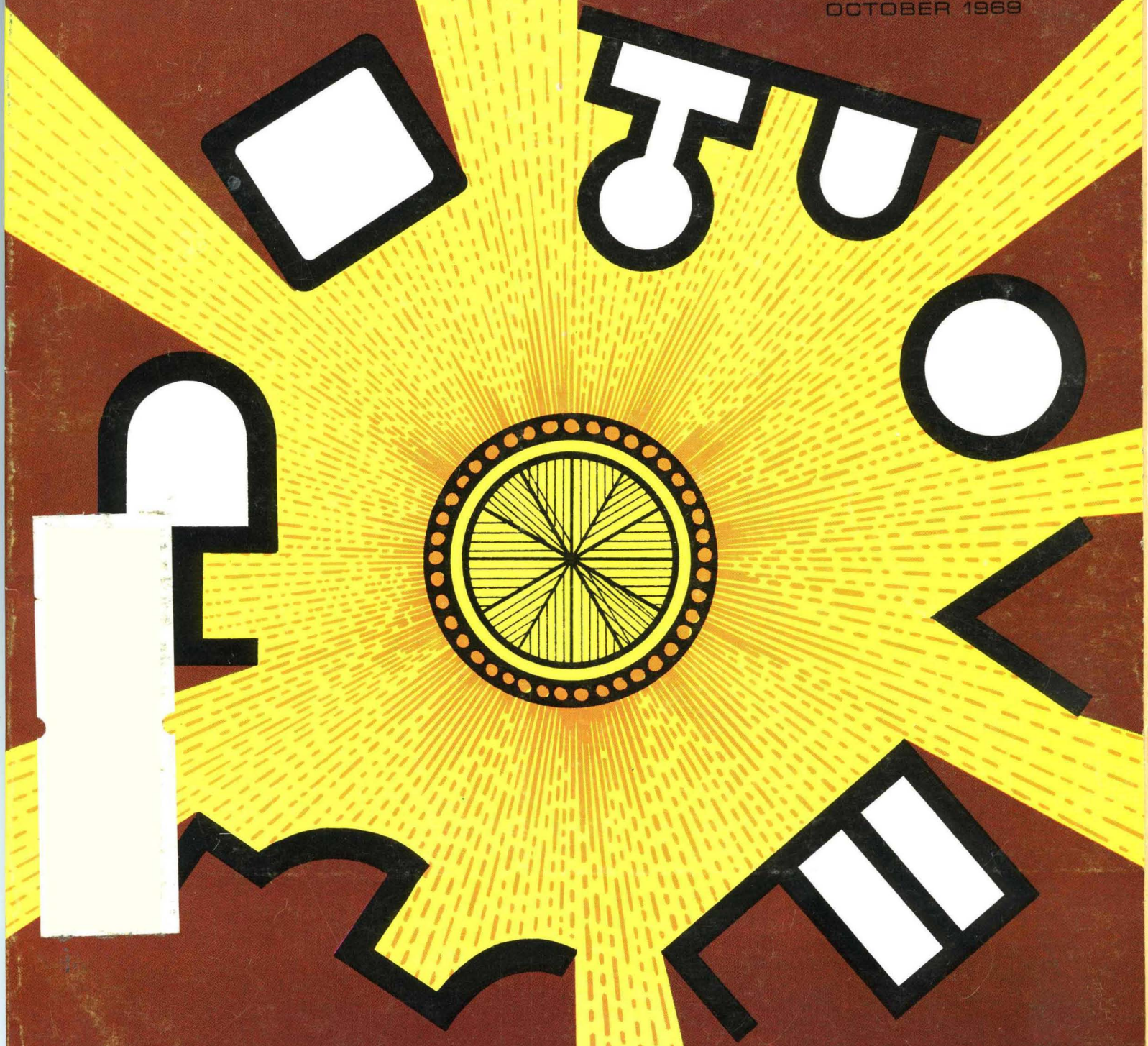
COMPUTER DESIGN

THE MAGAZINE OF DIGITAL ELECTRONICS

OCTOBER 1969



THE INCREMENTAL METHOD OF COMPUTER SHIELDING

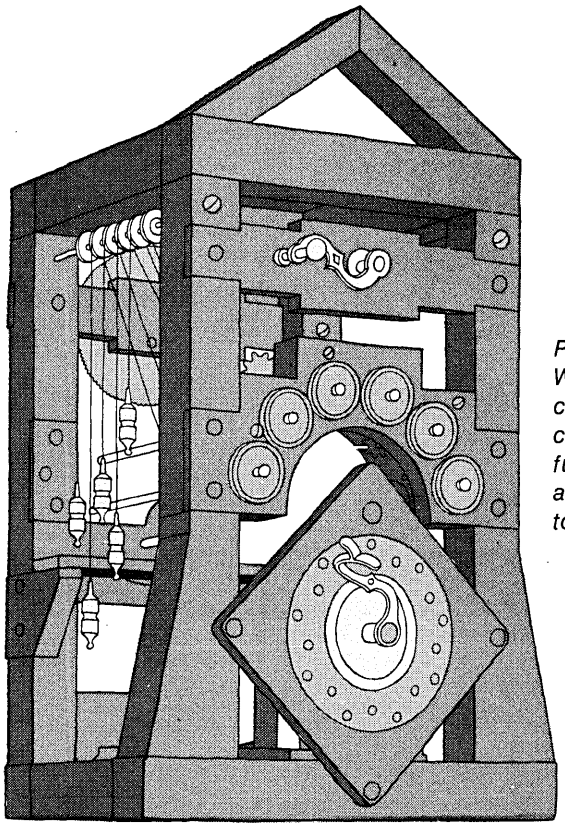
A MACHINE AIDS SYSTEM FOR DIGITAL DESIGNERS

A GENERATOR OF POSITIVE BIT-WEIGHT CODES FOR DIGITS IN ANY RADIX

THE DESIGN OF A STANDARD TYPE FONT FOR OPTICAL CHARACTER RECOGNITION

ISA CONFERENCE FOCUSES ON COMPUTER SCIENCES

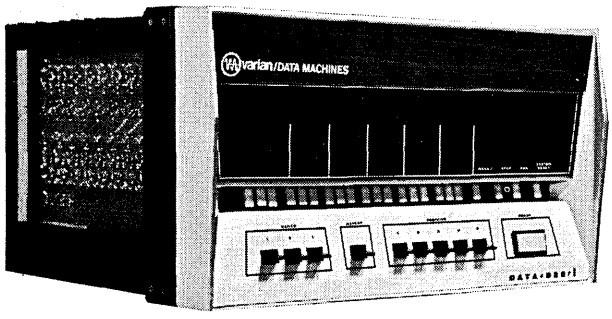
In 1709, Giovanni Poleni had a wild idea.



Poleni's passion. Wind it up, and you could automatically compute the four fundamental arithmetic operations to three figures.

The Varian Data 620/i is the latest word in 1969. It may give you some even wilder ideas.

Imagine a system-oriented computer that takes only 10½ inches of rack space, yet will out-data any machine in its class. A computer with hardware indexing, over 100 instructions, 1.8 μsec cycle time, 16/18 bit words, easy interfacing capability, optional multilevel priority interrupts, a 4 to 32K memory, and is available in a ruggedized version.



Congratulations. You've just imagined Varian Data's 620/i computer. Now you know why there are over 500 delivered.

Now here's something else that may boggle your imagination. The 620/i costs only $11,750 with ASR 33 TT.

Write for your brochure today. Then tomorrow you can start figuring the money you'll save.

varian data machines

a varian subsidiary/
2722 Michelson Drive/Irvine/California 92664
(714) 833-2400

SALES OFFICES: U.S., Downey, San Diego and San Francisco, California; Vernon and Westport, Connecticut; Chicago, Illinois; Houston, Texas; Fort Washington, Pennsylvania; Washington, D.C.; Waltham, Massachusetts. INTERNATIONAL: Australia, Belgium, Canada, France, Germany, India, Italy, South Africa, Sweden, Switzerland, United Kingdom and Ireland.

CIRCLE 1 ON INQUIRY CARD

18 mil core stacks at 20 mil prices

(Now your memory dollars can go 300 nsec faster)

Building a 700 nanosecond, 18 mil core, 3D, 3-wire, stack for the same money as a 1 microsec stack is now a reality.

In fact, you can save both money and nanoseconds. Our new 18 mil cores have such uniquely tight distribution in electrical parameters that you can use lower-cost, wider-tolerance components with no sacrifice in cycle time.

We also build 2½D stacks around our unique 18 mil cores that can give you a 500 nsec memory at lower cost. And if you want to build your own stacks, we'll sell you the bare cores.

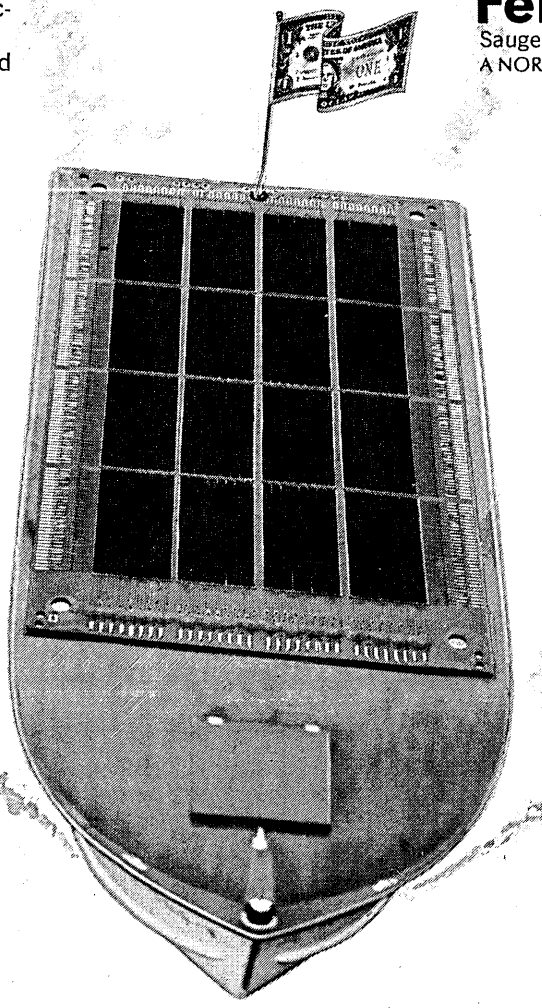
To top it off, Ferroxcube 18 mil cores are not a "sometime thing." We're shipping stacks and cores in production quantities now.

Talk to Ferroxcube today. We'll send you all the core and stack data you can use, plus sample cores. There's no reason for your dollars to dawdle, now that the same bucks can build a faster memory.

Ferroxcube

Saugerties, New York

A NORTH AMERICAN PHILIPS COMPANY.



Burbank, Calif.—(213) 849-6631; **Dallas, Texas**—Data Marketing Associates, Inc. (214) 231-1406; **Denver**—Wm. J. Purdy Agents, (303) 794-4283; **Minneapolis**—(612) 920-1830; **Northlake, Ill.**—(312) 261-7880; **Orlando, Fla.**—W. A. Brown & Assoc., (305) 425-5505· **Philadelphia**—(215) 643-4117; **Phoenix**—(602) 264-3129; **San Francisco**—Wm. J. Purdy Agents, (415) 347-7701; **Saugerties, N.Y.**—(914) 246-2811; **Union, N.J.**—(201) 964-1844; **Waltham, Mass.**—(617) 899-3110; **Toronto, Ontario**—Philips Electron Devices, Ltd. (416) 425-5161.

CIRCLE 2 ON INQUIRY CARD

Read us . . . we're ready

Your strobe signal to IKOR will trigger inputs that will solve your keyboard problem

IKOR has revolutionized the keyboard business with a simple, rugged solid state design that interfaces with virtually any data handling device.

And, at an attractive low price—only $150 for a basic configuration that meets your requirements.

There are solid reasons why this keyboard represents the present state of the art:

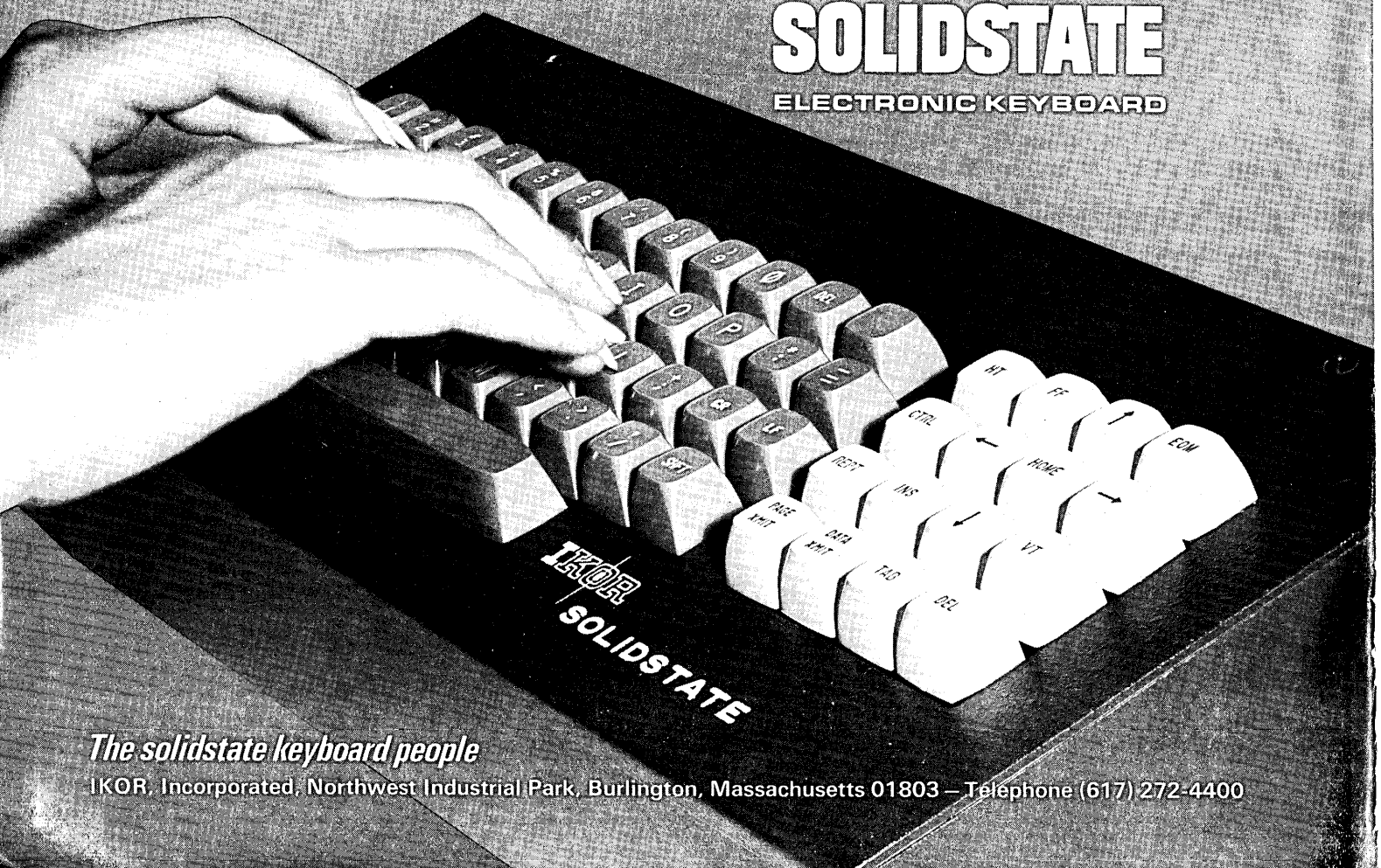
- The keyboard is true solid state. No electromechanical switches to fail. No circuitry in the key element itself to burn out due to high transient voltages. Rated for 30,000 hours MTBF.
- Output is TTL compatible. You can specify serial or parallel coded outputs including ASCII, EBCDIC, BAUDOT, Teletype or other code of your choice.
- Exclusive one key memory holds the code in an output buffer until cleared by operation of the next key. Need for supplementary memory unit is eliminated.
- Each key carries its own built in code so you rearrange key locations at will with no wiring or circuitry changes. You can have any number of function keys with their encoded outputs—and locate them anywhere you like. If you later wish to expand your keyboard the simple addition of more keys does it without complications.
- Two-key rollover prevents garbled encoding. Two keys struck simultaneously result in no data output. Automatic strobe signal generated by each key.

Bring your keyboard problems to IKOR . . . the solid state keyboard people. And do it early in your design program to get the full benefits of this new state of the-art advance.

We'll give you a prototype of your own proprietary design in 30 to 60 days. Delivery of production quantities beginning in 90 days following approval.

Phone IKOR at 617-272-4400. We'll work with you to get the keyboard you want, when you want it.

IKOR
SOLIDSTATE
ELECTRONIC KEYBOARD



The solidstate keyboard people

IKOR, Incorporated, Northwest Industrial Park, Burlington, Massachusetts 01803 — Telephone (617) 272-4400

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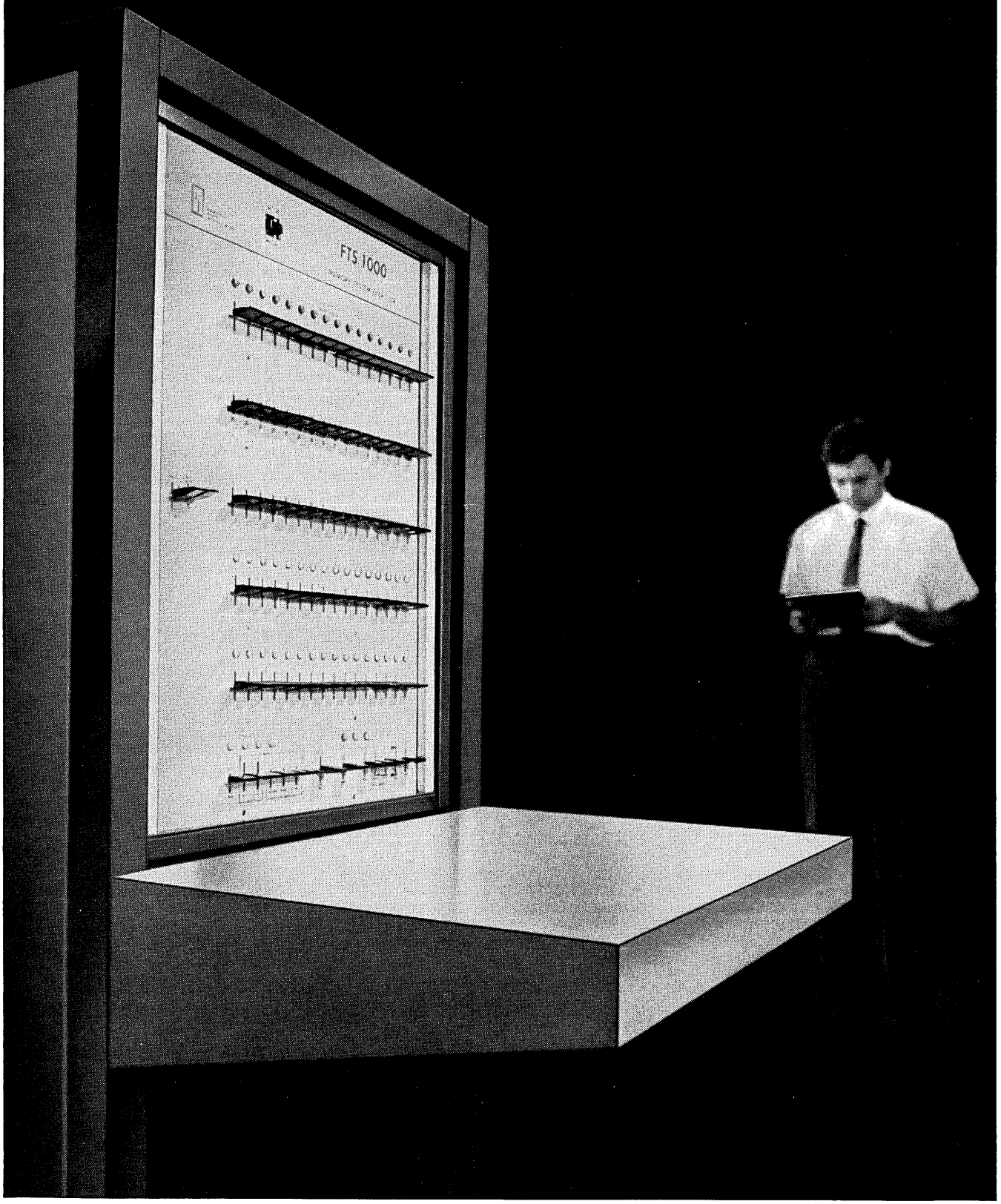
Editorial & Executive Offices
Prof. Bldg., Baker Ave.,
W. Concord, Mass. 01781
Tel. 369-6660

FEATURES

DEPARTMENTS

CTC's NEW FTS-1000 100ns
Memory System Exerciser...

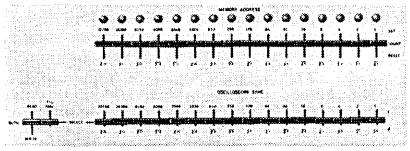


You design it. We build it. With off-the-shelf options. In 60 days!

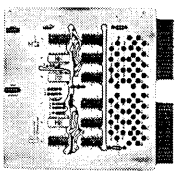
SEE THE FTS-1000 At Booths 8414,15,16 FJCC

You read it right. You specify your own expandable digital computer simulation system for evaluating magnetic memories and go/no-go production testing. Your system depends upon your application requirement *and* your budget. We build it for you, using standard option modules. And we deliver in 60 days—with complete documentation unique to that system, including a computerized/options wire list and instruction manual.

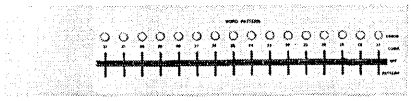
The FTS-1000 *customized design options philosophy* eliminates added expense of unwanted and unneeded capabilities, while providing a practically unlimited choice of memory test/capability cost options. For example, you can select the minimum capability needed to test ferrite core memory systems, or add modes for testing plated wire, and planar film and semiconductor memories, including MSI and LSI. The FTS-1000 can also be configured to evaluate large digital arrays of combinational and/or sequential logic, provide go/no-go or read-only testing, and full-scale computer simulation—all this at a 10 MHz operating rate to meet the most stringent current requirements. With FTS-1000, the choice is yours:



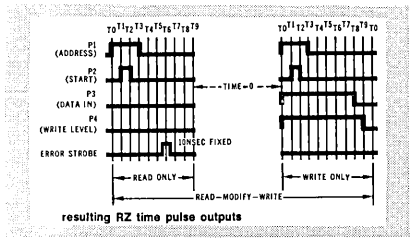
ADDRESS GENERATION ranges from 8 to 20 address bits. Oscilloscope Sync at each address, all addresses, or binary multiple addresses is available. Min-Max Address Control by register jamming switches or Min-Max address switches, or both, may be ordered. Buffer Mode, Random Address Generation and Adjacent Cell Disturb may be included. Address Organization is available as Straight Binary or BCD, X-Y Binary and X-Y BCD.



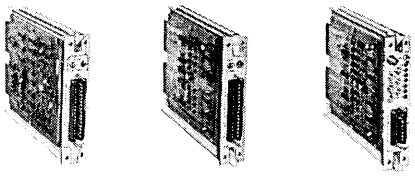
PATTERN GENERATION options include from 2 to 8 programmable binary pattern generators built on plug-in printed circuit boards. Random and Bit Oriented Storage Patterns also available.



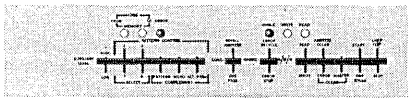
WORD GENERATION and Error Check options may be ordered for Data Expansion from 8 to 120 bits, as well as Error Count, Pause, Accumulate, Rate Indicator and Parity Check options.



TIMING GENERATION options include Timing Expansion from 4 to 8 channels, Asynchronous or Synchronous, or both, and External Clock Input. Independent Read-Write timing control is provided.

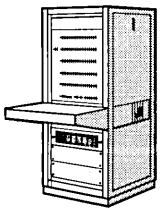


I/O INTERFACE OPTIONS may be specified for either TTL, ECL or Universal. Either single rail, double rail, or double rail complementary is available, and/or in RZ or NRZ. Low level, high level and input threshold levels are variable.

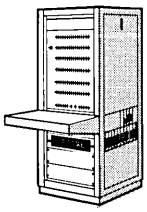


MASTER CONTROL options are available for Auxiliary Level, Cycle, Address, Master Clear and Lamp Test. Automatic Test Sequences, Paper Tape and other controller device interfaces may be specified.

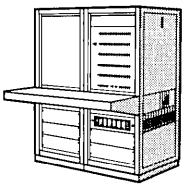
The physical configurations of the FTS-1000 are based on the total number of data bits required and the various options selected.



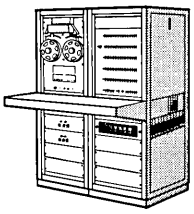
The basic FTS-1000 is housed in a single cabinet 24″ wide, 24″ deep and 64″ high, and can utilize up to 190 I/O line pairs or 60 data bits.



Beyond 190 I/O line pairs or 60 data bits, or where additional control section switches are required, a 72″ high cabinet may be specified.



Where a Universal Interface is specified, two 64″ high cabinets are usually required. Inclusion of this option increases the minimum cycle time from 100nsec to 150nsec.



Where a Universal Interface and a large number of other options are specified, two 72″ high cabinets are usually required.

The FTS-1000, with its unique *customized design options philosophy,* is a new concept in solving memory test problems. It's one of CTC's complete line of innovative manual and automatic memory testers designed for maximum economy/applications flexibility. Whether you're planning memory test facilities or expanding existing capabilities, we'll show you how FTS-1000 lowers cost-per-unit throughput while increasing speed. Write, wire or call for more information.

COMPUTER TEST CORPORATION

THREE COMPUTER DRIVE, CHERRY HILL, N. J. 08034 ■ PHONE: 609/424-2400 ■ TELEX: 845120 ■ CABLE: COMPUTER

CIRCLE 4 ON INQUIRY CARD

LAST YEAR DATA GENERAL OPENED ITS BIG MOUTH AND INTRODUCED "THE BEST SMALL COMPUTER IN THE WORLD."

We were cocky when we brought out our Nova a year ago.

We knew we had the best small computer in the world, and we weren't embarrassed to say so.

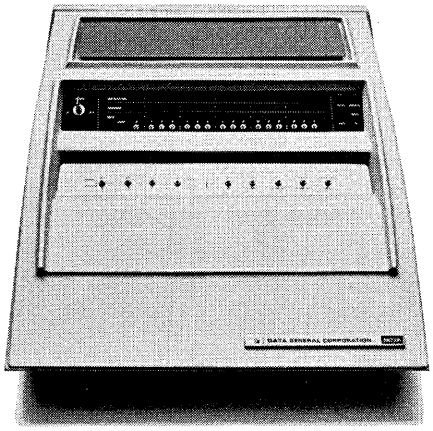
So maybe we came on a little strong.

And maybe some people said, "Put up or shut up."

But look at what we put up:

The first mini computer built around medium-scale integration.

The first mini computer with a multi-accumulator organization, an expandable



read-only memory you can program like core, a high-speed data channel and automatic interrupt source identification.

A big plant, so we could mass produce the remarkable Nova.

A technical service group big enough to really service our customers.

And a price of $7950 (rack-mountable version) with a basic 4096 16-bit word memory and Teletype interface.

A while back, we delivered our 100th Nova. We're now well on our way to delivering several hundred more. The Nova is a smash hit by anybody's calculations.

Of course, if this computer had bombed, we'd have felt pretty silly.

But we'd have felt even more surprised.

NOVA
$7950

THE MOUTH STRIKES AGAIN.

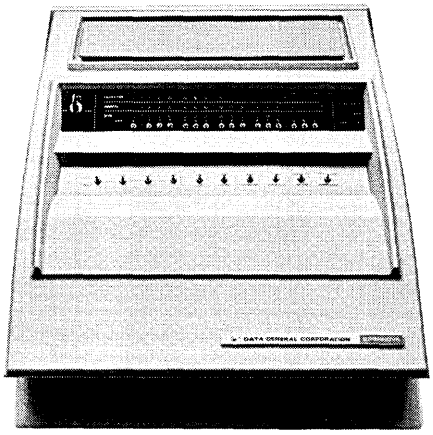
Introducing the best small computer in the world.

The Supernova. With all the features that made the Nova a great mini computer. And a price of $11,700.

Maybe you wonder why it costs $3750 more than the Nova.

For one thing, the Supernova is the fastest small computer in the world. Add time is 300 nanoseconds in read-only memory, 800 nanoseconds in core.

And by overlapping fetch and execute cycles in read-only memory, the Supernova



has an effective operating speed that's 3-10 times faster than its competition's.

Core memory is expandable to 32,000 words and interchangeable with read-only. The same programs run in both memories.

As options, Supernova has a hardware multiply/divide and memory- and I/O-protect hardware. Automatic program load is standard.

Supernova's hardware and software are compatible with Nova's.

Does all this mean we've obsoleted the Nova?

No, it doesn't. It just means Data General now has the *two* best small computers in the world.

So if you thought we had a big mouth before, we'd better warn you:

We have not yet begun to bellow.

SUPERNOVA
300-NANOSEC. ADD

CIRCLE 5 ON INQUIRY CARD


Before you freeze your board

plans, better call TI

Our experience in high-density boards can keep you off a lot of thin ice. And TI service is complete, taking you from drawing board to production boards, all in a single plant.

The important thing is to call us early in the game.

We'll help you finalize the design. Our Automated Electronic Design Service will prepare your artwork. Breadboard and check the circuitry. Build your prototype. And give you fast turn around if the logic must be changed. Schedule your production. Handle complete chemical and mechanical processing on the finest array of equipment ever assembled. Routinely give you etchback and other production steps sometimes listed as "extras." Move your boards through a quality control system that maintains a statistical reliability unequalled in the industry. And probably save you money.

We'll be glad to sit in on your next "board meeting."

Just call or write:

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Chemical Materials Division
Mail Station 924 • P.O. Box 5621 • Dallas, Texas 75222

TEXAS INSTRUMENTS
INCORPORATED

CIRCLE 6 ON INQUIRY CARD

CONFERENCE CALENDAR

Oct. 14-15—Symposium on Optical Character Recognition in Government and Industry, Dept. of State West Auditorium, Wash. D.C. **Spsrs:** Nat'l Bur. of Stds. and Nat'l Archives & Records Serv. **Info:** NBS Office of Tech. Information & Publications, Rm. A500/101, Washington, D.C. 20234.

Oct. 22-23—2nd Ann. Connector Symposium, Cherry Hill Inn, Cherry Hill, N.J. **Spsr. & Info:** Electronic Connector Study Group, Box 3104, Philadelphia, Pa. 19150.

Oct. 20-24—Course on "Developing Computer Problem-Solving Skills for Managers—Hands-On Direct Access Computer Usage." **Spsr:** American Management Assoc. **Info:** AMA Course Registrar, Amer. Mgt. Assoc. Bldg., 135 W. 50th St., New York, N.Y. 10020.

Oct. 24—4th Ann. Symposium on the Application of Computers to the Problems of Urban Society. **Spsrs:** Metropolitan N.Y. Chptr's of Assoc. for Computing Machinery. **Info:** Mrs. Jessica Hellwig, Computer Center, Columbia Univ., New York N.Y. 10027.

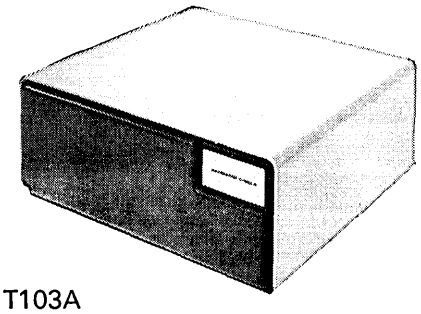
Oct. 14-16—Sym. on "Cybernetics in the 70's and Conflict Resolution." **Spsrs:** Nat'l Science Foundation & Nat'l Bur. Stds. **Info:** Dr. C. Hammer, Univac Div., Sperry Rand Corp., 2121 Wisconsin Ave., N.W., Wash., D.C. 20007.

Oct. 22-24—System Science and Cybernetics Conf., Warwick Hotel, Philadelphia, Pa. **Spsr:** IEEE Sys. Sci. & Cyber. Grp. **Info:** J. E. Kienle, Pub. Chrmn., Univac Div. Sperry Rand Corp., Blue Bell, Pa. 19422.

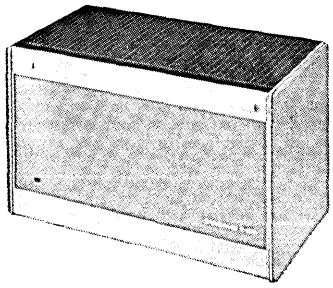
Oct. 27-30—24th Ann. ICA Conf. & Exhibit, Astrohall, Houston, Tex. **Spsr:** Instr. Soc. of Amer. **Info:** H. Buntzel, Jr., Bonner & Moore Assoc., Inc., Suite 1124, 500 Jefferson Bldg., Houston, Tex.

Nov. 3—Semi-tutorial Seminar on Fluidics, Annenberg Auditorium, U. of Penn. **Spsr:** Philadelphia Section IEEE. **Info:** J. E. Kienle, Seminar Chrm., Univac Div. Sperry Rand Corp., Blue Bell, Pa. 19422.

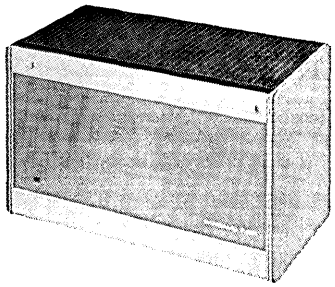
Nov. 18-20—Fall Joint Computer Conf., Convention Center & Sahara Hotel, Las Vegas, Nev. **Spsrs:** AFIPS, ACM, IEEE Computer Group. **Info:** AFIPS Hdqs., 210 Summit Ave., Montvale, N.J. 07645.



T103A



T201B



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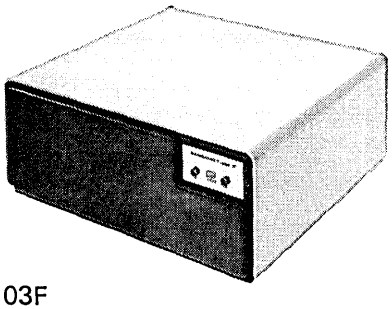
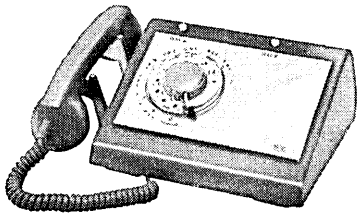


T103F



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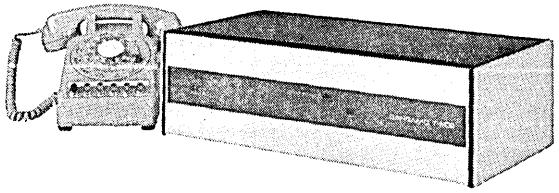
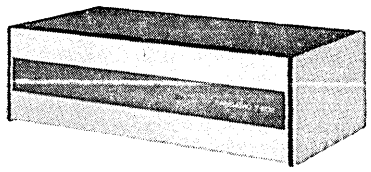


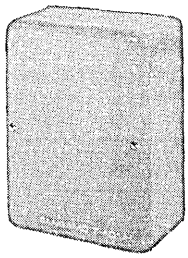
T202C



T202D

SANGAMODEMS...

the most complete line of Bell compatible data sets!



T401H

Have you been purchasing data sets here and there? You don't have to! SANGAMO can supply 93% of your data set requirements with guaranteed Bell compatible units *now*.

Check this listing:

103A1	201A1	202D4	202C7
103A2	201A2	202C1	202C8
103F2	201A3	202C2	401E2
201B1	201A4	202C3	401E3
201B2	202D1	202C4	401E4
201B3	202D2	202C5	401E5
201B4	202D3	202C6	401H1

We can also supply customized variations of these standard sets, with obvious economies for unlimited applications.

Field Service Contracts available on request.

Need Data Sets? Let's communicate!

T69-05

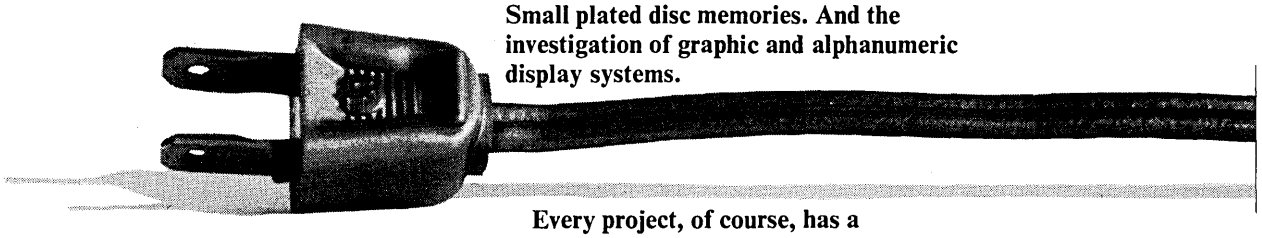
Communication Systems
SANGAMO
Electric Company
Springfield, Illinois 62705
217 544-6411

The incredible

The bigger we get in laser technology, the smaller our memory systems will become.

By 1970, Bryant will be ready to spot one million bits of information into one itty bitty inch. By the mid 1970's that figure could easily reach 25 million.

Laser research in focusing and positioning is just one of the projects our 45-man Research and Development group is currently working on. Projects that include oxide materials for magnetic recordings (we're pioneers in this field). Small plated disc memories. And the investigation of graphic and alphanumeric display systems.



Every project, of course, has a practical application. Leading in the past to such advancements as the largest (capacity) storage unit on the market and the "flying head" principle used in our drum and disc file systems.

Through the efforts of our Research and Development people we've been able to offer the largest and most experienced line of random access drum and disc file systems in the world.

Small wonder more companies are becoming "Bryant Believers" every day.
Bryant Computer Products, 850 Ladd Rd., Walled Lake, Michigan 48088.

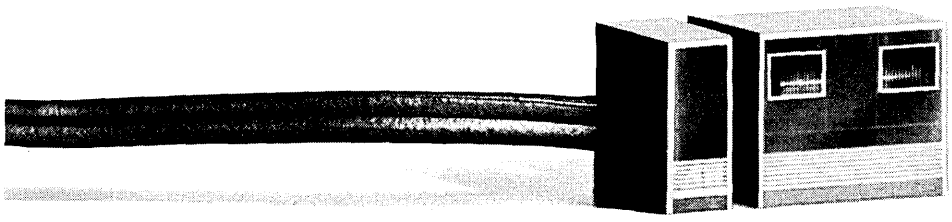
A match for any computer

BRYANT
COMPUTER PRODUCTS

XLO®
EX-CELL-O CORPORATION

CIRCLE 9 ON INQUIRY CARD

shrinking machine.



LETTERS TO THE EDITOR

To the Editor:

The attempt to provide "A Survey of Data Communication Devices and Facilities" in your July issue unfortunately fell far short of the article's objective. It is totally accurate that the successful implementation and operation of an information processing system is directly dependent on the knowledgeable and effective utilization of data communication technology. To attempt, however, to condense this technology into a few brief paragraphs coupled with incomplete and/or outdated tables does not contribute to the desired system solutions and tends to lull a reader into a sense of false security concerning communication considerations. Unfortunately in attempting to answer all areas of communication facilities, Mr. Bhushan only succeeded in providing additional confusion. To provide a detailed critique of the [above reference] article is beyond the scope of this correspondence. I will attempt, however, to emphasize its more serious shortcomings.

The attempt to identify transmission facility capacity in terms of bits per second is always subject to misinterpretation. As the article states communication engineers grade a transmission facility in terms of bandwidth. Modems are graded in terms of information rate (bits per second). To attempt to grade circuits exclusively in terms of information rate is as meaningless as grading modems in terms of required transmission spectrum. To identify transmission facilities in terms of "bits per second" is "unnatural" and results from a hazy understanding of the entire communication technology. The missing link is an appreciation of the transmission spectrum and the information rate relationship as a function of modulation and demodulation techniques. Any attempted shortcuts only lead to greater confusion.

For example, a voice-grade circuit (bandwidth-nominal 4 kHz) is capable of reliable 4800 bits per second and 9600 bits per second information rates and are not characterized in theory or in practice to ". . . 1200 to 3600 bits per second." Perhaps the modulation and demodulation techniques of the modems about which the author is familiar as being used on voiceband channels may constitute such a characterization but it should never be considered as an absolute measurement of grading transmission facility capacity.

The implication that serial transmission requires "a single wire" and parallel transmission requires "multiple wires" is a serious misconception. This is compounded by the author's conclusion that "except for very short distances . . . , serial transmission is more efficient. . . ." Parallel transmission may be very desirable for any distance transmission, since the terminal logic at each end of such a circuit is less complex than that required for serial transmission. Western Electric manufactures a family of parallel transmisiosn modems (the 400 series) for "single wire," long distance transmission. To dismiss this transmission technique as limited to "very short distances" and requiring "multiple wires" is a serious error.

The article also contains other numerous incidents of misleading and incomplete data. The following list presents some of the more significant items.

- WATS is also available on an inward basis; that is, calls can be made from any number of locations in a specified geographical area to a single point.
- The Bell System 203 modem is still experimental and presently is not tariffed (interstate or intrastate).
- Telpak A and B are no longer available and the rates for Telpak C and D have been considerably modified.
- Schedule 4A, 4B, and 4C circuits are no longer specified as such. Conditioning or equalization is identified as C-1, C-2, and C-4 for com-

mercial data communication facilities.

- Interstate measured WATS is 10 hour per month for the basic monthly rate.

In conclusion, I have only two other comments to direct to this article. The author should have taken the space to clearly explain to his readers the relationship between interstate and intrastate tariffs. The fact is that rates, and in some cases services, vary from state to state.

Secondly, the article could have achieved a considerably greater value to its readers if it had not implied that ". . . selection is the common carrier's responsibility. . . ." The common carrier's sole responsibility is to implement and maintain the communication services and facilities selected and ordered by the customer within the scope of the applicable interstate and/or intrastate tariffs. To create the illusion that a potential communication user can relegate communication system design and selection responsibility to the common carrier is an erroneous and dangerous concept to perpetuate.

I appreciate the problem faced by the author in attempting to document in a limited space and at a single point in time a technology—and its application—as dynamic and extensive as data communications. My major criticism is that the article was an attempt to provide instant expertise in this field and did not identify the true nature and complexity of this vital area to the readers. The philosophy of do-it-yourself data communications can be traced to the interpretation that such surveys are all inclusive, coupled with the claim that common carriers' assumed "responsibility" will automatically solve any and all data communication problems. The inherent fallacy of this philosophy is repeatedly demonstrated in inefficient, costly and ineffective data communication system attempts.

John E. Buckley
Director, Communication Services
Computer Group, Inc.
King of Prussia, Pa.

To the Editor:

It appears to me that Mr. Buckley has seriously misinterpreted the article's objective. The intent of my article was not to provide "instant expertise in the field," as he states in his letter. For if this were possible in the scope of a single article or even a book, there would be no need of data communica-

(Letters to the Editor cont.)

tions engineers or experts. Instead I claim much more modest goals—that is, of familiarizing the user with some of the terminology, technology, equipment and facilities available. This should have been apparent from its title of being a *survey* and not "How to Solve All Your Data Communications Problems."

Some of Mr. Buckley's comments, I feel, add to the so-called "existing confusion." Nowhere in the article has it been stated that circuits should be rated in bits per second. It is for the combined communications facility (referred to as channel), including the modems and circuits, that bits per second is a more useful and universal measure than characters per second or words per minute. I don't think Mr. Buckley would dispute this.

I am well aware of Rixon and other modems transmitting reliably at 9600 bps over voice-grade lines (available in the $10,000 price range), but it should be noted that these are not as yet available over the dial network. Modem communications over the dial network are still generally available in the 1200 to 3600 bps range. Concerning the advantages and disadvantages of serial vs. parallel transmission, the efficiency is directly related to costs which are determined by individual cases. Specific instances may deem parallel techniques to be advantageous for larger distances, but this is usually not so or else the serial modems would not be that prevalent.

As to the 203 data set, it was indicated in the article that it "is a new development . . . intended for use on the dial telephone network" and did not imply that it is currently available. The differences of tariffs between states, areas, and operating companies were noted specifically and the reader was so advised. Nowhere does the article imply, as stated by Mr. Buckley, that selection is the common carrier's responsibility. What is said is that "the representatives of the communications companies should be consulted in order to obtain current information on rates, availability of service, channels and other devices pertinent to data transmission."

I am aware of some of the other points mentioned by Mr. Buckley and gratefully acknowledge them as useful information.

Abhay K. Bhushan
Massachusetts Institute of Technology
Cambridge, Mass.

MAC's priority interrupts are in the hardware. To keep you out of the software.

Creating programs to handle every conceivable interrupt should have gone out with brass spittoons. Especially when MAC gives you 4 hardware interrupts for only $11,950.

You'll have to double MAC's price to find hardware interrupts anywhere else. And triple it to find a computer with MAC's automatic store-and-restore.

MAC responds to interrupts and shifts to new jobs in 6 microseconds average. That's fast enough to operate in almost any real-time or time-sharing system.

And if 4 interrupt levels aren't enough, MAC's can expand to 64.

MAC's basic 16-bit, 4K memory can also expand. To 8K in the mainframe. To 65K with additional chassis.

With MAC, creating software is a fairly simple proposition. What MAC's hardware interrupts don't eliminate, MAC's internal structure simplifies.

So here's another proposition: either build your system around MAC or order plenty of eye shades.

Write to MAC, Lockheed Electronics Company, Data Products Division, 6201 East Randolph Street, Los Angeles, Calif. 90022.

LOCKHEED ELECTRONICS

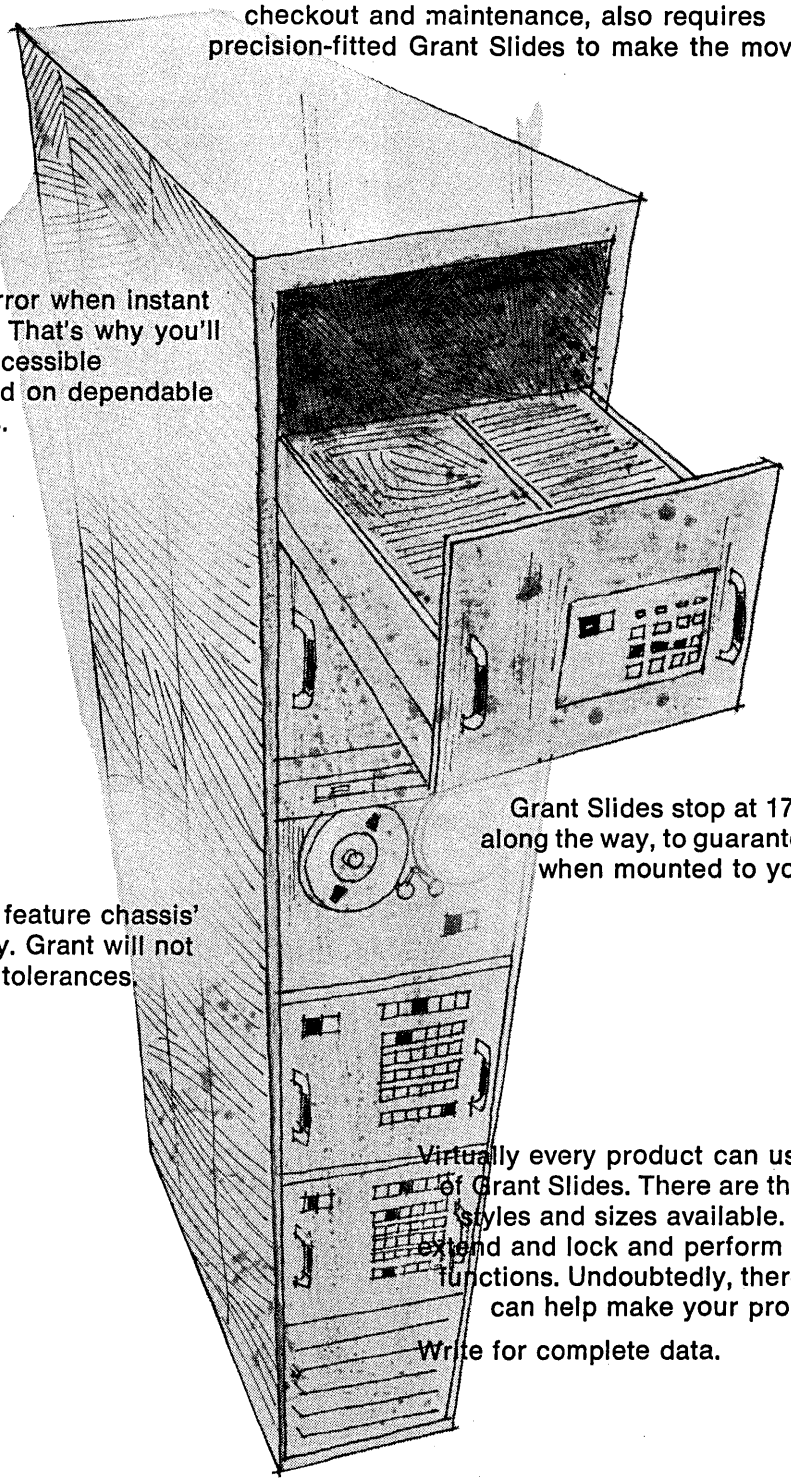
A Division of Lockheed Aircraft Corporation.
See MAC in action at Island 3200, FJCC.

CIRCLE 13 ON INQUIRY CARD

A lot rides on Grant® Slides. For good reasons too.

Valuable, sensitive equipment which requires checkout and maintenance, also requires precision-fitted Grant Slides to make the move.

There's no room for error when instant access is necessary. That's why you'll find most normally inaccessible components mounted on dependable Grant Slides.



Grant Slides stop at 17 inspection stations along the way, to guarantee peak performance when mounted to your equipment.

Many Grant Slides feature chassis' interchangeability. Grant will not tolerate sloppy tolerances.

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

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The Friden 1150 Digital Printer.

It didn't fail us. So it won't fail you.

For nearly two years now, the Friden* 1150 Digital Printer has been an integral part of our electronic printing calculator.

So we know all about its reliability from first-hand experience, out in the field.

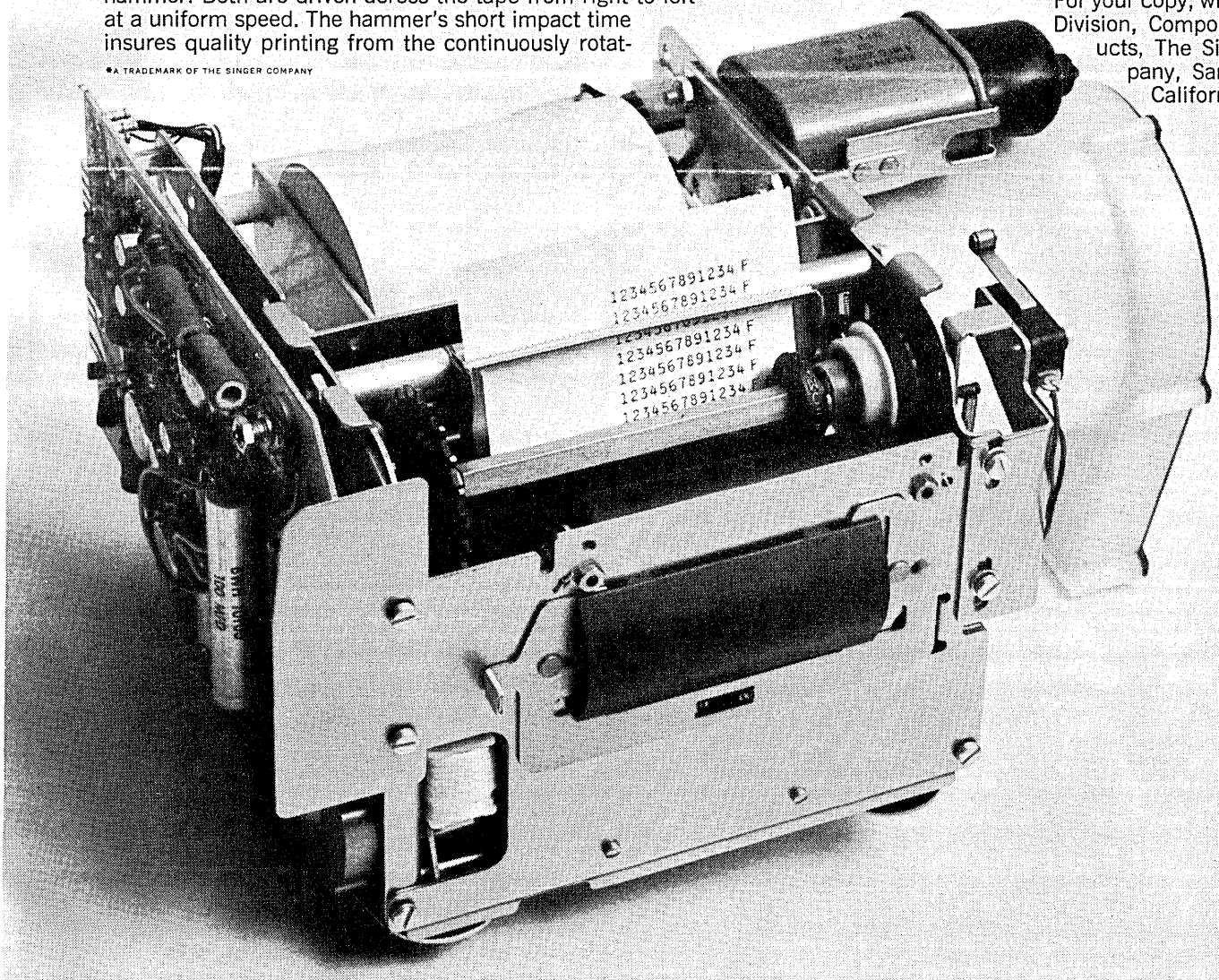
This 50-character-a-second printer is *durable* because it has fewer moving parts than ordinary medium-speed printers. It is easier to maintain. This means less downtime for your OEM product. The 1150 Digital Printer contains a single 20-character print wheel and a synchronized print hammer. Both are driven across the tape from right to left at a uniform speed. The hammer's short impact time insures quality printing from the continuously rotating wheel. And we have eliminated messy ribbons with our disposable ink roller.

Logic requirements are simple, making it easy to integrate the 1150 Digital Printer into your OEM product.

One more important thing: the 1150 Digital Printer is *not* expensive. It just sounds expensive. With its low initial cost and desirable operating features, the 1150 Digital Printer gives you a price/performance ratio unique among OEM printers.

The complete specs are all in our Specification 1001. For your copy, write: Friden Division, Component Products, The Singer Company, San Leandro, California 94577.

*A TRADEMARK OF THE SINGER COMPANY



Friden Component Products. One way Singer serves the Original Equipment Market.

SINGER
FRIDEN DIVISION

CIRCLE 15 ON INQUIRY CARD

80 lines per second!

Clevite's new hardcopy electrostatic printer zipped out the facing page in 1.8 seconds flat. That's up to seven times faster than most printers on the market.

Eighty lines per second . . . 412,000 characters per minute . . . 4800 lines per minute. No matter how you figure print-out speed, dollar for dollar Clevite 4800 is far and away the fastest and most economical. It's four to seven times faster than most line printers . . . ten to twenty times faster than usual photographic hardcopy techniques. No other print-out system is even in the same ball park.

Words. And pictures.

Clevite 4800 handles both alphanumerics and graphics. Simultaneously. It will reproduce words, numbers, drawings, charts and graphs. Paper is an easy-to-file 8½" wide and page height is infinitely variable up to the full 300' length of the paper supply roll!

More of the fonts you want.

Clevite 4800 generates a wide variety of fonts from the smallest matrix on up. In an equally wide variety of weights, sizes and styles.

Archival quality.

Clevite 4800 uses a special, high-contrast paper. The electrostatic print-out won't smear. And the paper won't curl, yellow or get brittle in storage. You can write on it with ball point pen, pencil, felt-tip or whatever.

The sound of silence.

Clevite 4800 is an electrostatic printer. So it is quiet. (Think about that next time you're trying to make yourself heard above a chorus of impact-line printers.) And no impact means less wear and tear on the printer, less maintenance and downtime.

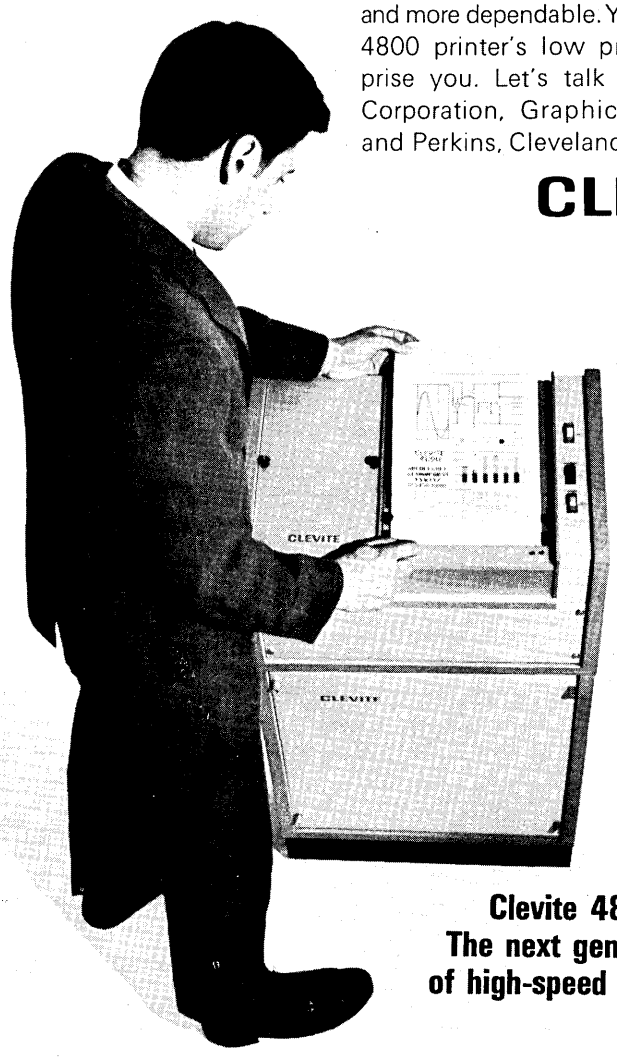
Beyond the computer.

Clevite 4800 has uses beyond the computer. In communications it can replace banks of teletypes and prints out data transmitted by telemetry, radio microwave and/or land lines. And it prints out graphic displays from CRT's using a TV raster display memory. The Clevite 4800 whips out full pages of alphanumerics and graphics as fast as signal sources can feed it. You may have other application ideas. Let's kick them around.

A word from the sponsor.

Clevite 4800 is based on proprietary equipment and proprietary paper. There is nothing else quite like it. It's faster, more versatile, quieter and more dependable. Yet, the Clevite 4800 printer's low price will surprise you. Let's talk soon. Clevite Corporation, Graphics Dept., 37th and Perkins, Cleveland, Ohio 44114.

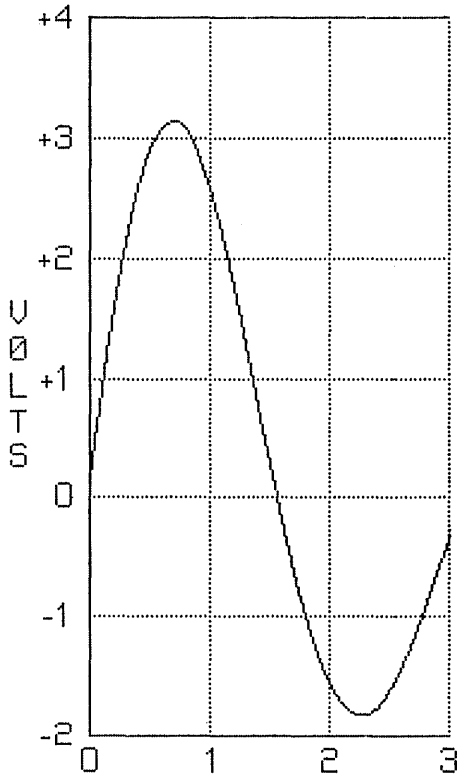
CLEVITE

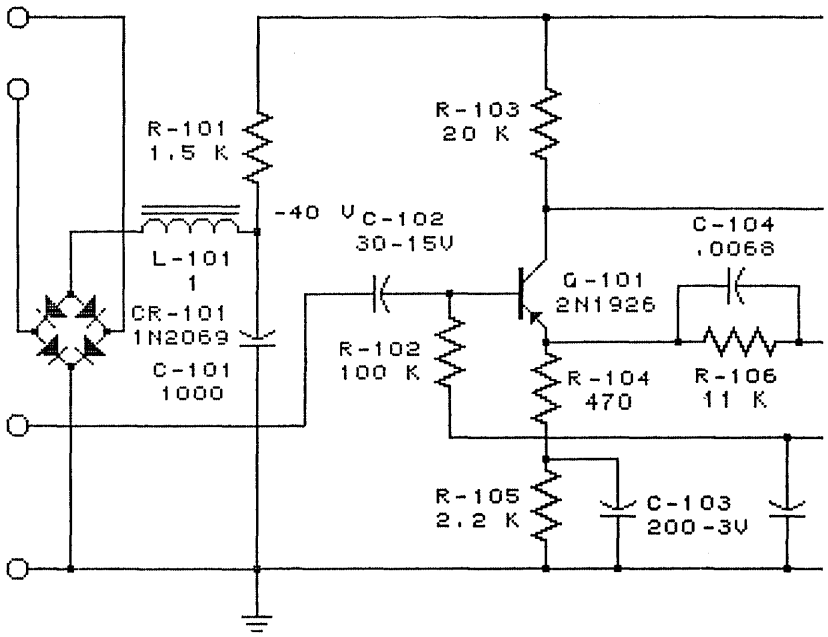


Clevite 4800. The next generation of high-speed printers.

See Clevite 4800 at the Fall Joint Computer Conference in Las Vegas November 18, 19, 20, Booths 112 and 113.

CIRCLE 16 ON INQUIRY CARD





CLEVITE 4800

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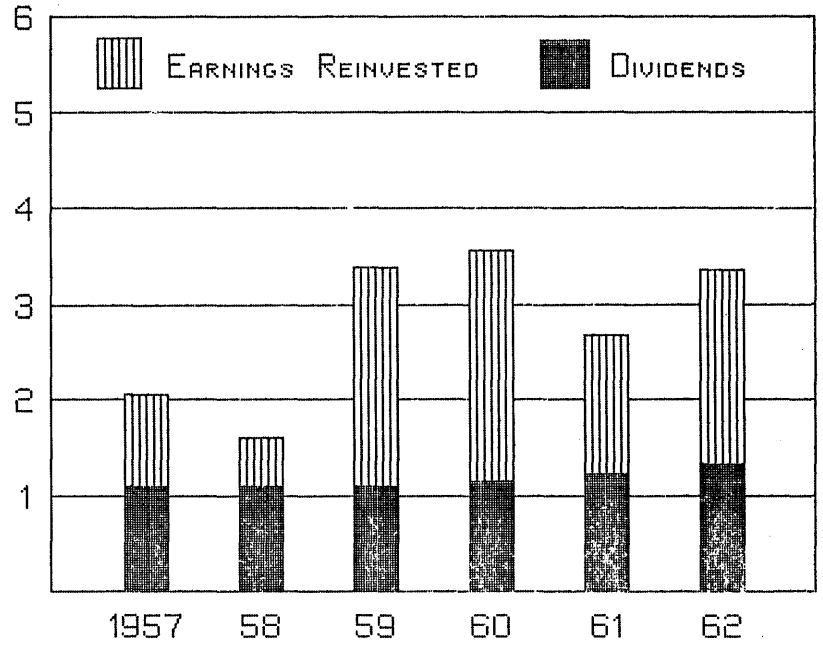

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THESE CHARACTERS ARE N0MINALLY 10 UNITS HIGH BY 6 UNITS WIDE. THE HEIGHTS VARY FR0M 6 T0 14 UNITS. THE WIDTHS VARY FR0M 1 T0 9 UNITS.

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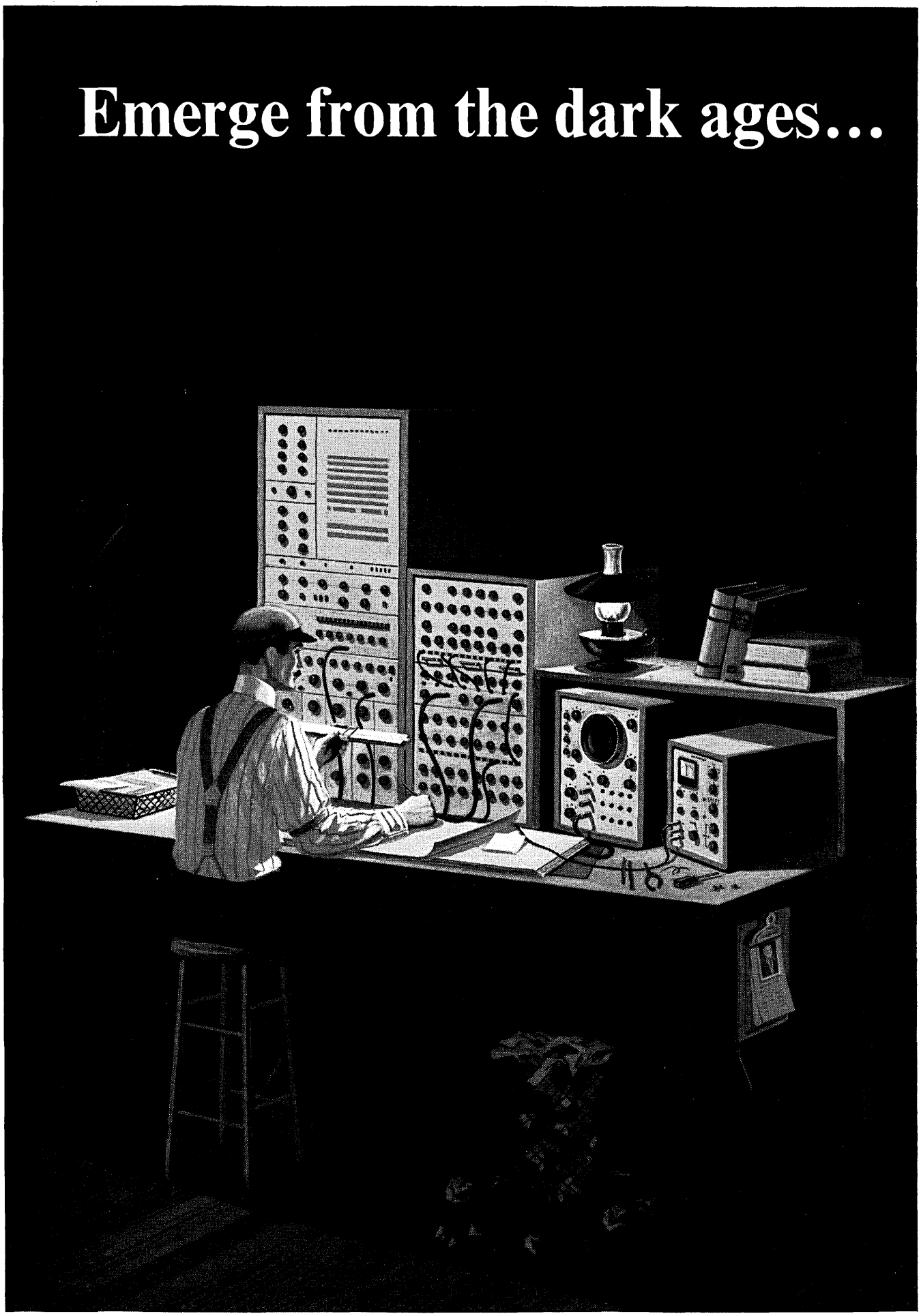
THESE CHARACTERS ARE N0MINALLY 6 UNITS HIGH BY 5 UNITS WIDE. THE WIDTHS VARY FR0M 1 T0 7 UNITS.

This page printed in 1.8 seconds flat

Emerge from the dark ages...



CTC's New DELTA 400 Stored Program Magnetic Test System

SEE THE DELTA 400 At Booths 8414,15,16 FJCC

Sheds new light on plane and stack design.

Ah . . . those good old days of guessing at plane and stack margins. When measurement and evaluation meant "eyeballing"—period. And scope readings were interpreted to manually record failure causes. A lot of time was wasted gathering data of questionable reliability because of human errors. Much time and money was spent . . . simply to test a *single* stack for *limited* output data. Those good old days. Will you face another one tomorrow? Not with Delta 400.

Delta 400 solves all of today's memory design/test measurement problems. And tomorrow's too. It provides *total program control* for all drive, switching and pulse sequencing parameters. Schmoo plotting is complete and automatic, as are other important stack characteristic tests. Delta 400 permits continuous testing over the entire spectrum of values. And the result is *real* data output—not merely go/no-go response. But the big payoff with Delta 400, is that for the first time *total evaluation* of a stack is possible . . . in a mere fraction of the time usually required to achieve far less comprehensive data by any other method.

The Delta 400 Series is a family of integrated test/measurement/data acquisition systems which operate under digital computer-type stored program control. A typical system consists of a Magnetics Test Terminal, a Stored Program Controller, an Input/Output Console, and Operating Programs to control the system. The major parts of the system, and their functions:

INPUT/OUTPUT

All test operations are controlled through the Input/Output Console. Input commands are entered through the keyboard, through switches on the control panel, and/or by loading a pre-punched paper tape into the Console's paper tape reader. The Switch/Display Control Panel of the Input/Output Console replaces many of the typewritten commands with a push-button input. In addition, a variety of I/O options are available for the Delta 400 system, including higher speed paper tape readers and punches, card equipment, graph plotters, line printers.

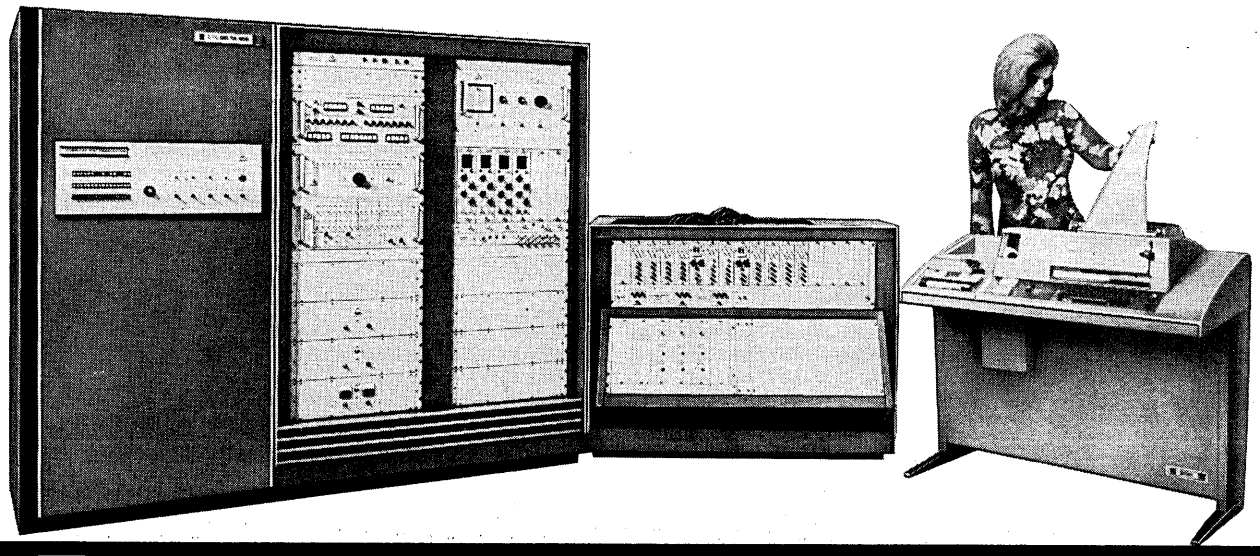
SOFTWARE

Delta 400's Stored Program Concept is the key to the system's flexibility and adaptability. Test operations are accomplished through a prepared program written by a simple, English-type language called TOOL (Test Oriented Operators Language). TOOL commands enter parameters and instrument settings necessary to establish the limits for plane and stack testing and reporting.

DATA ACQUISITION AND REDUCTION

Test information data acquired through the Delta 400 system is reduced to a convenient report format to provide listings of error occurrences by type, the minimum and maximum values measured, and histogram tabulations indicating the number of bits falling into specified value categories. Any of these final printouts may be suppressed by the operator if they are not required, and additional optional programs may be included which best suit the specific application. Typical printouts include Print All Addresses, Print Error Addresses, Print Distribution for Peak Amplitude, Peaking Time and Switching Time, and Print Error Summary.

The Delta 400 system, with its unique *Stored Program Concept,* is a new method for solving plane and stack test problems. It's one of CTC's complete line of innovative manual and automatic memory element and array testers designed for maximum economy/applications flexibility. Whether you're planning memory test facilities or expanding existing capabilities, we'll show you how Delta 400 decreases memory development time and cost while increasing speed and yields. Write, wire or call for more data.



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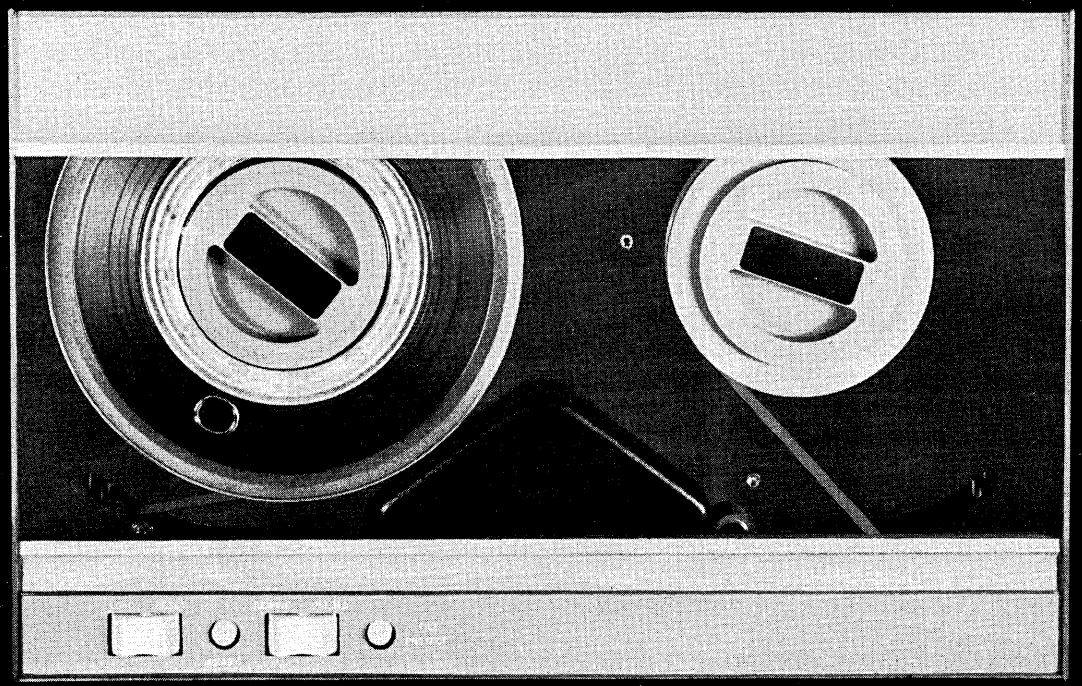
CIRCLE 17 ON INQUIRY CARD

Digitronics new magnetic tape handler has everything but a high price.

The new Digitronics Model 3600 Magnetic Tape Handler is complete . . . ready to plug in and is priced under $3,000 . . . includes read/write electronics, read after write head, IBM 360 compatibility, 8½" reels, speed to 24 ips, rewind 120 ips, BOT/EOT detection, advance to load point and power supply. A totally new advanced electronic package, compact and simply designed. Featuring a dual head for easy deskewing; a combination of pulse width and peak signal detection to provide highest degree of noise discrimination; single capstan drive photoelectrically controlled; single or dual density; in-line loading and more . . . and it's from Digitronics. Contact your Digitronics representative (listed in EEM or EBG) or write Digitronics Corporation, Albertson, New York 11507, (516) 484-1000.

unit price
under $3,000 complete

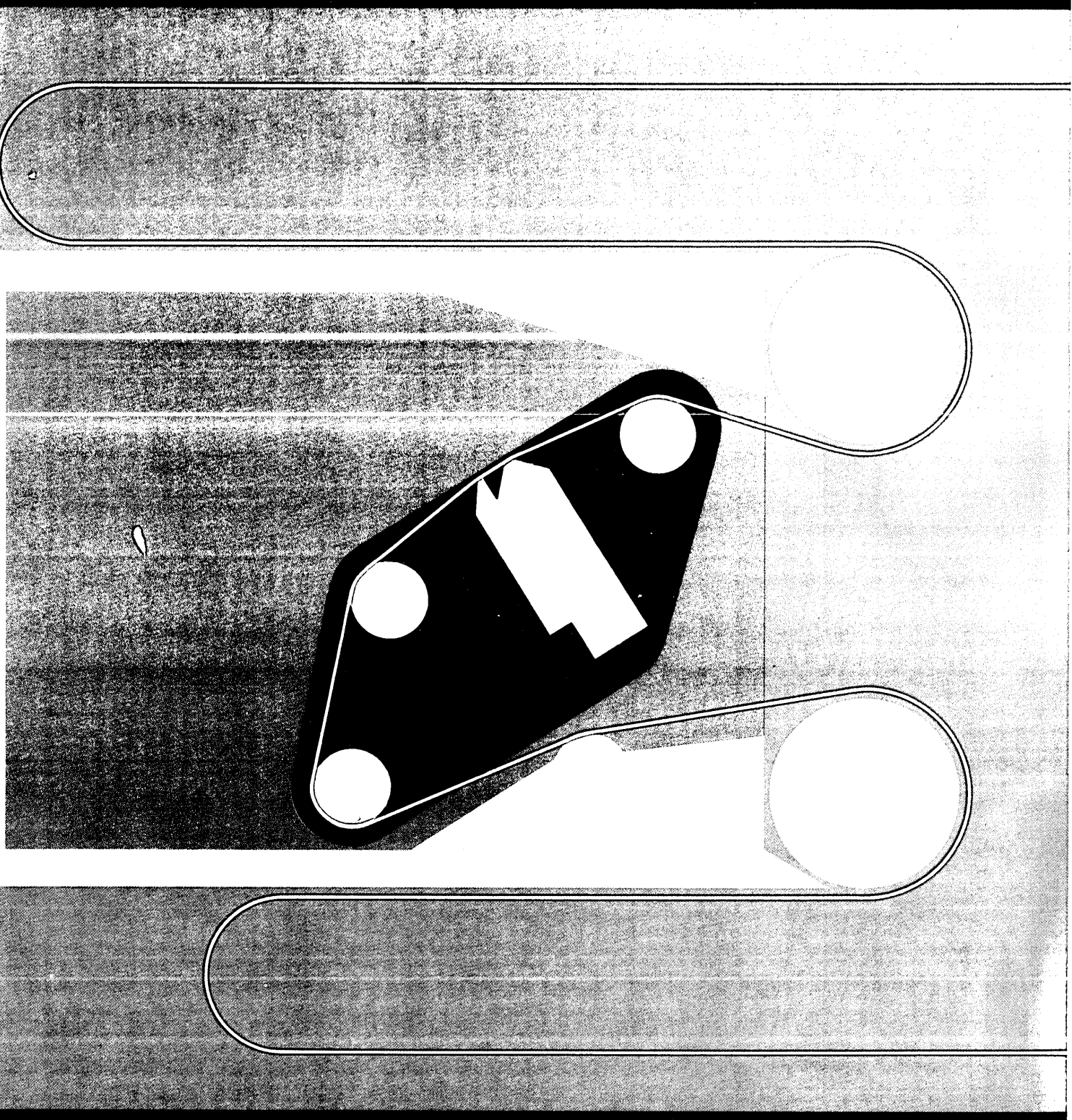


Premiere showing at FJCC
Las Vegas - November

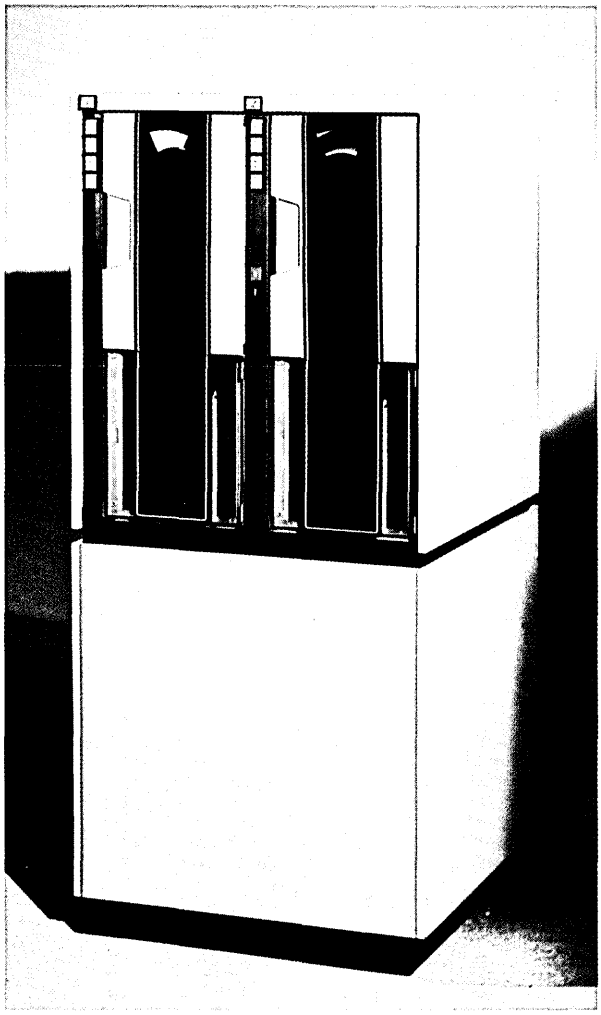
DIGITRONICS
when every bit counts

CIRCLE 18 ON INQUIRY CARD

A modular vacuum tape drive for less than $3000

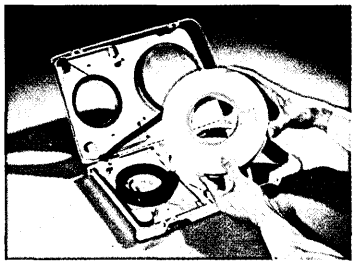


The D.I.D. V-Series



Select the "pack" you need

Designed on a "subtraction modular" principle, the V-SERIES is available to the OEM user in a group of packs—in range from the basic rack-mounted "deck" to the complete free-standing unit with electronics and cabinet. Instead of negotiating on components, and price, we spell out the package in both respects. Let us know which on the right fits your needs, and we'll give you exact costs.

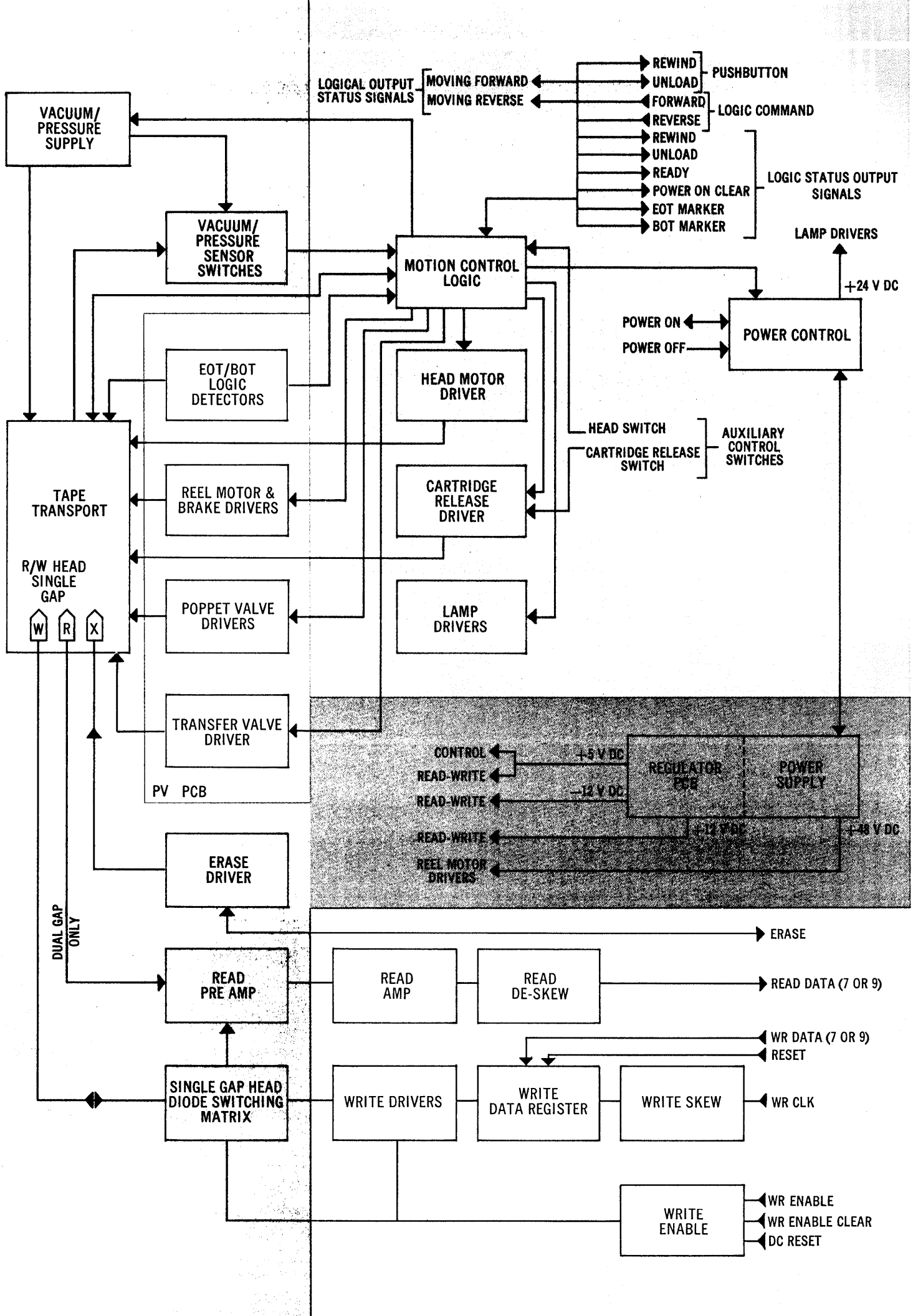


Dust proof cartridge holds computer-compatible reel and tape

The virtues of vacuum tape drives are widely known: gentle tape handling, freedom from dust, a minimum of moving parts and, thus, the greatest possible reliability. Previously, these benefits have been restricted to high speed drives in the $30,000 price range.

D.I.D. now offers a compact, low-cost vacuum tape transport that duplicates the high-cost drives in everything but speed and price. In our V-SERIES, magnetic tape is moved by high precision dual vacuum capstans. Vacuum columns provide uniform tape tension. No pinch rollers are used, and the oxide side of the tape touches only the read/write head mechanism. Other vacuum controls: reel locking on hubs . . . loading and unloading . . . positioning of tape on the head . . . tape guiding, braking, buffering, and tensioning.

Plus an exclusive, common-sense feature: a computer-compatible cartridge that simplifies operator handling and protects the tape constantly, even in a non-computer environment. A standard 8½ inch reel of tape is placed in the cartridge and started on the take-up reel. Cartridge is locked into V-SERIES drive which loads and advances tape automatically to load point. On "unload" signal, tape automatically rewinds and retracts into cartridge.


VACUUM/
PRESSURE
SUPPLY
VACUUM/
PRESSURE
SENSOR
SWITCHES
MOTION CONTROL
LOGIC
LOGICAL OUTPUT
STATUS SIGNALS
MOVING FORWARD
MOVING REVERSE
REWIND
UNLOAD
FORWARD
REVERSE
PUSHBUTTON
LOGIC COMMAND
REWIND
UNLOAD
READY
POWER ON CLEAR
EOT MARKER
BOT MARKER
LOGIC STATUS OUTPUT
SIGNALS
LAMP DRIVERS
+24 V DC
POWER ON
POWER OFF
POWER CONTROL
EOT/BOT
LOGIC
DETECTORS
HEAD MOTOR
DRIVER
HEAD SWITCH
CARTRIDGE RELEASE
SWITCH
AUXILIARY
CONTROL
SWITCHES
TAPE
TRANSPORT
REEL MOTOR &
BRAKE DRIVERS
CARTRIDGE
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DRIVER
R/W HEAD
SINGLE
GAP
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X
POPPET VALVE
DRIVERS
LAMP
DRIVERS
TRANSFER VALVE
DRIVER
PV PCB
CONTROL
READ-WRITE
READ-WRITE
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REEL MOTOR
DRIVERS
+5 V DC
−12 V DC
+12 V DC
REGULATOR
PCB
POWER
SUPPLY
+48 V DC
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DUAL GAP
ONLY
ERASE
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PRE AMP
READ
AMP
READ
DE-SKEW
READ DATA (7 OR 9)
WR DATA (7 OR 9)
RESET
SINGLE GAP HEAD
DIODE SWITCHING
MATRIX
WRITE DRIVERS
WRITE
DATA REGISTER
WRITE SKEW
WR CLK
WRITE
ENABLE
WR ENABLE
WR ENABLE CLEAR
DC RESET

A brand new old-fashioned company

In the rash of hardware manufacturers in today's computer business scene, *Digital Information Devices* stands somewhat apart. The difference is not conspicuous, but it is significant.

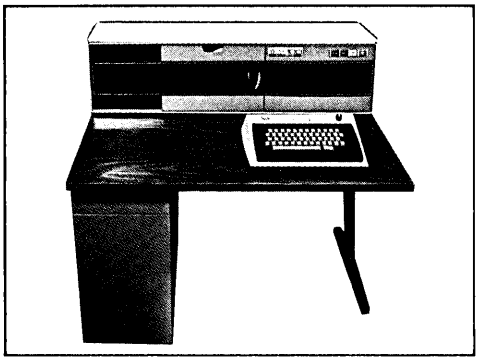
Our history, thus far, is brief. D.I.D. was formed in 1968 by people who have extensive backgrounds in computer manufacturing and management. Our business is to design, produce and distribute computer terminal devices and man-machine communications equipment.

We supply the Data Transcriber*, a keyboard-to-magnetic tape converter that is unique in its simplicity and dependability. Designed from a systems viewpoint, it is a modular machine that is quickly adapted to each customer's requirements.

We are now entering the OEM market, with the industry's first vacuum tape drive selling under $3000. Here again we offer a modular machine that can be conveniently adapted to each customer's needs. The venture demonstrates our preoccupation with problem areas of computers . . . and with finding solutions that do not breed a new set of problems of their own.

Some people think our slogan "Dedicated to Integrity and Dependability" is a little old fashioned. All things considered, we're inclined to agree.

*Available from MAI



Digital Information Devices, Inc.

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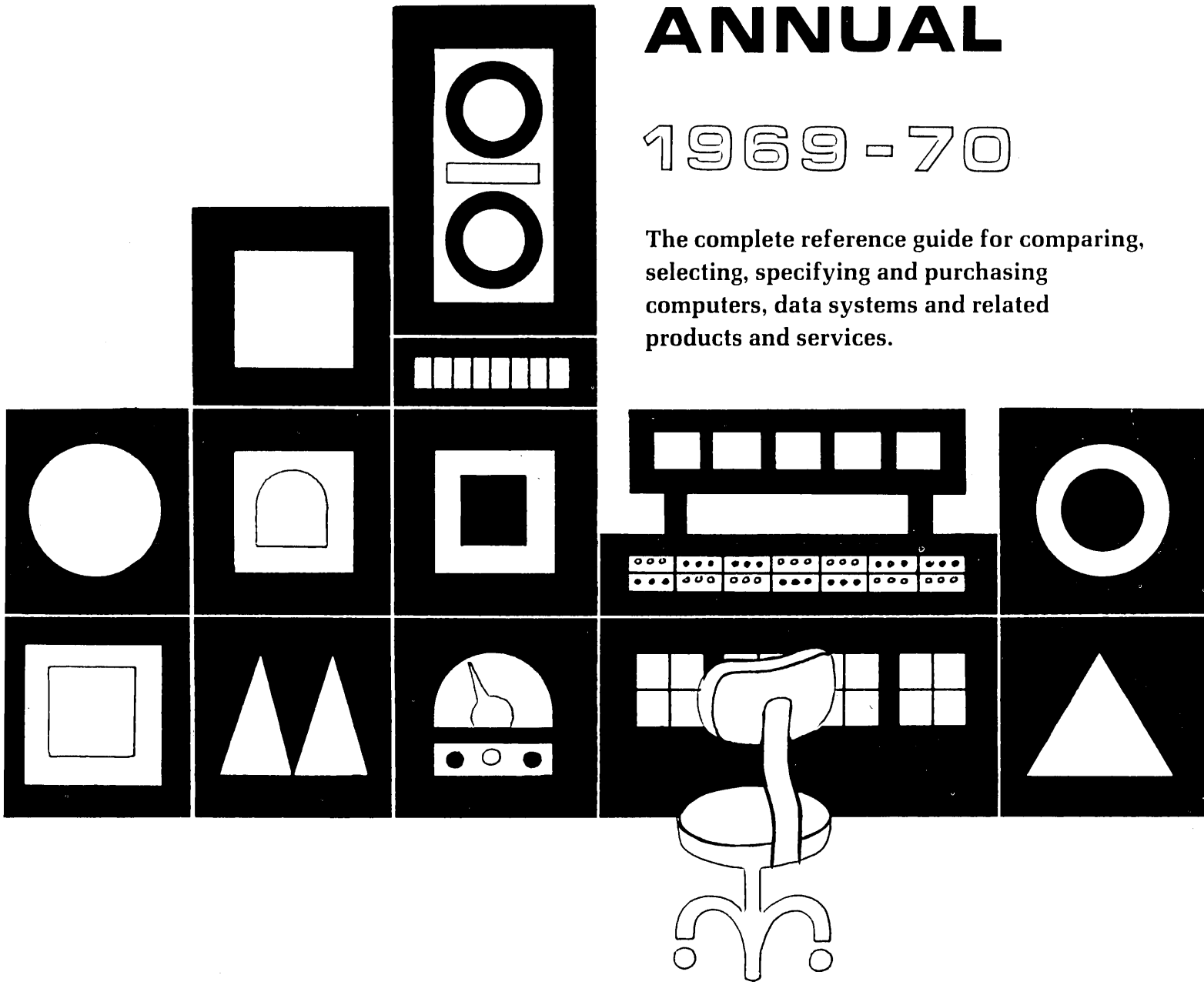
COMPUTER INDUSTRY ANNUAL

1969-70

The complete reference guide for comparing, selecting, specifying and purchasing computers, data systems and related products and services.



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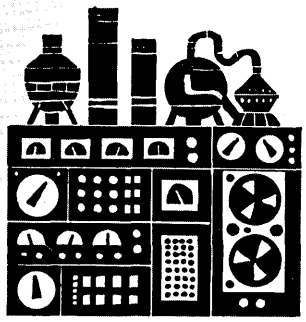
← CIRCLE 19 ON INQUIRY CARD



INDUSTRY NEWS

DPMA ELECTS OFFICERS FOR 1969-70—The new international officers of the Data Processing Management Association assumed office July 1 following their election at DPMA's annual meeting in Montreal, Canada.

D. H. Warnke, manager of management services, Control Data Corp., Minneapolis, was elected international president. He was previously executive vice president, and succeeds Charles L. Davis, Logic Data Systems, Inc., Arlington, Texas, who remains on the DPMA executive committee as immediate past president.

James D. Parker, Jr., CDP, was elected executive vice president. He is assistant manager, Systems and Data Processing, Texas Eastern Transmission Corp., Shreveport, La.

David B. Johnston, Jr., department manager of Information Systems Methods and Office Services, Western Electric Co., Indianapolis, Ind., was re-elected to a fourth term as international secretary-treasurer.

Other elected DPMA international vice presidents are:

Bernard R. Purslow, CDP, manager, data processing/360 installation, Health Insurance Registration Board, Toronto, Ontario, who will serve as vice president—research and special projects.

Herbert B. Safford, CDP, senior systems analyst, General Telephone Co. of California, Santa Monica, vice president—certification and testing.

Shirl T. Reinhart, CDP, senior staff —professional training services, Eastman Kodak Co., Rochester, N. Y. —member education.

Edward O. Lineback, Seattle Branch computing manager, The Boeing Co., Renton, Wash.—bylaws.

B. W. (Jack) Taylor, vice president, Computer Management and Research Corp., Dallas, Texas—planning.

James B. Sutton, assistant data processing officer, Birmingham Trust National Bank, Birmingham, Ala.—membership.

Anthony J. Long, CDP, director systems and data processing services, World Publishing Co., Cleveland, Ohio—external education.

FUTURE AEROSPACE COMPUTER APPLICATIONS ARE PREDICTED—Digital computers are finding increased utilization within the aerospace industry for more complex and varied applications, due to such computer technology advances as faster circuit and memory speed, dramatic cost reductions, and microminiaturization techniques which have multiplied digital computing capability within smaller and lighter packages. This trend has been discussed by James H. Crenshaw, manager of Avionics Systems at IBM's Federal Systems division in Owego, N. Y.

In his paper entitled "Federated vs. Integrated Computer Systems," the author reviewed the advantages and disadvantages of these extreme approaches from the standpoint of such system-dependent variables as vulnerability to battle damage, graceful degradation, queing problems, waiting time, loading factor, and relative cost.

According to Mr. Crenshaw, computer subsystem organization must be solved in such a way as to best accommodate the system requirements while providing flexibility, expandability, and reliability. He indicated that computer organization can vary between:

- The completely dedicated, loosely federated system made up of as many computers as there are tasks
- The completely integrated simplex or multi-processor system capable of performing all of the required tasks

However, the author stated . . . "In practice, computer organization may be a combination of both as in the FB-111, MARK II, A-7D/E, IHAS. (Integrated Helicopter Avionics System), and ILAAS (Integrated Light Attack Avionics System)."

From the examination of past system organizations, technological development, and the comparison of federated vs. integrated systems, the author has predicted probable future trends for aerospace computer applications.

LASER RECORDER DIVISION FORMED—The acquisition of the laser recorder product line and patents from Sylvania Electric Products, Inc., and the formation of a laser recorder division has been announced by Synergistics, Inc., of East Natick, Mass.

The principal product is a unique computer data storage system utilizing a laser optical recording head—a significant advance over present magnetic tape recording and storage.

Senior vice president, Robert E. Wiltz, who will have overall responsibility for the new division, says that key Sylvania personnel working on the data recorder/reproducer and other products will join Synergistics. Stanley J. Parnas, marketing manager of Sylvania's Instrumentation Recorder Products Organization, will become the division's general manager, and Dr. C. Jack Peters, who was responsible for much of the system's development, will be associated with Synergistics as a consultant.

Instead of magnetic heads and oxide tape, the device utilizes a laser optical system that can record over 180,000 bits of information on 36 discrete channels on a single inch of 8 mm photographic film at a transfer rate of up to ten million bits per second. A total of 4.3 billion bits can be stored on a single 10½-inch reel. The result, according to Mr. Wiltz, is a permanent indelible record, unaffected by atmospheric conditions or electromagnetic environment. One reel of 8 mm photographic film inscribed by this system can store as much information as approximately 40 magnetic tape reels.

One unit is claimed to do the work of approximately five conventional magnetic tape recorders. The photographic film can be replayed almost indefinitely without noticeable output degradation and has a shelf life of fifty years. The unit can record and reproduce at variable speeds with no loss in fidelity.

Orders for the recorder/reproducer are now being accepted. The company is quoting six months delivery.

INDUSTRY NEWS

NOVAR WILL SPECIALIZE IN FOURTH GENERATION SYSTEMS DESIGN—The Novar Corp., of Mountain View, Calif., has recently joined the computer hardware field. The company will specialize initially in the design and manufacture of high-speed business data communications and teleprocessing equipment for the computer industry.

According to William C. Bennett, who has been named president and chief executive officer of the company, the market for data communication and teleprocessing equipment is estimated at approximately $600 million and is expected to be a $2.0 billion market by 1972.

"The large increase in the number of applications being handled by computers, coupled with the extension of the computer to smaller businesses and remote facilities," Mr. Bennett states, "creates a rapidly growing need for newer and better equipment to capture information into a form that may be read from remote locations by the computer at far greater speeds than is presently available in currently marketed systems."

The company's first high-speed system is a fourth generation, total capability teleprocessing terminal, believed to be the first of its kind due to proprietary design features that stress speed, accuracy, ease of operation, dependable performance, and compatability with most large central processors. The system not only prepares hard copies for business use, it also simultaneously prepares digital copies for computer input as well.

The company is marketing the first units throughout the U.S. and Europe on both a purchase and rental basis.

MINI-COMPUTER LEASE/RENTAL PLAN ESTABLISHED—Varian Data Machines, of Irvine, Calif., announced what it believes is a first in the mini-computer industry—a lease plan in which computers and peripheral equipment can be rented for periods ranging from four months to four years.

The new Data Lease Plans cover the company's 520/i and 620/i computers and all peripheral equipment.

"The plans should be a real boon to the scores of new systems houses springing up," states George J. Vosatka, president.

"Now they can engineer their systems around a commercially available and proven computer without having to commit $20,000 for equipment purchase.

"Others who will benefit are customers gearing up for potentially large OEM orders who now can prove feasibility with minimum expense, and those customers funded by government contracts or grants who now can utilize a computer only during the funding period," Vosatka added.

It was also pointed out that quantity discount structures apply to the leasing plans. SLS Corp. (Sedillo Leasing Services) of San Jose, Calif., is the leasing and rental agent. The computers are available from 4K to 32K memory on immediate delivery, with service contracts fulfilled by Varian.

COMCET INTRODUCES COMPUTER PERIPHERALS—Availability of a complete line of computer peripheral equipment has just been announced by COMCET, Inc., of Rockville, Md., computer communications systems manufacturers. The line, described by the company's president, Lee Johnson, includes a printer, card reader and punch, magnetic tape units and a variety of disk storage units.

All compatible with COMCET systems, the peripherals add to the product line the fundamental advantages of simplifying the software requirements as a front end communications computer for multi-terminal EDP installations, and permitting use of the COMCET 60 and 40 Systems as free-standing computers for those situations where the primary application is store and forward for message switching systems. Airline reservations, car rental, and hotel reservation systems are typical of this type of application.

Available peripherals include:

- line printer: 300 lines per minute, 136 position
- card read/punch: Read—500 cards per minute; Punch—100 cards per minute
- magnetic tape units: 7 or 9 track, 200/556/800 bpi
- disk storage units

AFIPS ESTABLISHES PUBLISHING OPERATION—The American Federation of Information Processing Societies (AFIPS) has established a publishing operation, AFIPS Press, to serve the computing and information processing field.

According to Dr. Richard I. Tanaka, AFIPS president, "The AFIPS Board of Directors has authorized establishment of AFIPS Press to provide all required coordinating and management functions necessary for publication of proceedings of the semi-annual Spring and Fall Joint Computer Conferences, as well as additional AFIPS proceedings, reports, brochures and information booklets."

The organization is planning to make available copies of all Joint Computer Conference proceedings since the inception of conferences in 1951, and has acquired existing stocks of volumes 30 through 34 which cover the period of 1967 to the present. Current investigations are underway pointed toward making proceedings available on either microfilm or microfiche.

In addition to serving as a central source for all AFIPS publications, past and future, the Federation will also make its publishing services available to its constituent societies on an as-required basis.

CAELUS FORMS AFFILIATE TO MANUFACTURE DISK CARTRIDGE DRIVES—Caelus Data Products, an affiliate of Caelus Memories, Inc. of San Jose, Calif., has been formed to manufacture and market an advanced line of rotating disk memory files for the small-to-medium sized computer systems.

The three Data Products units—1101, 1102 and 1103—are high-performance disk cartridge drives with removable cartridges permitting unlimited off-line storage. The 1101 has almost twice the storage capacity (20.6 megabits) of comparable industry standard units; the 1102 is an IBM compatible unit with a capacity of storing up to 11 megabits of information; and the 1103 is a hybrid unit combining the capabilities of the 1101 and 1102. By means of a single switch selection and media change, the 1103 can be transformed from an IBM compatible unit to a higher-storage device.

The cartridge drives have an extremely rapid access time of 50 milliseconds. Important systems circuits such as address register, discriminator, access velocity control and dc power supply, which are normally part of the controller, are an integral part of these units.

NEW AMI/MOS — 256 x 10 Bit Read Only Memory. This unique ROM is one of a family of LSI ROM's mass produced by AMI for your immediate needs. Even if you don't need to miniaturize your system, you can stand a substantial reduction in complexity and a startling increase in reliability, can't you? Send for the MOS facts of life. Better yet, hop a jet and visit the new, expanded AMI/MOS production facility — America's largest.

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BIT/READ ONLY MEMORY

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CIRCLE 22 ON INQUIRY CARD

INDUSTRY NEWS

MICROMEMORY™ PRICE REDUCED—Electronic Memories, a division of the Electronic Memories & Magnetics Corp. of Hawthorne, Calif., has announced a major price reduction for its MICROMEMORY 1000 Core Memory System. Formerly priced at 7 cents per bit, the system now costs 4 cents per bit in quantity production.

Specifically designed for applications requiring small amounts of digital data, with uses including format or speed conversion, or fixed and variable program storage, the unit incorporates many features normally restricted to more expensive designs, including:

- Full cycle time of only 2.5 microseconds and access time of 1.0 microsecond
- All magnetics and electronics are incorporated into a volume of approximately 300 cubic inches for the 1K x 8 configuration
- All magnetics are mounted on plug-in printed circuit boards which can be easily removed
- No special circuit components are used
- Integrated circuitry, used for the major portion of the system electronics, provides exceptionally reliable circuit performance and dependability

Since it is not encased, convenient packaging can be accomplished because of its physical configuration and weight of six pounds. It can be treated as a component and mounted among other electronics to reduce overall size and maintain consistency in equipment appearance.

WESCON PRESENTS "AWARDS OF EXCELLENCE"—The 8201 Keyboard from the Singer Co.'s Friden Division has won an "Award of Excellence" in the 1969 WESCON industrial design award competition. Designer Edward E. Salter accepted on the company's behalf. The solid-state unit, used with perforators for computerized typesetting, comes in two configurations: a basic model, containing 65 keys, which punches all standard codes, while an expanded one adds the capacity to punch 6-, 7-, and 8-channel tape.

Designed for high-speed operation, the unit has a production capacity of 15 characters per second, due to the fact that a key can be pressed down before the previous one has been completely released, and that all characters, format and instructional codes can be punched directly from the keyboard.

The Ampex Corp. received an "Award of Excellence" for design of a low-cost, computer-class TMZ digital tape memory system, which was introduced at half the price of previous complete computer tape memories.

The system includes tape transport and data electronics in a single 100-pound package. It is designed to combine low cost and ease of maintenance with the performance and reliability of higher-priced tape drives.

Designer was Leon Sanderson, senior industrial designer assigned to the computer products division.

CALLS FOR PAPERS—The 1970 Joint Automatic Control Conference (JACC) will be held at the Georgia Institute of Technology, Atlanta, June 24-26. Sponsoring societies are the American Institute of Aeronautics and Astronautics, American Institute of Chemical Engineers, American Society of Mechanical Engineers, Fluid Power Society, IEEE (Group on Automatic Control), Instrument Society of America, and the Simulation Councils Inc.

Authors are invited to submit full length papers (no abstracts) on theory, design, applications, components, simulation, machine computation, etc., for presentation at the conference. Papers must be submitted by November 15, 1969, and should be clearly marked "For the 1970 JACC." Authors of accepted papers will be notified before March 1, with their works to be reproduced in the JACC Preprint Volume.

For submission through IEEE, five copies may be forwarded to Prof. J. B. Lewis, Dept. of Electrical Engineering, Pennsylvania State University, University Park, Pa. 16802.

For further information contact the program chairman: Prof. Donald W. Lyons, Sirrine Hall, Clemson University, Clemson, S. C. 29631. Tel: (803) 654-2421.

"The Challenge of the 70's—Memories, Peripherals and Terminals, Trends and their Meaning" will be explored at the 1970 IEEE Computer Group Conference and Exposition, to be held June 16-18 at the Washington Hilton Hotel, Washington, D. C.

Topics for solicited papers include memories, slave computers and related technologies, data preparation and conversion, terminals and displays, testing and packaging, and systems configuration management.

To submit a paper send five copies of a preliminary draft (not exceeding 6,000 words) and a brief summary of the essential points and conclusions (100-300 words) by November 15, 1969 to Mr. T. C. Foote, IEEE Computer Group Conference—1970, P. O. Box 1727, Rockville, Md. 20850. Tel: (301) 840-7925.

Papers should be double-spaced with original drawings and photographs keyed to the text. Authors will be notified of acceptance by February 10. For general information, contact either Bob O. Evans or Donald E. Doll, conference vice chairmen, at IBM Federal Systems Div., 18100 Frederick Pike, Gaithersburg, Md. 20760.

The 1970 International Symposium on Information Theory, sponsored by the Information Theory Group of the IEEE, and Commission VI of the Union Radio Scientifique Internationale, will be presented at the Hotel Huis ter Duin, Noordwijk, The Netherlands, June 15-19.

Papers may be submitted in English, French, or Russian, covering coding theory; detection and estimation; prediction and filtering theory; stochastic processes; pattern recognition, learning and adaptive systems; and applications.

"Long" papers, appropriate to a 30-minute presentation, will be accepted on the basis of the complete manuscript; "short" papers, for a 15-minute presentation, will be accepted on the basis of a 300 word abstract (equations to be excluded).

Submission deadline is January 1, with acceptances to be made by March 1. Manuscripts should be forwarded to: Dr. P. E. Green, Jr., MIT Lincoln Laboratory, Lexington, Mass. 02173.

The third in a series of idea-exchange seminars on relay applications, called Think-In, will be held February 18, 1970, at the International Hotel, Los Angeles, Calif. Papers on typical circuit applications, specifying information, pitfalls in selecting relays, materials, testing, or evaluation vital to the proper usage of relays should be received no later than December 1, 1969 by Mr. H. J. Roeser, Ohmite Manufacturing Co., 3601 W. Howard St., Skokie, Ill. 60076. Tel: (312) 675-2600.

Our new all solid-state keyboard. It makes even fast operators operate faster.

A big part of developing our new keyboard was in helping the operator operate faster. Without goof-ups.

Here's what we came up with:

Two-key rollover. This allows "burst-speed" typing. An electronic interlock eliminates errors when two keys are pushed at the same time.

That old typewriter feel. Key spacing is the same as on office typewriters. And spring loading simulates typewriter touch.

Shift lock. A handy option for dual applications that require extensive typing in the shifted position.

And several choices. Sloped or stepped key rows. Standard and custom key character sets. Over 500 legends (and we're continually developing more to meet your growing needs). A whole bunch of button colors as well as several button shapes.

They're all part of another thing we came up with, the world's first use of an integrated circuit as a keyboard switching element.

This micro-miniature circuit eliminates mechanical linkages. Electromechanical parts. Moving contacts. Black boxes. And a big price tag.

But it retains the reliability of our other keyboards. Proven by tens of thousands of operators, in hundreds of applications.

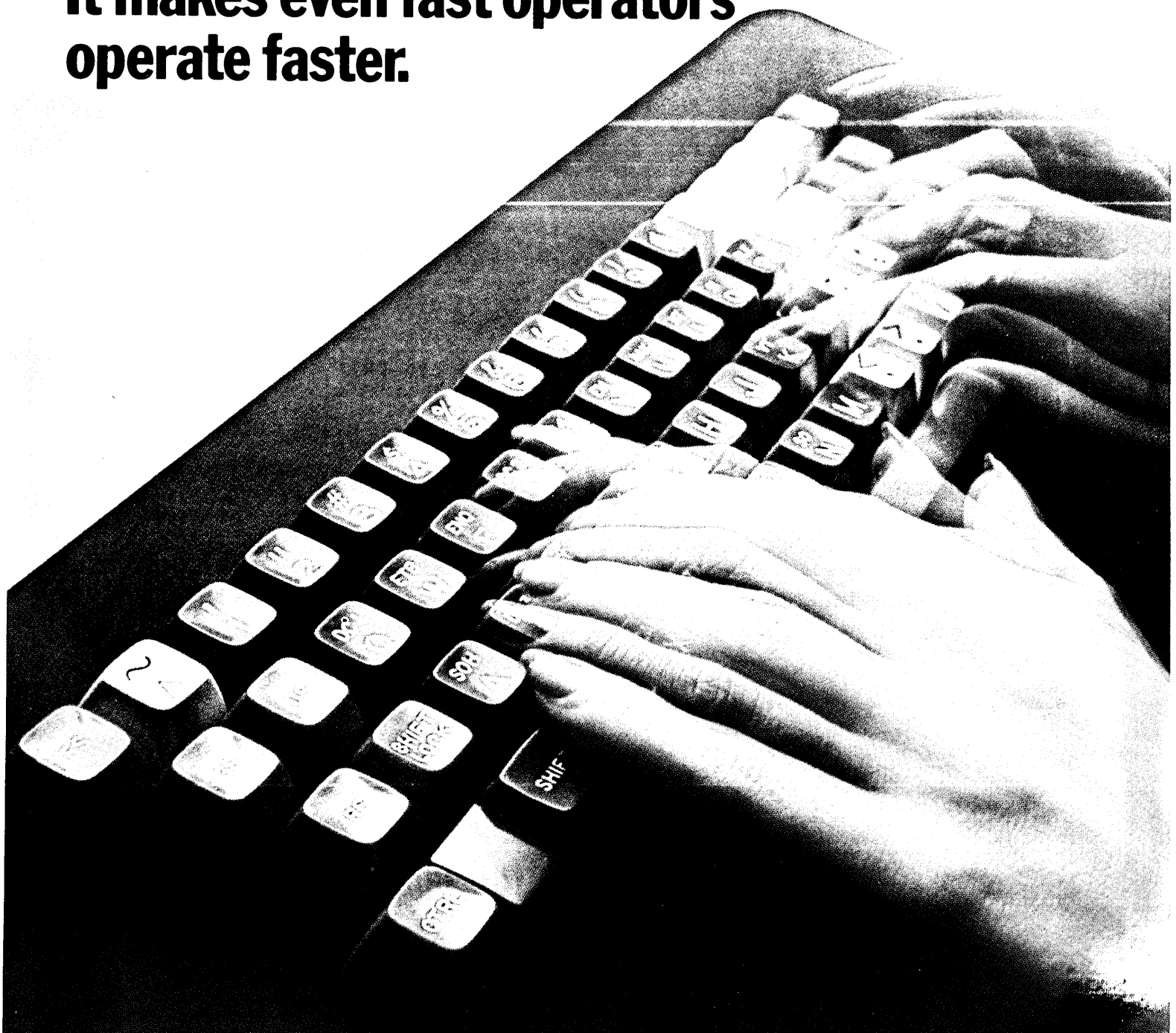
"Condensed Keyboard Guide" briefly discussess MICRO SWITCH keyboards and options. Become a fast operator.

Write for a copy.

MICRO SWITCH

FREEPORT, ILLINOIS 61032

A DIVISION OF HONEYWELL



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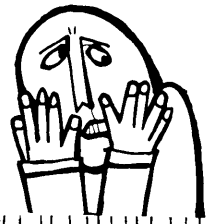
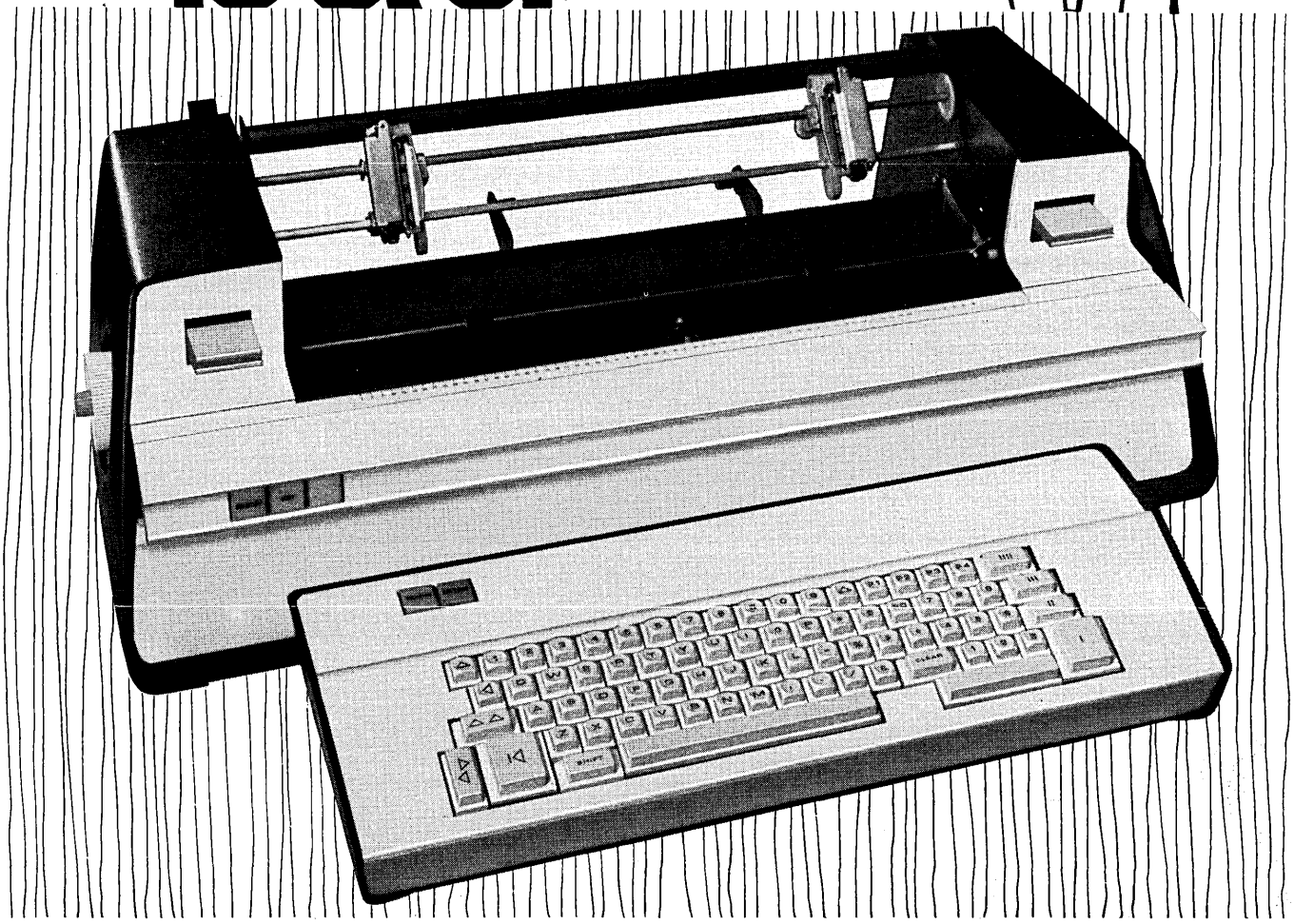




1

Print Speed

Spaces at 100 cps, tabs at 144 cps, but only 25 cps alpha/numeric and 30 cps numeric (as opposed to incredibly high-speed, high-cost printers).

2

Print Impression

Only one original and six smudge-free copies (but it tends to eliminate added paper shuffling).

3

Print Ribbon

Limited to 2 color print selection (ample if you're not publishing a magazine).

4

Mechanism

Electrically controlled stepping motors (uses electricity, so invest in utilities).

5

Vertical Spacing

Output is only 10 lines per second under program control (at least it's controlled).

6

Tabulating

We tab in two directions directly to any of 64 locations (you can't tell whether you're coming or going).

Despite its "faults", Model 30 is the only serial printer on the market with split platen, front feed form insertion and moving printwheel. It is tooled, in production and available. With or without control electronics. With or without companion keyboard. For our uncluttered, one page Model 30 spec sheet, call any of our field representatives. Or, OEM Products (201) 935-2200. It could keep you out of a jam.

AT THE FJCC — BOOTH 5500, CONVENTION CENTER, LAS VEGAS

AUTOMATED BUSINESS SYSTEMS

DIVISION OF LITTON INDUSTRIES

600 WASHINGTON AVENUE, CARLSTADT, NEW JERSEY 07072

CIRCLE 24 ON INQUIRY CARD

MICRO-SPACE™ memories cut graphic display costs

A new precision technology is now creating computer display systems that cost about half as much as conventional X-Y systems.

MICRO-SPACE memories—by using heads operating a measured half-wavelength of light from the disc—are able to store 64 graphic displays on a single disc. One memory fed by one character and graphics generator can refresh 64 independent display terminals.

Other MICRO-SPACE memories record digital data at 100,000 bits per track for a 13,000,000 bit maximum. Yet others record video signals with 6 MHz bandwidth. All are unusually reliable because heads so close to the disc can record sharp, well-defined magnetic regions and reproduce strong, clean signals. And because data is densely packed on the disc, the cost is remarkably low for the amount of information stored.

For information on computer displays, contact Display Division. For digital storage, contact Computer Products Division. For video recording, contact Video Division. All at Data Disc, Inc., 1275 California Ave., Palo Alto, Calif. 94304. Phone (415) 326-7602. TWX 910-373-1248.

CIRCLE 26 ON INQUIRY CARD

DATA DISC

For 14 months we would have said "no"

to even the President of the United States.

"Sorry, Mr. President."

That's what we would have said.

When we got into the MOS business in 1967, we resolved not to follow the over-enthusiastic marketing practices of the industry.

So we didn't sell to *anybody* until our products were fully tested, documented, and deliverable in volume.

That's why you didn't hear from us until February of this year—14 months after we began our operations.

Electronic Arrays is a volume producer of state-of-the-art MOS products. That's all we do.

We work with no other technology.

We have the know-how to manufacture complex circuits at low cost by packing a lot of electronic function into tiny silicon chips.

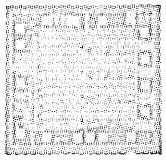
Our EA 3500, a 2560 bit Read-Only Memory, for example, is made with 3000 transistors all contained in a chip of silicon .065 inches by .094 inches—about as small as the head of a pin.

Our experience with MOS integrated circuits goes way back. In fact, Gene Stephenson, our director of manufacturing operations, designed the very first MOS circuit in 1964. Others on our staff account for the next three, along with many current designs.

Our plant is already over 27,000 square feet. Production standards are impeccable. This year, we will deliver about 100,000 circuits. And next year, many times this number.

We worked a long time behind the scenes. Now we're delivering.

Address your purchase orders to Electronic Arrays, Inc., 501 Ellis Street, Mountain View, California 94040. (415) 964-4321.



To the left is our EA 1200, the industry's only Quad 32 bit shift register. Other products include dynamic and static registers, random access read/write and read-only memories and logic arrays.

electronic arrays, inc.

Proven MOS products delivered in volume

DEVELOPMENTS

Magnetic "Bubbles" Provide Compact and Inexpensive EDP

Minute magnetic "bubbles" may provide compact and inexpensive data storage and processing for tomorrow's computers and telephone switching systems. The bubbles, locally magnetized areas that can move about in thin plates of magnetic material, are the basis of a technology now being explored at Bell Telephone Laboratories in Murray Hill, N.J.

Bell scientists have long sought new technology to make possible low cost, low power, all-digital data processing and switching. In present computer and communication technology, connections between electronic components are a major factor in costs. In this technology, the bubbles can be created, erased, and moved anywhere in thin sheets of magnetic material without interconnection. They may interact with one another in a controlled fashion and their presence or absence can be detected. Therefore, devices employing this technology could be made to perform a variety of functions—logic, memory, switching, counting—all within one solid magnetic material.

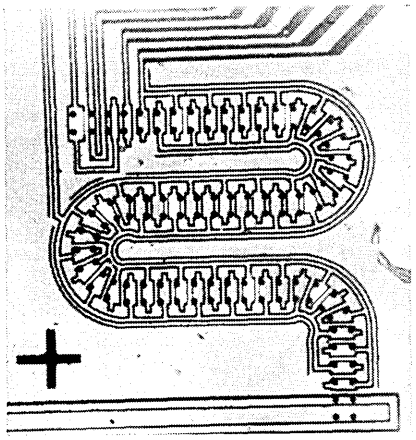
The energy needed to manipulate the bubbles can be applied by current carrying conductors or picked up from a surrounding magnetic field by microscopic "ferromagnetic antennae" in printed patterns distributed over the surface of the material. The bubbles may be controlled either by programming electric currents in an overlayed pattern of conductors, or —with no connecting wires—by controlling the surrounding magnetic field.

Stepping-stones to the technique are the orthoferrites—magnetic materials composed of rare earth iron oxides, which were grown as crystals. When a magnetic field of a critical value is applied to an orthoferrite, bubbles—almost perfectly cylindrical magnetic domains—are formed. These bubbles can be moved at high speed in the plane of the sheet of the orthoferrite material. As the bubbles are moved into precisely defined positions, their presence or absence at different positions can represent binary numbers.

Bubbles of a size corresponding to only a few wavelengths of light can be manipulated. These lead to memory densities of about one million bits per square inch. The energy required to move or switch such a bubble is minute—a fraction of that needed to switch a transistor. One experimental device using the bubble technology is a shift register, a component widely used in data transmission equipment and computers for temporary storage of binary digits. Data rates of 3,000,000 bits per second have been demonstrated.

Only a few processing steps are required to realize its simple structure, and devices of very low cost are anticipated.

Much work still remains before these devices can be shown to be practical for use in computer or communications systems. However, their potential for functional adaptability, physical simplicity, small size, low power and cost may open the door to new strategies in systems organization. The conventional random access memory organization does not appear to be a particularly suitable vehicle for the bubble technology. On the other hand, the fact that logic and memory now appear almost indistinguishable suggests that other organizations may be appropriate. The potential low cost suggests the possibility of new trade-off between hardware and software.



Looking more like a block diagram or flow chart, this actual circuit, a photolithographic pattern on the surface of a sheet of thulium orthoferrite, can move magnetic "bubbles" (large white dots) through a shift register. The magnetic bubbles are 4 thousandths of an inch in diameter.

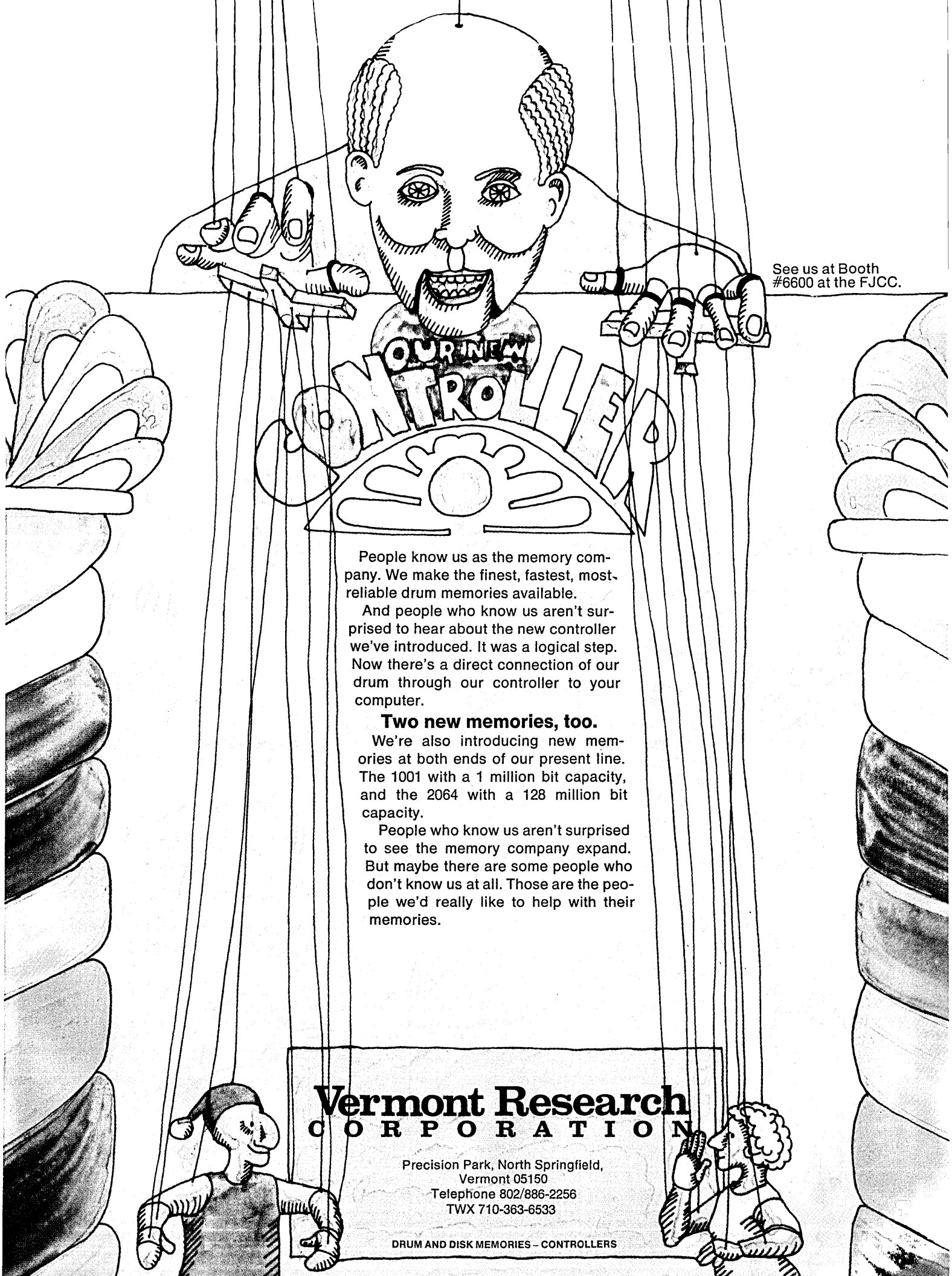
Changeable Glasses May Serve as Computer Parts

New kinds of computer components may stem from glasses that become dark in ultraviolet sunlight but regain their original transparency indoors and at night when the UV stimulus is removed.

Scientists from Corning Glass Works report that "photochromic" glasses fulfill the basic requirements for information storage and display. The functions of writing, reading and erasing information on the glasses are all feasible.

Writing is done in the form of spots on the glass caused by UV light beams. Erasing is done with a different wavelength of light. Meanwhile, the glass being used keeps its spots long enough to be read without fading naturally. The spots make a kind of information analogous to pencil marks on paper.

The reversible darkening and clearing action of photochromic glass compositions stems from tiny crystallites of silver halides in their formulae. A commercial photochromic glass is used for prescription eyeglasses trademarked Photogray lenses.



See us at Booth #6600 at the FJCC.

People know us as the memory company. We make the finest, fastest, most reliable drum memories available.

And people who know us aren't surprised to hear about the new controller we've introduced. It was a logical step. Now there's a direct connection of our drum through our controller to your computer.

Two new memories, too.

We're also introducing new memories at both ends of our present line. The 1001 with a 1 million bit capacity, and the 2064 with a 128 million bit capacity.

People who know us aren't surprised to see the memory company expand. But maybe there are some people who don't know us at all. Those are the people we'd really like to help with their memories.

Vermont Research
CORPORATION

Precision Park, North Springfield,
Vermont 05150
Telephone 802/886-2256
TWX 710-363-6533

DRUM AND DISK MEMORIES – CONTROLLERS

DEVELOPMENTS

Special-Purpose Computer Solves Differential Equations

A digital differential analyzer (DDA) computing unit on a single slice of silicon using discretionary large scale integration routing technology is available from Texas Instruments, of Dallas. Interconnection of two of these units will provide the incremental solution to the sine and cosine functions—one computes the sine while the other computes the cosine. It is particularly suited to any application where radian measurements are required such as a radar antenna or a machine tool control.

To produce a large improvement in speed and interfacing capability, the DRA 1001 incorporates a 10-bit up-down binary counter and 10-bit add-subtract accumulator (essentially, the accumulation is a 10-bit adder-subtractor with a 10-bit output buffer). It also incorporates a directional control with two independent inputs, a sign bit output, which also feeds into the direction controls internally, and a special false count suppression circuit which prevents ambiguous conditions from occurring.

Even at 253 equivalent gates, the computer represents only a medium complexity LSI array (a flip-flop is considered as six equivalent gates). When two units are cross-connected properly, they will accept a serial incremental radian measurement, such as the pulse train from an Azimuth Change Pulse (ACP) generator connected to a radar antenna, and compute the relevant sine-cosine pairs at roughly one milliradian increments. Since digital computations are unaffected by temperature, voltage variations, etc., the output depends only on the incremental radian steps.

The DDA's have been designed with high-speed TTL parallel logic implementation and can operate with an input clock rate of 2 MHz. The resolution on the input angular pulse is better than 1 milliradian.

Assembly Method Reduces Cost of Complex Harnesses

Another major step in the reduction of the cost of producing harnesses for electronic and electrical equipment by shortening set-up time, simplifying complex wire routing, and eliminating storage problems has been announced by the Thomas & Betts Co., of Elizabeth, N.J.

The method uses a universal harness assembly board and a variety of wire routing devices.

The board, which is available in any size, is of lightweight, aluminum honeycomb, sandwiched between three layers of fine mesh stainless steel screen. After the harness layout drawing is fastened to the board, routing devices are mounted at the indicated points simply by pushing nails through the board surface. When all harnesses have been fabricated, the routing devices and drawing are removed easily by withdrawing the nails, and the board can be set up in minutes for the next harness to be assembled. All that has to be stored, then, is the drawing.

Maximum savings in costs can be achieved by using appropriate harnessing aids and routing devices. These reusable devices are developed to provide speed, safety and convenience in harness assembly. Among those introduced are a crescent-shaped, removable corner post which is designed to retain the round shape of the wire bundle as it turns a corner, a foam-filled bundle shaper retainer which holds the wire bundle off the board for easy tying, metal corner posts which permit routing wires in any direction, and a plastic chute which guides the cable tie under the wire bundle.

The harness board will be marketed as part of the Ty-Rap® line, which includes cable tying straps, mounting clamps, identification plates, and other devices for installing wire and cable.

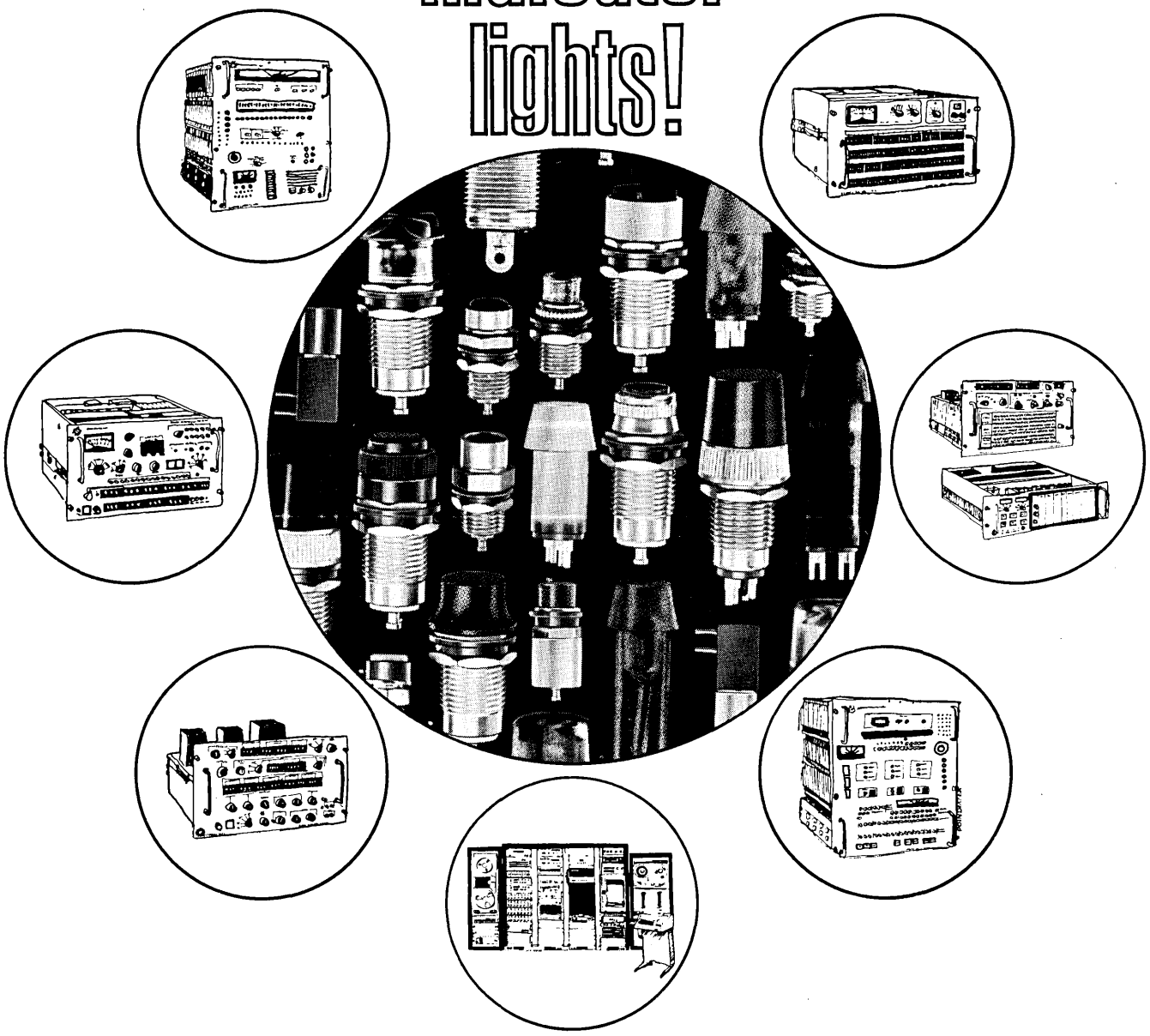
Dot Matrix is Self-Scanning

The SELF-SCAN panel display, developed by the Burroughs Corp. of Plainfield, N.J., utilizes time sharing of the cathode electrode drivers in conjunction with data activated anodes to selectively energize gas cells of a dot matrix display. The display effects significant cost savings by eliminating the need for up to 90 percent of the drive electronics normally required for a dot matrix-type display.

Cathode strips, each having a plurality of small apertures, are located behind each display cell in the dot matrix grid. The strips are arranged into groups, each of which is successively momentarily activated in sequence. This process is repeated continuously at a sufficiently high rate so that the information or patterns displayed appear flicker free. The cathode groups are time-shared together with rear anode wires to form a glow on the rear side of the cathode strips not discernible from the front of the panel.

To transfer the glow to the front of the panel in order to form a message, the front anodes are selectively addressed from a data source, in synchronism with the associated cathode strips, using a signal of sufficient amplitude to transfer the glow through the small cathode aperture. The transferred glow appears as a visible dot when viewed from the front side of the panel display. Only three clock-controlled cathode drivers are required regardless of the number of display positions; the significance of this development in reducing the electronics needed to operate the display is apparent. In addition to reducing the vast number of connections heretofore required, the unique panel design has solved basic problems relating to uniformity, brightness, costs and reliability that have had limited success in the past.

indicator lights!



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CIRCLE 28 ON INQUIRY CARD

DEVELOPMENTS

MOS/LSI Computing Calculator Announced

A desktop computing calculator featuring MOS/LSI circuitry and an ultra-powerful single-stroke keyboard has been introduced by Cintra, of Mountain View, Calif.

The Cintra Scientist 909 allows the operator to write his equation *directly* on its keyboard and read out the answer as soon as he presses the "equals" key. This approach bypasses "machine language," and even the most complex equations can be solved in seconds.

Dynamic range of the calculator is 200 decades with ten significant figure accuracy. Answers are displayed on a Nixie® readout to ten figures plus illuminated scientific notation and decimal point.

All functions are executed by a single key stroke. These include such standard keys as +, −, ÷, ×, change sign, X^2, $\sqrt{x}$, $\frac{1}{X}$, Log X, Ln X, e^X, Integer X, and π. Among its more powerful keys are "equals," "parenthesis," define a function "f(X)," and execute "f(X)," define and use a constant "$K_{(\ )}$," degrees/radians conversions, unlimited "remote" data addressing key and two variable functions over all values of X and y such as "$|X|^y$" and $\sqrt{X^2 + Y^2}$. All trigonometric arc and hyperbolic functions are also included.

Another unique feature of the machine is its ability to accept data in any form—scientific notation, floating decimal point, or combinations thereof, and it automatically keeps track of decimal point and exponent. Twenty-six storage registers are provided with up to 122 supplied optionally.

Logic Analysis Techniques Seen for LSI System Design

Computer-aided design techniques that enable circuit designers to select a set of complex logic functions, vary the parameters of machine design, and implement the optimum design with large scale integrated circuits have been introduced by the IBM Corp.

The advent of large scale integration (LSI) has already led to development of new logic circuit packaging techniques.

"For LSI to be wholly successful, additional computer design concepts must be developed. Designers must move away from unit logic and toward dense packages where many integrated circuits are contained in extremely small areas. This approach implies optimum utilization of input/output pin connections, since the package size is strongly dependent on the number of I/O's," says Maurice T. McMahon, one of the participating engineers.

An IBM 1130 computer was used to study two theoretical data processing machine systems—one a high-performance system containing a mix of control logic and highly-iterative data path logic, and the other, a small low-performance system containing mostly control logic.

By varying the parameters of machine design, comparing results and selecting the best design approach, the engineers were able to specify implementation of the computers into circuit components.

Data for the study was provided by a truth table based on a four-unit logic NOR circuit with two outputs, a true and a complement. This data was stored and automatically manipulated by the computer with a 32K word memory and five disk files. The data provided various Boolean functions which were classified into a list of numerical descriptors representing selected sections of machine logic. The descriptor listings were then cataloged with respect to function type and frequency of occurrence, and from this listing a set of cells or part numbers were selected, and the reimplementation of the logic was evaluated using the selected set of part numbers.

The partitioning parameter limits in the study were 16 terms per function, 16 variables per term, 16 variables per function, and 4 logic levels. The automatic partitioning program partitions one module at a time, with the logic partitioned to clusters having one output, and the function parameters not exceeding specified limits.

A function generation program is used to generate the Boolean function for each partitioned-out cluster. The Boolean expression is in a sum-of-products form. Variables in each term are ordered alphabetically.

The descriptor generation program then generates a numerical descriptor for the Boolean function produced by the function generation program. The description is multi-level and can be used to represent any sum of products function having 16 or less terms and 16 or less input variables.

Once the desired modules of machine logic have been partitioned and assigned descriptors, the descriptors are cataloged according to frequency of occurrence. The output of the system is therefore a catalog of numeric descriptors with their frequency of occurrence, representing the machine logic. The frequency of occurrence of each descriptor indicates the number of times a certain function is used within the machine or system. Machine reimplementation techniques can then be employed, and the function subsets selected to provide the desired system performance.

The study was sponsored in part by the Air Force Cambridge Research Laboratories, Office of Aerospace Research, Bedford, Mass., under the title "Multipurpose Logic Cell Study," AFCRL-68-0594.

Dale Mrazek
National Semiconductor

MOS BRIEF 8

DIGITAL DISPLAY SYSTEMS

TTL-compatible MOS storage circuits solve a dilemma that has plagued display designers: the question of how to generate the display. Eliminating digital-to-analog conversion allows a data system to remain digital right up to the display drivers, but may exchange one economic headache for another. If the data source generates the digital control signal, its cost and that of communications links rise. Doing the job in the terminal, on the other hand, has made displays costly in the past.

MOS read-only memories reduce, to a few relatively inexpensive integrated circuits, the hardware required to convert a character communications code to signals that will control a display. Display rates fast enough for most applications can be achieved, when the MOS ROMs are controlled by bipolar logic circuits. And when the ROMs and bipolar ICs can be coupled directly, without the use of special voltage translators, the character generator becomes that much more inexpensive.

Two cases in point are shown in Figures 1 and 2. The MOS read-only memories can be bought for less than 2¢ per bit of storage. A small additional investment in MOS registers and TTL counters will produce a display-control system, such as the one in Figure 3. This system adds data buffering, message storage and display refresh to the basic character-generation function.

Ordinarily, read-only memories are custom-made and programmed for special applications. A large order must be placed to amortize the setup costs and bring the price below 2¢ per bit. These ROMs are different. They are mass-produced as preprogrammed, off-the-shelf kits. Each kit contains three 1024-bit ROMs programmed to generate 64 alphanumeric display symbols when addressed by the ASCII code. The kit for raster-scan displays is SK0001 and the kit for vertical scanning is SK0002. Figure 4 shows how the characters in the raster-scan font look on a television-type display.

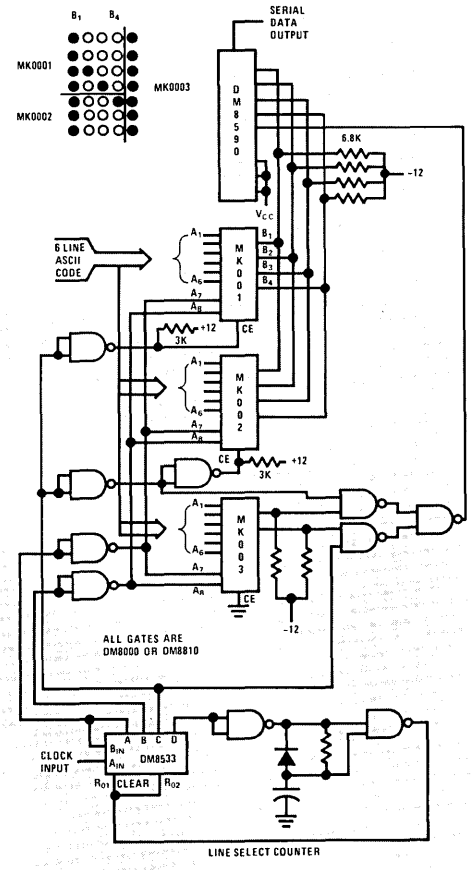

FIGURE 1. Raster-Scan MOS/TTL Display Character Generator.

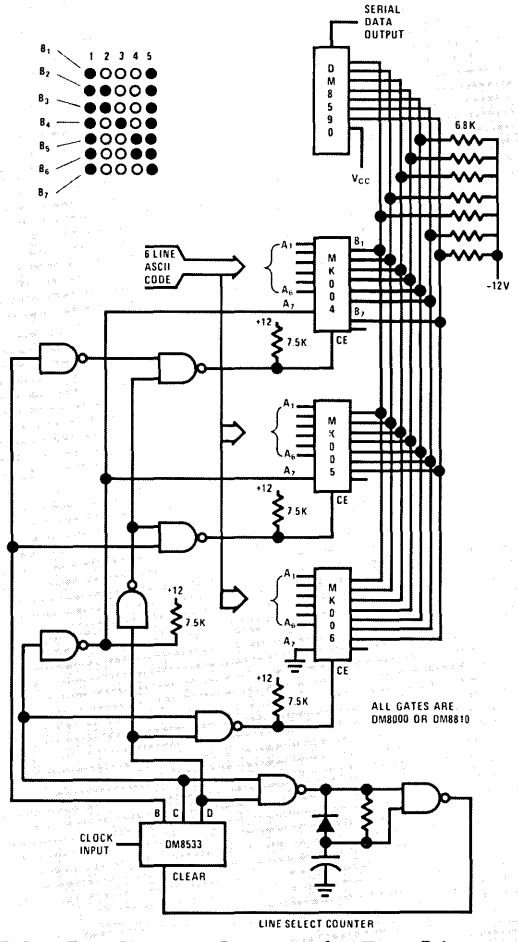

FIGURE 2. Character Generator for Tape Printers and Other Vertical-Scan Applications.

MOS BRIEF 8 DIGITAL DISPLAY SYSTEMS Write: National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, California 95051

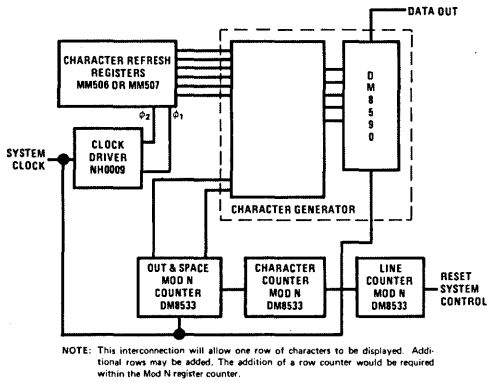

FIGURE 3. MOS/TTL System for Generation and Display Refresh.

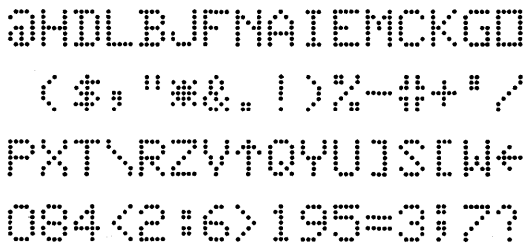

FIGURE 4. Raster-Scan 64-Character Display Font. Similar Standard Symbols Are Produced by the Vertical-Scan Memory Kit.

Some of the characters in the vertical-scan font look a little different, but the same symbols are generated and the displays are just as clear. Special symbol fonts can be made to order, on request.

Cathode-ray tubes can be controlled with the serial output of either character generator. Symbols are seen as bright dot patterns on the screen when the output is used to gate the CRT's electron beam. The raster-scan system of Figure 1 is ideal for low-cost television displays, while the vertical-scan system of Figure 2 is applicable to tape printers, billboards, and Broadway-type lamp displays, as well as CRT displays. The techniques should also be adaptable to electroluminescent panels and other advanced types of scanning displays.

Characters generated by the vertical scanning kit are displayed in five columns of seven bits per column. These are selected in the right order, under control of the DM8533 binary counter. The counter and gates are connected so that the first and third columns of the 5 x 7 patterns come from the top ROM (MK004 in Figure 2), the second and fourth columns from the center ROM, and the fifth column from the lower ROM. The counter toggles the system and also causes spacing bits (logic "0") to be loaded between characters on the CRT or other display. Its modulus establishes the number of spacing bits between the end of one character and the start of the next.

A DM8590 parallel-in/serial-out shift register arranges the parallel outputs into the serial gating-control stream. This TTL register is fast enough to permit the memories to operate in less than 1 μsec.

To generate raster-scan characters requires the selection of seven 5-bit lines. Therefore, the DM8533 in Figure 1 is used to count off the lines as well as the spacing interval between characters. After counting six intervals of N bits (five dots plus a spacing interval), the counter clears and counts six intervals again. The first four bits of the top four lines in each 7 x 5 display pattern are selected from the top ROM (MK001 in Figure 1), the first four bits of the bottom three lines come from the center ROM, and the last column of seven dots is generated by the lower ROM.

One method of implementing a complete system is blocked out in Figure 3. All functions are controlled by the system clock so that proper alignment of the symbols on the display is assured. The dot and space counter provides addressing control to the character generator, the character counter keeps track of the number of symbols displayed on each line in the display, and the line counter monitors the number of lines being displayed.

Other display functions can also be provided inexpensively with MOS memories. The MM520, for instance, can be the basis for a graphical display generator. If you like, we'll send data on our bipolar-compatible ROMs and shift registers, along with further information on MOS/TTL coupling techniques and the kits and devices used in these display systems.

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DEVELOPMENTS

Photocell Sensor Introduced

A CdS photocell sensor for card reading purposes has been introduced by the Matsushita Electric Industrial Co., Ltd. of Japan. Enclosed in a plastic case, the sensor utilizes unique sandwich-type cadmium sulfide cells which are considerably smaller and more sensitive than conventional CdS cells.

The photosensitivity of each unit under a given voltage is fifty times greater than CdS cells and 300 times greater than most silicon sensors. The cells have an electrode on each surface of the CdS film, with one of the electrodes being transparent.

Diameter of the sensor aperture is 0.055", and it is ideal for high density arrays. The amplifying circuit is simple and economical because of a large output signal. In addition, the light source can be 10 to 30 ft-c. Small power lamps can be used and very little heat is generated from the apparatus.

Display System Could Speed Analysis of Combat Data

A multi-color display system which could enable Air Force personnel to speed analysis of vital combat data is being designed and produced by Sylvania Electric Products Inc., of Needham, Mass.

Employing a single electron gun cathode ray tube (CRT), the system will display information in red, green, and yellow on a 12-inch diameter screen. The Air Force presently uses single color displays in command and control centers.

The display will allow military personnel to distinguish hostile and friendly forces, enemy aid and ground troops, or any combat situation in which rapid visual distinction of information is required.

"A squadron of friendly aircraft, for example, might be coded in green, while enemy planes are presented in red," explained Roy S. Mushrush, Jr., vice president and general manager of the Electronic Systems' Eastern Division. "One or more aircraft of the squadron might be displayed in yellow to provide a quick reference for the observer."

When activated by the electron gun, red and green phosphors in the CRT give off colored light, creating the display. A low-voltage beam activates the red phosphor, but is prevented from stimulating the green by a physical barrier. High voltage passes through the barrier and activates both phosphors.

Yellow is added by stimulating the phosphors between voltage extremes, mixing the red and green colors. By switching rapidly between voltages, all three colors appear on the display simultaneously.

According to preliminary designs, the display will switch voltages in 15 millionths of a second. Words, numerals, and symbols will be displayed as small as one-eighth of an inch without loss of clarity or resolution.

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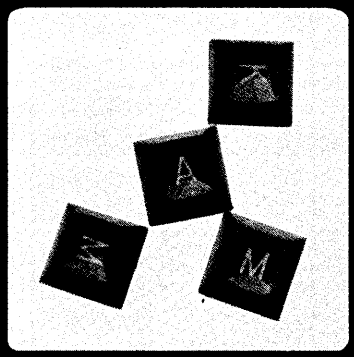

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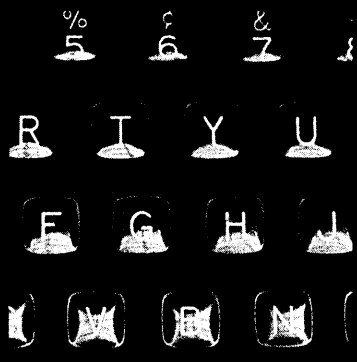

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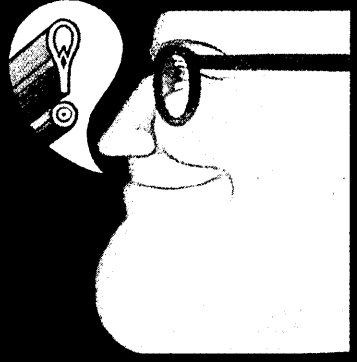

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ISA Conference Focuses On Computer Sciences

Special emphasis is being placed on data handling and computation during the Instrument Society of America's 24th Annual Conference and Exhibit at the Astrohall, Houston, Texas, October 27-30.

ISA officials report that the exhibit has been sold out since June, and that attendance is expected to exceed 15,000.

Registration fees for all technical sessions, including Exhibit admission, are $12 for ISA members and $18 for non-members. Pre-registration for the exhibit alone is free. At the meeting, registration fee for the exhibit only will be $3 for non-members with no charge to members.

Advance registration forms may be obtained by writing to: Instrument Society of America, 530 William Penn Place, Pittsburgh, Pa. 15219.

TECHNICAL PROGRAM EXCERPTS

Wednesday, October 29

Session 44

Practical Aspects Of Computer Control

Room D—10:00-11:30

Chairman: C. R. Pearson, Computrol Systems, Inc.

A GENERAL LABORATORY COMPUTING FACILITY, D. L. Hutchins, Proctor & Gamble Co.

DESIGNING INSTRUMENTATION AND COMPUTER FACILITIES, H. W. Terry, McDonnell-Douglas Corp.

FEATURES OF COMPUTERIZED BUILDING AUTOMATION, A. F. McCrea, Robertshaw Controls Co.

THE COMPUTER IN ENVIRONMENTAL CONTROL SYSTEMS, P. A. Schumann, Robertshaw Controls Co.

Session 56

Hardware/Software Trends In Computer Control

Room D—2:30-4:00

Chairman: A. C. Lumb, Procter & Gamble Co.

ANALYSIS OF SMALL COMPUTERS AVAILABLE FOR PROCESS CONTROL, S. P. Jackson and J. R. Copeland, Jackson Associates

BICEPS IN COMPUTER CONTROL, P. McCurdy, General Electric Co.

COMPUTER ARCHITECTURE FOR PROCESS CONTROL, P. M. Green and R. A. Klososky, Bailey Meter Co.

FIELD EXPERIENCE WITH FLUIDIC CONTROLLERS, R. N. Laakaniemi and P. H. Sorenson, Johnson Service Co.

Session 63

Workshop: Fluidics

Room O—2:30

Chairman: E. Norman, Consultant

This "hands on" workshop will allow attendees to develop fluidic circuits which solve control problems from their own work.

Thursday, October 30

Session 69

Developments Affecting Computer System Design

Room D—10:00-11:30

Chairman: D. G. Pistole, Information General Corp.

DIGITAL SIMULATION FOR SEQUENTIAL LOGIC; A CASE IN POINT: WILLOW GLEN UNIT NO. 3 DOWN OPERATION, G. R. Carlo-Stella, Bailey Meter Co. and J. A. Johnson, Gulf States Utilities

APPLICATIONS OF GENERALIZED NONLINEAR PROGRAMMING TECHNIQUE, J. E. Cotter, Information General Corp.

AN INVESTIGATION OF EVALUATION TECHNIQUES OF REAL-TIME SYSTEMS, R. J. Greco, IBM Corp.

DESIGN OF CHROMATOGRAPHS AND DIGITAL MONITORING SYSTEMS, W J. Ryan, Chevron Research Co.

Session 77

Fluidic Applications

Room O—10:00-12:00

Chairman: L. R. Kelley, General Electric Co.

THE UNWRITTEN CODE OF FLUIDICS NON-USERS, F. Yeaple, Product Engineering

THREE APPLICATIONS OF FLUIDICS TO SOLVE SYSTEMS ENGINEERING PROBLEMS, R. E. Wagner, W. E. BeVier, and S. Luchter, Mechanical Technology, Inc.

THE FLUID BEAD AS A PULSE TRANSMITTER, J. J. McConnell and J. N. Wilson, University of Saskatchewan

FLUIDIC ACCELEROMETER, C. G. Ringwall and J. N. Shinn, General Electric Co.

FLUIDIC SIMULATION OF A TRANSPORTATION LEG, M. G. McKinnon and J. N. Wilson, University of Saskatchewan

Session 81

Process Computer System Project Management

Room D—2:30-4:30

Chairman: J. C. Cugini, Davis Computer Systems

TRENDS IN MANAGEMENT OF INDUSTRIAL COMPUTER CONTROL PROJECTS, P. A. Ast, J. C. Cugini and R. S. Davis, Computer Systems, Inc.

PROJECT MANAGEMENT FOR COMPUTER PROCESS CONTROL, W. F. Bond, St. Regis Paper Co.

EVOLUTION OF A COMPUTER CONTROL FOR CHEMICAL PROCESSING IN THE PHARMACEUTICAL INDUSTRY, V. V. Dobrohotoff, L. Silver, and T. G. Gaspar, Merck & Co., Inc.

MANAGEMENT OF CONTROL COMPUTER SYSTEMS, D. R. Jones, Armco Steel Corp.

IMPLEMENTING COMPUTER CONTROL AT THE BAYTOWN FUELS CONTROLS CENTER, M. Rosenbaum, Humble Oil & Refining Co.

Session 82

Panel: Computerized Maintenance Systems

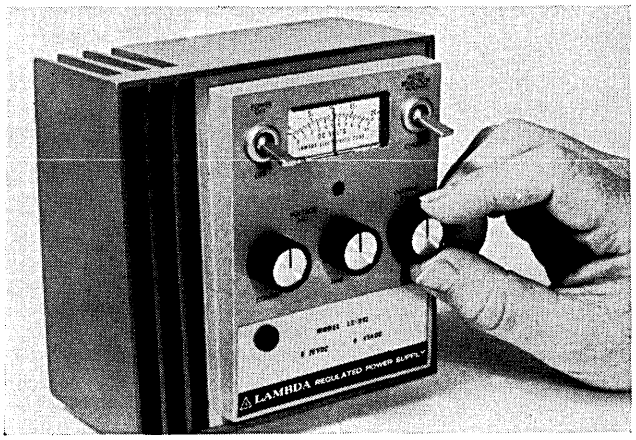
Room H—2:30

Chairman: S. E. Whigham, Celenese Chemical Co.
Panelists: J. A. Trotter, E. I. du Pont de Nemours & Co., Inc.; A. W. Adams, Jr., Monsanto Co.; L. M. Buttery, Bonner & Moore Associates, Inc.

The discussion will be a practical examination of the use of the computer as a tool for maintenance management. Each member will describe case histories including results obtained, costs, problems encountered and how they were solved, limitations, and expected advantages and disadvantages.

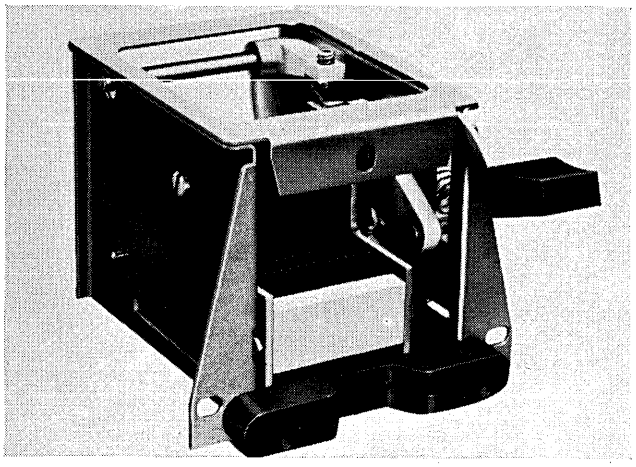
ISA PRODUCTS

IC REGULATED POWER SUPPLY



The first all-silicon, convection-cooled, fully integrated-circuit regulated laboratory power supply, the LL Series, utilizes an IC to replace the regulation system, resulting in the elimination of over 30 discrete components and reductions in size and weight. The unit is only 5 x 5 x 3", weighs less than 4 lbs., and can lie flat or stand erect. Regulation is .01% + 1 mV for line variations from 105-132 Vac, and 4 mV for load variations from no load to full load. Ripple and noise is 250 μV rms, 1 mV p-p. Temperature coefficient is 0.015% + 300 μV/°C. The series is provided with wide input voltage and frequency ranges of 105-143 Vac, 47-440 Hz. Operating ambient temperature range is 0. One meter provides monitoring of both voltage and current. Lambda Electronics Corp., Melville, N.Y. Booth 1045.

CIRCLE 277 ON INQUIRY CARD

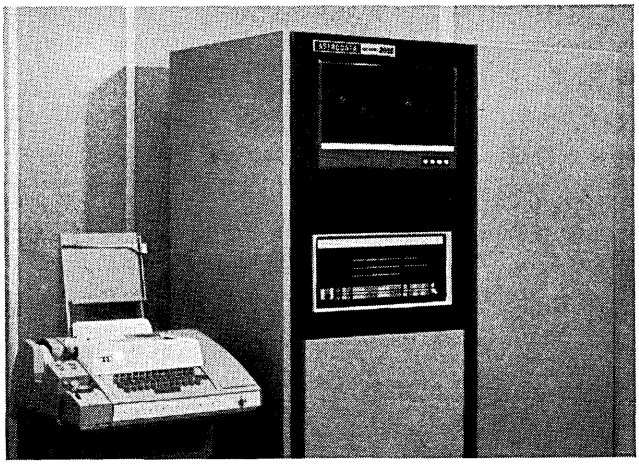


CARD READERS

Designed for use as data input devices for remote terminals, three credit and badge matrix readers are capable of handling .018 to .030" thick plastic or paper cards. When the card is fully and properly inserted, the spring-loaded read head automatically closes. Depressing the operating handle opens the read head and ejects the card. Model 61 is used with a Type I badge card (15 column); with only 10 of the columns read, this is the smallest badge card reader available. Model 161 is designed for use with the Type II (20 column) card; 15 columns of the possible 20 can be read with this unit. Model 261 is for a Type III (22 column) badge card; it senses a max. of 17 columns of the 22 column badge. Each reader features redundant contacts, solderless interface connections, positive card orientation and can be wired for split-column, alphanumeric, and telephone dial coding. AMP Inc., Harrisburg, Pa. Booth 1316.

CIRCLE 278 ON INQUIRY CARD

ANALOG & DIGITAL ACQUISITION/CONTROL



The versatile system economically acquires low- and/or high-level analog signals, enables the input of such on-line functions as data editing, and produces a digitized computer compatible output.

The ADAC can be interfaced quickly and inexpensively to all typical peripheral units by a "plug-in" intercoupler, and utilizes a variety of program languages, including FORTRAN, FOCAL, BASIC, and ALGOL.

A low-speed transport is being offered with the basic system to form an economical unit that records the digital equivalent of analog input signals on magnetic tape in computer-compatible form. Astrodata, Inc., Anaheim, Calif. Booth 141.

CIRCLE 279 ON INQUIRY CARD

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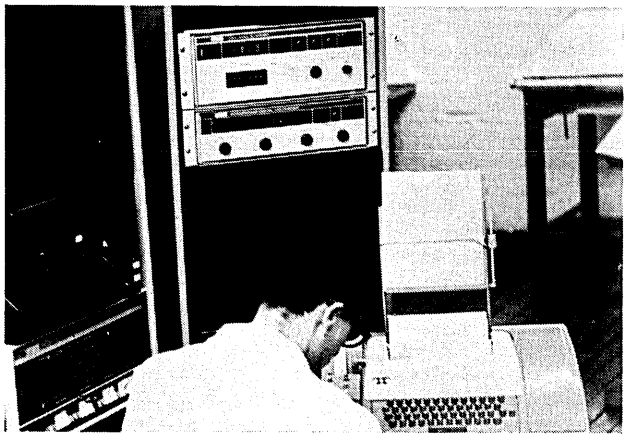
ISA PRODUCTS



INDUSTRIAL DATA ACQUISITION

A computer-based industrial data acquisition system, INDAC-8, designed for such functions as data logging, alarming, basic set-point control, and quality testing, includes a PDP-8/1 or PDP-8/L computer with a core memory of 8192 12-bit words; two Teletypes; disk storage facilities for up to 65,536 words; 50 contact inputs; a 100-channel A/D converter; and a real-time clock.

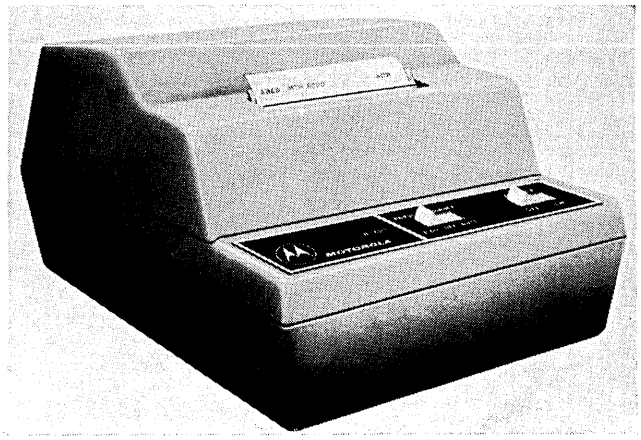
The system's software package features the first compiler-level, real-time software for any small computer which has been designed for the engineer with FORTRAN-level programming experience. Digital Equipment Corp., Maynard, Mass. Booth 1332.

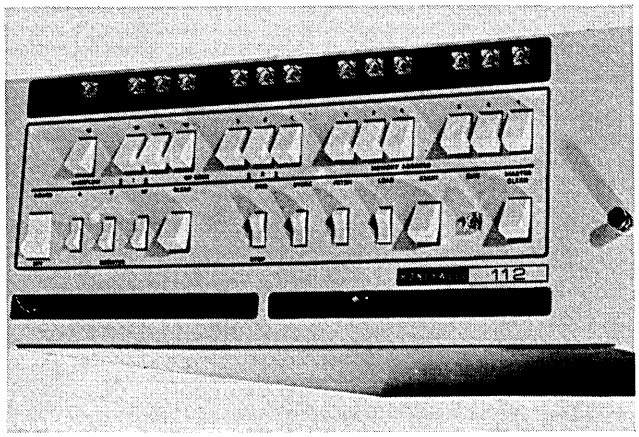
CIRCLE 280 ON INQUIRY CARD

SILENT PRINTER

The electronic printer, designated MTP-600, is a desk-top-sized unit capable of operating up to 4,000 words/min. over voice-grade telephone lines to automatically provide real-time, hard-copy read-out where large volumes of data must be recorded. A decoder converts digital input codes to control and printing signals, a printer accepts the resultant signals, then reproduces the copy on an 8.5" wide roll of electrosensitive paper through 1 of 4 print heads equally spaced on a moving belt. As one head completes a line, a second moves into place to print the next line. Each print head has 7 spring-like conductors accepting current impulses from the printer which are transferred through the conductive surface of the paper to ground. The passage of the impulse changes the paper chemically resulting in close-set dark spots, appearing as Arabic characters. Motorola Instrumentation and Control Inc., Phoenix, Ariz. Booth 844.

CIRCLE 281 ON INQUIRY CARD



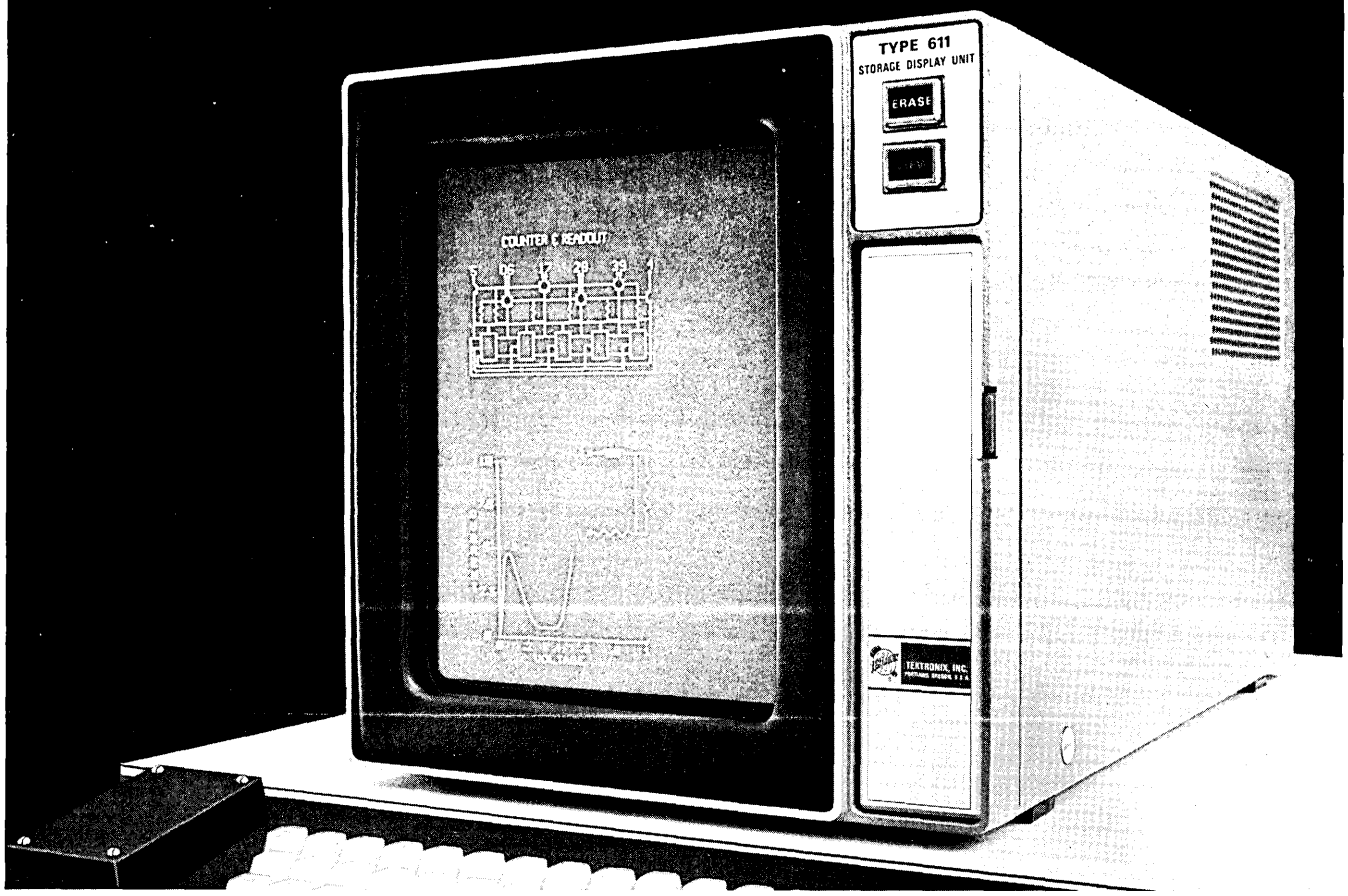


DIGITAL CONTROLLER

The H-112 is a programmable systems component for on-line real-time control, data collection, and reduction applications. It features a plug-in removable control panel which has complete register display and manual data entry capabilities as well as RUN/STOP, STORE, FETCH, START and MASTER CLEAR functions. The system has 6 internal registers and a party line, and a software-controlled priority interrupt I/O bus. All data transfers are in parallel, whether I/O or internal. I/O rate is one 12-bit word/3.39 μs or 295K words/second. Memory is organized into 128 word sectors, with a cycle time of 1.69 μs. Power consumption is 200 W. Honeywell Computer Control Div., Framingham, Mass. Booth 723.

CIRCLE 282 ON INQUIRY CARD

Information Displays Without Refreshing



CRT Storage Affords flicker-free displays of both complex graphics and high-density alphanumerics

The Type 611 Storage Display Unit is designed to function as a readout device for computer consoles and remote terminals. With X, Y and Z inputs provided by peripheral equipment, this new instrument produces displays of high density alphanumeric and complex graphic information without drift or annoying flicker.

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CIRCLE 34 ON INQUIRY CARD

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CIRCLE 35 ON INQUIRY CARD

NEREM-69 Plans Computer Seminar

The IEEE Northeast Electronics Research and Engineering Meeting (NEREM), to be held November 5, 6, and 7 at the Sheraton Boston Hotel and the Boston War Memorial Auditorium, will feature new technical program sessions on advanced proposals and developments in communications, transportation, and computers; will broaden its system sessions to include the earth as well as the ocean sciences; and will have special meetings on such evolving devices as monolithic memories and digital signal processing devices. There will also be five technical application sessions, aimed at the operating and problem-solving level, which are expected to draw many design and manufacturing engineers.

Another innovation at NEREM-69 will be a preshow, paid seminar on "Desk-Top Computers: Their Design, Application, and Usage." Sponsored by the Boston Section of the IEEE, the seminar will be held at the Sheraton Boston on Tuesday, November 5. In conjunction with several sessions in the technical program on small computers and computer-instrument systems, exceptional coverage of evolving computer technology will be provided.

TECHNICAL PROGRAM EXCERPTS

Wednesday, Nov. 5

Session 1

10:00 a.m., Commonwealth Room

OPTO-ELECTRONICS

Chairman: William T. Maloney, Sperry Rand Research Center, Sudbury, Mass.

ELECTRO-OPTICAL LIGHT DEFLECTION FOR A HOLOGRAPHIC MEMORY, D. C. Chang, M. A. Habegger, and J. Lipp, IBM Corp., Poughkeepsie, N.Y.
ELECTRICALLY CONTROLLED HOLOGRAPHIC STORAGE IN STRONTIUM-BARIUM NIOBATE, J. B. Thaxter, Sperry Rand Research Center, Sudbury, Mass.
ELECTRO-OPTIC CERAMICS FOR INFORMATION STORAGE AND DISPLAY, C. E. Land, Sandia Laboratories, Albuquerque, N.M.
ELECTRO-OPTIC EFFECTS IN LIQUID CRYSTALS, J. vanRaalte, RCA, Princeton, N.J.
ELECTRO-OPTIC GASES FOR SIMPLE AND EFFICIENT LASER MODULATION, A. Landman, NASA/ERC, Cambridge, Mass.

Session A1

2:30 p.m., Weber Room

DEVICE MODELING FOR COMPUTER-AIDED DESIGN

Chairman: Nathan O. Sokal, Design Automation, Inc., Lexington, Mass.

TRANSISTOR, DIODE AND PARASITIC MODELING FOR INTEGRATED CIRCUIT DESIGN, P. Spiegel, Honeywell, Inc., Waltham, Mass.
SEMICONDUCTOR MODEL DATA: MEASUREMENTS, PITFALLS, AND PERFORMANCE, R. H. Dickhaut, Dynetics, Inc., Bellevue, Wash.
MODELING ZENER DIODES FOR COMPUTER-AIDED CIRCUIT ANALYSIS, E. Schnall, Design Automation, Inc., Lexington, Mass.

Session 3

10:00 a.m., Independence Ballroom

COMPUTER-AIDED DESIGN

Chairman: Nathan O. Sokal, Design Automation, Inc., Lexington, Mass.

AUTOMATION OPTIMIZATION OF ENGINEERING DESIGNS-POSSIBILITIES AND PITFALLS, J. W. Bandler, McMaster University, Hamilton, Ontario, Canada
DEVELOPMENT OF AN INTEGRATED NSTTL LOGIC ELEMENT, J. D. Allen, Honeywell, Inc., St. Petersburg, Fla., D. E. Marshall, Jr. and J. A. DeFalco, Honeywell, Inc., Framingham, Mass.
CIRCAL—2: A GENERAL APPROACH TO ON-LINE CIRCUIT ANALYSIS, G. P. Jessel and J. R. Stinger, MIT, Cambridge, Mass.
WHAT'S REALLY NEEDED IN INTERACTIVE COMPUTER-AIDED DESIGN . . . A USER'S POINT OF VIEW, S. Bernstein, Perkin-Elmer Corp., Norwalk, Conn.

Session 4

10:00 a.m., Constitution Ballroom

COMPUTER-INSTRUMENT SYSTEMS

Chairman: Robert E. Owen, General Radio Co., West Concord, Mass.

AN LSI TEST SYSTEM USING THE IBM 1130, R. S. Broughton, E-H Research Labs, Inc., Oakland, Calif.
IN-PLANT DIGITAL COMMUNICATION AND CONTROL SYSTEM, D. A. Bobroff, Hewlett-Packard Co., Palo Alto, Calif.
A COMPUTER CONTROLLED LOGIC CIRCUIT TESTER, M. L. Fichtenbaum, General Radio Co., West Concord, Mass.
AUTOMATIC DATA ANALYSIS IN COMPONENT TESTING, G. d'Arbeloff, Teradyne, Inc., Boston, Mass.

Session 9

8:00 p.m., Independence Ballroom

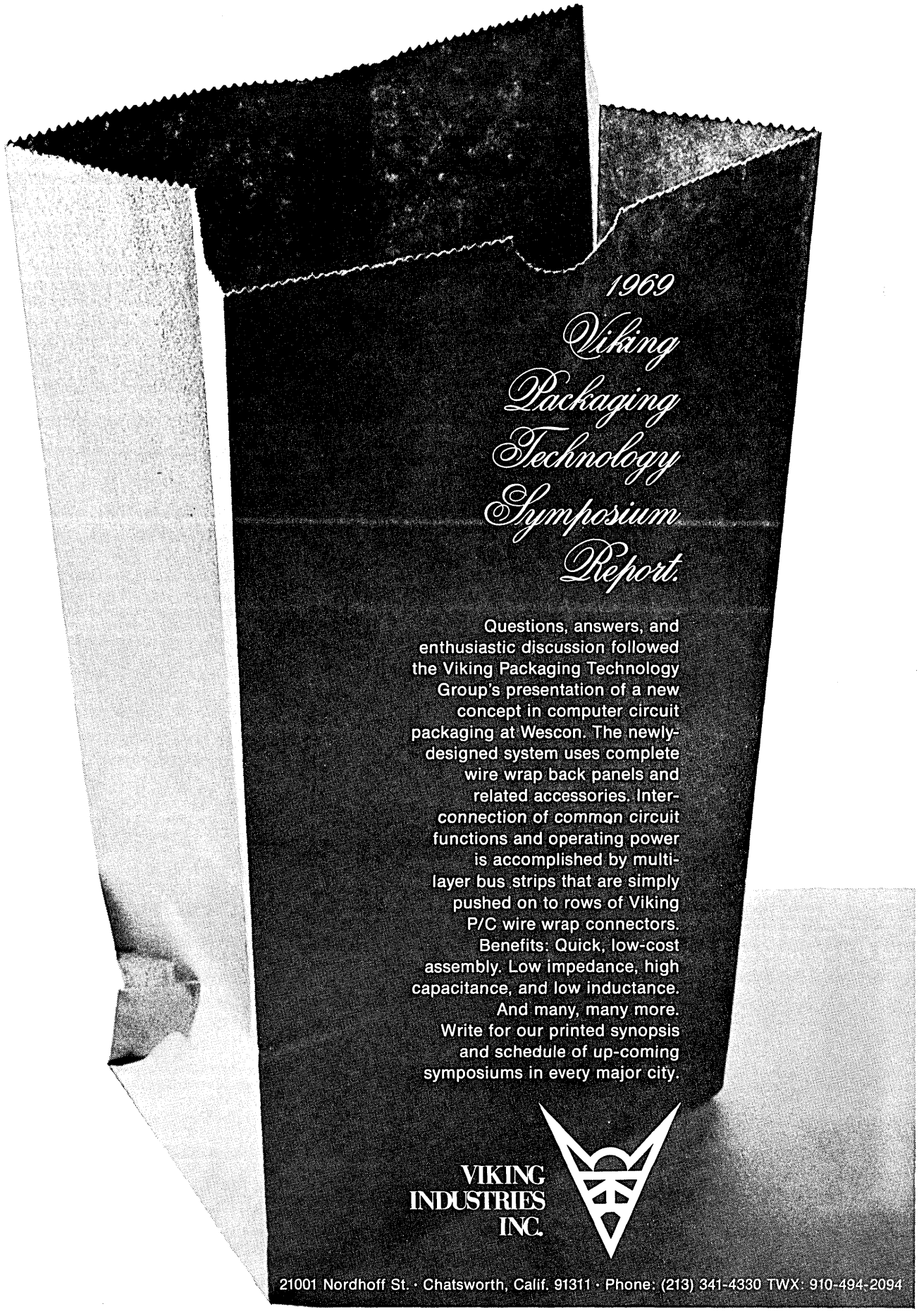
THE NEW ENTERPRISE—ITS LIFE CYCLES

Chairman: Knox Charlton Black, Scientific Analysis Corporation, Wayland, Mass.
WHY START YOUR OWN COMPANY?, N. DeWolf, Teradyne, Inc., Boston, Mass.
NEW COMPANY SURVIVAL—THE SECOND PHASE OF PLANNING, R. A. Brooks, Harbridge House, Inc., Boston, Mass.
REPRODUCTION, M. Hecht, Jr., Unitrode Corp., Watertown, Mass.
ENTREPRENEURSHIP—LIFE OR DEATH, E. B. Roberts, MIT, Cambridge, Mass.

Thursday, Nov. 6

Session 13

10:00 a.m., Constitution Ballroom



CIRCLE 36 ON INQUIRY CARD

DIGITAL SIGNAL PROCESSING

Chairman: Alan V. Oppenheim, MIT Lincoln Laboratory, Lexington, Mass.

COMPUTER STRUCTURES AND SIGNAL PROCESSING, B. Gold, MIT, Lincoln Laboratory, Lexington, Mass.
SPECIAL-PURPOSE HARDWARE FOR DIGITAL SIGNAL PROCESSING, L. B. Jackson, Bell Telephone Laboratories, Inc., Murray Hill, N.J.
FLOATING POINT ROUNDOFF NOISE IN DIGITAL FILTERS AND FFT, C. J. Weinstein, MIT Lincoln Laboratory, Lexington, Mass.
APPLICATIONS OF DIGITAL SIGNAL FILTERING TO IMAGE PROCESSING, T. G. Stockham, Jr. and R. L. Britton, University of Utah, Salt Lake City
THREE-DIMENSIONAL IMAGE RECONSTRUCTION FROM ELECTRON MICROGRAPHS BY DIGITAL PROCESSING, D. J. DeRosier, University of Texas, Austin

Session 17

2:30 p.m., Constitution Ballroom

SMALL COMPUTERS

Chairman: W. J. Poppelbaum, University of Illinois, Urbana

MINICOMPUTERS AND DEDICATED INFORMATION SYSTEMS, N. S. Zimbel, Arthur D. Little, Inc., Cambridge, Mass.
PREVIEW OF A 1970 LSI DIGITAL COMPUTER, W. F. Dawson and R. J. Edry, Raytheon Co., Sudbury, Mass.
THE GRI 909, A DIRECT FUNCTION PROCESSOR, S. B. Dinman, G. R. Industries, Inc., Newton, Mass.
A SMALL TSS/8 TIME-SHARING COMPUTER SYSTEM, J. D. Bailey and N. Doeling, Digital Equipment Corp., Maynard, Mass.

Friday, Nov. 7

Session 21

10:00 a.m., Constitution Ballroom

MONOLITHIC MEMORIES

Chairman: Harvey Rubinstein, Sylvania, Waltham, Mass.

MONOLITHIC SEQUENTIAL MAGNETIC MEMORIES, R. J. Spain, Sylvania, Waltham, Mass.
PROGRAMMED ADDRESS READ ONLY MEMORY, W. R. McKinley, H. Ng, and P. Schenck, Fairchild Semiconductor, Mountain View, Calif.
SYSTEMS POSSIBILITIES WITH NEW BIPOLAR MEMORY PACKAGES, C. R. Schmitz and A. Hemel, Raytheon Co., Mountain View, Calif.
INTEGRATED CIRCUIT READ ONLY MEMORIES, J. A. Narud, J. Beemiller, and K. Waite, Motorola, Inc., Scottsdale, Ariz.

Session 25

2:30 p.m., Constitution Ballroom

COMPUTERIZED TESTING TECHNIQUES

Chairman: Frank F. Tung, NASA/ERC, Cambridge, Mass.

THE CRITICAL PROBLEM FOR THE TESTING OF LARGE SCALE INTEGRATED CIRCUIT ARRAYS, D. W. Moore, Moore-Peterson Associates, Santa Barbara, Calif.
LARGE SCALE ARRAY TESTING TECHNIQUES, E. Sarkisian, NASA/ERC, Cambridge, Mass.
HIGH ORDER LANGUAGE REQUIREMENTS FOR ELECTRONIC TESTING, L. P. McNamee, University of California, Los Angeles
A LABORATORY TEST FACILITY, D. J. Mees and R. E. Thun, Raytheon Co., Bedford, Mass.
A COMPUTERIZED ONBOARD CHECKOUT SYSTEM DESIGN FOR A SPACE SHUTTLE VEHICLE, J. F. Hughes and L. H. Browning, NASA Manned Spacecraft Center, Houston, Texas

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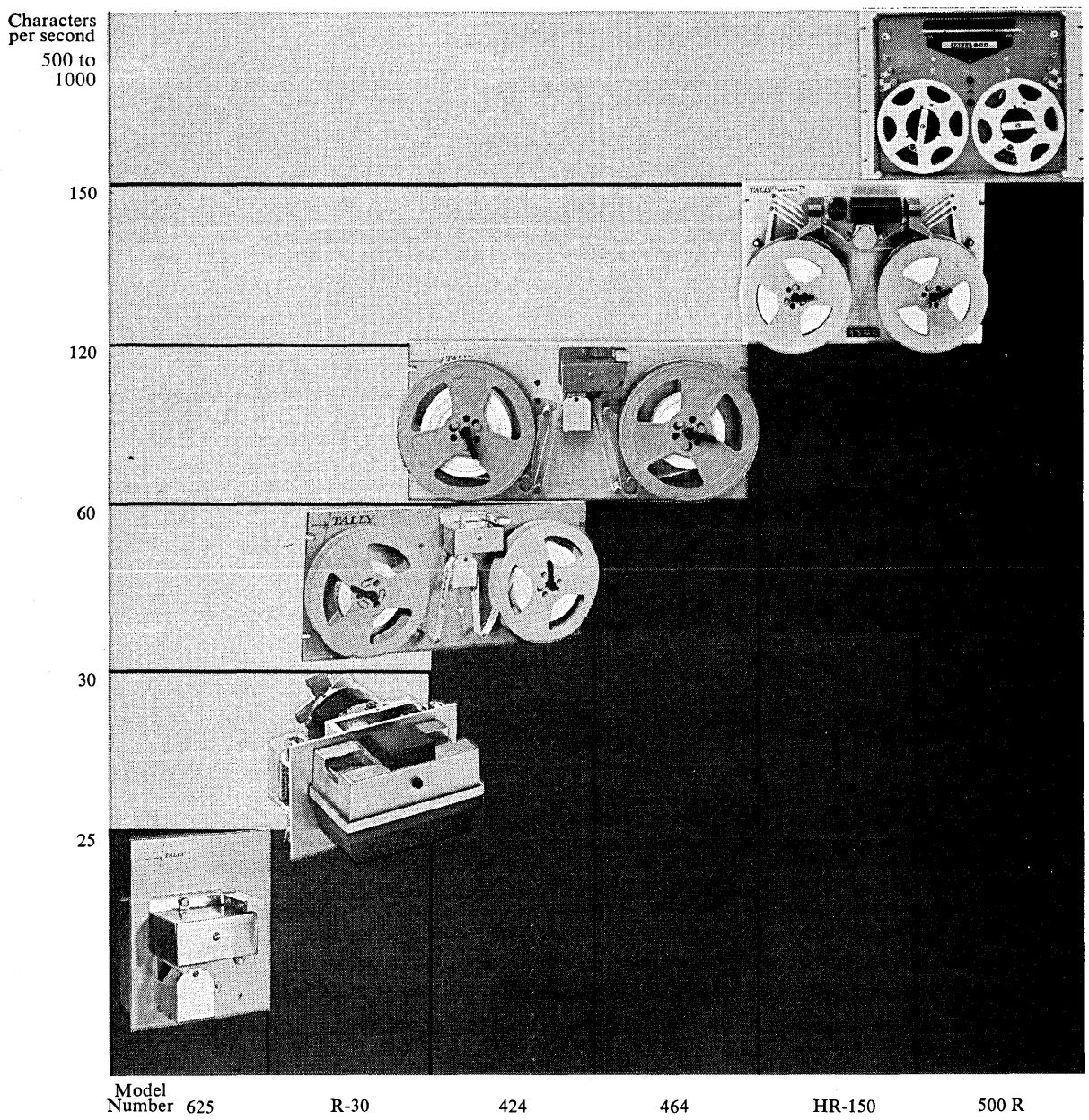
CIRCLE 38 ON INQUIRY CARD



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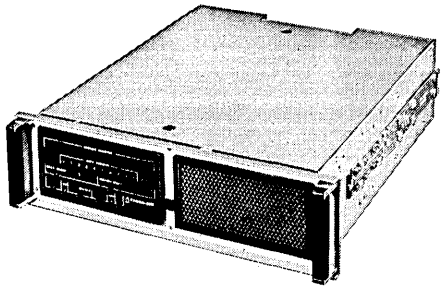

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CIRCLE 40 ON INQUIRY CARD

When applied to electronic systems, this design technique provides an EMC base for the attainment of many levels of effectiveness through incremental hardware amendments

The Incremental Method Of Computer Shielding

John L. Steenburgh

IBM Corp.
Systems Development Division
Kingston, New York

Unwanted electromagnetic energy (electrical "noise") from external transmitting sources can be conducted and/or radiated into computers or other electronic equipment, causing excitation of sufficient amplitude to disturb its operation. Sometimes the computer itself generates this noise, disturbing its own operation and that of other nearby equipment. Shielding has been identified as a useful method for controlling the emanation of unwanted noise, as well as for protecting sensitive circuits from its effects. EMC shielding considerations must be applied during the early design stages of the equipment if meaningful and effective shielding goals are to be realized.

A method is required that assures the application, during design, of basic EMC provisions allowing the addition of extra shielding hardware to the equipment at anytime. Through this method, EMC requirements are broken down to the absolute basic recommendations that may be applied during design stages. These recommendations allow:

- A minimal cost burden on equipment having minimal shielding requirements
- The capability of adding shielding hardware on an "incremental" basis to equipment requiring the extra shielding
- Easy field retrofit, should unexpected additions or changes be required

Using these recommendations, the designer contributes significantly during packaging layout, permitting shield design to progress in parallel with equipment design without dependency on operational EMC tests. Eventually these tests, under this concept, determine nearly the exact shielding requirements and define the shielding hardware to be added on an incremental basis after the equipment has been built. The designers task then, is to assure that these hardware additions can be made at anytime.

The method is based primarily on the "integral shield" concept wherein the frame, covers, and other existent parts cooperate to provide a shielding function in addition to their normal functions. The "conductive" frame (Fig. 1) is the heart of this type of shielding and is therefore regarded as the most basic recommendation to be considered.

THE CONDUCTIVE FRAME

The basic computer structural component is the main

John L. Steenburgh, who joined the company in 1956, is a technical associate assigned to the Electromagnetic Compatibility Department. He studied machine technology at Ulster County Community College in New York and has participated in IBM's voluntary education program and in courses conducted by the International Correspondence School.

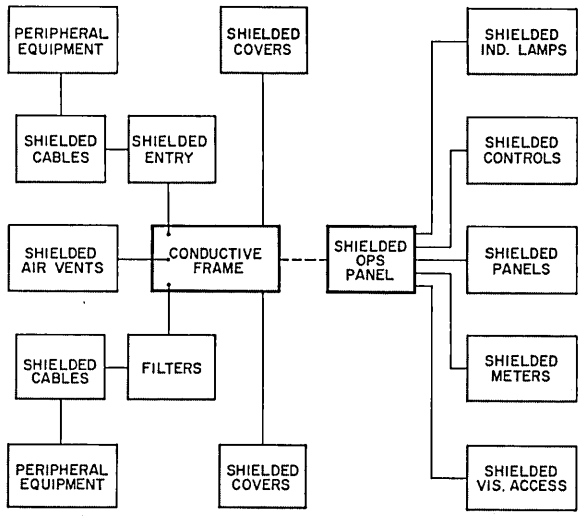

Fig. 1 Relationship of conductive frame to shielded components of computer system

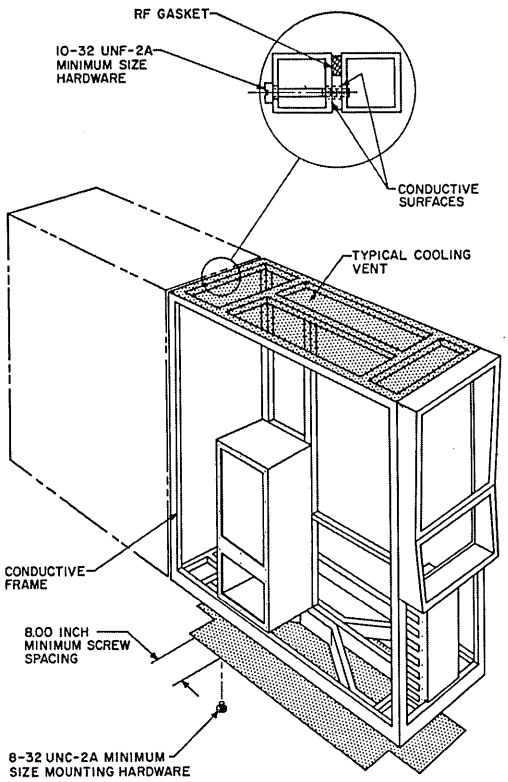

Fig. 2 Considerations for installing cooling vents to conductor frame. Inset shows typical configuration of interface between two conductive frames

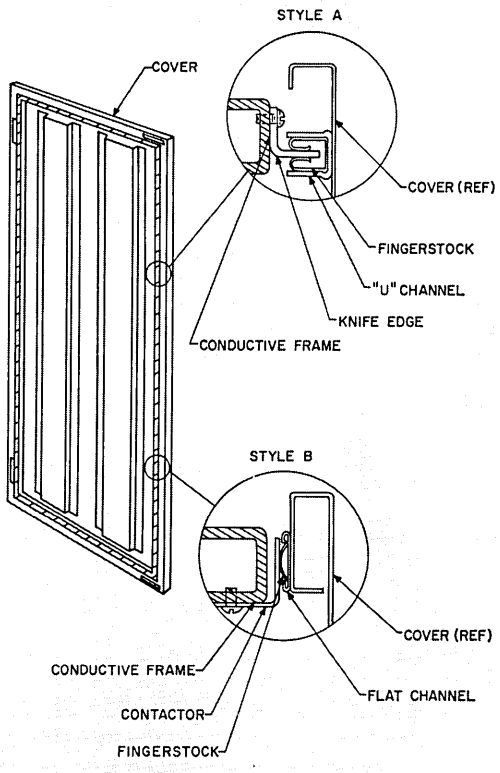

Fig. 3 Computer cover with critical conductive areas and two RF bonding hardware (fingerstock) configurations

frame which supports the second level subassemblies and the covers. This frame can provide a RF electrical bond function if the surfaces which must contract the covers and sub-assemblies are made conductive by such processes as electro-plating. Plating the entire frame structure tends to be more economical than area plating on section surfaces. In addition, bulk plating minimizes detailed drawing efforts and facilitates possible subsequent field EMC retrofit requirements by providing plating on all surfaces. Many demands are placed on these plated surfaces—they must display good corrosion and wear resistance, and maintain a good appearance for the life of the equipment. EMC further demands the maintenance of a low contact impedance across the essential frequency range during the life of the product. Tin exhibits the desired electrical characteristics while a bi-plating system, such as tin over nickel, appears to satisfy the total requirement.

COOLING VENTS

In the form of electro-plated perforated steel sheets, the vents are added to the top and bottom of the frame. The recent UL requirements for hole size and open area limitations are adequate for EMC purposes.

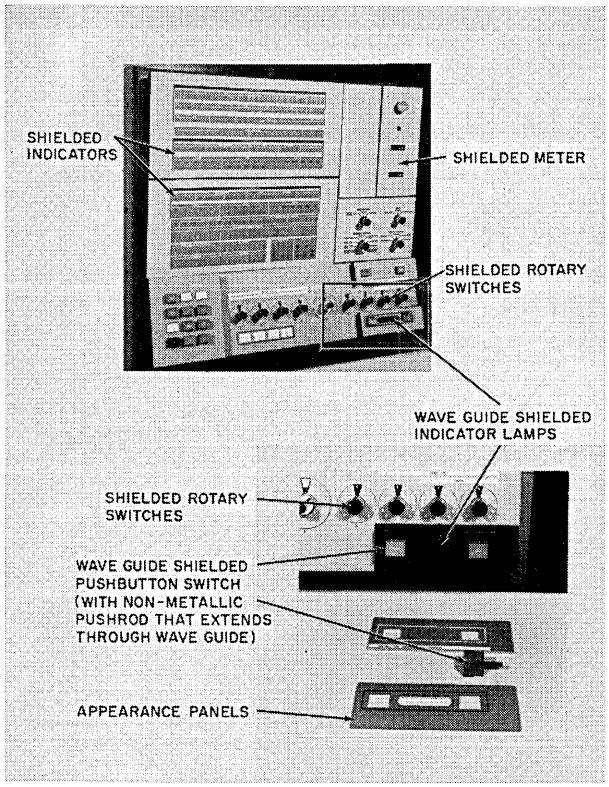

Fig. 4 EMC computer model with shielded treatment to controls and appearance panels

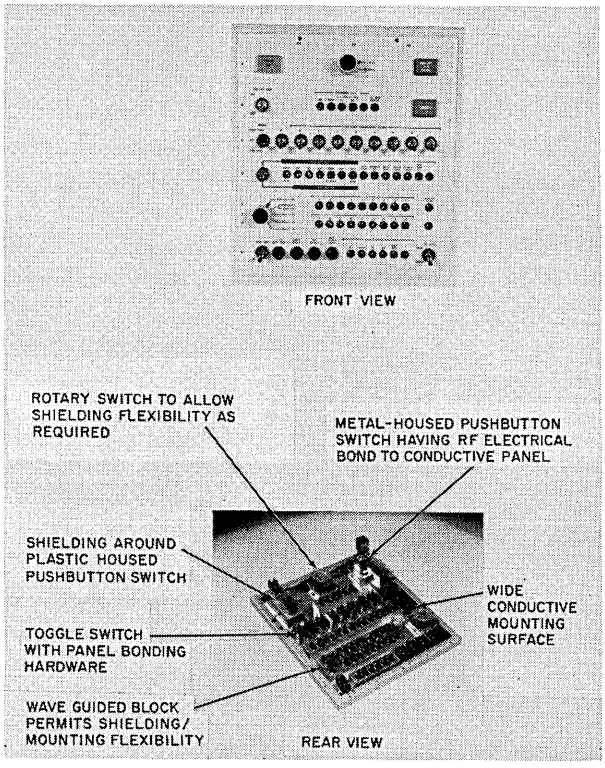

Fig. 5 EMC shielding, such as wave-guide blocks and housings (rear view) consume space for functional controls unless careful design is applied

Attaching these sheets with 8-32 UNC-2A screws (or longer) on 8.00 inch (max.) spacings around the periphery is recommended (Fig. 2). This allows the addition of extra screws on a closer spacing and of RF gasket material, and even the replacement of the released shield for one of a different configuration if necessary.

COVERS

The hinged metal covers on the computer provide adequate shielding if RF electrical bonding members are applied at the cover/main frame interface seams. Because of low spring forces and self-cleaning wiping action, beryllium copper fingerstock is used. Design emphasis is placed on fingerstock damage protection, easy installation and replacement, as well as good RF electrical bonding. Two designs presently in use (Fig. 3) exhibit all of these features while allowing an incremental addition of bonding (or shielding) to be attained by clipping pieces of fingerstock into pre-attached, conductive channels. The conductive surfaces of the channel, the fingerstock, and the conductive frame cooperate to electrically unite the covers and frame, providing the necessary shielding capability.

Fabrication of the covers and channels is performed as follows:

- The covers and channels are fabricated separately.
- The channels are plated, then welded to the raw metal covers.
- The critical conductive surfaces of the channels are masked.
- The entire assembly is painted.

Removal of the masking leaves a completed cover with conductive areas for fingerstock attachment. The cover is now ready, at minimal additional cost, to serve as an "integral shield" component.

OPERATOR'S PANELS AND CONTROLS

The operator's control panel, due to its combination of density and variety, is an area demanding the utmost of the designer's skills if adequate shielding provisions are to be made. Its configuration, as shown in Fig. 4, is basically a chassis with attached control panels. These panels are usually heavily populated with switches, indicators, meters, and other types of controls. Adding shielding tends to consume space at an alarming rate. Therefore, control layout geometry may tend to suffer unless care is used in design. Figure 5 is an example of this type of design. It is suggested that the operator's control panel assembly be considered as a smaller version of the main frame and associated covers, thereby allowing the same basic incremental shielding recommendations to be made.

Plating the surfaces of the chassis allows RF electrical bonding to the chassis/main frame and to each chassis/control panel interface. This allows the chassis and the panels to assume shielding functions and thus serve as integral shield members. Attention to

fasteners and to RF gasket material attachment provisions assures that incremental shielding additions can be made as required. If shielding at the exterior appearance panels proves unfeasible, the shielding of hidden sub-panels should be investigated.

The main emphasis, after the basic panel plating recommendation, is that designs, having various levels of shielding capability, be drawn up for each panel. One design for moderate and one for heavy shielding should exist on at least a paper layout basis in addition to the released commercial EMC version. These designs assure the easy incorporation of extra shielding on an incremental basis if it becomes necessary, by allowing panels having heavier shielding to be substituted into the equipment. Additional EMC considerations, suggested for the heavier shielded panels, generally consist of more elaborate treatment of control and control apertures.

CONTROLS AND APERTURE TREATMENT

The panel-mounted controls are generally of two main types: movable, such as switches, and visual access, such as indicator lamps or meters. It has been found that such minimal EMC considerations as RF-bonding the controls to the plated panels, will suffice for most commercial EMC applications. This suggests that the "incremental method of shielding" can be applied to the controls and their mounting apertures—allowing them, in cooperation with the plated panels, to serve as minute, but important, extensions of the integral shield if further shielding is required. (Figs. 6, 7, and 8.)

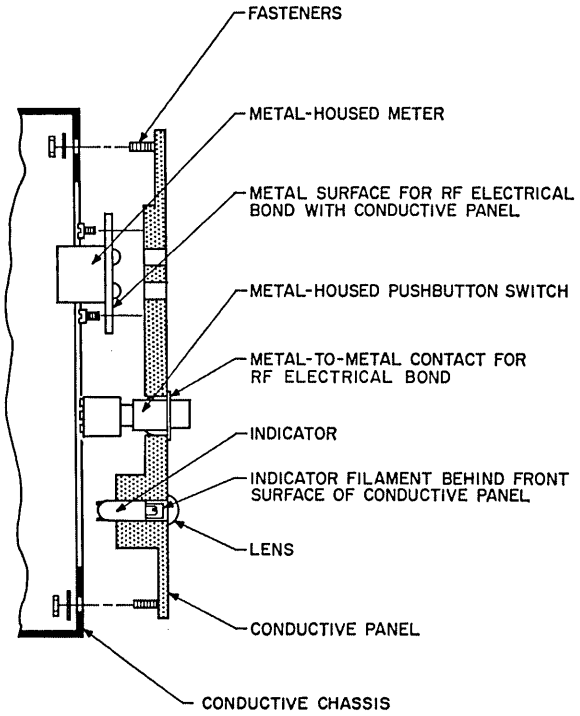

Fig. 6 Lightly shielded control mounting panel for EMC purposes

SWITCHES

A basic EMC consideration for switches (and most other panel-mounted controls) is the capability of easy RF electrical bonding to the plated panel. For instance, several types of commonly used toggle switches have plated threaded barrels and nuts for direct attachment to the mounting panel, which are recommended over the type that mounts on a sub-panel and requires a slot through the shield for its control lever operations.

Also, the choice of a metal-housed pushbutton switch is recommended in preference to a similar device having a plastic (or non-metallic) housing. This discriminate selection of controls imposes minimal, if any, additional cost and achieves a built-in shielding capability. This is the recommended version for equipment having commercial EMC requirements.

To comply with the incremental method, parallel designs should be generated for at least two additional levels of shielding. The design for moderate shielding could advocate the use of switches specially designed for EMC applications.

The parallel design for the stringent EMC shielding could show switch apertures which are decreased in size and in some cases, wave-guided. For instance, push buttons, having large apertures for mounting purposes, must be mounted on sub-panels and a non-metallic push rod must be used to actuate the switch

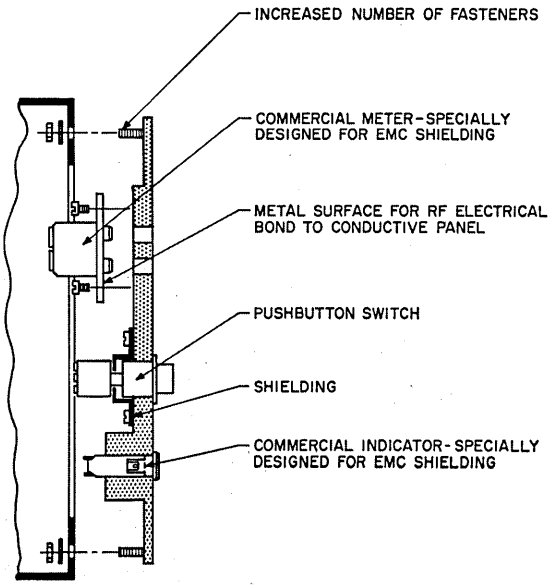

Fig. 7 Moderately treated EMC panel

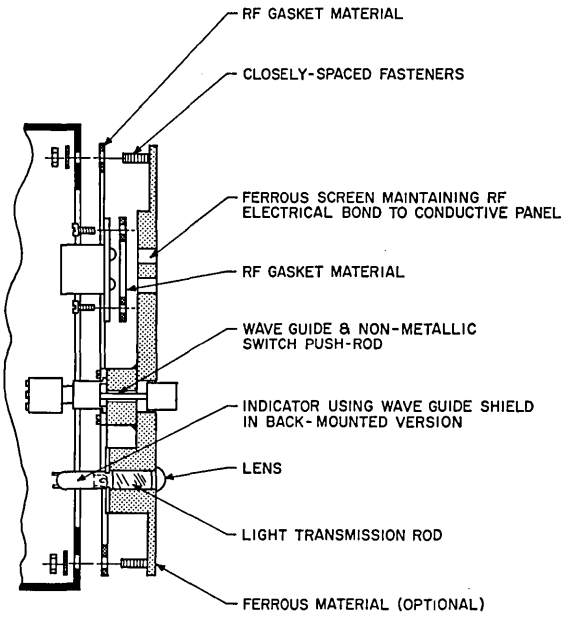

Fig. 8 Heavily treated EMC panel

through the wave-guided shield panel. Figure 8 shows an example of this type of shielding.

INDICATOR LAMPS

Since they generally require small, easily treated apertures, indicator lamps lend themselves to the incremental method. Several choices are available for the released hardware design version having commercial EMC requirements. The first consideration is to select a product having a metalic housing that can be RF electrically bonded to the conductive mounting panel. Mounting the indicator so that its filament is behind the conductive mounting panel will also help minimize the amount of energy conducted into, or out of, the shield. Finally, the aperture should be designed to the smallest functional size, and each indicator lamp should have its own aperture if possible.

The design for moderate shielding should demand the use of special commercialy available EMC shielded indicators. Otherwise, the indicator apertures should display the addition of shielding in the form of metallic screening with good RF electrical bonding to the plated panel.

For the stringent shielding requirements, wave-guide shielding is suggested for the indicator lamps. If light visibility is impaired, light energy conducting rods can be employed in the wave guides, as shown in Fig. 8.

VISUAL ACCESS

Meters and other similar visual access devices demonstrate the ability to be shielded on an incremental basis. Normally, however, a visual readout degradation can be expected as the amount of shielding increases. For most commercial EMC applications, adequate shielding can be obtained by aperture reduction and the use of metal housed meters that maintain an RF electrical bond to the conductive panel. The released hardware should reflect this type of design.

For the moderate shielding requirement, the design effort should consider the use of commercially available meters that are intended especially for EMC applications. Otherwise, the use of a fine metallic screening material that maintains a good RF electrical bond to the conductive panel is suggested to fill the meter aperture.

The design of the visual access shield for stringent EMC environments depends largely on the configuration of the readout device and on its location in relation to sensitive or noisy circuitry. The aperture screen mentioned above generally requires an increase in mass and a change to a ferrous material, if not already used. Also, the aperture size should be reduced as much as possible, even to the extent of dividing it into several smaller apertures. Wave-guide shielding may be necessary in some cases to meet the shielding requirements. Additional shielding over the meter housing and special treatment to the meter wiring may be required on some designs.

CABLING

Both internal and external cabling has been identified as a consideration for EMC treatment. This is especially true of external cables which conduct unwanted energy into the circuitry if not properly shielded or otherwise treated. As predictions regarding EMC requirements are difficult, the treatment of cabling is adaptable to the incremental method. Computer system cabling consists of power, control, and data cables. From an EMC treatment standpoint, power and control cables are similar; thus, the same basic recommendations apply to both.

As mentioned previously, designs should be generated for at least three levels of shielding. The cable design effort should adhere to this to allow the incremental addition of EMC hardware as required in order to achieve an economically viable system. Basic to all three design levels are power line filtering and discrete cable routing.

POWER LINE FILTERING

Incoming power lines can conduct spurious energy into the shield confines if not properly treated. Since shield terminations are not always feasible on the supply end, power line filtering at the equipment shield is recommended. One end of the filter should have metal-to-metal contact with the shield at the point of entry to allow separation of input from output wiring. This type of installation will limit unwanted energy coupled into the shield confines.

CABLE ROUTING

The application of proper interior cable routing can significantly reduce the equipment susceptibility to electromagnetic energy. Power cables can induce sufficient current into nearby data cables to cause malfunction in attached sensitive circuitry. In order to prevent this, it is important that power cables be routed as far from data cables as possible, with twelve inches as the suggested minimum distance of separation. In addition, power cables should be routed close to the frame members, especially toward the bottom of the frame. The metallic frame members tend to "absorb" the spurious energy generated by the power cables.

Data cables should be isolated from the frame members by at least one inch, and should be routed in the upper portions of the equipment if possible. The goal is to achieve as little "cross-talk" as possible, thus providing relatively inexpensive shielding. In the event that physical separation is inadequate, cable shielding in various forms should be employed.

CABLE SHIELDING

Computers generally have masses of associated cables running between various units of the system. Shielding is usually the only method of treating these cables if serious EMC problems exist. The designer can incorporate provisions for incrementally adding the shielding hardware as required. Several parallel designs should be generated to address several levels of shielding requirements. The released design should maintain the capability of mounting the hardware as shown in the other designs by assuring the allotment of sufficient space and adequate mounting provisions. As in other EMC hardware considerations, the definition of the exact requirements will be specified during EMC tests on the operational equipment and can be added prior to shipment.

CONCLUSION

At times, after any normal equipment design/build cycle is completed, an oversight is uncovered and there is a flurry of activity to correct it. These oversights are generally not serious since the design group has the skills to overcome even he most grievous errors. This is not true if a substantial error is made on shielded equipment where the necessary rework could impair appearance, and worse, result in degraded performance if this occurrence had not been anticipated.

Most of the merit of the "incremental method of computer shielding" lies beyond the drawing board and manufacturing facility. It resides in the fact the EMC hardware changes are anticipated, due to deviations in operational environments, and that positive means are provided to deal with these deviations. During the EMC test phases, prior to shipment, the equipment's intended design goals are met by incrementally adding the EMC shielding hardware as required. Should this hardware prove to be marginal or inadequate in performance, the back-up designs can be reviewed for possible incorporation. Generally, the trouble spots will have been pinpointed during the test cycle, can be individually addressed, and the respective "fix" easily applied.

This method of shielding appears to permit slight amendments to the EMC shield configuration if necessary at the customers facility. Computer servicemen, using normal hand tools, and a "bagful" of easily attached parts could bring the equipment to its exact intended operational level, suggesting that a truly customized shield can be achieved.

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A character set has been developed which is suitable for human and machine reading without restricting the future generation of automatic reading techniques

The Design of a Standard Type Font For Optical Character Recognition

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The type font described here was developed by the USASI Subcommittee X3-1, Optical Character Recognition; the numeric-symbol subset was developed with the cooperation of the International Standards Organization. In July, 1966, the font was approved as the USA Standard Character Set for Optical Character Recognition (X3-17, 1966). In 1966 the font became part of an Iso recommendation (No. 996) which was circulated for voting to national standard organizations in June 1967. In the ISO recommendation the font is referred to as OCR-A, and this identification will be used here.

USASI Subcommittee X3-1 held its first meeting in July, 1960. Its task was to develop a character set acceptable for human reading and suitable for machine reading without restricting the future development of automatic reading techniques. Further considerations were that the character shapes in the recommended sizes should be defined such that they were accurately printable on existing and proposed printing devices using supplies of a quality readily available in the marketplace, and that the number of characters in the font should be sufficient to satisfy the requirements of the maximum number of applications.

To ensure that these goals were met, the development of OCR-A was organized into three Task Groups, each responsible for one facet of the job.

- Font Development, responsible for the design of the character shapes including definition of the criteria to be used in shape selection.
- Print Devices and Printing. Initially this group concentrated upon the identification of the printing devices expected to be used in OCR applications, and measurement of the variation in print quality representative of these devices. It was soon recognized that the choice of supplies (paper, ink, ribbon etc.) can have a marked effect on print quality, and conversely, that the definition of print quality can affect both the price and availability of supplies. Therefore, the Printing activity was expanded to include the development of specifications for supplies.
- Applications and Format. Basic to the development of a font for OCR applications is the number of characters in the set. Several applications were identified as being satisfied by a numeric-symbol set,

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Fig. 1 OCR-A Font

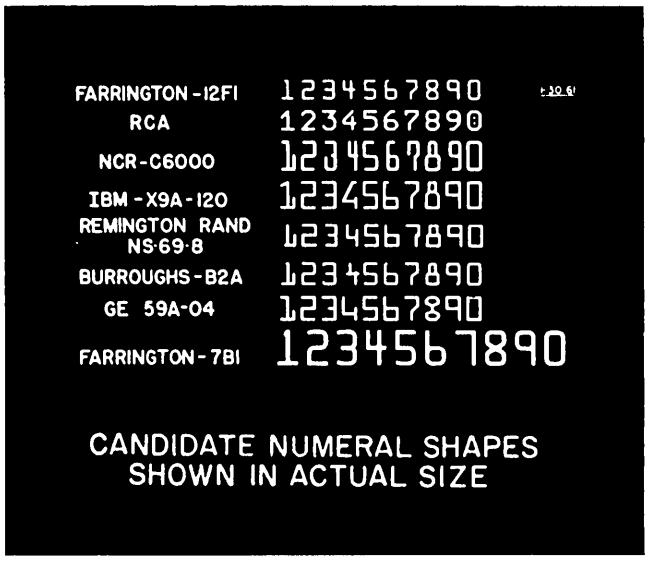

Fig. 2 Candidate numeral shapes

others required a full alphanumeric set. This information was developed for an analysis of applications for which OCR was being used or considered.

CRITERIA FOR SELECTION OF CHARACTER SHAPES

The wide range of sizes and shapes of numerals submitted for consideration as candidates for standardization (Fig. 2) reflects the differences in printing and reading devices in use or under consideration in January, 1961. Instead of trying to resolve the differences between the individual candidates, a set of criteria was developed. Every character shape was required to meet these criteria before being considered further. These criteria represented the properties identified as being required in a machine readable font. They include:

- Characters must be reasonably pleasing in appearance and should be accurately and easily readable by human beings.
- All strokes must have uniform width.
- Characters shall be constructed with a minimum of serifs.
- All radii and fillets should be non-critical, i.e. should have no effect on machine readability.
- Characters should be designed for maximum distinction based on two-dimensional information. They need not be recognizable solely on the basis of information contained in vertical or in horizontal strokes only.

Altogether fourteen criteria were used. The five above, however, are sufficient to show the concern for human reading and machine printing.

EVALUATION CRITERIA

A great deal of effort was spent in the development of evaluation criteria which would provide a quantitative measure of the distinguishability of a set of character shapes. It was recognized that many different recognition techniques were available or under development in laboratories and that, for proprietary reasons, full information could not be made available on much of this work. Because of the wide disparity between the many efforts directed towards an optical character recognition machine, it was felt that no single measure of distinguishability would be adequate and further, that if a single evaluation technique were chosen, it would restrict future developments of OCR technology. Therefore, two guiding principles were observed throughout the development of OCR-A:

- Any quantitative measure of character differentiation which was deemed desirable by any number of the Task Group was provided through the cooperative efforts of the entire group.
- Every member was expected to bring to the selection of evaluation criteria and character shapes, the full body of knowledge available to him. This included proprietary information of specific machines under development as well as information exchanged within the Task Group.

To ensure that full use was made of all the information available during the development of OCR-A, every company known to be attempting to develop or market a reading machine was invited to participate. A measure of the success of this effort is the number of individuals who took part in the work of the Task Group (over 50 individuals representing manufacturers of printing and reading equipment, forms and ribbon supliers and users).

Six quantitative techniques were used in evaluating the numeric-symbol character set. They were designated as:

- Hamming distance
- Average cell entropy
- Area correlation
- Normalized worst-case area difference (WAD)
- Stroke analysis I
- Stroke analysis II

The Hamming distance, average cell entropy, area correlation and both stroke analysis techniques assume that the characters are in perfect registration on the 5 x 9 design grid. Only the WAD analysis measures the character pair differences under conditions of vary-

ing stroke width and registration.

Each of the quantitative analyses was used to measure the difference between each of the characters in the set, taken two at a time. The results of the analysis were used to determine which were the worst character pairs. Characters were changed to increase the measured difference, and the analysis was repeated.

In addition, a very thorough feature analysis was made. This technique does not lend itself to quantitative analysis but demonstrates that the proposed character set can be read by recognizing the presence of a limited number of features.

HAMMING DISTANCE

The Hamming distance was based upon the 5 x 9 grid used in the development of the numeric symbol set. Two kinds of measurement were made. One considered each cell in the 5 x 9 grid occupied by one character and not by the other, as a point of distinction. The other gave increased weight to a cell if it was not only a part of one character and not the other, but was also at a greater distance from cells occupied by the second character.

Four matrices were constructed, each being nine rows by five columns. In the first matrix, every cell occupied by one character and not by the other is given a weight of one (1); all other cells are zero (0).

In the second matrix, a cell has a value of one (1) whenever it is occupied by one character and is separated by at least one cell (vertically and horizontally) from any cell occupied by the other character; all other cells are zero (0).

In the third matrix, the separation must be at least one cell horizontally, vertically and diagonally for a cell to have a value of one (1); all others are zero (0).

The fourth matrix is simply the sum of the first, second and third matrices.

The Hamming distance is equal the sum of the cell values in a given matrix. The values of the first and fourth matrix were used in the evaluation. The two types of Hamming distance give almost identical results. Figure 3 shows a typical calculation for a pair of numerals in the OCR-A set.

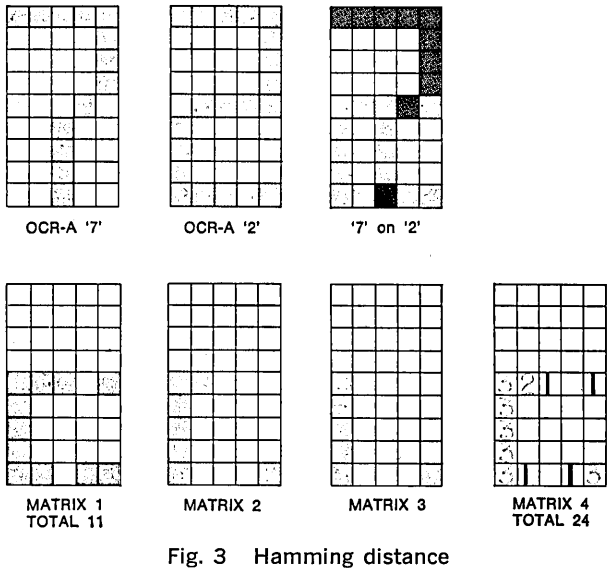

Fig. 3 Hamming distance

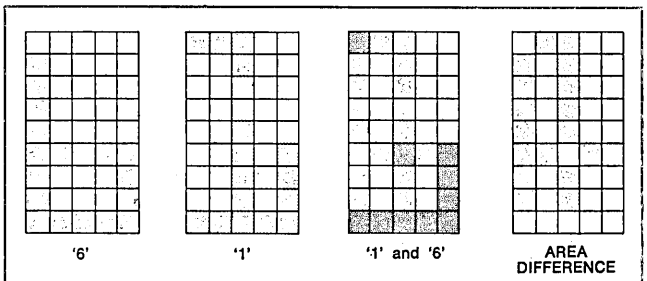

Fig. 4 Area difference between a pair of OCR-A characters

AVERAGE CELL ENTROPY

The average cell entropy is given by the following formula:

$$S_{av} = \frac{1}{45} \sum_{i=1}^{45} [\, P_i \ln_2 (P_i) + (1-P_i) \ln_2 (1-P_i) \,]$$

S_{av} = Average cell entropy
P_i = Probability of cell i being black (45 elements)

If a given cell of the 5x9 grid is used in 5 characters in a 10 character set, P_i would be 5/10 or 0.5. Probability values were calculated for each of the 45 cells and substituted in the formula. A large value of S_{av} indicates that the characters are equally distributed among the grid elements. Conversely, a small value of S_{av} indicates that most characters of a set have many grid elements in common. Therefore, the character set with the highest S_{av} is preferred.

It is possible that a set of characters with a high average cell entropy might have one pair of characters which are difficult to distinguish. For example, if the same character were repeated twice in a large set, the value of S_{av} would not change appreciably. In actual practice, any of the candidate character sets with a high average cell entropy maintains this high average even when a smaller subset is considered. This is due to the fact that the characters were not submitted at random, but had been subjected to many tests of distinguishability before being submitted.

NORMALIZED AREA CORRELATION

The area correlation of two characters, each of which is described by a 5 x 9 grid, is Bij, the number of cells which are black in character i, and also black in character j. The larger the value of Bij, the greater the common area shared by the characters i and j. This correlation may be normalized to remove the effect of character size by simply dividing Bij by A (area of the 5 x 9 grid) to give a normalized area correlation Nij, where Nij = Bij/A. The lower the value of Nij, the better the character pair. To use this technique effectively, various degrees of misalignment and stroke width variation should be considered. The maximum value of Nij achieved during these variations presents a measure of the difference between the character pair.

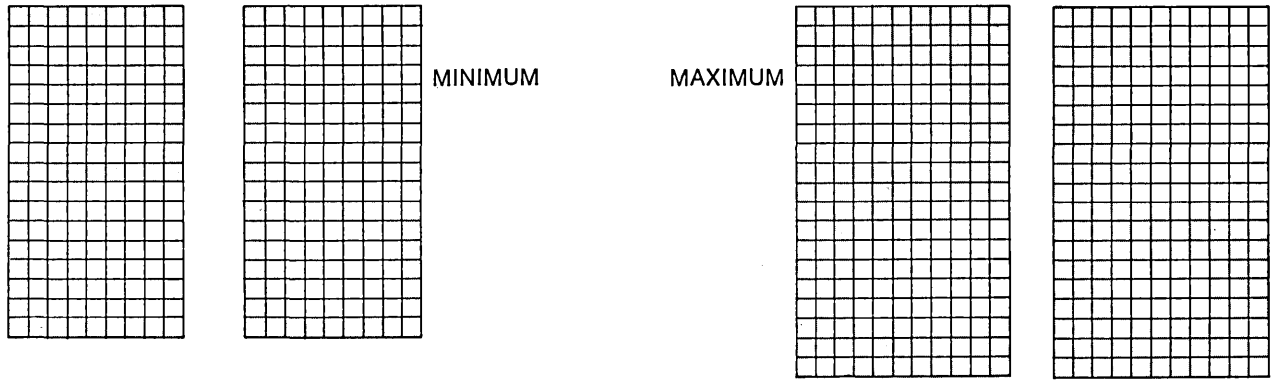

Fig. 5 Minimum and maximum stroke width versions of '2' and '6' on 9 x 17 matrix

NORMALIZED WORST-CASE AREA DIFFERENCE

The area difference between two black and white patterns is well defined for a fixed relative registration between patterns. It is defined as the area where the first is black and the second white, and vice versa (Fig. 4). The term "worst-case" refers to the variable area difference that is computed, as the stroke width and the relative alignment of the two characters vary.

Specifically, the worst-case area difference for two characters A and B is defined for any degree of misalignment as the sum of the area where A (with minimum stroke width) is black and B (with maximum stroke width) is white, and the area where A (with maximum stroke width) is white and B (with minimum stroke width) is black. The value of the worst-case area difference considered in evaluating the difference between any two characters is the minimum value computed for all amounts of relative misalignment.

The normalized worst-case area difference (WAD) is obtained by dividing the worst-case area difference by the area of a rectangle whose width is equal to the centerline width of the largest character in the set plus the nominal stroke width, and whose height is the centerline height of the largest character in the set plus the nominal stroke width.

In practice, the characters are coded on a 9 x 17 grid and stroke widths vary from 1 to 3 grid cells. Figure 5 shows the characters 6 and 2, coded on the grid. Figure 6 shows a typical calculation of the WAD value for that character pair. The degree of misalignment was not limited, but computation was aborted when the area difference began to increase as the characters were moving apart. The choice of matrix resolution (approximately .006 inch) and degree of misalignment are the result of empirical tests to determine the coarsest resolution possible (which minimizes computer time) without changing the analysis results, and the maximum misalignment which can occur before the WAD value reaches a minimum and begins to improve. Although this choice of grid resolution leads to variations in stroke width which are not necessarily what would be found in an actual OCR system, they are not significantly different for purposes of evaluation, and the evaluation results do not change for a slight difference in stroke width. The same is true of character size, which is modified slightly by the grid resolution chosen.

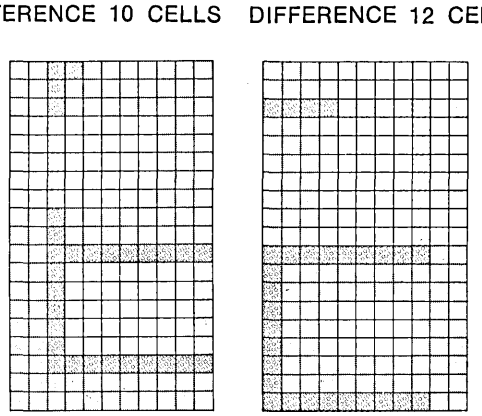

Fig. 6 WAD analysis for '2' and '6'

STROKE ANALYSIS I

Two slightly different methods of stroke difference rating were used in evaluating the candidate characters. They have in common the fact that they constitute a coarse resolution examination of character differences. Both methods use the 5 x 9 grid used in the numeric set design, and both give zero weight to small area differences between character pairs, even though there may be in total a large number of these small differences between the two characters.

In Stroke Analysis I, an acceptable stroke difference between two characters is defined as a continuous line of grid elements, at least three elements long, such that every element is occupied by part of one character and no element in the line is occupied by part of the other character, nor is any element in the line adjacent to an element occupied by the second character. An acceptable stroke difference may be a horizontal, vertical or diagonal line. Figure 7 shows examples of acceptable stroke differences. In order to be acceptable, every combination of character pairs within a character set must be characterized

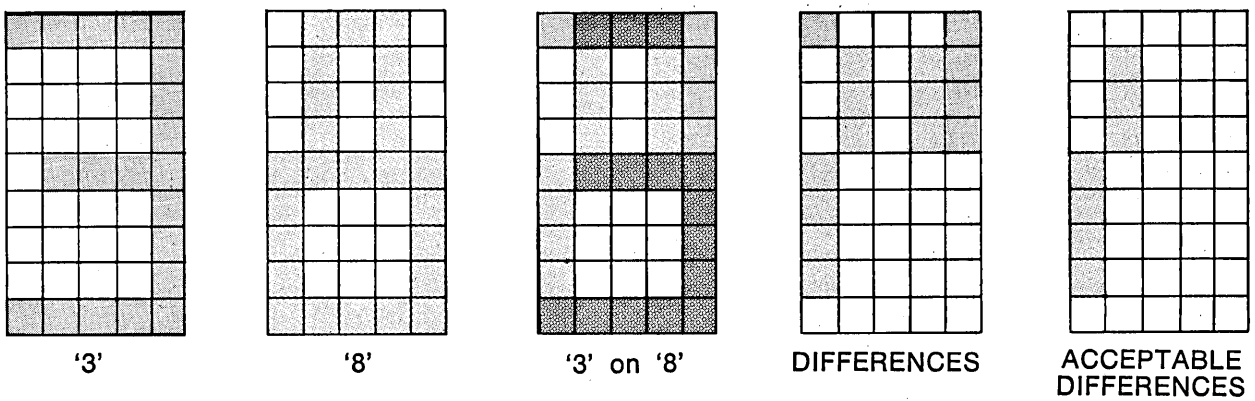

Fig. 7 Examples of acceptable stroke differences in stroke analysis

by at least one acceptable stroke difference. The larger the number of stroke differences, the more reliable the font.

STROKE ANALYSIS II

All strokes are classified as short (one grid element), mid-length (three grid elements), long horizontal (five grid elements), or long vertical (nine grid elements). Whenever a stroke of one character in a character pair occupies three or more grid elements, at least two of which are not occupied by any part of the other character, the difference is given a rating in accordance with Table I. The only exception is that when a stroke of one character is parallel and adjacent to a stroke of the second character, the difference is given a rating of zero (0). The difference between the weights assigned under Stroke Analysis I and II is shown in Fig. 8.

TABLE 1 STROKE ANALYSIS II WEIGHTS

Type of Stroke	Subset of Stroke in Common with another Character	Stroke Analysis II Rating
M	None or S	1
M	2S	0
LH	None or S	2
LH	2S	1
LH	M or 3S	1
LH	4S	0
LV	None or S or 2S	3
LV	M or 3S	2

Where S = short stroke (1 grid element)
M = mid-length stroke (3 grid elements)
LH = long horizontal stroke (5 grid elements)
LV = long vertical stroke (9 grid elements)

FEATURE ANALYSIS

Although the quantitative evaluation methods described above were used extensively during the development of OCR-A, they are not sufficient to satisfy the requirements of all character recognition methods. It is possible to build a reader which recognizes each character by identifying the presence, or absence, of a selected set of "features." Some examples of the features which a machine might recognize are given in Table 2. It is possible that differences between characters which are small on the basis of the WAD or stroke analysis methods might nevertheless be significant when incorporated into a particular set of features.

TABLE 2

Partial List of Features Adequate for Distinguishability of OCR-A Characters

Code	
BLC	Black Lower Center
BOB	Bounded Open Bottom
BOT-D	Bounded Open Top-Deep
BOT-S	Bounded Open Top-Shallow
FHC	Full Height Character
FHLE	Full Height Left Edge
FHRE	Full Height Right Edge
HAD	Hole Area Difference
HB	Horizontal Bottom
HC	High Character
HCHLE	Half Character Height Left Edge

STROKE POSITIONS	RATING: STROKE ANALYSIS I	RATING: STROKE ANALYSIS II
	0	0
	0	0
	0	1
	0	1
	1	1
	1	2

Fig. 8 Stroke analysis ratings for six different stroke combinations

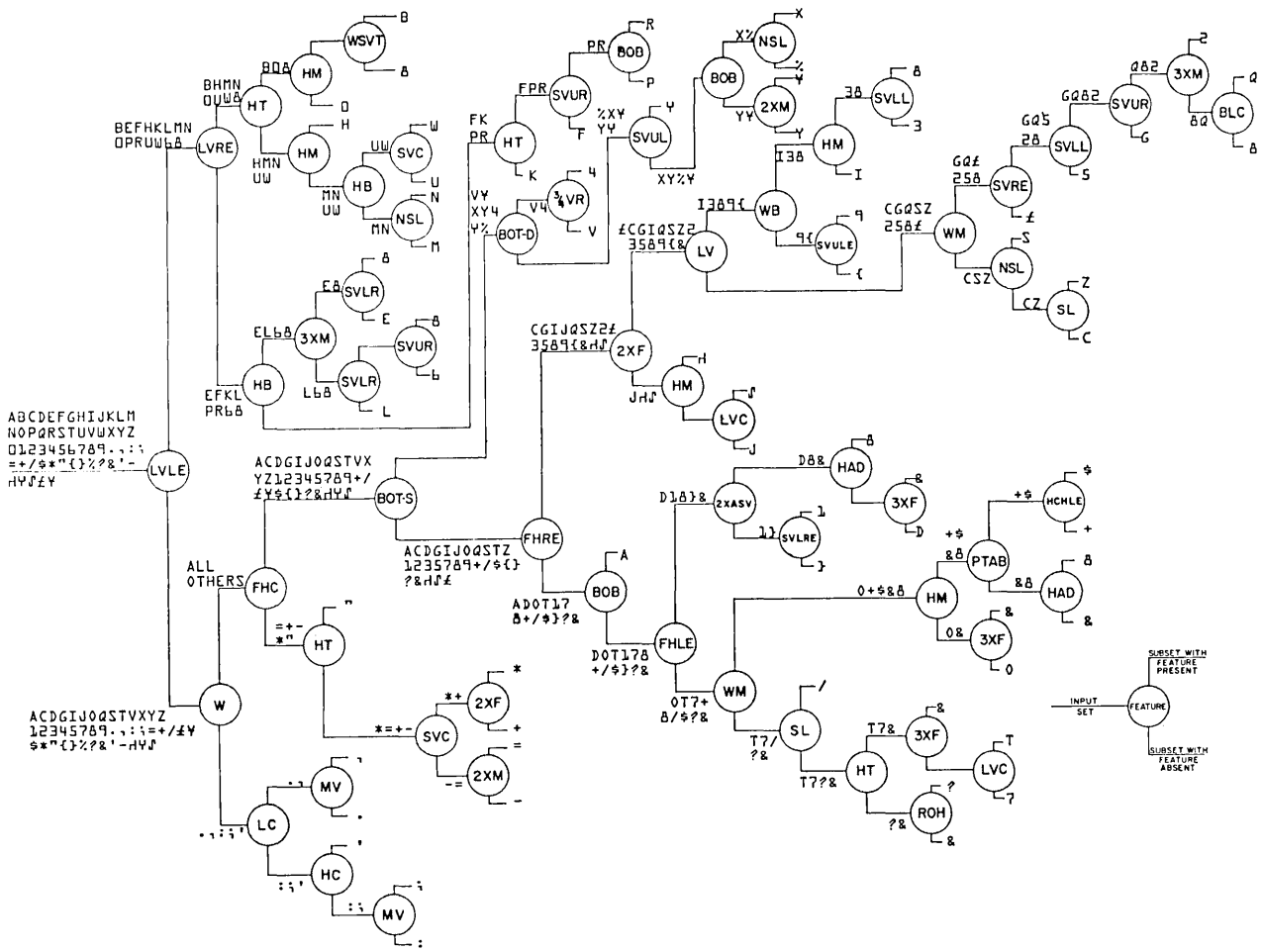

Fig. 9 Character separation based on features for the OCR-A Font

Figure 9 shows the character separation of the OCR-A set based upon features identified by Farrington Electronics. These features were identified for evaluation purposes only and are not necessarily the ones which are used to recognize the characters of the OCR-A font.

ASSESSMENT OF ANALYSIS RESULTS

In a detailed examination of the numeric-symbol character set, it was found that the Hamming distance, average cell entropy, area correlation and WAD analysis differed very little. Furthermore, the differences were explainable by the fact that the WAD analysis was more precise, using smaller increments of stroke width variation and character misregistration.

As a result of these similarities, the quantitative analysis of the numeric-symbol set was confined to the WAD analysis and Stroke Analyses I and II. No attempt was made to further reduce the number of evaluation techniques. Instead, the result of each analysis was presented and weighed in the design of the OCR-A set.

Although Stroke Analyses I and II could have been modified and extended to be applied to the choice of the alphabetic characters and additional symbols, they were not. It was decided that they did not adequately represent reading techniques likely to be used for a full alphanumeric set. Thus the WAD and feature analysis techniques were the primary considerations for the selection of the OCR-A set.

The development of the evaluation techniques used in the selection of the OCR-A shapes was a necessary step in the development of a standard OCR type font, acceptable to printers, users and readers. OCR-A has become well established since its approval in the U.S.A. in July, 1966, and several machines are now on the market to read this font. The present and predicted growth of OCR in the United States is, in no small measure, due to the existence of this U.S.A. Standard Character set for OCR.

The work described here was carried out by USASI Subcommittee X3-1 over a six-year period from July, 1960 to June, 1966. A large number of individuals were concerned in this work, and without singling out any individual, I would like to acknowledge all their efforts.

To be effective in today's rapidly changing technology, strictly project-oriented machine aids systems must be replaced by those of a more flexible nature

A Machine Aids System for Digital Designers

Benson H. Scheff

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Missile Systems Division
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Between initiation of an engineering design specification and completion of the implemented system, much time, effort, and money is spent by skilled engineering personnel performing essential repetitive clerical tasks. Currently throughout the industry, diverse computer-based systems provide automated machine design aids to expedite engineering design by eliminating these routine chores.

A machine aids system is oriented toward assisting the engineer at every state of design (Fig. 1). For example, some of the usual procedures involve translation of circuit logic into circuit schematics. A model chassis is built, using the schematic, and then tested. Chances of error detection prior to chassis checkout are minimal. Changes or improvements are costly and time consuming to implement once construction has begun. A machine aids system allows design information to be obtained continuously with changes in logic, and permits immediate testing for errors by means of simulation long before chassis construction. The advantages are self-evident in reducing costs as a result of increased availability of manpower and the capacity for more complete design analysis, reducing design time, and providing documentation and change control.

The Raytheon Automated Digital Design System (RADDS) consists of:

- A language used by design engineers
- A central computer storage file in which a generalized description of the network, i.e., the model of the network, is stored (the information in the file may be placed on a storage medium, such as magnetic tape, for reference and modification as the design progresses), i.e. the data base
- A set of computer routines to extract design information from the network storage file
- A program which allows the model in the file to be exercised under various sets of conditions

The present system assists the design engineer who desires to maintain an up-to-date list of circuits, logic, and pin list of the wiring needed to build his equipment, ensure the allocation of logic to a location on a

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specific module at a specific plate position, verify consistency of assigned loads with the load capabilities of the circuit, and simulate his logic to ensure accuracy. It also aids the hardware builder who wishes to model and test his chassis by simulation prior to its construction, and to produce input to an automatic wiring machine. The various stages in the automatic process are shown in Fig. 2.

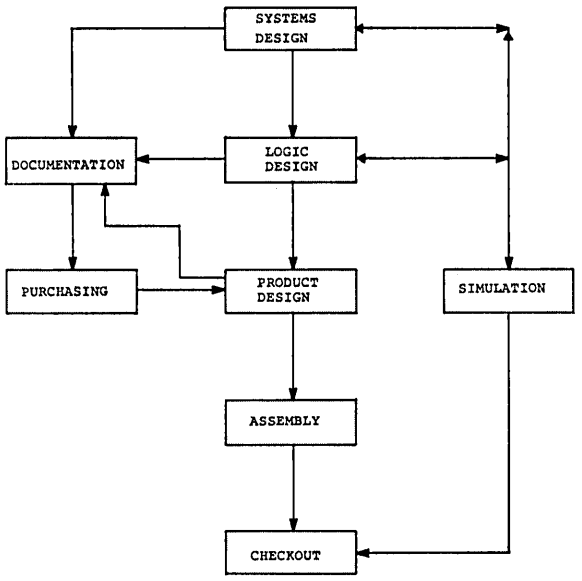


Fig. 1 General engineering design phases

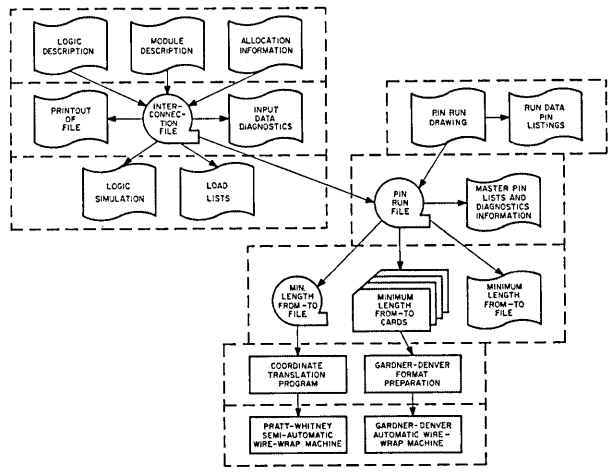


Fig. 2 Machine aids system functions

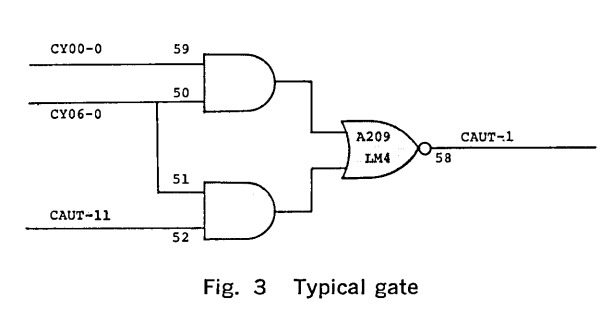


Fig. 3 Typical gate

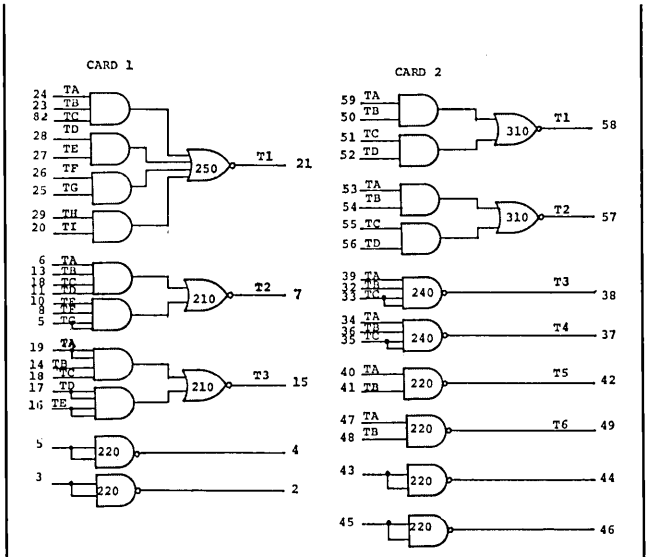


Fig. 4 Typical gate module

LOGIC AND MODULE DESCRIPTION

The drawings in Fig. 2, Block 1 describe registers, gates, and flip-flops. The logic drawing describes the logic at the flatpack level, shows interconnection information, and details component placement. A register logic drawing describes a single logic card; a gate-type drawing describes a flatpack or part of a flatpack, and a flip-flop drawing shows its set, reset and true and false outputs.

Consider, by way of example, the gate drawing, as shown in Fig. 3. Gates are represented by the typical MilSpec symbols for AND-gates and OR-gates. Each terminal is labeled by pin number and signal name. The function CAUT1 has input functions CY000, CY060 and CAUT11. This gate is on a type LM4 module and is located at A209 on the parent plate.

Module descriptions may be either specific, describing a function, or general, describing components. The module drawings identify the position of all flatpacks and connector pins, and the gating structures of each flatpack including the interconnections on a logic card and the loads drawn for each pin.

Figure 4 illustrates a module containing 13 separate gates on two separate logic cards, with the gates identified by MilSpec symbols. Each input and output pin of every circuit on a flatpack is connected to a connector pin of the module. The first circuit, illustrated in Card C of Fig. 4, drives connector pin 58.

INPUT CODING SHEET

The input language used on the coding sheets is relatively straightforward and is aimed toward facilitating its direct use by design engineers. The language treats both logic and modules as packages of electronic elements, permitting them to be expressed in the same form. The system allows engineering terms (Boolean expressions and black box equations) to be used directly on the input sheets.

The information on the logic and module drawing is put on "RADDS Equation" coding forms, on which gates are specified by Boolean-type equations. This is

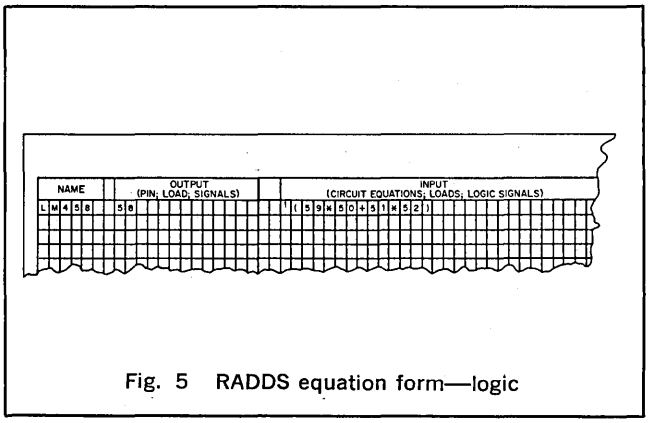


Fig. 5 RADDS equation form—logic

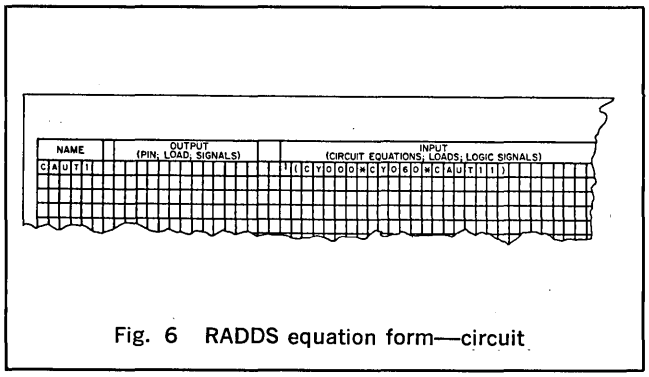


Fig. 6 RADDS equation form—circuit

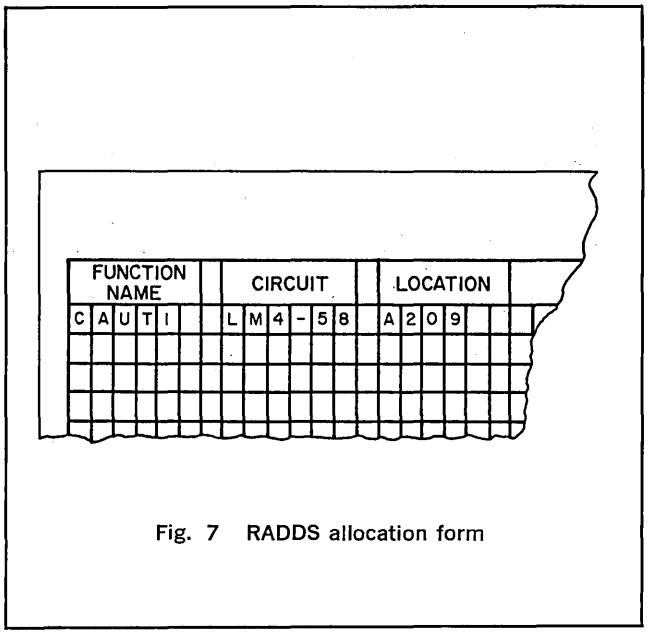


Fig. 7 RADDS allocation form

illustrated in Fig. 5, which corresponds to the logic drawing in Fig. 3. In these equations, AND's and OR's are shown as astericks (*) and plus signs (+) respectively, and inversion is shown as an apostrophe ('). Function CAUT1 is produced by ORing the terms produced by ANDing CY000 with CY060, and ANDing CY060 with CAUT11. The function name is written under the heading "NAME" and the gating structure is under "INPUT." Since the only output has the same name as the function, the output column is left blank.

The corresponding input sheet for the gate module is shown in Fig. 6. The module is identified by its name (LM4), and its ouptut pin number (58). The pin number is repeated under "output," and the gating structure goes under "input."

In addition, Boolean equations can be assigned to a specific position or particular module, using a "RADDS Allocation" form. Figure 7 shows the input required to place function CAUT1 on module LM4, pin 58, at position A209. The program assigns numbers to input pins and shows which pins are not being used. Thus when a four-input NAND, is used as a three-input NAND, one of the inputs is marked as unused.

INTERCONNECTION FILE

The logic, module and allocation information submitted by the engineer are combined to form an interconnection file. This information may be printed for his use in tabular form. Figure 8 shows the contents of the file after each step in a simple processing sequence:

- Logic description (8a)

Fig. 8

CIRCUIT FUNCTION EQUATION

CAUT1 = '(CY 000 * CY060 + CY060 * CAUT11)

(a) Logic description

CIRCUIT (OUTPUTS PINS/LOADS)
= INPUTS-PINS/LOADS

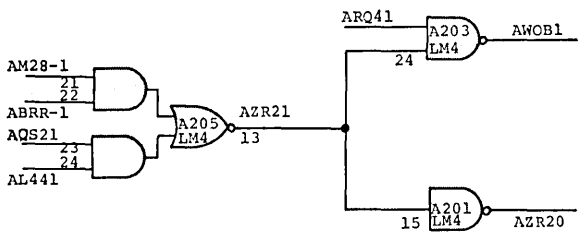
LM4 = 58 (58) = '(59 * 50 + 51 * 52)

(b) Corresponding circuit description

CIRCUIT FUNCTION
LM4-58 CAUT1 [58]
EQUATION
= '(CY000 [59] *CY060 [50] + CAUT11 [52])

(c) Logic description after insertion of circuit information

Fig. 9



(a) Typical circuit

SIGNAL SOURCE		USED ON			
		FUNCTION	LOCATION	LOAD	TOTAL LOAD
AZR21	AZR21	AWOB1	A203-24	2.1	
		AZR20	A201-15	2.0	
					4.0

(b) Associated load list printout

```
LØW/CY000, CY060, CAUT11 $
PRINT/CY000, CY060, CAUT11, CAUT1 $
SCHEDULE/CY000 (4), CY060 (2), CAUT11 (1),
    STØP (9) $
CHART/
SIMULATE/
EXIT/
```

Fig. 10 Input form specifying waveforms in particular inputs

```
                SIMULATION BEGINS
   C     C     C     C
   Y     Y     A     A
   0     0     U     U
   0     6     T     T
   0     0     1     1
                1
1  0     0     0     0
2  0     0       1   0
3  0       1   0     0
4  0       1     1     1
5     1   0     0     0
6     1   0       1   0
7     1     1   0       1
8     1     1     1     1
9  0     0     0     0
```

Fig. 11 Output form with waveform for each signal

- Corresponding circuit description (8b)
- Logic description after insertion of circuit information (8c)

Before the logic is allocated, the logic file looks as it does in Fig. 8a. That is, the Boolean equation is present, but the circuit type and pin numbers are missing. The printout of the circuit types in Fig. 8b gives the circuit identification, consisting of module type and pin number, followed by the list of output pins and gating structure in terms of pin numbers. Figure 8c shows a logic equation which has been assigned to a particular circuit. The circuit type, LM4-58, is printed under "Circuit" and the pin numbers are in square brackets.

LOAD LIST PRINTOUT

The engineer can verify the accuracy of the loads at each pin for any circuit described in the interconnection file by obtaining a load list printout, which includes every source function and pin, together with the associated loading. All load functions which draw current from that source, together with the total current drawn, are also listed. If the current drawn exceeds current capability, an error message is printed next to the total loading. A typical circuit and its associated load list printout is shown in, Fig. 9. In this circuit, one function, AZR21, drives functions AW0B1 and AZR20. The functions are located at module position A203, pin 24, and position S201, pin 15, respectively. They both draw 2.0 milliamps so that the total of 4.0 milliamps does not exceed the maximum of 22.0.

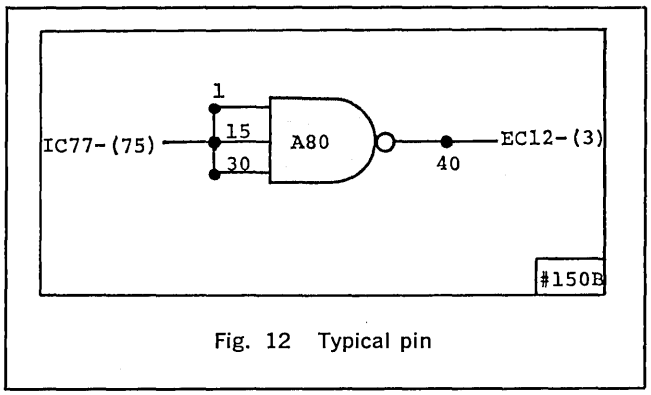


Fig. 12 Typical pin

SIMULATION

The design entered into the interconnection data base is exercised with 'simulated' inputs to obtain information before hardware is available, and obtain reference information after hardware is available. Input information consists of circuit delays, input signals (such as pulse width), square waveforms in terms of the delays and inversions, delay tolerance, and fan-out delay variations. The simulator checks for errors in the logic and identifies such suspicious actions as trying to simultaneously set and reset a flip-flop or trying to load a register from two sources at the same time.

Optional output includes an asynchronous digital simulation. The input specifies wave forms on particular inputs. Figures 10 and 11 show the input and output forms. The first line of the input indicates that

```
PARENT PLATE    5.    CP/10
5 NEW  0 1 0
A 7915 IC77-0-0     75A A 8015 IC77-0-0
1A 8015 IC77-0-0    150B A 7915 IC77-0-0
1A 8030 IC77-0-0    150B,
1A 8001 IC77-0-0    150B A 8015 IC77-0-0
1A 8030 IC77-0-0    150B A 8015 IC77-0-0

        DRAWING NO. 18876    E10257945

150B,                                    060668
 75A A 8001 IC77-0-0      150B           060668
                                         060668
                                         060668
                                         060668

PRINTOUT OF SUCCESSIVE RECORDS FROM TAPE L8
CONTAINING THE UPDATE RUNS
          PLATE = 5, FUNCTION = IC77-0-0,
PINS          A 79-15   A 80-15   A 80- 1   A 80-30
SHEET, REV      75A       150B      150B      150B
WIRE CODE
  DATE = 060668, PIN TOTAL = 4, RUN NO. = 1
```

Fig. 13 Input pin list data

CY000, CY060, and CAUT11 start out at a low voltage. The second line sets an alternating pattern of four clock cycles on signal CY000, and similarly for the other signals. The output shows the waveform for each of the signals.

PIN GROUPS

Standard digital diagrams describe pin groups consisting of a particular pin and its input and output connectors. A typical input drawing (Fig. 12) shows that a pin of function IC77, located on Logic Sheet 75, is connected to pins A 80-1, A 80-15 and A 80-30 of Sheet 150 (Revision B). In this case, pin A 79-15, having function name IC77, is located on another sheet. Output pin A 80-40 is the input to at least one pin for function EC12 and Sheet 3.

Statements describing the pin groups are prepared from these drawings either by connecting each node of the particular pin with its immediate connectors or automatically from the interconnection file. This input information may be printed out, as shown in Fig. 13.

- Header: parent plate number, drawing number
- Line 1: plate number, type of job (new), type of printout
- Line 2: input card data, pin type, pin number, function, sheet number revision, date

A master pin list is formed containing all the defined pin connections, as shown in Fig. 14, for a circuit consisting of only the input shown in Fig. 13.

- Line 1: plate number, function, date, pin total, run number

```
PRINTOUT OF SUCCESSIVE RECORDS FROM TAPE 18
CONTAINING THE UPDATE RUNS
          PLATE= 5, FUNCTION = IC77-0-0
PINS          A 79-15   A 80-15   A 80- 1   A 80-30
SHEET, REV      75A       150B      150B      150B
WIRE CODE
  DATE = 060668, PIN TOTAL = 4, RUN NO. = 1
```

Fig. 14 Printout of master pin list file

```
PLATE NUMBER  5  REVISION******  DATE060668
DISTANCE BETWEEN TWO CONSECUTIVE PINS IN
  A CONNECTOR 1250
DISTANCE BETWEEN TWO CONSECUTIVE
  CONNECTORS IN A BOARD 3750
DISTANCE BETWEEN TWO CONSECUTIVE COLUMNS
  OF PINS IN A CONNECTOR 1250
DISTANCE BETWEEN TWO CONSECUTIVE ROWS OF
  CONNECTORS 53750
NUMBER OF PINS PER COLUMN WITHIN A
  CONNECTOR  30
NUMBER OF CONNECTORS PER ROW OF
  CONNECTORS  55
HORIZONTAL DISTANCE BETWEEN MODULE ONE
  AND SIDE PINS 16250
VERTICAL DISTANCE BETWEEN MODULE ONE AND
  SIDE PINS 8750
HORIZONTAL DISTANCE BETWEEN TWO SIDE
  PINS 1250
VERTICAL DISTANCE BETWEEN TWO GROUPS OF
  SIDE PINS 13750
VERTICAL DISTANCE BETWEEN TWO SIDE PINS 1250
NUMBER OF PINS PER COLUMN ON SIDE
  CONNECTORS  7
ALL MEASUREMENTS ARE CENTER TO CENTER
```

Fig. 15 Plate specification printout

```
PLATE NUMBER  5  REVISION ******  DATE060668
FIRST LEVEL WIRE WRAP
A 79-15 TO A 80-15
TOTAL LENGTH OF WIRE NEEDED   10.0000INCHES
TOTAL NUMBER OF WIRE WRAPS          6

SECOND LEVEL WIRE WRAP
A 80- 1 TO A 80-15

THIRD LEVEL WIRE WRAP
A 80-15 TO A 80-30
```

Fig. 16 From-To list three level wire wrap

```
PLATE NUMBER  5  REVISION******  DATE060668
RUN NO.  SIG. NAME
      1  IC77-0-0

      RUN
      75A  A-79-15 150B  A 80-15  150B
      A 80- 1  150B  A 80-30
```

Fig. 17 Run-pin list

PLATE NUMBER 5	REVISION******	DATE060668
SHEET-REV MODULE	RUN NO.	SIG. NAME
75A A 79-15	1	IC77-0-0
150B A 80- 1	1	IC77-0-0
150B A 80-15	1	IC77-0-0
150B A 80-30	1	IC77-0-0

Fig. 18 Pin-run list

- Line 2: pin list
- Line 3: corresponding sheet and revision number
- Line 4: corresponding wire code

In this case, the pin list describes A 79-15, A 80-15, A 80-1 and A 80-30.

The master pin-run file (Fig. 2, Block 4) or the interconnection file (Fig. 2, Block 2) is used as input by the wire-assignment program to determine the minimum wire route for the network to be evaluated.

The engineer can specify the distance between two consecutive pins, two consecutive connectors, two consecutive columns of pins, and between two consecutive rows of connectors, as well as the number of pins per column within a connector and number of connectors per row of connectors.

These plate specifications can be printed out as shown in Fig. 15.

- Line 1: plate number, revision, date
- Lines 2-13: plate specifications

From these inputs, the machine aids system computes the minimum length wire assignments for the specified level of wire wrapping.

A list of wires with their bend pins in the order in which they would be wrapped by an automatic machine is printed out. This From-To list is generally the first and second levels of wrap. Three-level wrapping may be obtained as an option, the third level being used only if it contributes to the shortest path. The total wire length also is computed.

The From-To List, Fig. 16, contains:

- Line 1: plate number, revision, date
  (subsequent lines are columnized by wire wrap level)
- Pin to pin
- Total length of wire
- Total number of wraps

An obtainable Run-Pin list ordered by run number (Fig. 17) contains:

- Line 1: plate number, revision, date
- Line 2: run number, signal name (function), run (pins)
- A Pin-Run list ordered by module (Fig. 18) contains:
- Line 1: plate number, revision, date
- Line 2: sheet number, revision code, module, run number, signal name (function)

The output of this program can be used to produce inputs to the Gardner-Denver automatic wiring machine, or translated to the coordinates required for the Pratt and Whitney semi-automatic wiring machine and converted to paper tape. Alternatively, the Pratt and Whitney inputs can be prepared separately from input cards.

SUMMARY

The machine aids system is neither technology limited nor restricted to a specific project, and forms the nucleus of a more comprehensive digital design facility. As such, it can be expanded to handle such diverse tasks as automatic assignment of logical elements to standard modules, generating masks, automatic production of self-check and diagnostic routines, and comprehensive checkout of a digital system before hardware prototypes become available.

Of equal significance to the simplification of the engineering process of designing and building digital equipment provided by the RADDS system, is its use for standardized documentation, document control, error analysis, and product design. The savings in time and cost from these application byproducts will exceed the systems' development costs.

ACKNOWLEDGMENTS

In the production of the RADDS system, credit is due E. Kronstadt, Dr. F. Luconi, and S. Young for the design and implementation of the language and file structure; L. Shafer for the simulation program, and J. Acosta and T. Melia for the pin list and wire-wrapping processes.

REFERENCES

The following papers describe specific aspects of RADDS:

1. B. H. Scheff, "The Role of a Computer Machine Aids System in the Digital Design process," Joint Conf. of Mathematical and Computer Aids to Design, Oct. 30, 1969.
2. L. Shafer, E. Kronstadt, and B. H. Scheff, "Efficient simulation Within a Comprehensive Automated Design System," Ibid.
3. H. Varian, E. Kronstadt, B. H. Scheff, and S. Young, "RDDL: A Versatile Computer Design Language Based on a Precedence Grammar," Ibid

Two limiting equations permit selection of any desired codes and establish exactly what codes are available and valid in every radix, so that every possible code becomes known

A Generator of Positive-Bit-Weight Codes For Digits in Any Radix

Leopold Schorsch

Consulting Engineer

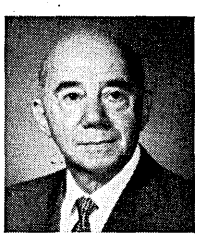
It is intended by this introduction to provide a "feel" for the infinite range of available numerical systems. While mankind, rooted in the decimal system, does somehow seem to get the world's work done more or less efficiently, it is to be expected that research will discover which systems are better for particular tasks to be performed.

Consider the following simple sums:

(a)	(b)	(c)
145	95	22
+166	+149	+ 45
333	222	111

They are "incorrect" if common arithmetic is assumed, but they are quite valid in numerical systems known as

(a) octal, (b) duodecimal, (c) sexadecimal.



***Leopold Schorsch** holds degrees of BSEE (1918) from Cooper Union, New York, and MSE (1969) from Arizona State University where he is continuing graduate study in computer sciences, mathematics, and networks. He has engaged primarily in circuit design and instrumentation, principal employers having been the Navy and Ebasco Services, Inc.*

Significance lies in what may be sensed behind mere digital operation. With a code being the interface between man and his machine, the future computer should employ any code suited to the work, and even select that code according to proper algorithms. It is conceivable that the future computer will function simultaneously in a number of codes, as prompted by assignment, and that such operation will be carried on by the computer independently.

It is known that weighted codes have been part of computer technology for an appreciable time, but heretofore the mathematical establishment of every valid positive-bit-weight code had not been accomplished, and certainly not in every radix.

Computer functions are generally implemented by binary-state devices. Therefore numerical systems must be binary or binary-coded using bits that are "weighted."

Starting from the bit-weight "1," the generator produces every usable positive-bit-weight code in any radix. Operation of the generator proceeds according to two limiting equations which permit selection of any codes desired and which establish exactly what codes are available and valid in every "radix band," no more and no less, so that every possible code becomes known.

It is demonstrated how, within each radix band, the count of codes actually possible in each radix decreases as the radix increases, because a code that is self-complementing in radix r, is no longer a valid code in radix (r + 1).

THE GENERATOR

It is convenient to regard a code as only one combination of its bit; for example,

5 3 2 1

5 2 1 3

5 1 2 3, etc.,

will all be taken to represent the code 5 3 2 1, the bit-weights being arranged in descending magnitude from left to right.

Where single digits are greater than 9, as occurs in radices greater than 10, bracketed numbers (decimal-valued) will represent such single digits: [10], [11], [12], --- etc.

Figure 1 shows some properties of numerical systems beginning with radix 2. Positive-bit-weight codes will be generated for these systems, the n bits being arranged as:

$$b_n \quad b_{n-1} \text{ --- } b_i \text{ --- } b_2 \quad b_1$$

msb (most significant bit) — lsb (least significant bit)

These bits will form the proper digit symbols indicated in the second column of Fig. 1, from which it is evident that the sum of all bit-weights must be not less than the radix minus one, so that

$$b_n + b_{n-1} + \text{---} + b_i + \text{---} + b_2 + b_1 \geqq (r-1).$$

limiting equation I

For the decimal system, which is a special case, the equation above reduces to

$$b_4 + b_3 + b_2 + b_1 \geqq 9.$$

Next, limiting equation II is derived by writing the necessary conditions that any possible code places upon any bit b_i:

Lower limit Since the n positive-bit-weights are arranged in descending magnitude from b_n down, bit b_{i+1} must be not less than b_i.

Upper limit In all positive-bit-weight codes bit b_{i+1} must be not greater than the sum, augmented by one, of all lesser bit-weights $b_1\ b_2$ --- b_i. Unless this condition exists, there will be a digit gap between b_{i+1} and the sum, augmented by one, of all lesser bit-weights.

The limits noted above mean that

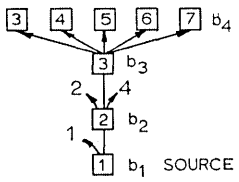
$$b_i \leqq b_{i+1} \leqq 1 + \sum_{i=1}^{n} b_i \quad \text{limiting equation II}$$

where n = number of bits

Operation of the code generator now proceeds according to equations I and II. Each code is generated from the positive-bit-weights $b_1\ b_2\ b_3$ --- b_n, beginning with b_1, called the "source" because it is the common origin of every positive-bit-weight code in every radix. In forming digit symbols, a bit-weight may sometimes be omitted, but it can not vanish by having an assigned value of zero. As to b_1, the least significant bit-weight, it is obvious in all numerical systems coded

RADIX (r)	DIGITAL SYMBOL (r STATES)	NUMBER OF BITS (n)	RADIX BAND	REMARKS
2	0,1	1	1st	
3	0,1,2	2	2nd	n = NUMBER OF BITS n = NUMBER OF BINARY-STATE DEVICES
4	0,1,2,3	2		
5	0,1,2,3,4	3	3rd	
6	0,1,2,3,4,5	3		
7	0,1,2,3,4,5,6	3		n IS A MINIMUM; EXTRA BITS NOT INCLUDED
8	0,1,2,3,4,5,6,7	3		
9	0,1,2,3,4,5,6,7,8	4		
10	0,1,2,3,4,5,6,7,8,9	4		DECIMAL SYSTEM
11	0-----[10]	4		
12	0-----[11]	4	4th	
13	0-----[12]	4		
14	0-----[13]	4		
15	0-----(r-1)	4		
16	0-----(r-1)	4		
17	0-----(r-1)	5	5th	
18	0-----(r-1)	5		
$2^{n-1}+1$	0----- (r-1)	n	nth	$(2^{n-1}+1) \leqq r \leqq 2^n$
2^n	0-----(r-1)			

Fig. 1 Properties of numerical systems



FIVE CODES ARE IMMEDIATELY GENERATED; NAMELY,

7321
6321
5321
4321
3321

Fig. 2 Codes along one line in the decimal system

in positive-bit-weights that b_1 must always equal one.

$$\therefore\ b_1 = 1.$$

It has but the one value ($b_1 = 1$), yet $b_2\ b_3\ b_4$ etc. may each have several generated values according to

$$b_1 \leqq b_2 \leqq 1 + b_1$$
$$b_2 \leqq b_3 \leqq 1 + b_1 + b_2$$
$$b_3 \leqq b_4 \leqq 1 + b_1 + b_2 + b_3$$
etc.

Consider, as an example, code generation through bits $b_1\ b_2\ b_3\ b_4$ along just one line in the decimal system, the line selected as indicated by the circled bit-weights in the following equations:

$$\textcircled{1} \leqq 1, \textcircled{2} \leqq 2$$
$$\textcircled{2} \leqq 2, \textcircled{3},\ 4 \leqq 4$$
$$\textcircled{3} \leqq 3,\ 4,\ 5,\ 6,\ 7 \leqq 7$$

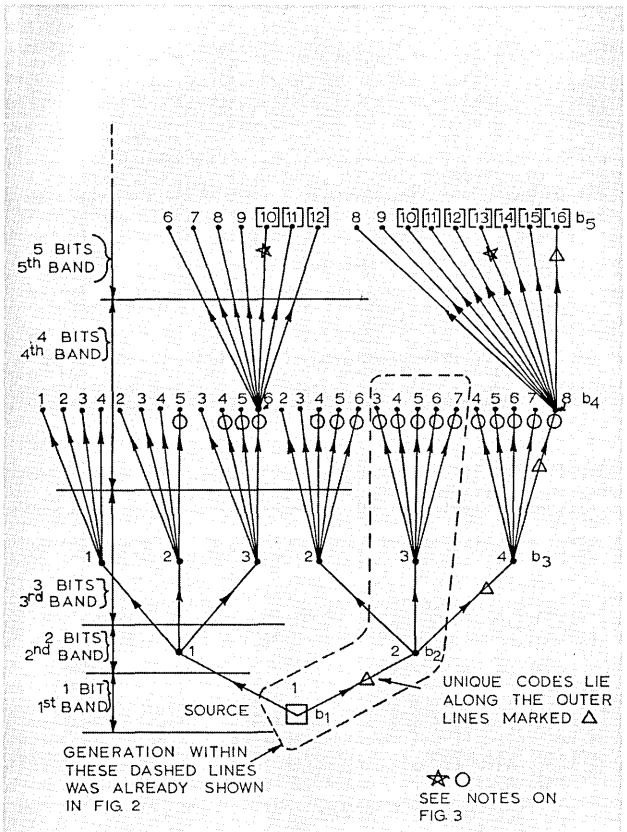


Fig. 3 Generation of all positive-bit-weight codes

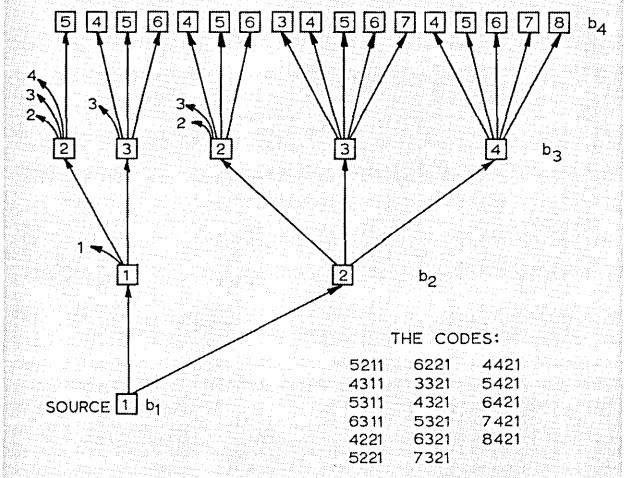


Fig. 4 4-bit code generation in the decimal system

This is presented graphically in Fig. 2.

Generation of all positive-bit-weight codes that are possible in every radix, proceeds according to Fig. 3.

NOTES ON FIGURE 3

- Generation is complete through the first 4 bands; i.e., complete for the first 4 bits b_1 b_2 b_3 b_4 which cover all radices from 2 through 16.
- Generation extended into the 5th band is illustrated from codes 6 3 1 1 and 8 4 2 1. The 5th band contains the 5 bits b_1 b_2 b_3 b_4 b_5 which cover all radices from 2 through 32.
- Beyond generation actually shown in Fig. 3, infinite code generation through all radices is possible according to the developed limiting equations.
- The symbol ☆ indicates for example how two 5-bit codes in the 5th band may be picked off; thus:

  [10], 6, 3, 1, 1 valid in radices 17 through 22,
  [13], 8, 4, 2, 1 " " " 17 " 29.

  Code [10], 6, 3, 1, 1 is self-complementing in radix 22 and code [13], 8, 4, 2, 1 is self-complementing in radix 29; the self-complementing property of a code occurs whenever the sum of all bit-weights equals the radix minus one.
- The symbol ◯ indicates each of the 17 positive-bit-weight codes known for the decimal system and noted by Scott[1], Richards[2], Chu[3], and Weeg[4], among others. These codes are repeated in Fig. 4 to show their special generation as part of the universal scheme of Fig. 3.

All n-bit codes in any radix may now be generated from the universal scheme of Fig. 3 by application of the limiting equations I and II. While the process does, with validity, extend out through any radix desired, it will be illustrated in Figs. 5a and 5b as generating all positive-bit weight codes in radices from 2 through 16. Figures 5a and 5b show for each radix band such properties as

- Total number of codes, generated according to limiting equation II only
- Out of the above total the number of codes actually possible in each radix, satisfying limiting equation I for that radix. Codes that do *not* satisfy smallest radix in a band, are enclosed thus ▭ .
- Codes that are self-complementing are marked •;
  Codes that are unique are marked △;
  Codes that are *both* are marked ◬
- If the table of Figure 5b were extended (to the right) out to n bits, the entries would be

number of bits	n
bit-weights	b_1 b_2 -- b_n,
band	n^{th}
radix (r)	$(2^{n-1} + 1) \leq r \leq 2^n$.

- Regarding the count of codes actually possible in each radix, it is noted that (within each band) this count decreases as the radix increases. A pattern for this decrease is discernible and is shown in Fig. 6 where the fourth band of bits is used as an example. However, this pattern exists in every band.

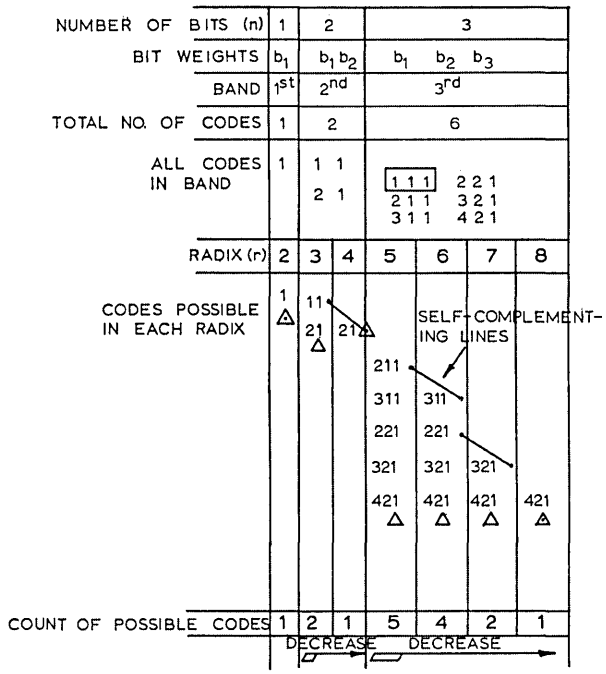


Fig. 5a All positive-bit-weight codes (radices 2 through 8)

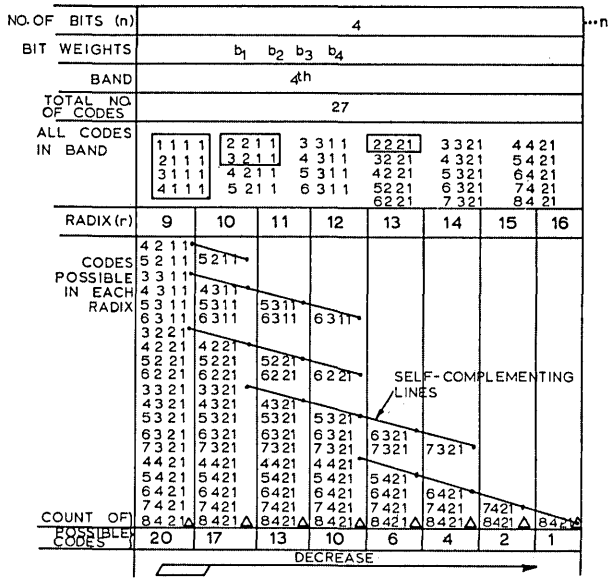


Fig. 5b All positive-bit-weight codes (radices 9 through 16)

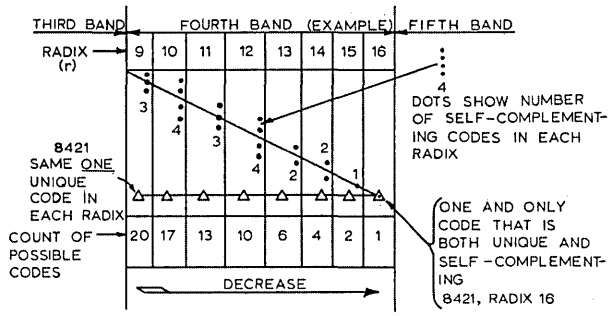


Fig. 6 Pattern of code count decrease

NOTES ON FIGURE 6

The pattern shows that the code-count-decrease within a band may be expressed thus:

let

M_r = count of possible codes in radix r,

M_{r+1} = count of possible codes in next higher radix (r+1),

M_{r+2} = count of possible codes in next higher radix (r+2), etc.

S_r = number of self-complementing codes in radix r,

S_{r+1} = number of self-complementing codes in next higher radix (r+1),

S_{r+2} = number of self-complementing codes in next higher radix (r+2), etc.

Then $M_r - S_r = M_{r+1}$

$M_{r+1} - S_{r+1} = M_{r+2}$

$M_{r+2} - S_{r+2} = M_{r+3}$

etc.

The above relationship is a consequence of two properties of positive-bit-weight codes; namely

- The sum of all bit-weights must be not less than the radix minus one, (this is limiting equation I)
- A bit-weight code is self complementing in that radix where the sum of all bit-weights is equal to that radix minus one

SUMMARY

The mathematical equations, together with the related graphical representations have been shown whereby every valid positive-bit-weight code in every radix may be generated. It may be said that this generation constitutes a process that is new; therefore, information as to which of these valid codes exist in any radix is now immediately and positively available.

It may be expected that research into the various numerical systems will determine the merits and advantages of using a certain valid code in a particular computer operation. This will require establishment of algorithms for all computational processes, which in turn may lead to desirable implementation in the hardware.

REFERENCES

1. N. R. Scott, "Analog and Digital Computer Technology," McGraw-Hill, 1960
2. R. K. Richards, "Arithmetic Operations in Digital Computers," Van Nostrand, 1955
3. Y. Chu, "Digital Computer Design Fundamentals," McGraw-Hill, 1962
4. G. P. Weeg, "Uniqueness of Weighted Code Representations," *IRE Transactions on Electronic Computers*, December 1960

APPLICATION NOTE

An MSI Multi-Port Memory for High-Speed Computers

Robert Andrade

Fairchild Semiconductor
Mountain View, Calif.

The multi-port memory consists of a 1/10 decoder, eight 4-bit latches, and eight 8-bit multiplexers. It can independently and simultaneously write into one storage location port and provide access to two others. This feature, coupled with ultra-high speed, makes it ideal for applications requiring instant recall of information, e.g. high-speed computers used in avionic and military systems. The technique used for enabling the reading, writing, and various selections in the memory allows tailoring of both word and bit sizes for a particular system.

The 64-word by 4-bit memory consists of eight 8-word by 4-bit memory modules using 13 MSI (medium scale integration) packages per module. Each of these modules incorporates three basic functions: the write address decoder, word storage, and the word access multiplexers. Additional circuitry for module selection, read-write enable selection, and the various gating and buffering requires three additional MSI and CCSL (compatible current sinking logic) devices.

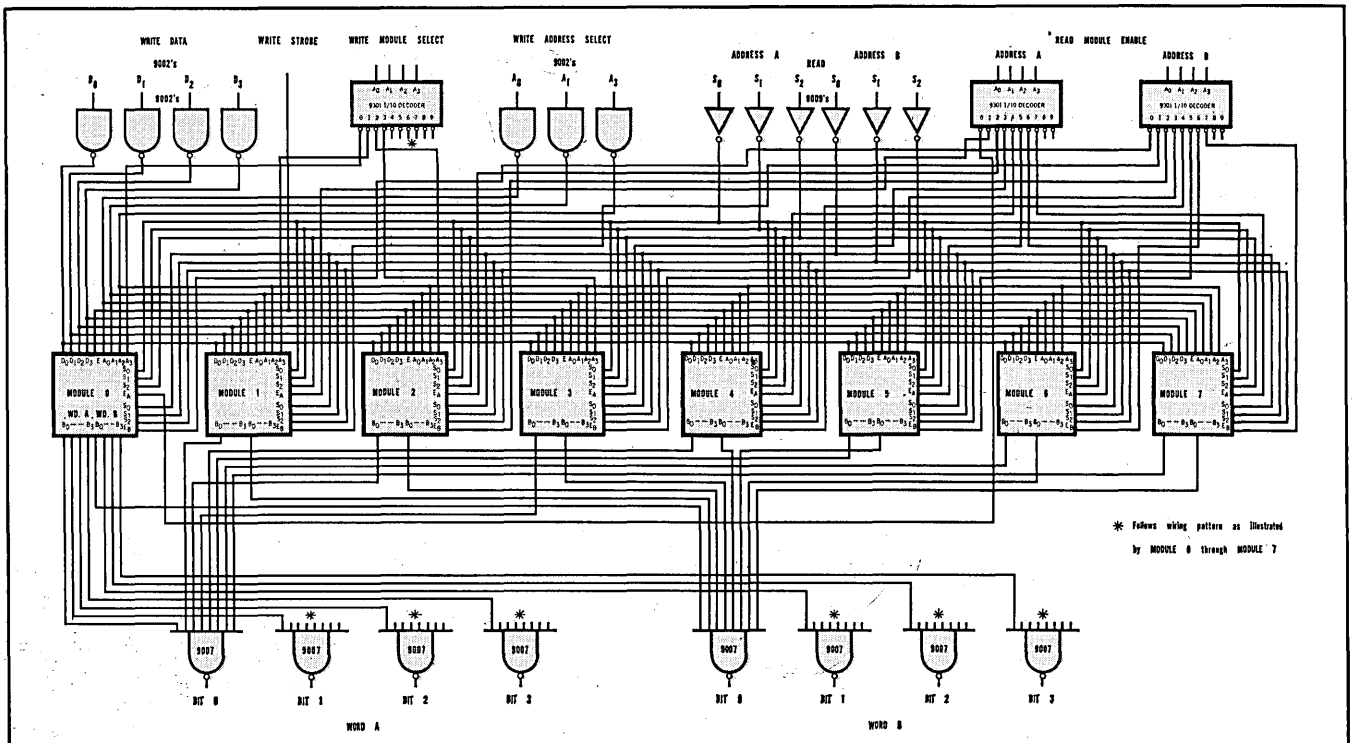


Fig. 1 Multi-Port memory module

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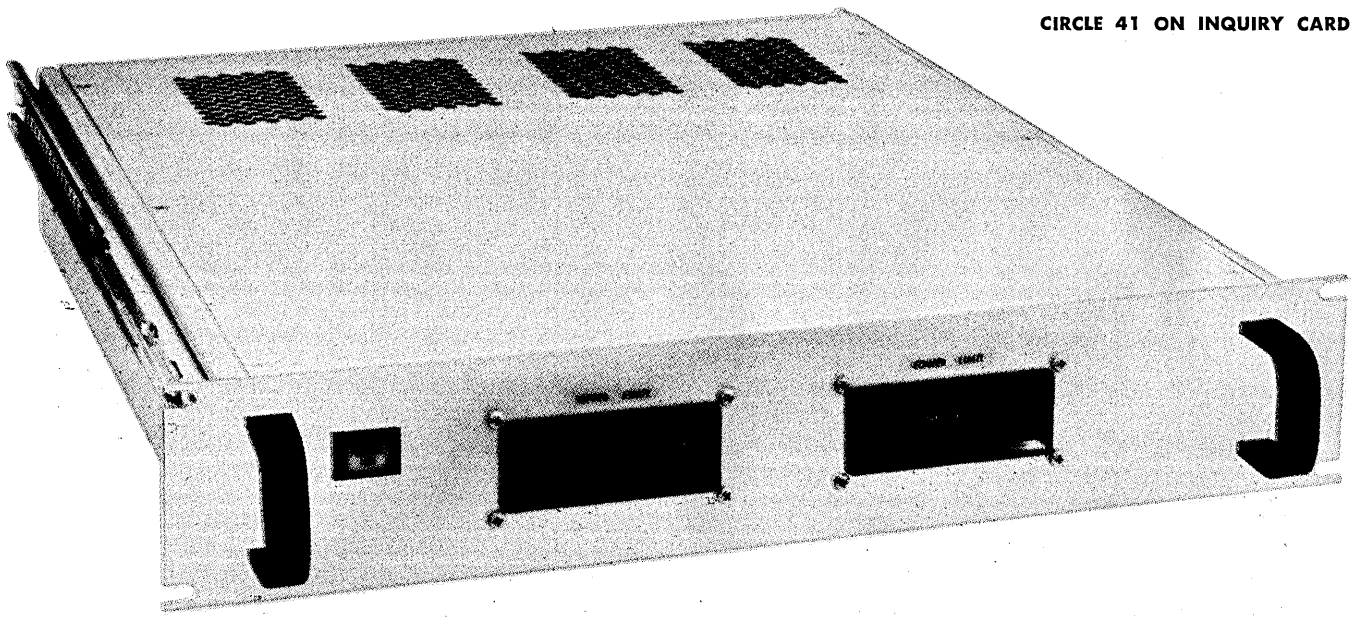


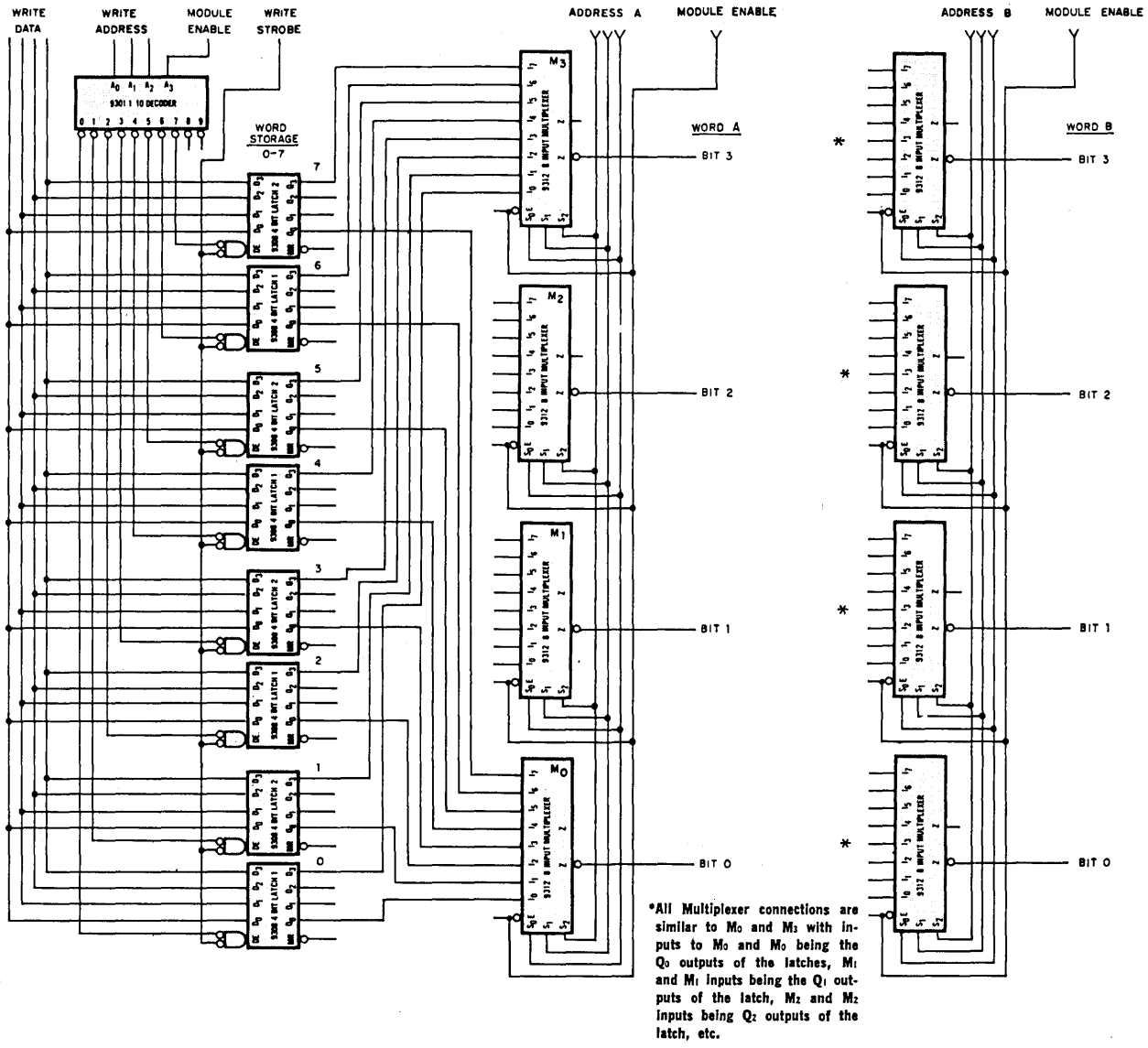


Fig. 2 Word storage section of Multi-Port memory

WRITE ADDRESS DECODER

The 1/10 decoder uses a binary input to select an address (from 0 through 7), works in conjunction with a write strobe to enable the word storage section, and enters write data into this section. For example, when the write address (a 3-bit binary number) is programmed 101 and simultaneously the write strobe lines goes low, word "5" is enabled and the information on the write data lines is shifted into the word storage—unit 5.

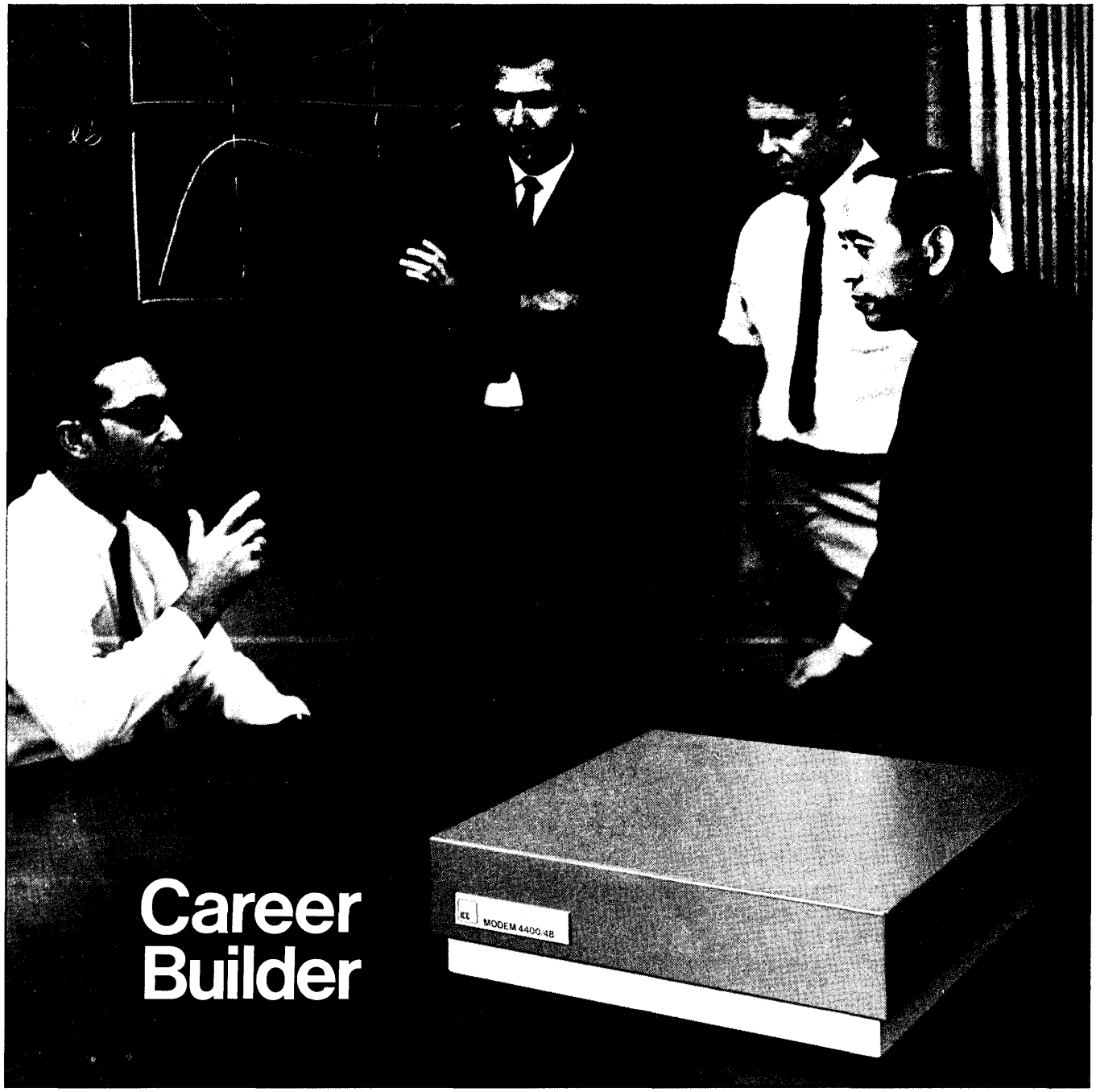
As shown in Figs. 1 and 2, there are four inputs (A_0, A_1, A_2, A_3), which correspond to the standard 1 2 4 8 BCD code. Since the word storage units number from 0 to 7, the decoder is either enabled or not depending on whether A_3 is in the high or low state. This selection method is also used for individually selecting a module for programming. The selected module's write address decoder is made operational by controlling the A_3 input of the write address decoder.

WORD STORAGE

In the word storage section there are four dual 4-bit latches, each constituting one word. The write data lines are used to program the modules, and information enters the latches when both a word is selected and the write strobe is low. This information is then stored until the word storage is again enabled.

WORD ACCESS MULTIPLEXER

The multiplexer consists of two colums and four rows of 8-input multiplexers wired so that all the first bits of each word tie to an input of two multiplexers in the same row; the second bits of each



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word then go to the next row of multiplexers; and the third and fourth bits are similarily wired.

For accessing words in a module, the two multiplexers with common inputs (0 through 7) are separated by isolating the select and enables lines common to each column, thus allowing independent and simultaneous access of two words.

SYSTEM OPERATION

In the expansion from an 8-word, 4-bit module to a 64-word, 4-bit memory, consideration must be given to the read-write functions. These must remain independent for each module so that they may be individually programmed. To accomplish this, one uses three 1/10 decoders which enable or inhibit the write address decoders and the word access multiplexers (address A and address B have independent enables) for each module.

EXPANSION CAPABILITIES

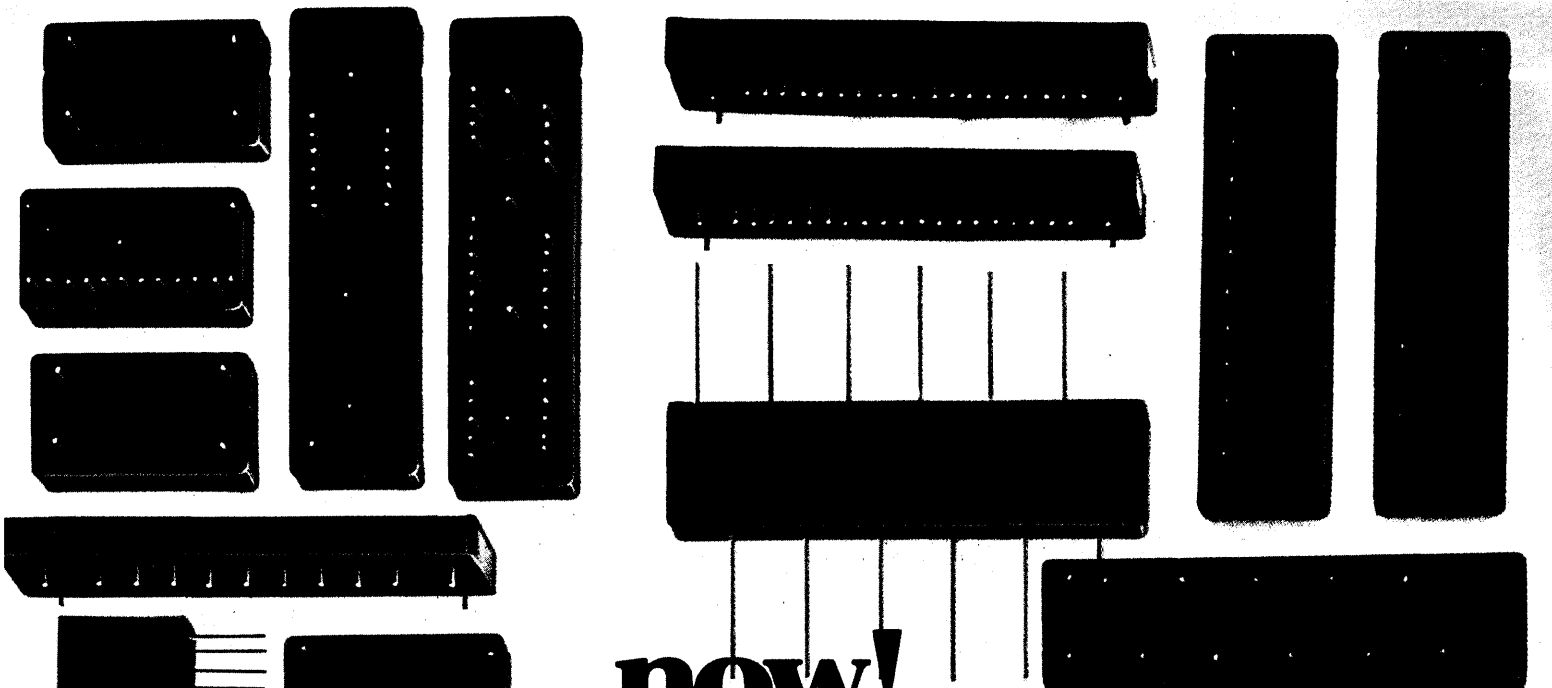
For memories with a larger number of words, all that is necessary are additional modules. However, for memories with words of more than four bits, further changes must be made.

For example, if an 8-bit word is desired, the output of the write address decoder must go to the enable of one dual 4-bit latch and tie to the enable of the next latch. In the case of a 16-bit word, the output would go to four dual 4-bit latches, and so on. In addition, there would be a write data line and multiplexer for each bit.

SUMMARY

The multi-port memory allows independent and simultaneous writing of information into one location while reading out of either that location or two others. The fact that it can be easily expanded to any desired read, write or storage number, along with its high speed, light weight, and compactness makes the system desirable for numerous memory and computer applications.

For additional information, circle 198 on Inquiry Card



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With its highly flexible arrangement of satellite machines, the processor gives the user the capability to solve the simplest or most complex mathematical problems at a cost which can approach that of the simple arithmetic-and-square-root machines.

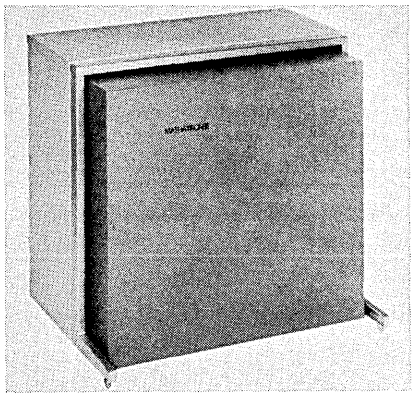
Terminals may be Mathwriter keyboards, Model 33 Teletypes, or customers' own input devices (any ASCII coded terminal), and may be directly wired for short distances (1,000 ft.) using 4-wire telephone-type cable, or acoustically coupled for unlimited distances. Remote terminals may be all of one type or any combination of the three.

Each of the terminals may simultaneously (has logic to) perform the following functions (all in floating point arithmetic): add, subtract, multiply, divide, left and right parenthesis, ½ power square root, log base e, e^x, and N^x.

Each has eight storage registers and a programmable memory bank with 128 formula steps in eight "addressable" sectors of 16 steps each. If Model 33 Teletypes are used, each has 96 program steps. The terminals can also overflow formula storage into the first 6 of the 8 storage registers expanding its programmable memory steps to 176, or 2816 program steps total.

An administrative control switch is featured, which allows restriction of writing into memory. Use of the 3-position switch will:

- Allow all terminals to use any portion of the memory in any desired way
- Allow any terminal to assign its memory and storage registers to another terminal
- Restrict the assignment of memory or storage registers; it does not restrict the terminals' ability to simultaneously read and execute stored programs of common interest



A single terminal sells for as little as $1,000; total cost per user terminal is as low as $1,500 for a 16-terminal installation.

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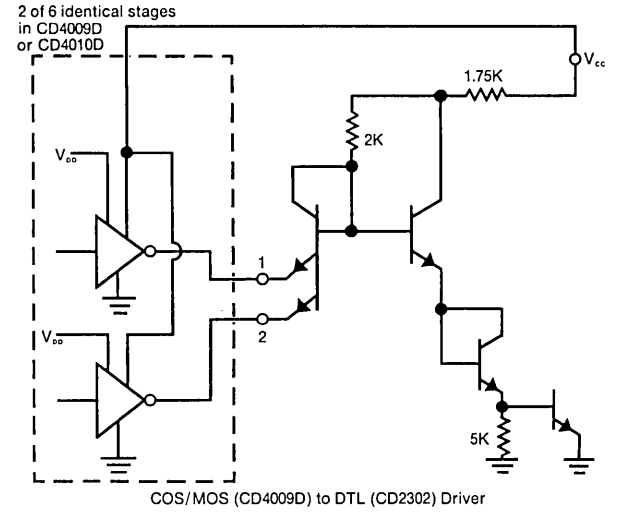
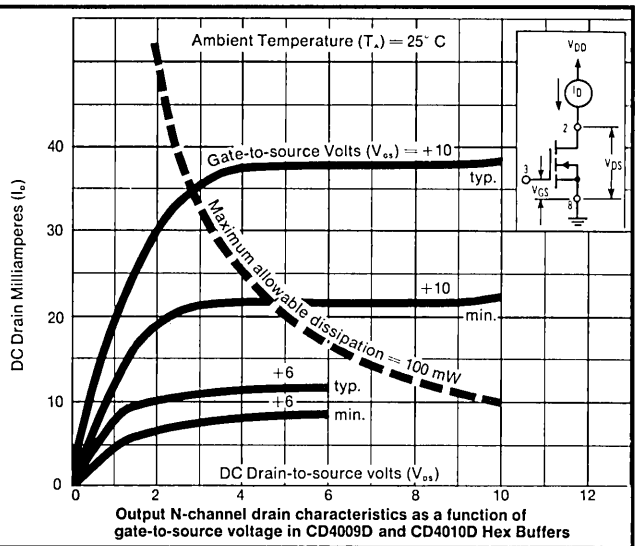
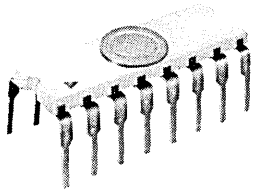


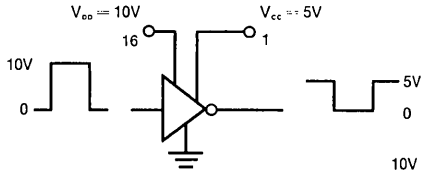
COS/MOS (CD4009D) to DTL (CD2302) Driver



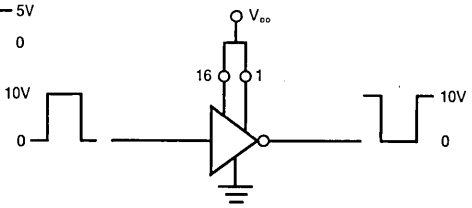
Output N-channel drain characteristics as a function of gate-to-source voltage in CD4009D and CD4010D Hex Buffers

16-lead DIC Hex Buffer/Logic-Level Converters
CD4009D — Inverting Type $7.00
CD4010D — Non-inverting Type $7.00
(1,000 unit prices)





CD4009D as a Logic-Level Converter/Inverter



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NEW PRODUCTS

VACUUM TAPE DRIVE

A digital magnetic tape unit priced under $3,000, for data acquisition systems, communications terminals, and small computers, is a totally vacuum-operated and controlled transport and has its own loading cartridge for computer-compatible tape. The series is designed for standard ½" tape operated at velocities from 18¾ to 37½ ips with data transfer rates of from 15 to 30 kHz. Single and dual gap head units recording on 7- or 9-channel tape are offered for packaging densities to 800 bpi. Recording mode is continuous NRZI-IBM compatible with a start/stop time of 12 ms and start/stop distance of .040" at 18¾ ips. The floor model is 54⅝" high, 24" wide, and 23" deep; the table model measures 19 x 24 x 23". Power supply is 115 Vac, 50 or 60 Hz. Digital Information Devices, Inc., Lionville, Pa.

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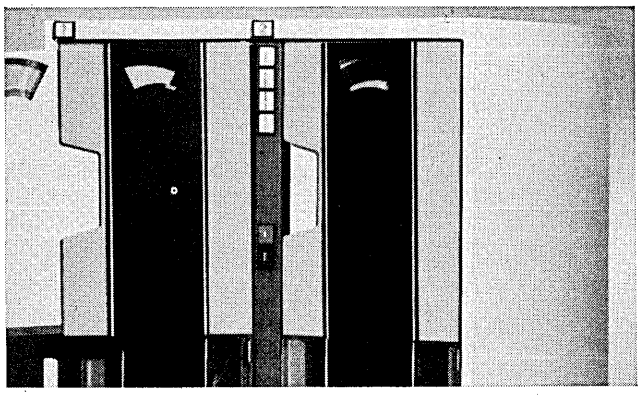

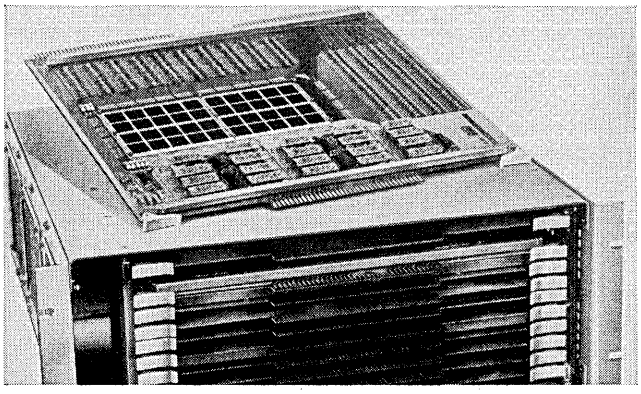

500-NANOSECOND MEMORY

Designed for high-speed memory applications, a small-to-medium capacity ferrite core memory, Model CE-50, having a 250-ns access time and 500-ns cycle time, is available in capacities of 4, 8, and 16K words of 10 to 60 bits, with multiple-module capabilities permitting expansion to larger capacities and word lengths. Made for standard 19" rack mounting, the system requires only 5¼" of panel space for the small sizes—4K words of up to 20 bits, and for larger capacities—16K words of 40 bits, only 17½". Modular electronics accommodate a wide variety of interface levels, timing and control functions, and such special features as parity generation and check, self-test, data save, zone transfer etc. The standard interface is TTL compatible, with the unit available in volume production. Lockheed Electronics Co., Data Products Div., Los Angeles, Calif.

CIRCLE 201 ON INQUIRY CARD

READ-ONLY MEMORIES

Two MOS read-only memory kits generate control signals for digital data displays. The three 1024-bit memories in each kit are preprogrammed to convert standard communications code words (ASCII) into raster or vertical scan control signals. Displays can be operated at high speed by TTL ICs. Each kit stores 64 standard 5 x 7 alphanumeric symbols. Kit SK0001 is programmed so that the 6-line input will select the desired symbol and generate seven 5-bit horizontal lines. Kit SK0002 generates five 7-bit vertical columns suitable for displays requiring verticle scan techniques. Each memory operates in less than 1 μs on 12 V supplies. Both kits are tested for TTL compatibility from 0 to 70°C. The SK0001 is available in a 16-pin hermetic dual-in-line package; the SK0002, in a 24-pin package. National Semiconductor Corp., Santa Clara, Calif.

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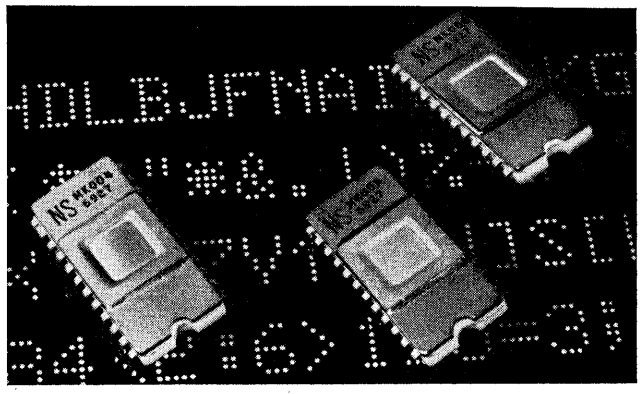

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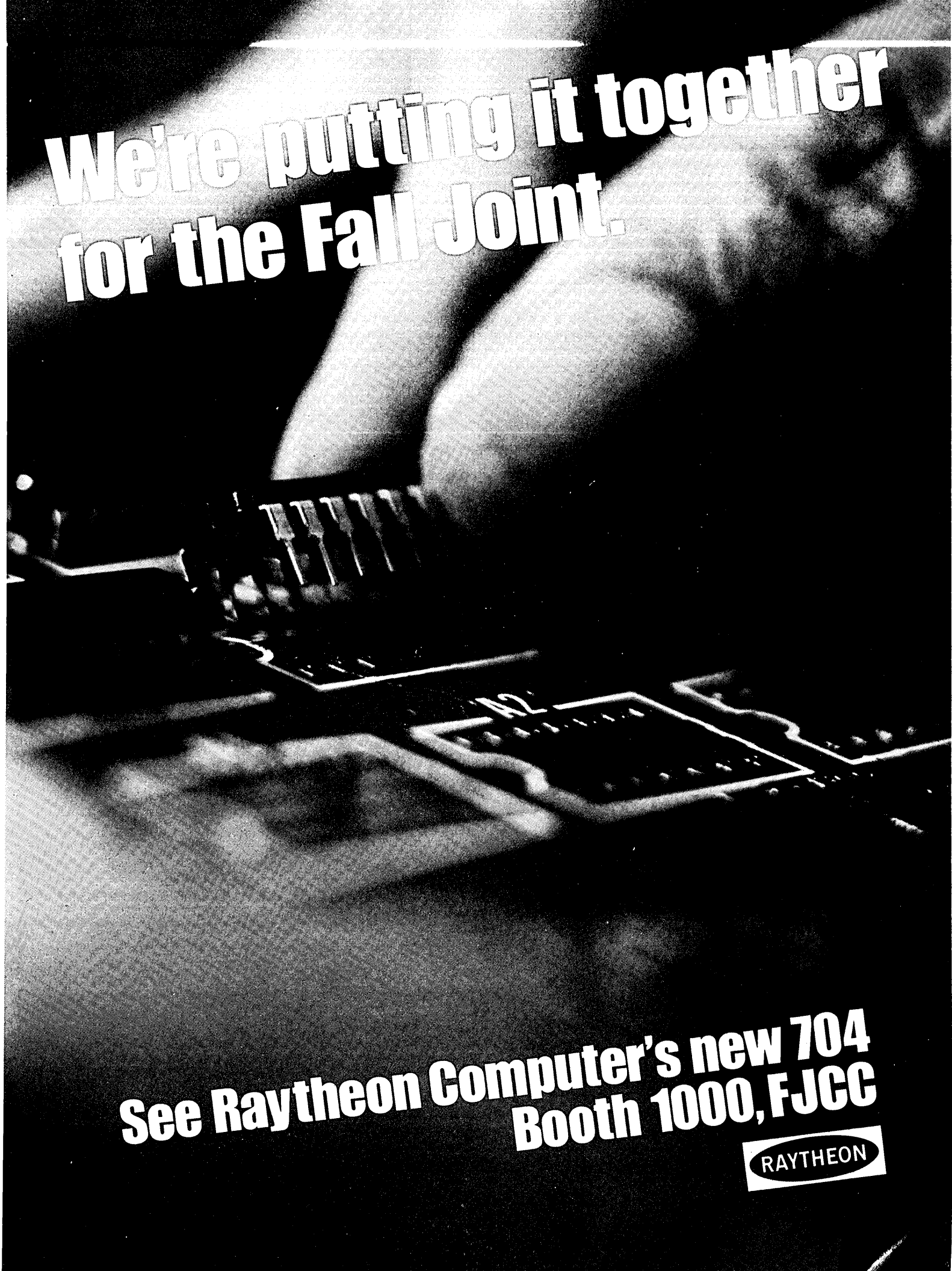
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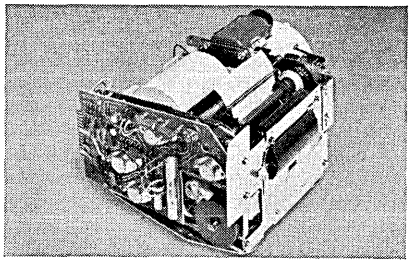


DIGITAL PRINTER

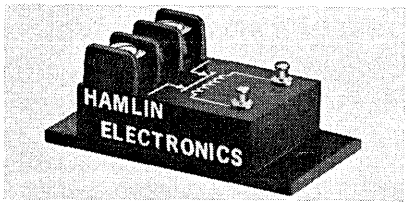
The 1150 digital printer, operating at 50 characters/sec, includes a 20-character print wheel and synchronized print hammer which move across the paper at uniform speed. The hammer's short impact time ensures neat, easy-to-read printing from a wheel that rotates continuously. Printing from right to left, the unit features automatic carriage return at the left margin and an automatic paper-threading device. It measures 7½ x 11¾ x 7½". Singer Co., Friden Div., San Leandro, Calif.

CIRCLE 203 ON INQUIRY CARD

DECODER/DRIVER

A 1-of-10 decoder/driver, MSI 9315, is a medium-scale IC possessing stable, high-voltage output characteristics, accepts 8421 BCD inputs and provides 10 mutually exclusive outputs for directly driving Nixie tubes. Available in a ceramic 14-lead flatpack and a 16-lead dual-in-line package, the unit is compatible with current sinking logic and can be driven from any TTL, DTL, or LPDTL circuit. Fairchild Semiconductor, Mountain View, Calif.

CIRCLE 204 ON INQUIRY CARD



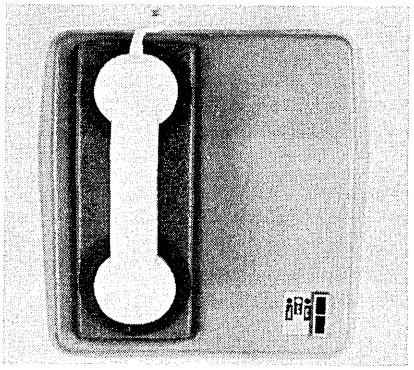
AC CONTROLLERS

Control-pak ac controllers, capable of switching up to 25 A from a wide range of input voltages, are completely self-contained, offer a max. I/O isolation, integral heat sinks, and are ruggedly constructed to provide reliable, arcless, bounceless, maintenance-free switching in excess of 50M operations. Operate time is 1 ms max., and release time in no longer than ½ cycle. Hamlin Electronics, Inc., Phoenix, Ariz.

CIRCLE 205 ON INQUIRY CARD

ACOUSTICAL DATA SETS

A series of portable acoustical data sets designed for error-free coupling of remote terminals with computers via conventional telephone handsets features a linear frequency discriminator, automatic gain control, multiple-tuned receiver circuits, high-stability transmitter oscillator and low second-order harmonic distortion transmitter output. The sets interface between ordinary handsets and most popular keyboard printing devices. Digital Techniques Corp., Royal Oak, Mich.

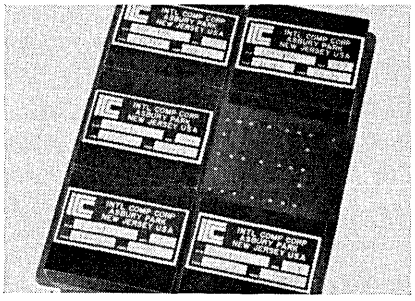


CIRCLE 206 ON INQUIRY CARD

TELETYPE ENCLOSURE

An enclosure for Models 32 and 33 ASR and KSR teletypewriters reduces noise output by 10 dB, or 50%. Other TE/33 features include a built-in fluorescent lamp and a noise-free fan which reduces motor temperature by 30°. The unit is available with a built-in acoustic coupler where the teletype is being used in a dial-up system. Novation, Inc., Tarzana, Calif.

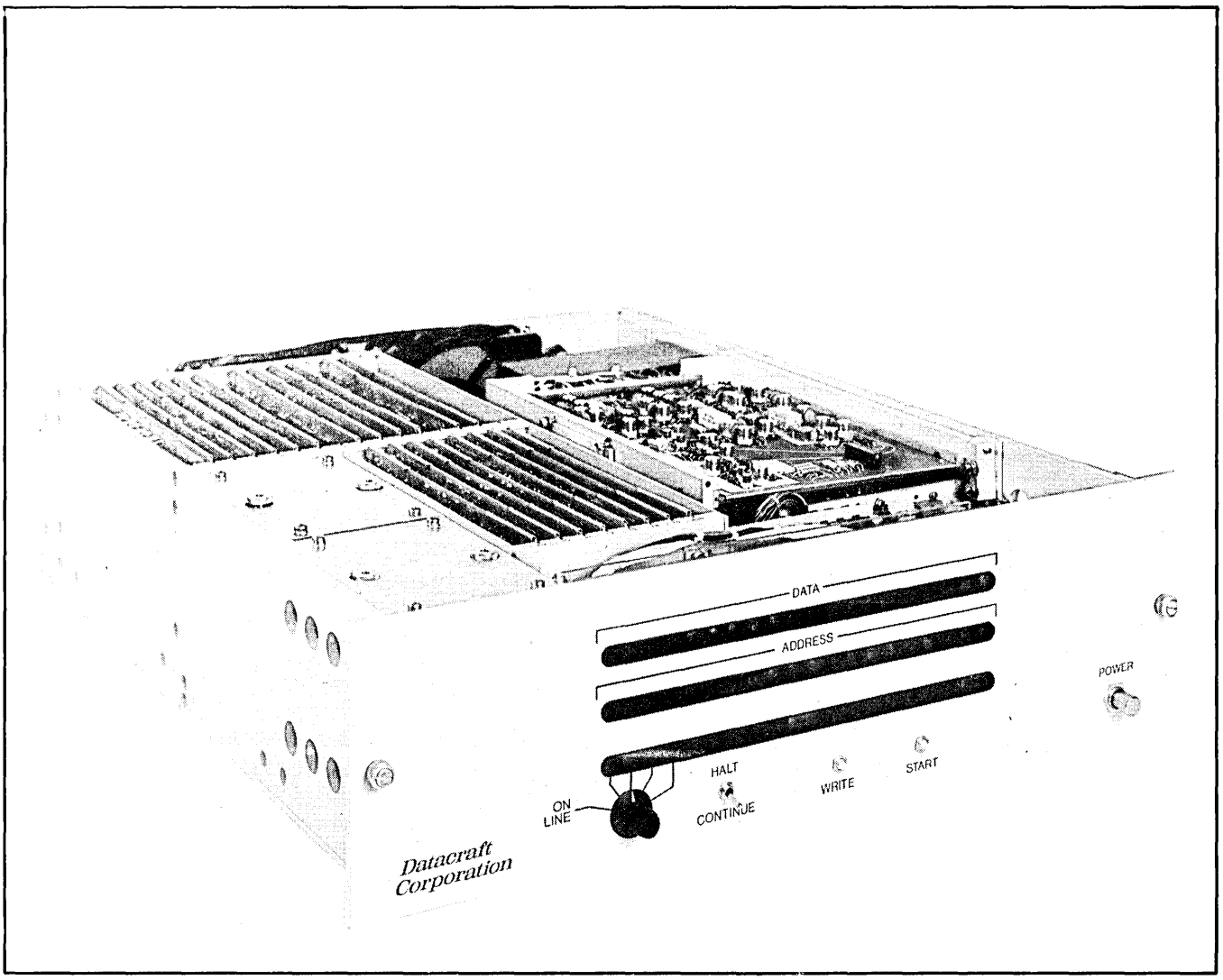
CIRCLE 207 ON INQUIRY CARD



RECORD/PLAYBACK

A dc-coupled FM record/playback subsystem for accurate data acquisition, SDM-119, consists of a VCO, a limiter, discriminator and 2 low pass filters designed for use with tape decks having recording speeds of 3¾ and 7½"/sec. The unit can be supplied on a standard 4 x 6½" plug-in finger pc card or as individual, functional building blocks. Operating temperatures are from 0 to 55°C; working voltages are ±15 V. International Components Corp., Asbury Park, N. J.

CIRCLE 208 ON INQUIRY CARD



Datacraft already figured out how to give your system a memory.

We say flat out that our DC-22 is the most versatile standard production memory system in the world.

Our list of standard options covers everything we've ever had requested by a customer. It includes such useful variations as half-cycle, split-cycle, sequential interlace, internal test, registers and counters for everything, memory data save, address register output, etc.

The DC-22 comes with a power plug you push into the AC and whatever connectors it takes to get in and out of your system. This is a complete working magnetic core memory system with a full-cycle time of 900 nanoseconds. You turn it on and it works.

DC-22s exist in a half-completed stage at Datacraft. Tell us what options you want, what kind of panels you need, and what connectors are required to finish them. We finish them.

Suddenly your system makes sense. Datacraft already figured out how to give it a memory.

Call your nearest

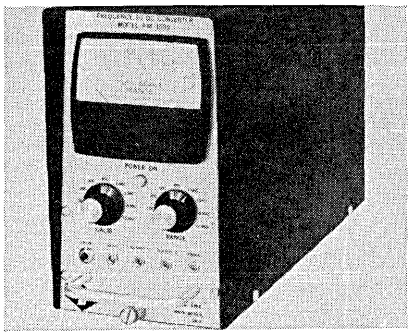
Datacraft

Memory Man.

Datacraft Corporation • P. O. Box 23550, Ft. Lauderdale, Fla. • (305) 933-2651 Southeast: (305) 727-3205 • Mid-Atlantic: (215) 265-5800 • New York: (516) 482-3500 • New England: (617) 245-9530 • East Central: (216) 243-6500 • West Central: (312) 775-7594 • Southwest: (713) 643-2114 • Rocky Mountain: (303) 794-4231 • Far West: (213) 870-5951 • England: AYLESBURY 4778

CIRCLE 48 ON INQUIRY CARD

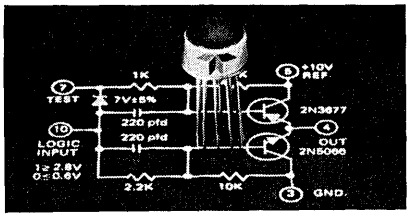
NEW PRODUCTS



FREQUENCY CONVERTERS

Featuring 10 switchable frequency-metered ranges with full vernier adjustment from 100 Hz to 100 kHz, the PM 1300 Series Megacyclers have temperature coefficients of less than ±50 ppm/°F. Temperature range is 0 to ±150/°F. Output dc voltage varies from 0 to 5 V with any load, from 0 to 20 mA, accomplished with an output impedance of less than 0.2 Ω. Full scale output ripple is less than 10 mV. Long term drift is less than ±0.1%/week. Normal input signal range is from 5 mV to 20 V rms. Pioneer Magnetics, Inc., Santa Monica, Calif.

CIRCLE 209 ON INQUIRY CARD



D/A LADDER SWITCHES

The CDA4 hybrid IC ladder switch, for direct-from-logic operation in D/A converters, is designed for use with a +10-V reference. When used in conjunction with a 10K/20K ladder network, the switch provides 12-bit accuracy. Settling times are well under 1 μs. Crystalonics, a Teledyne Co., Cambridge, Mass.

CIRCLE 210 ON INQUIRY CARD

PRINTER TERMINAL

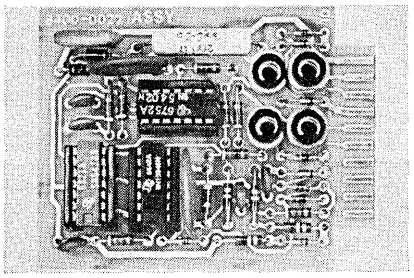
The DCT-500 data communication terminal, a low cost, asynchronous input-output printer, is a free-standing, ASCII-compatible system consisting of a 132-column printer mechanism, a control unit, and a keyboard. The terminal operates in full or duplex at optional speeds of 10, 15, or 30 cps. Univac Div. of Sperry Rand Corp., San Francisco, Calif.

CIRCLE 211 ON INQUIRY CARD

SYNCHRO/DIGITAL CONVERTER

Based upon a unique feed-forward algorithm, the SDX features 13-bit resolution, 3.9′ accuracy and total conversion time of 40 μs for any angular input. Operating from 60 or 400 Hz, 11.8 or 90 V synchros or resolvers, the 8-channel unit measures 5⅛ x 7 x 1¾″ and is totally solid-state —no transformers, relays, gears, or periodic adjustments. It is available in military or industrial configurations. Dynalex, Inc., Burbank, Calif.

CIRCLE 212 ON INQUIRY CARD



MINI-DRIVER

The unit is an ideal interface between a sensing circuit and positioning step motor. IC logic accepts serial pulse train on 1 of 2 input lines and converts them to the sequential output required to drive a 4-phase step servo motor from 0 to 300 pulses/sec. Output amplifiers are suitable for driving up to a 0.5 A, 28 Vdc motor. Dimensions are 3.175 long x 2.400″ wide. Tasker Industries, subs. of Whittaker Corp., Counter Products, Newport Beach, Calif.

CIRCLE 213 ON INQUIRY CARD

TRANSMISSION LINE

Point-to-point wiring in computers requires that uniform characteristic impedance be maintained for a 50-Ω twisted pair transmission line. The Extruso-Bonding technique permits extrusion of Teflon® insulations as thin as 0.5 mils in long continuous lengths. The line can be manufactured in wire gauges from AWG 20 to 32, and with characteristic impedances from 25 to 95 Ω. Berk-Tek, Inc., Reading, Pa.

CIRCLE 214 ON INQUIRY CARD

READ-ONLY MEMORY

ROM1K, a static read-only memory, is available in 4 word and bit organizations —128 words x 8 bits, 256 x 4, 512 x 2, and 1024 x 1—made possible by a unique on-chip 3-D decoder. The unit has the speed of core, but its packaging is 50 times denser, it uses less power, and costs less than core. It features bipolar compatible outputs and chip inhibit capability. Union Carbide Corp., Semiconductor Dept., San Diego, Calif.

CIRCLE 215 ON INQUIRY CARD

The Peripheral People offer

a new, quiet, lightweight portable output device that prints with heat

EM-T1 Thermal Page Printer

The new EM-T1 Thermal Page Printer utilizes a principle developed by NCR which converts electrical signals directly into characters or symbols. Non-impact printing! It prints 300 words per minute with heat. The only noise you hear is the rustle of paper. A five by seven dot matrix head prints 96 alpha (upper and lower case) numeric and symbol characters on a low cost thermochromic paper which won't flake, peel or abrade. You can't smear it, it's insensitive to light and it will reproduce in any common paper copier. The EM-T1 requires only 50 watts power and weighs approximately 10 lbs. It is quiet (including no RFI), exceptionally reliable and amazingly fast.

Unit Features & Specifications

Physical: 11½"W. x 9¾"D. x 3½"H. Approx. 10 lbs., no mechanical printing elements.

Code Format: ASCII Serial Input (Parallel and additional codes available).

Line Length: 80 columns.

Electrical: 50 watts operating, 16 watts idle; 115 VAC, 50-60 Hz; 230 VAC, 50 Hz.

Speed: 300 words per minute, 30 cps.

Applications: mobile communications; fixed and portable terminals; communications printing; small systems page printer; output writer for computer consoles.

For more information, write for EM-T1 spec sheet.

NCR®

THE PERIPHERAL PEOPLE

Random Access Devices • Mass Storage Devices • Magnetic Tape Units • Printing Mechanisms • Line Printers • Card Readers • Tape Readers • MICR Readers • Card Punches • Tape Punches • Digital Printers • Keyboards

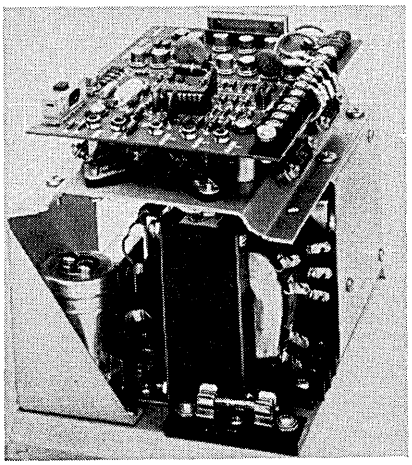
THE NATIONAL CASH REGISTER COMPANY
Industrial Products Division • Dayton, Ohio 45409

CIRCLE 51 ON INQUIRY CARD

NEW PRODUCTS

SERVO AMPLIFIER

Model A5201 is a low cost, 50-W motor control with peak current capability to a 20-A output pulse in 100 μs. Motors may be started and stopped repetitively providing the 50-W continuous rating is not exceeded. The unit comes with power supply for operation from 115/230 V, 50/60 Hz and features high gain and adjustment potentiometers on the signal inputs. Westamp, Inc., Santa Monica, Calif.



CIRCLE 216 ON INQUIRY CARD

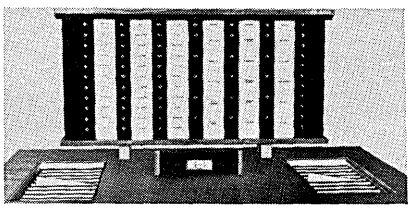
PUSHBUTTON CAP

A ¾" sq. bezel, available in 4 colors, accommodates the 300 and 304 Series ⅝" sq. pushbutton caps, when used with the clear colorless Kap-Kover®. The bezel, cap, and Kap-Kover combination may be used for snap-in mounting switches and/or matching indicators; or the cap and Kap-Kover only may be used for standard panel mounting switches and/or matching indicators. Dialight Corp., Brooklyn, N. Y.

CIRCLE 217 ON INQUIRY CARD

INPUT SYSTEM

Datacode searches all cards in a system simultaneously by reading small notches which are automatically cut into the card edge by an easy-to-use built-in punch. Single cards, or meaningful groups "pop up" on command. Retrieval can be by name, number or special code. Models are available from complete single tray systems to 12,000-card units which can be interconnected. Randomatic Data Systems, Inc., Trenton, N. J.



CIRCLE 218 ON INQUIRY CARD

Information, Mechanism and Meaning
by Donald M. MacKay
This collection of papers, articles, and broadcasts on communication and information is the work of one of the original founders of information theory, who is also one of the most original thinkers in probing its philosophical foundations.

The book is divided into two parts: the first is general and introductory, consisting of a new opening paper and three talks given on the BBC's Third Programme; the second is more specific and technical in its interests. But the entries in both parts are marked by a concern for uncovering the "meaning of meaning" that is neither facile nor narrow. **$6.95**

In Honor of Philip M. Morse
edited by Herman Feshbach and K. Uno Ingard
When Philip Morse was promoted to Professor Emeritus of Physics at M.I.T. in 1969, he already had behind him at least three full professional careers — in quantum physics, in acoustics, and in what Julius Stratton calls "the reduction of theory to numerically useful results," a general field of which Morse was a founder and for which no good term yet exists, that includes operations research, machine computation, and systems analysis. This volume contains papers in all these fields, written by Dr. Morse's students and colleagues. **$20.00**

The Sciences of the Artificial
by Herbert A. Simon
This book reveals the design of an intellectual structure aimed at accommodating those empirical phenomena that are "artificial" rather than "natural." The goal is to show how empirical sciences of artificial systems are possible, even in the face of the contingent and teleological character of the phenomena, their attributes of choice and purpose. Developing in some detail two specific examples — human psychology and engineering design — Professor Simon describes the shape of these sciences as they are emerging from developments of the past 25 years. **$5.95**

The Impact of Computers on Collective Bargaining
edited by Abraham J. Seigel
Abraham J. Seigel, Professor of Industrial Relations and Associate Dean of M.I.T.'s Sloan School of Management, has edited and foreworded a compilation of material which was a product of the 1968 Conference on the Impact of Computers on Collective Bargaining held at M.I.T.

The book contains papers by experts who have followed the use of computers in collective bargaining through the years and who probe the dynamics of their future applications to this field.

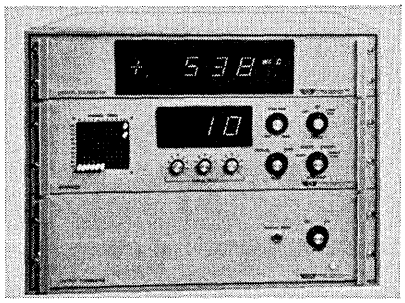
A companion volume, *The Impact of Computers on Management*, edited by Charles A. Myers, was published by The MIT Press in 1967. **$15.00**

The MIT Press
Massachusetts Institute of Technology
Cambridge, Massachusetts 02142

NEW PRODUCTS

SCANNING DATA SYSTEM

A highly flexible system has the capability of scanning up to 1,000 channels and reading out directly in engineering terms. The H4200 Data System, with the use of modular building blocks, monitors and measures temperature, pressure, load, thrust, voltage and resistance from linear and nonlinear signals. Howell Instruments, Inc., Fort Worth, Texas.

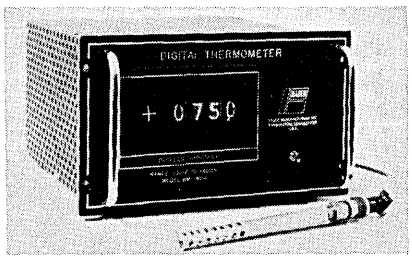


CIRCLE 219 ON INQUIRY CARD

FREQUENCY DIVIDERS

Binary and decade programmable dividers, designated SM143 and SM153, are rated for operation over the 0 to +75°C range and are available in 14-lead, hermetic flat pack or plug-in packages. Both arrays consist of a 4-input clock shaper AND gate, 4 interconnected and synchronously triggered flip-flops, a decoder-output gate structure, a decoder enable, 4 set gates, a set enable, and a clear line. Sylvania Electric Products, Inc., Semiconductor Div., Woburn, Mass.

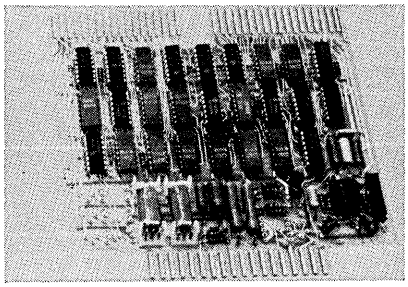
CIRCLE 220 ON INQUIRY CARD



DIGITAL THERMOMETER

The BMI Series 1500, a compact, solid-state, platinum probe digital thermometer, with an accuracy of within ± .01% of reading, ± span nonlinearity, ±1 count, features a temperature range of −350 to 1350°F, providing optimum linearity; max. readability with stable non-blinking readout; a display storage of 3 to 6 reading/sec; and a compact, lightweight design for panel, modular or portable installation. Dimensions are 10 x 10 x 6". Bauer Mfg. Co., Farmington, Conn.

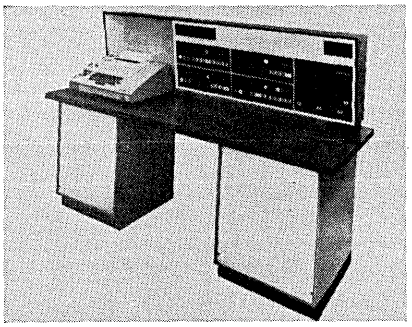
CIRCLE 221 ON INQUIRY CARD



TELETYPE INTERFACE

The Teletypewriter Controller, Model 1362, automatically generating timing and control signals needed for operating Teletype equipment from the computer processor, can control Teletype Models 28, 32, 33, and 35 Automatic Send/Receive, Keyboard Send/Receive, and Receive Only sets. A built-in echo sends input signals back to the Teletype for no-delay operation of the printer. The telegraph-grade interface works with cable lengths up to 2,000 ft. General Automation, Inc., Automation Products, Div., Orange, Calif.

CIRCLE 222 ON INQUIRY CARD



WEIGHING CONTROLLER

Compuweigh, which introduces the speed and precision of digital electronic techniques to control of batching and materials handling operations through automatic weighing, has a panel providing 4 displays of 5 digits each for monitoring any process. Also included are signal conditioners, an A/D converter, software, and 4 load cells or dummy platforms to serve as inputs. Detecto-Comtel Corp., Bridgeport, Conn.

CIRCLE 223 ON INQUIRY CARD

WIDEBAND AMPLIFIERS

FET input true differential amplifiers, the VA-24 series, has an ultra-stable 6 dB/octave, insuring a gain-bandwidth product of 50 MHz min. The unit has an output of ±30 mA at ±10 V, with a min. frequency for full output of 5 MHz, and an open loop dc voltage gain of 96 dB at rated load. Input impedance is 10" Ω; input bias current 30 pA; and voltage drift 20 μV/°C. Data Services Corp., Hicksville, N. Y.

CIRCLE 224 ON INQUIRY CARD

The maxi display for the mini computers.

The maxi display. That's what we call DELTA 1. A ready-now display terminal for all the minis. Ready with a flexible, high-capacity party line I/O bus for minis like the HP 2116, DATA 620/i, PDP-8/I, INTERDATA Model 4, and NOVA. Think of the applications: scientific/engineering control, process control, automatic test systems, communications systems, graphic arts, and education. You can interface with a CRT display that has a lower cost/performance ratio than any other data display system.

And check these maxi features. Compatible with all mini computer systems. No software modifications needed. Compatible with EIA TV signals. You can superimpose closed circuit TV, or add your own TV monitors at a fraction of the cost of a full terminal. And talk about savings. Extensive LSI and MSI integrated circuitry keeps manufacturing costs of DELTA 1 to a minimum. Add this to a full 12-inch diagonal screen with a 960 character display capability, a unique "selective blink" that highlights selected data on the screen, and you've got one of the best values in a CRT display. Get the complete specs on DELTA 1. Delta Data Systems Corporation, Woodhaven Park, Cornwells Heights, Pa. 19020 (215) 639-9400.

Delta Data Systems Corporation

In Las Vegas, put your money on the maxi display. FJCC, Booth 6409-10

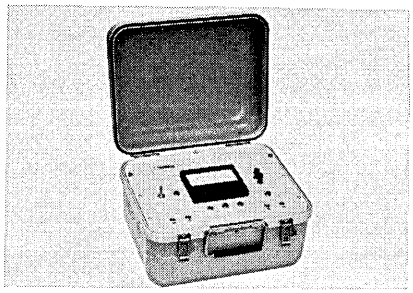
CIRCLE 56 ON INQUIRY CARD

NEW PRODUCTS

COMPUTERIZED PROGRAMMER

The Series 3060C computerized controller, for programming such point-to-point N/C machine operations as pc board drilling, consists of a direct computer core package located in the data control module. Tape formats are fixed block length, universal word address, D10 to T01 codes with optional offset. Also available are sign +5 digits X and Y, 2-digit M functions selected by switches, format conversion, and sequence number. Digital Systems, Inc., subs. of Resdel Engineering, Covina, Calif.

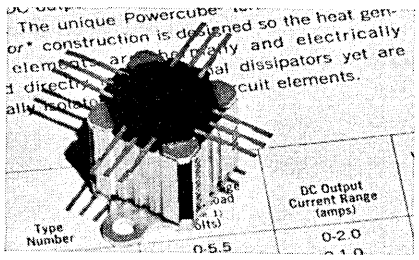
CIRCLE 225 ON INQUIRY CARD



DATA TESTING

The Test Set checks overall quality of high-speed telephone data circuits with one single reading at low cost. Transmissionline problems indicated by low readings include envelope delay distortion, excessive noise, bandwidth reduction, nonlinearity, and compression and resonances. Readout is a single overall value from 0 to 100. Wiltron Co., Palo Alto, Calif.

CIRCLE 226 ON INQUIRY CARD

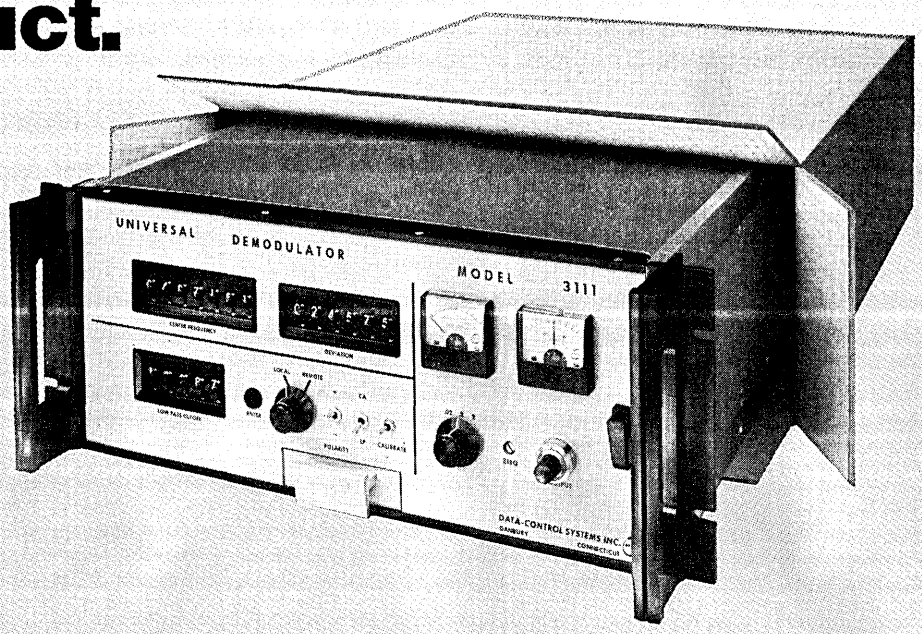


COMPLEMENTARY CONVERTER

A line of miniature ac-dc converters use a rectifier-filter network to provide equal positive and negative dc outputs when used with a dc-ac inverter. Operating from −55 to +100°C, the 0.8-oz. units can provide outputs of 0 to 5.5 Vdc @ 0 to 2.0 A, to 30 Vdc @ 0 to 0.5 A/output. In all cases the conversion is performed with a max. voltage drop of approximately 1.0 Vdc. Powercube Corp., Waltham, Mass.

CIRCLE 227 ON INQUIRY CARD

DCS's Universal Demodulator is more than a new product.



It's a revolution in telemetry.

Here's a single unit that can select and demodulate any subcarrier frequency between 400 Hz and 1.5 MHz. • deviation from 30 Hz to 250 KHz • distortion typically <1.5% at MI=2 • .01% setting accuracy • manual or computer programmable • superior tape-speed error compensation.

Once you've bought this demodulator*, there's nothing more to buy. Interested? Write or call today for full information.

*U.S. patent pending

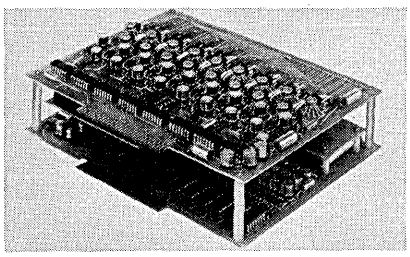
DCS **DATA-CONTROL SYSTEMS INC.** Commerce Drive, Danbury, Conn. 06810
Telephone: (203) 743-9241

CIRCLE 58 ON INQUIRY CARD

NEW PRODUCTS

LOW-COST MEMORY

A plug-in random access core memory system has capacities of 80 or 160 words with up to 17 bits/word. With a 2-μs access time, this 8-μs full-cycle system incorporates semiconductors for logic, sense, timing and interface circuits. Size is 8 x 6 x 2½". Power required is +5 V at 3 A max. and —5 V at 0:6 A max. Ferroxcube Corp., Englewood, Colo.

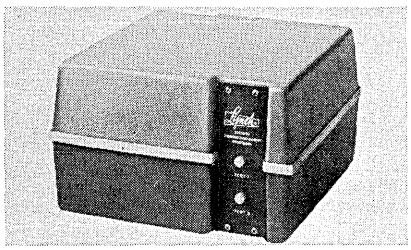


CIRCLE 228 ON INQUIRY CARD

DECODER/DRIVER MSI ICs

A family of 7-segment decoder/driver MSI ICs consists of the CD2500E and CD2502E, which include a decimal point driving circuit and are specified at 30 and 80 mA/line respectively; and CD2501E and CD2503E, which include a ripple planking circuit plus an intensity control provision, and operate at the same current levels respectively. They are contained in a 16-lead dual-in-line plastic package and are pin-compatible with other low current devices. Storage range is from —65 to 150°C; operating range from 0 to 75°C. RCA/Electronic Components, Harrison, N. J.

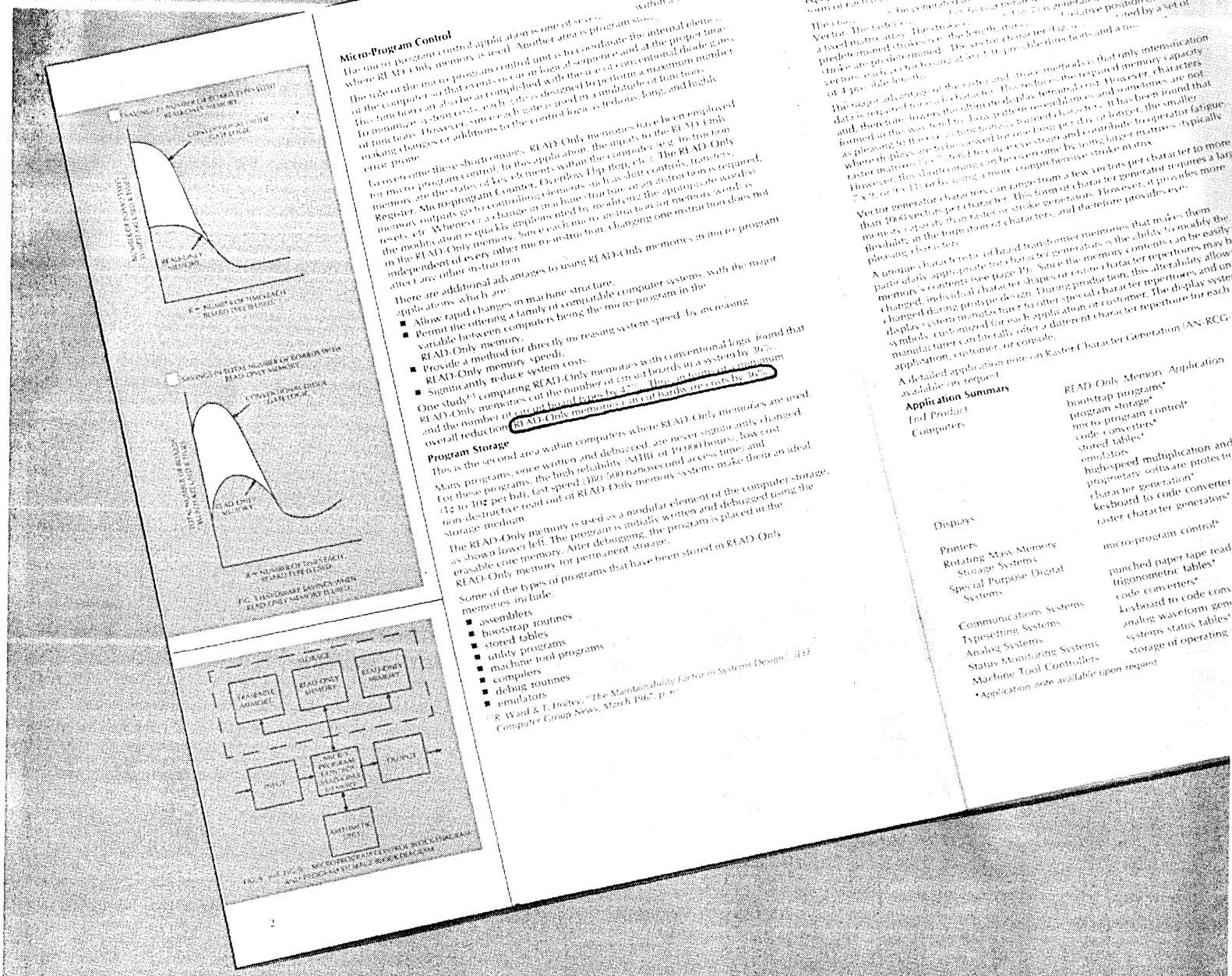
CIRCLE 229 ON INQUIRY CARD



SOLID-STATE DATA SETS

Providing narrowband full duplex transmission of data at speeds up to 300 bits/sec, the L2103A will provide for alternate voice and data communication between telephone stations in the exchange and toll switched voice message (DDD) network, and the L2103F is designed for use on private or leased lines. Lynch Communication Systems, San Francisco, Calif.

CIRCLE 230 ON INQUIRY CARD



Micro-Program Control

Program Storage

Application Summary

"READ-Only memories can cut hardware costs by 36%."

The above statement comes from the Engineering Guide to READ-only Memory Systems, a basic, working text written to get you into the technology with a minimum of fuss and bother. So you'll know when to use READ-only memory. And how.

It has everything an engineer needs. From the theories behind the technology to block diagrams of specific applications like program storage, microprogram control, character generation. With lots of nice little touches *in* between. Sequence photos showing how you can modify the memory contents. And a huge, fold-out work sheet with all the facts you need when designing a system. Timing diagrams, interface specifications, mechanical dimensions. The works.

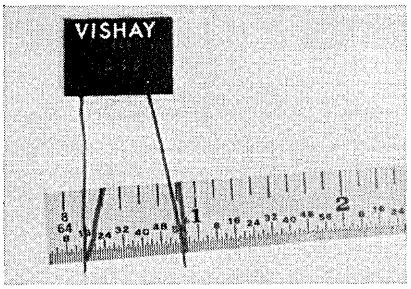
Spend a quiet afternoon with the Engineering Guide to READ-only Memory Systems. It's free.

Write Paul Rosenbaum, Memory Technology Inc., 83 Boston Post Road, Sudbury, Mass. 01776. (617) 443-9911.

Memory Technology Booth No. 4405 at FJCC
Incorporated

CIRCLE 60 ON INQUIRY CARD

NEW PRODUCTS



TEMPERATURE SENSOR

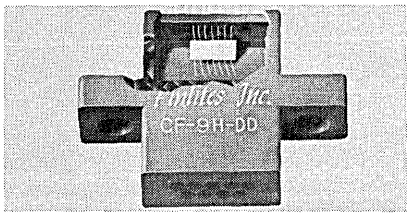
A network made of bulk-metal-film-resistors providing temperature coefficients of ±1 ppm/°C absolute, with tracking of ±0.5 ppm/°C and matching of 0.25 ppm/°C together with nickel resistors will provide near perfect linearity over the range of 0 to 60°C and with any preset temperature coefficient from 0 to 5600 ppm/°C. Vishay Resistor Products, Div. of Vishay Intertechnology, Inc., Malvern, Pa.

CIRCLE 231 ON INQUIRY CARD

DISC RECORDERS

The 4100 and 4250 Series wideband instrumentation disc recorders are multichannel, multitrack devices that can read or write up to 64 channels on a plated, 12″ magnetic storage disc. The 4100 and 4250 store parallel signal transients having frequency components from dc to 2 and 4 MHz respectively, with a signal-to-noise ratio of better than 33 and 30 db (rms/rms). Data Disc Inc., Palo Alto, Calif.

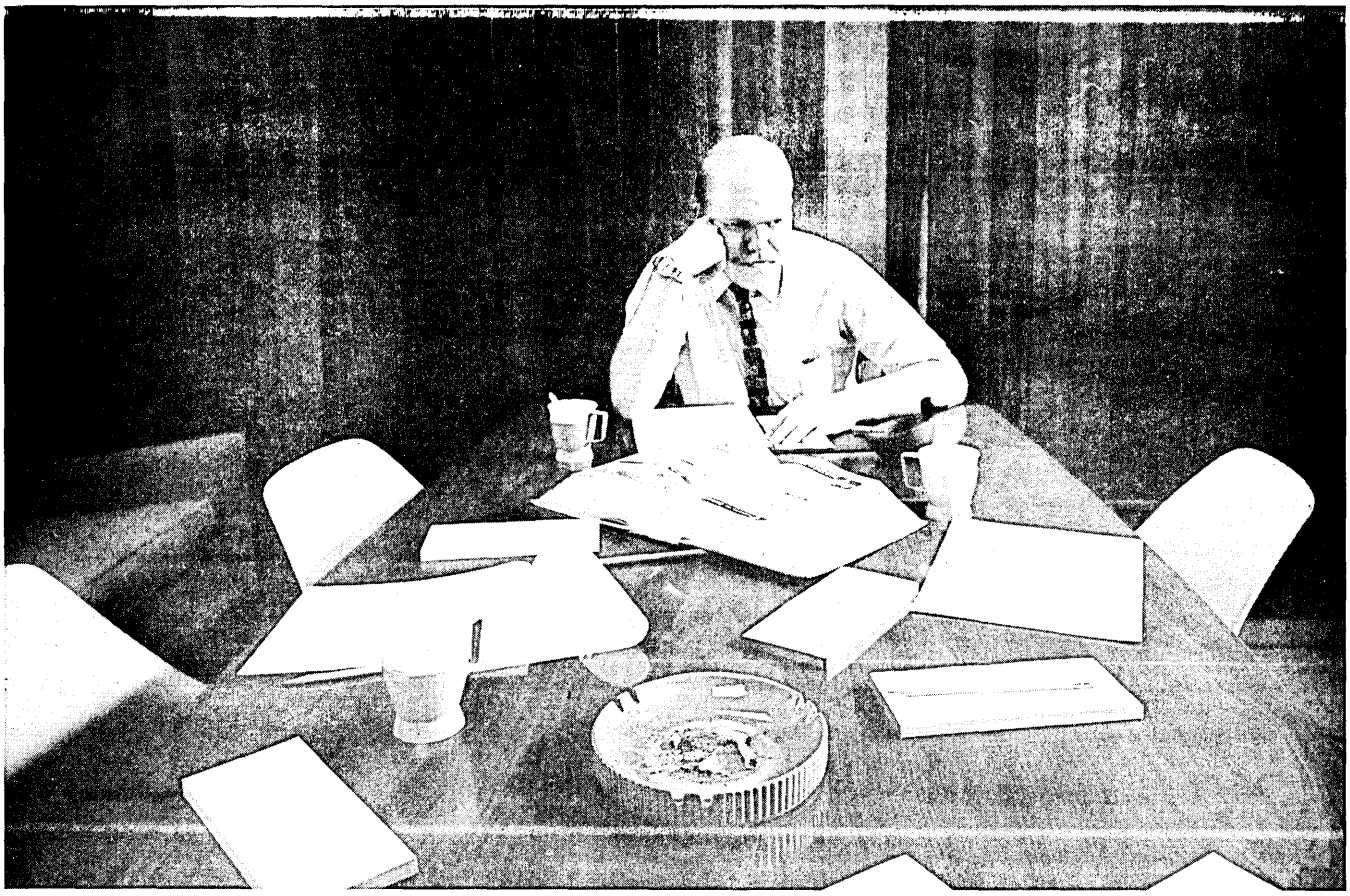
CIRCLE 232 ON INQUIRY CARD



MIDGI-CODER

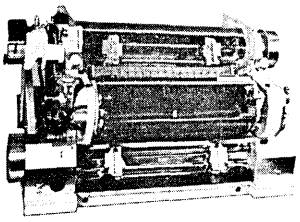
Model CF-9H-DD, providing 8 4 2 1 BCD decoding/driving to the 7-segment Midgi-Lite display, has been reduced in depth to ½″, and its driving capacity has been doubled to 20 mA/segment. It operates from an IC power supply, decodes and drives Midgi-Lites with segment brightness to 12,000 fL, includes a miniature 9-pin connector, is available with ½″ wire leads, and weighs only 5 g. Pinlits Inc., Fairfield, N. J.

CIRCLE 233 ON INQUIRY CARD

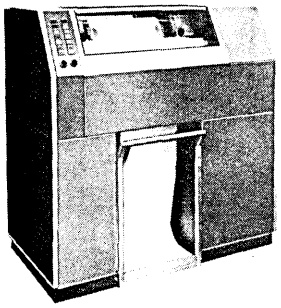


So . . . they left it up to you to decide on High-Speed Line Printers.

Make it painless . . . call MDS!



MDS SERIES 5013 HIGH-SPEED
LINE PRINTER MECHANISM



MDS SERIES 5320 HIGH-SPEED
LINE PRINTER (CONSOLE)

After all the talking is done, someone has to do the work. If you're the one who has to come up with recommendations for high-speed line printers, do what others in similar situations have done for years . . . *call MDS.*

MDS Line Printers are called the "work-horses of the industry". This reputation for reliable, long-term performance has contributed significantly to the MDS position as a leading independent source for line printers. This "work-horse" reputation works equally well for you.

MDS High-Speed Line Printers (1000-1250 lpm) offer you three choices: *The 5013 Printer Mechanism only, for integration with your own equipment; the 5320 Buffered Line Printer (Console); the 5300 Line Printer (Console, unbuffered). Console models are complete with MDS electronics and DC power supplies.*

MDS 5013, the high-speed rotating drum, on-the-fly printer mechanism, is the indispensable, vital center of every MDS High-Speed Printer. It contains the critical precision-built components that assure top performance.

OTHER IMPORTANT FEATURES: Dual Tractor Paper Feed; improved Clutch/Brake mechanism with vacuum cleanout system; Tape Control Vertical Format with standard 8 channels (12 channels optional); Improved Ribbon Tracking Mechanism; New Fibre Optics System with only 3 light sources . . . plus others.

Phone or write for literature. Your Man from MDS will gladly help you make your decision.

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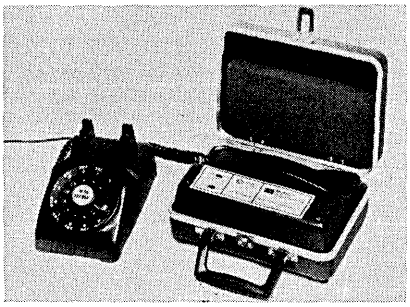
BUFFERED TAPE UNITS • DIGITAL STRIP PRINTERS • LINE PRINTERS • CARD PUNCHES AND READERS • PAPER TAPE PUNCHES AND READERS

CIRCLE 62 ON INQUIRY CARD

NEW PRODUCTS



DATA/TONE COUPLERS

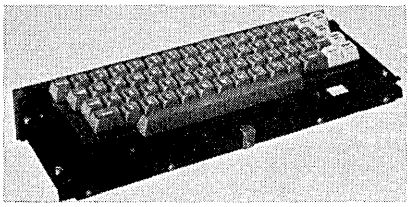
A series of accoustic couplers connecting business machines and printers to voice-grade telephone lines includes Model 440/MP, which accommodates Models 25, 33, 35 and 37 teletypewriters, IBM Selectric, type 2741 terminals and other EIA equipment at 300 baud; Model 440/MQ, which provides full duplex communications at 600 baud; Model 440/MR, accommodating Inktronic printers operating at 1050 and 1200 baud; and Model 440/MS, with a high rate capability of 1800 baud and is compatible with the Bell System and Dataphone Model 202D. Multitech Data Products, Monterey Park, Calif.

CIRCLE 234 ON INQUIRY CARD

INTEGRATED LIGHT SWITCH

The I.P.I.11, first fully integrated light switch available, combines silicon planar photodiode and IC technology to produce a complete optoelectronic function in a single TO-18 encapsulation. All that is required for operation is −27 V and an RC timing circuit which allows the sensitivity level at which the device switches, to be controlled externally. Teknis, Ltd., Guildford, Surrey, Eng.

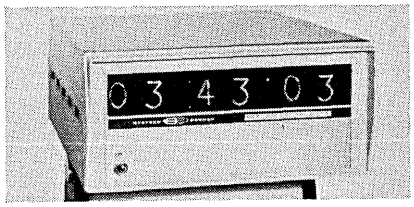
CIRCLE 235 ON INQUIRY CARD



ELECTRONIC KEYBOARD

"Slim silhouette" keyboards for computer data terminals feature self-contained encoding, simplified keyboard circuitry, low-cost electronics, high-speed typing, reliability of an ordinary carbon resistor, and is completely passive—sealed against environmental effects, with the same touch as an electric typewriter. Datanetics Corp., Redondo Beach, Calif.

CIRCLE 236 ON INQUIRY CARD



TIME CODE READER

The Model 8230 time code reader is designed to translate IRIG A, B, and E modulated time code formats in terms of BCD hours, minutes, and seconds without switching or code plug removal. While translating the incoming code, the unit can optionally provide parallel BCD information for use with a remote display. Systron-Donner Corp., Concord, Calif.

CIRCLE 237 ON INQUIRY CARD

TAPE ASSEMBLIES

Fully integrated Inductosyn tape scale spar assemblies fit practically every machine tool, regardless of size. All electronics and cabling are self-contained, mounted on an aluminum covered spar. Accuracy is ±0.0002″ over 30″, ±0.0004″ over 6′, with lengths up to 40′ available. The scale is printed several "tenths" short to permit tensioning to exact overall length. Farrand Controls, Inc., Valhalla, N. Y.

CIRCLE 238 ON INQUIRY CARD

DISK STORAGE DRIVE

An 11-high drive, designated the ISS 714 disk storage drive, maintains disk pack and data compatibility with the IBM 2314, though start-up time is 3 times faster. Access time ranges from 10 ms min. to 60 ms max., and storage of 29M bytes is provided at a data transfer rate of 312,000 bytes/sec. The unit features a closed-loop servo-system controlling an electro-magnetic actuator without detents. Information Storage Systems, Inc., Cupertino, Calif.

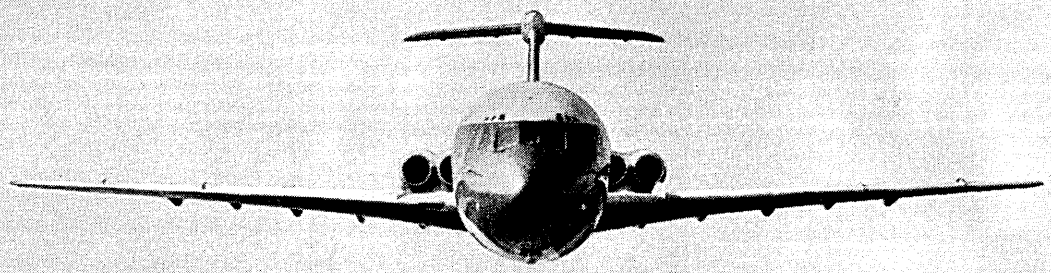
CIRCLE 239 ON INQUIRY CARD

KEYBOARD-TO-TAPE SYSTEM

A keyboard-to-magnetic tape data processing input system, DATA/TAPE 2100, may reduce EDP input costs by 50%. Components include keyboard printers; sight verification stations; supervisory control station with page printer; Computer Automation 816 Data Accumulator with a core memory of 8K in 16 byte words; Data Disc, Inc. disc memory unit with 800K capacity; and two 9-track, 800-bpi Ampex TMZ tape drives. General Computer Systems, Inc., Dallas, Texas.

CIRCLE 240 ON INQUIRY CARD

It takes a fast printer to keep up with BOAC's 100 million dollar computer system.

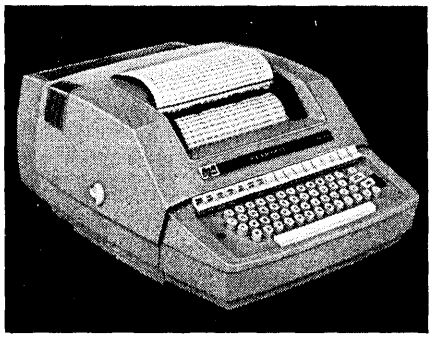


Kleinschmidt.

The amazing Kleinschmidt 311™ Teleprinter is part of BOAC's 100 million dollar computer system called Boadicea. This system puts all the BOAC offices in the United States right next door to the home office in London.

For example, if the BOAC office in Miami needs a passenger list for any BOAC flight, Kleinschmidt gets the answer from London in seconds. At 400 words a minute.

The Kleinschmidt 311 Teleprinter gives BOAC the ultimate in speed and reliability. Furthermore, the 311 Teleprinter can accept parallel information on demand at an average speed of 40 characters a second, which eliminates the formatting problems of serial printers.

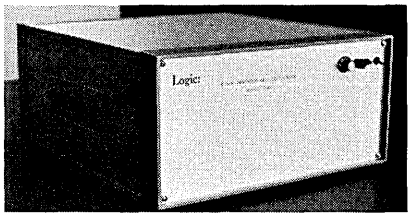


What Kleinschmidt is doing for BOAC it can do for any business that requires quick reception of the printed word. If you would like to learn more, please write Kleinschmidt Division of SCM Corporation, Deerfield, Ill. 60015. Or call us at 312-945-1000.

SCM®

CIRCLE 64 ON INQUIRY CARD

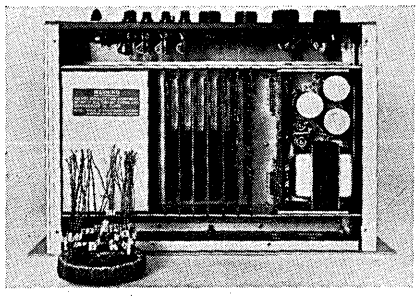
NEW PRODUCTS



TIME DIVISION MULTIPLEXOR

The TDML multiplexor accepts data from 18 simultaneously active data terminals at multiple locations, and channels it for transmission over one 2400-baud data circuit. Designed to work with single speed terminals (110 baud), the unit is compatible with Teletype Models 33 and 35. Control data format provides an update of 3 signals for each channel every 900 ms. Communications Logic. Inc., Houston, Texas.

CIRCLE 241 ON INQUIRY CARD



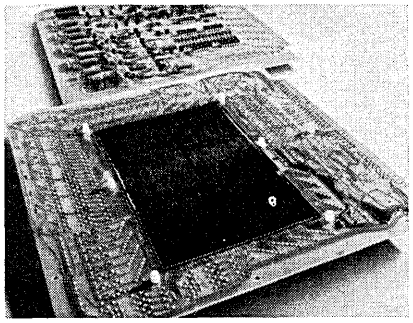
DIGITAL/AC CONVERTER

Model 508/10 uses solid-state switches to set up new I/O levels. By using precision tapped transformers, long term accuracy is dependent upon transformer winding ratios. With 10,000 I/O ratio steps, providing 0.0001-to-1 increases in output amplitude, and approximately 0.01% long term accuracy, the unit's imput impedance is 300,000Ω, and output, 25Ω. It accepts BCD input commands from practically any digital source, and updates in 10 to 30 μs of the "Data Ready" command. North Atlantic Industries, Inc., Plainview, N. Y.

CIRCLE 242 ON INQUIRY CARD

PERIPHERALS MEMORY SYSTEM

The PDM-12, a 4096 6-bit word capacity core design with a 5 μs cycle time, is designed for optical character recognition, data display and numerical control. It utilizes standard IC logic and consumes 16 W max. at ±12 Vdc and +5 Vdc. Logic levels are designed for interfacing with standard 830/930 DTL and TTL logic. The system comes in pc cards, subchassis mount, or in a 19" relay rack mount. Dataram Corp., Princeton, N. J.



CIRCLE 243 ON INQUIRY CARD

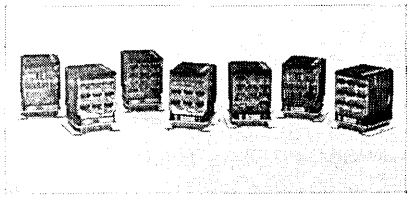
HIGH-SPEED PROCESSOR

The FilmMate 16/50 is a low cost, high-speed compact 16mm b&w/microfilm unit which can process film at 50 ft/min. Construction includes a stainless steel frame, corrosion-resistant PVC tanks, quick-disconnect stainless side panels for easy access to inside components, and integral operating controls to minimize space requirements. Overall length is 79". Terminal Data Corp., Los Angeles, Calif.

CIRCLE 244 ON INQUIRY CARD

LOGIC DESIGN AIDS

Seven hand-sized MINI-BLOCs for design simplification include the MINI-VERTER, a combination multiplexer, sample and hold amplifier, and A/D converter; MINI-MUX, a multiplexer with up to 32 channels/block, expandable in 8-channel increments; MINI-DAC, a D/A converter available in 10-bit, 12-bit, and 3-bit BCD formats; MINI-SAMPLE, a sample and hold amplifier for simultaneous sample and hold operations; BCD/BINARY CONVERTER, converting 5 BCD characters to 16-bit binary word form in 3 μs; BINARY/BDC CONVERTER, converting a 16-bit binary word to 5 BCD characters in 3 μs; and MINI-MEM, a memory that stores up to 32 sixteen-bit words. Raytheon Computer, Santa Ana, Calif.

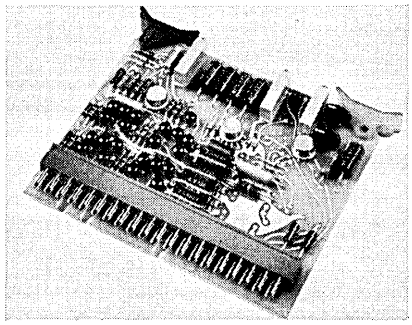


CIRCLE 245 ON INQUIRY CARD

D/A CONVERTER MODULE

Based on the principle of vernier transformer windings and MOSFET ICs, Model D/A 011 has a resolution of 11 bits and accuracy is ±½ bit. Input voltage is 3.5 V rms, 400 Hz with input impedance of 90K Ω min. Output impedance without amplifier is 2K Ω max. Operating temperature range is −55 to +125°C. Perkin-Elmer Corp., Industrial Products Div., Wilton, Conn.

CIRCLE 246 ON INQUIRY CARD

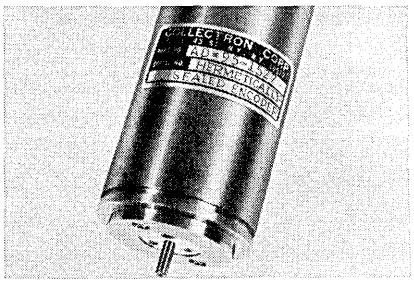


D/A CONVERTER

A D/A converter with operational amplifier output, adjustable gain and precision voltage reference is packaged on one 3.5 x 4.3″ card. Features include up to 12-bit resolution, 4 μs settling time, 0 to 70°C operation and DTS/TTL compatibility. Standard Logic, Inc., Santa Ana, Calif.

CIRCLE 247 ON INQUIRY CARD

NEW PRODUCTS



HERMETICALLY SEALED ENCODER

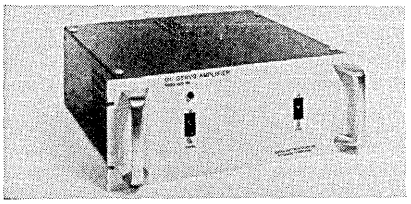
A high reliability encoder is made with one dynamic O-ring seal, with the unit's interior filled with high-grade insulation oil to protect the contact surfaces from contamination. It can be designed as an encoder—either gray or binary—or be modified as a switch—programmed multipole. Interfacing logic circuitry can be transistorized and packaged within the unit itself. Collectron Corp., New York, N.Y.

CIRCLE 248 ON INQUIRY CARD

TIME DELAY MODULES

Solid-state logic time delay modules provide time delays in the 10 ms to 100 sec range with a typical overall accuracy of ±5%, and operate from a 5 ± 0.5 V dc source over the 0 to 75°C range, drawing only 10 mA during the timing cycle. The package occupies less than 0.5 in^3 and is compatible with pc boards and op amp sockets. Product Designs Inc., Albuquerque, N. M.

CIRCLE 249 ON INQUIRY CARD



SERVO AMPLIFIER

Contained in a standard 19 x 7 x 16″ chassis, the Model 1000SRA "operational-type" features forced air cooling, heat sinking and power supplies for direct operation from 115 Vac 50/60 or 400 Hz power. From this self-contained unit, the amplifier delivers a continuous output of ±44 Vdc and ±23 A. Adjustable current limiting is provided to adjust the max. current from ±7 to ±23 A. Control Systems Research, Inc., Pittsburgh, Pa.

CIRCLE 250 ON INQUIRY CARD

DIAGNOSTIC COMPUTER

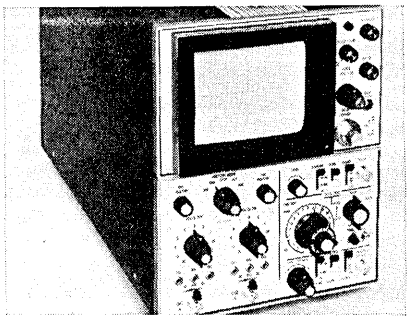
The Model III computer is available with ICS including logic cards and complete rack systems. It can test a logic card in 1 to 4 sec. by testing each element against a punched tape.

For testing the most advanced logic systems, an interface package for the computer converts the operating voltage to any realistic logic level other than 0 and +5 V. Digital Systems Corp., Cleveland, Ohio.

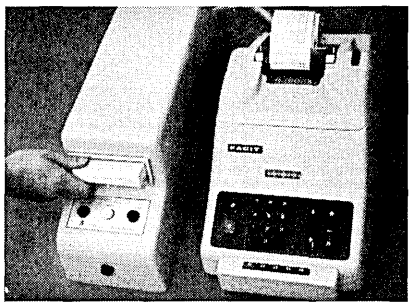
CIRCLE 251 ON INQUIRY CARD

DUAL CHANNEL OSCILLOSCOPE

A solid-state, high frequency duel channel oscilloscope features a triggering device which eliminates the "trace flicker," and maintenance of signal synchronization regardless of the vertical positioning of either trace. The Model 1050 has FET input amplifiers and micrologic switching circuits which provide quick warm-up time and low trace drift. Dumont Oscilloscope Laboratories, Inc., West Caldwell, N. J.



CIRCLE 252 ON INQUIRY CARD

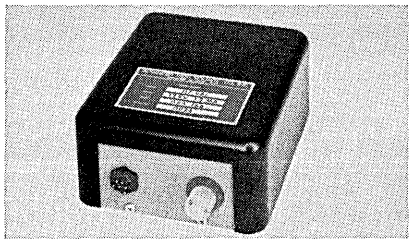


DATA COLLECTION

A system for collecting data electronically on a magnetic tape cartridge, the RJ Store-Data System comprises, at the remote location, a mobile data entry keyboard with hard copy printout, and a digital magnetic cartridge recorder. The information is transmitted to the central office via a telephone line using either an acoustic coupler or Data-Phone, where the received information is recorded onto computer-compatible 7- or 9-track tape. RJ Communications Products, Inc., Phoenix, Ariz.

CIRCLE 253 ON INQUIRY CARD

NEW PRODUCTS



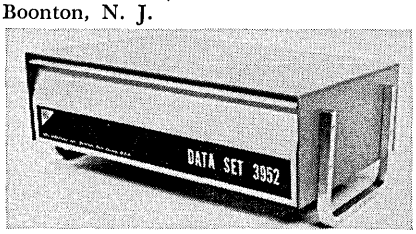
HIGH-VOLTAGE POWER SUPPLIES

Line-operated, regulated, 2-lb. units, with an output of 4 to 18 kV, are designed for use with CRTs, image pickup, display and photo-tubes. They operate with a ripple of less than 0.1%, a combined line/load of 0.1%, and a temperature of −20 to 75°C. Advanced High Voltage Co., Inc., Northridge, Calif.

CIRCLE 254 ON INQUIRY CARD

HIGH-SPEED DATA SET

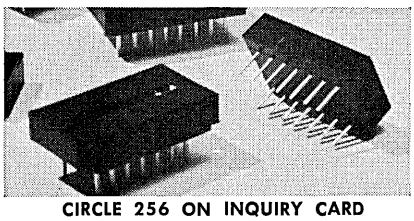
Model 3952 transmits and receives serial binary data over a voice bandwidth at a synchronous rate of 2400 bits/sec, a rate achieved by using 4-phase, differentially coherent modulation. It is available in either desk-top or standard 19″ rack mount assembley. RFL Industries, Inc., Boonton, N. J.



CIRCLE 255 ON INQUIRY CARD

IC-COMPATIBLE CONNECTORS

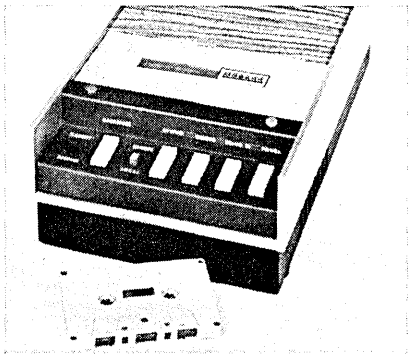
Low-profile 0.200″ high IC compatible connectors, available as separate items, can terminate round conductors of up to 30 AWG into pc and motherboards, backplanes and other IC circuit elements, and can serve as jumper blocks to switch or interconnect pins in a given IC socket by use of internal wiring. Spectra-Strip Corp., Garden Grove, Calif.



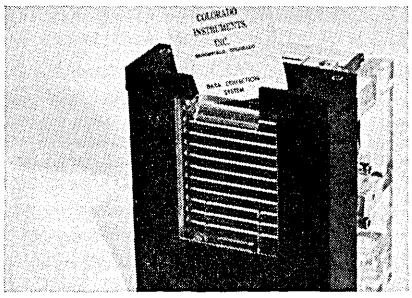
CIRCLE 256 ON INQUIRY CARD

DIGITAL RECORDERS

Three low-cost incremental digital magnetic tape recorders include a parallel entry recorder/reproducer system for 8-bit ASCII format sources (7-bit character + parity), Model 305; a parallel entry system for 5-bit BCD numeric code, Model 315; and a system for recording scientific and research data with parallel entry in BCD format consisting of 5 digits of 4 bits each, Model 325. Mobark Instruments Corp., Mountain View, Calif.



CIRCLE 257 ON INQUIRY CARD



STATIC CARD READER

The solenoid-operated reader can be implemented to read up to 12 rows and 22 columns of data. As many as 22 read elements can be placed anywhere within the 22-column field. Contact between selected read elements and common output bus bars constitute an electrically scannable image of the Hollerith hole pattern enabling data retrieval on a column-by-column basis. Colorado Instruments, Inc., Broomfield, Colo.

CIRCLE 258 ON INQUIRY CARD

LOGARITHMIC CONVERTER

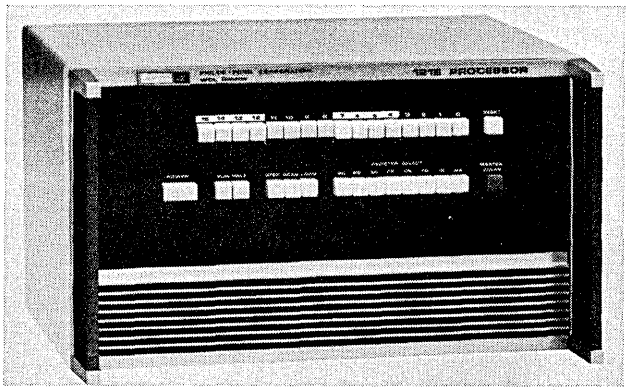
The CM-1000 log converter accepts dc signals of 0.1 to 10 V (2 decades) and converts them to an output voltage proportional to the logarithm of the input. The unit, meeting MIL-E-16400 Class 4 specs, incorporates close regulation to provide tight control of the log characteristic over the temperature range. An external switch selects 1- or 2-decade full scale gain. Dranetz Engineering Labs., Plainfield, N. J.

CIRCLE 259 ON INQUIRY CARD

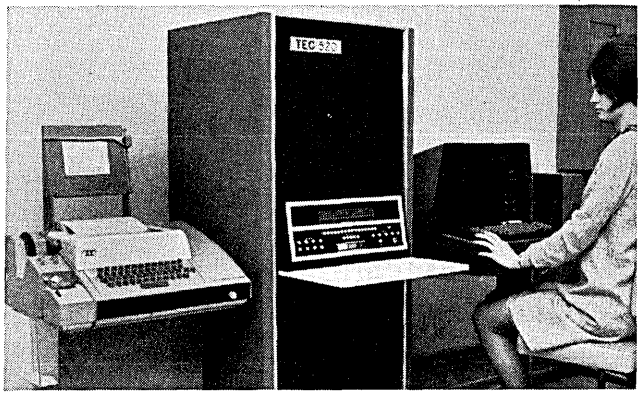
NEW PRODUCTS

KEYBOARD SWITCHES

Low cost "feather-touch" keyboard switches, Series 400, provide long life duty to 20M electrical operations per key. Designed to plug directly into pc boards, the units are ideal for high-volume keyboard applications. Switch contacts are inclosed within a ½" sq. x 1¼" long body to prevent contamination. Contact materials ranging from silver-plated copper alloy to precious metal are available. Initial contact resistance is less than 100 mΩ and contact bounce duration is under 10 ms. Using polycarbonate and phenolic insulating materials, the switches withstand −25 to +85°C temperatures. Oak Mfg. Co., Crystal Lake, Ill.



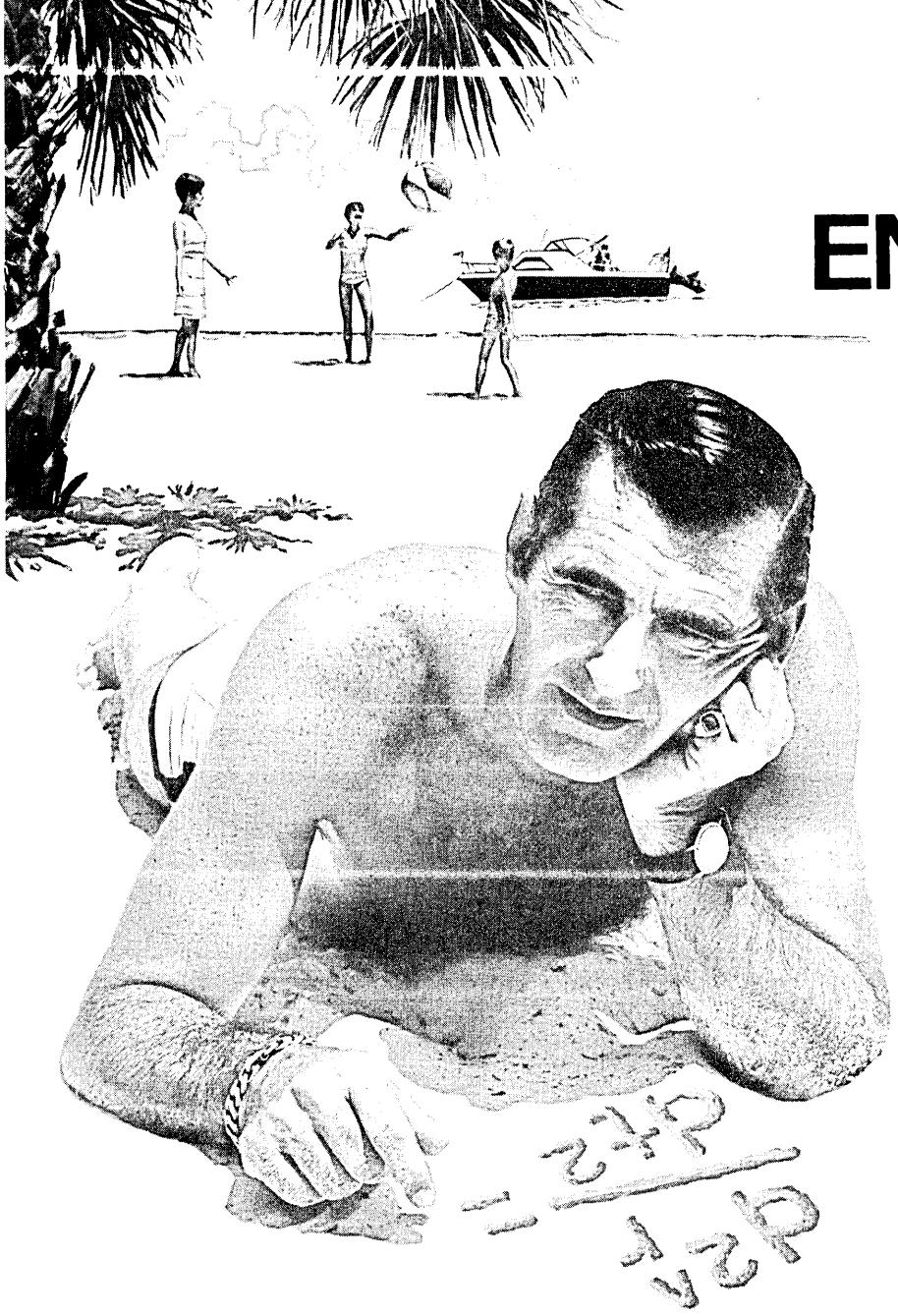
CIRCLE 283 ON INQUIRY CARD



PROGRAMMABLE COMMUNICATIONS SYSTEM

Model 520 processor provides complete turnkey terminal systems capability, offering direct pre-processor connection to most computer systems, including the IBM 360. It can function as a multiplexer/controller to control and refresh up to 32 Data-Screen display terminals. Utilizing an 80-instruction repertoire and 1 μs cycle memory, the processor provides the power and speed needed for fast-paced communication systems. Memory is expandable to 32K bytes, with 10 DMA channels and 16 buffered I/O channels available. It will perform a 16-bit add in 2 μs and a 16-bit shift in 1 μs. Peripheral configurations include CRT displays, card readers, card punchers and line printers. It can function as a remote batch processing terminal, operate as a multistation CRT controller, provide a data acquisition system, and can perform data concentration functions. Transistor Electronics Corp., Data Terminal Systems, Eden Prairie, Minn.

CIRCLE 260 ON INQUIRY CARD



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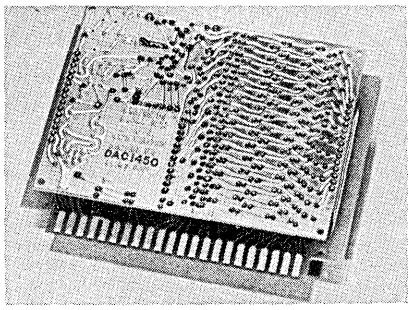
NEW PRODUCTS



14-BIT D/A CONVERTER

The converter is capable of generating full-range outputs of ±10 V with an accuracy of ±0.01% of full range. Model DAC 1450 "piggibac DAC" utilizes TTL and TTL/MSI digital ICs, monolithic linear ICs, and discrete components, and measures only 4.5 x 3 x .75". Phoenix Data, Inc., Phoenix, Ariz.

CIRCLE 261 ON INQUIRY CARD

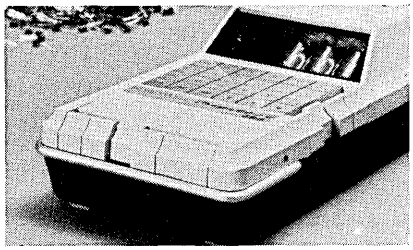
D/A CONVERTER

The "MINIDAC," Model MDA-L, is only 4/10" high x 2" sq., and solders directly onto pc cards. It has a resolution of 12 bits, giving 2^{12} analog current increments in approximately 0.5 μA steps. Worst case settling time is 300 ns to 0.05% of full-scale output level. Accuracy specs include ±½ LSB linearity and 0.4% full-scale output variation per % of supply voltage change. Analog Devices, Inc., Pastoriza Div., Cambridge, Mass.

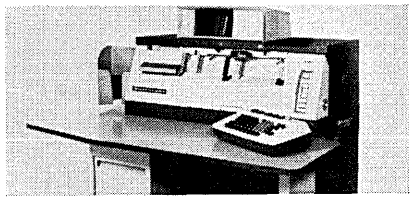
CIRCLE 262 ON INQUIRY CARD

3-DIGIT MULTIMETER

The Digitest 500 measures 17 ranges of ac and dc voltage, current and resistance; has accuracies from 0.2 to 1.5%; and low range sensitivities of 100 μV and 100 nA. Input impedance is listed from 2 to 50 MΩ. The unit operated from 110 Vac or 11 to 18 Vdc power sources. Honeywell Inc., Test Instruments Div., Denver, Colo.



CIRCLE 263 ON INQUIRY CARD



CARD KEYPUNCH

Punching and interpreting standard 80-column cards at up to 20 card columns/sec, the A150 incorporates both regular and alternate stacking pockets which are operator selectable. There is a 500-card capacity feed hopper and primary stacker, plus a 400-card capacity alternate stacker. Duplicating capability permits full duplication of 12 zones or any combination in a single card column. Burroughs Corp., Detroit, Mich.

CIRCLE 264 ON INQUIRY CARD

PARAMETRIC TESTER

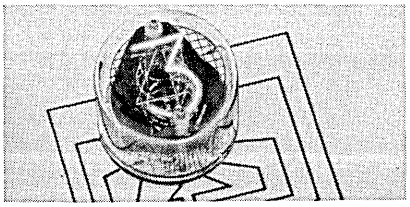
The 580 software-oriented system is capable of performing dc parametric tests and recording data on 20,000 devices/hr. With a test speed of less than 2 ms/test, and the test rate of the mainframe, testing costs can be in the range of 1/10 to 2/10 cent/device. Texas Instruments, Inc., Industrial Products Div., Stafford, Texas.

CIRCLE 265 ON INQUIRY CARD

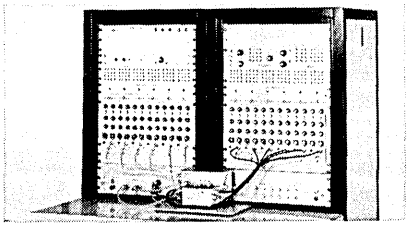
NEW PRODUCTS

DECODER/DRIVER

A BCD-to-decimal decoder/driver, Type MC9860/9760, converts a 4-bit complementary BCD code into a 1-of-10 output with sufficient voltage to drive a neon-filled display tube. The high-voltage output transistors in the monolithic circuits −70 V in the 0 to +75°C range (MC9860) and 65 V in the +15 to 55°C range (MC9760) allow direct operation of the display tube without background glow. Typical power dissipation is 115 mW. Motorola Semiconductor Products Inc., Phoenix, Ariz.



CIRCLE 266 ON INQUIRY CARD



PLATED-WIRE TESTERS

Two magnetic plated-wire element testers, Models E-310 and E-310A, supplied with integral test stations, are modularly constructed, 2-axis pulse generators which provide "worst case" current pulse patterns to a plated-wire load while preserving the best possible pulse fidelity. They feature a 15-ns rise time into load, 16- or 32-step current-pulse programming, and a 50% duty cycle. Computer Test Corp., Cherry Hill, N. J.

CIRCLE 267 ON INQUIRY CARD

DISPLAY/KEYBOARD

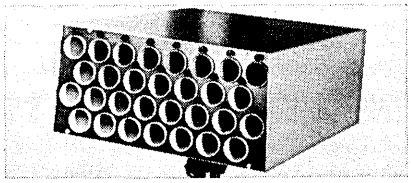
Two optional features for the Model 520 display-keyboard include an expanded (1,920-character) display screen, for handling larger records, and upper/lower case printout characters, for aiding work in document composition. Computer Consoles, Inc., East Rochester, N. Y.

CIRCLE 268 ON INQUIRY CARD

MINIATURE POWER SUPPLIES

The PS-120 economy series of encapsulated power supplies are designed to power op amps and function modules. Four units supply ±15 V dc: PS-121, 50 mA; PS-122, 75mA; PS-123, 100 mA; and PS-124, 200 mA. Operating from standard ac line, 50 to 400 Hz, the series maintains up to .05% load and .01% line regulation and less than 0.5 mV rms ripple. GPS Instrument Co., Inc., Framingham, Mass.

CIRCLE 269 ON INQUIRY CARD

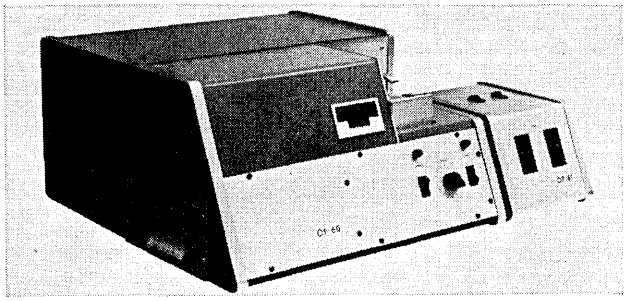


WIRE HOLDER

An indicating bin for holding various lengths of connecting wires used in high-density panel wiring production features the ability to interface with the N/C unit operating the wire termination system with which it is normally used. The steel constructed bin measures 20" wide x 10" high x 27" deep. Synergistic Products, Inc., Santa Ana, Calif.

CIRCLE 270 ON INQUIRY CARD

NEW PRODUCTS



CARD DUPLICATOR

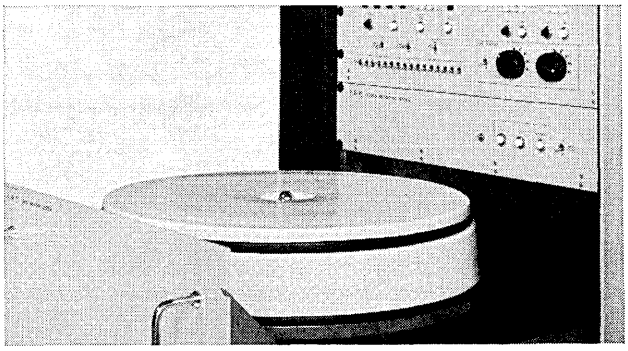
A compact, heavy-duty semi-automatic card duplicator, OP-60, with an optional add-on module, OP-61, is designed for lower volume users of diazo cards. The duplicator feeds copy cards from a deck, with master cards singly inserted in the exposing plane; copy cards needn't be handled individually. A long-life mercury vapor light source is supplied, and no venting is required. The module allows automatic reproduction of up to 99 copies of any master card. The 103-lb. duplicator is 10⅞ x 21⅝ x 23⅛". The module weighs 9 lbs. and measures 6½ x 8⅜ x 11 7/16". Itek Business Products, Rochester, N. Y.

CIRCLE 271 ON INQUIRY CARD

VIDEO ANALYSER

A unique means of utilizing the TV camera as a scientific instrument is provided by Model 321 video analyser. Similar in principle to the sampling oscilloscope, the unit provides an interface between the camera and computer, as well as for low cost chart recording of video waveforms. Noise reducing characteristics allow significant video detail to be extracted from weak signals. The analyser may be used for rapid, convenient visual data reduction in one static and three scanning modes. Accuracy is better than 3%, and several functions may be remotely controlled. Colorado Video, Inc., Boulder, Colo.

CIRCLE 272 ON INQUIRY CARD



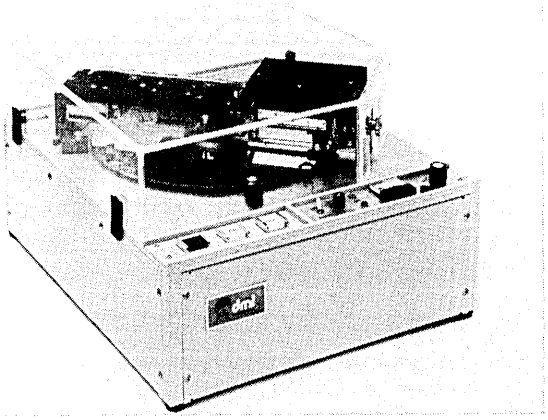
DISC MEMORY SYSTEM

The MDS-2000 is a 6.5M-bit capacity system operating at serial bit transfer rates of up to 3 MHz and has an average access time of 8.5 ms. Complete with Read/Write and head selection and decoding electronics, the unit requires only 10.5" of panel height in standard 19" wide racks, features 128 data channels with fixed "flying heads," and requires no periodic maintenance. It unitizes all TTL/MSI circuits and has a simplified interface requiring a 7-bit address. Engineered Data Peripherals Corp., Santa Monica, Calif.

CIRCLE 273 ON INQUIRY CARD

MAGNETIC DISC RECORDERS

Designated IDR-100, the 45-lb. self-contained instrumentation disc recorder will record transient signal events over a 20-s real-time duration and upon command replay the entire disc or repetitively reproduce any 25-ms "window" for hours or even weeks of constant analysis without signal degradation. The unit has a sine wave recording bandwidth of 2 MHz and equivalent pulse response of 4 MHz. Utilizing a recording mode where the head is "in contact" with the disc, signal-to-noise ratio is 25 dB rms signal/rms noise. Replay is instantaneous, and head and plated disc life is warranted at 1,000 hrs. Data Memory Inc., Mountain View, Calif.



CIRCLE 274 ON INQUIRY CARD

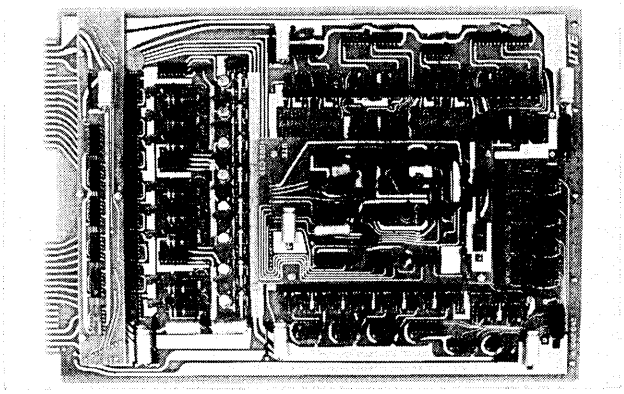
CONTROL PROCESSOR

Fully parallel, stored program digital processor, Model 1216, with a 16-bit word length, 3.5 μs memory cycle time, 4096 words of core memory, control panel, party line I/O, power supply, power failure and restart, 8 interrupts and real-time clock, is among the 1200 Series of processors, designed for on-line, real-time monitoring and control systems and offering word sizes of 12, 16, and 20 bits in conjunction with memory cycle times of 1.9 or 3.5 μs. Philco-Ford Corp., Newport Beach, Calif.

CIRCLE 275 ON INQUIRY CARD

CORE MEMORY SYSTEMS

The single card 1K x 8 coincident current memory operates at 2 μs in a full cycle, with a dc power consumption of less than 29 W. On-line operation is controlled by the signal interface with operation over a 15 to 40°C range. The system features bit arrays layed out on a single card along with a data register, address decoding and drive circuits. The control circuits ride on a low-profile platform directly above the core arrays. The unit measures 9.75 x 14 x 1.1" overall. United Telecontrol Electronics, Asbury, N. J.



CIRCLE 276 ON INQUIRY CARD

LITERATURE

RFI Filters

Four catalog sheets include design specifications, voltage rating, frequency, and amperage, as well as line drawings and schematics of RFI filters for data processing equipment, and are available from Hopkins Engineering Co., San Fernando, Calif.
CIRCLE 300 ON INQUIRY CARD

Shield Design

"Electromagnetic Shielding Design Manual," a 48-page book, covers both drawn and fabricated shields, includes formulae, tables and graphs, and is being offered by the Magnetic Metals Co., of Camden, N. J.
CIRCLE 301 ON INQUIRY CARD

Coaxial Cables

Included in a 26-page brochure are descriptions, specifications, and engineering data for microminiature, "Mini-Noise," dual-shielded coax, twin-axial, triaxial, and special hookup types of coaxial cable available from Microdot Inc., of South Pasadena, Calif.
CIRCLE 302 ON INQUIRY CARD

Memory Components

Description and specifications of the complete line of magnetic tape drives, core memories and memory components for computer manufacturers and users are contained in quick-reference pocket catalog C105, issued by the Ampex Corp., of Redwood City, Calif.
CIRCLE 303 ON INQUIRY CARD

Digital Angle Indicator

Data File 115, a 4-page brochure describing a series of digital angle indicator—solid-state, all electronic devices for measuring and displaying angle inputs from remote synchros or resolvers—is available from Astrosystems, Inc., of New Hyde Park, N. Y.
CIRCLE 304 ON INQUIRY CARD

Encoder Guide

A 12-page guide detailing encoder technology and providing extensive data on encoder applications, including A/D conversion systems, natural binary notation and conversion equivalents, the gray code, and incremental encoders, has been compiled by the Collectron Corp., of New York City.
CIRCLE 305 ON INQUIRY CARD

Indicator Lights

A 2-page technical data sheet, describing transistorized microminiature indicator lights that incorporate a silicon planar transistor, either PNP or NPN, operating from a signal level as low as 0.25 mA, is being offered by Shelly Associates, Inc., of El Segundo, Calif.
CIRCLE 306 ON INQUIRY CARD

Relay Components

Bulletin ES-110 describes four components used in military ground support and electronic control systems, which conform to Mil-Specs MIL-R-5757D and MIL-R-5757/9C. Sigma Instruments, Inc., Braintree, Mass.
CIRCLE 307 ON INQUIRY CARD

Magnetic Tape Recorder

Features of the model 10-236 magnetic tape recorder, which is of compact size and light weight, making it ideally suited for special applications where space is at a premium, are described in a bulletin available from the Genisco Technology Corp., Compton, Calif.
CIRCLE 308 ON INQUIRY CARD

"On Line" Key Punch

Operation of the unit as a communications terminal, transmitting cards at 200 words/min, and as a key punch, punching/duplicating cards 25% faster than conventional machines, is covered in a bulletin released by Oneida Electronics Inc., Yorkville, N. Y.
CIRCLE 309 ON INQUIRY CARD

Solid-State Keyboard

Product sheet 16SW3-1 features a solid-state numeric keyboard, including descriptions of keys, electrical compatibility, bounce-free output and off-the-shelf availability, and is being offered by Micro Switch, a div. of Honeywell, Inc., Freeport, Ill.
CIRCLE 310 ON INQUIRY CARD

Flexible Fiber Optics

Included in a 2-page data sheet covering the company's line of flexible glass fiber optics is an ordering chart, specifications, including chemical stability and bend radius, and performance curves. Available from the Bendix Corp.'s Mosaic Fabrications Div., Sturbridge, Mass.
CIRCLE 311 ON INQUIRY CARD

Electronic Packaging

Outlining proper selection, specification and termination procedures, a 6-page brochure describes in detail how the company's connectors transform flat cable or discrete wire to wire wrap posts and printed circuit boards. 3M Co., St. Paul, Minn.
CIRCLE 312 ON INQUIRY CARD

Data Modem

The interface package, providing full- or half-duplex serial data transmission over voice bandwidth private or leased lines, is described in a data sheet by Quindar Electronics, Inc., of Springfield, N. J.
CIRCLE 313 ON INQUIRY CARD

Connectors/Assemblies

Photos, line drawings, electrical characteristics and mechanical specifications are provided for connectors, sockets, and switches, as well as a line of ten coaxial cable connector assembies, in a general line catalog from Amphenol Distributor Div., The Bunker-Ramo Corp., Broadview, Ill.
CIRCLE 314 ON INQUIRY CARD

Reliability Program

"National/883," a brochure on the Mil-Std-883 reliability program, describing the background, production and flow of 883 standard parts through process and ordering is available from the National Semiconductor Corp., Santa Clara, Calif.
CIRCLE 315 ON INQUIRY CARD

Power Supplies

For help in specifying subminiature high power supplies, a 24-page designers aid catalog features data on a complete line of subminiature modules which can be easily connected to meet any power supply requirement. Powercube Corp., Waltham, Mass.
CIRCLE 316 ON INQUIRY CARD

MIL-Lites

A brochure providing comprehensive cross-reference data on revised MIL-L detail specification numbers, with the relevant military type designation, previous designation, mating parts, part numbers and generic part descriptions, has been issued by Eldema, of Compton, Calif.
CIRCLE 317 ON INQUIRY CARD

Monolithic TTL IC's

A pocket-size brochure lists all monolithic TTL integrated circuits included in the SUHL I and SUHL II families, with logic diagrams, descriptions, and type numbers given for each product. The brochure, indexed according to family and categorized by function, is offered by Sylvania Electric Products Inc., Buffalo, N.Y.

CIRCLE 318 ON INQUIRY CARD

Data Monitors

Technical bulletin 67-12A describes instruments which provide continuous digital readout and computer interface signals as well as a printed record of remotely-located analog variables. The parameter being monitored may be an angular rotation, synchro or resolver output, or voltage output from a pot or load cell. Theta Instrument Corp., Fairfield, N. J.

CIRCLE 319 ON INQUIRY CARD

CCSL Building Blocks

The second edition, 54-page brochure entitled "Total Capability with CCSL Building Blocks," giving full page descriptions of more than 40 CCSL blocks, together with special features and suggested uses, and including over 100 logic diagrams, has been published by Fairchild Semiconductor, of Mountain View, Calif.

CIRCLE 320 ON INQUIRY CARD

Fluoroplastic Applications

A 16-page brochure offering complete technical information on the use of components made with Kynar® for chemical processing systems, including illustrations of its unique applications in the aerospace, electronics, chemical and petrochemical industries, is available from the Pennwalt Corp., Philadelphia, Pa.

CIRCLE 321 ON INQUIRY CARD

Custom Hybrid Circuits

Discussing the advantages of custom hybrid microcircuits and explaining how these devices can combine the best features of integrated circuitry to make available a wide range of specialized circuits for today's systems design requirements, is a 16-page booklet which is available by request on company letterhead, from Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. 85008.

Time Sharing Systems

A comparison between the TSC/System 16 and the GE Mark I and Mark II time-sharing systems is contained in a bulletin entitled, "A Basic Comparison," which shows the differences and similarities of commands, functions, and matrix and file commands between the systems, from the Time Share Corp., of Hanover, N.H.

CIRCLE 322 ON INQUIRY CARD

Logarithmic Feedback Principles

Summarizing the concept of logarithmic elements for use in an operational amplifier's external feedback circuitry so as to extend the use of op amps into such functions as multiplication, division, roots, powers, and amplitude compression and expansion, is a 12-page technical article issued by Analog Devices, Inc., Cambridge, Mass.

CIRCLE 323 ON INQUIRY CARD

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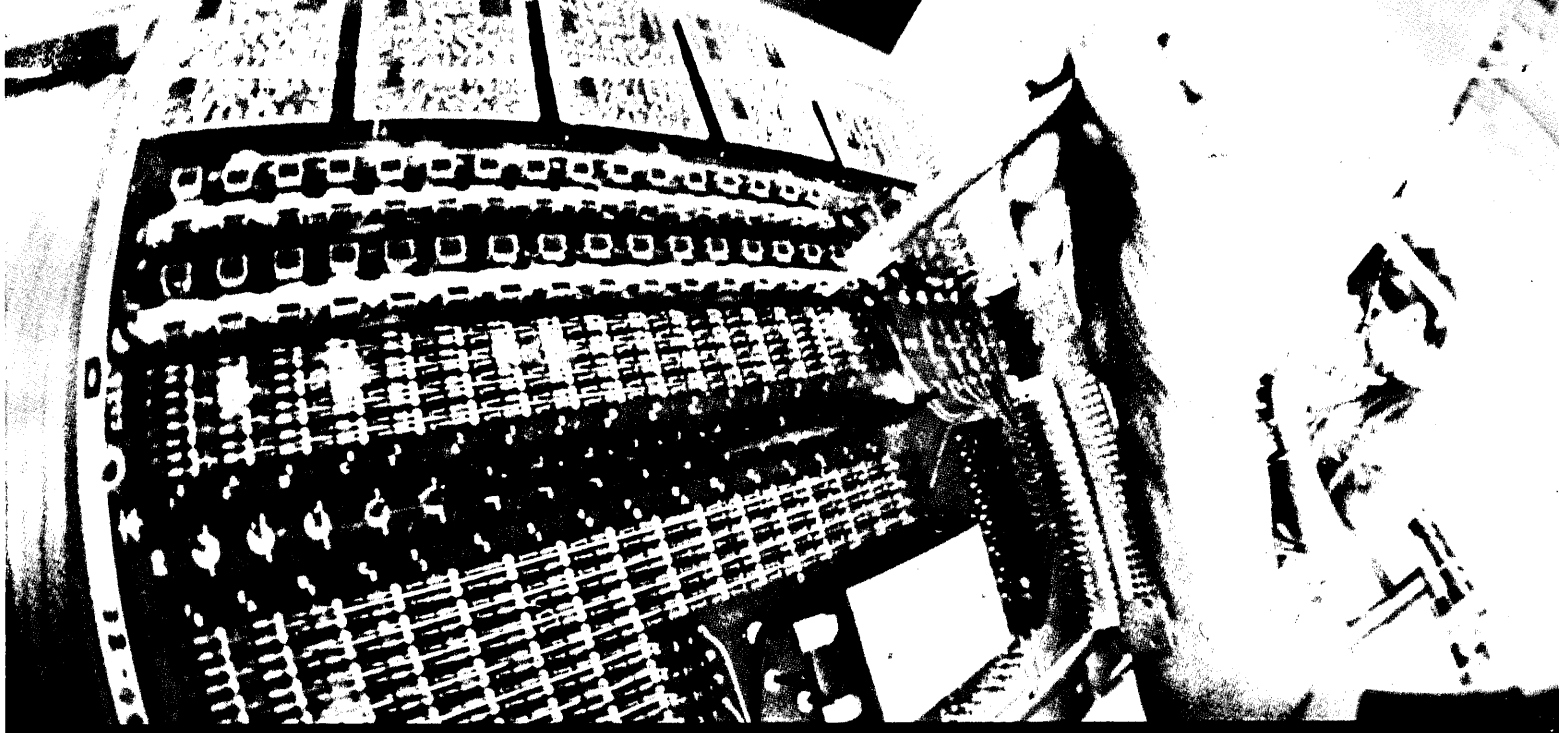

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How? By bundling micro-program instruction sets into user-oriented FIRMware packages—at a savings of up to 50% in some cases. Some of the packages available for the INTERDATA Model 4, in addition to the 76 basic general purpose instructions are:

- Fast Fourier Transforms
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These are some of the reasons why the Model 4 is the most effective and versatile general purpose computer available for the price.

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CIRCLE 80 ON INQUIRY CARD

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- Rugged construction
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- Designed for low-cost 9-pin miniature sockets

Interested? For more information on the new RCA NUMITRON Digital Display Devices, contact your local RCA Representative or write to RCA Electronic Components, Commercial Engineering, Section J202DE, Harrison, N.J. 07029. Also ask for data on the new RCA Integrated Circuit Decoder/Drivers, especially designed for use with RCA's Digital Display Devices.

Type Numbers of NUMITRON Digital Display Devices:

RCA-DR-2000—Numerals 0 through 9

RCA-DR-2010—Numerals 0 through 9, with decimal

RCA-DR-2020—Plus-Minus and Numeral 1

RCA-DR-2030—Plus-Minus

Unretouched photograph of operating NUMITRON devices mounted on plastic tubing.

RCA

Digital Display Devices