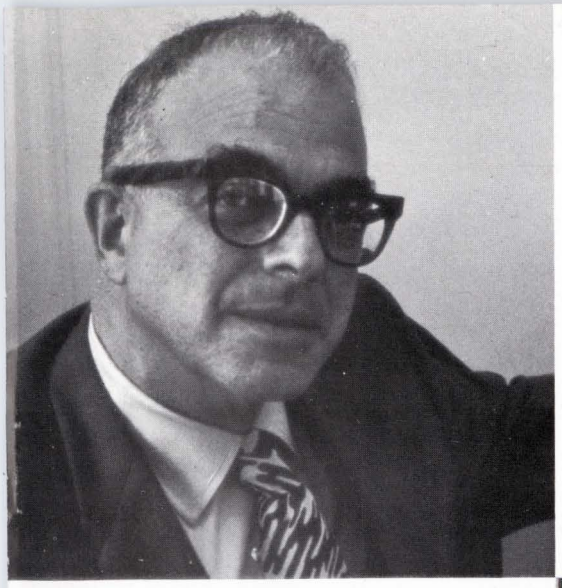

FCC's Strassburg: breaking the communications walls

CHILTON'S

THE ELECTRONIC ENGINEER

VOL. 30 NO. 8
AUGUST 1971

Everything you ever wanted to know about data terminals

Memory course—storages for the future & a final exam

What's a good buy in waveform generators?

Ceilings unlimited for the '70s: Data Communications

Introducing the best DC power supply catalog in the world.

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Mini-modules with regulated single or dual outputs. Save space and improve reliability by mounting them directly on printed circuit boards. $30 up.

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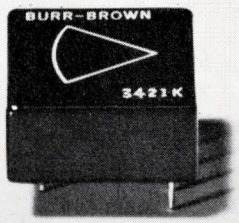
Acopian also offers rack mounting power systems, designed to meet specific multi-output power needs. Shipping time for these fully wired, fully tested systems is only 9 days from your order. $150 up.

For your copy of the world's best power module catalog, write or call Acopian Corp., Easton, Pa. 18042. Phone: (215) 258-5441. The power modules you order from it will be shipped with (you'll happily agree) the world's best tag . . .

Circle Reader Service #1

Look what's new in FET op amps

The lowest drift FET available ±1.0μV/°C, max.



An ultra low Bias Current FET 0.1 pA, max.

from Burr-Brown, of course!

The Low Drift Model 3420 — At ±1μV/°C, this Burr-Brown unit is the industry's lowest drift FET op amp. It also offers low noise (1.5μV, p-p), high gain (106db), high common mode rejection (90db), and a bias current of only 1 pA, max. This combination makes it ideal for use in preamps and as a precision buffer amplifier for low level signals in data acquisition systems, recorders, and measuring instruments.

The Low Bias Model 3421 — With a 0.1pA, bias current rating, the 3421 approaches units incorporating MOSFET or varactor input stages. But, it doesn't have the performance limitations of such devices. A differential unit, it slews at 0.3V/μsec, has high common mode rejection (80db), and high input impedance ($5 \times 10^{13}\Omega$). You'll find it perfect for any application where the input bias current is the primary source of error — such as long-term integrators and memory amps, current-to-voltage converters, and electrometers.

MODEL NO.	3420L	3420J	3421K	3421J
Unity Gain Bandwidth	1 MHz	1 MHz	250kHz	250kHz
Slew Rate, min	1V/μsec	1V/μsec	0.3V/μsec	0.3V/μsec
Input Offset Voltage vs temperature, max.	±1μV/°C	±5μV/°C	±25μV/°C	±50μV/°C
Input Bias Current, max.	—1pA	—10pA	±0.1pA	±0.5pA
Input Impedance, cm	$10^{12}\Omega$	$10^{12}\Omega$	$5 \times 10^{13}\Omega$	$5 \times 10^{13}\Omega$
Price, 1-9	$78.00	$55.00	$59.00	$36.00

Rated Output for all units is ±10V, ±10mA.

FOR COMPLETE INFORMATION on these two new FET op amps, use this publication's reader service card or contact your Burr-Brown Representative.

NEW BURR-BROWN BOOK "Operational Amplifiers — Design and Applications", over 500 pages, 300 illustrations. Written by Burr-Brown application-engineering staff, published by McGraw-Hill. U.S. price, 15.00 dollars. **Order from Burr-Brown, today.**

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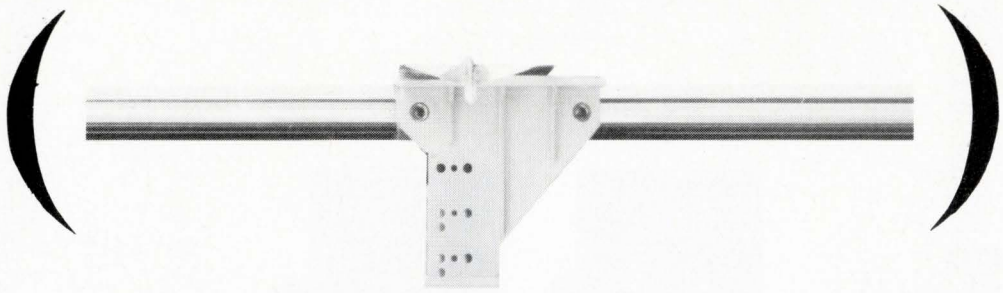
Circle Reader Service #2

A very uncomplicated new OEM recorder with just one thing going for it...



You'll like what you see in our new approach to dedicated OEM strip chart recorders. First, we eliminated all those complicated moving parts from the writing mechanisms. No more pulleys, cables and slip clutches. Instead, there's just one simple moving part—the slider/pen assembly. That's because a linear servo motor keeps the pen going magnetically ... and very reliably.

When you see the HP Model 7123, you'll notice how the low power servo system makes the recorder smooth, precise and trouble-free. You could drive it off scale around the clock without noise or danger.

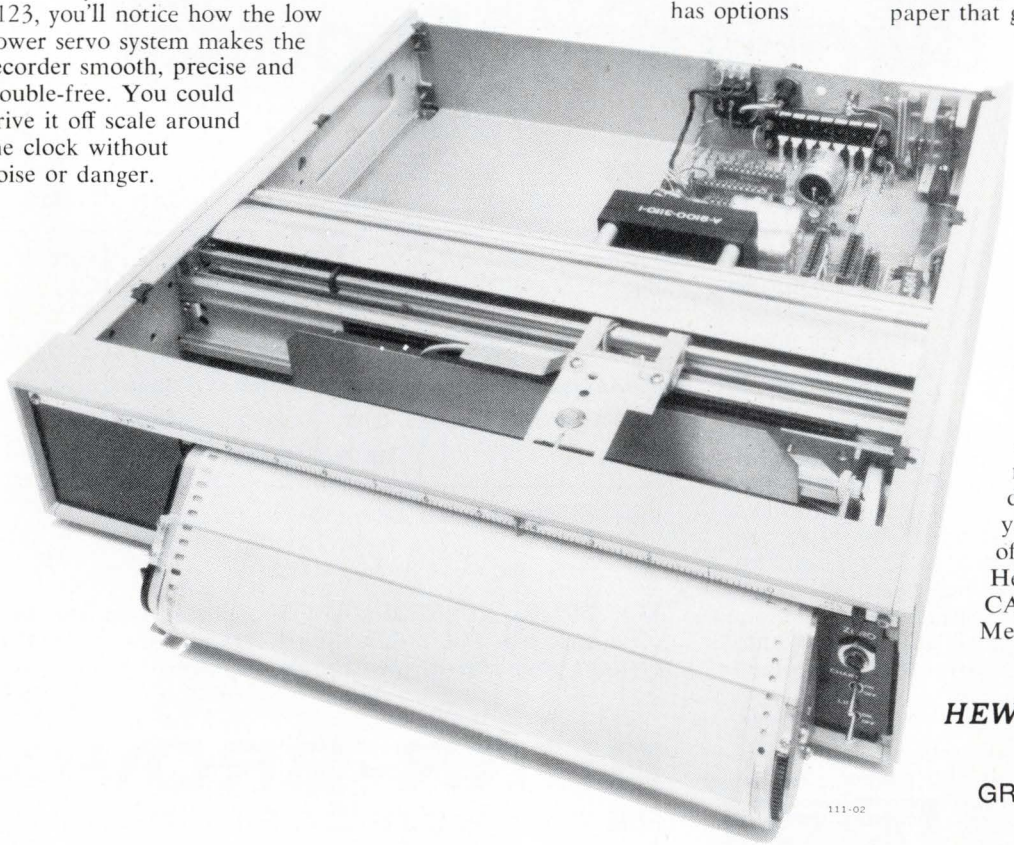
Even with all that, you've got a lot more going for you with the 7123. Like a swing-out chart paper drive for quick reloading and reinking. The viewing/writing area is slanted so you can make notes right at the disposable pen tip. And you can work without worrying about a lot of circuit adjustments. They're simply not needed anymore.

Since it's an OEM machine from the ground up, the 7123 has options for everybody. Select any chart speed and voltage span in English or Metric scaling. In all, nearly 50 options will customize the recorder exactly to a specific application.

You'll probably be most intrigued by an option we call electric writing. Normally, the ink system works like a cartridge fountain pen. But electric writing is designed for people who don't even want to mess around with that. A highly stable electrosensitive paper that gives you a crisp, clear trace without ink.

Available in full rack or half rack versions, the 3½ inch high 7123 makes totally unattended operation a reality. Simplicity, reliability, precision and even electric writing. With all that going for you, you can turn it on Friday and forget about your work all weekend.

To see the uncomplicated new 7123 and its matching price and OEM discount schedule, call your nearest HP sales office. Or write, Hewlett-Packard, Palo Alto, CA 94304; Europe: 1217 Meyrin-Geneva, Switzerland.



HEWLETT hp PACKARD

GRAPHIC RECORDERS

THE ELECTRONIC ENGINEER

August 1971 Vol. 30 No. 8

Cover: top left. Having unanimously opted for the technically qualified and financially able special common carrier in their recent decision, the FCC Commissioners confirmed the trend towards competition, and away from monopoly, as a regulatory device. For the full implications of this decision on our industry, read "Regulation reoriented," by Bernard Strassburg, Common Carrier Chief of the FCC, on p. DC-3.
Bottom right. This photo of a TD-2 tower being raised symbolizes the growth of one of the most exciting fields of the 70's—data communications. Recognizing this, **The Electronic Engineer** introduces in this issue a new section—Data Communications—devoted exclusively to the engineers, the designs, the equipments, and the systems of this dramatically growing technology. (Photo courtesy of Western Electric)
Data Communications cover: Photos courtesy of Martin-Marietta Corp., Orlando Div.; Bell Telephone Labs.; and ITT, ITT Data Equipment and Systems Div.

THE ELECTRONIC ENGINEER

August 1971
Vol. 30 No. 8

Executive and Editorial Offices:
One Decker Square, Bala-Cynwyd, Pa. 19004
Tel. (215) SH 8-2000

Address Mail to:
56th & Chestnut Sts., Philadelphia, Pa. 19139

Western Offices:
Stephen A. Thompson
3727 W. 6th St., #202, Los Angeles, Calif. 90005
Tel. (213) DU 7-1271

Sheldon Z. Edelman
199 First St. Rm. 335, Los Altos, Calif. 94022
Tel. (415) 941-6655

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Monthly publication of Chilton Company, Chestnut & 56th Sts., Phila., Pa. 19139. (Area Code 215) SHerwood 8-2000. Controlled circulation postage paid at Philadelphia, Pa. $1 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $12.00; 2 yrs. $20.00. Canada 1 year $14.00; 2 yrs. $25.00. All other countries 1 yr. $20.00; 2 yrs. $35.00. © Chilton Company 1971. Title Reg. U.S. Patent Office. Reproduction or reprinting prohibited except by written authorization. Microfilm reproductions of **The Electronic Engineer** and its predecessors, **Electronic Industries** and **Tele-Tech,** may be obtained from University Microfilms, 313 N. First St., Ann Arbor, Mich.

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You get 25 ranges. We only get $595.

Go ahead. Try to compare the new Weston 1242 with the other good multimeters. They usually cost $700 or more with options that add still more cost.

The 1242 is $595 complete, including a 100-mV range for AC and DC, and a full 100% over-range (±1.9999 display).

The full-scale response speed of ½ second with input filtering is better than bench-meter performance. But the Weston 1242 measures just 3″ x 7″ x 7.9″ and weighs less than 4 lbs.

What else do you get for $595? Externally-replaceable fuses. Gold-on-gold contacts. Weston excellence in every detail. (Portable battery pack and leather case are optional.)

If you'd like the additional usefulness of a fully-isolated BCD output compatible with T²L logic, get the new Weston 1243. It's only $100 more than the 1242. Order from Weston distributors, or direct from us. Weston Instruments, Inc., Newark, New Jersey 07114.

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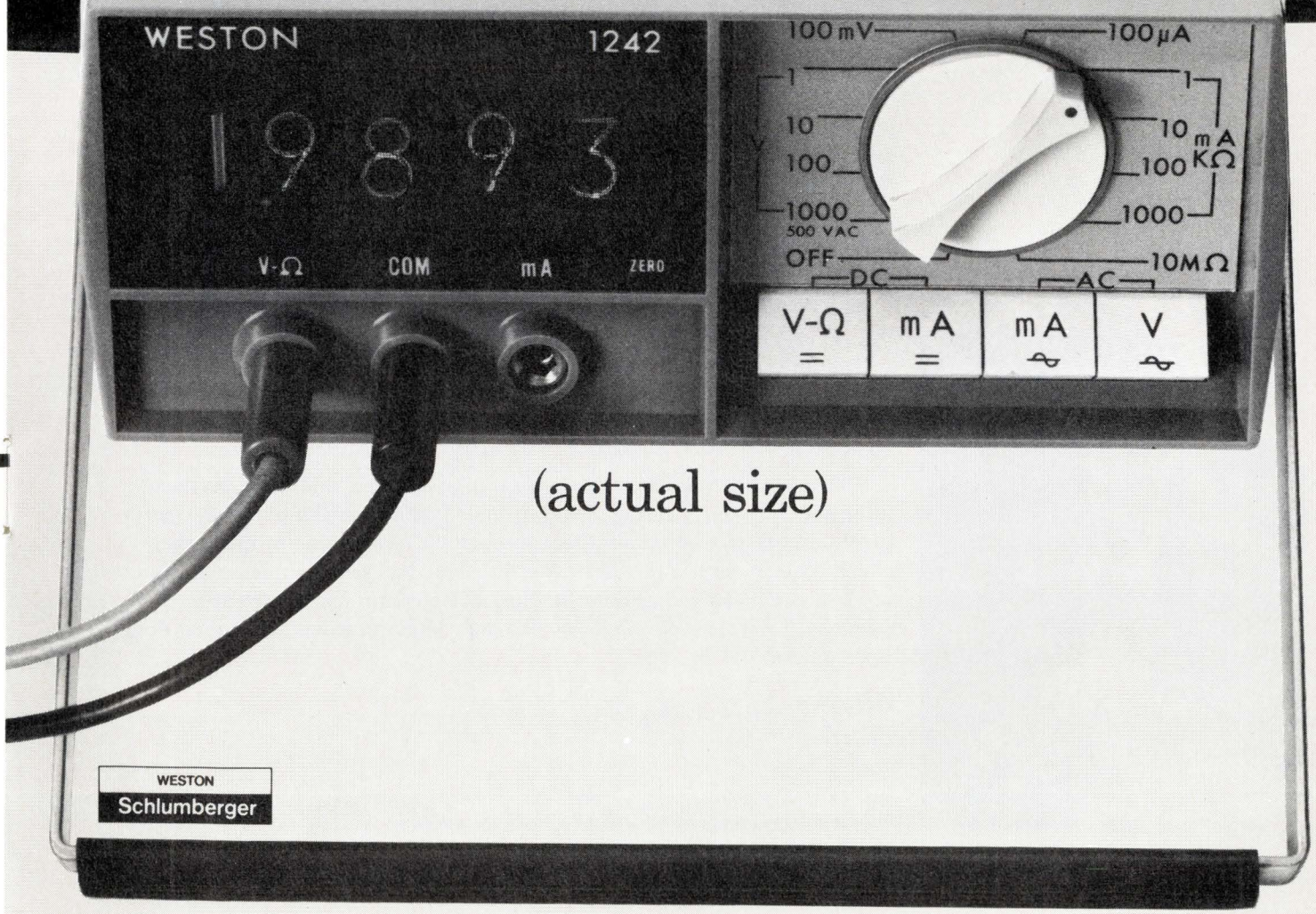

(actual size)

WESTON
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Circle Reader Service #5

Let's not kill a good thing

This magazine endorses the Federal Communications Commission's recent decision to allow competition by new common carriers in specialized communications as both far-sighted and responsible. Far-sighted, because it is based on the agency's conviction that the market for data communications is big enough to allow competition, and that such competition would be in the public interest. And responsible, because the FCC certainly didn't take the easy way out with its decision. It would have been much easier to simply let the present carriers, the Bell System and Western Union, extend their monopoly from the field of voice communications to that of data communications, since they were already transmitting data.

It was, as Mr. Bernard Strassburg, head of the FCC's Common Carrier Bureau puts it*, "one of the finer hours" for both Government regulation and the communications industry. We agree, and we are impressed with the FCC's celerity. It followed up its decision with action, by inviting comments on the technical and economic feasibility of local distribution, of frequency allocations for data transmission, and on transmission equipment. The Commission may even consider a "developmental" authorization to use single-sideband at 2 GHz for data transmission.

In our view, this is the kind of action that it takes for Government to insure that a fine hour doesn't end after 60 minutes, but instead heralds a fine era. But that applies to industry, too. American manufacturers of communications equipment should not simply watch this fine hour tick away. Manufacturers of data transmission and of data processing equipment have a responsibility to follow up with economical equipment for the data transmission networks and the data communications systems of the seventies. If they won't, there are plenty of manufacturers abroad who will.

In Japan, for example, Nippon Telephone & Telegraph (NTT), the telephone monopoly, has recently started a Public Data Communications Project for data users (it didn't allow any data transmission over its switched telephone network until Aug. 1970). For this project, it has specified that *"all the equipment . . . including software, . . . will be produced by Japanese manufacturers under NT&T specs."*

Will American manufacturers need the same kind of protection to compete in the American market for data communications? We hope they won't but, if they should need this kind of protection to insure the development of data transmission and terminal equipment in the United States, then such protection would be preferable, at least temporarily, to importing all the equipment.

This magazine will cooperate by providing technical and other pertinent information for engineering managers and systems and equipment designers involved in Data Communications, through the new section of that name which we introduce in this issue. We will study the issues, express our points of view, commend and criticize, and provide a forum for constructive opinions. The recent developments in data communications are a good thing. Let's not kill it.

Alberto Socolovsky
Editor

*Mr. Strassburg comments on the FCC decision in the guest editorial he wrote for this issue, inaugurating the Data Communications section of this magazine.

741's don't work

. . . in critical situations. They're fine in ordinary applications. But, when specs get critical, save your design with one of our new "optimized 741's" — the successor to the good old 741.

When you need more gain or less drift, or more slew rate or less bias current error, or less power consumption (say, for battery operation), or more speed, why change or imperil your design?

The simplest, sure-fire solution is to select the "optimized 741" with the precise specifications your circuit demands — all with Philbrick's built-in reliability. Pin-for-pin compatibility makes the change-over easy. Models available in most popular package configurations.

What's more, if you want to produce something new or improve upon an existing design, without expensive circuit redesign — just plug in an "optimized 741." They're not ordinary or modified 741's.

They're different by design.

Philbrick takes over where others leave off. Right now we have seven models of microcircuit modules ready to ship — with premium versions also available.

Send for our data packet today. Or, contact your Philbrick sales representative. Teledyne Philbrick, Allied Drive at Route 128, Dedham, Massachusetts 02026. TEL. (617) 329-1600. TWX (710) 348-6726. TELEX: 92-4438. CABLE: TELEPHIL.

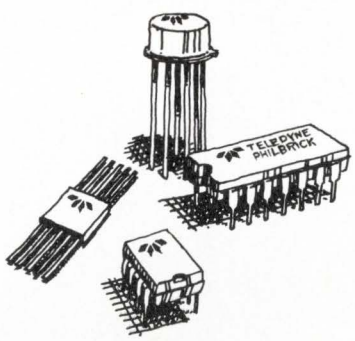
MODEL 1321 HIGH INPUT IMPEDANCE -- 100 MHz GAIN BANDWIDTH, 300 MΩ Z Diff 35 V/μ sec SLEW RATE IN 100's - $12.50

MODEL 1420 FET 741-TYPE -- $10^{11}\Omega \| 3pF$ DIFFERENTIAL INPUT IMPEDANCE, -15 pA TYPICAL I_B IN 100's - $15.75

MODEL 1322 HIGH SLEW, WIDEBAND -- 20 MHz GAIN BANDWIDTH, 120 V/μ sec SLEW RATE IN 100's - $16.50

MODEL 1323 LOW POWER, GENERAL PURPOSE -- 2,000,000 OPEN LOOP GAIN, ±80 μA QUIESCENT CURRENT, ±5.5V TO ±20 V POWER SUPPLY RANGE IN 100's - $12.50

MODEL 1339 34 V/μ sec SLEW RATE, GUARANTEED 60nA MAX OFFSET CURRENT, GUARANTEED LATCH-UP PROOF PERFORMANCE IN 100's - $3.35



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TELEDYNE PHILBRICK
MICROCIRCUITS

The first PROM to offer an extra *bit*...

...for greater reliability!

Introducing the MCM5003A, the industry's first field-programmable ROM with a built-in reliability factor. Basically a 512 bit bipolar device organized as 64 eight-bit words, the MCM5003A offers "instant customizing" by merely "blowing" nichrome resistors and thus breaking metalization links. The blown links change the initial logic "0" state to a logic "1" state to meet specific program requirements.

A *bit* more for reliability

Since unprogrammed ROM's have all outputs low regardless of address, testing does not detect many faults in amplifier inverters, address decoders, memory array and sense amplifiers. Special consideration is required in the areas of Program Element Testing, Functional Testing and AC Testing. To solve these problems, Motorola expanded the memory from a 64 word, 8 bit memory to a 64 word, 9 bit memory with the 9th bit dedicated to testing.

By blowing some of the 9th bits, we can assure that the links can be blown without using up any of the normal 64 x 8 bit array. With some of the links blown, functional and AC performance testing is now possible. This is important in that all of the 64 x 8 bit array elements are in a logic "0" state regardless of the address selected, and no way would be available to determine whether the functions are correctly operating without the 9th testing bit.

The MCM5003A circuit contains six address inputs to select the proper word and two chip enable inputs, as well as outputs for each of the eight bits. Supplied in a hermetic 24-pin dual in-line ceramic package, the MCM5003A has positive enable with open collector outputs. Another version, the MCM5004A, has positive enable with 2.0 kilohm pullup resistors on the collector outputs. Both devices are MDTL/MTTL compatible and access times are less than 75 ns.

By stocking the MCM5003A you can work up custom microprograms, lookup tables, code and number conversions without the worry of turnaround time and costly mask charges. And speaking of costs, either the MCM5003A or 5004A is available for $45.00 (100-up price) — less than 9¢/bit. Programming can be accomplished at your facility, through your distributor, or here at Motorola.

Take advantage of the MCM-5003A's "instant customizing" by calling your local Motorola distributor for evaluation devices today. Or write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Arizona 85036. We'll send complete specifications plus our latest application note describing several programmers that can be built specifically for programming the MCM5003A/5004A.

It'll pay to evaluate the MCM5003A . . .

A Memory To Remember For Reliability

Motorola can now supply memories to meet your specific requirement, whether it be high-speed, low power, or custom products. In traditional Motorola fashion we can draw from the technologies of MOS (Ion-Implanted, Silicon Gate CMOS, N-Channel) or advanced bipolar techniques — each technology offering specific advantages to meet your application.

MEMORIES TO REMEMBER

RAMs				
DEVICE	**FUNCTION**	**TECHNOLOGY**	**ORGANIZATION**	**ACCESS TIME**
MC1680/81	4 Bit RAM	ECL - BiPolar	2 x 2	< 4 ns
MC1682/83	4 Bit RAM	ECL - BiPolar	2 x 2	< 4 ns
MC1684/85	4 Bit CARAM	ECL - BiPolar	2 x 2	< 4 ns
MC1036/37	16 Bit RAM	ECL - BiPolar	4 x 4	< 50 ns
MC4004/5	16 Bit RAM	TTL - BiPolar	16 x 1	< 25 ns
MCM4064	64 Bit RAM	TTL - BiPolar	16 x 4	< 60 ns
MCM1170	64 Bit Static RAM	Metal Gate P-MOS	16 x 4	500 ns
MCM14505	64 Bit Static RAM	Metal Gate CMOS	64 x 1	200 ns (typ.)
MCM1173/72	1024 Bit Dynamic RAM	Metal Gate P-MOS	1024 x 1	400 ns
ROMs				
MCM4001 (XC170/171)	128 Bit ROM	TTL - BiPolar	16 x 8	< 45 ns
MCM4002	256 Bit ROM	TTL - BiPolar	32 x 8	< 50 ns
MCM4004	1024 Bit ROM	TTL - BiPolar	256 x 4	< 60 ns
MCM4006	1024 Bit ROM	TTL - BiPolar	256 x 4	< 50 ns
MCM5003A/4A	512 Bit PROM	TTL - BiPolar	64 x 8	< 75 ns
MCM1130	2240 Bit Static ROM	Metal Gate P-MOS	Open Option	500 ns
MCM1131/32	2240 Bit Char. Gen.	Metal Gate P-MOS	Col. Sel. 64 x 35 (5 x 7)	500 ns

MEMORIES TO COME

RAMs				
DEVICE	**FUNCTION**	**TECHNOLOGY**	**ORGANIZATION**	**ACCESS TIME**
MC10140	64 Bit RAM	ECL - BiPolar	64 x 1	< 15 ns
MCM4256/7	256 Bit RAM	TTL - BiPolar	256 x 1 / 128 x 2	< 60 ns
MCM2372	1024 Bit RAM (1103 Equiv.)	Si-Gate P-MOS	1024 x 1	300 ns
MCM2374	1024 Bit RAM (1103-1 Equiv.)	Si-Gate P-MOS	1024 x 1	180 ns
MCM2377	2048 Bit RAM	Si-Gate P-MOS	2048 x 1	360 ns
ROMs				
MCM4003	512 Bit ROM	TTL - BiPolar	64 x 8	< 75 ns
MCM4005	1024 Bit ROM	TTL - BiPolar	1024 x 1	< 50 ns
MCM4007	1024 Bit ROM	TTL - BiPolar	512 x 2	< 50 ns
MC10139	256 Bit PROM	ECL - BiPolar	32 x 8	< 17 ns
MCM5005	1024 Bit PROM	TTL - BiPolar	256 x 4	< 60 ns
MCM1110	2048 Bit ROM	Metal Gate P-MOS	256 x 8	600 ns
MCM1120	2240 Bit ROM	Metal Gate P-MOS	64 x 7 x 5	700 ns
MCM1140	4096 Bit ROM	Metal Gate P-MOS	512 x 8	700 ns
MCM1150	2560 Bit ROM	Metal Gate P-MOS	256 x 10	600 ns

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MOTOROLA MEMORIES
. . . IC Systems for the 70's!

UP-TO-DATE

Light memories

In case you haven't noticed, a tremendous number of research dollars are being poured into laser type memories. And the companies doing the work are "for real."

Ultimately, laser/optical memories hold great promise as high capacity, low cost-per-bit memories. Many different ideas and "twists" are being experimented with in order to develop a good working system. Here are three systems just announced.

Sound modulated

RCA will build a novel computer memory for NASA. The experimental six-ft. long, telescope-shaped device will be a full-cycle, all-optical memory that will allow a million bits of data to be written, stored, read out repeatedly, or erased by laser.

A pulsed ruby laser beam first passes through two electroacoustic crystals which deflect the beam (one from left to right, one up or down) in proportion to the frequency of sound waves that pass through them. As a result, the beam can be aimed at 1024 different positions. Next, the deflected beam strikes one of 1024 holograms in a flat array called a "hololens," which splits the beam into two parts. One goes straight through, while the other is bent (diffracted) to fall on a flat plane (3 in. square) consisting of 1024 liquid crystal cells.

These cells introduce digital information into the laser beam in the form of tiny areas that are dark where the liquid crystal cell is reflective, or light where it is transparent. These correspond to binary "1's" and "0's."

The coded, or modulated, laser beam is then directed to one of the 1024 positions available on a manganese-bismuth film where it recombines with the first, or straight-through, part of the beam. At the selected position this forms a magnetic hologram. Thus, the information represented by the liquid crystal is holographically stored.

To read the information, another laser beam strikes the hologram to be read on the manganese-bismuth film without touching the liquid crystal array. The beam reconstructs the image of light and dark areas stored in the hologram and projects it onto an array of light-sensitive elements that displays the data.

Erasure is similar to writing except that neither beam is modulated or coded by the liquid crystal array.

Special optical plate

The central research laboratory of Hitachi Ltd., Tokyo, has developed a high-density holographic memory system. It can store 20,000 bits of digital information, equivalent to 2,500 characters, in a circle 0.5 mm in diameter. Just imagine, for instance, all of the information in one volume of the Encyclopedia Britannica being crammed into the area of two postage stamps!

Storage density is 100,000 bits per square millimeter with a special optical plate. The plate, called a "Random Phase Shifter," disperses and evenly diffuses the data-carrying laser beams as they pass through. It's made of a multilayered thin film of cerium oxide evaporated on a glass substrate through several kinds of random patterned screens.

Since the stored information is read by shining a laser beam on the holographic memory, the time factor has been reduced to 1μs. This is 10,000 to 100,000 times faster than a disc memory system.

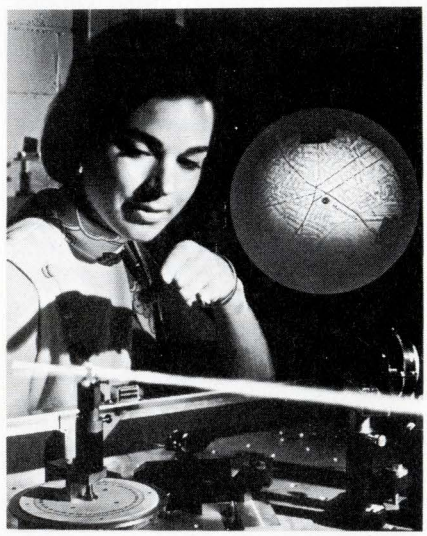
Sensitive crystal

RCA Laboratories has developed a crystal that stores holographic images as atomic patterns. The patterns can be read out one-by-one by slow rotation in a laser beam, like photographic slides in a projector. Although holograms have been recorded in crystals before, it required a very powerful laser to do the job, and often the hologram would be erased during the read-out process.

The new crystals are 500 times more sensitive than any others, and the stored holograms can be "fixed" permanently. With a relatively low power laser you can write data in, store it for as long as you want, or erase it when you no longer need it. Theoretically, a trillion bits of information can be stored in a cubic centimeter of crystal.

Crystal or volume holograms are made in a way similar to the conventional holograms recorded on photographic film. The conventional method, however, has two serious limitations: the sensitivity of the materials to the laser light is too low for read-write types of applications; the read-out laser beam frees the electrons once again and the stored holographic pattern erodes quickly. The new RCA development efficiently solves these problems.

For more information about laser type memories, see our Memories Course on page 33.



A new RCA crystal unit stores several hologram images as atomic patterns that can be read out, one-by-one, with a laser beam. As the laser beam traverses the crystal, lower left, part of it is diffracted (bent) to fall on the round mirror, center, where it reconstructs a map stored in the crystal. This may lead to a document storage system in which files of statistics, drawings, computer data, photographs, maps and other graphic materials are stored permanently in crystals in the size of sugar cubes.

No sooner did we bring out the broadest and best line of multipliers in the industry than we dared to publish a comprehensive guide for the curious. Step by step explanations of theory and operation, ten how-to examples with actual circuit diagrams, and a selection guide for the highly motivated. But not one word of hard sell. The hard sell is here, in this ad. We offer the highest performance multipliers in the business (slewing rates to 120v/usec. accuracies to 0.1% full scale, offset drifts to 0.2mv/°C) as well as the widest selection, including an economy model for only $39 and the first monolithic—for even less. Don't be modest. Be a multiplier authority. Ask for your free copy of "Evaluating, Selecting, & Using Multiplier Circuit Modules for Signal Manipulation & Function Generation." Mailed in a plain brown wrapper, if desired. Analog Devices, Inc., Norwood, Mass. 02062. (617) 329-4700.

ANALOG DEVICES

Everything you've wanted to know about multipliers but were afraid to ask.

UP-TO-DATE

Expansion into industrial electronics . . . Philco-Ford has set up a new division combining industrial learning and electronics functions as part of Philco's Consumer Products and Industrial Electronics operation. Aptly named the Industrial Learning and Electronics Operation, the new division will be comprised of the Education Operations at Fort Washington, Pa., and the Sierra Electronic Operation in Menlo Park, Calif.

Computers help with exhaust emission . . . Two Honeywell data-acquisition and control computer systems will be installed in Ford Motor Co.'s Los Angeles assembly plant. The systems will perform end-of-line tests to meet California's standards for the control of exhaust emission. During the testing, the computer will handle 85 analog and 60 digital inputs, 30 analog and 250 digital outputs, and will run unattended for up to two 10-hour shifts per day.

Pay as you go . . . Bill S. 1255, submitted by the Patent Office, proposes fees to cover the costs of Patent Office services. The fees would cover 100% of the "direct and immediate costs of examining patent and trademark applications and providing other services to special beneficiaries." The income from Patent Office fees has fallen to about 50% of the cost of operating the office.

Car 54, where are you? . . . Sylvania has developed a vehicle location system that allows the driver to report his location status in less than 1 second. The driver makes his report by touching a pressure-sensitive map, called digimap,™ located within the vehicle. The system operates with existing GTE Sylvania communications equipment by sending the information in quick tone bursts. Through a base computer at headquarters, the dispatcher can see the vehicle's status and location on a master map.

Logic control arrays . . . LSI Computer Systems Inc. has successfully completed the development of four MOS/LSI random logic control arrays, operating at 4 MHz clock rates. The complex arrays, each containing 1500 MOS transistors and having the logic power of 500 TTL gates, were processed with standard high threshold, p-channel MOS. These will be used in a miniaturized computer yet to be announced by Control Data Corp. The computer is said to have the complexity of a DEC PDP-8.

Circle Reader Service #220

Wanta' buy a computer? . . . The $10 billion worth of computers installed and in operation in the United States today would have a resale value of over $5 billion in the used computer market at current market prices. "Sales in 1970 were $50 million, only 1% of the potential volume," according to Frost & Sullivan Inc. For those involved with data-processing equipment, they are offering a study titled "All about used computers."

MOS prices going down . . . The days of the one-cent-a-bit MOS RAMS in quantity are gone. Today, eight manufacturers are quoting 1024-bit packaged units at ½ to 1¢ bit in large quantities (50-100,000 units).

More public radio . . . The Electronic Industries Association has petitioned the FCC for a new Class "E" Personal Radio Service. The EIA contends that personal communication needs have become critical and that additional spectrum is essential at high frequencies where long-range skip communication and high noise levels would be eliminated. The petition calls for a segment of 80 channels between 220 and 222 MHz, fm mode, with 25 kHz spacing and a maximum 25-W output.

In the market for used test equipment? . . . The TEKscope, Tektronix's monthly magazine, publishes a list of instruments whose owners want to swap or sell. We spotted a 453, the 50-MHz dual-trace portable, for $1850.

How healthy am I? . . . Missouri University cardiologist Dr. Russell Sandburg, is analyzing the heartbeats and respiration of Missourians by telephone. Linked to an XDS Sigma 3 computer, each of 16 town clinics uses an "ECG acquisition cart" with an electrocardiograph, a signal recorder, and a phone hookup to feed data into the computer. Within 15 minutes the computer will speed a report back over the telephone lines to a typewriter at the clinic. Each report is then reviewed by an electrocardiographer for a final diagnosis.

A $25,000 sundial? . . . A $25,000 developmental clock is Motorola's showpiece for their electro-optical capability. All components, from crystal oscillators, to ICS, to light-emitting displays, are manufactured at Motorola. It has no moving parts and uses 72 LEDS to display time.

Bits of information . . . **Zenith Radio Corp.** has developed a new high-resolution laser deflector. The head uses glass instead of exotic crystals as the basic interaction medium . . . IBM has shipped the System/370 Model 145 a month ahead of their announced schedule. This is IBM's first com-

Whittaker Corp. has an ion-deposition process to produce diamond-like coatings. One possible application is videotape recorder heads to gain exceptional wear resistance . . . **Harris-Intertype Corp.** and **Erie Technological Products** are discussing the possible merger of Erie into Harris.

GTE Sylvania now has a color CRT featuring a deflection angle of 110° . . . **North American Rockwell Corp.** and **Collins Radio Co.** announced that the boards of directors of both companies have approved the terms of a proposed investment by NAR in Collins.

A $50 million contract to build an 1840-channel transatlantic telephone cable link between Canada and Great Britain was received by a British subsidiary of ITT . . . To encourage **greater student membership.** the Association for Computing Machinery has reduced its student membership fee from $12.50 to $8.00.

Hughes Aircraft Co., has successfully completed research tests on a radar system that simultaneously tracks close flying multiple targets . . . **IBM** has developed an electric arc method for stripping insulation from a wire as small as one mil.

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A simple case of putting 12 years of thyristor know-how in a simple case.

It's Elementary.
We offer plastic SCRs at competitive prices for those who don't require the optimum environmental protection of our hermetically sealed metal packages. In either case, there's the same Unitrode high quality inside. The kind you expect from a company that makes thyristors a major part of its effort . . . not just a sideline. Our expanding line of SCRs offers a wide range of choices for easy interchangeability in literally hundreds of applications, including lamp and relay driving, or as sensors in pulse generators, tuning circuits, motor controls and process controllers. We can build an even more convincing case for these IP100-IP104 series industrial SCRs when you request complete specs, pricing and samples.
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Unitrode Corporation, 580 Pleasant St.,
Watertown, Mass. 02172

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Unitrode Corporation, Inquiry Processing Dept. 8D,
37 Newbury St., Boston, Mass. 02116

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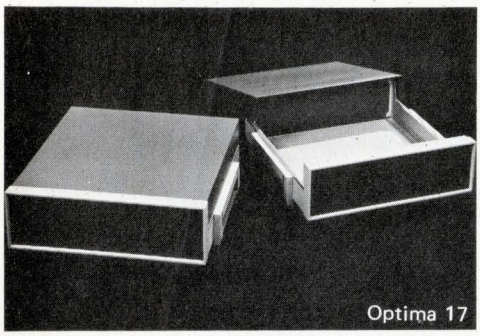
COMPANY_____

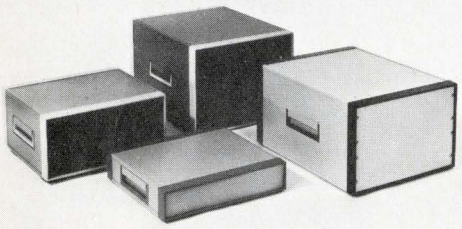
ADDRESS_____

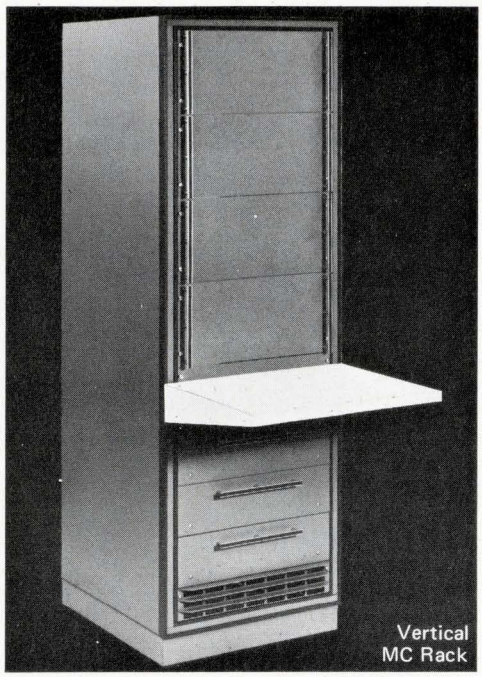
CITY_____ STATE_____ ZIP_____

Circle Reader Service #9



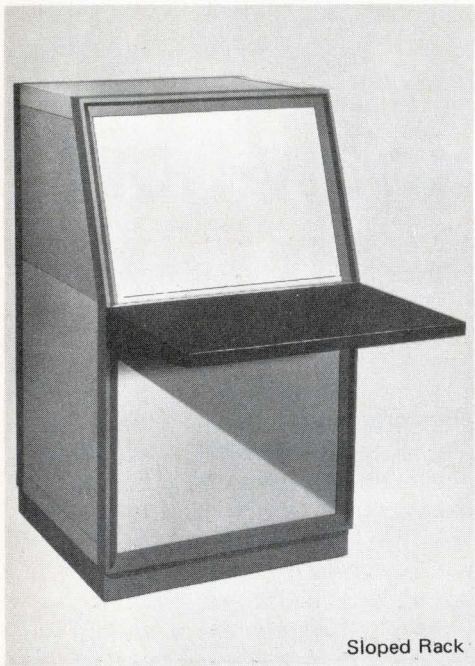
Instrument Cases



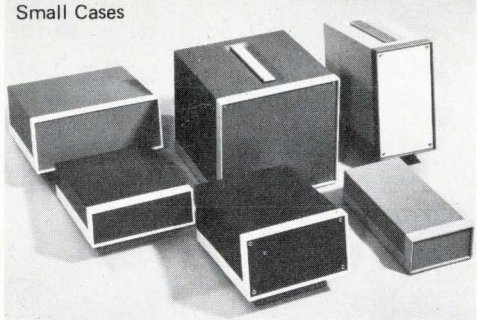


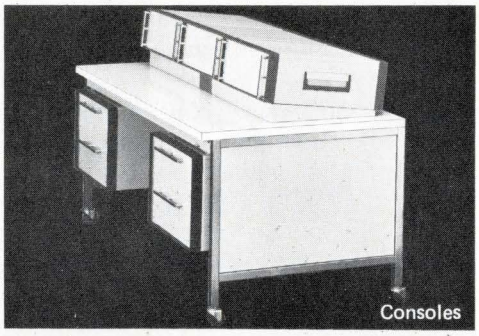
Optima standard enclosures

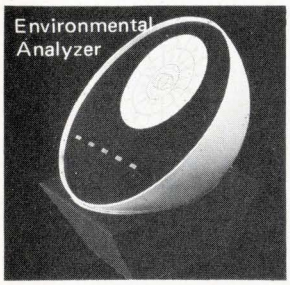
We have over 14,000 standard enclosures at Optima. And we have a wider selection of finishes and color combinations than anybody in the industry. So, in effect, you can have an almost completely customized appearance at standard prices. There's a pretty good reason for all of this – Optima grew from the environment of the electronics industry. It was created specifically to design and manufacture enclosures for the instruments made by its parent company, Scientific-Atlanta. Our enclosures proved such unique, innovative solutions to our packaging problems that we offered them to the industry. Acceptance has been spectacular: we believe it's because there are no afterthoughts at Optima - because every feature of every enclosure meets a need and solves a problem. In fact, we've received awards for design excellence. These pictures show some of the reasons why . .☐Optima 17 - an elegant total package consisting of chassis and case in one compact, lightweight unit. ☐ The classic Optima Instrument Cases - 72 basic sizes for both 19" and 24" panel mounted instruments. ☐ Small Cases, the rackable little boxes in 25 shapes and sizes that offer amazing flexibility. ☐ Three basic styles of racks. They are handsome, lightweight and look better, last longer, and do more than anyone else's - because we don't cut corners on quality. ☐ Optima Consoles, a unique concept of "executive-look" instrument housing combining flexibility, generous counter & storage space, fine workmanship, and a high degree of human engineering.

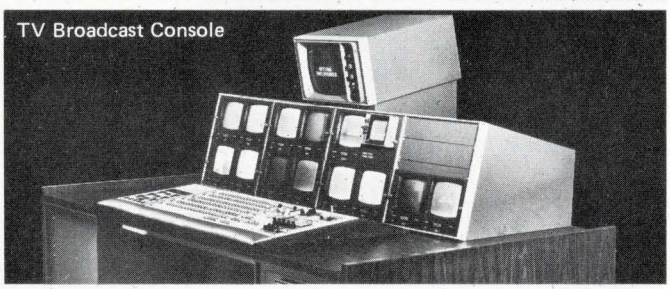


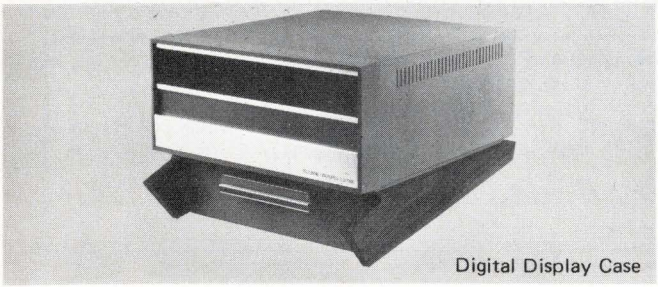
Small Cases

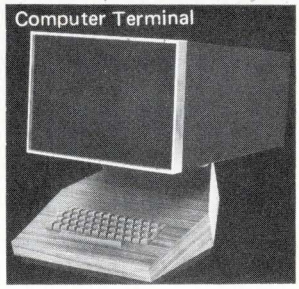












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Family portrait.

Take a good look at one of America's first families—the Mallory family of aluminum electrolytic capacitors. And you'll see quality, experience and dependability.

THE FP. "Pop" has been around quite awhile and is still going strong. It's got a twist mount, solder lug terminals, —30 to +85°C temperature range, 80 to 60,000 mfd capacitances and voltages from 3 to 475 VDC.

THE TC. "Mom's" got temperature ranges of —40 to +85°C, —30 to +85°C and —20 to +65°C; capacitances of 5 to 3,000 mfd; and voltages from 50 to 500 VDC.

THE TCW has axial leads and all-welded construction. It operates from —40 to +85°C, in capacitances from 2 to 20,000 mfd and voltages from 3 to 450 VDC.

THE TT is a miniature axial lead capacitor with beautiful performance from —40 to +85°C. The TT goes from 1 to 4600 mfd, in voltages from 3 to 150 VDC.

THE MTA has axial leads and all-welded construction—in a good-looking molded plastic case. It operates in a range from —30 to +85°C, with 3 to 4500 mfd capacitances and voltages from 3 to 100 VDC.

THE MTV is the latest addition to our aluminum electrolytic, molded-plastic-case family. It's all-welded, with a single-ended vertical mount. And has an operating range of —30 to +85°C, capacitances from 5 to 1400 mfd and voltages from 3 to 100 VDC.

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WELCOME

Melcor's memories

Data Memories is the name of a new division, formed by Melcor Electronics Corp., which will design and manufacture magnetostrictive delay lines. Applications for these are as memory refreshers in alpanumeric CRT terminals, main memories in desk top calculators, and buffer memories in data communication terminal equipment. The delay lines may also be used to handle video signals in TV broadcast equipment and analog signals in voice communications systems. The new company is located in Farmingdale, Long Island, New York.

Circle Reader Service #370

More specs for your money

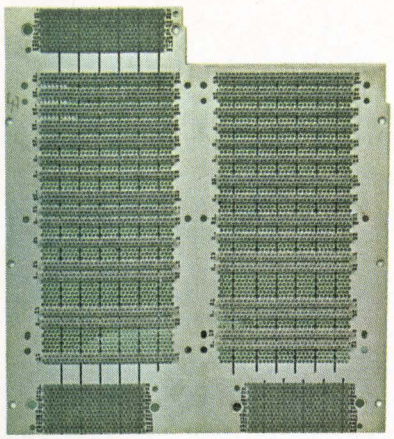
"When I was still at General Electric, I used to see semiconductor companies trying to duck the obligation to provide data on their own devices." That's the problem Joe Johnson, applications engineer at Communications Transistor Corp., claims he'll lick at this new company, an affiliate of Varian Associates. Communications Transistor Corp. tells us that it will design, build, and sell exactly what the company name implies: high frequency semiconductor devices for the communications systems market. The new company is located at 301 Industrial Way, San Carlos, Calif.

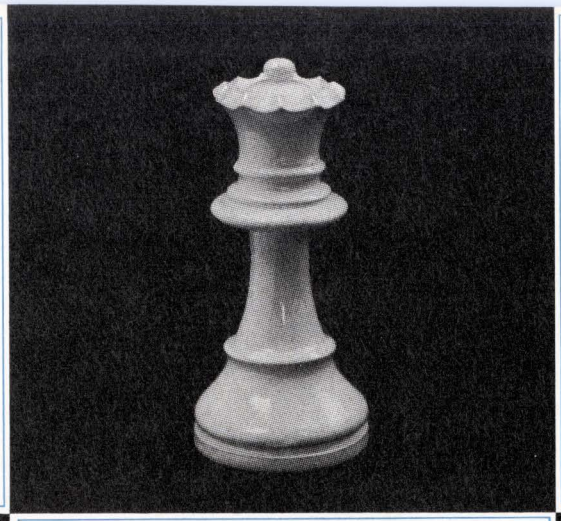
Circle Reader Service #371

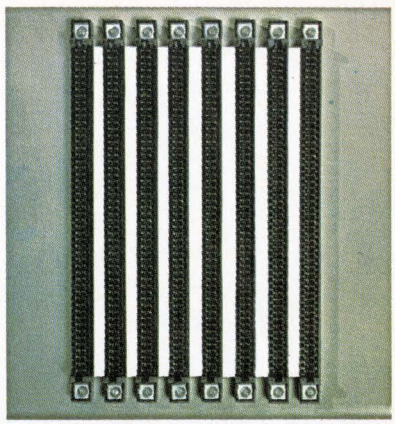
Automatic testing system

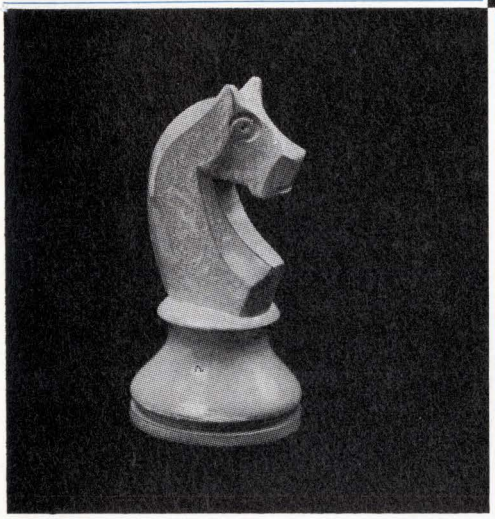
Compu-Systems Co., a new division of Gordon Engineering Co. in Wakefield, Mass., specializes in computer-controlled instrumentation for measuring physical parameters. The new division's first product is the CSC-1000, a computer-controlled logic card and module test-analyzer for digital and analog applications. It does functional testing of digital modules and complete parametric tests, with fault location, of both digital and analog modules. With 64 pins of logic test capability installed, the system sells for $31,300. Another product offered is a precision voltage standard source and comparator, called Compu-Dac, featuring 0.0003% accuracy from −100 to +100 V in 100 s. Included in this package is a plug-to-plug solid-state interface for popular minicomputers. Compu-Dac's prices range from $2,750 to $3,300, depending on options.

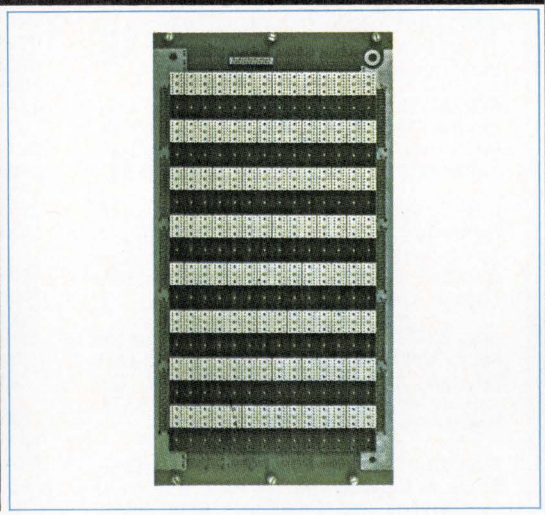
Circle Reader Service #372

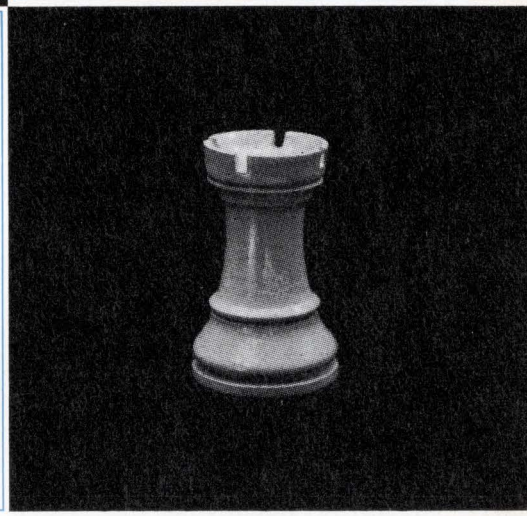








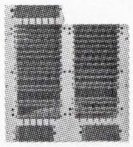




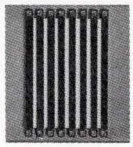
THREE EASY PIECES...

. . . to help you avoid reaching a stalemate in your circuit design. And in these days when components, connectors, circuits, terminations, DIP's, substrates, modules and submodules are becoming more sophisticated . . . and their interrelationships exponentially more complex, you need all the help you can get.

CONNECTRONICS, the Elco Total Connector Capability, is our first move in the strategy of coping with these complexities. And in keeping with the Elco gambit, here are three back panels you can use to checkmate your interconnecting problems.



Variplate™ *metal plate back panel, one of the most widely used interconnection systems. Like the Knight, it's a formidable and valuable piece that should not be underestimated or overlooked when you have a design problem. It's rigid. Provides for voltage and ground planes, and bussing. Accommodates components and connectors in any configuration. And is ideal for automatic wire wrapping.*



Variframe™ *discrete connector mounting system. Personifies the strength and stability of the Rook. It's an economical structural member that provides strength and rigidity for phenolic boards of all sizes. And it is a convenient mounting frame for p.c. board edge connectors and rack and panel connectors.*

Variboard™ *p.c. mother board interconnection system. The Queen. The most flexible and versatile system yet. Lets you move in any direction. You can mount components directly on the board: mount connectors (including our modular Mojo™ connectors) in plated through holes (no wiring needed), or mount connectors in non-plated holes for wiring. Provides for voltage and ground planes. Just pick the shape, size and configuration . . . and mix the methods to satisfy your requirements.*

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CALENDAR

AUGUST						
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Aug. 11-12: DOD/NSIA Schedule Briefing For Industry on "Major Defense Systems Acquisition," Washington, D.C. Addtl. Info.—NSIA, Dept. DS, Suite 700, Union Trust Building, 740—15th Street, N.W., Washington, D.C. 20005.

Aug. 11-13: Joint Automatic Control Conference, Washington Univ., St. Louis, Mo. Addtl. Info.—R. W. Brockett, Pierce Hall, Harvard Univ., Cambridge, Mass. 02138.

Aug. 16-20: Jerusalem Conference on Information Technology (JCIT), Israeli Capital, Israel. Addt. Info.—P.Z. Rosner, Government of Israel, 850 Third Ave., New York, N.Y. 10022.

Aug. 23-28: European Microwave Conference, Royal Inst. of Tech., Stockholm, Sweden. Addtl. Info.—H. Steyskal, European Microwave Conference, Fack 23, 104 50 Stockholm 80, Sweden.

Aug. 24-27: WESCON, Western Electronic Show & Convention, Brooks Hall/Civic Auditorium, San Francisco, Calif. Addtl. Info.—Don Larson, General Manager, 3600 Wilshire Blvd., Los Angeles, Calif. 90010.

Aug. 25-27: Product Liability Prevention Conference, Newark College of Engineering, Newark, N.J. Addtl. Info.—PLP Conference, Box 408, Wayne, N.J. 07470.

SEPTEMBER						
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Sept. 9-10: Fifth Annual Instrumentation Fair, Washington Hilton, Washington, D.C. Addtl. Info.—Norman J. Ward, Executive Director, P.O. Box 475, McLean, Va. 22101.

Sept. 14-16: Electro-Optics '71 East, New York Coliseum, Addtl. Info.—Industrial & Scientific Conference Management, Inc., 222 West Adams St., Chicago, Illinois 60606.

Sept. 20-23: 1971 Electrical Insulation Conference, Chicago's Palmer House Hotel, Chicago, Ill. Addtl. Info.—TechniCom Services, Inc., Box 2429, Wilmington, Del. 19899.

Sept. 22-24: 1971 IEEE Computer Conference, Sheraton-Boston Hotel, Boston, Mass. Addtl. Info.—James Sterling, Publicity Vice Chairman, Raytheon Co., 141 Spring St., Lexington, Mass. 02173.

OCTOBER						
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Oct. 1-7: 1971 Japan Electronics Show, International Trade Fair Grounds, Osaka, Japan. Addtl. Info.—Mamoru Tsukamoto, The Electronic Industries Assn. of Japan, 437 Fifth Ave., New York, N.Y. 10016.

Oct. 4-5: 1971 Joint Engineering Management Conference, International Hotel, Los Angeles, Calif. Addtl. Info.—L. D. Chipman, c/o Western Elec. Corp., 218 Lynn Lane, Westfield, N.J. 07090.

Oct. 4-7: 26th Annual International Conference and Exhibit, McCormick Place, Chicago. Addtl. Info.—Philip N. Meade, Exhibit Director, Instrument Society of America, 400 Stanwix St., Pittsburgh, Pa. 15222.

Oct. 6-8: 1971 IEEE Electronic and Aerospace Systems Convention (EASCON), Marriott Twin Bridges Motor Hotel, Washington, D.C. Addtl. Info.—Matthew B. Thorp, Bell Aerospace Co., 1000 Connecticut Ave., N.W., Washington, D.C. 20036.

Oct. 11-13: International Symposium on Hybrid Microelectronics, Pick-Congress Hotel, Chicago, Ill. Addtl. Info.—R. P. Anjard, Symposium Publicity Chairman, Int'l Society for Hybrid Microelectronics, Suite 102, 1410 Higgins Rd., Park Ridge, Ill. 60068.

Oct. 18-20: Consumer Electronics Symposium, McCormick Place, Pick-Congress Hotel, Chicago, Ill. Addtl. Info.—Wayne Luplow, Zenith Radio Corp., 1851 Arthur Ave., Elk Grove Village, Ill. 60007.

Oct. 20-21: Fourth Annual Connector Symposium, Cherry Hill Inn, Cherry Hill, N.J. Addtl. Infor.—Wm. M. Rees, Jr., P.O. Box 3104, Philadelphia, Pa. 19150.

Oct. 25-29: 1971 Joint National Conference on Major Systems, Disneyland Hotel, Anaheim, Calif. Addtl. Info.—J. E. Olivares, Jr., Sysdyne Inc., 6911 Topanga Canyon Blvd., Canoga Park, Calif. 91303.

'71 and '72 Conference Highlights

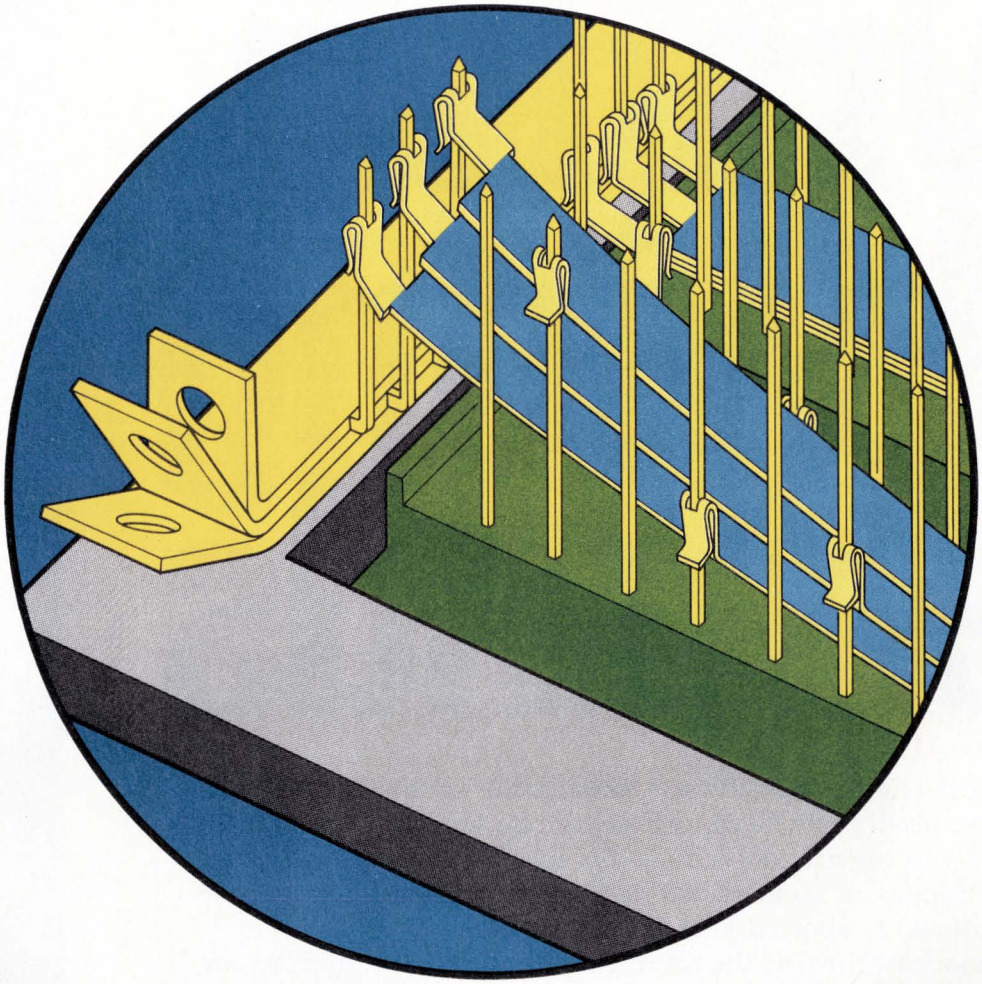
WESCON—Western Electronic Show & Convention, Aug. 24-27; San Francisco, Calif.

NEREM—Northeast Electronics Research & Engineering Meeting, Nov. 3-5; Boston, Mass.

INTERCON '72—IEEE International Convention and Exposition, March 20-23; New York, N.Y.

PARIS ELECTRONIC COMPONENTS SHOW, April 6-11; Paris, France.

NOTE: The 27th annual National Electronics Conference and Exhibition and **ComFor/71** has been cancelled.



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the multi·layer bussing system

Bus·con is a new multi-layer power distribution system for high speed logic systems. The first three-level bussing system on the market, it provides an alternative to custom and costly plates, voltage planes and back panels. Bus·con is versatile, easy to install, economical and available from distributor stock.

Basically, bus·con consists of 3-layer bus bars for high capacity distribution of Vcc, ground and signal and multi-layer bus strips designed to make connection on the first wire wrap level of .125″ x .250″ PC connectors. With bus·con you get maximum power distribution density, separation of analog and digital inputs and closed loop bussing capabilities.

But bus·con is only the new part of the SAE story. The addition of bus·con completes our product capability as the only single source of connectors, mounting frames, mounting hardware and bussing system . . . everything you need to package your logic. Of course, if you'd like us to deliver a completed system, just send us your wire lists. We'll even assemble and wrap it for you.

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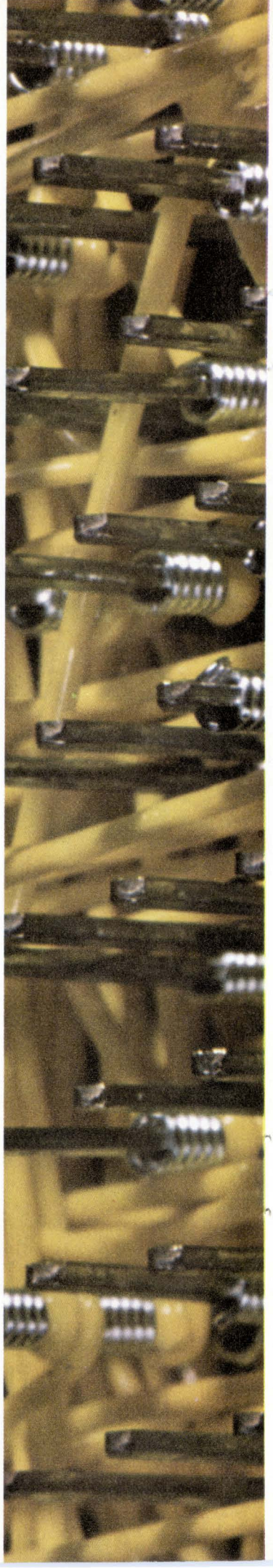
wrap up all wiring demands



There's Gardner-Denver Wire-Wrap* terminating equipment to match any production need! Only Gardner-Denver offers manual, semi-automatic, and fully-automatic equipment for making solderless wrapped connections. Billions of connections have already been made on our equipment without a reported field failure.

Check the models shown at the right. See which is best suited to your production needs. Operating highlights are mentioned below. Complete details are available on our whole family of electronic products including the wire stripping unit, cable binding tool, Grid-Drill™ machine, and N/C tape programmer. Just write for Bulletin AC-35.

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Portable Wire-Wrap power tools for lab and pilot work and production runs. Air, electric, or battery operated. Also pencil-size wrapping and unwrapping tools for servicemen. Wire-Wrap strapping tools to interconnect terminals with a continuous length of bare wire.

SEMI!

Semi-automatic Wire-Wrap terminal locating machine. Reads punched tape and automatically locates terminals with .001″ accuracy. Comes complete with numerically-controlled wire preparation unit which automatically produces the wire needed, cut to length, and stripped both ends. Lighted wire bins also available as an optional feature.

AUTOMATIC!

Fully-automatic Wire-Wrap machine wires back panels at rates of up to 1,600 connections an hour. Eliminates costly rework and troubleshooting due to accuracy and repeatability. Machines are programmed with punched cards for greater flexibility. Contract wiring is available on a production basis at our plant in Grand Haven, Michigan.

*Wire-Wrap is a registered trademark of Gardner-Denver Company

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois 62301

GARDNER-DENVER Since 1859

Circle Reader Service #16


PORTABLE!
SEMI!
AUTOMATIC!

Pomeroy's complaint

Sir:

In the December 1970 issue of The Electronic Engineer, p. 43, you published an article entitled "Pomeroy's complaint," by Roger D'Aprix. I deem this very refreshing vignette as being most timely and would like to order 1000 reprints.

I am a member of the national membership committee of the AIAA (American Institute of Aeronautics and Astronautics). We are currently conducting some 40 employment workshops nationally to assist unemployed engineers in obtaining jobs. One of our most difficult (and unpleasant) tasks is to apprise each engineer of the fact concerning his present state. I find your article to be the most palatable testimonial to the "real life" conditions facing the engineer today. Your article is a gentle means of introducing Joe Blow, typical unemployed engineer, to the world of reality. I need not mention the gravity of the situation throughout the industry as your editorials have been a constant source of material upon this subject.

R. D. Hawkins, Chairman
Workshop for Professional
Employment Committee
AIAA—Mt. Diablo, Calif.

Sir:

"DR. FRIED: . . . What you need first is a paycheck. Well, that shouldn't be too difficult. Get yourself a reasonable job so you can keep going until you can find the job you really want." . . .

Right-O: But what if there is not even a "reasonable" job?

I. M. Berman
System Design Engineer
Schenectady, N.Y. 12301

A great inventor

Dear Editor:

This letter is to remind you people that this coming July 10, will be the 115 birthday of the inventor Nikola Tesla and I believe it would be a good idea that you have a few pages on Tesla and the great work that he did.

Nick Basura
3414 Alice Street
Los Angeles, California 90065

Letters to the editor are published at the discretion of the magazine. Please say so if you do not want to be quoted. Signed letters have preference over anonymous ones.

NEW BOURNS MODEL 3861 ...and more to come

RV6 VARIABLE RESISTOR

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¾″ dia., metal bushing, locking or non-locking, rated 2 watts at 70°C, resistance to 5 megohms, and tolerance of ±10%. The price: 81 cents each in 2500-piece lots.

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Model 3862

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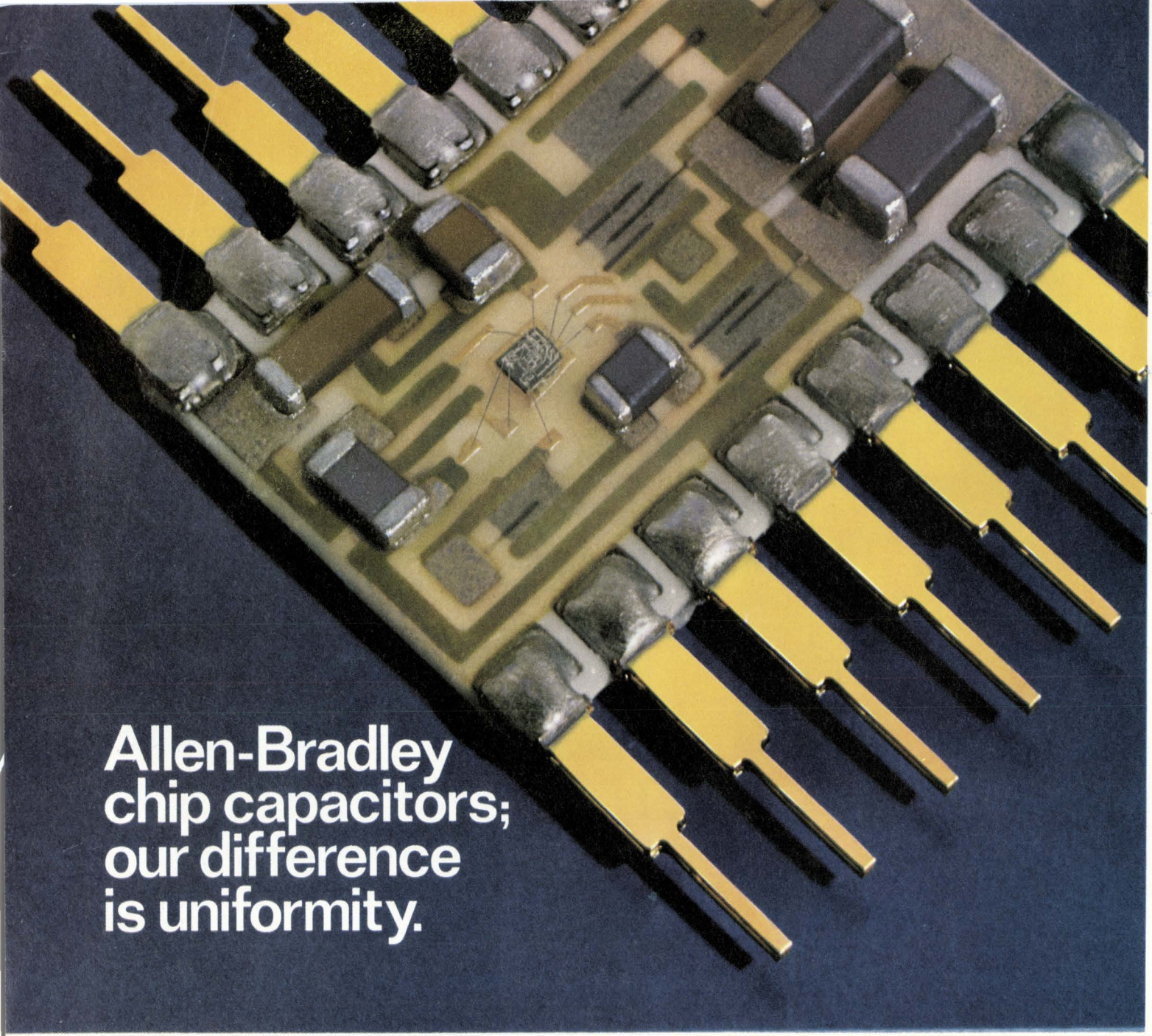

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Actual Size

NEW DIMENSION ELECTRONICS

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Circle Reader Service #19

UPDATE '71:

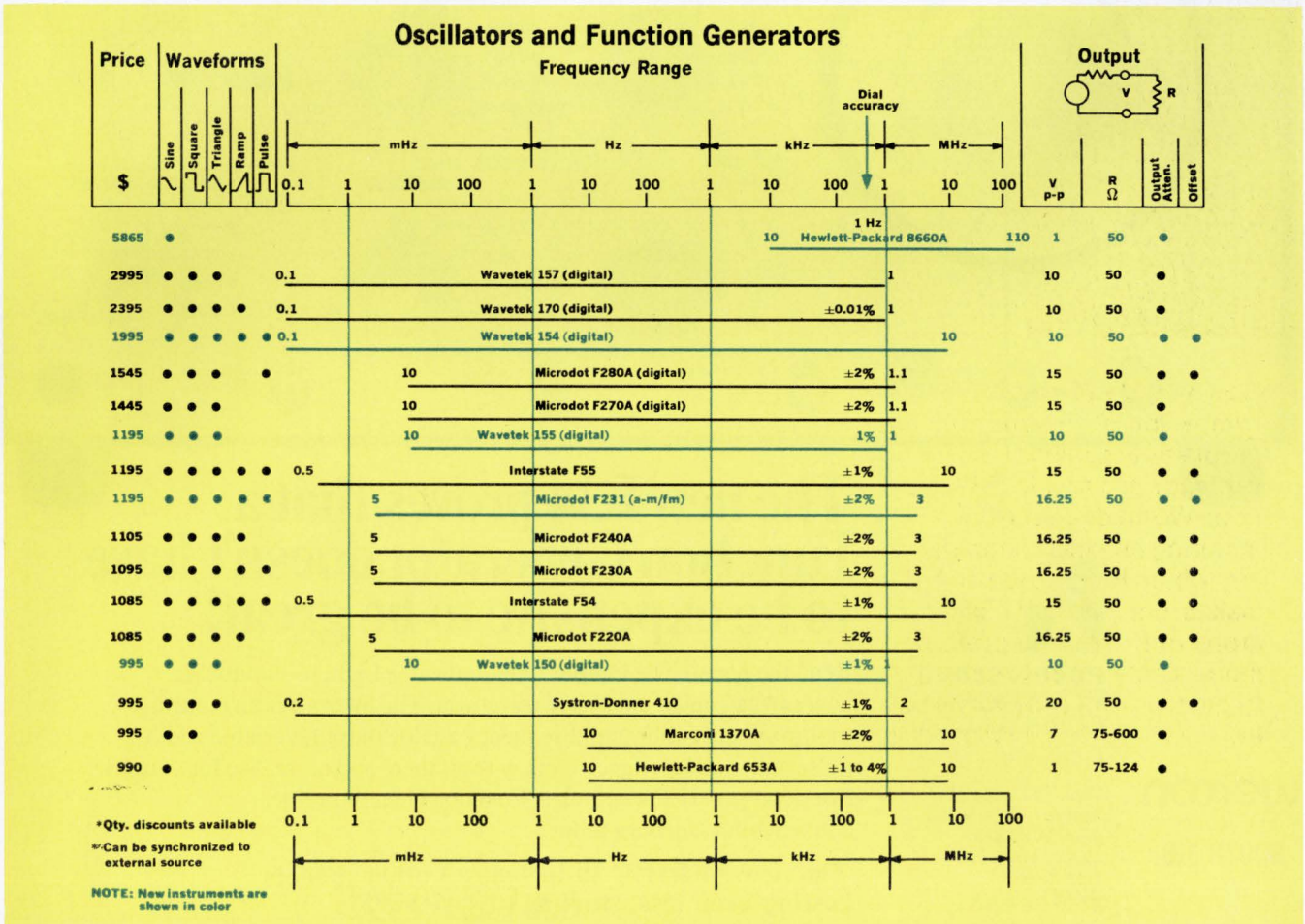
Oscillators and function generators at a glance

With these charts you can compare the major characteristics of popular makes of oscillators and function (waveform) generators. Arranged in order of decreasing price, the instruments listed here operate mainly from 1 mHz to 10 MHz. We have excluded all instruments whose upper limit is below 1 MHz. New instruments are shown in color on the chart.

Last year's listing (**The Electronic Engineer,** March 1970) charted 67 instruments. In querying the manufacturers for these new charts, we found only five instruments deleted: Microdot's F250B; Waveforms' 401F and 511A; Wavetek's 141; and Exact's 502. Most manufacturers added to their lines, making the listing about one-third longer than it was last year. There have been only a few price changes since.

Leading in new instruments is Exact Electronics. This company has added, since last year, eight sources suitable for inclusion in this listing. Interesting because it's a two-in-one package, Exact's Model 7060 is a wide-range, full-function waveform generator combined with

Text continued on p. 29



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The new F34 proves that a Function Generator doesn't have to be great!

Read the panel! The Output Limit indicator Light — unique! It guarantees you an unclipped waveform. The Sweep Width control — foolproof and calibrated. Frequency analog output, variable width pulse and manual trigger — they're all there and more. See for yourself! For details on IEC's complete Function Generator line, contact John Norburg today.

The new SERIES 30 includes 3 other models costing even less, starting at just $295!

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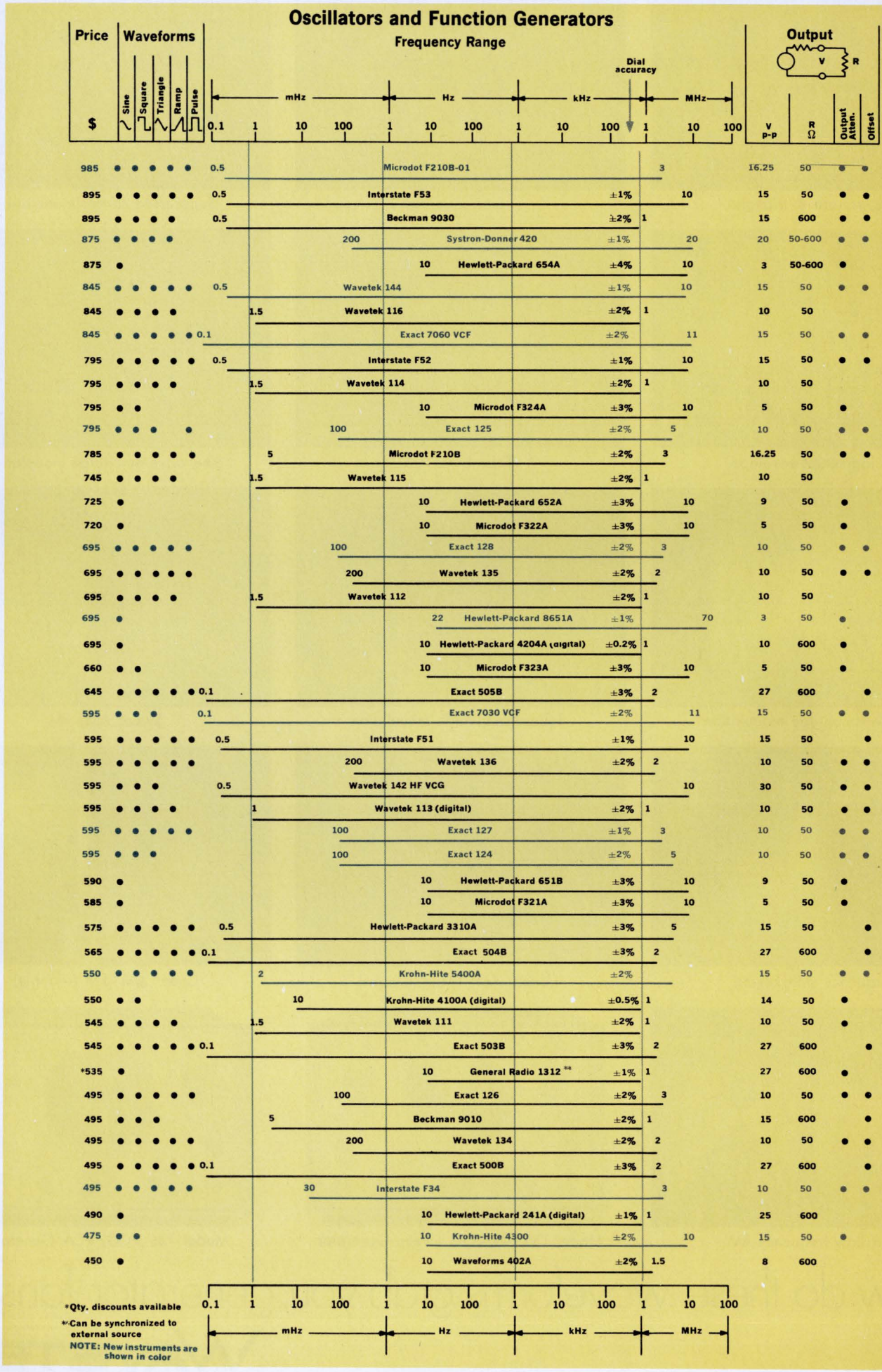
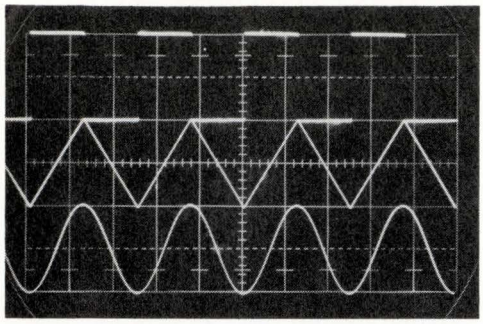
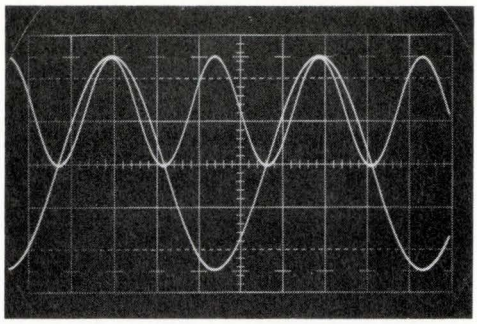
Oscillators and Function Generators

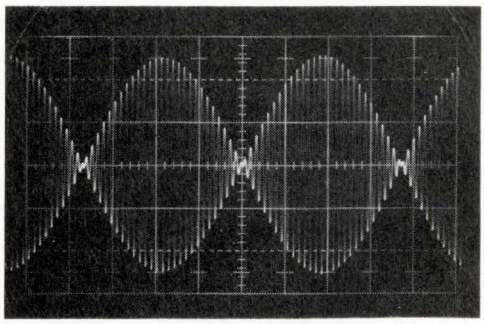




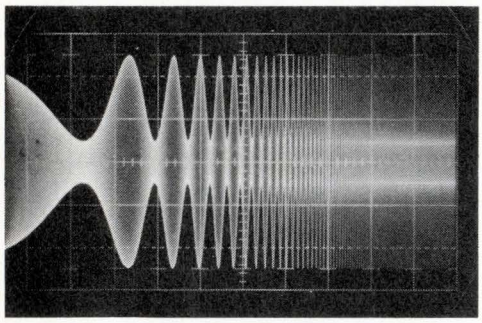
Sine, square & triangle



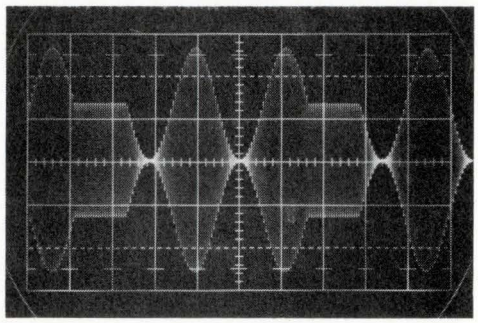
Sine squared



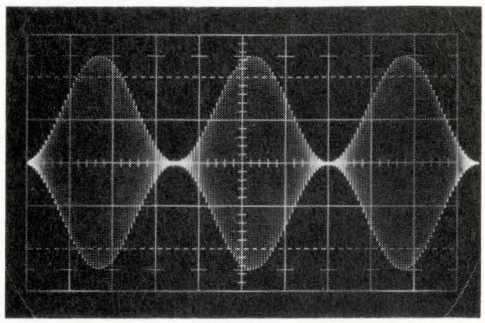
Suppressed carrier modulation



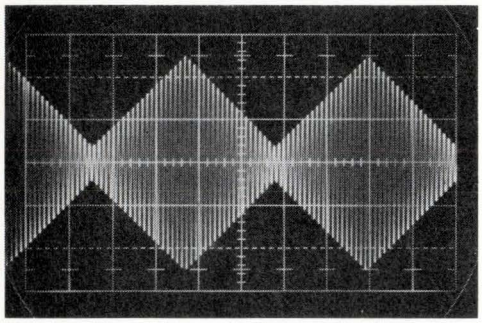
AM log swept envelope



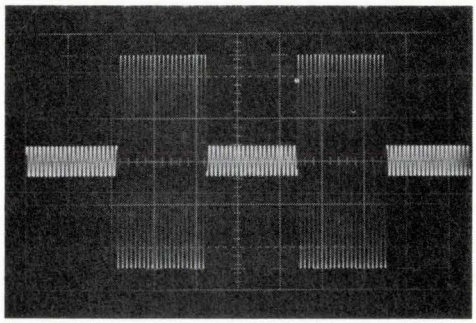
Tone burst AM



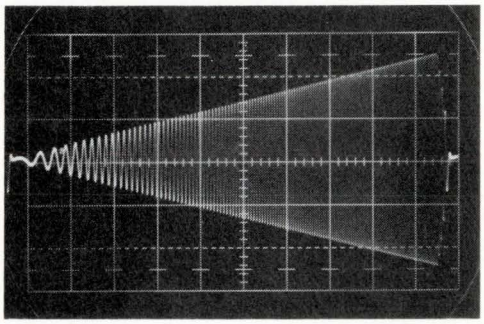
Sine wave amplitude modulation



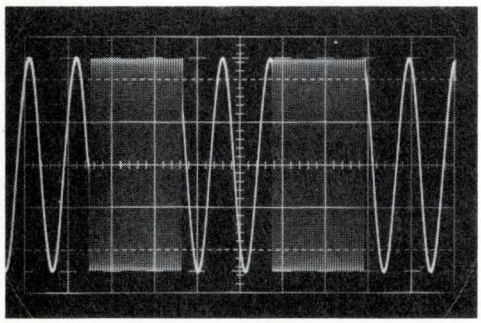
Triangle amplitude modulation



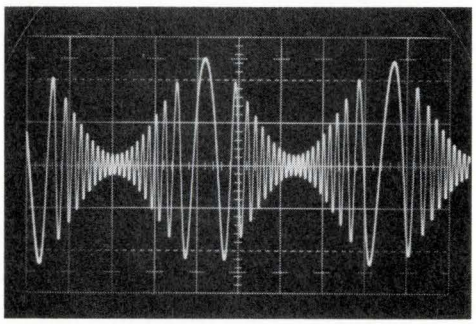
Square amplitude modulation



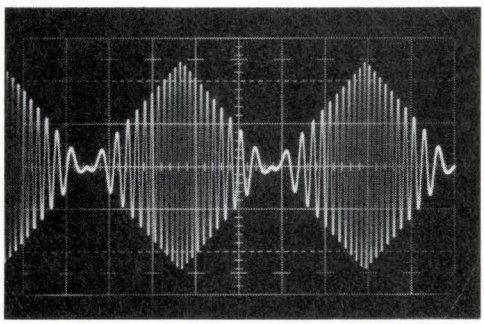
Swept AM - FM



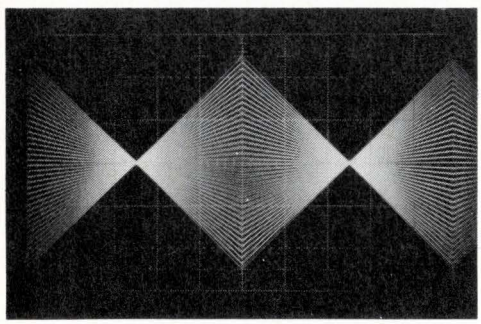
Frequency shift keying



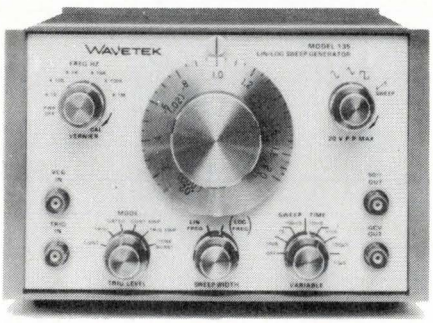
Linear AM - FM (sine wave)



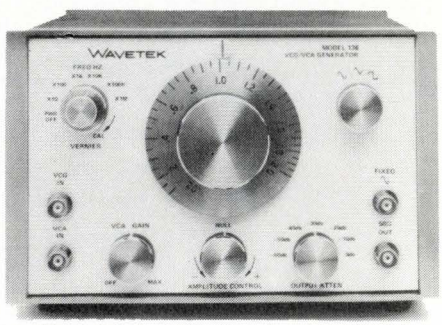
Linear AM - FM (triangle)



Ultra low frequency AM



Model 135 LIN/LOG Sweep Generator



Model 136 VCG/VCA Generator

How do these waveforms grab you, generator fans?

See more pictures like these at WESCON Booths 1124-26

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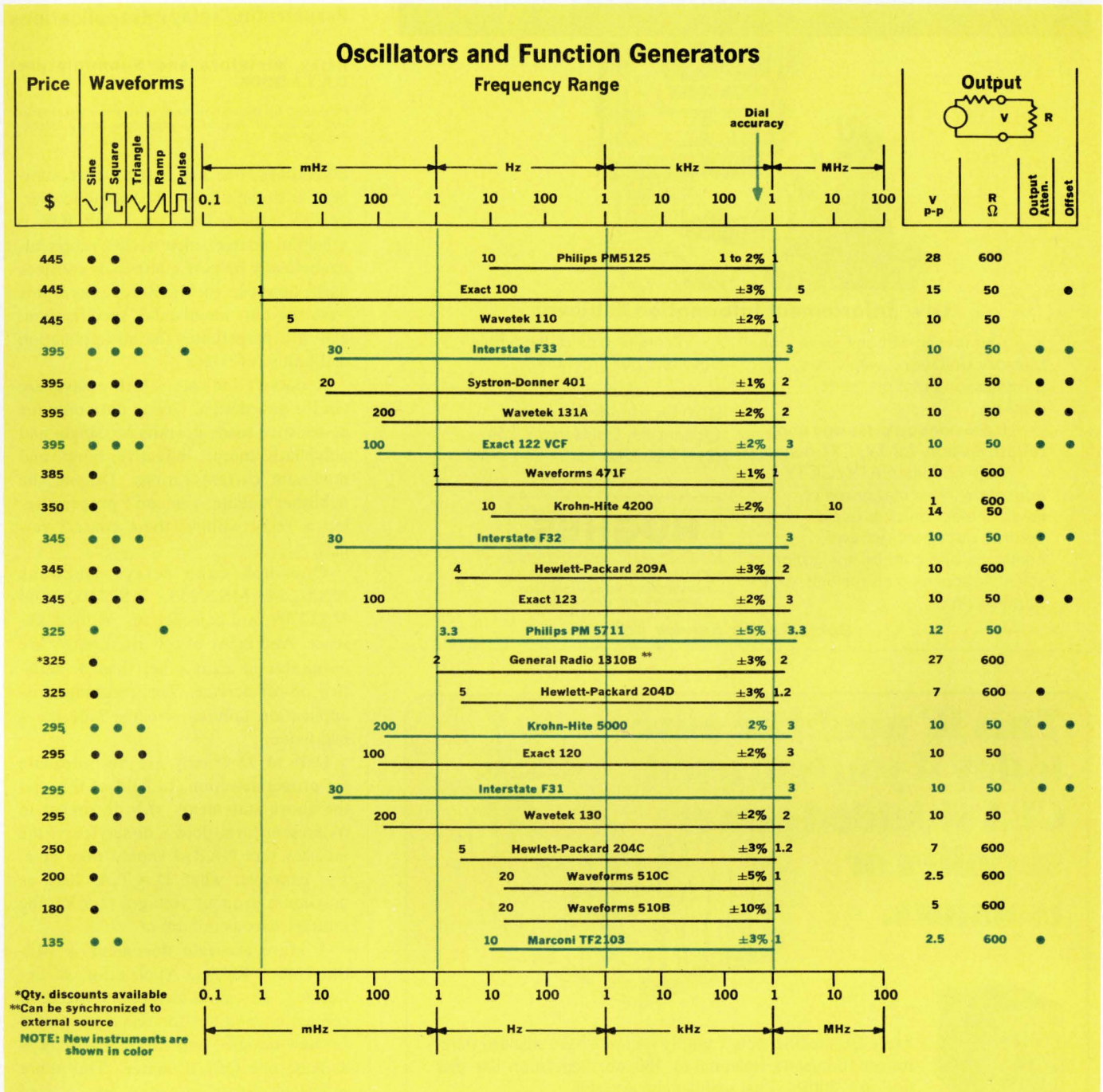
Circle Reader Service #22



a sweep generator. The capabilities of the instrument together with its medium price ($845) make it an attractive offering.

At the high-priced end, Hewlett-Packard has just announced its Model 8660A at $5865. If this seems like a lot of bread for a 10-kHz to 110-MHz sine-wave source, consider that its output signal is exceptionally clean, and that the instrument is fully computer-programmable.

At the low-cost end, Marconi's TF2103 is yours for just $135. It's a battery-powered (optional ac power unit), sine- and square-wave source operating between 10 Hz and 1 MHz, and could turn out to be a handy package to have around, in the lab, on the line, or in the field.

This listing can serve only to whet your appetite. So for more information on any instrument listed here, just circle the appropriate Reader Service number:

	Reader Service No.
Beckman Instruments	201
Exact Electronics	202
General Radio	203
Hewlett-Packard	204
Interstate Electronics	205
Krohn-Hite	206
Marconi Instruments	207
Microdot	208
Philips Electronic Instruments	209
Systron-Donner, Datapulse Div.	210
Waveforms	211
Wavetek	212

BOOKS

Perpetrating relay misapplications

Relay Miniature and Subminiature D.A.T.A.BOOK

Published by Derivation And Tabulation Associates Inc., 32 Lincoln Avenue, Orange, New Jersey, 07050. Price $27.50.

Oftentimes, one has a relay part number but doesn't know the manufacturer. In this respect, this D.A.T.A.BOOK is a helpful source since it lists relays alphabetically by part number. It confines itself, however, to Mil-R-5757, as if this were the only small relay specification, and thus perpetuates the misapplication and failure of relays.

It doesn't indicate which relays are not for new design. Giving data only for dc resistive loads it omits ac, single and polyphase, motor, inductive, lamp, and minimum current ratings. Despite the publisher's claim, you can't properly select a relay without these contact ratings.

One-inch cube relays, such as MS27254, MS27255, MS27400, and MS27709, are conspicuous in their absence. And many of the listed relays are unsuitable in areas other than dc resistive on-off service. The resulting misapplication failures give the industry a bad name.

Data at 25°C only are not adequate for proper selection. In light of this and the above statements, this document in its present form does a disservice to the industry and NARM should take note. For example, what D.A.T.A. lists as maximum dropout voltages (1.5 V), the military lists as minimum.

A more accurate document is Mil-Std-1346, "Relays, Application & Selection." This gives a complete listing of contact capabilities for relays suggested for new designs, and for which there is at least one QPL'd source. This more practical document may be secured from C.O.-U.S. Naval Supply Depot, 5801 Tabor Ave., Philadelphia, Pa. 19120, at a cost far less than $27.50.

E. U. Thomas

Circuit Theory: An Introduction to the State Variable Approach

By Ronald A. Rohrer. Published 1970 by McGraw-Hill Book Company, 330 W. 42 St., New York, N. Y. 10036. Price $14.50. 314 pages including index.

Network Theory

By Joseph B. Murdoch. Published 1970 by McGraw-Hill Book Company, 330 W. 42 St., New York, N. Y. 10036. Price $16.00. 525 pages including index.

RCA is supplying production quantities of custom-designed COS/MOS ICs now, developed to meet the most exacting performance requirements.

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For fast information on how RCA's custom COS/MOS ICs can help you, call Andy Bosso at (201) 722-3200 — ext. 3434. Or write: COS/MOS Marketing Dept., RCA Solid State Division, Route 202, Somerville, N.J. 08876. International: RCA, Sunbury-on-Thames, U.K., or P.O. Box 112, Hong Kong.

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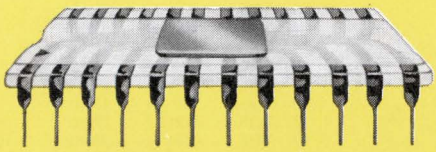

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AMI American Micro-systems, Inc.

	PART NUMBER	DESCRIPTION	LEADS/PKG.	FREQUENCY RANGE	NUMBER OF BITS	TYPICAL POWER DISSIPATION	CLOCK LEVELS	GATE THRESH-OLD
DYNAMIC SHIFT REGISTER	RD55G	Dual 50	10 TO5	10KHz - 1MHz	100	240mw	-27V	HVT
	S1708	Quad 40	12 TO8	10KHz - 1MHz	160	200mw	+5, -12V	LVT
	RD63G	Triple 66	10 TO5	10KHz - 1MHz	198	125mw	-27V	HVT
	S1724	Variable 256	14 DIP	10KHz - 1MHz	2-257	200mw	+5, -12V	LVT
	S1606	Quad 84	16 DIP	10KHz - 2MHz	336	200mw	+5, -12V	LVT
	RD65G	Single 426	10 TO5	1KHz - 5MHz	426	280mw	+5, -12V	LVT
	S1723	Dual 256	10 TO5	10KHz - 2MHz	512	150mw	+5, -12V	LVT
	S1705	Dual 256	10 TO5	10KHz - 1MHz	512	300mw	+5, 0V	LVT
	S1685	Dual 480	12 TO8	10KHz - 2MHz	960	200mw	+5, -12V	LVT
	S1687	1000/1024	12 TO8	10KHz - 2MHz	1000/1024	150mw	+5, -12V	LVT
	S1701	Dual 512	14 DIP	10KHz - 2MHz	1024	250mw	+5, -12V	LVT
	S1709	FIFO 8 x 13	24 DIP	10KHz - 100KHz	104	500mw	+5, -12V	LVT
STATIC SHIFT REGISTERS	SP51L	12 bit Serial/Parallel	24 DIP	DC - 2MHz	1-12	250mw	-27V	HVT
	RS53G	Dual 40	10 TO5	DC - 1MHz	80	150mw	-27V	HVT
	S1463	Dual 64	12 TO5	DC - 3MHz	128	180mw	+5, -12V	LVT
	S1670	Dual 100	14 DIP	DC - 3MHz	200	250mw	+5, -12V	LVT
RANDOM ACCESS MEMORIES	S1509	128 x 1, 64 x 2, 32 x 4	28 DIP	1.5 MHz	128	300mw	+5, -12V	LVT
	S4006	1024 x 1, Static	16 DIP	1.5 MHz	1024	600mw	None	I^2
	S2103	1024 x 1, Dynamic	18 DIP	1.5 MHz	1024	320mw	-15V	SIGATE
READ ONLY MEMORIES	S8452	256 x 4	28 DIP	DC - 200KHz	1024	500mw	None	HVT
	S8457	128 x 12 Hollerith to ASC II	24 DIP	DC - 300KHz	1536	500mw	None	I^2
	S8539	128 x 12 ASC II to Hollerith	24 DIP	DC - 300KHz	1536	500mw	None	I^2
	S8538	2048 x 1	24 DIP	20KHz - 1MHz	2048	400mw	+5, -12V	LVT
	S8453	512 x 4	28 DIP	DC - 200KHz	2048	500mw	None	HVT
	S8502	256 x 8	28 DIP	DC - 1MHz	2048	650mw	+5, 0V	LVT
	ME51L	2240 - 5 output	28 DIP	DC - 1MHz	2240	300mw	None	LVT
	S8327	2240 - 5 output	24 DIP	DC - 2MHz	2240	400mw	+5, -12V	LVT
	S8499	2240 - 7 output	28 DIP	DC - 300KHz	2240	300mw	None	HVT
	S8501	256 x 10	40 DIP	DC - 1MHz	2560	650mw	+5, 0V	LVT
MULTIPLEXERS	MX52D	6 Channel	14 FP			NA	NA	HVT
	MX53C	10 Channel	22 FP			NA	NA	HVT
	MX54C	4 Channel, 50Ω	22 FP			NA	NA	HVT
	MX55C	4 Channel, 50Ω	22 FP			NA	NA	LVT
STANDARD LOGIC ARRAYS	UL51L	Dual FF, Dual Excl OR	24 DIP	1 - 100KHz		60mw	-27V	HVT
	UL52L	Quad 2 NAND Expandable	24 DIP			40mw	-27V	HVT
	UL53L	Quad 2 NOR Expandable	24 DIP			120mw	-27V	HVT
	MX53L	10 Input Expander	24 DIP					HVT
	SP51L	12 bit Serial/ Parallel	24 DIP	DC - 2MHz	12	250mw	-27V	HVT
	S1694	8 bit Counter/ Shift Register	40 DIP	DC - 1MHz	8	15mw		LVT

	PART NUMBER	DESCRIPTION	LEADS/PKG.	RON @ -15V	PROTECTION	TYPICAL V_{GST}
DISCRETES	DM01B	Dual Matched 50mw	6 TO5	1250	No	-4V
	DM02B	Dual Matched 100mw	6 TO5	1250	No	-4V
	DM03B	Dual Matched 150mw	6 TO5	1250	No	-4V
	DM05A	Dual	8 TO77	250	Yes	-4V
	DM06A	Dual	8 TO77	250	No	-4V
	DD07K	Single	4 TO72	125	Yes	-4V
	DD08K	Single	4 TO72	125	No	-4V
	DD09K	Single	4 TO72	250	Yes	-4V
	DD10K	Single	4 TO72	125	Yes	-2V
	DD11K	Single	4 TO72	700	Yes	-4V
	DD12J	Single	3 TO5	32	Yes	-4V
	DD13K	Single	4 TO33	32	Yes	-4V
	DD15K	Single	4 TO33	18	Yes	-2V
	T1368	Quad	14 FP	125	Yes	-2V
	T1337	Quad	14 DIP	125	Yes	-2V

MEMORIES:

Future storage techniques

Steve Thompson, Western Editor—Los Angeles

Crystal-balling is a necessary, calculated risk. Because data bases are incomplete, uncertainty and inaccuracy increase with increased extrapolation. Yet, without some estimate of our direction, we would be unprepared for the most trivial evolutionary step.

There are probably dozens of ideas, theories, and guesses on how to build a better memory. All you have to do to enter the contest is show how to package nature's cheapest, smallest, fastest, two-state phenomenon and you can move on to the next problem.

With full realization that there is infinite room for disagreement, we have asked Jack Morton of Bell Labs to comment on three likely candidates for future memory dominance: integrated circuits, bubbles, and charge-coupled devices (CCD). Mr. Morton proposes some thoughtful criteria for searching out the next generation of "best" technology, if there is one. His basic question is, "Can it adapt?" Then he uses his criteria to handicap the contenders.

In addition, this, our last chapter of the memories course, takes a closer look at what could be two of the most promising future memories, magnetic bubbles and holographic memories.

After our tour of future memories, you can return to the present by taking our "Memories course exam." It promises a tangible, real-life reward of a certificate of accomplishment for all who pass. Good luck.

Picking the winning technologies

Jack A. Morton, Vice President, Electronic Technology
Bell Telephone Laboratories, Inc., Murray Hill, N.J.

Each new memory technology requires large investments in materials, processes, and structures. In addition, each impacts on present-day software and hardware organization. Plus the odds are that the new technology will be revised so often that its original form will be obsolete by the time it gains widespread acceptance.

Memory and computing are inseparable. When systems designers agree on criteria for the "best" universal computer, memory designers will define a "best" memory. Meanwhile we can only search for technologies that are widely applicable and long-lived, that can adapt to changes in materials science and technology, in systems function and structure.

Effectiveness criteria

To be adaptive, a technology must be: well understood, so its capabilities can be extended over many applications; cost-effective for different sizes and functions (RAM, ROM, etc.); and compatibly partitioned between kinds and sizes of memories, including fine scale mixes of logic and memory for associative processors.

Cost-effective technology requires low manufacturing cost. The key is total batch processing at all steps. The cumulative cost of all steps is spread over the number of elements and subsystems produced per batch. This forces a search for the maximum function density in the largest arrays consistent with good yield. Yield improves as the number of steps and defects per step decrease.

To evaluate memories, we need a measure that includes all costs. "Service effectiveness" is such a measure; it is

the amount of performance per total expense,

$$\frac{\text{system throughput in bits/s}}{\text{manufacturing cost + present worth of annual charges of installation, operation and maintenance expenses}}$$

Reliability is implicit in maintenance expense. Reliability also determines system availability as computers grow larger and more complex. The fact that failure rates of batch-processed integrated subsystems can approach those of discrete elements is what makes possible reliable, big, complex memories.

One very important component of operating costs is power. In high density technology, system size is dictated by power because of cooling requirements. With only convection cooling, the cost of just the space required averages out to about $1-2 for each watt of power being consumed. Total present cost (cost in dollars now for future charges) of annual power charges may range from $5-10/W. A good rule of thumb is about one millicent/microwatt.

Adaptability means a high service effectiveness value for different kinds, sizes, and mixes of memories; it means cost-performance tradeoffs are possible.

Alternate solutions

Core has dominated memory for almost two decades, mostly because improvements in size, speed, reliability, and power have been matched by improvements in batch assembly. It has been our most adaptive memory, but seems to be losing ground. Barring major breakthroughs in materials, devices, or system structure, the cost of further progress looks high.

Despite its outstanding performance up to now, core has size and access mode limitations. These limitations resulted in computer structures with these characteristics. They are memory concentrated, instead of having memory partitioned among multiprocessors or interspersed with logic. They also exhibit a memory hierarchy, with cores used primarily for fast random access and they are burdened with costly, inflexible software, because of the large amount of bookkeeping required. Three new contenders, ICs, CCDs, and magnetic bubbles, all exhibit adaptability that may overcome some of these limitations.

Integrated circuit memories

Integrated transistor memories already surpass cores in speed and are within striking distance in cost, power, and reliability/bit. Partitionability is orders of magnitude better, because read/write power is so low that access and memory may be integrated in the same material. Batch-processed ICs can adapt to ROMs and SAMs (sequential access memory). Even in CAMs, (contents addressable memory) the cost/bit only rises by a factor of about two.

Transistors are well understood, and research will probably continue to expand this understanding, as needed. All the service effectiveness factors look promising. To see this, factor cost/bit into (components/bit) · (area/component) · (cost/area). Circuit designers are approaching an ultimate limit of one or two components/bit, down from the original six. Devices are fabricated with 7-10 μm lines. Today's photolithography might reduce this to 3-5 μm. Electron beam pattern definition makes line-widths of ½-1 μm practical, if high temperature diffusion and chemical etching are replaced by much more controllable ion milling and implantation. That would reduce the area/component by more than an order of magnitude.

The combined advances in component/bit and component density allows safe predictions of chips with tens of thousands of bits, with a corresponding RAM cost of less than 0.1¢/bit. These predictions are independent of higher yields, fewer defects, and lower cost/area of processed silicon which will result from fewer, more precise, low temperature electron and ion processes. Adding the results of those processes, even the slower field-effect transistors will attain speeds of tens of nanoseconds.

Because of these improvements power will be reduced. In addition, power gating and dynamic operation will help even more. Operation at 300 μW/bit has been achieved and can be expected to fall as low as 10 μW/bit.

Magnetic bubbles

Silicon technology, though highly adaptive, requires complex processes to vary the homogeneous silicon structure so that it can perform different functions. However, magnetic bubbles use identical particles to do logic, memory, and switching, without changing a material's structure. The physical feasibility of magnetic bubbles has been proven. We can create and destroy bubbles, move them reversibly in two dimensions, detect presence or absence, and utilize their mutual repulsion to perform logic.

Micron-sized bubbles can be supported in magnetic rare earth garnets grown epitaxially on non-magnetic matching substrates. These processes are very simple and highly adaptive. Layers a few microns thick have defect densities below 10/cm^2. The number of similar process steps is much smaller than for silicon, so the cost/area should be lower. Shift registers 1,000 bits long, at densities of 1.6 Mb/in.^{2} are routine. Mask size, not defect density, is the present size limitation.

Bubble memories may cost a few millicents/bit. Electron beam processing should benefit bubble technology to at least the same degree as transistors. Smaller bubbles for higher packing densities and lower costs are available.

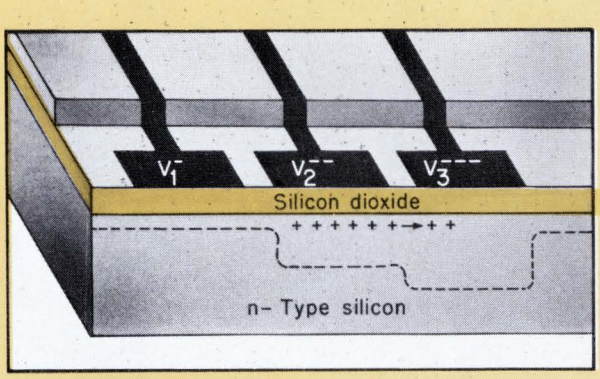
Although bubble technology scores high on adaptability, it is in different ways from IC memories. Partitionability is about the same, but garnet chips carry more bubbles. Lower defect densities, smaller cells, and simpler processes allow economical integration to higher levels than for silicon. Logic, memory, and switches can be intermixed on a finer scale within the garnet, because no restructuring is needed. Bubbles are non-volatile and reversible. Sequential memories and CAMs may cost the same. Bubble serial bit speed is slower, about 1 μs, but system throughput may approach the highest speed silicon RAMs where associative and parallel processing can be used. The system innovator has many opportunities for new system architectures and software-hardware tradeoffs.

Charge-coupled device (CCD). This relatively simple, three-layer MOS structure greatly reduces the complexity of device fabrication. Any semiconductor can be used.

Charges are stored (coupled) in potential wells (spatially defined depletion regions) at the surface of the substrate. Minority carriers (holes in n-type silicon) are injected into a depletion region by surface avalanching at the semiconductor-oxide interface by light-induced hole-electron pairs, or by forward biasing a p-n junction.

Charges are moved about the surface by moving the well to which they are coupled. The charges do not leave the substrate. The metal pattern deposited on the insulating layer forms an array of conductor-insulator-substrate capacitors. Applied voltage controls well depth.

Above, charges flow from the well at V_2 into the deeper well at V_3 produced by a larger negative voltage. Proper voltage adjustments move the charges to the right or left. Detection can be done at any electrode by sensing capacitance changes due to charge presence by measuring the surface potential, or by transferring the charge into an output p-n junction. A digital system would detect the presence or absence of charge packets. An analog system could detect the amount of charge, which is variable controlled at the injector.



RELATIVE MERITS OF MEMORY TECHNOLOGIES

Simultaneous RAM Specs.

	CORE		IC		BUBBLE		CCDs	
	Now	Future	Now	Future	Now	Future	Now	Future
Components per bit (#)	1	1	4	1-2	n/a	n/a	n/a	n/a
Bit density (bits/inch^2)	$3x10^3$	10^4	$5x10^4$	10^6	$1.5x10^6$	10^7	$5x10^5$	$4x10^6$
Maximum block (or chip) size (bits)	1	1	10^2-10^3	$2x10^4$	10^4	10^5-10^6	10^3	$4x10^4$
Power per bit (microwatts)	100	50	$3x10^2$-10^4	10	.5	.2	n/a	1.5
Cost (cents per bit)	1	.5	1-10	<.1	n/a	<.01	n/a	<.01

Technology Quality	CORE	IC	BUBBLE	CCDs
Process Simplicity	good	complex	good	good
Reliability	good	low-good	good	good
Cost/Performance Trade-offs	limited	good	good	good
Partitionability and Architecture Flexibility	limited	good	best	good

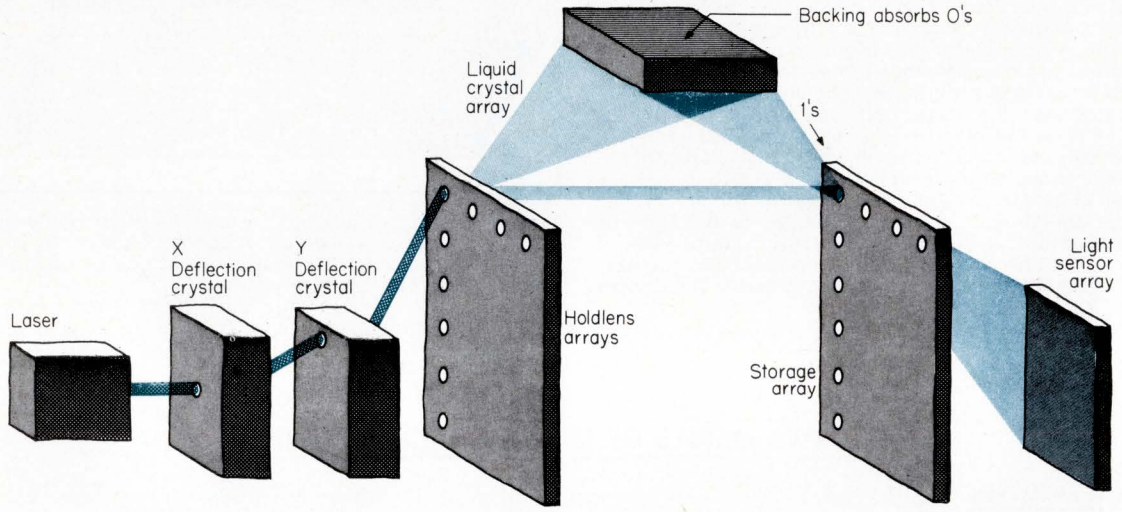
Note: n/a= not applicable.

Charge-coupled devices (CCDs)

Bubbles and CCDs are related in concept. In bubbles, we manipulate magnetic domains; in CCDs, regions of charge. The CCDs require very little host material restructuring. The fundamental difference between CCDs and conventional semiconductor ICs is that charge remains in the CCD's substrate. It is not routed from place to place, through windows, via conductors.

Area/bit can be a few square mils and will shrink further with electron-ion processing. Volatile charge packets imply periodic regenerators. They increase the effective bit area and add process steps. They also tend to limit versatility, since they hamper the asynchronous operation easily attainable with bubbles. Charge packets do not interact with each other, so logic is not as easily intermixed with memory as in bubbles; however, charge packets are intrinsically many times faster and have no trouble competing on power/bit.

Considering all factors, CCDs and bubbles will cost less than transistor memories, on the order of millicents/bit. Bubbles will probably have the lowest cost, but are currently slower. All three technologies rank high in adaptability in different, but perhaps complementary, ways (see chart). The gains in service effectiveness they will bring are a small fraction of the gains possible when system innovators take advantage of the new levels of adaptability.



Holographic memory

A million bit read/write memory is being built by RCA, based on holograph concepts. It may be the forerunner of very large, 10^{10} bit, systems.

Acousto-optic crystals deflect a laser beam in X and Y in proportion to the frequency of sound waves passing through them. This spacially selects a hololens (optical reference pattern) from a 1,024 lens matrix.

The hololens splits the beam, sending one portion to its corresponding point in the 1,024 element storage array. The storage medium is a unidirectionally magnetized film, usually manganese bismuth (MnBi). The other portion of the beam diffracts to an array of 1,024 liquid crystal cells.

Each cell can be made transparent or reflective (a 1 or a 0) electronically. Transmitted light is absorbed behind the crystals. Reflected light refocuses on the same storage area as the undiffracted beam. Where the beams coincide, they locally heat the MnBi above its Curie point. When the light is removed, the film cools, and formerly hot areas reverse their direction of magnetization. This stores data in a magnetic hologram in the film.

To read, a reduced power laser shines on the film, but not on the liquid crystals. The film's transmission properties vary with magnetic state, so the magnetic hologram is converted to light and dark areas that are detected by a 1,024-bit sensor array.

Erasing is done by uniformly illuminating the storage medium. This heats an entire storage area above the Curie point. Applying a magnetic field during cooling returns the film to its original, uniformly magnetized state.

A ROM does not require the hololens and liquid crystal arrays. Deflection crystals directly select stored holograms. State-of-the-art components could produce a 10-100 Mb ROM with access time on the order of 5 μs.

Holographic memory capacity is the product of storage areas and liquid crystal cells, so the number of discrete components increases roughly as twice the square root of capacity.

Contributed by RCA Laboratories, Princeton, N.J.

Magnetic bubbles

Andrew H. Bobeck, Bell Telephone Laboratories, Inc., Murray Hill, N.J.

Some magnetic materials have a single axis of magnetization. Electron spins align along this unique axis, minimizing the crystalline magnetic energy. Transition zones, called domain walls, separate regions of opposite spins, see illustration, a. Magnetization gradually reverses direction within a domain wall.

One such uniaxial material is orthoferrite, a rare-earth iron oxide. In the absence of external fields, magnetic islands bounded by a closed domain wall are common, see b. As an applied bias field increases in opposition to the island's magnetic state, the island shrinks, c, until at a critical field value, it snaps into an almost perfectly circular domain, d. These cylindrical domains, or "bubbles," represent clusters of magnetic spins within the material that are stable under the combined influence of applied field, domain wall energy, and magnetostatic energy.

Bubble size is a function of bias field strength. Those bubbles cannot exist below a minimum critical diameter. They are annihilated when the bias field exceeds a critical maximum. Above a maximum diameter, they become el-

liptically unstable and revert to strip domains. New bubbles, which can be generated by "slicing" a bubble in two, will quickly grow to full size. Electronic slicing is done by pulsing a conductor loop upon which the bubble is positioned, i.

There are several methods for moving a bubble by exerting unbalanced forces on its domain well. If a current near a bubble produces an attracting magnetic force on the domain, the bubble will move under the current loop. A succession of such loops forms a shift register. Adding loops in a second direction extends motion through the plane.

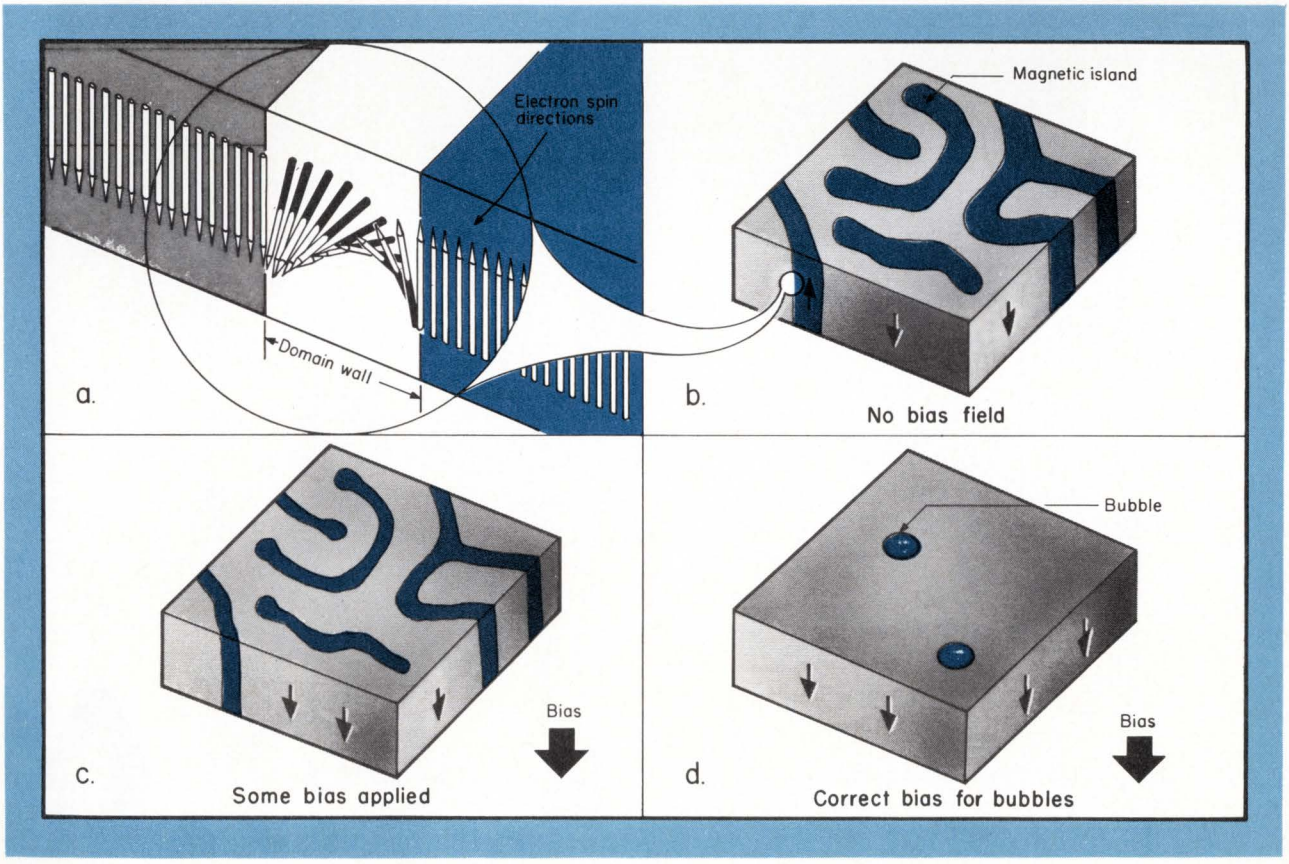
In another approach, a pulsating bias field causes the bubble diameter to pulsate. Motion is achieved by maneuvering the bubble in and out of asymmetrical energy traps, where an expanding domain "pushes" from its trailing edge, while a contracting one "pulls" on its leading edge.

An alternate method has a magnetic field rotating in a plane which generates travelling positive and negative magnetic poles in a structured permalloy pattern (e-h). They selectively repel and attract a bubble to achieve motion. A very important and fundamental departure from conventional circuits, this method eliminates access conductors, a real problem in minute memories.

Non-destructive readout can be accomplished three ways. A pickup loop can sense the induced voltage of the bubble's dipole field pattern as it moves by. A silicon Hall sensor circuit with an amplifier can act as a probe, detecting passing bubbles and sending millivolt signals, k. An optical technique detects changes in light transmission as bubbles pass.

Bubbles interact with one another like magnets, when they get closer than about three diameters. Bubbles with diameters of 0.0003 in. are limited to densities of about a Mb/in.^{2}. Interactions limit storage density, but are necessary for logic circuits. Since two bubbles cannot occupy the same position at the same time, a restrictive set of logic functions can be developed based on the principle alone. The long-range (dipolar) interaction permits greater design flexibility and generation of a complete table of logic functions.

Shift registers have operated at data rates faster than 300 kb/s, and at densities of 1.6 Mb/in.^{2}. Preliminary experiments and calculations indicate that a 15-million bit disk file might be built in a two or three inch cube, which would dissipate 10 W and cost about $300.



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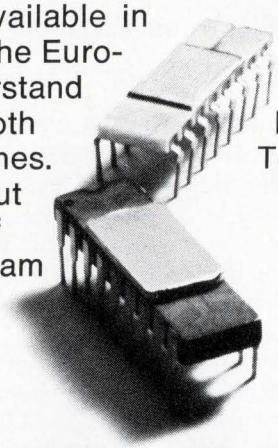

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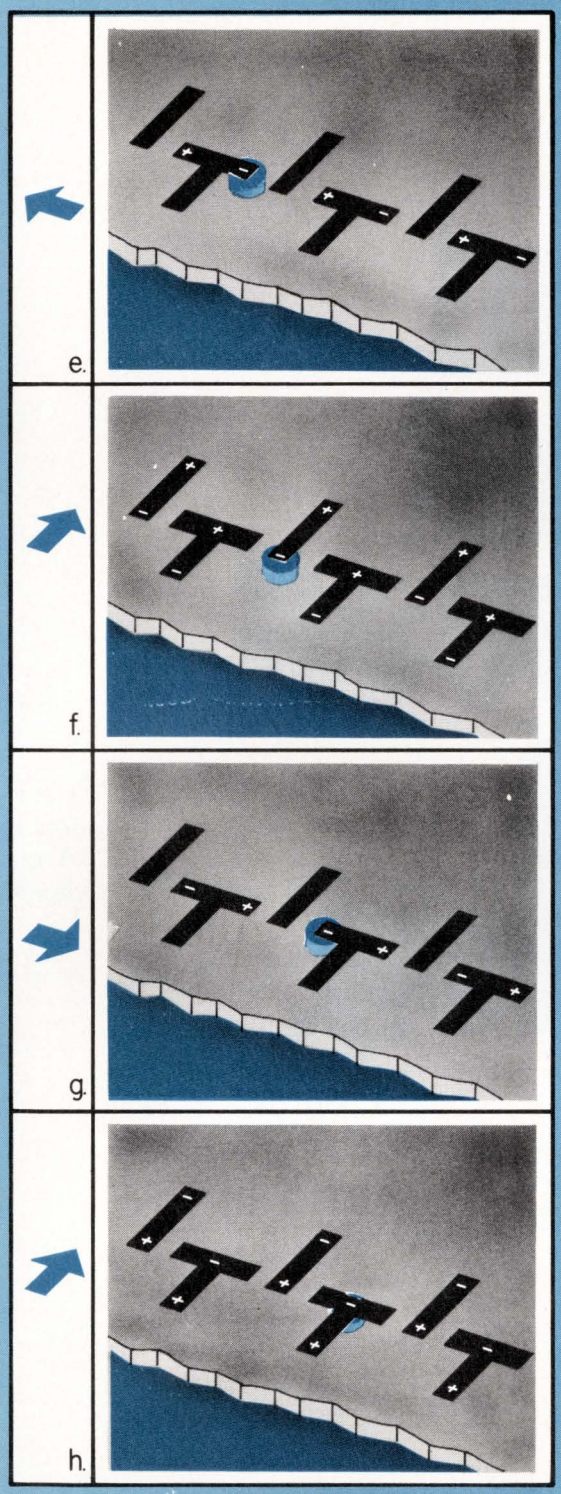
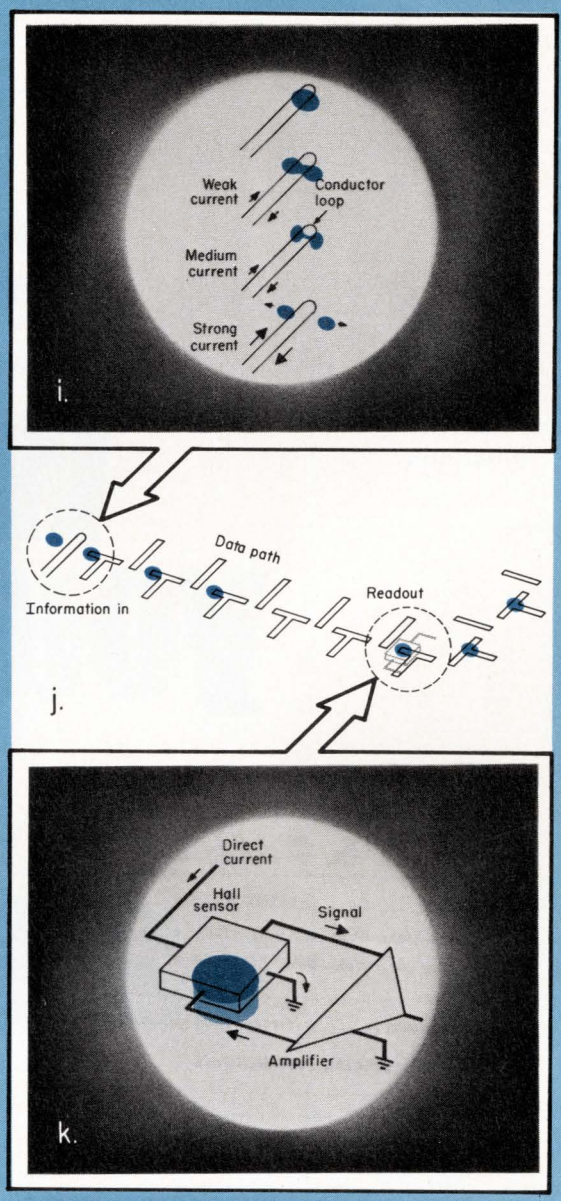


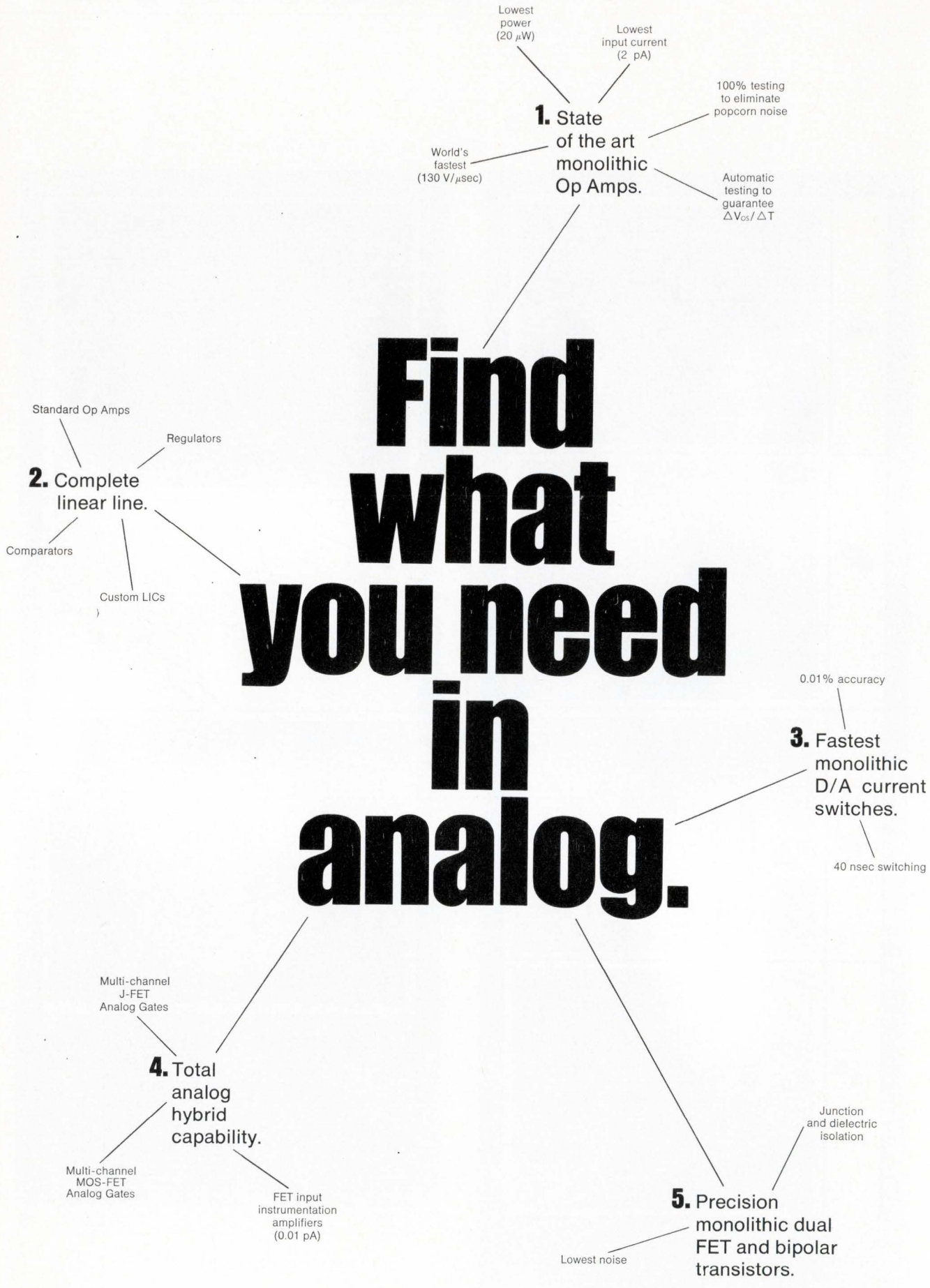
As a magnetic field rotates clockwise (arrows), the magnetic poles in an etched, thin-film, permalloy pattern of Ts and bars change, moving a bubble from left to right.



This idealized shift register moves bubbles from left to right. Data are inserted by selectively splitting a source bubble (left). The bubble is formed for a 1, and not formed for a 0. The bubble stream is moved and stored by the T-bar register (center). Silicon circuits (right) read the stream of bubble signals. They sense the presence of a bubble by the Hall effect—the influence of its magnetic field on an electric current. During a calculation, one bubble can return to a sensor often.

INFORMATION RETRIEVAL

Computers and peripherals, Digital design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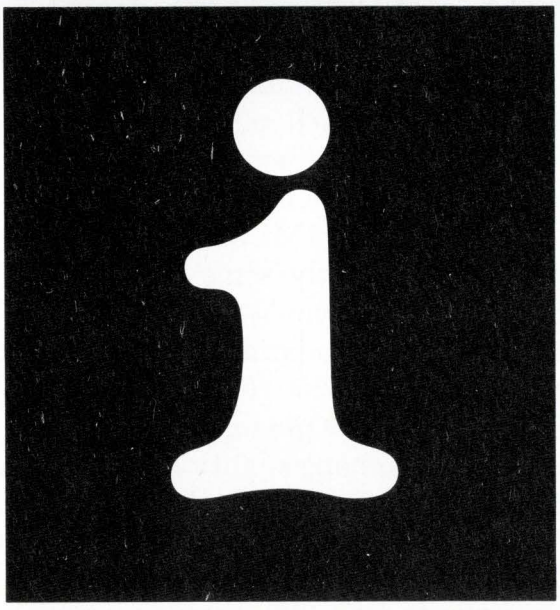
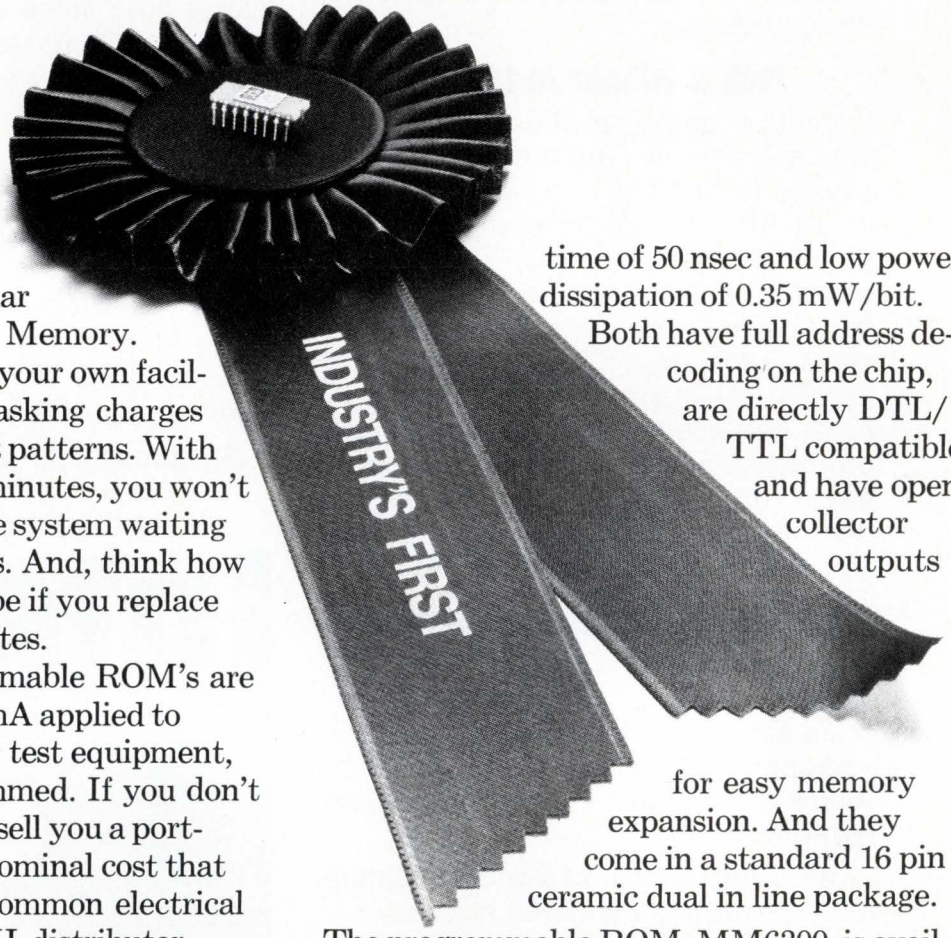


Monolithic Memories bipolar 1024 bit field programmable ROM



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How is YOUR memory?

Steve Thompson, Western Editor—Los Angeles,

In considering memories, no discussion is complete without considering the portable human variety with its virtually unlimited capacity, high adaptability, adequate speed, low power consumption, variable organization (content addressable would help here), and questionable logic. However, since none are for sale, it must still be in R&D.

The object here is to measure its reliability. Blacken the one box by each statement that you consider correct for each question. All questions are based upon material given in the course.

Those memories which exhibit enough of the correct outputs will be sent a certificate, in care of their owner, showing successful completion of the course.

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1. Which of these memories is static, sequential, and primarily used in main frames? (a) core. (b) semiconductor. (c) disc. (d) mag tape. (e) delay line. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

2. Paper cards can be unit records because (a) they have a fixed record length. (b) humans can interact with them. (c) they are cost-effective for small amounts of data. (d) they can be physically separated. (e) they are alterable and nonvolatile. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

3. Rotational switching is faster than domain switching because (a) several small vectors turn together. (b) more switching power can be applied. (c) the flux path is shorter. (d) rotating one vector completes the switch. (e) all of these. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

4. The usual plated wire organization is (a) bit organized. (b) linear select. (c) 16-bit words. (d) 3D. (e) ROM. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

5. Mag tape is favored over paper tape when the read and write requirements (a) exceed 300 and 100 cps. (b) use variable data formats. (c) are above 5,000 and below 300 cps. (d) require more than 3,000 passes. (e) exceed 1,000 and 300 cps. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

6. The main application for ROMs is in (a) process control. (b) semiconductors. (c) numerical control. (d) archival storage. (e) microprogramming. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

7. A linear transformer, or braided wire, ROM with eight transformers can store words. (a) 8. (b) 2^8. (c) 8^2. (d) 16. (e) $8 \cdot 10^2$. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

8. Magnetic film memories become cheaper per bit as (a) word length and speed decrease. (b) word length and capacity increase. (c) word length decreases and capacity increases. (d) capacity increases and thickness decreases. (e) CAM organization is implemented. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

9. The chief advantage of bubble memories is (a) the stable vapor-liquid interface. (b) small, ion-implanted bubbles can be formed. (c) finer scale logic and memory intermixing. (d) low defect density. (e) conductor patterns can be defined with electron beams. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

10. In hierarchical systems, value relates to (a) the amount of implicit storage. (b) the probability the processor will require an item next. (c) the apportionment between levels of memory. (d) buffer capacity as a percent of backup storage. (e) ratio of data transforming cycles to total cycles. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

11. In a display system, increased memory segmentation allows (a) a lower refresh memory data rate. (b) clock rates to 20 MHz. (c) a lower persistence buffer. (d) lower power dissipation. (e) larger disc capacity to be used. a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

12. Shift registers differ from delay lines because registers (a) are faster. (b) store more bits. (c) can recirculate data. (d) are sequential. (e) can alter data propagation rate.

13. Choose disc or drum storage over mag tape when (a) non-volatile archival storage is needed. (b) the EDP task requires auditing and sorting. (c) CPU reprogramming is undesirable. (d) programs require skipping from block to block. (e) all of the above.

14. An operand is (a) an argument. (b) a parameter. (c) a result. (d) the address of the next instruction. (e) all of these.

15. Tri-state logic helps overcome (a) current sourcing and sinking limitations of MOS driver outputs. (b) slow MOS speed by supplying more power. (c) binary coding restrictions. (d) complex RZ read electronics. (e) none of the above.

16. Parallel data search is implemented in (a) RAMS. (b) CAMS. (c) ROMS. (d) RMMS. (e) word organization.

17. Phase modulation coding has the advantage of (a) built-in clocking. (b) storing twice as much data as NRZ formats. (c) using flux transitions only for 1s. (d) transferring analog data. (e) all of the above.

18. The unified bus concept allows (a) one computer to supervise many controllers. (b) a separate I/O bus for each peripheral device. (c) converting computers to controllers by unplugging ROM modules. (d) MOS-bipolar interfacing. (e) direct memory access by any system element.

19. The inherent core characteristic that makes them useful in memories is their (a) round shape. (b) small size. (c) coordinate addressability. (d) switching speed. (e) square loop hysteresis curve.

20. Optical memories promise good cost effectiveness in very large sizes because (a) they adapt to CAM organization. (b) photographic masks can be used directly. (c) capacity increases roughly as the square of discrete components. (d) optical path length remains fixed. (e) none of the above.

21. The two major disadvantages of bistable flip-flop storage are: (a) large capacitance and periodic refresh. (b) large size and many transistors. (c) high power dissipation. (d) many decoding lines and high current.

22. The principal limitation when partitioning bipolar support chips for a hybrid semiconductor memory is (a) chip area. (b) gain bandwidth for sense signal amplification. (c) available I/O terminals. (d) MOS compatibility. (e) decoder and driver power dissipation.

23. A schmoo plot shows _____ for core array sense amplifiers. (a) the strobe position and threshold voltage tradeoffs. (b) signal polarity. (c) presence or absence of signal. (d) a 1 having 10 times the amplitude of a 0. (e) Sense Channel Margin Over 0.

24. A pushdown stack operates on the principle of (a) LIFO. (b) a shift register. (c) FIFO. (d) segmentation. (e) paging.

25. The fundamental operation of a memory is (a) access. (b) storage. (c) writing. (d) programming. (e) all of these.

26. A ROM is a special type of RAM that (a) reads faster. (b) reads slower. (c) has a relatively long write time. (d) is larger. (e) none of these.

27. A random access memory is (a) the fastest. (b) coordinate addressable. (c) larger than a ROM. (d) organized in blocks. (e) one in which data retrieval time is location independent.

28. The most common type of memory is (a) random access. (b) content addressable. (c) read only. (d) pushdown stack. (e) coordinate addressable.

29. Charge-coupled device memories require (a) fewer conductors than bubble memories. (b) complementary MOS circuits. (c) no refresh circuitry. (d) only one lead to couple adjacent cells. (e) none of these.

30. Hierarchical memories take advantage of the fact that system (a) cost/performance characteristics are better than the sum of the individual memories. (b) processors do not access data randomly. (c) most fetch cycles fetch programmed instructions. (d) program organization influences system efficiency. (e) all of the above.

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

31. A domain wall (a) separates magnetic from nonmagnetic domains. (b) can only exist in thick films. (c) is the equivalent of a bit. (d) all of the above. (e) none of the above.

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

32. Compared to gate-programmed semiconductor ROMs, custom-programmed ROMs (a) are faster. (b) have smaller elements for larger arrays. (c) reduce customer turn-around time by allowing more wafer pre-processing. (d) take advantage of complementary process technology. (e) are restricted to enhancement mode devices.

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

33. Bit, word, or hybrid organizations are determined by (a) choosing bit organization for high speed and word organization for low cost. (b) memory technology, which can limit the choices. (c) the number of cores a sense line can handle. (d) core diameter, which limits the number of wires. (e) the read/write circuitry.

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

34. An optical/thermal mass-memory system can store _____ bits. (a) 10^{10}. (b) 10^{12}. (c) analog data equal to 10^{14}. (d) 10^{15}. (e) (length of data strip)/2(laser wavelength).

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

35. Memory locations contain numbers that represent (a) instructions. (b) operands. (c) addressing information. (d) all of these. (e) none of these.

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

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Physical definitions of optoelectronic terms . . .
Materials—for both sources and detectors . . .
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Detectors—Photoconductors (or photoresistors) photodiodes—Materials, efficiency . . .
Amplifiers—Phototransistors, photoFETS—Materials, efficiency, sensitivity . . .

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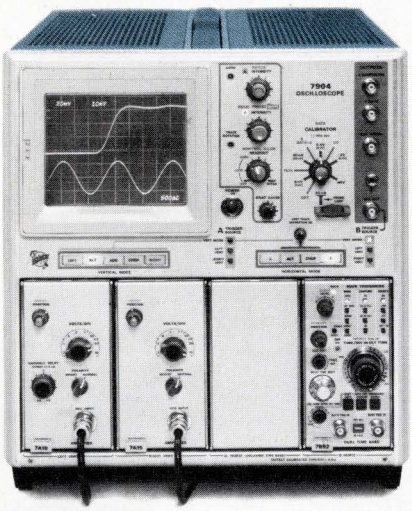

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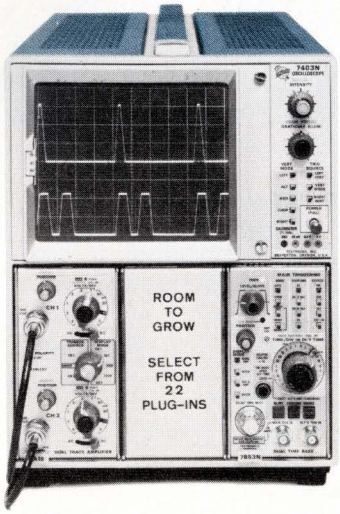

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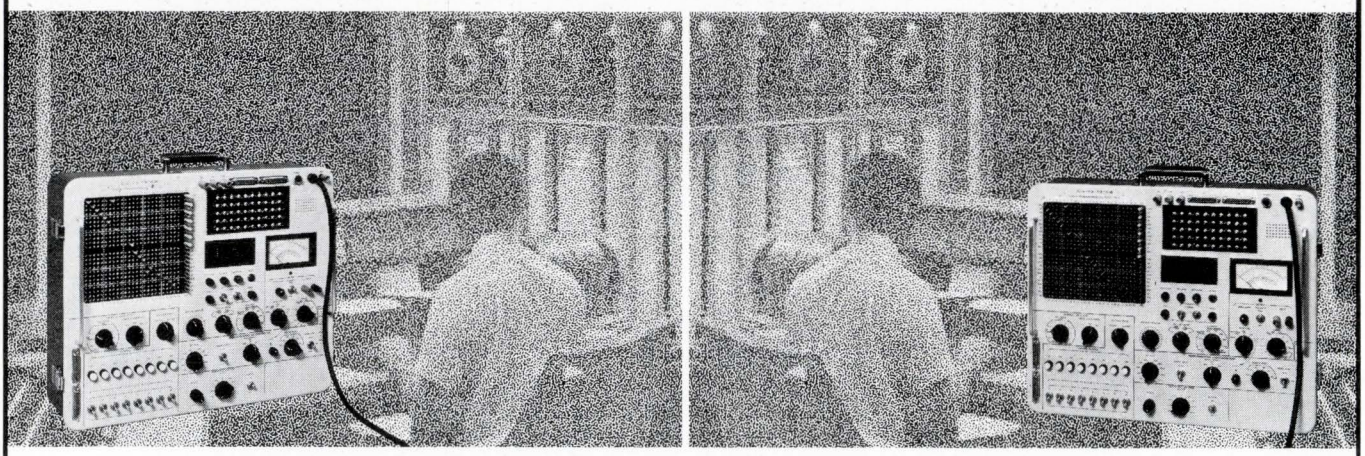
DATA COMMUNICATIONS

FCC Common Carrier Bureau chief Bernard Strassburg speaks on new vistas for data

Data Terminals—introducing a new five-part course

Data communications products

Testing data transmission systems end-to-bnɘ makes a lot of sense



no matter which end you're on

When trouble develops in a data communications system, the cause can be anywhere. Business machine. Computer. The data set. The transmission system. Isolating errors can take time, and time to the data customer is money.

The Sierra 1914B Data Transmission Test Set can localize the problem within a data system quickly and accurately. It simulates data and control signals going to and from the terminal equipment, and even checks the interface between equipment while the system is operating. With its unique programmable crosspoint matrix, the 1914B is instantly compatible with most any data set made today — or tomorrow, for that matter.

The 1914B counts and displays bit and block errors, determines error margins, and checks sequence and timing of control signals. It tests synchronous modems from 10 to 20,000 b/s, asynchronous from 150 to 2400 b/s, and 8-channel parallel systems at 75 b/s.

Look at the picture. You can tell the 1914B will do more for you than we've said. Whether you're a telephone company, modem manufacturer, or data system user, we'd like to tell you more.

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Sierra manufactures a complete line of transmission, data and RF instruments for the communications industry.

Regulation reoriented

Government regulation and the communications industry had one of their finer hours in May when the Federal Communications Commission announced its landmark policy decision which will make possible the freer entry of new common carriers to serve the rapidly expanding and changing markets for specialized communications services, such as data, facsimile, and other forms of record transmission. The Commission determined that competitive rather than monopoly supply of these dynamic markets would more readily achieve our national goals of adequate and efficient communications at reasonable cost to the user.

This decision, like the record on which it is based, is a comprehensive one and should be required reading by any one with an interest in this nation's communications resource. However, apart from the "watershed" importance of the decision from the standpoint of the industry's future structure, the decision has other noteworthy meanings which may not be readily apparent.

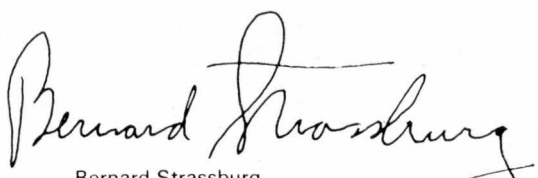
First, the decision is the product of a proceeding which serves as an example of how a regulatory agency can adapt the administrative process to the modern-day need for speedy and effective policy determinations. The proceeding, which was completed in record time of less than a year, was designed by the FCC to resolve the basic policy issues which were common to a large number of applications filed with the agency by various entities seeking entry into the specialized communications markets. Each application was staunchly opposed by the existing carriers who urged the FCC to treat the applications in an adjudicatory framework. The FCC opted for a quasi-legislative approach rather than *ad hoc* adjudicatory case-by-case litigation. Its choice was dictated by the nature of the essential issues which it deemed to be nationwide in scope involving the total structure of the communications industry and market.

Second, the decision is an example of the willingness and capability of the FCC to alter the structure of the industry so as to better adapt it to the changing conditions of supply and demand in the communications field. In effect, it is an extension of other actions taken by the FCC in recent years to remove restrictive policies and practices which have been characteristic of the predominantly monopoly structure of the domestic common carrier industry. Commission removal of the prohibitions against the customer's right to interconnect equipment and systems of his own choosing to the carriers' facilities is one example. This and other actions of the FCC have opened up the communications environment to the technical and innovative capabilities of individuals outside of the existing carrier establishment. In turn, the public has been afforded a much expanded range of choice as to how it may best satisfy its requirements for new and diversified communications.

Third, the entry of competing carriers will require some changes in traditional regulatory concerns. Heretofore, regulation has focused mainly on jurisdictional cost separations, rate of return, technical quality and adequacy of monopoly services. With multiple entry into the emerging specialized communications market, competitive rivalry may be expected to provide the social and economic benefits which regulation has sought to achieve in a monopoly setting. Realization of these goals is, of course, complicated by the fact that one of the principal competitive rivals, the Bell System, will be operating from a powerful base of monopoly revenues which could be used to stifle or control *bona fide* competition in the specialized markets. The existence of large monopoly markets could in the absence of regulatory restraint enable Bell to earn its maximum allowed rate of return even though it were to provide competitive services below cost.

Thus, once new carriers enter the specialized communications markets, pricing policy become particularly important to the maintenance of fair and efficient competition. In this connection it must be noted that the specialized markets will be the total business of the new carriers, whereas these markets will be only a small fraction of Bell's total operations. Accordingly, one of the most important concerns of regulation will be to prevent Bell's monopoly service from subsidizing its competitive services. The FCC now has a major hearing in progress in which it expects to establish pricing standards which will prevent cross-subsidization by Bell.

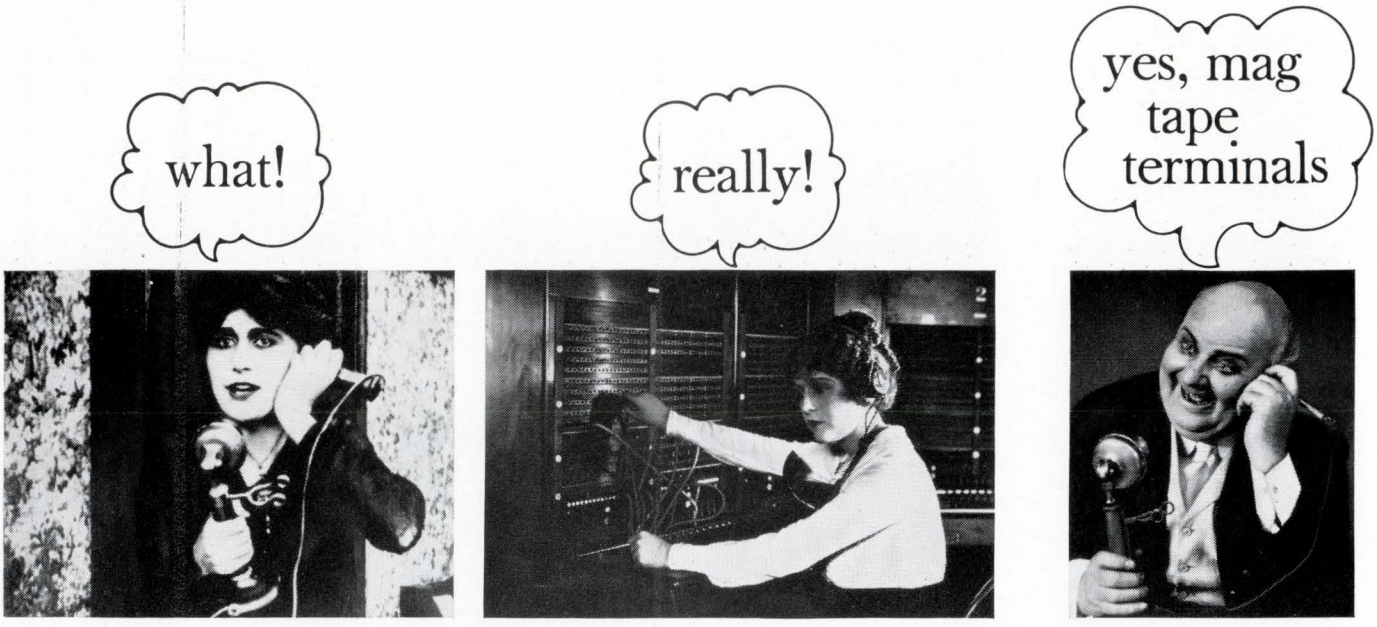
Finally, restrictive carrier practices and other tariff limitations of the past may have been acceptable under the presumption of the natural monopoly. However, they may well be unacceptable in an environment of competitive freedom. Thus, the antitrust and fair trade laws, designed to prevent monopolization, become an important part of the new competitively oriented regulatory policy. The landmark FCC decision on specialized carriers has established the foundation for this reexamination.



Bernard Strassburg
Chief, Common Carrier Bureau
Federal Communications Commission

Introducing Bernard Strassburg

Bernard Strassburg is in a unique position to speak on the recent (May 1971) Federal Communications Commission's landmark decision opening up the data communications field to competition. As Chief of the FCC's Common Carrier Bureau, he issued a report just a year ago that recommended the entry of new carriers into the specialized communications area because of the explosive growth of communications, particularly data. Specializing in common carrier regulation since joining the FCC in 1943, Strassburg has been singled out by knowledgeable insiders as a key motivating force in the decisions that have given new life to the communications industry.

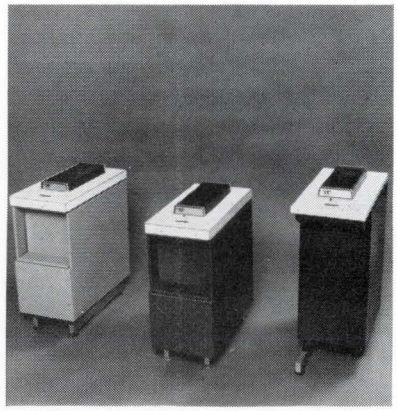


It's true.

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.

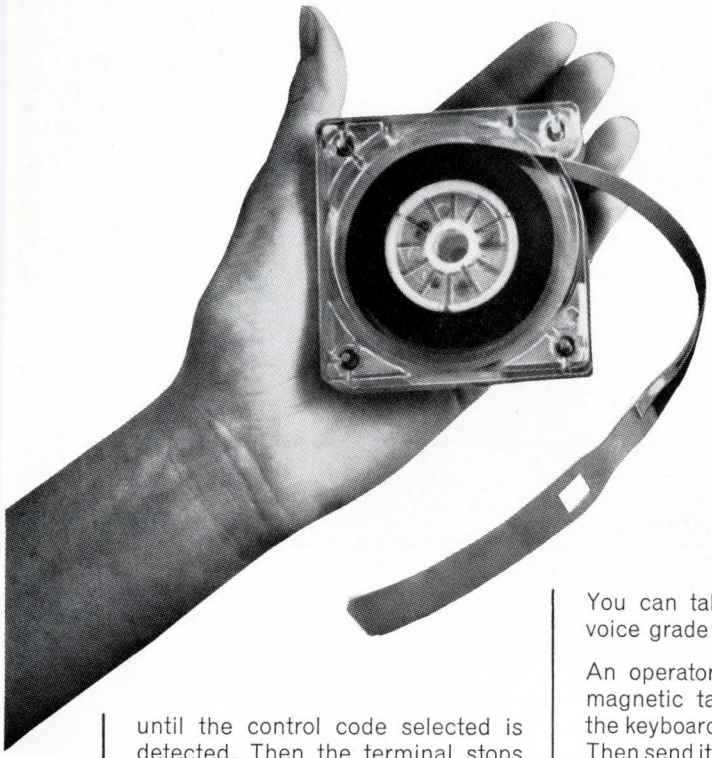
This means that your data is easier to store, easier to handle, easier to work with than ever before. And it's reusable.

Teletype is a trademark registered in the U.S. Pat. Office.

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.



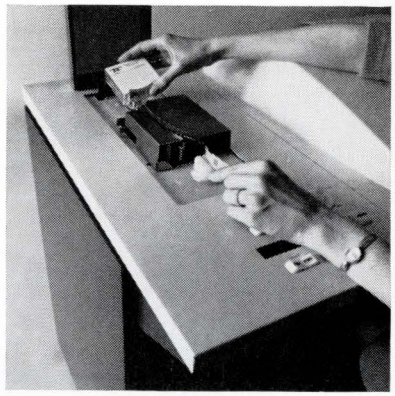
Also magnetic tape adds high speed on-line capability to low speed data terminals.

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 model 38 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 on-line.

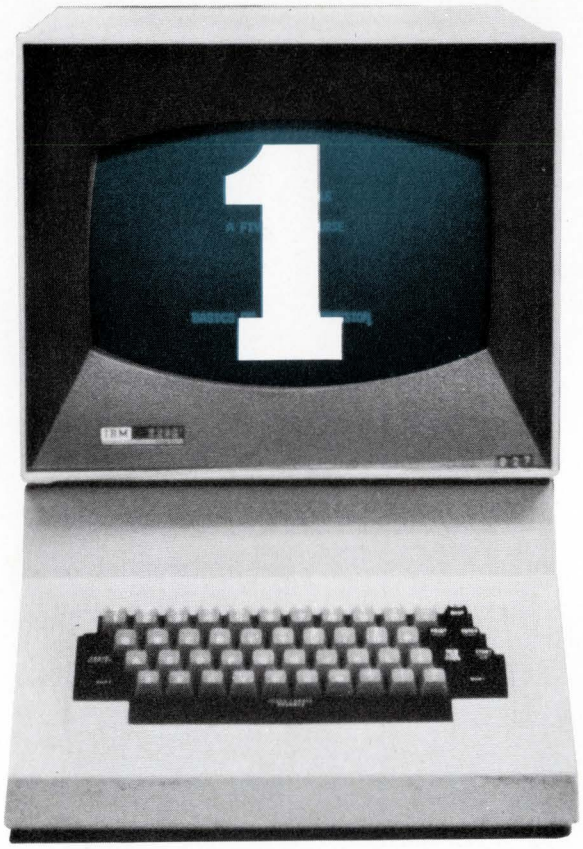
If you would like to know more about this new line of Teletype magnetic tape data terminals, please write Teletype Corporation, Dept. 55-15, 5555 Touhy Avenue, Skokie, Illinois 60076.

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

TELETYPE

machines that make data move

DATA TERMINALS:



One of the keystones for the growth of data communications in the '70s will be the need for state-of-the-art data terminals, intelligently integrated into a communications system. (The data terminal market alone has been conservatively estimated at $8 billion by 1980.) Recognizing this, **The Electronic Engineer** begins this month a five-part course—Data Terminals. Assembled by Technical Editor Arthur J. Boyle, from inputs from individual experts in their respective specialties of data terminal technology, the course will discuss in detail all facets of terminals. Beginning this month with the basics of data transmission, the course will then move on to examine such primary components as keyboards, CRTs, character generators, and so on. Following that will be an in-depth look at such data transmission equipment, as modems, multiplexers, and minicomputers. The final two sections of this course will be devoted entirely to the varieties of data terminals available now and later.

THE EVOLUTION OF AN INDUSTRY: DATA COMMUNICATIONS

COMMUNICATIONS		TELEPROCESSING		COMPUTERS	
				1822	Babbage differential engine
1832	Morse's telegraph				
1876	Telephone				
1915	Teletypewriter			1886	Hollerith card
				1917	Electric key punch
1931	TWX	1933	Racetrack toteboard (Arlington Park, Chicago)		
1935	Facsimile service			1937	Harvard Mark I calculator
				1940	Bell Labs relay computer
1946	Microwave telephony			1945	ENIAC-electronic computer
				1949	EDSAC-stored program computer
1951	Direct distance dialing (DDD)			1951	Univac I-gen'l purpose computer
		1952	American Airlines "Reservisor" system		
1958	Dataphone® service			1958	IBM 7090-solid state computer
1960	ESS I (electronic switching system)			1960	COBOL
1961	Wats—Telpac	1961	Howard Savings Bank on line terminals		
1962	Telstar satellite			1962	Message switching computers
1963	ASCII	1963	MIT's Project MAC Time sharing		
		1964	PCM (pulse-code modulation)		
		1973	?		

Max Beere, of Tymshare Inc., traces in this chart the development of communications and computers. In 1933, at Arlington Racetrack in Chicago, the two disciplines were merged and a new industry was born.

a five-part course

Battle of the bits

Alberto Socolovsky
Editor, **The Electronic Engineer**

It all started in 1968, when the Federal Communications Commission (FCC) ruled that telephone companies could not apply tariffs to discriminate against the attachment of the Carterfone equipment to their telephone lines.

Until then, the only way to connect a so-called "foreign attachment"—such as a piece of digital equipment—to a telephone line was to get both permission and interface equipment from the telephone company. In other words, the user's installation ended at the point where the digits were coming out of his equipment, and the telephone carrier worried about how, where and when to hook them into its lines.

Even though the original Carterfone attachment was for coupling mobile radio systems—not computers—to phone lines, the FCC's ruling opened up the field to interface equipment designed for data communications. Once in possession of this type of equipment—the data terminal—its users requested more lines from the telephone company and loaded them with digits. This loading, of course, placed an additional burden on the telephone network. A burden the carrier had not accurately estimated since, having lost their interconnection monopoly, they could not count the new data terminals entering the field.

This communications lag, in turn, prompted several companies to apply to the FCC for authorization to become communications carriers. Since the issues involved a delicate balance between technology and tariffs, the FCC commissioned Stanford Research Institute (SRI) in the summer of 1968 to study the "interdependence of computer and communications services." The SRI study, released in May 1969, answered the technological question by agreeing that "the present telephone network (in the United States) was not built for data transmission."

The FCC then invited comments to the study by the new applicants, by the existing carriers, and by other "interested parties" such as manufacturers and users of digital equipment. The comments developed into a controversy, which was aired at hearings the FCC called in January 1971. The Commission finally reached a decision at the end of May 1971. This decision, which may have lasting repercussions in both the fields of communications and data processing, authorizes competition among carriers of "specialized communications," a term which includes data communications.

In addition to the existing carriers (AT&T and Western Union), which will also be allowed to compete, there are 33 companies which have applied for a total of 1877 microwave links. Seventeen of these companies are affiliated with Microwave Communications, Inc. (MCI), which the FCC has already authorized to build a microwave link between Chicago and St. Louis. Another applicant, Data Transmission Co. (Datran), is of special interest because it proposes to build a network solely for the transmission of data, which will include not only long distance transmission, but also switching and local distribution.

Data terminals and data communications

The FCC's decision rested primarily on its conviction that the market (the number of data messages) is large enough to justify competition, and that users will benefit from such competition among carriers in both price and quality of service. These benefits, in turn, will create more demand for digital terminal equipment—the data terminals.

But there is another benefit the new carriers will bring about. As their name—specialized carriers—indicates, they will offer specialized service. By their very nature, terminals such as teletypewriters or card readers have data rates much slower than, for example, key-to-tape or interactive CRT terminals. The specialized carriers have proposed transmission rates tailored specifically to the diverse data rates of terminals. The availability of these custom services, which are not presently offered by AT&T or Western Union, should bolster the demand for all types of terminals.

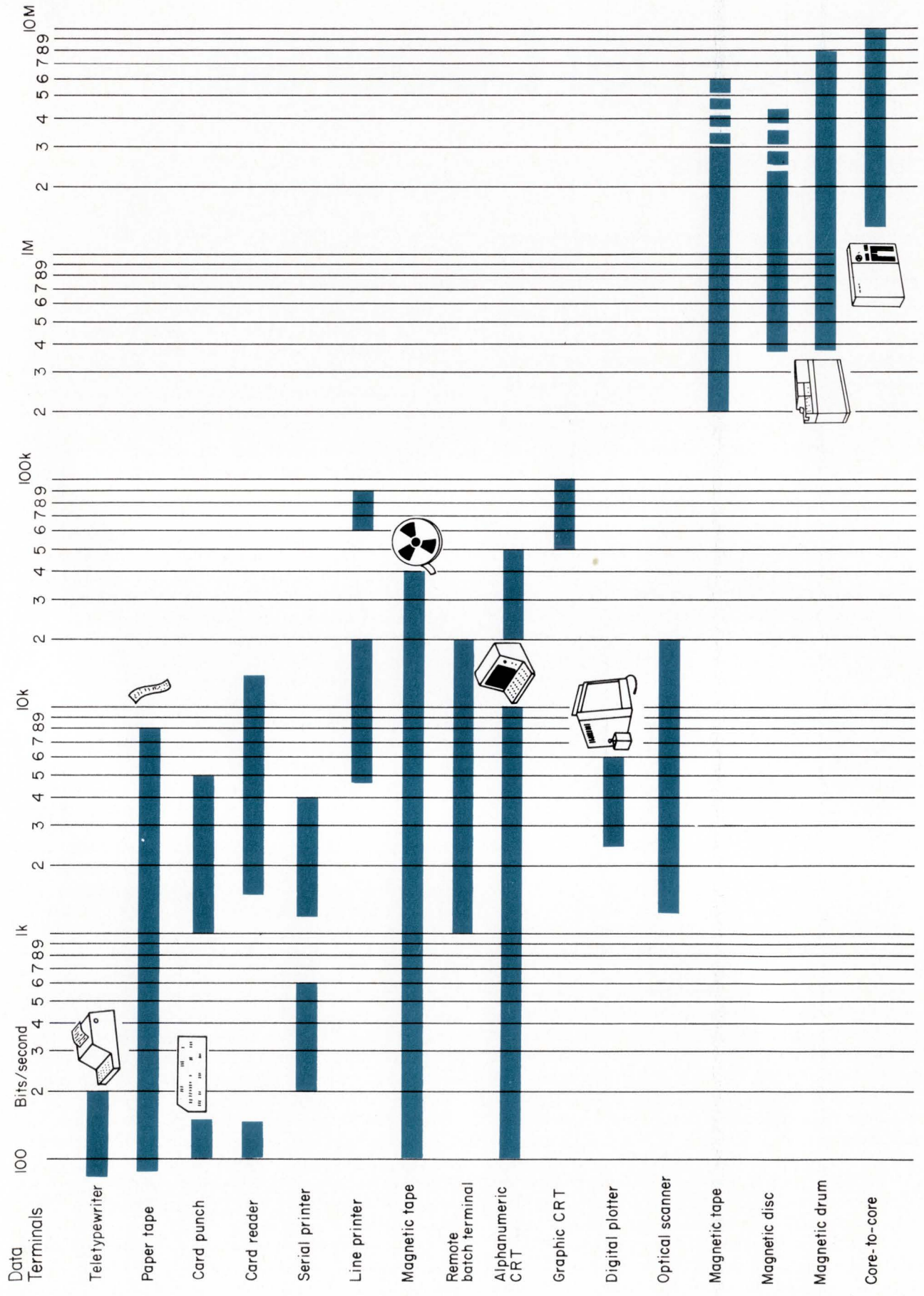
The chart shows typical operating data rates for some popular types of terminals. While the teletypewriter is unquestionably the most popular terminal used today, and it will remain so for a long time, most of the development activity for new terminals will take place in the kilobit/second range (for remote batch terminals).

Because of this dramatic upswing in the opportunities for data communications, and, of course, data terminals, we are introducing in this issue the first installment of a five-part course on data terminals. These terminals, inextricably linked to the growth of data transmission, will provide much of the design possibilities for our readers in the future.

This first installment will concentrate on the basic elements of data communications itself. A subsequent section will treat the components that go into a terminal's design, such as keyboards, cathode ray tubes, and the integrated circuits which find their application as character generators, keyboard encoders, and transmission line drivers and receivers. Following that, we will look at the types of equipments that data terminals must interface with: modems, multiplexers, and minicomputers. In other words, the various pieces of equipment that combine with a terminal to make a complete data communications system. Finally, there will be a two-part examination of the varieties of terminals—teletypewriters, magnetic and paper tape terminals, cathode ray tubes, etc.

We hope that this course on data terminals, through the participation of our readers, will contribute to the development of the dynamic and very promising field of the 70's—data communications.

OPERATING DATA RATES FOR MAJOR TYPES OF DATA TERMINALS



(Chart courtesy of Microwave Communications, Inc.)

DATA COMMUNICATION

Getting it from here to there

Arthur J. Boyle, Technical Editor

Any discussion of data terminals must begin by talking about data communications. For, after all, the only purpose of a data terminal is to communicate. Before the advent of the modern computer, man's communication problems were much simpler. When he wanted to transmit a message or some data, he wrote it down or spoke it into a telephone. Because he was communicating with another man he had no problems with special languages or incompatible speeds. Now, however, this same man must communicate with a computer, and that is an entirely different ball game.

The language

The first problem that our human communicator faces is that he and the computer do not speak the same language. The computer talks in binary 1s and 0s, not in letters and decimal numbers. Therefore the first step is to translate from man language into machine language, or in other words, to encode the data.

What complicates this encoding process is that while the machine does not speak the same language as the man, it does not necessarily speak the same language as another machine either. This has led to the development of several codes aimed specifically at allowing machines to communicate with each other.

Most data communication systems today use either the ASCII (American Standard Code for Information Interchange), or EBCDIC (Extended Binary-Coded-Decimal Interchange Code). Other possibilities include Baudot, Hollerith and four-of-eight codes.

The Baudot code is a five-level (five-bit) code which is principally used in telegraph systems. Because it contains only five bits, the code would normally be able to convey only 32 characters. However, 26 of the code combinations are assigned dual characters depending on whether they are proceeded by a *Letters* (shift to lower case) or *Figures* (shift to upper case) character.

The Hollerith code was developed for punched card applications. It is a 12-level code which is broken into three-zone bits and nine-data bits. One zone bit and one data bit represent each character. Because of this structure, the code lends itself to easy error detection.

The four-of-eight code is a fixed ratio code. This means that every character has the same ratio of 1s to 0s. In this case, each character consists of four 1 bits and four 0 bits. While the code is less efficient than some of the others, it lends itself very well to applications which require easy error detection. For example, the Bell System Touch Tone inquiry units use the four-of-eight code.

The ASCII code, which is the most widely used today, is a seven-level code plus parity bit. (Parity is a simple error checking scheme which makes the number of 1 bits in a word always odd or always even.) Practically all communication terminals use ASCII. However, individual manufacturers will make minor changes in the code to make it more efficient for a particular terminal.

Another possible code is a binary-coded decimal (BCD) version of the Hollerith punched card code. This compresses the code into six bits, two of which represent the three-zone bits and four of which represent the nine-data bits. A far more popular version is the EBCDIC code mentioned above. This is an extension of the BCD code to eight bits which allows it to handle control and graphic characters also.

Once our communicator has translated his information into a code which is suitable for communication between machines, he is immediately faced with another dilemma. The binary wave train which contains his information is just not suitable for transmission over most forms of communication links. He solves this problem in exactly the same way it is solved in analog communication systems; he modulates a carrier with the signal which contains his information. For more information on modulation in data communication systems, see the box in this article.

Transmission facilities

Having finally arrived at a suitable carrier signal which contains our information, we are ready to consider the actual transmission system. The most familiar system today

DATA TERMINALS COURSE

is Bell's Direct Distance Dialing network (DDD). This is a switched network, which means any subscriber may call any other subscriber. The actual mode of transmission (e.g. coaxial cable, microwave, etc.) in the DDD will vary depending on the two points being connected. It will also vary among calls between the same two points depending on the routing which each takes.

The alternate to a switched communications network is the private line. Here, a permanent transmission link is established and maintained between two or more points. This link is "dedicated" to providing communication between these points.

The basic communication channel is the voice-grade channel. This is a channel with a nominal bandwidth of 4000 Hz. The usable bandwidth is, however, about 2700 Hz because of guard bands at either end which prevent interference between adjacent channels.

For low speed applications, such as teleprinters, communication is usually accomplished over a telegraph channel. Such channels are usually restricted to transmission speeds of 75 baud. At the other end of the spectrum from the telegraph channel, you will find broadband channels. This is a rather loose definition, and usually means any communication channel with a capacity greater than a voice grade channel. Broadband channels are generally available with bandwidths which are multiples of the basic voice-grade channel bandwidth.

Communication between two points may be either simplex, half duplex or full duplex. In simplex communication, point A may only talk to point B; there is one-way communication only. A half-duplex system is one in which point A can talk to point B, and point B can talk to point A, but only one may talk at a time. There is two-way communication, but in only one direction at a time. Full duplex is full two-way communication. Point A talks to point

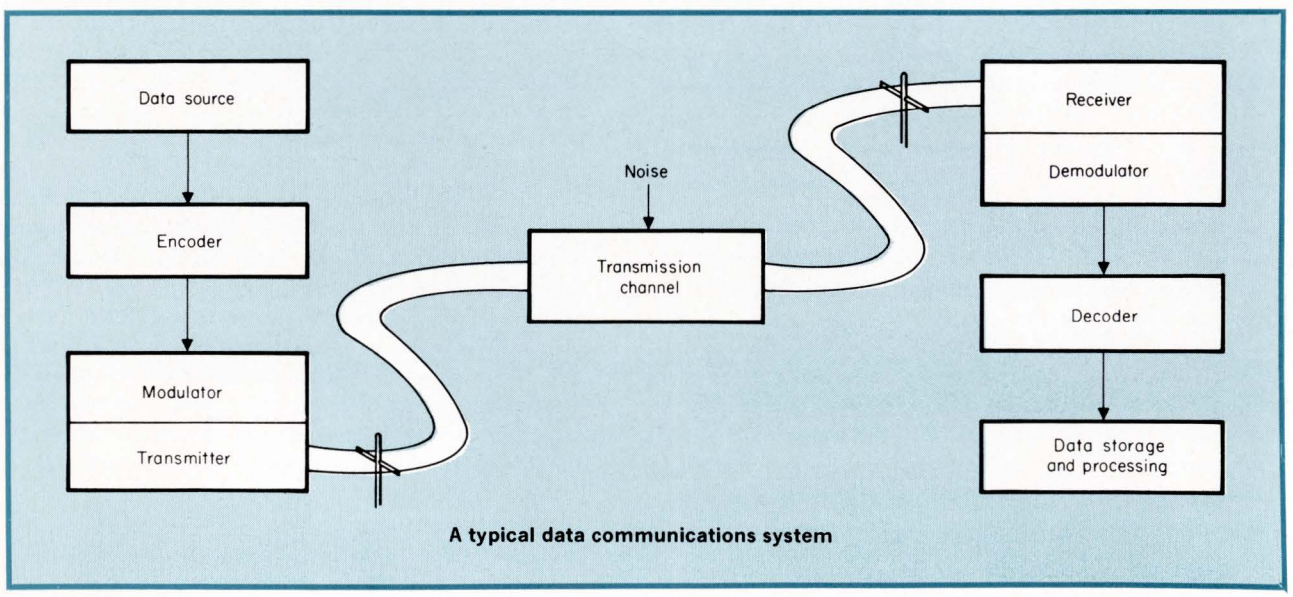
TRANSMISSION SPEED

Defining speed in a data communication system can be a confusing proposition. There are two basic terms used, and they do not really mean the same thing, although they are sometimes interchanged.

One of these, bits per second, is a measure of how fast information can be transmitted in a particular system. An important point to remember is that when talking bits per second, you only consider actual data bits. The other term, baud rate, is a measure of the signaling speed of the actual channel. By definition, the baud rate is equal to the reciprocal of the time in seconds occupied by the shortest element in the code.

Let's take for an example a Teletype Model 35. This unit operates in an asynchronous mode and uses the eight-bit (seven bits + parity) ASCII code. Data is transmitted by means of FSK type of modulation, so each signaling element (in this case, each change in frequency) contains one bit of information. Because of its asynchronous operation, the code for each character is prefixed by one start bit and followed by two stop bits. Therefore each time the unit transmits one character of information, it sends 11 bits down the line. If the unit is operating at 10 cps, the information rate is 80 bps (10 characters x 8 data bits character). However, because there are really 110 changes in frequency in each one second interval, the shortest signaling element is 1/110 of a second and the channel must have a capability of 110 baud.

To take a different example, consider a synchronous system which has a carrier modulated by a four-level modulating signal. With synchronous transmission there are no start and stop bits, so all bits transmitted are data bits. In addition, because of the four level modulating signal, each signaling element contains two bits of information. Therefore a system transmitting 9600 bps could operate over a 4800-baud channel.



A typical data communications system

ASC II CODE

Bits b_4 b_3 b_2 b_1	ROW ↓ / COLUMN →	b_7 b_6 b_5 = 0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
		0	1	2	3	4	5	6	7
0 0 0 0	0	NUL	DLE	SP	0	@	P	`	p
0 0 0 1	1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0	2	STX	DC2	"	2	B	R	b	r
0 0 1 1	3	ETX	DC3	#	3	C	S	c	s
0 1 0 0	4	EOT	DC4	$	4	D	T	d	t
0 1 0 1	5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0	6	ACK	SYN	&	6	F	V	f	v
0 1 1 1	7	BEL	ETB	'	7	G	W	g	w
1 0 0 0	8	BS	CAN	(	8	H	X	h	x
1 0 0 1	9	HT	EM	)	9	I	Y	i	y
1 0 1 0	10	LF	SUB	*	:	J	Z	j	z
1 0 1 1	11	VT	ESC	+	;	K	[	k	{
1 1 0 0	12	FF	FS	,	<	L	\	l	¦
1 1 0 1	13	CR	GS	-	=	M	]	m	}
1 1 1 0	14	SO	RS	.	>	N	^	n	~
1 1 1 1	15	SI	US	/	?	O	___	o	DEL

ENQ—Enquiry
ACK—Acknowledge
BEL—Bell
BS—Back space
HT—Horizontal tab
NUL—Null
SOH—Start of heading
STX—Start of text
ETX—End of text
EOT—End of transmission
ETB—End of transmission block
CAN—Cancel
EM—End of media
SUB—Substitute
ESC—Escape
SI—Shift in
DLE—Data link escape
DC1-DC4—Device controls
NAK—Negative acknowledge
SYN—Synchronize
FS—File separator
GS—Group separator
RS—Record separator
US—Unit separator
LF—Line feed
VT—Vertical tab
FF—Form feed
CR—Carriage return
SO—Shift out

B at the same time point B is talking to point A. The common carriers provide both half- and full-duplex service and the choice depends on the application, although the majority of terminals operate in the half-duplex mode.

At the receiving end of our communication link, the procedure is merely the reverse of what occurred at the transmitting end. First, the modulating information is stripped off the carrier. It is then translated into the form in which it will be used and goes into the storage and processing portion of the system.

DATA TERMINALS COURSE

MODULATION TECHNIQUES

When two pieces of digital equipment communicate with each other, they usually do so over an analog communication link. The digital transmission between the two devices is accomplished by having the bit stream modulate a carrier which is suitable for transmission by microwave or coaxial cable.

With digital communication, as with all communication systems, there are three approaches to modulating a carrier with information. These are to vary the amplitude, the frequency or the phase of the carrier in accordance with the information to be conveyed.

Frequency modulation The most popular technique in data-transmission systems is frequency modulation, or frequency shift keying (FSK). Two different frequencies are transmitted to differentiate between the 1 state and the 0 state of a bit (mark and space in telegraph terms). In the low-speed applications which account for most present-day data-transmission systems, asynchronous FSK is the most advantageous choice of modulation.

Among the biggest advantages of FSK is that it is relatively immune to many kinds of errors, because each bit time is relatively long. This means it is difficult for a noise burst to distort a bit to such an extent that it will be misinterpreted. Frequency shift keying, however, is not very efficient in terms of bandwidth utilization, and consequently it is not used in high-speed systems or where bandwidth efficiency is important.

Amplitude modulation With amplitude modulation, or amplitude shift keying (ASK), the amplitude rather than the frequency of the carrier contains the modulation information. In two-level ASK systems, the carrier's amplitude is varied between two discrete levels to indicate the value of a particular bit.

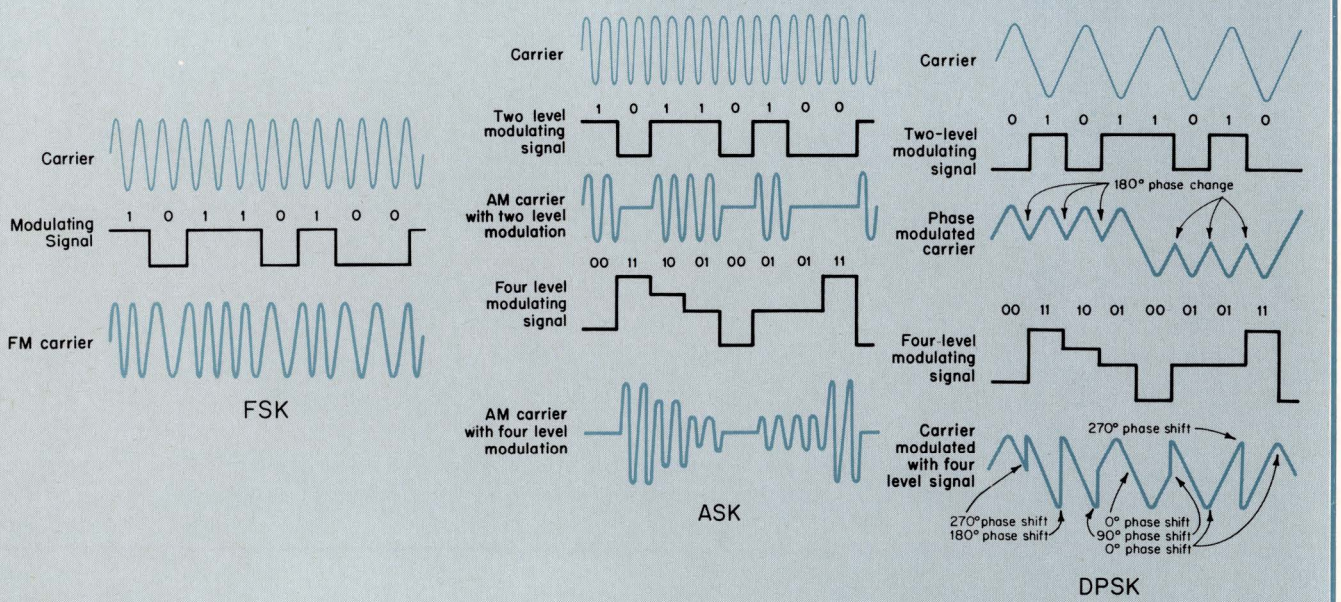
The most popular approach to data transmission by amplitude modulation is vestigial sideband transmission (VSB). This popularity arises from the fact that it is very efficient in terms of bandwidth utilization and provides a good signal-to-noise ratio.

The VSB-am approach also lends itself to multilevel coding schemes. Instead of the modulating signal being restricted to one of two possible levels, it is allowed to assume any one of four (in most cases) possible levels. Now, each level contains two bits of information. This allows, in the ideal case, a doubling of the bit rate with no increase in bandwidth. While it is possible to adopt multilevel coding to FSK, the advantage is not as great. With ASK, you get a higher bit rate with no increase in bandwidth. In FSK systems, however, you usually must increase the bandwidth in order to use multilevel coding schemes.

Phase modulation As with VSB-am, phase modulation or phase shift keying (PSK) finds its application primarily in high-speed data transmission systems. In its simplest form, two phases of the carrier, 180° apart, are transmitted. Each phase carries one bit of information.

Phase shift keying also lends itself to multilevel coding. Additional phase angles are created, allowing each phase angle to carry more than one bit of information. The limiting factor is that as the number of phase angles is increased, the noise susceptibility of the system also increases. Characteristics of present data communication links limit the practical number of angles to eight, so that each state carries three bits of information.

The most popular form of PSK is differential phase shift keying (DPSK). Here, each phase angle is made relative to the preceding angle, rather than to some standard. This approach overcomes some coherence problems and is less sensitive to phase jitter and certain other kinds of impairments in the transmission link.



EBCDIC CODE

Bit Positions → 01 / 23 / 4567	00	01	10	11
0000	NUL			
0001				
0010				
0011				
0100	PF	RES	BYP	PN
0101	HT	NL	LF	RS
0110	LC	BS	EOB	UC
0111	DEL	IDL	PRE	EOT
1000				
1001				
1010				
1011				
1100				
1101				
1110				
1111				

01 / 4567	00	01	10	11
0000	Blank	&	-	
0001				
0010				
0011				
0100				
0101				
0110				
0111				
1000				
1001			/	"
1010	?	!		:
1011		$	,	#
1100	←	*	%	@
1101	(	)	¬	'
1110	+	;	_	=
1111	‡	¢	±	✓

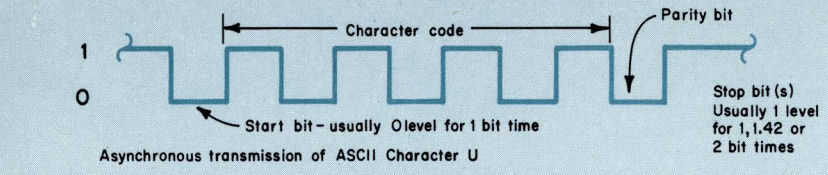
10 / 4567	00	01	10	11
0000				
0001	a	j		
0010	b	k	s	
0011	c	l	t	
0100	d	m	u	
0101	e	n	v	
0110	f	o	w	
0111	g	p	x	
1000	h	q	y	
1001	i	r	z	
1010				
1011				
1100				
1101				
1110				
1111				

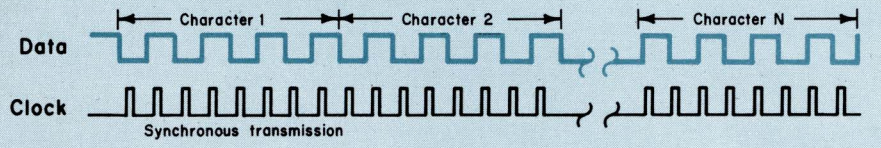
11 / 4567	00	01	10	11
0000	>	<	‡	0
0001	A	J		1
0010	B	K	S	2
0011	C	L	T	3
0100	D	M	U	4
0101	E	N	V	5
0110	F	O	W	6
0111	G	P	X	7
1000	H	Q	Y	8
1001	I	R	Z	9
1010				
1011				
1100				
1101				
1110				
1111				

Asynchronous and synchronous transmission. In the asynchronous mode, each character is prefixed by a start bit and followed by one or more stop bits. During the time occupied by the start bit, the receiver enables its internal clock and then samples the rest of the message at the frequency of this clock. The time period of the stop bit(s) allows the transmitter and receiver to resynchronize for the transmission of the next character.

With synchronous transmission, long blocks of data are sent with only a simple framing pattern at the beginning of the block. Most synchronous transmitters also provide clock information in addition to transmitting the data. This tells the receiver when to sample the data stream and means the receiver does not need its own clock.

Asynchronous transmission is not nearly as efficient as the synchronous mode because of the start and stop information (non-data bits) associated with each character. On the other hand, loss of synchronization between the transmitter and receiver in an asychronous system means you lose only one character. In a synchronous system, you may very well lose an entire block of data.





Assuming that all has gone well, and that noise has not distorted his data too badly, our man has now successfully communicated with his computer, be it across town or across the country. The implications of this ability are just now being realized.

Our modern civilization has imposed a great many demands on the technical community. Perhaps the most challenging of these is the need for almost instantaneous communications. Airlines, banks, the stock market and countless other businesses of all types are utilizing data communications daily and clamoring for better and cheaper means of communicating with the computer. The next step is to make the power of the computer available to each of of us through terminals in the home. Man's need to communicate can do nothing but continue to grow. Fulfilling this need promises to be as exciting a project as we have ever undertaken.

INFORMATION RETRIEVAL

Computers and peripherals, Communications

DATA COMMUNICATIONS PRODUCTS

MODEM TEST SET

Model 251A connects directly to the

RS-232-C connector on the modem. Its pattern generator sends one of five selected patterns to the modem and self-synchronizing circuit compares the modem output to the known pattern. If a difference is detected, a numerical counter is incremented, and the error rate can be directly read from the solid state display. Bowmar/ALI Inc., Acton, Mass. 01720.

Circle Reader Service #330

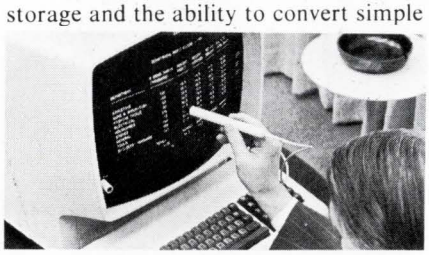
MODEM BAND-PASS FILTERS

These filters pass the mark and space frequencies of one channel, while rejecting the adjacent channel. The μIM1100 series has a bandpass range between 1070 Hz and 1270 Hz, and the IM2200 series has a bandpass between 2025 Hz and 2225 Hz. Both series let you select 40 dB, 50 dB, or 60 dB channel separation. The group delay of all the options is constant across the bandpass to within 1%. Integrated Electronics Inc., 16845 Hicks Rd., Los Gatos, Calif.

Circle Reader Service #331

INFORMATION DISPLAY SYSTEM

The IBM 3270 system features buffer storage and the ability to convert simple



computer commands into sophisticated display and printer operations. The system can be attached to a System/370 or System/360 Model 25 or larger, with up to 32 display stations linked to a control unit. International Business Machines Corp., Data Processing Div., 1133 Westchester Ave., White Plains, N.Y.

Circle Reader Service #332

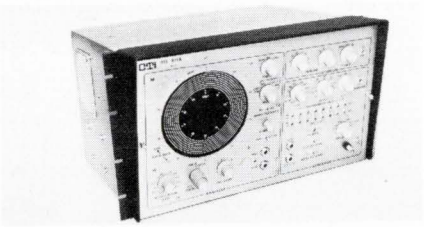
DATA PUMP

The Data Pump 2400 is a compact, frequency shift keyed modem, which operates over 3002 voice-grade telephone lines. The unit can replace the Bell 201B Data Sets and is available for lease or purchase. Ultronic Systems Corp., Data Communication Products Div., Mt. Laurel Industrial Park, Moorestown, N.J. 08057.

Circle Reader Service #333

SIGNAL DISTORTION ANALYZER

The DTS-531 analyzes each transition of the signal and provides a LED

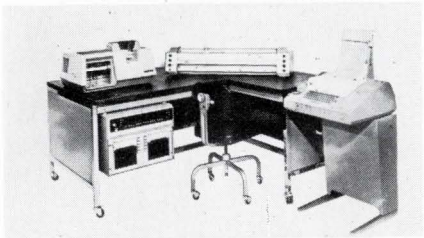


display pattern to show the type of distortion and its magnitude from 0 to 98%. The display indicates the type of distortion, such as marking bias, spacing bias, speed and cyclic distortion. The standard unit can operate at data rates as fast as 4800 baud. Communications Technology Inc., 1900 York Rd., Timonium, Md. 21093.

Circle Reader Service #334

BATCH TERMINAL

This system, dubbed GEORGE, is a

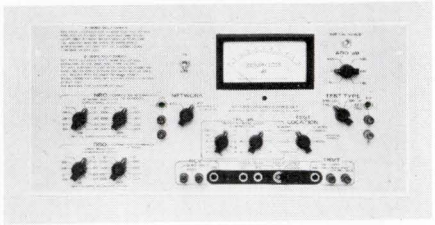


real-time data acquisition and remote batch terminal, aimed at engineering, scientific, and business applications. The unit includes a mini-computer, selected peripherals, and a complete software package. In many applications, it cuts communications costs with its high speed precomputed data transmissions. Applied Computer Systems, Inc., Box 6479, Austin, Tex. 78767.

Circle Reader Service #335

BALANCE TEST SET

This self-contained rack mounted unit

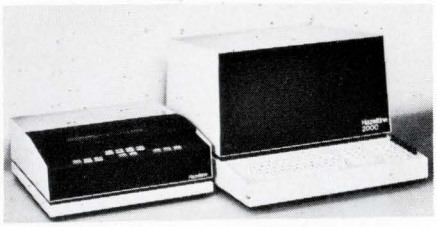


measures echo return loss and singing point of 4-wire or 2-wire telephone circuits. Model 9032 features readout (direct in dB) of return loss from -10 to $+50$ dB without correction factors. Price $800.00; delivery, two weeks. Wiltron Co., 930 E. Meadow Dr., Palo Alto, Calif. 94303.

Circle Reader Service #336

CRT/TAPE CASSETTE TERMINAL

This system combines a high-speed,

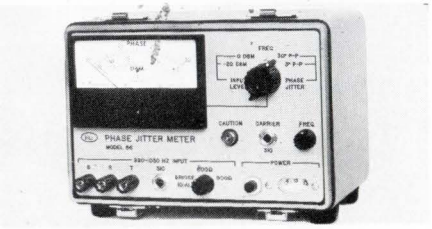


fully-buffered CRT terminal and high-speed magnetic tape storage device. The system features dual tape drives, paper tape emulation, and an exceptional capability for on/off line data storage and retrieval. Hazeltine Corp., Greenlawn, N.Y. 11740.

Circle Reader Service #337

PHASE JITTER METER

The Model 56 is designed to Bell System specifications, and measures p-p



phase jitter on 30° and 3° full scale ranges. The instrument accepts test frequencies between 990 and 1030 Hz for testing over both conventional and T carrier facilities. $965.00. Hekimian Laboratories, Inc., 322 N. Stonestreet Ave., Rockville, Md. 20850.

Circle Reader Service #338

Where to Get...

1-WATT TWTs for Military Applications

Now there's a whole new series of 1-watt TWTs built to withstand the severe environments of military applications. Designated as the W-J 2500 series, these reliable tubes were designed for use as drivers in ECM systems and communications links. They meet the shock, vibration, and temperature requirements of MIL-E-5400, class 2, and MIL-E-16400, class 2.

Operating in selected octave bandwidths in the 0.7 to 17 GHz frequency range, the WJ-2500 series of TWT's provides +30 dBm minimum power output and 30 dB minimum signal gain as standard performance features. Variations, such as 2- to 5-watt versions, can be provided to suit your requirements. Computer designed and standardized packaging has made these tubes the least expensive of this type you can buy.

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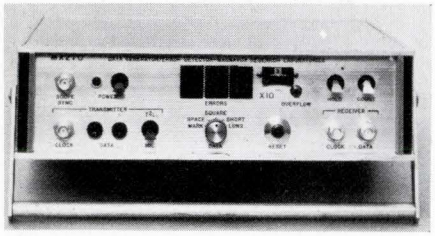
DATA COMMUNICATIONS PRODUCTS

BIT ERROR RATE ANALYZER

The MX-270 provides performance



test of modems and channels on simplex, duplex, or loop basis. Mark, space, sq. wave, or short or long pseudo-random sequences are compared bit-by-bit with a generated sequence and the error rate indicated directly. The unit operates up to 10 Mb/s and indicates error rates between $1x10^{-2}$ and $1x10^{-9}$. Magnavox Research Labs, 2829 Maricopa St., Torrance, Calif. 90503.

Circle Reader Service #339

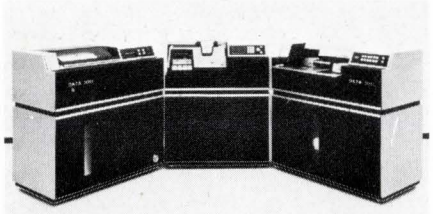
DATA MODEM

The 4800B-1 is an eight phase, differentially coherent modem offering performance at 4800 b/s full duplex over a 3002-C2 four wire network. The modem uses an adjustable equalizer with an integral signal quality meter for scope-free equalization. Penril Data Communications, Inc., 960 Thompson Ave., Rockville, Md. 20852.

Circle Reader Service #340

REMOTE BATCH TERMINAL

The Model 70-2 is a plug-in replacement for IBM 2780-2 terminals. It offers card reading and punching, and

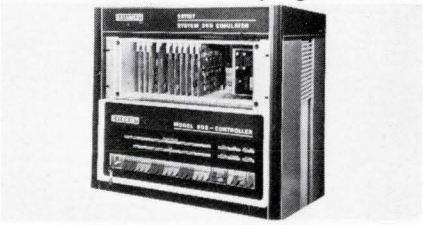


printing capability, with transmission speeds of 2000-3600 b/s. Two 400-character, 7-record buffers are std. equipment, as are automatic answer/disconnect, automatic error detection and recovery, point-to-point and multi-point line control, record truncation, and off-line listing and card reproducing. Data 100 Corp., 7725 Washington Ave. So., Minneapolis, Minn. 55435.

Circle Reader Service #341

SYSTEM 360 SIMULATOR

Model 531107 is a programmable

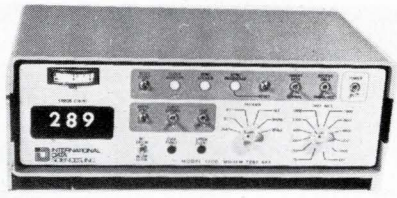


System 360 simulator. This unit provides the same responses, timing, and control for bi-directional communication as a selector or multiplex channel on an IBM System 360. With a software and a slight hardware change it can also simulate the IBM 270X. Datawest Corp., Box 1208, 7503 E. Osborn Rd., Scottsdale, Ariz. 85252.

Circle Reader Service #342

MODEM TEST SET

The Model 1200 tests synchronous

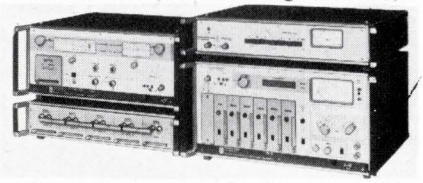


and asynchronous modems, multiplexers and digital transmission systems. It features bit or block error counting, a bias distortion meter, an independent transmitter and receiver data rate capability. Test patterns allow compatibility with Western Electric and other test equipment. International Data Sciences, Inc., 100 Nashua St., Providence, R.I.

Circle Reader Service #343

WHITE NOISE MEASURING SET

Model RK 5 measures signal-to-noise



ratios, noise power and noise power ratio on multi-channel carrier and radio link systems. The instrument is designed for balanced and coaxial systems of 6 kHz to 30 MHz (with optional extension to 60 MHz), is highly sensitive and has an intrinsic noise level of ≤ -125 dBm. W. & G. Instruments, Inc., 6 Great Meadow Lane, Hanover, N.J. 07936.

Circle Reader Service #344

TELETYPE 38 LINE

The 38 line includes ASR, KSR, and RO terminals. The line includes an optional

modem that will be installed, pretested and offered as one complete package. These terminals have many of the features of the 33 line, however, they include both upper and lower case printout and also a wide platen which will allow a std 132 character line at 10 char./in. Teletype Corp., 5555 Touhy Ave., Skokie, Ill. 60076.

Circle Reader Service #345

VIDEO TERMINAL

The RDS Programmable Terminal combines a small computer with an input keyboard and a 14-in. CRT monitor. The function and operating characteristics can be changed completely, by replacing the tape cassette that contains the system's program. Raytheon Data Systems Co., 1415 Boston-Providence Tpke, Norwood, Mass. 02062.

Circle Reader Service #346

INQUIRY TERMINAL

Designed for credit or stock status inquiry applications, the SYSCOM™ inquiry terminal will automatically dial up

a computer, enter variable and fixed data and display one of two computer responses. The typical terminal includes a 12-position slide switch for entry of variable data and an internal group of five rotary matrix switches set to program the fixed data. AMP Incorporated, Harrisburg, Pa. 17105.

Circle Reader Service #347

Circle Reader Service #39 ⟶

The broadest digital module line in the world includes a lot of analog modules.

You'd expect DIGITAL to sell digital modules. And we do. Fast ones for computer design and interfacing, slow ones for the industrial environment, simple ones, complex ones—all digital.

But we also sell a good many analog modules as well. A lot of the world that uses digital, uses analog first. So sometimes you need analog modules to get the job done. And getting the job done is what we really sell.

Write.

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PANEL DISPLAY IT

now it's possible

We've done the hard work— by making the first commercially available panel display subsystem for use in your application. Burroughs new SELF-SCAN panel display subsystem provides 256-character alphanumeric panel display capabilities and all necessary electronics — *drivers, memory, timing and character generation* — in a compact module.

And because SELF-SCAN panel display technology reduces electronics by 90% and cuts display thickness to less than 1½ inch, you get unprecedented flexibility and cost advantages for display applications.

The easily-read characters used in this unit are formed of dots on .040″ centers, with eight 32-character rows in a 5 x 7 dot matrix format. Application versatility is designed-in with options including visual cursor, tab controls and expanded memory capability. The 256-character unit shown is available for off-the-shelf delivery; 64- and 128-character subsystems available soon. Units with only display and driver electronics are also available. Write or call for additional information: Burroughs Corporation, Electronic Components Division, Box 1226, Plainfield, N. J. 07061 (201) 757-3400.

(Size 5.5 x 11 x 1.4)

256-Character SELF-SCAN™ Panel Display Subsystems Burroughs

Circle Reader Service #40

IC IDEAS

THIS MONTH'S IDEAS **PAGE**

VOTE for the one you like best
Write the number of the Idea you like best in the box on the inquiry card and send it to us.

SEND us practical, reproducible ideas that are original with you and have been implemented with linear or digital ICs.
If we publish your idea, you win a check for $25.00.
If our readers vote yours the best of the issue in which it appears, you have your choice of a Simpson 270 or Triplett 602 multitester.
After 12 issues, our readers will vote on the best idea for all 12 issues.
The winner gets his choice of either a Hewlett-Packard 1206A or a Tektronix 5103N oscilloscope.

Submit your IC Ideas to:
Alberto Socolovsky, Editor
THE ELECTRONIC ENGINEER
Chestnut & 56th Sts.
Philadelphia, Pa. 19139

HOW YOU VOTED

The winning Idea for the March 1971 issue is "Triggered ramp generator."

Our winning Idea for this month was authored by Harry Garland. Mr. Garland is a graduate student in the Biophysics Program at Stanford University. For his prize, Mr. Garland has selected the Triplett 602 TVO.

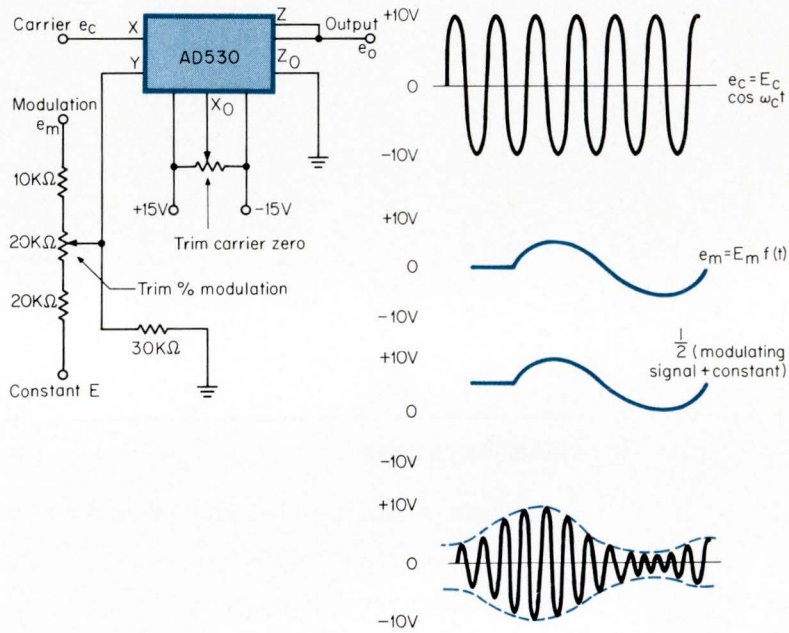
IC IDEAS

Amplitude modulator uses an IC multiplier

Dan Sheingold, Analog Devices, Inc., Norwood, Mass

The new AD530 miltiplier can easily be adapted to perform amplitude modulation. The modulating signal is added to a constant derived (in this case) from the power supply in a resistive attenuator. The attenuator provides the needed 50% scale factor correction to allow for the full positive swing of the modulating signal at 100% modulation. The unmodulated carrier output level is ± 5 V and the modulation adds ± 5 V to the carrier envelope.

The potentiometer provides a trim of the modulation percentage, and the only other trim required is of the carrier zero (x_o). Offset trim is not required because the output is usually ac-coupled, and overall gain trim can be controlled either by the carrier or in the circuitry following the output.



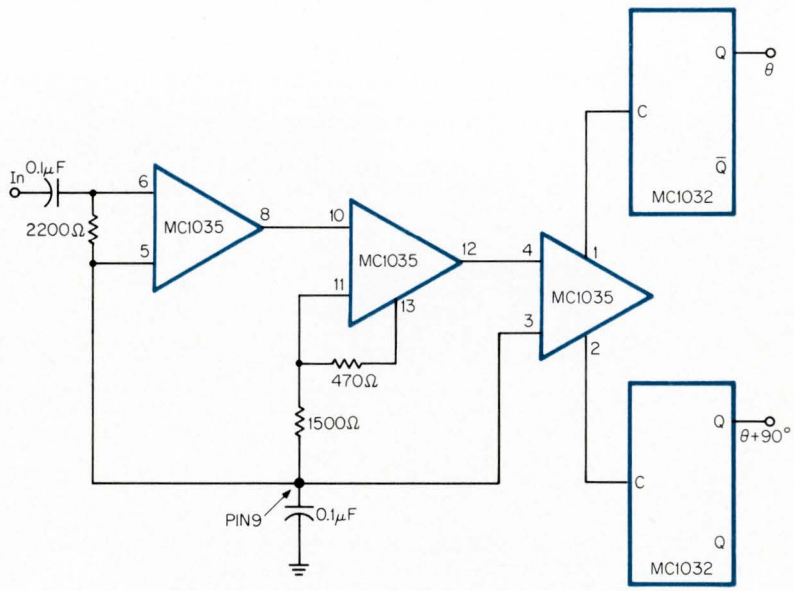
To vote for this IC Idea, circle 987 on the Reader Service Card

A digital 90° rf phase shifter

G. K. Shubert, Hisonic, Inc., Olathe, Kan.

Accurate 90° phase shift is often required for single sideband or synchronous detection or for the generation of single sideband signals. One approach is to use a flip-flop to obtain Q and $\overline{Q}$ outputs, and then to divide each output by two with additional flip-flops. The overall division by four however requires an unnecessarily high frequency.

This solution reduces the frequency division to division by two by using an amplifier with differential outputs to obtain the Q and $\overline{Q}$ outputs. The Motorola MC 1035 triple differential amplifier provides input amplification, a Schmitt trigger and an amplifier with differential outputs all very economically. An MC 1032 85 MHz dual J-K flip-flop completes the circuit. This simple circuit can often be used to replace a number of RC and LC phase shift networks because of its extremely wide operating frequency range.



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ANALOG SWITCH PITCH.

We'll get right to the point.

We're in the analog switch business. (In addition to our very own designs, we're also second sourcing all of the best switches in the industry. Including the entire DG126 thru 164 series.)

More importantly, we're also in the op amp business.

And the sample-and-hold circuit business.

And the high speed voltage follower business.

And the comparator business.

And so on and so forth.

In short, if you have any kind of analog switch application, we'll be glad to sell you the switches. And everything else you'll need in the same application. (Which means you'll only have to make one phone call, write one letter, TWX once or send a single cable.)

National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051. Phone (408) 732-5000. TWX: (910) 339-9240. Cable NATSEMICON.

National

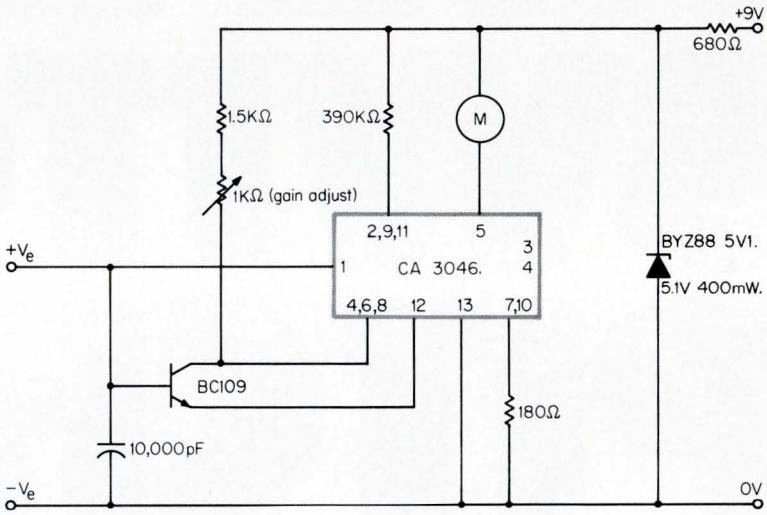
C IDEAS

Current amplifier circuit

H. MacDonald, London, England

This circuit will give you a full scale deflection of a 200 μA moving coil meter with a 1 μA input. Accuracy and linearity are within 1% over a 0 to 50°C range for outputs up to 200 μA with an 8- to 12-V supply voltage. There is no significant warm-up drift.

If the circuit is built on a printed circuit card, leakage can cause fairly large errors. You can avoid this problem by separating the supply rail and the input circuit with a copper strip across the width of the board. This guard strip should be connected to the negative supply terminal. The 1 KΩ pot sets the circuit gain.



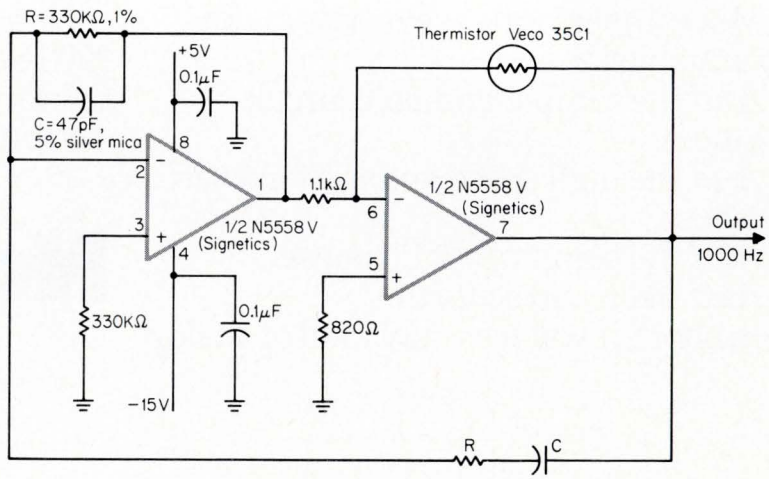
To vote for this IC Idea, circle 989 on the Reader Service Card

Dual op amp makes simple sine wave generator

Hank Olson, Stanford Research Institute, Menlo Park, Calif.

There are many applications which require a simple pure sine wave generator. The Wein bridge circuit is a good one for this purpose, and is used in most laboratory audio oscillators because of its purity. There are a number of Wein bridge oscillator circuits using IC amplifiers as the gain block, but most all have been forced to use relatively small values of R in the bridge because of the low input impedance of the amplifier.

In this modification of the Wein bridge, the parallel branch of the bridge is connected from the inverting input to the output of one of two op amps, thus seeing a very high impedance. The amplitude control portion of the bridge is around the second op amp and uses a bead thermistor. This 1 kHz oscillator can now use R = 330 kΩ and C = 470 pF for frequency determining components.

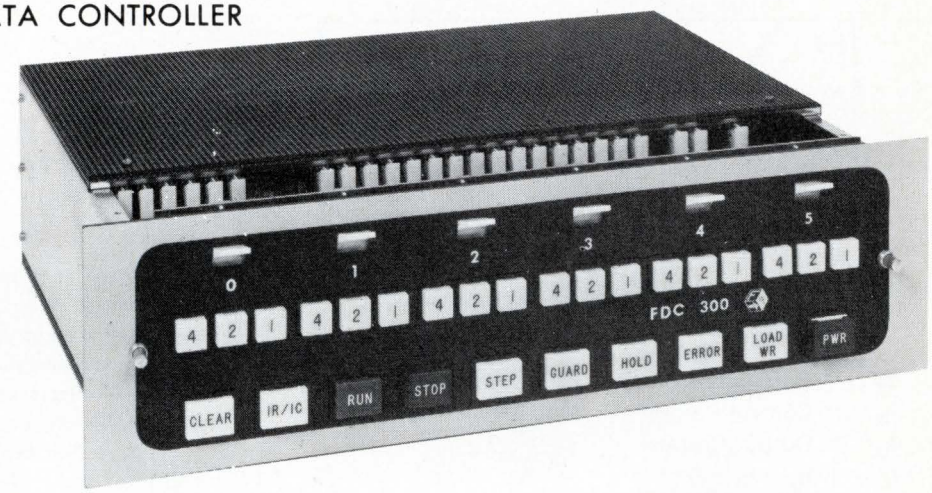


To vote for this IC Idea, circle 990 on the Reader Service Card

UN-BURDEN System Costs
UN-BUCKLE Software Shackles
UN-CORK Design Creativity
with Ferroxcube's new
UN-COMPUTER™

PROGRAMMABLE DIGITAL DATA CONTROLLER

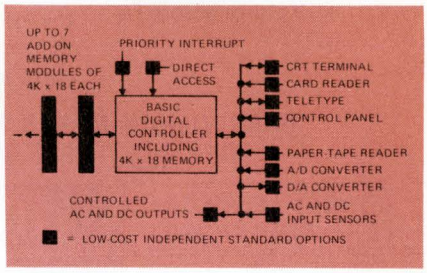
FOR: **PROCESS CONTROL, DATA ACQUISITION, DATA REDUCTION, DATA MANIPULATION, BUSINESS SYSTEMS, SCIENTIFIC INSTRUMENTATION, DATA-LINK INTERFACING, DIAGNOSTIC TESTING, DATA RETRIEVAL & EDITING**



The odds are 2 to 1 that your system doesn't need a minicomputer. That's right—in 2 out of 3 applications, you can save from $5,000 to $15,000 per system, and get *more* interface flexibility . . . *higher* reliability . . . *lower* software costs (if any!) . . . and *much greater* freedom from hardware restraints—by designing around Ferroxcube's unique, completely modular **UN-COMPUTER.**™

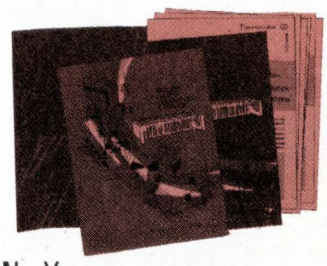
UN-COMPUTERS do *more*—and let *you* do more—than arithmetically oriented, general-purpose machines, with their over-committment to the central-processor interface. Check the **UN-COMPUTER's** block diagram. When you consider that *every block is an independent option,* you'll understand why we say that, for many applications, the minicomputer is a tragic misfit.

The **UN-COMPUTER** is backed by the most comprehensive software package in its class . . . and by an alert, imaginative, *responsive* interface-engineering team. (They've even developed software for moderate-speed arithmetic routines —*sans* processor!) Call them for a conference on *your* plans. Or write for their mind-bending, un-shackling *DESIGN FILE on UN-COMPUTING.*



It's free—and it'll sell you on UN-COMPUTERS . . . UN-DOUBTEDLY.

CALL TODAY! (914) 246-2811



FERROXCUBE CORPORATION / SAUGERTIES, N. Y.

A NORTH AMERICAN PHILIPS COMPANY

WESCON 71

exhibits down, sessions up

Markets for the '70s are making waves

In comparison to last year's show, the smaller number of exhibitors at Wescon/71 reflects the hard times our industry has seen in the past year. But the increased number of technical and general sessions—and the content of these sessions—reflects our industry's hopes for the remaining years of this decade.

There are, for example, only about 700 booths this year, a drop of some 300 from last year. And foreign exhibitors—mostly from the United Kingdom, West Germany, and Japan—account for 10% of the total. The entire show—the exhibits, sessions, and science film theater—is small enough to be put under one roof. And the building under that roof this year is Brooks Hall/Civic Auditorium in San Francisco.

On the street level of the Civic Auditorium you'll find the components and microelectronics exhibits, one of seven product exhibit categories. One level down puts you in Brooks Hall amidst exhibits of computer equipment and information technology, instruments and instrumentation, science systems and communications equipment, solid-state fabrication gear, circuit packaging, and production and processing equipment.

New fields to conquer

This year there are 32 sessions, an increase of about six from what has been typical of Wescon in past years. A look at the session titles gives you the impression that our industry is recovering from the shock of the past year, and is finally taking a fresh look around to see where it should go from here.

Air-pollution control, medical electronics, medical information systems, and *commercial* applications of automatic test equipment, for example, are topics for this year's sessions. Automatic (and computer-aided) testing and manufacturing alone account for about 20% of the total number of sessions. Sheldon Z. Edelman, Western Editor in San Francisco for **The Electronic Engineer,** will be chairing another very relevant session,"The challenge of the data communications explosion," scheduled for Wednesday afternoon.

There are no special symposia, and only two panel discussions. Session 1 is a five-member panel session that will discuss how a user should choose a minicomputer. The other panel session, Session 7, should prove enlightening to most of the 30,000 expected registrants: it's a discussion titled "The engineer's role in the economic world." Chairman of this panel is John Guarrera, a regional director of IEEE. Other panel members are Dr. James Mulligan, president of IEEE; Paul Robbins, executive secretary of NSPE (professional engineers); H. H. Heffner, deputy science adviser to President Nixon; and Dr. Mercure, president of WEMA (Western Electronic Manufacturers Association).

Several other sessions touch on the engineer in the (new) real world, new markets, and so on. In view of what's happened in our industry, and in terms of long-range goals, the sessions on the new markets and the engineer's new role in society may turn out to be the most important sessions any of us could attend.

WESCON/71 — Technical and general sessions
Civic Auditorium (1st floor), San Francisco

Mornings 10 am–12:30 pm	Tuesday August 24	Wednesday August 25	Thursday August 26	Friday August 27
Meeting Rm. 1	**1** Choosing a minicomputer — the user's viewpoint (panel)	**9** Exploiting computer programs in circuit design	**17** Instrumentation for automatic dynamic test systems	**25** Hybrid manufacturing
Meeting Rm. 2	**2** Trends in vacuum deposition technology	**10** The future of medical information systems	**18** Automatic manufacturing	**26** Microwave solid-state devices
Meeting Rm. 3	**3** Automated testing of MOS ICs	**11** Employee loyalty: a two-way street	**19** Tomorrow's programmable calculators	**27** Mobile radio in the '70s
Meeting Rm. 4	**4** Recognizing & gearing up for new electronic markets	**12** Microwave point-to-point communications: equipment/systems	**20** Beam-lead technology: here & now	**28** Ion-implantation technology for microelectronics
Afternoons 2–4:30 pm				
Meeting Rm. 1	**5** Peripherals for minis	**13** Needs & trends in medical electronics	**21** Commercial applications of automatic test equipment	**29** Micropower microelectronics
Meeting Rm. 2	**6** Direct detection laser communications	**14** Present & future of automatic-test languages	**22** Computer-aided manufacturing	**30** Computer-aided Braille translation using time-shared systems
Meeting Rm. 3	**7** The engineer's role in the economic world (panel)	**15** The challenge of the data communications explosion	**23** Computer-aided design of high frequency circuits	**31** Electro-optic memory, image storage, and display devices
Meeting Rm. 4	**8** Trends in inductorless filters	**16** Turnaround '71: strategy for the '70s	**24** Optoelectronics	**32** Air-pollution control: where we are & where we are going

The Electronic Engineer recommends the sessions shown in color.

NEW PRODUCTS

Plug-ins expand calculator capabilities

Three years ago, Hewlett-Packard introduced its Model 9100A calculator. It offered more-than-ordinary desk-top calculator capabilities at less cost ($4900 then, $3300 now) than a computer.

Well, HP's newly announced Series 9800, Model 10 calculator, has all the features of its predecessor, plus some tricks of its own.

Blocks in slots

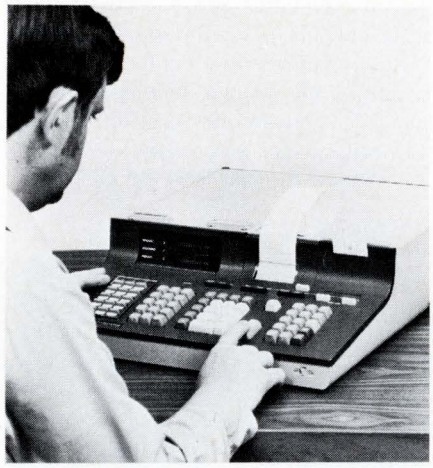
The Model 10 uses plug-in function blocks to expand its capabilities according to the needs of the user. Each block contains read-only memories and determines the function of 15 keys. These keys are grouped together at the left side of the Model 10's keyboard. A template comes with each plug-in function block; it slips over the 15 keys to identify their operations with a particular function block.

One slot in the machine accepts one of the three function blocks currently available: MATHEMATICS; STATISTICS; or USER-DEFINABLE. Another slot accepts an ALPHA block to control the optional built-in printer. And yet a third slot is for hard-wired control of peripherals (otherwise, the peripherals are under software control).

When you plug in the Model 11210A MATHEMATICS block, you get 28 functions to play with, including all the logarithmic, trigonometric, and transcendental functions found on an engineering slide rule.

Plug in the Model 11214A STATISTICS block, and you can perform all the typical calculations used in statistical data reduction. These include summation of variables (one to five), sums of cross products, sums of squares, and so on.

There is a third function block available to you: the Model 11213A USER-DEFINABLE block. This block gives you nine keys for functions that apply specifically to your work needs. You can,



for example, program a single key to compute a Bessel function. You can key in any subroutine of function, and then execute it.

Printout and display

The 9100's CRT has been replaced in the Model 10 by a solid-state display. The 5-x-7 dot-matrix LEDS show the contents of the three registers (x, y, and z), and there is a total of 45 characters available.

The three registers each display up to 10 significant digits with a two-digit exponent. Should the registers overflow in fixed point, the display automatically switches to floating point. Dynamic range is 10^{-98} to 10^{98}.

The optional thermal printer prints a 16-character line with full alphabet, numbers, and all commonly used punctuation marks.

Programming

You program the Model 10 via its keyboard. A KEYLOG key, when pressed, gives you a printed record (if you've installed the printer) of keys pressed during the programming process.

Programs can be recorded on magnetic cards and entered from such cards. The Model 10 uses a new, feedthrough card reader that accepts cards up to 6 in. long. Each card holds up to 1000 program steps, and the cards can be automatically linked for long programs.

Prices and peripherals

The Model 10 makes liberal use of n-channel MOS (HP's own) and bipolar technology to increase speed and decrease size and cost.

For example, the basic Model 10, at $2975, comes with a 51-register (11-kb) data memory and a 500-step program memory. Optionally, you can increase data memory to 111 registers ($400), and 1012 program steps ($500), or 2036 program steps ($850).

Each function block plug-in costs $485, and the printer goes for $675.

The new calculator is part of a complete system. And in this system is HP's new, fast, X-Y plotter, Model 9862A, at $2675. Actual plotting time is determined by the calculation being performed, although it's spec'd as a constant-speed (10 in./s) plotter.

With an optional ROM plug-in, you have available complete A/N plotter output, axis generation, automatic function scaling, special symbol point plotting, and titling, scaling, and labeling.

There's also a new marked-card reader, Model 9860A, that reads cards marked with a soft-lead pencil. The cards are eight-columns wide. The standard card holds 30 program steps, while a longer version holds 50; the cards can be cascaded.

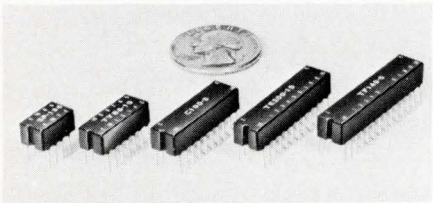
Model 9861A—typewriter, I/O and plug-in—converts the Model 10's keyboard to a typewriter keyboard. As of this writing, prices are not yet available for either the 9860A or the 9861A.

For more information, contact Inquiries Manager, Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304. (415) 493-1501.

Circle Reader Service #238

For quick information use the reader service card inside the back cover.

NANOSECOND DELAYS



Lumped constant delay lines aimed at timing and digital applications are now available in 0.225 in. high DIPS. Packages range from 8 pins, tapped every 20%, to 14, 20, 24, and 28 pins, tapped every 10%. Any nanosecond interval may be selected from 1 ns to 1 μs. The shortest delays are supplied as a 5 ns delay tapped every ½ ns. Delay-to-rise-time ratios of 4:1, 8:1, and 12:1 are available. Generally, ratios and price increase with number of pins. Pin-outs are configured so that packages can easily be connected in series end-to-end or side-by-side. Impedances are 50, 100 and 200 Ω. Prices in 1-9 quan. are from $4.70 to $20.00. Rhombus Ind., 24248 Crenshaw Blvd., Torrance, Calif. 90510.

Circle Reader Service #239

CRYSTAL FILTER

Model 6627B band-pass crystal filter is a low loss unit designed for use in the front end of low noise receivers. Noise factor contribution by the filter is typ. only 0.5 dB. Damon Corp., 115 Fourth Ave., Needham Heights, Mass. 02194.

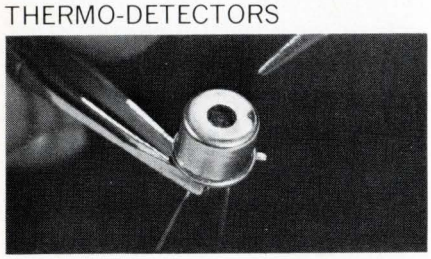
Circle Reader Service #240

PRESS-FIT CONNECTOR

Series 6317 connectors press-fit into plated-thru holes on PC board back-panels. Solderless wrap tails enable solderless wrapping to handle any additional connections that cannot be done by printed wiring. Elco Corp. Willow Grove, Pa. 19090.

Circle Reader Service #241

THERMO-DETECTORS



These thermo-detectors operate in the range from UV to 30 μm with response time down to 4 ms. Sensors, Inc., 303 W. Ann St., Ann Arbor, Mich. 48103.

Circle Reader Service #242

RACK MOUNTING SUPPLIES

PT series supplies mount in std. 19 in. wide RETMA racks. Outputs range from 1.5 to 50 Vdc, and from 5 to 32 A. Regulation is ±0.005%; ripple, 0.25 mV rms. From $230 to $350. ea. Acopian Corp., Easton, Pa. 18042.

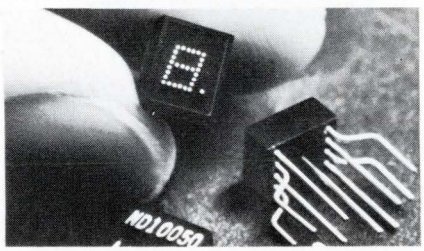
Circle Reader Service #243

DUAL TRIMMER

Type FD trimmer is for Bridged-T or L-Pad attenuator and normal trimmer applications. The hot-molded composition trimmer has a single shaft that rotates both contact brushes simultaneously. Allen-Bradley Co., 1201 S. 2nd St., Milwaukee, Wis. 53204.

Circle Reader Service #244

SS DISPLAY MODULE



Seven-segment FND10 numeric display module has ⅛ in. characters. Assembled in a 0.220 x 0.270 in. plastic package, 12 digits will fit in < a 3 in. panel. Fairchild Camera and Instrument Corp., Microwave & Optoelectronics Div., 3500 Deer Creek Rd., Palo Alto, Calif. 94304.

Circle Reader Service #245

CONTROL ALARMS

These ac current and motor load Montrolarms monitor, control and alarm ac currents from 1 A to 3000 A. They come complete with a current transformer and installation instructions. $105.00 for a 5 A unit. PMF Electronics Inc., 810 W. Third Ave., Columbus, Ohio 43212.

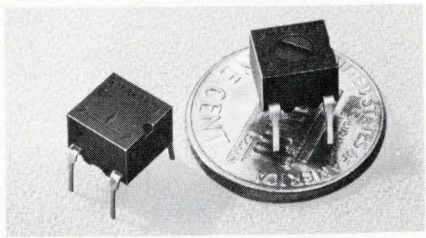
Circle Reader Service #246

MICROPOWER TRANSISTOR

New MSX200 hf transistor achieves a 1.2 GHz transition freq. at emitter currents as low as 100 μA. High-frequency operation is possible with a collector voltage as low as 1.0 V, permitting operation from a single-cell battery. Texas Instruments Incorporated, Box 5012, M/S 308, Dallas, Tex. 75222.

Circle Reader Service #247

MACHINE-INSERTABLE POT



Those square-style film element trimmers, designed for automatic packaging, are available in two series: 87 (single-turn) and 85 (12-turn). The Fastpack trimmers come in a range from 10 Ω to 1 MΩ. Standard TC is ±150 ppm/°C. Dale Electronics, Inc., Box 609, Columbus, Nebr. 68601.

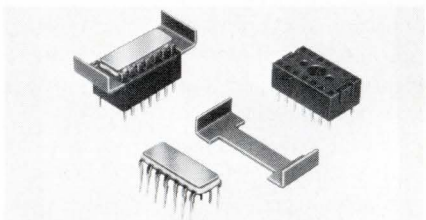
Circle Reader Service #248

FET VOLTAGE FOLLOWER

The Model 9746 provides you with low input bias current, high output current capability and very fast and wide band operation. $36.00 ea. (1-2) to $29.00 ea. (10-29). Optical Electronics Inc., Box 11140, Tucson, Ariz. 85706. (602) 624-8358.

Circle Reader Service #249

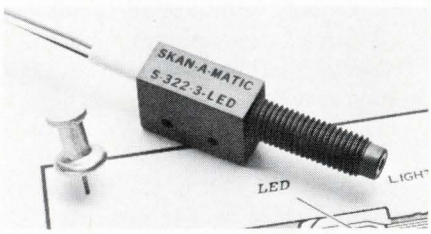
DIP HEAT SINKS



Temperature rise with Model 2906A heat sinks is limited to < 40°C at 0.3 W and to < 50°C at 0.8 W with natural convection. Astrodyne, Inc., 353 Middlesex Ave., Wilmington, Mass. 01887.

Circle Reader Service #250

LED FIBER OPTIC SCANNER



Here is a scanner which can detect a 0.003 in. dia. mark. Designated the S322-3 LED, it can differentiate between 0.040 in. width lines spaced 0.040 in. apart. Skan-A-Matic Corp., Drawer 68, Skaneateles, N.Y. 13152.

Circle Reader Service #251

RAYTHEON SEMICONDUCTOR. OUR RAY III IS THE FASTEST FULL LINE OF TTL PRODUCTS YOU CAN GET.

RAY III has 33 logic functions for superfast TTL circuit designs in both industrial and military applications. There are 22 gates with speeds down to 4 nanoseconds. There are 8 flip-flops with speeds down to 10 nanoseconds. And there are complex MSI arrays that add, decode, generate and check parity.

RAY III is available off-the-shelf. It provides the functions, the speed, the power savings, and the flexibility necessary for fast circuit design.

We've got the process nailed down. DC and AC specs are tight over the entire operating temperature range. We provide the guaranteed specs you need for no-guesswork system design. And RAY III is compatible with all DTL and TTL logic levels, power supplies, and design rules. RAY III saves power. Up to 20% per gate at high operating frequencies.

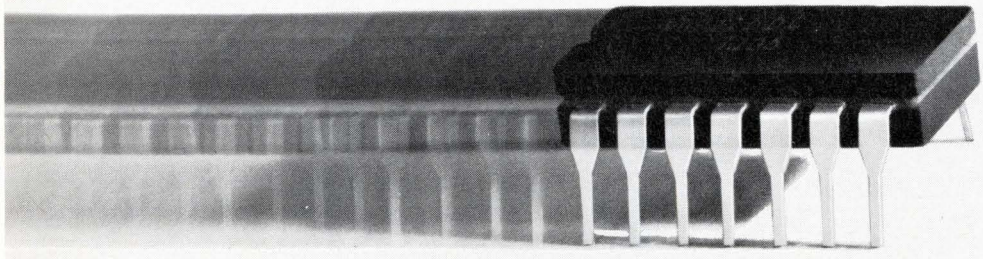
RAY III has proven acceptance. In computer central processors and airborne computers. In digital tests and measurement instruments. In minicomputers, multiplexers, computer graphics, and peripheral logic.

We're continuing to expand our broad line of superfast TTL products. We have a new technical team. And new development programs providing new design tools. We're the first source for SUHL. We have 57 functions in RAY I and 42 functions in RAY II TTL products. Available in all standard industry packages. And there are more RAY III MSI arrays and logic functions being developed.

Get more information on the fastest complete line of TTL available. Ask your nearest Raytheon Semiconductor franchised distributor for the "RAY III" design manual. Or stop by Raytheon Semiconductor, 350 Ellis Street, Mountain View, California 94040. (415) 982-9211.

RAYTHEON

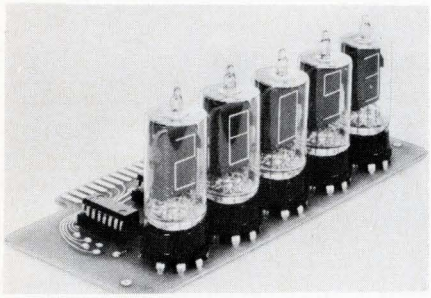
PERIOD.



Circle Reader Service #46

Products with Booth Numbers will be exhibited at WESCON

DIGITAL DISPLAY



TR-5 series display modules operate directly from a single 5 V supply, eliminating the need for special multi-level regulated supplies required by normal displays. They feature the RCA Numitron display tube. Tronix, Inc., Box 349, Phillipsburg, N.J. 08865.

Circle Reader Service #252

SUBMIN COAXIAL CABLES

Five subminiature coaxial cables with various ranges of characteristic impedances have been developed for solderless wrap applications. However, because they use a drain wire to terminate the shield, they may also be used with crimp-on connectors or may be terminated by soldering methods. Berk-Tek, Inc., Box 60, R.D. #1, Reading, Pa. 19607.

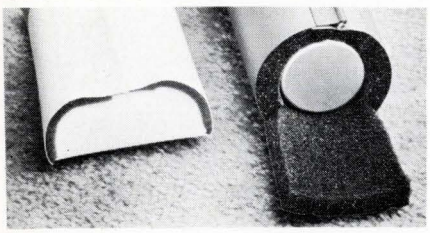
Circle Reader Service #253

DIGITAL SHAFT ENCODER

Model 300DT consists of a ratiometer and an A/D converter built into the housing of a precision film pot trimmed to 0.025% linearity. The ratiometer feeds the 12-bit A/D converter, which divides the 360° of pot rotation into 4096 words. New England Instrument Co., 14 Kendall Lane, Natick, Mass. 01760. (617) 873-9711.

Circle Reader Service #254

SNAP-ON JACKETING



Thermazip PVC jacketing has a thick, resilient, durable lining of polyurethane foam padding. It will withstand temp. from 0° to +180°F; it has a tear strength of 580 lbs. psi, and it is self-extinguishing. Zippertubing Co., 13000 S. Broadway, Los Angeles, Calif. 90061. Booth 1548.

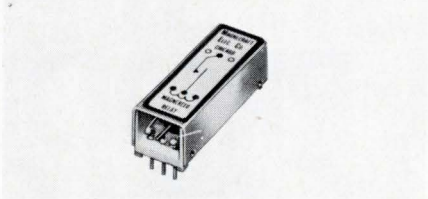
Circle Reader Service #255

POWER MODULE

P2.12.200 and P2.15.200 supplies provide dual regulated outputs of ±12 and ±15 V respectively at 200 mA. Regulation is 0.01% max., line (105-125 Vac); and 0.01% max., load (0-100%). Semiconductor Circuits, Inc., 163 Merrimac St., Woburn, Mass. 01801.

Circle Reader Service #256

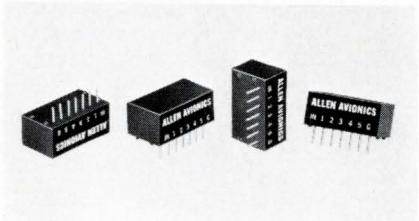
REED RELAY



The class 137M low cost, bounce-free (with diode suppressed coil) mercury-wetted reed relay mounts in any position. It comes in either a low-profile, PC-mounting package, or the in-line axial lead model. Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. 60630. Booth 2230.

Circle Reader Service #257

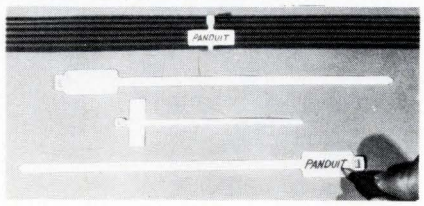
DIP DELAY LINE



DIP 5 is a lumped constant delay line with five tapped increments of delay. Standard lines are available in 100, 500 and 1000 Ω impedances in a range of time delays from 10 to 1000 ns. Allen Avionics, Inc., 224 E. 2nd St., Mineola, N.Y. 11501. Booth 2504.

Circle Reader Service #258

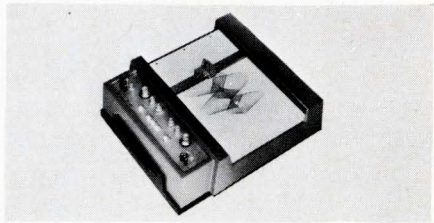
ONE-PIECE MARKER TIES



These all-nylon Pan-Ty identification market ties (PLM1M and PLM2S) have all the advantages of 90° "easy angle" insertion of the tie into the self-locking head, as well as low-profile design. Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill. 60477. Booth 1601.

Circle Reader Service #259

ANALOG X-Y RECORDER



The Brush 500 X-Y recorder has pressurized ink-writing which ensures crisp, clear, uniform traces. Gould Inc., Brush Div., 3631 Perkins Ave., Cleveland, Ohio 44114. Booths 1207-08.

Circle Reader Service #260

ZENER DIODE KIT

This 51-piece assortment of 1% tol., 1 W zener diodes covers the range of 2.7 to 16 V. $24.50 net, a $54.57 value if the diodes were purchased separately. Schauer Mfg. Corp., 4500 Alpine Ave., Cincinnati, Ohio 45242.

Circle Reader Service #261

HYBRID RELAY

New transistor-size hybrid relay has a transistor driver and a suppression diode inside the square TO-5[2] can. The relay can be controlled directly by microwatt, rather than milliwatt signals. General Electric, Data Communication Products Dept., Waynesboro, Va. 22980.

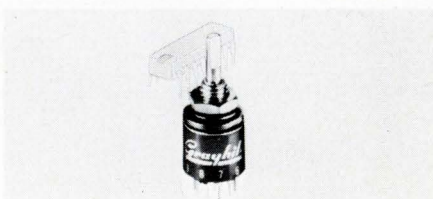
Circle Reader Service #262

POWER SCRs

Sixteen SCRs span the range of from 100 to 1400 V at 110 A. Two package styles will be available—flexible leads (TO-94) for the 2N4361-68 series, and flag-tabs (TO-83) for the 2N4371-78 series. Motorola Semiconductor Products Inc., Box 20912, Phoenix, Ariz. 85036.

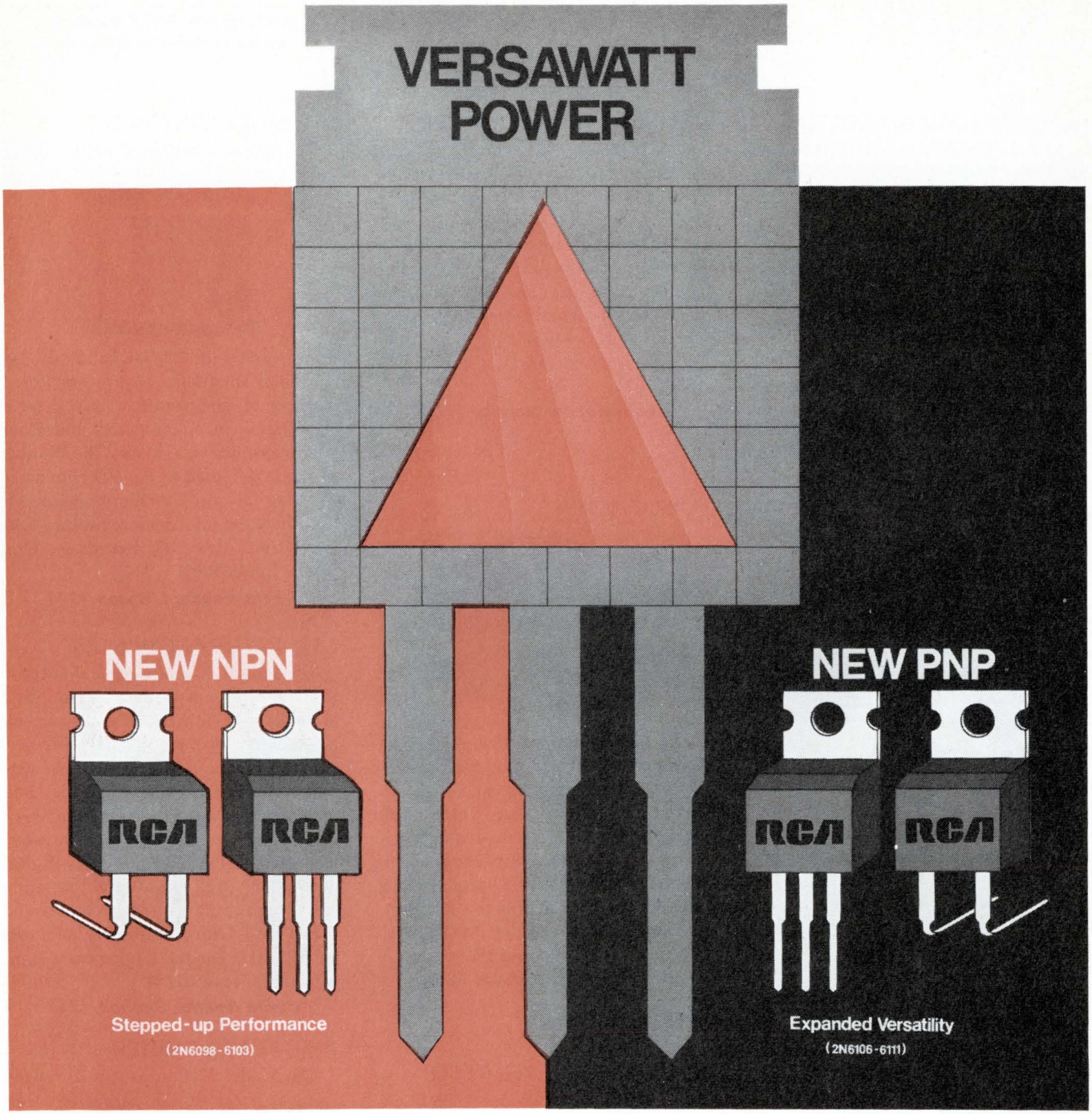
Circle Reader Service #263

PRESET SWITCH



Series 50 rotary switch provides a Johnson code output which is required to preset Johnson Counter configurations such as RCA CD4018, CD4018A, or equivalent COS/MOS integrated circuit. Grayhill Inc., Box 373, Hillgrove Ave., La Grange, Ill. 60525. Booths 2324-25.

Circle Reader Service #264



RCA's 2N6103 series is new! It now makes available to designers an extended current capability in the RCA VERSAWATT line—from 0.5 to 8.0 Amp. Utilizing a chip similar to the 2N3055, this silicon power n-p-n family is the next step up from the 2N5298 and 2N5496. You get all the advantages of Hometaxial-base construction, backed by thermal cycle ratings and safe area operating curves. The 1000-unit prices in the family start at 65¢.

The 2N6103 family is recommended for such applications as hammer drivers, series regulators, motor speed controls, inverters, and output stages of audio amplifiers to 40 W.

Also new, the 2N6111 family is another in the series of RCA epitaxial-base p-n-p power transistors, offering designers new p-n-p versatility in the popular VERSAWATT package. Intended for complementary use with 2N5298 and 2N5496, these epitaxial devices are backed by RCA's exclusive thermal cycle ratings and complete safe area operating specifications. The 1000-unit prices in the family start at 70¢.

Ideal in a variety of circuits, the 2N6111 will especially interest those working with audio amplifiers to 25 W, vertical deflection circuitry, high frequency inverters, positive/negative series regulators, and automotive applications.

To be confident of plastic power transistor quality and reliability, look to RCA. We engineer and build our economy-priced plastic power to the exacting standards that have made our hermetic products your bench mark for power transistor dependability.

For more information, see your local RCA Representative or your RCA Distributor. For technical data, write: RCA, Commercial Engineering Section 59H/UTL19, Harrison, N.J. 07029. International: RCA, Sunbury-on-Thames, U.K., or P.O. Box 112, Hong Kong.

RCA Solid State

Products with Booth Numbers will be exhibited at WESCON

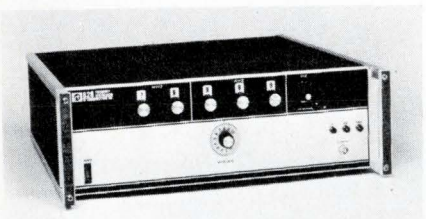
VCF WAVEFORM GENERATOR

Model 7030 has a 0.0001 Hz to 11

MHz range and extremely flat response. The instrument is a precision source of sine, square, triangle, ramp, pulse and sync waveforms, and features several choices of dc offset to make it usable in more applications. Exact Electronics, Inc., Box 160, Hillsboro, Ore. 97123. Booth 1118.

Circle Reader Service #265

FREQUENCY SYNTHESIZER

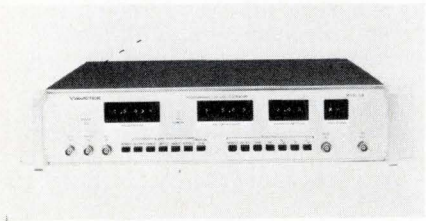


The Model RF-828 is a programmable synthesizer which operates from 1 kHz to 80 MHz. The basic unit offers 5 digit control in 1 kHz steps with a stability of 1 part in 10^6/mo. An option is offered to provide a vernier for 1 Hz resolution. RF Communications, Inc., 1680 University Ave., Rochester, N.Y. 14610. Booth 1046.

Circle Reader Service #266

WAVEFORM GENERATOR

This programmable waveform gener-



ator, the Model 154, gives you sine, square and triangle waveforms and dc voltage output. It has local and remote digital control of frequency, function, offset, and amplitude. All programming is DTL/TTL compatible, logic level inputs. Wavetek, Box 651, San Diego, Calif. 92112. Booth 1124.

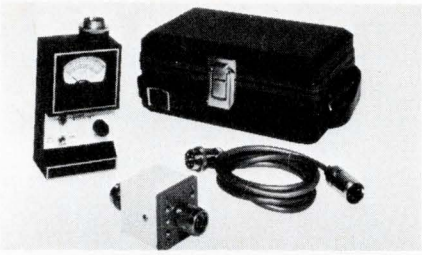
Circle Reader Service #267

MEMORY SYSTEM EXERCISER

The MD-100 is a complete package for testing both memory devices, (RAMS, ROMS and shift registers) and memory systems. The system consists of a special purpose multiprocessor which is micro-programmed to provide worst case test patterns of any length, on line, at the actual memory operating speeds up to 5 MHz. Micro-data Co., 20440 Corisco St., Chatsworth, Calif. 91311. Booth 1021.

Circle Reader Service #268

POWER METER



The Model 8400 is a lightweight battery operated device which makes accurate rf power measurements in the 10 MHz to 12.4 GHz range. Three interchangeable mounts are available, each with a 20 dB dynamic range. The mounts provide power indications of 10 μW to 100 mW (−20 dBm to +20 dBm). Narda Microwave Corp., Plainview, L.I., N.Y. 11803. Booth 1252.

Circle Reader Service #269

LOGARITHMIC LEVEL METER

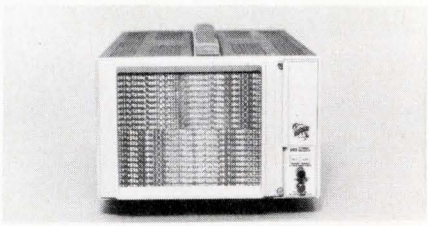
The Model 501 provides a linear dB

measurement range of −40 to +20 dBm with an accuracy of ±0.5 dB using any general purpose rf detector. Applications include 60 dB range transmission gain and loss measurements also return loss measurements over a range limited only by the directivity of the VSWR bridge used. Wiltron Co., 930 E. Meadow Dr., Palo Alto, Calif. 94303. Booth 1323.

Circle Reader Service #270

STORAGE DISPLAY UNIT

The 603 is a half rack width storage



display unit with 2 MHz bandwidth X, Y, and Z amplifiers. It provides stored displays of alphanumeric and graphic information from computers and other data transmission systems. The bistable storage CRT used in the 603 eliminates the need for costly memory devices for refreshing the information display. Tektronix Inc., Box 500, Beaverton, Ore. 97005. Booth 1001.

Circle Reader Service #271

LABORATORY COMPUTER

The Lab-11 is a new general-purpose laboratory computer system built around the 16-bit PDP-11 processor and a two-color point plot display. The new system features a wide variety of new and improved peripheral devices and application programs. The basic Lab-11 system includes the PDP-11 processor, programmable range analog-to-digital converter, programmable real-time clock, high-speed paper tape reader and punch, and color CRT display and sells for $27,900. Digital Equipment Corp., Maynard, Mass. 01754.

Circle Reader Service #272

DIGITAL MULTIMETER

The Model 3310 measures 32 ranges, covering most of the parameters nor-

mally used in laboratory, standards, calibration and service testing. These include: 5 true rms ac voltage ranges; 5 dc voltage ranges; 5 true rms ac current ranges; 5 dc current ranges; 7 resistance ranges and 5 dBm ranges. Overranging on all but the kilovolt ranges is 100%. Instrumentation/Control Div., The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio

Circle Reader Service #273

CAN YOU REALLY AFFORD TO MAKE YOUR OWN CUSTOM ASSEMBLIES?

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We make thousands of custom assemblies each year which include relays and electronic components. We're geared for this work. We have the know-how, the people, the test gear, the necessary production equipment. We normally purchase the components we do not make—diodes, resistors, capacitor, transistors—at maximum discounts.

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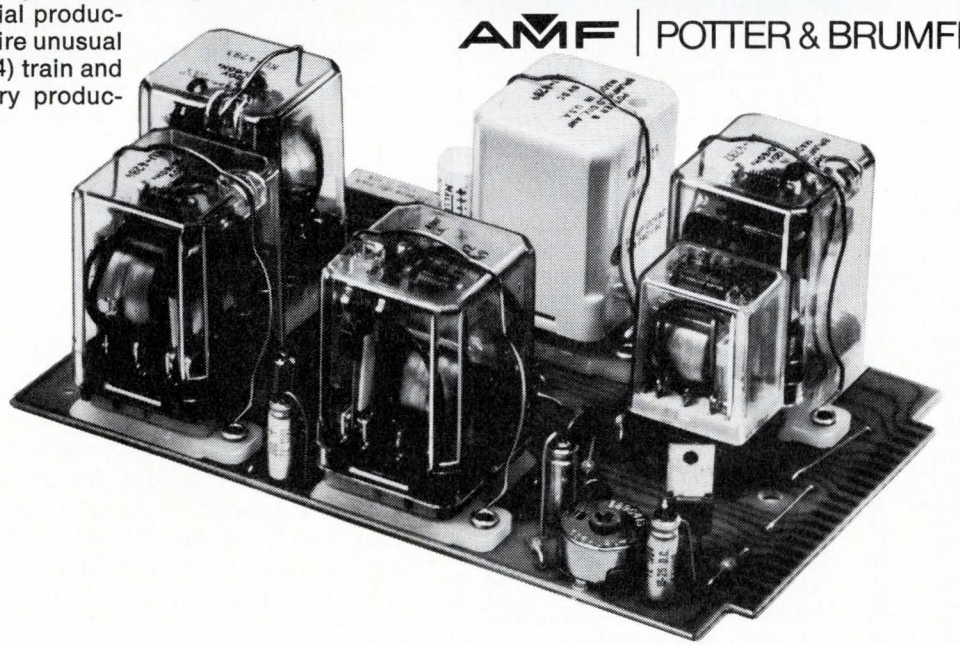
Call your local P&B representative or Potter & Brumfield Division of AMF Incorporated, Princeton, Indiana 47570. 812 385 5251

AMF | POTTER & BRUMFIELD

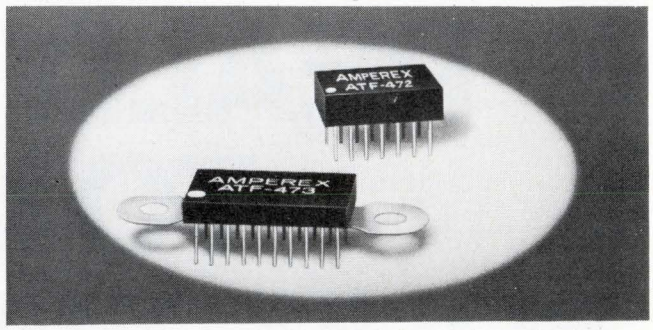


P&B performance. Nothing else comes close.

MICROWORLD

DUAL IC CLOCK DRIVER

This device can drive the two phase clock lines for 35,000



bit MOS arrays at 1 MHz. Intended for such applications as driving a circulating memory or multiples of large MOS arrays, the ATF473 can source and sink up to ±2.0 A in each circuit at output swings up to ±30 V. Switching is both extremely fast and highly symmetrical. Maximum rise or fall time into a 7,000 pF load (e.g., 35,000 bits of MOS register at 0.2 pF/bit) is only 40 ns and delay time is only 10 ns. Amperex Electronic Corp., Hybrid Integrated Circuits, Cranston, R.I. 02920.

Circle Reader Service #274

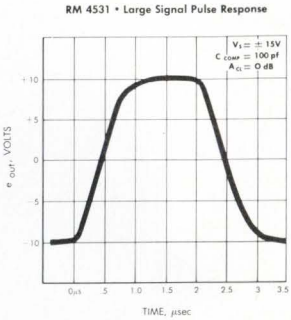
ONE-SHOT POWER PULSER

The PIC 400/401 is a hybrid integrated circuit, that will switch high power loads for a precisely timed interval, when triggered by a logic level input. The device delivers an output pulse up to 8 A, 60 V for a precisely timed interval. Other features include: an output pulse temperature coefficient of 0.04/°C, a DTL, TTL, or RTL input, inhibit capability, input/output isolation, and a low standby current. $8.00 in 100-999 lots. Inquiry Processing Dept. Unitrode Corp., 37 Newbury St., Boston, Mass. 02116.

Circle Reader Service #275

HIGH PERFORMANCE OP AMPS

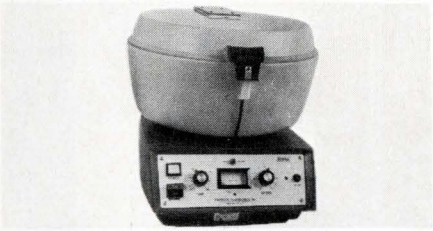
These two high slew rate op amps, the RM4531 and



RC4531, provide the dc performance of the 741 plus 30 V/μs slew rates. The 4531 input stage retains small signal characteristics even when subjected to large differential input signals. Both the military RM4531 (−55 to 125°C) and the industrial RC4531 (0 to 70°C) devices have small signal bandwidth of 1 MHz, large signal bandwidth of 500 kHz, and exhibit typical 1% settling times of < 1.5 μs. Raytheon Semiconductor, 350 Ellis St., Mountain View, Calif. 94040.

Circle Reader Service #276

SPIN DRYER



Model 2 p-3 is designed for drying wafers used in the semiconductor and IC industries. The dryer is used in conjunction with the manufacturer's rectangular TFE wafer carriers and matching quartz carriers. Emerson Plastronics, Inc., 1383 Seabury Ave., Bronx, N.Y. 10461. (212) 792-4400.

Circle Reader Service #277

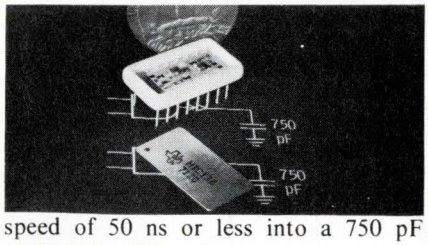
JAPANESE FONT GENERATOR

The EA4016 contains 64 EBCDIC encoded Japanese Katakana characters. Katakana is a phonetic alphabet character set used primarily as a technical printed language for applications in computers, telegrams, foreign place names and foreign words. Electronic Arrays, Inc., 501 Ellis St., Mountain View, Calif. 94040.

Circle Reader Service #278

DUAL MOS CLOCK DRIVER

The HIC138 features a switching



speed of 50 ns or less into a 750 pF load. It is designed for use as an interface circuit between TTL logic levels and MOS levels where fast switching into capacitive loads is required. Price $21.30 in 100 pc quan. Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, M/S 308, Dallas, Tex.

Circle Reader Service #279

HIGH SPEED DECODER

The Type 3205 decoder converts a binary code at three inputs to a signal on 1 of 8 output leads. Input to output delay is 18 ns max. The decoder may be driven directly by conventional TTL/DTL logic, and input load current is 0.25 mA max. High fan out is provided by a sink current of 10 mA minimum. Intel Corp., 365 Middlefield Rd., Mountain View, Calif. 94040.

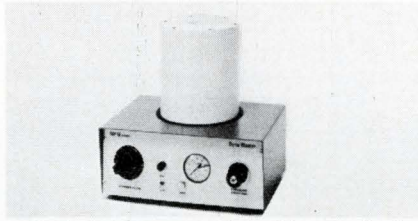
Circle Reader Service #280

SINE/COSINE TABLES

These MOS read-only memory kits store sine or cosine valves of 2048 angles between 0 and 90°. The SK0003 look-up tables are available in commercial, military, and Mil-STD-883 grades for applications such as shaft encoding, machine-tool control, radar processing and navigation systems. National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif.

Circle Reader Service #281

AIR ABRASIVE GENERATOR



Called the Accu-Trim, this unit is designed for applications where a precisely controlled, uniform mixture of abrasive powder with compressed gas is essential. Engineered specially for thick and thin film resistor trimming, it allows the operator to independently vary both the powder flow rate and the propellant pressure. M.P.M. Corp., 9 Harvey St., Cambridge, Mass. 02140.

Circle Reader Service #282

MOS DRIVER

The HCTRO107D includes an up-down decade counter, four latches for BCD storage, buffered BCD outputs, and BCD to 7-segment decoding with 30 voltage switches. The 7-segment output switches will standoff −30 V and sink 10 mA for direct drive of many electroluminescent, LED, and liquid crystal displays. Price $6.00 ea. (1000-lot quan.). Hughes Microelectronic Products Div., 500 Superior Ave., Newport Beach, Calif. 92663.

Circle Reader Service #283

IC OP AMP

The 3501 series minimizes input voltage drift and input bias current, without resorting to exotic processing. The input bias current of ±3 nA is achieved by a current cancellation technique, and the same input circuitry gives very high input impedance, both differential ($5 \times 10^7\ \Omega$) and common mode ($10^{10}\ \Omega$). Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz.

Circle Reader Service #284

Circle Reader Service #51 ⟶

ALPHANUMERIC DISPLAY

The Data-Lit 300 comes in a 10-pin skinny-DIP package. A GaAsP unit, the luminance spec is 100 ft-L/segment at 5 mA. $3.80 ea., 1000 pcs., Litronix, Inc., 19000 Homestead Rd., Vallco Park, Cupertino, Calif. 95014.

Circle Reader Service #285

KEYBOARD REED SWITCHES

Special plating developed for the MARK-3 and MARK-4 switches provides improved stability of contact resistance at low level loads. Both are Form A, SPST switches each with a 0.105 in. max. glass dia. Hamlin, Inc., Lake Mills, Wisc. 53551.

Circle Reader Service #286

MICA CAPACITORS

The El-Menco Line of transmitting dipped mica capacitors features low cost and very small size. Typical uses are tuned amplifier tank circuits, dc blocking in hf amplifiers, hf filter nets, and in timing circuits. Electro Motive Mfg. Co., Inc., Willimantic, Conn. 06226.

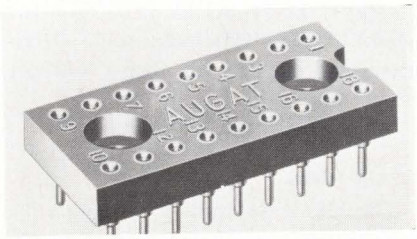
Circle Reader Service #287

POWER SUPPLY MODULES

These OEM series supplies are available with output voltages from 4 Vdc to 32 Vdc, and currents to 36 A. They have 0.1% reg., remote voltage sensing and overload protection. ACDC Electronics, Inc., Oceanside Industrial Ctr., Oceanside, Calif. 92054. (714) 757-1880.

Circle Reader Service #288

DIP SOCKET



This 18 contact socket has BeCu contacts, gold over nickel plated, insuring low contact resistance. Socket material is glass filled nylon. Socket accepts DIPs with round or flat leads on 0.100 in. spacing with 0.300 in. between rows. Augat Inc., 33 Perry Ave., Attleboro, Mass. 02703. Booths 1632-33.

Circle Reader Service #289

ELECTRONIC SEARCHER

Tracing circuits and wires takes only seconds with this electronic searching device. You merely touch a probe to the leads which Pathfinder then translates into numbers appearing on a computer logic display. W. H. Brady Co., 726 W. Glendale Ave., Milwaukee, Wisc. 53201. Booths 1409-10.

Circle Reader Service #290

COAX CONNECTORS

"Kwick-Konnect™" coaxial connectors have an actual VSWR of 1.20:1 from dc to 12.4 GHz and 1.30:1 from 12 to 18.0 GHz. They also feature fast connect/disconnect mating. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543. Booth 1609.

Circle Reader Service #291

LIDS FOR IC PACKAGES

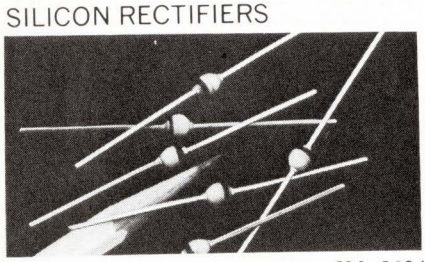
UNiLiDS are for final hermetic sealing of microelectronic packages. Self-locating, they withstand pressures of up to 100 psi without oil canning. Solid State Equipment Corp., 4343 E. River Dr., Phila., Pa. 19129. Booths 1423-24.

Circle Reader Service #292

NEW PRODUCTS

Products with Booth Numbers will be exhibited at WESCON

SILICON RECTIFIERS



New 3 A rectifiers, types IN 5624 through IN 5627 and type SPD 5628 have max. PIVs of 200, 400, 600, 800 and 1000 V respectively. Dual heat sink construction absorbs voltage transients providing better cooling for junctions. Solid State Devices, Inc., 12741 Los Nietos Rd., Santa Fe Springs, Calif. 90670. Booth 2212.

Circle Reader Service #293

VOLTAGE BOOSTER

Low line voltage booster automatically and economically protects computers, test equipment, control panels, and so forth, from malfunction or damage due to low line voltage. Micro-Tran Co., Inc., 145 E. Mineola Ave., Valley Stream, N.Y. 11582. Booth 2115.

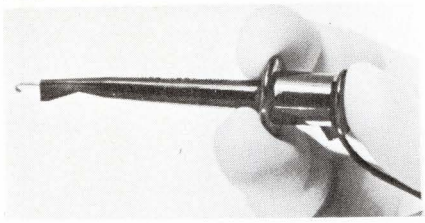
Circle Reader Service #294

OP AMP

Model VDA-100 op amp settles in < 60 ns. It has a BW of over 100 MHz, a slew rate of 1 V/ns and an output of ±10 V at 100 mA. Its drift is < 0.16 nA/°C. Valid Data Corp., Box 441, Calabasas, Calif. 91302. Booth 1227.

Circle Reader Service #295

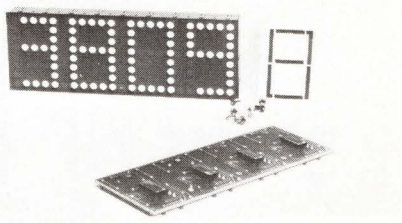
TEST CLIP



This series of test clips includes Model 3780 with clip one end only; Model 3781 with clip both ends; Model 3782 with clip one end, std. stacking banana plug other end; Model 3783 with clip one end, 0.025 in.^{2} pin receptacle (fits over 0.025 in.^{2} pin) other end. Pomona Electronics Co., Inc., 1500 E. 9th St., Pomona, Calif. 91766. Booth 1622.

Circle Reader Service #296

7-BAR NUMERIC READOUTS



Series 68033 units come with bezel, front panel and color filter, complete and ready to mount into a rectangular panel cutout. Mating DTL/TTL BCD to 7 segment decoder-drivers can be installed onto the lamp terminal board. Info-Lite Corp., 2337 Lemoine Ave., Fort Lee, N. J. 07024.

Circle Reader Service #297

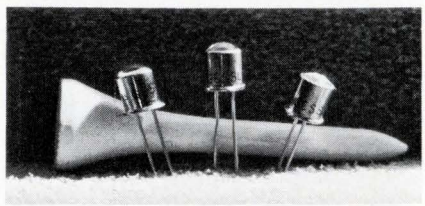
EPOXY ADHESIVE

Tra-Bond 2111 is a fast, clean way to "stake" delicate electronic components to chassis parts or PC boards. Electrically insulating, it resists weathering, petroleum products, salts, mild acids and alkalis and many organic solvents. Tra-Con, Inc., 55 North St., Medford, Mass. 02155.

Circle Reader Service #298

NEW PRODUCTS

IR SOLID STATE LAMPS



Three new GaAs lamps are the SSL-54, SSL-55B and SSL-55C with typ. ratings of 1.0 mW, 4.8 mW and 6.0 mW, respectively. Narrow beam of the units contains about 50% of the total IR energy produced. GE Inquiry Bureau, Nela Park, Cleveland, Ohio 44112. Booth 2308.

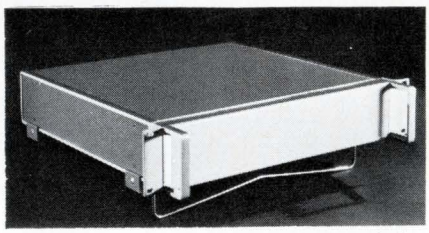
Circle Reader Service #299

PHOTOCELL AMPLIFIER

Control-Trak® Model PCT is a low cost amplifier for use with most photocells and thermistors. It has an adjustable setpoint, differential or dead band, and time delay. Curtis Development & Mfg. Co., 3250 N. 33 St., Milwaukee, Wis. 53216. Booth 2310.

Circle Reader Service #300

ENCLOSURES



Styleline enclosures are designed for rack-mounting or free standing. An integral stand tilts them at an angle for easy viewing. They come in five heights and three depths, all 17 in. wide to fit std. EIA cabinet dimensions. Honeywell's Modu-Mount Group, 22 Bond St., Wabash, Ind. 46992. Booth 1227.

Circle Reader Service #301

RH/TEMPERATURE RECORDER

Model 225 electronic RH/Temp. recorder measures relative humidity from 10 to 90% while its temp. range is 60 to 90°F. It records both parameters on one chart. Avoid drying, static electricity register, sticking and other such problems. Rustrak Instrument Div., Gulton Industries, Inc., Municipal Airport, Manchester, N.H. 03103. Booth 1251.

Circle Reader Service #302

Products with Booth Numbers will be Exhibited at WESCON

SAMPLES

Cable ties

This sample package contains a variety of cable and wire ties and clamps from the Fastrap™ line. The cable and wire ties come as a permanent strap-type for one-time installation, or as a beaded chain wire which can be refastened to allow wire repair of the addition of new wires. You're given a choice of materials, colors, and lengths to accommodate bundles up to 4 in. in diameter. Grayhill Inc., 535 Hillgrove Ave., La Grange, Ill. 60525.

Circle Reader Service #373

Switches

Free samples of snap-in panel mount pushbutton switches are now offered to you in a variety of colors. All samples feature basic momentary action, and all are available in double pole or single pole, for standard 10-A or low energy switching. The low energy switches feature gold "crosspoint" contacts compatible with solid-state systems. All samples have snap-in mounting and quick-connect terminals. Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085.

Circle Reader Service #374

Metal film resistors

Attached to this data sheet are samples of three conformal coated metal film resistors, the MR24, 34, and 54. Features include tolerances of 1% or better, cap and lead construction for positive electrical contact between the resistance element and the termination, protective conformal coated enclosure, 100% screening, and performance exceeding the requirements of Mil-R-10509. Mepco Inc., Morristown, N.J. 07960.

Circle Reader Service #375

Instant circuit boards

Here's an offer for stick-on copper conductor shapes and forms for making your own printed circuit boards. These pressure sensitive sub-elements and materials let you make your own custom PC boards quickly and easily. They feature strong adhesion and withstand soldering temperatures, and they can be removed for easy circuit design modifications. Circuit-Stik Inc., 1518 W. 132nd St., Gardena, Calif. 90249.

Circle Reader Service #376

Teflon cable

Here's a sample of foamed FEP teflon cable called Micro-Cell F110. It's mechanically stronger than other foamed dielectrics with a tensile strength of 3000 psi, and it maintains its electrical properties and physical flexibility from −65° to +200°C. It's inert with virtually all solvents, resistant to solder, and will not shrink. And it has the lowest dielectric constant available in a cable—1.4. Microdot Inc., Cable Div., 220 Pasadena Ave., South Pasadena, Calif. 91030.

Circle Reader Service #377

Pins and sockets

Rugged pins and sockets in a wide range of sizes are now available as samples. Mating pin sizes are 0.019- and 0.029-in. diameter. The sockets accept pin diameters of 0.019 in. to 0.028 in., and 0.028 in. to 0.035 in. This range fits most standard, modularized components, controls, circuit boards, testing and computer peripheral equipment. Sockets and pins are solder cup design for attaching conductors up to 22 AWG. A P Inc., 72 Corwin Dr., Painesville, Ohio 44077.

Circle Reader Service #378

Coaxial cables

Five subminiature coaxial cables with various ranges of characteristic impedances are the subject of this samples offer. They were developed especially for use in solderless wrap applications, but because they use a drain wire to terminate the shield, they may also be used with crimp-on connectors or terminated by soldering methods. Impedance values are held to within 5%, and they feature low attenuation losses to frequencies up to 400 MHz. Berk-Tek Inc., Box 60, R.D. #1, Reading, Pa. 19607.

Circle Reader Service #379

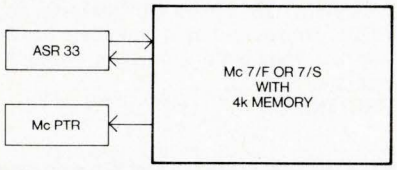
Circuit indicator

This "circuit condition" indicator is designed for printed circuit or panel mount. It measures 0.80 (l) x 0.375 (h) x 0.25 in. (w). Driven by 500 mW of power, the indicator "remembers" the polarity of the last 25-ms pulse it receives. Free samples are available if you write on company letterhead to Minelco Corp., 600 South St., Holbrook, Mass. 02343.

LITERATURE

Minicomputers

Here are small, fast minicomputers for the OEM and systems designer. They're the Mc7/F and Mc7/S digital computers built around the basic 16-bit functional design, with TTL and DTL integrated circuits throughout. The Mc7/F is the more powerful of the two. Its basic design includes all the real time



Mc 7 series standard configuration

control features with high speed input/output capacity. And, of course, complete software packages and a wide choice of peripherals are available for both. Matsushita Electric Corp. of America, 200 Park Ave., New York, N.Y. 10017.

Circle Reader Service #380

Update on TTL

This 64-page booklet describes new additions to the maker's 54/74 product line. The first section discusses 54/74 in general. Section two shows, for each new IC, logic and schematic diagrams, recommended operating conditions, switching characteristics, packages, and so forth. The booklet also includes descriptions of the Utilogic II/SP600 family, 8200 and 8T MSI logic, MOS products, and a linear family of shift registers. Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086.

Circle Reader Service #381

Computer system semiconductors

Here's the first volume of Motorola's new computer market-oriented semi-annual publication, "New Semiconductors for Computer Systems." It's packed with short articles, all illustrated, and featured in this issue are such topics as 4096-word by 16-bit MOS memory system, MECL 10,000 logic series, TTL/LSI in minicomputer design, line-operated inverter power system, and custom hybrids for computers. Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. 85036.

Circle Reader Service #382

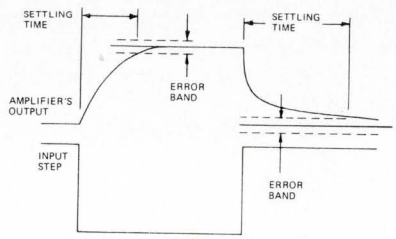
Computing counter applications

This application note discusses "Nonlinear systems applications of the computing counter system." Its 28 pages tell how the counter can be programmed to measure the electrical output of a transducer, perform the necessary calculations, and display the result directly in appropriate units. Instructions are detailed and thorough examples of this programming are provided. Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304.

Circle Reader Service #383

A Pease masterpiece

The title, "The New Lightning Empiricist," looks innocent enough except to those of us who recognize it as Teledyne Philbrick's revival of "The Lightning Empiricist" which started in 1952 and became an often amusing and always delightful discussion of op amps and other linear modules. Its first issue, June 1971, contains an article, "The subtleties of settling time," by Bob



Pease and Ed Maddox. The authors define settling time and warn about a far more insidious part of settling time they call "long tail"—the amplifier seems to have settled but has settled at the wrong value. To make their article complete, the authors include a thorough list of oscilloscopes to test high speed/fast-settling circuits. Teledyne Philbrick, Allied Dr. at Rt. 128, Dedham, Mass. 02026.

Circle Reader Service #384

ICs manual

A jim-dandy 96-page products manual details Raytheon's IC series. Physical and mechanical characteristics and schematics for type numbers are provided, as are full descriptions of complex circuits and logic diagrams. Raytheon Co., Semiconductor Div., 350 Ellis St., Mountain View, Calif. 94040.

Circle Reader Service #385

Semiconductor memories

Semiconductor memory devices using silicon-gate MOS and Schottky bipolar technologies are the subject of this 20-page catalog. Highlighted items are a 1024-bit MOS RAM, a 256-bit bipolar RAM, a 2048-bit MOS RAM, and a 512-bit recirculating shift register. Other products covered are decoders, drivers and latches designed for use with memories. Intel Corp., 3065 Bower Ave., Santa Clara, Calif. 95051.

Circle Reader Service #386

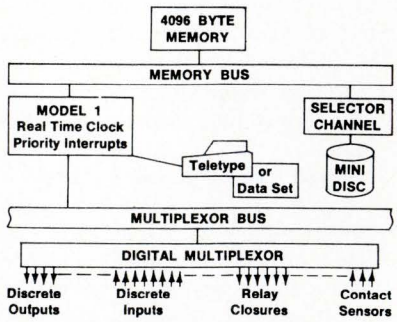
Tape application notes

"Application notes for editing pre-recorded tapes" details the problems and procedures faced in updating selected records on pre-recorded digital magnetic tapes. Each editing technique is discussed as well as precautions you may follow to limit detrimental effects, and alternate solutions you may use for transient effects, accumulative tolerancing, and erase-head interference. Peripheral Equipment Corp., 9600 Irondale Ave., Chatsworth, Calif. 91311.

Circle Reader Service #387

Modular processor

The Interdata Model 1 is a small, high-speed, application-oriented modular processor that uses 8- and 16-bit instructions for coding and core utilization. Many of the instructions contain test and skip options for byte handling and loop control. And an auto-indexing



Monitoring and control system

feature enables the system to use a maximum of 8,192 index registers. It uses 2,048-byte core modules, has a cycle time of 1 μs, and its memory system is organized into 256-byte pages. Interdata, 2 Crescent Pl., Oceanport, N.J. 07757.

Circle Reader Service #388

Field effect transistors

New types of FETs for use by design and circuit engineers are listed in a 14-pager. N-channel, dual N-channel and P-channel MOS FETs for applications in circuits requiring general purpose amps and switches, low noise amps, high frequency amps, and high speed switches are contained in the rundown including complete package outlines. Semiconductor Specialists Inc., Box 66125, O'Hare International Airport, Chicago, Ill. 60666.

Circle Reader Service #389

Digital plotting systems

Pertinent points of consideration in the evaluation of plotting systems are discussed in these 16 pages. You'll find information on various digital plotters, magnetic tape units, remote digital graphic systems, microfilm systems, digital plotting accessories, software and programming, and disk storage systems. Calcomp, 2411 W. La Palma Ave., Anaheim, Calif. 92801.

Circle Reader Service #390

PC edge connector chart

Edge connectors, interconnectors, high density connectors, and combination connectors are outlined for you on this selector chart. To help you choose the connector best suited for your application, each connector is categorized by body material, contact style, contact material, termination styles, contact spacing, number of connections, and shape of contact springs—a very thorough job. Mepco Inc., Columbia Rd., Morristown, N.J. 07960.

Circle Reader Service #391

MOS/LSI circuits

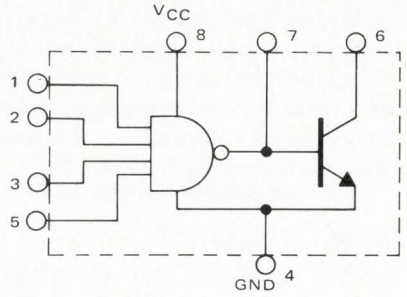
Here's a line of MOS/LSI ICs in plastic dual in-line packages. The 8-page catalog is comprised in part of a chart describing assembly steps and covering package dimensions, environmental results, and life-test results. The catalog centers on 14-, 16-, 18-, 24-, 28-, and 40-pin packages. Texas Instruments Inc., Box 5012, M/S 308, Dallas, Tex. 75222.

Circle Reader Service #392

LITERATURE

Hybrid data package

Comprising this package are data sheets detailing a complete line of hybrid 5-V DTL/TTL interface driver circuits for applications requiring output capabilities up to 100 V/250 mA. The package gives schematic diagrams, absolute maximum ratings, guaranteed and typical characteristics, and test configurations for the 2001BE, 2050CE, 2051BE and 2052BE interface drivers. Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94040.



Circle Reader Service #393

Remote terminal

The UCC 1225 COPE remote terminal offers optimum performance for communication circuits in the 2000-4800 bps range. The basic terminal consists of: a UCC 1225 remote controller, a programmed communications or COPE mode communications interface, 4096 12-bit word core memory, a card reader (300 cpm), a line printer (300 lpm), and a communications console. Optional equipment, interface, and software are also discussed in this bulletin. University Computing Co., 1500 UCC Tower, Box 6228, Dallas, Tex. 75222.

Circle Reader Service #394

Mini digital recording

A comprehensive and well-organized design digest includes applications and technical considerations for designers of mini digital tape recorders, test procedures for such equipment, and product information. "Mini digital," which is a rather new term for the industry, refers to the smaller and lower cost recording systems and components that are being used with minicomputers and small data entry systems. Tables, schematics, graphs, and electrical and mechanical specs are included in the brochure. Nortronics Co., Inc., 8101-10th Ave., N., Minneapolis, Minn. 55427.

Circle Reader Service #395

Word processing

Here is a word processing system that lets you draft, edit and record information on magnetic tape cassettes for error-free power typing. This data sheet explains the capabilities of the system, gives you functional specs, and discusses standard operating modes. Ty-Data Inc., 109 Northeastern Blvd., Box 841, Nashua, N.H. 03060.

Circle Reader Service #396

Tape equipment

An industrial line of professional magnetic tape equipment for recorder/reproducers, reel and cartridge transports, amps and pre-amps are detailed in a 20-page catalog. Descriptions of types available including specs and suggested applications are included. Telex Communications Div., 9600 Aldrich Ave. S., Minneapolis, Minn. 55420.

Circle Reader Service #397

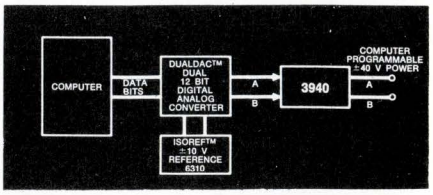
Interconnection system

Precision modular components for this interconnection system are discussed in this 6-page brochure. You receive details on crimp-to-wire disconnects and multiple housings, or more specifically, PV receptacles, daisy chains, "dead bug" IC mounting, snap- and mini-housings, and PV card connectors. Berg Electronics Inc., New Cumberland, Pa. 17070.

Circle Reader Service #398

Poweramps

Applications discussed in this data sheet on a ±40-V precision poweramp pair include a 40-V precision step load buffer, programmable power supplies, and 40-V sinewave programmable test signals. Also provided are complete specs—dynamic characteristics, accuracy, inputs, and outputs—and operation requirements. Xincom also offers compact, but very thorough data bulletins on their ±10-V isoref 0.01% reference, their 40-V precision level switch, and their Dualdac™—a pair of 12-bit DACS. Xincom Corp., Box 648, 20931 Nordhoff St., Chatsworth, Calif. 91311.



Circle Reader Service #399

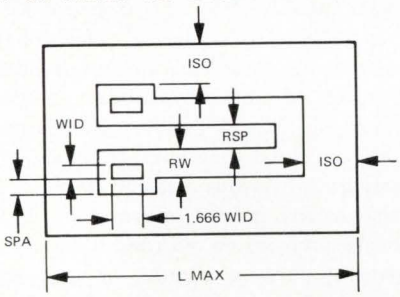
UHF-TV klystrons

The installation and operation of RCA's UHF TV klystrons are covered in an application note which also includes information on rf connectors. The klystrons discussed are designed to cover the frequency range from 470 to 890 MHz. Maximum ratings and specs for each type are provided as is performance data. RCA Large Power Application Engineering, Lancaster, Pa. 17604.

Circle Reader Service #400

ICEMAP

The Integrated Circuit Engineering Corp.'s mask plotting program, ICEMAP, assists you in rapid layout of bipolar monolithic ICs and provides final mask drawings. The computer plotter cuts rubylith for isolation, buried layer, base, emitter, contact, and metal masks at any scale, and it prepares a composite of all masks for instant review. With



this new man-computer interface you can quickly see the results of a completed layout. You can insert any desired changes or initiate a new trial layout, and see where any design decisions are required. Integrated Circuit Engineering Corp., 4900 E. Indian School Rd., Phoenix, Ariz. 85018.

Circle Reader Service #401

Semiconductor catalog

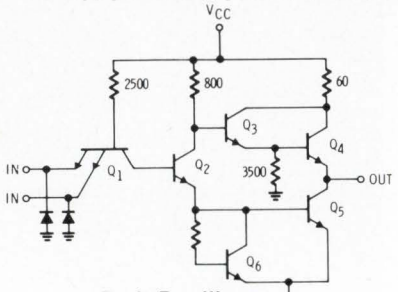
Here's a new version of the semiconductor condensed catalog, 20 pages in all. It outlines all of Centralab's solid-state product line—chips, discretes, hybrids, and optoelectronic products—and profiles their new program, PRIME'. The new program sees that all products come from common high-performance manufacturing lines and are graded, tested, and priced to fit one of four customer-specified requirements. Centralab Semiconductor, 4501 N. Arden Dr., El Monte, Calif. 91734.

Circle Reader Service #402

LITERATURE

Gates, flip-flops, and MSI circuits

Raytheon's TTL family, including 22 gate types, eight flip-flops, and three MSI circuits, are covered in a 68-page manual. Major characteristics of the family are provided, including propagation delay, power dissipation, and noise



Basic Ray III gate

immunity. Graphs, tables and schematics are scattered throughout, and ac and dc test characteristics for the flip-flops are included. Raytheon Semiconductor, 2930 W. Imperial Highway, Inglewood, Calif. 90303.

Circle Reader Service #403

Technical tid-bits

Analog Devices is offering its Vol. 5 #2 version of the Analog Dialogue to all interested parties. Featured in the booklet are applications for a new monolithic IC voltage switch, the use of analog multipliers for measuring sine wave amplitudes without averaging, and key features of new products being offered. Analog Devices Inc., 221 Fifth St., Cambridge, Mass. 02142.

Circle Reader Service #404

OEM computer equipment

Each model in each product line is described for you in a 20-page catalog. Here are some of the significant features you'll find for the various lines: the disk storage drive includes advanced voice-coil units with high-speed electromagnetic positioners for the read/write heads; one line printer types 1200 lines a minute with a line-skipping ability of 70 in./s; punched card readers can read 1200 80-column cards per minute or 1600 51-column cards per minute. There are similar characteristics for their OCR readers, disk packs, magnetic storage drums, tape transports, and just about any other kind of computer equipment you can think of. Control Data Corp., 8100 34th Ave., Minneapolis, Minn. 55420.

Circle Reader Service #405

Calculators

Compucorp's "Scientists" and "Statisticians" are general-purpose calculators, one a display type, the other a programmable printing type, and both with special-function keys. All of the "Scientists" use MOS/LSI for all logic and data storage which enables them to perform complicated multi-step tasks in response to simple commands. The "Statisticians" have the ability to automatically accumulate data in separate registers and perform calculations on the data as it accumulates. All details are provided in this series of data sheets. Computer Design Corp., 12401 W. Olympic Blvd., Los Angeles, Calif. 90064.

Circle Reader Service #406

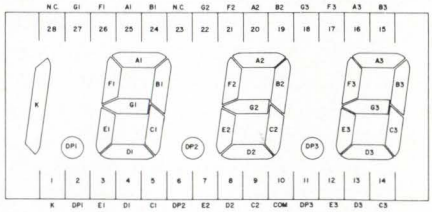
Magnetic relays

Here is a printed circuit relay that plugs directly into your PC board without sockets or soldering. This 8-page catalog discusses custom and standard features, dimensions, modes of operation, single and double coil voltages, resistance and time characteristics, and ratings at various current loads. You also receive helpful information on PC board preparation aids and a variety of general purpose boards for prototype testing. Printact Relay Div., Executone Inc., Box 1430, Long Island City, N.Y. 11101.

Circle Reader Service #407

Liquid crystal displays

This series of data sheets describes liquid crystal displays and storage displays. Characteristics, typical operating circuit diagrams, and features are provided. The 1043 liquid crystal digital voltmeter display, for example, is a 3½-



digit (over-range one), 3 decimal point unit for voltmeter and similar applications. The package is a dual in-line 28-pin IC package with 0.6-in. pin row spacing and 0.1-in. pin centers. Optel Corp., Box 2215, Princeton, N.J. 08540.

Circle Reader Service #408

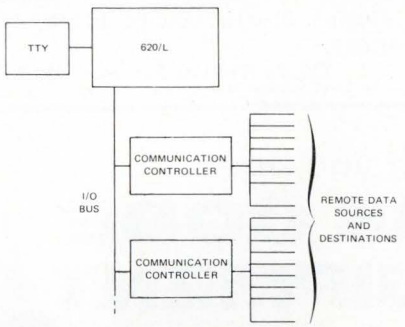
Semiconductor components

A variety of power semiconductor components including high-voltage thyristors, rectifiers, and transistors are described in a 16-page catalog. As a special feature, a descriptive product numbering system for easy reference to specific devices is used, and schematics and electrical characteristics are included. Catalog 54-000 is available from Westinghouse Electric Corp., Youngwood, Pa. 15697.

Circle Reader Service #409

620/L Computer handbook

Like the computer it describes, this handbook is designed for a wide variety of user applications. Its purpose is to provide you with all the basic information necessary for the programming, operation, and system interfacing of the 620/L computer. It discusses, for example, computer concepts, central processor unit, memory, peripherals and I/O interfaces, addressing modes, and programs. There's still much more in this handbook—all kinds of diagrams, instruction flow charts, and system interconnections. Varian Data Machines, 2722 Michelson Dr., Irvine, Calif. 92664.



Data communication switching center

Circle Reader Service #410

Computer density map

This map shows the density of monthly computer rentals per square mile in the United States by five separate dollar figure/month levels: under $250, $250 to $500, $500 to $1000, $1000 to $2000, and over $2000. It's interesting to note that 50% of the U.S. total is in the over $2000 bracket. A limited number of maps are available to suppliers in the computer industry. To get your copy, write on company letterhead to Computer Intelligence Corp., 525 B St., San Diego, Calif. 92101.

LITERATURE

AIA study summaries

To help improve and organize the relationship between Government and industry, the Aerospace Industries Association has launched a series of studies on Government contracting problems. Four summaries in booklet form have been released on these studies: Small business subcontracting by aerospace, Cost disallowances: causes and effects, Analysis of USAF requests for proposals, and Federal reports: impact on procurement. Aerospace Industries Assoc., 1725 De Sales St., N.W., Washington, D.C. 20036.

Circle Reader Service #411

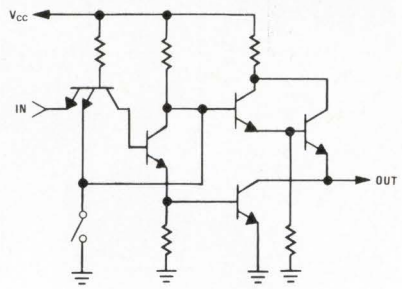
Terminal boards

A 20-page bulletin covers General Electric's line of terminal boards and factory-assembled terminal components for control and power circuits. Descriptions, specs, schematics, and application information is included. General Electric Co., General Purpose Control Dept., Box 913, Bloomington, Ill. 61701.

Circle Reader Service #412

Tri-State™ logic circuits

The Tri-State logic concept is explained in this 20-page document, including its unusual characteristics and typical uses. It covers details, specs, and provides schematics for multiplexers, demultiplexers, flip-flops, line drivers, buffers, a hexidecimal counter/latch, a



decade counter/latch, and a 256-bit read only memory. And it's filled with charts and graphs illustrating electrical and typical performance characteristics. National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051.

Circle Reader Service #413

Plastic primers

What's the difference between a transfer molding and an injection molding? The increasing number of electronic components in plastic packages are making these every day terms and processes for the engineer. You can find out more about them in these simple primers offered to you for 50¢ each. There are five in all: extrusion, thermoset molding, injection molding, compression and transfer molding, and finishing and decorating. The Society of the Plastic Industry Inc., 250 Park Ave., New York, N.Y. 10017.

Thermocouples

Comprehensive application data is given for each part of a thermocouple in this 18-page catalog. The catalog depicts construction criteria, suggested upper temperature limits, typical response time data, outside diameters, and environmental application information. Thermo Electric, Saddle Brook, N.J. 07662.

Circle Reader Service #414

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Measuring magnetic thin film

This instrument successfully assesses magnetic thin films for digital recording applications, as in computer storage. Because of the flux-sensitive magnetic head (which, in contrast to vibrating recording heads, remains in contact with the film) and an accurate displacement transducer, the recording properties of magnetic thin films may accurately be measured. Philips Research Laboratories, Eindhoven, The Netherlands.

Circle Reader Service #415

Silicon gate transistors

These transistors are produced by a silicon-oxide-silicon process that provides low capacitances (typically 0.5 pF) and low threshold voltages (-1 to -2 V). Schematics accompany the list of specs you're given in each of these data sheets, and each sheet illustrates a different application—TTL interface, analog switch function, and high input impedance op amp, for example. GEC Semiconductors Ltd., Freebournes Rd., Witham, Essex, England.

Circle Reader Service #416

Semiconductor survey

Here is a 60-page catalog that presents a summary of important data to facilitate your selection of a semiconductor type suitable to your application. Within each category (transistors and diodes, Gunn elements, ICs, photoelectronic devices, etc.) products are listed by application. The catalog is packed with specs and dimensional drawings, and there's even a glossary of symbols to clarify all designations used. Allgemeine Elektricitats-Gesellschaft, AEG-Telefunken, Fachbereich Halbleiter Export, D 7100 Heilbronn, Postfach 1042, Germany.

Circle Reader Service #417

Coaxial connectors

High voltage coaxial connectors are described in this literature. General and electrical characteristics are given, and dimensional drawings are provided for the plug, jack, and receptacle. Assembly instructions are provided and illustrated through diagrams. Radiall, 101, Rue Philibert Hoffmann, Zone Industrielle, 93, Rosny-Sous-Bois, France.

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Dynamic shift register

This dynamic shift register has a complexity of 512 bits and uses a 4-phase logic system for dynamic operation. Dynamic operation permits low power consumption (230 μW/bit) and high frequency operation (1 MHz). Arranged in two sections, one features recirculating logic for use in applications requiring accumulators. Societa Generale Semiconduttori, Via C. Olivetti, 1, 20041—Agrate Brianza, Milan, Italy.

Circle Reader Service #419

Computers and peripherals

Second and third generation computer equipment is offered through this 12-page catalog. All products are used, but completely refurbished to work to original specs. Among the systems offered are the IBM 360, the XDS 930, and the Sigma series—all at substantial savings. To see how you can save on purchasing computer and peripheral equipment ask for the catalog from Computer Sales & Service Ltd., 49/53 Pancras Rd., London NW1, England.

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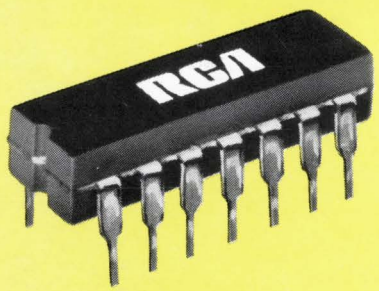
For further information see your local RCA Representative or RCA Distributor. For technical data bulletin file Nos. 406 and 490 and Application Notes ICAN-6158 and ICAN-6268, write: RCA, Commercial Engineering, Harrison, N.J. 07029. International: RCA, Sunbury-on-Thames, U.K., or P.O. Box 112, Hong Kong, or Ste. Anne de Bellevue, 810 Quebec.



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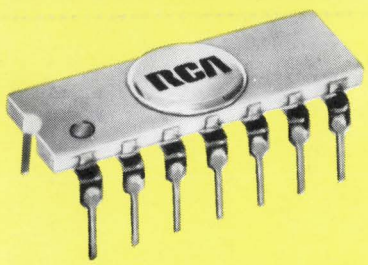

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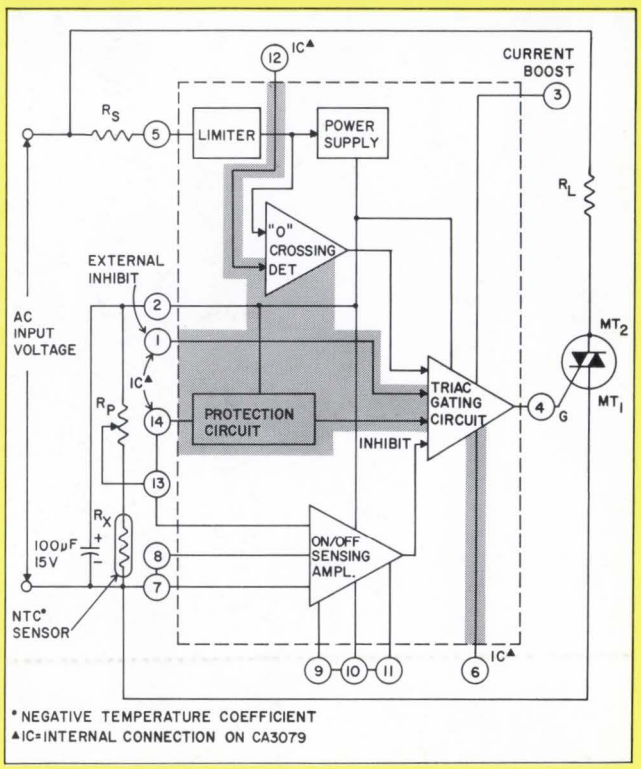

*NEGATIVE TEMPERATURE COEFFICIENT
▲IC=INTERNAL CONNECTION ON CA3079

Features	CA3058	CA3059	CA3079
• 24V, 120V, 208/230V, 277V at 50 60, or 400 Hz operation	√	√	√
• Differential Input	√	√	√
• Low Balance Input Current (max.)-μA	1	1	2
• Built-in Protection Circuit (Fail-Safe) for opened or shorted sensor (Term. 14)	√	√	
• Sensor Range (R_X)-kΩ	2 to 100	2 to 100	2 to 50
• DC Mode (Term. 12)	√	√	
• External trigger & inhibit (Terms. 6 & 1)	√	√	
• DC Supply Volts (max.)	14	14	10

RCA Solid State

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