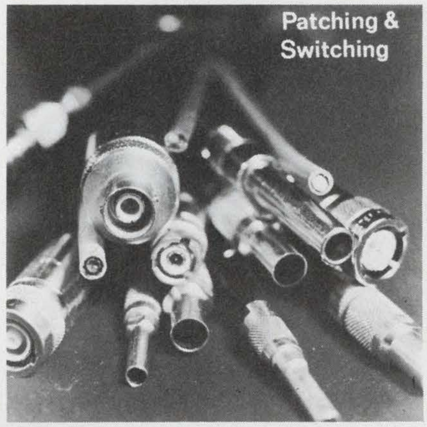
CIRCLE NO. 388

New Literature

Computer handbook

The 520/i, a versatile mini-computer priced at $7500, is the subject of a 408-page manual. It provides, in a single document, a complete description of the computer for such categories as hardware, interfaces and software. This information is a useful reference for systems designers, programmers and ultimate users. The various sections are cross-referenced to aid the reader in finding exactly what he needs. Varian Data Machines.

CIRCLE NO. 389



Patching and switching

Information detailing high and low-frequency switches and matrices is in a 44-page 1970 full-color catalog. It illustrates a complete line of coax, twinax, triac and quadrax connectors, plus patch panels, plugs, jacks, patch cords and accessories. These are employed in TV broadcasting, CATV, CCTV, telemetry, telephone, nuclear instrumentation and information retrieval. Included is a technical discussion on noise in cable systems which will assist materially in the design of instrumentation, communication and data systems. Trompeter Electronics Inc.

CIRCLE NO. 391

Bridge rectifiers

Characteristic charts for an entire line of silicon bridge rectifier assemblies are contained in a 12-page publication. The line covers diffused-junction silicon rectifiers with over 150 devices. These range in ratings from 1-mA 200-V units for consumer and low-voltage industrial applications to high-voltage rectifier assemblies. Featured is a double-page chart which serves as a designer's guide for rectifier circuits. It includes a sample calculation which enables an engineer to determine voltage ratings for high-voltage assemblies in circuit configurations. RCA Electronic Components.

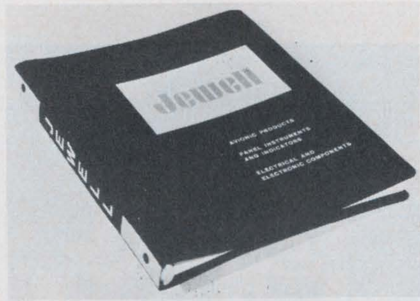
CIRCLE NO. 390

Readout tubes

Of interest to many users of display devices is a readout-tube quick-reference catalog. Design and development engineers will be particularly interested in it. It lists a complete line of readout tubes with condensed technical information. Complete technical data for readout tubes with display character size ranging from 0.31 to 2-in. is given, including data on a new economical side-view series. Improved driving circuits are also discussed. Critical ratings and characteristics, as well as photographs and outline drawings of all types are shown. National Electronics, Inc.

CIRCLE NO. 392

INFORMATION RETRIEVAL NUMBER 79 ►



Panel meters

A new 50-page catalog describes and illustrates various designs of several panel meter lines. It contains engineering specifications and dimensions on each meter line, which includes elapsed time indicators, taut-band panel meters and null indicators. Meters are available in round, square, rectangular, wing and edgewise styles to fit various equipment designs. Sizes range from 1-1/2-in. through 5-1/2-in. Some meters offer a choice of front or behind-panel mounting. Also included in this catalog is pricing information and a listing of sales representatives and distributors. Jewell Electrical Instruments, Inc.

CIRCLE NO. 393

CRT display software

The broad range of software packages available for the IDIIOM interactive graphics display system is described in a concise eight-page brochure. The booklet outlines the function and use of such packages as a FORTRAN package, an MOS master operating system, IDAS and DAS programming systems, an AID debugging package, a TED text-editing subroutine, a TRAK light-pen tracking program and a variety of graphics routines. This extensive library of software combines with the programming convenience and display capabilities afforded by the unique design concept of IDIIOM hardware to provide a practicable and economical means of utilizing the display as a direct man-computer interface. Information Displays, Inc.

CIRCLE NO. 394

Information retrieval

A three-page application abstract describes a computer program that enables time-sharing users stationed at desk-side remote terminal devices to perform data-management and information-reterieval functions. Called Aksess, the program can be used effectively by personnel, who have neither computer expertise nor programming ability, to maintain and retrieve files stored on disk units situated at the central computer site. Detailed are Aksess's capabilities, typical applications, and procedure for its use. Three examples show how commands are issued, information is selected, and various calculations are performed. Remote Computing Corp.

CIRCLE NO. 395

Miniature terminals

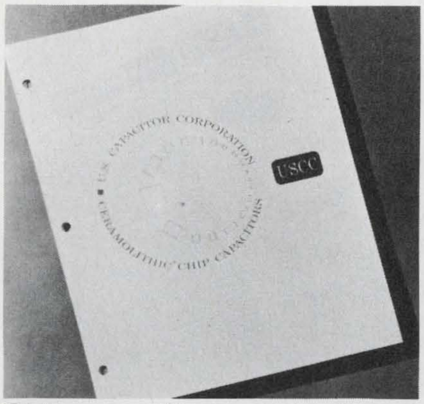
A six-page brochure describes a high-reliability disconnect terminal for electronic pilot or production assembly, cable and harness terminations. Other applications include customized back planes, test panels, programming boards, breadboards, and standard-wire terminations to wire-wrap pins. Also described are hand and machine crimping tools to facilitate crimping the terminals to leads, as well as standard molded housings for multiple, simultaneous terminations. Berg Electronics, Inc.

CIRCLE NO. 396

IC video amplifiers

A new series of video amplifiers useable from dc to 200 MHz is described in a new technical bulletin. In addition to complete characterization, this six-page bulletin contains two pages of applications notes. Specifications are also listed. Silicon General Inc.

CIRCLE NO. 420



Chip capacitors

A broad spectrum of chip capacitors is covered in a 16-page two-color catalog. It gives complete specifications, physical drawings, part numbers and ordering information. A multitude of sizes and capacitance values with the closest tolerances currently obtainable are covered. These provide solutions for most hybrid or integrated circuit problems requiring ceramic chip capacitors. Aslo included are typical curves for W and NPO dielectric characteristics and detailed test procedures during manufacture and subsequent high reliability testing. Among the charts supplied are capacitance vs temperature, capacitance vs ac voltage, capacitance vs dc voltage and dissipation factor vs temperature. U. S. Capacitor Corp.

CIRCLE NO. 397

Cathode-ray tubes

Selection of cathode-ray tubes is now available in an eight-page technical catalog. In three separate tables, it lists 41 registered screen phosphors and 165 magnetic-deflection and electrostatic-deflection CRTs, according to physical dimensions and operational characteristics. Listed types are categorized as general-purpose, military, industrial or special-purpose. Footnotes are utilized to denote special characteristics such as flat, gray, spherical face-plate and magnetic focus. General Electric Co., Tube Dept.

CIRCLE NO. 398

Rf connectors

Catalog 1069 is an rf connector booklet whose 161 pages cover all major rf connector classifications and sub-types. Included are comprehensive part number cross-reference tables for military to manufacturer and vice versa, and cable data and assembly instructions. Also included are a full line of adapters between series, terminations, and diagrams of mounting holes and mounting plates. Illustrations, dimensions and engineering data for each connector type within a series are shown. Bendix, Microwave Devices Div.

CIRCLE NO. 399

TTL ICs

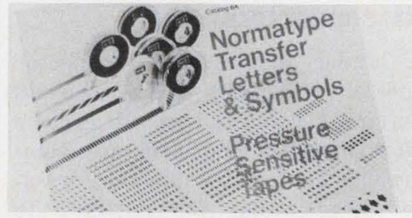
Series 54H/74H high-speed TTL integrated circuits are the contents of a comprehensive 88-page handbook. It is divided into three sections. One section provides general design characteristics information. A second section on electrical characteristics gives specific test limit and test condition information for device evaluation in integrated circuits. A third section has parameter measurement information with dc and ac measurement methods and procedures. Sprague Electric Co.

CIRCLE NO. 400

Active filters

An active filter data package consisting of data sheets, application notes, design notes and general information on the design and selection of active filters is available. The package is of significant use to engineers involved in filter design, communications, data processing and related fields. Three application notes detail the basic analysis of the state-variable filter, estimating filter complexity and tables of normalized section tuning for lowpass and highpass filters. Varadyne, Inc.

CIRCLE NO. 401



Engineering artwork

Durable heat-resistant transfer letters, numerals and symbols are the subject of a new catalog. They are especially designed to meet the needs of the engineer and industrial art director and feature a wide variety of type faces, including the widely used Leroy engineering standard and the new Microfont that is specifically designed for microfilming. Uniform matte density in both black and white insures excellent photographic resolution. Also shown are projection letters, numbers and symbols for use on overhead transparencies, and a wide selection of pressure-sensitive tapes for recurring symbols and patterns. Keuffel & Esser Co.

CIRCLE NO. 402

Instruments & components

A new eight-page sales bulletin lists many electronic components and instruments for sale. Listed are such components as capacitors, resistors, diodes, knobs, waveguides, coaxial switches, attenuators and couplers. Instruments include voltmeters, oscilloscopes, generators, power supplies and bridges. Baynton Electronics Corp.

CIRCLE NO. 403

Computer software

A 12-page brochure outlines new technical services and computer software available. Included in these services are engineering, design automation, computer simulation, project control, computer software and process control. Also included are such services as real-time and communications systems, technical applications, and consultation and contract programming. NCS Computing Corp.

CIRCLE NO. 404

A/d converters

A series of 14 analog-to-digital converters is shown in a new four-page bulletin. Units featured are plug-in printed circuit boards with 8, 10 and 12-bit binary and 12-bit BCD conversion. Included are complete electrical and mechanical specifications plus information on companion mounting cases. All necessary ordering information is included. Computer Products.

CIRCLE NO. 405

Thumbwheel switches

A complete line of thumbwheel switches, including four new series is contained in a six-page, two-color condensed catalog. Emphasized are both the convenience of operation of the switches and the enormous number of standard configurations or standard design variations that are available. Interswitch.

CIRCLE NO. 406

Microwave devices

Catalog 70A is a 12-page brochure that lists a wide variety of receiver components as well as a large selection of wideband FM receivers and transmitters. It includes FM microwave relay equipment, mixer preamplifiers and linear and logarithmic i-f amplifiers. Other items described are discriminators, pulse and rf amplifiers, filters and multipliers. Specifications, descriptions and illustrations are included. RHG Electronics Laboratory, Inc.

CIRCLE NO. 421

Capacitors

Polyester film, metalized polyester film, polystyrene and polycarbonate capacitors are listed in a 16-page catalog. Case types listed include ceramic, phenolic and tape-wrap in cylindrical and flat configurations. Photos, dimensional drawings and performance charts supplement the listings. Included are tolerances, temperature range ratings and lead specifications where applicable. Information on RC networks and special capacitors is also presented. Standard Condenser Corp.

CIRCLE NO. 407

Thyristors

A thyristor product line with over 150 different types of devices is described in a 24-page publication. Included are silicon-controlled rectifiers, diacs and triacs. Detailed matrices show principal characteristics of all the devices. There is a compilation of thyristor type numbers and ratings arranged by family classification. A group of charts present applications information in certain specialized categories. Introductory material includes a brief explanatory note on triac firing modes. RCA Electronic Components.

CIRCLE NO. 408

Programming costs

How to cut programming costs by 40% is the subject of a four-page brochure titled "Applying Computer Science to the Problems of Management." It describes contract services for computers which save costs in implementing programming design, coding, testing and documentation without sacrificing quality. Also described are the software systems design, consulting, and EDP education capabilities of the company which operates in the United States and overseas. International Data Applications, Inc.

CIRCLE NO. 409

CRT displays

Cathode-ray tube display products are described in a new brochure. It includes detailed descriptions of precision CRT displays, as well as display modules such as deflection amplifiers and tube and coil mounts. Also included are linearity and focus-correction circuits, high and low-voltage power supplies and phosphor-protection circuits. Beta Instrument Corp.

CIRCLE NO. 410

IC comparators

Four technical bulletins describe two new voltage comparators. One is a differential voltage comparator and the other is a dual-input voltage comparator. Each of these devices is available in four grades for military and commercial applications. Shown are specifications several typical characteristics curves, maximum ratings and schematic programs. Silicon General Inc.

CIRCLE NO. 411

Semiconductors

Ratings on a wide range of semiconductor devices are given in a 12-page catalog. It includes silicon and selenium bridges, high-voltage rectifiers, and custom assemblies. Custom circuits, package drawings and photographs are also included. A brief description of the relative merits of silicon and germanium materials is presented. General Instrument Corp.

CIRCLE NO. 412

Power supplies

Fourteen different lines of power supplies are indexed by output voltage in a short-form catalog. The 12-page booklet gives full specifications and prices for low and high-voltage dc power supplies, ac line-voltage regulators, and special-purpose power supplies. Raytheon Co., Sorensen Operation.

CIRCLE NO. 413

Rfi filters

A complete line of new low-cost rfi filters for equipment are described in a new design engineering catalog. Complete descriptions and details for 25 standard models are given with drawings and mechanical details. Electrically-detailed are 1, 2, 3, 5 and 10 A versions. Graphical illustrations are complete with attenuation characteristics. Components Corp.

CIRCLE NO. 414

Hybrid semiconductors

Hybrid semiconductor circuits are featured in a 36-page catalog. Listed are hybrid devices with their schematic diagrams and physical and electrical characteristics. The catalog gives characteristic curves, specification tables, dimensional case drawings, applications schematics and test circuits. Circuits include drivers, switches, amplifiers and regulators. Amelco Semiconductor.

CIRCLE NO. 415

Photo-thyristors

The applications of a photothyristor are discussed in an eight-page technical brochure. It starts off with an introductory discussion of the device's principles of operation, then proceeds to give applications examples. Seven different examples are thoroughly discussed. Each example application is shown in a circuit schematic configuration. Telefunken Sales Corp.

CIRCLE NO. 416

Temperature sensors

A newly-published 21-page two-color temperature-sensing catalog and reference manual provides data in text and tables, for both thermocouples and thermistors. Capabilities, relative speeds of response and temperature ranges are compared. Included is a line of standard and special mineral-insulated and metal-sheathed thermocouple cables. Specialized high-temperature designs and heavy-duty thermowell assemblies are also shown. The catalog can be used for specifying complete probe assemblies in almost unlimited combinations. Conax Corp. sub. of Easterline Corp.

CIRCLE NO. 417

Filter transformers

Descriptions of lowpass and bandpass coaxial filters and high-power low-loss impedance transformers are contained in a 12-page technical bulletin. By utilizing graphs contained, the design engineer can determine the size, weight, insertion loss and attenuation of an infinite variety of bandpass and lowpass filters. The coaxial filters shown cover a frequency range from 10 MHz to 6 GHz, with bandwidths varying from 1/2 to 100%. Included in the bulletin are standard specifications and prices. Lark Engineering Co.

CIRCLE NO. 418

Allied Radio supplement

A supplement to the 1970 Allied Electronics Industrial catalog number 700 is available. It introduces a wide range of new products for industrial use. This 56-page supplement includes an up-to-date revised semiconductor and integrated circuit directory. It also includes the latest digital display equipment, oscilloscopes, power suppies and other industrial products. Allied Electronics Corp.

CIRCLE NO. 419

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171

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172

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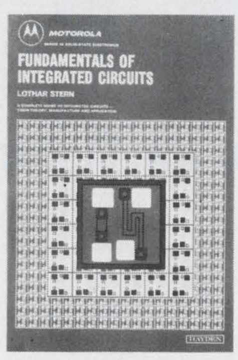

A practical guide to integrated circuits, their theory, manufacture, and applications. This new guide by Lothar Stern offers compete, highly readable coverage of the various techniques of circuit fabrication, and their effect on circuit design and performance. As to marketing considerations, it compares the characteristics of the numerous IC structures devised to date in terms of economics and logistics. A volume in the **Motorola Series in Solid-State Electronics.** 198 pages, 7 x 10, illustrated. $8.95, clothbound. Circle the reader-service number below for 15-day examination copies.

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Keith Aldrich
Sales Manager

New York 10022
Robert W. Gascoigne
Thomas P. Barth
Samuel M. Deitch
850 Third Avenue
(212) Plaza 1-5530
TWX: 867-7866

Philadelphia 19066
William C. Repetto
P. O. Box 206
Merion Station, Pa.
(215) MA-3-5888

Boston 01945
Joseph F. Palmer
14 Peter Hobart Drive
Hingham, Mass.
(617) 742-0252

Chicago 60611
Thomas P. Kavooras
Berry Conner, Jr.
200 East Ontario
(312) 337-0588

Cleveland
Thomas P. Kavooras
(Chicago)
(312) 337-0588
(call collect)

Los Angeles 90303
Stanley I. Ehrenclou
W. James Bischof
2930 Imperial Highway
Inglewood, Calif.
(213) 757-0183

San Francisco 94022
Arthur R. Shields, Jr.
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Los Altos, Calif.
(415) 941-3084

London W. 1
For United Kingdom and Holland
Brayton C. Nichols
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Verviers, Belgium
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Tokyo
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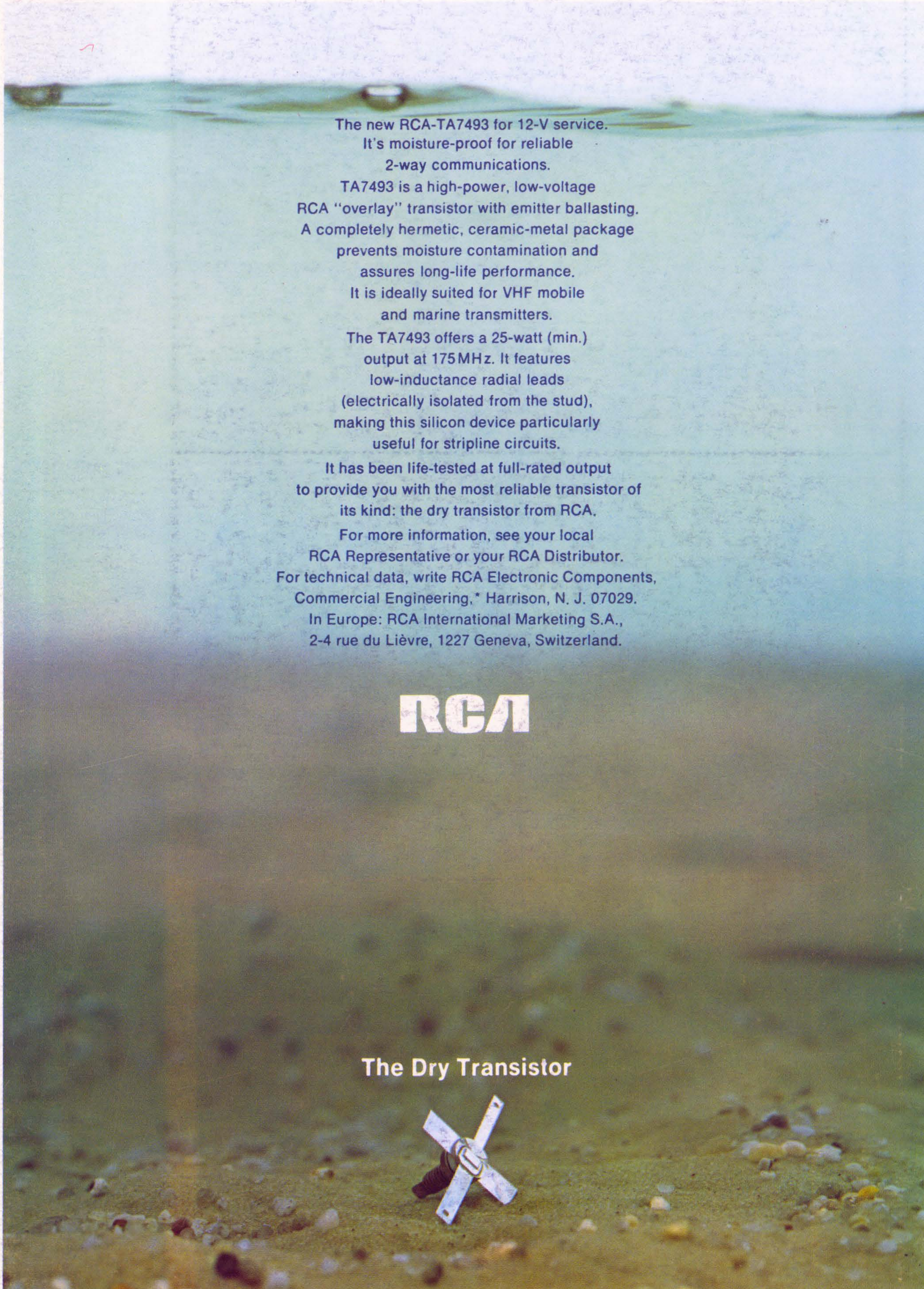

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