COMPUTER DESIGN

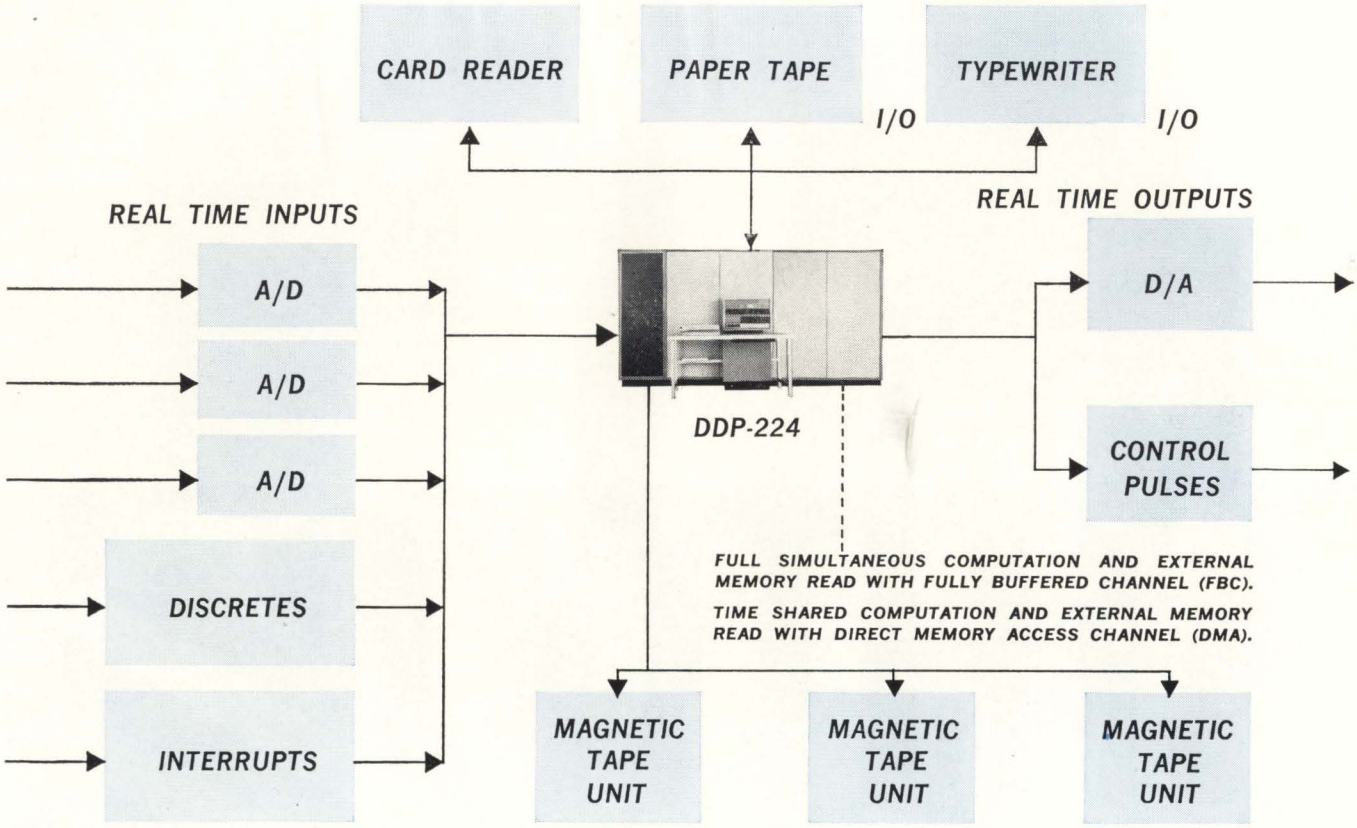
THE DESIGN AND APPLICATION OF DIGITAL CIRCUITS, EQUIPMENT & SYSTEMS

MARCH 1965

IN THIS ISSUE - FIRST OF A 5-PART SERIES

DESIGN GUIDE FOR COMPUTER-COMMUNICATIONS SYSTEMS
PART 1 - INTRODUCTION AND PROBLEM STRUCTURE

DDP-224
REAL TIME MACROMODULE*



DDP-224 is built for real time system teamwork. Functions comfortably in hybrid company. Communicates effectively with analog and digital system components. Solves complex problems in sophisticated system configurations. Applications to date include high energy physics research, jet transport flight characteristics simulation, Apollo mission simulation, and rocket engine operational display for automatic checkout. Special options make it possible to combine several DDP-224's into large scale integrated multi-processor systems. Off-line, DDP-224 offers even the occasional user a versatile problem solver with comprehensive support service including FORTRAN IV scientific programming software.

DDP-224 features 24-bit word, 1.9 μsecs (0.8 access) memory cycle, powerful command structure, and 260,000 computations per second. Transfer rates up to 325,000 words per second. 3.8 μsecs add. 6.46 μsecs multiply. 17 μsecs divide. 4096-word memory expandable to 65,536. Typical add time with optional floating point hardware 7.6 μsecs (24-bit mantissa, 9-bit characteristic). Fully program compatible with DDP-24. $96,000. Write for complete specifications.

**Mac' ro mod' ule — general purpose digital computer designed for special purpose systems implementation; a solution-oriented system "component" with off-line scientific capabilities.*

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Produces the most complete line of Optical Shaft-Angle Encoders

DIGISEC® Highest Accuracy Direct Reading Encoders . . . .

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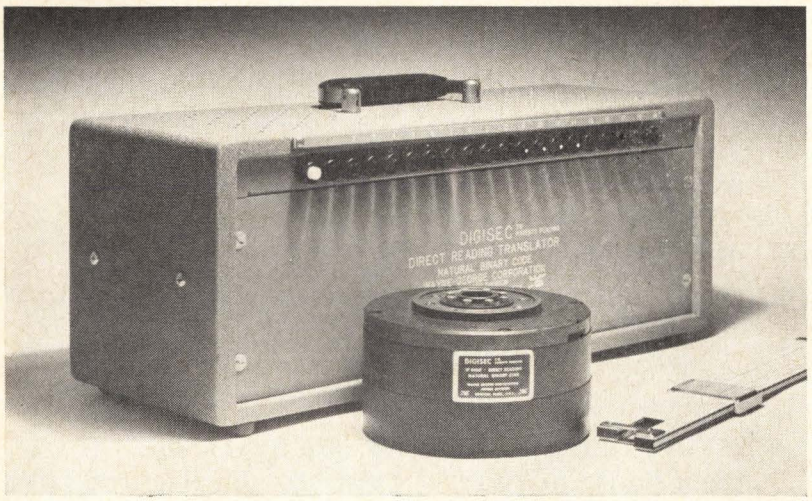

1 Arcsecond, Peak and Better

DIGISEC achieves highest accuracy in small case sizes with direct reading, continuous outputs — without code conversion, gears, brushes or reference rotor.

Optical Unit Diameter	Resolution
2.25″	to 40 arcseconds
3.5″	to 10 arcseconds
5.5″	to 2 arcseconds
10″	to 1 arcsecond

Outputs available in decimal or natural binary codes. Accuracy is ±1 quantum, peak. For example a 2^{20} DIGISEC provides resolution of 1.24 arcseconds and accuracy of ±1.24 arcseconds, peak. Complete system consists of Optical Unit and Translator containing electronics and display. The standard Translator weighs 15 lbs., is 6.5″ x 17″ x 7.5″, and can be miniaturized. Total input power for standard system is 30 watts. Bulletin 6310-1.

ARCSEC™ Highest Accuracy Incremental Encoders

Similar to DIGISEC Encoders in resolution, accuracy and size of Optical Unit, but providing incremental output with reduced electronic complexity. Available with direction sensing and zero reset signal. Bulletin 6310-1.

DIGISYN® Direct Reading Encoders for tracking, navigation, sampled data servos, indexing and positioning systems, and other readout applications.

CYCLIC CODE
2^{10} to 2^{15} Digits
Case Diameter: 3.5″
Bulletin 760-1C
(photo: RD-15)

CYCLIC CODE
2^{16} to 2^{17} Digits
Case Diameter: 10″
Bulletin 162-1
(photo: RD-17)

NATURAL BINARY
2^{5} to 2^{17} Digits
Case Diameters: 2.625″ to 10″
Bulletin 6302-2
(photo: NB-10)

DIGITAK® Incremental Encoders for rate measurement, angle counting, machine control, inertial platform systems — available with direction sensing and zero reset signal.

MINIATURE SYNCHROMOUNT
2^{10} to 2^{12} Digits
Case Diameter: 1.437″
Bulletin 6212-1
(photo: RI-12M)

STANDARD SYNCHROMOUNT
2^{13} to 2^{15} Digits
Case Diameter: 3.5″
Bulletin 861-1C
(photo: RI-20K)

PANCAKE
2^{13} to 2^{15} Digits
Case Diameter: 3.5″
Bulletin 862-2
(photo: RI-15S)

Special encoders can be designed to meet particular requirements. Available accessories include Power Supplies and Test and Display Sets.
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CIRCLE NO. 2 ON INQUIRY CARD

MARCH 1965 • VOLUME 4 • NUMBER 3

COMPUTER DESIGN

FOR ENGINEERING PERSONNEL RESPONSIBLE FOR THE DESIGN & APPLICATION OF DIGITAL CIRCUITS, EQUIPMENT, AND SYSTEMS IN COMPUTING, DATA PROCESSING, CONTROL AND COMMUNICATIONS.

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BPA Circulation over 20,000

FEATURES

DEPARTMENTS

CALL YOUR WIFE...YOU'LL BE HOME LATE FOR DINNER!

Just read these "worst-case" specs on the new NAVCOR 1mc module line* and you'll want to revise the specifications on your new design. We realize that your wife won't appreciate your excuse for working late, but your new "brainchild" deserves the best...

And if you want to put the blame on someone . . . BLAME NAVCOR!

When you add to these specifications: "System Function" versatility (one NAVCOR module can perform the functions of up to ten conventional cards); the most stringent quality control check in the industry (heat cycling equivalent to nine months use); instant check-out neon indicators; and one of the industry's most competitive pricing schedules . . . you'll quickly realize that you should know more about NAVCOR's new 1mc modules. Send in the quick-action coupon for full technical data.

* **Input noise immunity of 2.5v at frequencies of 1mc to 5mc.**
- **True 1mc speed through the use of parallel logic.**
- **Parallel operation of 120 binary counter stages at 1mc clock rate . . . with all outputs settling within 150 nanoseconds after the count pulse.**
- **Number of allowable stages of amplified logic between two flip-flops is minimum of 8 at 1mc clock rate.**
- **No external clamp supply required—Zener clamp supply on every card to cut power supply and wiring costs.**
- **Rise and fall time maximum of 100 nanoseconds.**
- **Complete ground shielding and ringing clamps to cut backplane "debugging" expense.**

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NAVCOR Valley Forge Industrial Park, Norristown, Pa.

YES! Please send me full technical information on NAVCOR'S new "System Function" compatible 1mc and 5mc modules.

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COMPANY_____

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CD-35

CIRCLE NO. 3 ON INQUIRY CARD

INDUSTRY NEWS

RCA AND SIEMENS & HALSKE A.G. OF GERMANY ANNOUNCED THAT THEY HAVE SIGNED PATENT LICENSE AND TECHNICAL INFORMATION AND SALES AGREEMENTS which will materially strengthen the position of both companies in the expanding, worldwide computer market. The 10-year patent license and technical information agreement is effective immediately. Under the patent license agreement, RCA has granted Siemens & Halske patent licenses for the manufacture and sale of data processing equipment. At the same time, Siemens & Halske has granted RCA patent licenses for the manufacture and sale of data processing equipment. Siemens & Halske and RCA will each make available to the other technical information relating to the engineering and manufacture of data processing equipment. Also included will be information on programming, testing, installation, training, and service and maintenance. The sales agreement is expected to result in substantial purchases by Siemens & Halske of the new RCA Spectra 70 series of computers. Siemens & Halske will market and service the electronic data processing systems it purchases from RCA, as well as those it manufactures itself, through its worldwide sales and maintenance organization. It also is anticipated that RCA will have available from Siemens devices and systems which can be included in the electronic data processing product lines of RCA.

LEEDS & NORTHRUP CO. WILL SUPPLY TWO DIGITAL COMPUTER SYSTEMS AND BOILER CONTROL EQUIPMENT totaling more than $1,000,000 for the new 1,800,000-kilowatt Keystone power station — the world's largest minemouth power plant — now under construction near Elderton, Pa. The two LN4000 digital computer systems, ordered by Gilbert Associates, Reading, design engineers for the project, will be used for performance monitoring, alarm scanning, data logging and efficiency studies on the No. 1 and No. 2 generating units at Keystone. Additionally, the systems will provide sequence monitoring and operational guides for starting and shutdown of the units.

SERVICES OF INDEPENDENT COMPUTER SOFTWARE FIRMS TO INDUSTRY AND GOVERNMENT ARE EXPECTED TO REACH OR EXCEED, $1 BILLION A YEAR BY 1970. This was predicted by Vernon D. Walker, president of Mesa Scientific Corp. He said that during the last five years the field of computer software — including everything from real-time programming to complete software package development — has been growing four to five times faster than the computer hardware industry. "Our long-range forecast is that the software field — particularly the independent companies — will continue to grow at this rate, at least from now until the end of this decade", Mr. Walker said.

SALES OFFICES

BOSTON

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W. Concord, Mass.
phone: (617) 369-6660

CHICAGO

Phil Holmes
410 N. Michigan Avenue
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phone: (312) 467-6240

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DATA COMMUNICATIONS

equipment for on-line, real-time processing

the shift-less keyboard that isn't!

Shifting between letters and numbers is no longer necessary as a result of the new 4-row keyboard on Teletype Models 33 and 35 page printers and automatic send-receive sets. However, when used in real-time data communications, these machines are anything but shiftless on the job.

"COMPUTER" SPOKEN HERE

Operating on the same permutation code approved by the American Standards Association for information interchange, this Teletype equipment can communicate with most business machines and computers. It is being used as input/output terminal gear in such applications as communications between branch offices and a centralized computer, making a data processing center available to all company offices.

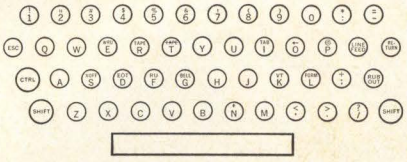
machines that make data move

b_7 →	0	0	0	0	1	1	1	1
b_6 →	0	0	1	1	0	0	1	1
b_5 →	0	1	0	1	0	1	0	1
b_4 b_3 b_2 b_1 ↓								
0 0 0 0	NULL	DC_0	b	0	@	P	UNASSIGNED	UNASSIGNED
0 0 0 1	SOM	DC_1	!	1	A	Q		
0 0 1 0	EOA	DC_2	"	2	B	R		
0 0 1 1	EOM	DC_3	#	3	C	S		
0 1 0 0	EOT	DC_4 (STOP)	$	4	D	T		
0 1 0 1	WRU	ERR	%	5	E	U		
0 1 1 0	RU	SYNC	&	6	F	V		
0 1 1 1	BELL	LEM	' (APOS)	7	G	W		
1 0 0 0	FE_0	S_0	(	8	H	X		
1 0 0 1	HT SK	S_1	)	9	I	Y		
1 0 1 0	LF	S_2	*	:	J	Z		
1 0 1 1	V_{TAB}	S_3	+	;	K	[		
1 1 0 0	FF	S_4	, (COMMA)	<	L	\		ACK
1 1 0 1	CR	S_5	–	=	M	]		ⓘ
1 1 1 0	SO	S_6	.	>	N	↑		ESC
1 1 1 1	SI	S_7	/	?	O	←		DEL

The American Standard Code is composed of eight columns of 16 characters each. Control characters, found in the first two columns, include those required for the control of terminal devices, input and output devices, format, or transmission and switching operations. Common punctuation symbols are found in the third column, numbers in the fourth, and the alphabet in the fifth and sixth columns. The final columns are reserved for future standardizations. Teletype Models 33 and 35 sets generate an even parity in the eighth level.

PRINTS ON BUSINESS FORMS

Any business form, such as invoices, payroll checks, sales orders, freight records, and reservations, can be typed on these Teletype sets and transmitted directly to various departments. This minimizes recopying errors. The 4-row keyboard further reduces the possibility of errors, because it isn't necessary to shift when typing numbers. Notice the similarity to a regular typewriter keyboard, which is why any typist can easily learn to use these new machines.



VERSATILITY PLUS

Added to the versatility of the 4-row keyboard is the complete reliability and economy of Teletype equipment. It's built to last, with pneumatic shock absorbers, nylon pulleys and gears, and all-steel clutches that keep maintenance down to a bare minimum. And, these sets are surprisingly low in cost.

That's why Teletype Models 33 and 35 page printers and automatic send-receive sets are made for the Bell System and others who insist on the most reliable communications equipment at the lowest possible cost. For more details on the capabilities of the Teletype 4-row keyboard in real-time data communications, write to: Teletype Corporation, Dept. 71C, 5555 Touhy Avenue, Skokie, Illinois 60078.

TELETYPE®

CIRCLE NO. 4 ON INQUIRY CARD

INDUSTRY NEWS

THE FIRST USER INSTALLATION IN EUROPE OF A HONEYWELL 200 ELECTRONIC DATA PROCESSING SYSTEM HAS BEEN MADE ON SCHEDULE at the New Southgate, North London, England, plant of Standard Telephone and Cables Limited. The system will be used by two product divisions of Standard Telephone and Cables for integrated production control. Its basic objective is to help reduce by as much as three months the existing manufacturing cycle for major products. The present production cycle ranges from nine to fifteen months. Such a time savings will increase the output of the plant and reduce inventory charges by about $300,000 a year, the company said. Orders will be analyzed, materials and machines scheduled, work-in-progress measured and output costed by the computer. The system consists of a central processor with 24,576 characters of memory, a card reader/card punch, six half-inch magnetic tape units with transfer rates of 20,000 characters per second and a high-speed printer that operates at 900 lines a minute.

A $1,572,326 CONTRACT HAS BEEN AWARDED BY NASA TO MONITOR SYSTEMS, INC., Fort Washington, Pa., for two telemetry systems to be installed at the Merritt Island Space Port, Kennedy Space Center, Florida. Under terms of the fixed price contract, Monitor Systems will fabricate in Fort Washington two digital telemetry systems. The systems will be used as intermediate data converters and processors during Apollo Saturn V rocket launches from Merritt Island.

TELEMETRICS, INC. OF SANTA ANA, CAL. HAS RECEIVED A CONTRACT EXCEEDING $67,000 from Astrodata Corp., of Anaheim, Cal., for six Model 6203A Digital Signal Synchronizers. As a part of the Pacific Missile Range modernization program, the Model 6203A synchronizers will be used in the construction of telemetry ground stations. Input into these systems may be from transmission lines, rf receivers, tape recorders, simulators, or other devices. The Model 6203A is an advanced, universal, self-contained unit capable of accepting all standard PCM (pulse code modulation) codes. Containing a patented digital phase-lock loop, the synchronizer regenerates the PCM serial pulse train, converts the data to the proper output format, and generates a precise clock signal which is in frequency and phase synchronization with the input bit rate.

RAYTHEON COMPANY RECENTLY PURCHASED, FOR AN UNDISCLOSED AMOUNT, THE COMPUTER MEMORY BUSINESS OF PHILCO CORP. AERONUTRONIC DIVISION. To be integrated into the Raytheon Computer operation at Santa Ana, Cal., the purchase includes: BIAX, a proprietary high-speed computer memory device, along with associated research and development; and MicroBIAX, a recently announced ultra high-speed memory unit. Annual volume of Aeronutronic's memory business is between $1 and $2 million. Acquisition of this advanced memory technology and capability is a significant step in building a fully integrated scientific computer capability, according to Joseph A. Ricca, Raytheon Computer general manager. For example, he added, Raytheon's stored logic 440 computer uses BIAX elements in one of its two memories.

DATA COMMUNICATIONS

equipment for on-line, real-time processing

put punch in your communications...with paper tape

The continuous evolution of data processing systems has brought new uses for punched paper tape. In fact, paper tape has become an important communications link, and is still the most inexpensive and reliable continuous recording medium available.

Paper tape is easy to handle and accommodates data of any length. In addition, Teletype paper tape units can transmit most recognized codes, including the permutation code approved by the American Standards Association for information interchange. This makes Teletype sets capable of communicating directly with business machines and computers.

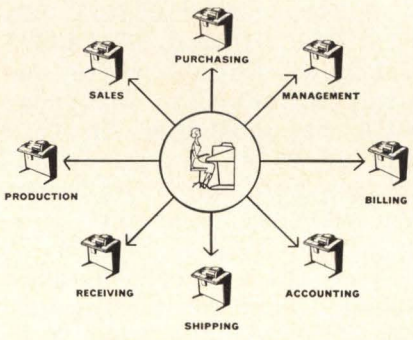
COLLECTION AGENT

Teletype punched paper tape units are versatile, flexible, and capable of collecting and distributing data from a large number of machines and transmitting to computers at high speeds. There is a paper tape unit for every need—from 60 to 2000 wpm.

Many business operations have been improved through the use of Teletype punched paper tape equipment within integrated data processing systems. This list includes: order entry, shipping, and invoicing for the accounts receivable procedure; production control; payroll computation; banking operations, insurance processes, etc. An important advantage of punched paper tape is that it can store fixed information, such as customers' names and addresses, which can be used over and over again to save retyping.

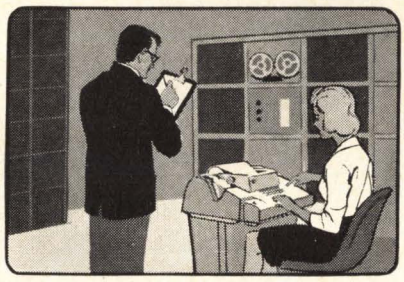
INDEPENDENT OPERATOR

On the Teletype Model 35 ASR (automatic send-receive) set, the tape punch and reader can operate independently of the page printer. Thus, messages can be received by the page printer, while the operator is preparing a tape for later transmission. This independent operation also means the keyboard can be used to prepare one tape, while the tape reader transmits the message of another tape.



VOICE OF A COMPUTER

Applications of Teletype equipment as input/output terminals for computers and other business machines are numerous. For example: a national insurance company has demonstrated a system that will link a large multiprocessing computer with more than 900 district offices. Teletype Model 33 ASR sets will be used in this system to print out premium information from the district offices, and as tape output equipment for a centralized computer in order to update all premium transactions.



This is another indication why these Teletype paper tape units and automatic send-receive sets are made for the Bell System and others who insist on the most reliable communications equipment at the lowest possible cost. To find out more on how they can be an important part in your data processing systems, write to: Teletype Corporation, Dept. 71C, 5555 Touhy Avenue, Skokie, Illinois 60078.

machines that make data move

TELETYPE

CIRCLE NO. 5 ON INQUIRY CARD

INDUSTRY NEWS

A NEW $23,500 PRICE FOR ITS 250 DIGITAL COMPUTER WAS ANNOUNCED RECENTLY BY RAYTHEON COMPANY. At the same time, the firm broadened substantially the 250's use for general scientific and engineering computing by offering a Fortran II programming package compatible with all earlier Fortran versions. The new price is for a rack-mounted unit with 3856 words of memory and a heavy-duty input/output electric typewriter with paper tape punch and reader. Previous price for this combination was $32,400. Prices of memory extension units, magnetic tape, paper tape and punched card equipment and other peripheral and accessory items remain the same. A new digital graph recorder for producing 29½-inch charts or graphs from computer output is also now available for $9500.

A SEMINAR ON "LOGICAL DESIGN FOR DIGITAL SYSTEMS," intended primarily for design engineers in industry, will be conducted in four cities this spring, by RCA Institutes' School of Custom Educational Programs. Beginning with a review of logic, the program develops design techniques using Designation Numbers, Logic Map, and Boolean Matrices. Effective methods for designing functional digital systems from logic blocks are covered in detail. The five-day seminar will be presented in New York City, March 22 through 26; Washington, D.C., April 5-9; Chicago, May 17-21, and Cleveland, June 7-11. For further information, write or call: BRADFORD DAGGETT, DIRECTOR, SCHOOL OF CUSTOM EDUCATIONAL PROGRAMS, RCA INSTITUTES, 350 WEST 4TH ST., N.Y.C. Tel: (212) YUkon 9-2000.

THE DATA PROCESSING INDUSTRY WILL HAVE ITS BIGGEST YEAR IN 1965, with annual shipments reaching $1.6 billion for the first time in history. Installations of EDP systems will exceed 20,000 by the end of next year, up from 16,000 at year's end this year. Total cumulative value of installed systems will exceed $6.8 billion by the end of 1965. These forecasts were made by Walter W. Finke, president of Honeywell's electronic data processing division, in a year-end statement. Mr. Finke said the cumulative rate of increase in installed systems will start to decline next year as many earlier computers reach the end of their useful life. "The past year has been one of transition in the EDP industry, in which the rate of obsolescence of existing equipment was hastened by introduction of a large number of new systems. As a result, there has been a dramatic increase in the size of the replacement computer market," Finke said.

He said the replacement market has been recognized as a large and growing share of the total EDP market by many manufacturers who introduced new equipment this year. This factor has also accelerated development of several trends which will become more apparent in 1965, according to the Honeywell executive.

ABACUS, INC., MANUFACTURER OF DIGITAL LOGIC MODULES, HAS BEEN ACQUIRED BY THE WHITTAKER CORP., A LEADING WEST COAST AEROSPACE FIRM. The entire operation of Abacus, as a division of Whittaker, has been transferred from Santa Monica to North Hollywood, California. Fred Zimmerman has been designated manager of the division.

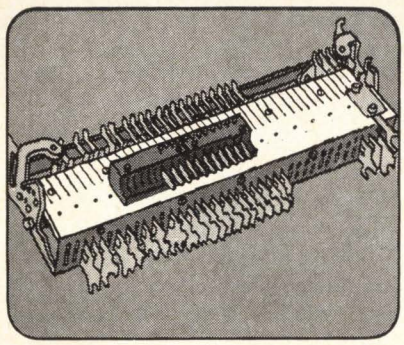
DATA COMMUNICATIONS

equipment for on-line, real-time processing

stunt box..your communication's girl friday*

An important component of all Teletype Model 35 page printers and automatic send-receive sets is the stunt box. This is an automatic switching device which performs remote control functions usually expected only of larger, costlier, and more complex equipment.

The stunt box handles anything that can be electrically controlled—ranging from performing such non-typing functions as automatic carriage return and horizontal tabulation . . . to activating remote apparatus, including tape punches and readers, business machines, and computers.



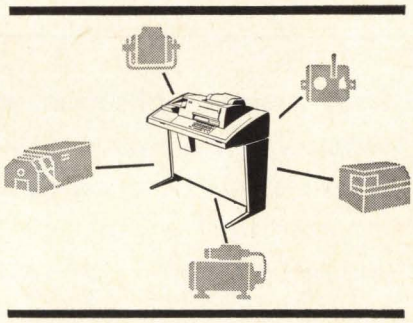
Basically, the stunt box does three things—mechanically initiates internal functions, electrically controls internal functions, and electrically controls external equipment.

STATION CALLER

Remote stations can be selectively called through the stunt box. Thus, one station can call others simultaneously, individually, or in predetermined groups. In this way, specific information can be selectively directed only to the stations specifically concerned with the information being transmitted. For example: an operator types out a sales order on a Teletype Model 35 page printer. Such information as the order number is received by all departments, while cost information is directed by the stunt box only to accounting, billing, and management departments.

AUTOMATIC BACK TALK

Teletype Model 35 sets can be equipped with an answer-back drum, which stores up to 20 characters. In on-line uses, the stunt box at a remote unattended station can trigger the answer-back mechanism so that the station automatically returns its identification call letters to the sending station.



The stunt box can activate the mechanism that automatically feeds the information needed to program a computer so that it can accept the input data which follows.

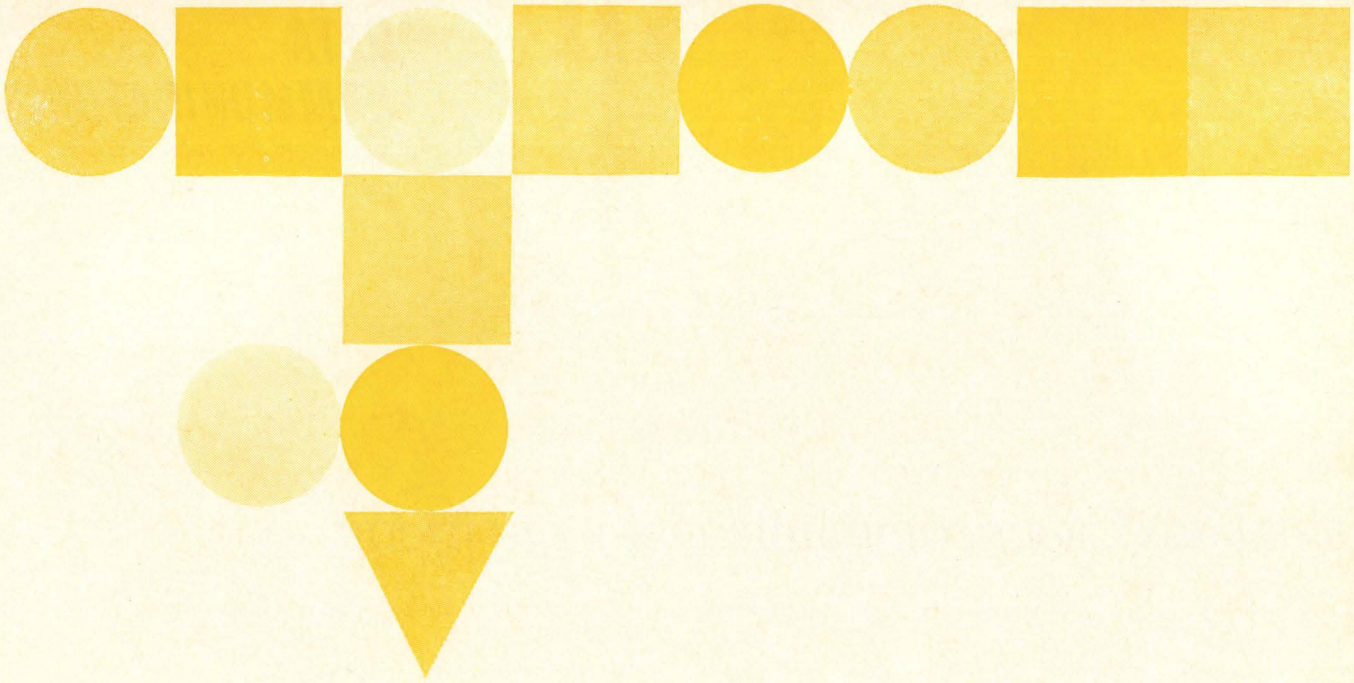
The versatility that the stunt box gives to Teletype Model 35 page printers and automatic send-receive sets is another reason why they are made for the Bell System and others who require the most reliable communications equipment at the lowest possible cost. For more detailed information on the real-time uses of Teletype equipment, write to: Teletype Corporation, Dept. 71C, 5555 Touhy Avenue, Skokie, Illinois 60078.

*This device is used in Teletype machines to perform non-printing functions such as carriage return, line feed, etc.

machines that make data move

TELETYPE

CIRCLE NO. 6 ON INQUIRY CARD



Four major application areas of telemetry — aerospace, industrial, biomedical, and oceanography — will be covered in this year's National Telemetering Conference. Many papers and discussions will center around transmitting digital information and/or the converting of telemetry data to digital computer format.

In addition to the technical sessions, a commercial and scientific exhibition will be held in the Hall of Exhibits of the Shamrock Hilton. Over 100 booths will display the latest in telemetry systems, equipment, and accessories.

All papers will be published in a Proceedings which will be given to all registrants. Registration hours, prior to opening day of the Conference, are 12 noon to 6:00 P.M. Tuesday, April 12 in the lobby of the Shamrock Hilton.

Here is a brief summary of some papers that should be of interest to readers of COMPUTER DESIGN.

Conference Papers

THEORETICAL CONSIDERATIONS IN AN EFFICIENT PCM DATA COMPRESSION SYSTEM

N. Estersohn, Bendix — Pacific Div., N. Hollywood, Cal.

Redundancy computer design, buffer storage, coding logic, and adaptive sampling techniques will be examined in this paper. Results of a comparison between zero-order hold and a predictor with memory, based on statistical concepts, will be presented.

COMPRESSION OF BIOASTRONAUTICAL DATA

H. Germond, Pan American ETR, Patrick Air Force Base, Fla.

This paper is a report on real-time transmission of the information contained in an electroencephalogram. The connecting process in a digital computer will be described. Results will be illustrated for normal and for pathological EEG traces.

DIGITAL TV COMPRESSION — FACT OR MYTH

G. L. Raga, Electro-Mechanical Research, Inc., Sarasota, Fla.

In an attempt to standardize the specification of compression, four relationships for calculating digital television bandwidth compression will be presented. Misconceptions regarding compression will be explained. The compression techniques will be analyzed on the basis of the fundamental limitations of digital television, compression, and the four relationships.

A SYNOPSIS ON DATA COMPRESSION

D. R. Weber, Lockheed Missiles & Space Co., Sunnyvale, Cal.

This paper will assess an adaptive process for transmitting sampled data at rates consistent with the information rate or activity and accuracy requirements of the signal source. It is possible to achieve data compression by **adaptive sampling** or by **redundancy reduction:** the process of regulating the sampling frequencies of each multiplexer gate to correspond with the information rate of the source. This paper will give considerable attention to the queueing buffer problem and discuss the philosophy and implementation of adaptive buffer control. Results showing the effects from adaptive aperture and adaptive filtering as they pertain to data fidelity and buffer queue length will be presented.

1965 NATIONAL TELEMETERING CONFERENCE
SHAMROCK HILTON HOTEL
HOUSTON, TEXAS • APRIL 13, 14, 15

OPTIMUM PCM SYNCHRONIZATION

V. L. Taylor, Telemetrics, Inc., Santa Ana, Cal.

Criteria involved in the optimum synchronization of PCM telemetry signals will be discussed. Also to be covered will be a mathematical model using the transition diagram method with information levels, sync levels, and sync modes as variables. Computer-derived optimum values will be presented.

A THEORY OF ADAPTIVE TELEMETERING

P. A. Wintz, Purdue University, Lafayette, Ind.

A philosophy of adaptive telemetering will be presented, including a theory of adaptive reception of telemetry signals and the results of experimental programs designed to test the theory.

APPLICATION OF TELEMETRY TECHNIQUES TO HARD LINE TRANSMISSION OF BIOMEDICAL INFORMATION

M. Freed, U.S. Naval Air Development Center, Johnsville, Pa.

A pulse-tone multiplex system developed to permit real-time magnetic recording at the Aviation Medical Acceleration Laboratory will be described. The method utilizes the available analog-to-frequency conversion of the telemetry system and presents on printed tape (with the use of programmed digital logic) those parameters, which by their relationship to one another, could help affect the required course of the program.

DIGITAL TELEMETERING MADE EASY — AND INEXPENSIVE

L. C. Menkes, Quindar Electronics, Inc., Springfield, N.J.

An increasing movement to the transmission of data digitally can be attributed largely to the appearance and availability of simplified modules that can be easily integrated into systems. This paper will deal with hardware and applications in the power, petroleum and gas industries.

MICRO-PCM MULTIPLEXER AND ENCODER

J. D. Corry, Radiation, Inc., Melbourne, Fla.

The electrical and mechanical characteristics of a microelectronic PCM encoder with 50 high-level (0-5 volts) analog channels and 96 digital-input channels will be offered in this report. Bit rates of 200 kc or below are available.

TELEPHONE TRANSMISSION OF ELECTROCARDIOGRAMS AND ON-LINE COMPUTER DIAGNOSIS

A. S. Berson, F. W. Stallman, J. H. Broderick, and H. W. Pipberge, Veterans Administration Hospital, Washington, D.C.

The use of digital computers for analysis of electrocardiograms is rapidly expanding. This report will cover a system serving to carry electrocardiograms recorded on magnetic tape over regular telephone lines to a computer installation at the National Bureau of Standards in Washington, D.C. A complete procedure for analysis of an individual electrocardiogram can be done in less than eight minutes from the time the electrodes are applied to the patient.

HIGH FREQUENCY DIGITAL OCEAN DATA TELEMETRY

R. H. Taplin and R. E. Gray, ITT Federal Laboratories, Nutley, N.J., and R. Walden, Woods Hole Oceanographic Inst., Woods Hole, Mass.

Data telemetry from mid-ocean based buoy sensors is constrained by power limitations in the buoy terminal. Results of long distance high-frequency digital data transmission experiments from low power telemetry buoys will be discussed and some system optimization parameters presented.

APPLICATION OF TELEGRAPH TRANSMISSION AND COMPUTER TECHNIQUES TO SUPERVISORY SYSTEMS

C. R. Ahooja, Canadian Aviation Electronics Ltd., Montreal, Canada

This paper is an appraisal of the trend toward centralization of control of remote sites by computers which offers a natural application of telegraph transmission and computer techniques to supervisory control and telemetering systems for pipe lines, tank farm and process control systems, etc.

SUPERVISORY CONTROL EQUIPMENT USING STANDARD TELEGRAPH TECHNIQUES

M. A. Fraser, Canadian Aviation Electronics Ltd., Montreal, Canada

The use of binary codes capable of operation with standard input-output equipment such as teleprinters on telegraph or voice channels will be discussed. Equipment consists of solid-state modules capable of application to simple or complex supervisory situations.

S	M	T	W	T	F	S	
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	✓	✓					EVENTS

COMPUTERIZED TELEMETERING SYSTEMS

T. J. Blocher, Dresser Controls, Inc., Houston, Tex.

This paper will discuss the reasons for using a digital computer on a telemetering system and the various functions which the computer can perform. Also to be described: methods of providing interface between the computer and the telemetering equipment.

PROGRAMMED DIGITAL GENERATOR

D. N. Hutchinson, E. Paranchych, and P. G. Bowie, Bell Tel. Co. of Canada, Toronto, Canada

This paper will describe a programmed digital generator and how it can provide format and machine control when used with teletypewriter apparatus.

ALL-DIGITAL AND COMPUTER TECHNIQUES FOR DETECTING PCM FRAME SYNC THRESHOLD

R. B. Lowry, General Dynamics/Astronautics, San Diego, Cal.

All-digital and computer techniques for detecting PCM frame sync threshold are more reliable and more accurate than analog threshold detection. Several all-digital techniques and computer subroutines will be shown and their operating rates determined.

COMPUTERS IN CARDIOVASCULAR SIMULATION

D. E. Kolbert and P. I. Wolf, Control Data Corp., Minn., Minn.

This paper will review the progress made in physiologic simulation of the cardiovascular system and then describe the technique and equipment being used: a high-speed A/D and D/A conversion system interfaced to a fast, medium, scale, digital computer to accept both real-time physiologic data and analog computer outputs.

PROJECT CELESCOPE — AN ASTRONOMICAL DATA PROCESSING SYSTEM

A. D. Robinson, R. K. Paxton, and W. N. Waggener, Electro-Mechanical Research, Inc., Sarasota, Fla.

A report on the data system designed to collect and process stellar spectral data in the vacuum ultraviolet. The system consists of four ultraviolet-sensitive telescopes and television cameras with both digital and analog output capability and a digital command system.

DIGITAL TELEMETERING AND COMPUTER CONTROL TECHNIQUES APPLIED TO WATER DISTRIBUTION SYSTEMS

D. J. Moon and J. S. Luscombe, Jas. MacLaren Ltd., Toronto, Canada

A description of the design and operation of a digital telemetering system used for collection and logging of essential data relative to a number of unattended automatically-controlled water pumping stations. The data are required for ultimate input to a process control computer for system load optimization.

NOTE ON JANUARY ISSUE

We are pleased with the many complimentary letters we received on the last January issue's Product Reference File — Perforated Tape Readers. However, we are unhappy about the unfortunate transpositional error that occurred in Table II on page 35. On the top of that page are photos and descriptions of Teletype Corp.'s Model DRPE tape punch and Friden's LCC-S Justowriter, but our **former** paste-up artist switched the photos. There was one consolation — the company nameplates, visible on the photos, helped to reduce the confusion.

FIRST SOLID-STATE OPTICAL ENCODERS—NO LIGHT BULBS

Rugged, durable gallium arsenide light sources are used in the new Litton solid-state optical encoders, guaranteeing exceptional reliability under extreme environments. Tungsten lamp instabilities and failures—a chronic problem with conventional photoelectronic shaft-to-digital encoding devices—are eliminated. Both power consumption and heat dissipation are far less than for comparable ordinary optical devices. MTBF—very conservatively rated—is 30,000 hours. The high reliability of all Litton solid-state encoders under adverse conditions is exemplified by the 2^{11} incremental Model No. IN35-11G1 shown. It operates dependably and accurately during 70-g shocks and recovers from 105-g shocks. The case, including associated electronics, is size 35. Operating speed is 480 rpm. Other environmental characteristics meet or exceed applicable military specifications. While especially well suited to applications employing incremental positioning devices, the Litton solid-state optical encoding technique can be applied to absolute position encoders and any code pattern. For details, write: 7942 Woodley Ave., Van Nuys, California. Phone 213-781-2111. New York: 212-524-4727. Chicago: 312-775-6697.

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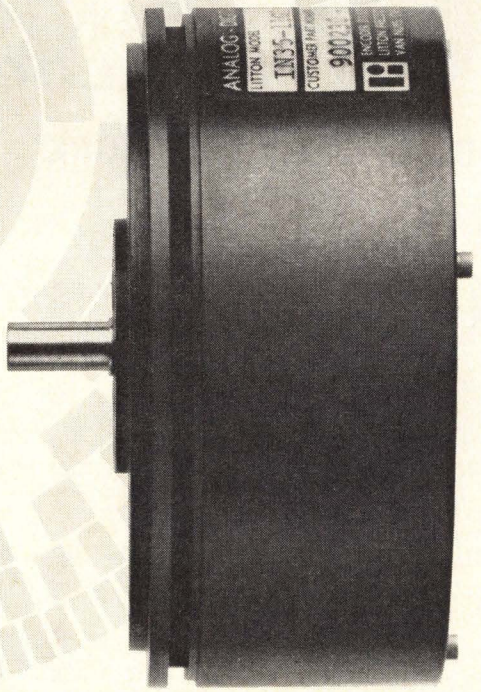

Optical ■ ■ ■ ■ Solid-State Optical ■ ■ ■ ■ ■ Magnetic ■ ■ ■ ■ ■ Contact

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	✓	✓					EVENTS

AUTOMATIC DATA COLLECTION AND INFORMATION TRANSFER-ELECTRIC POWER

R. E. Godfrey and T. W. Hissey, Leeds & Northrup Co., No. Wales, Pa.

This paper covers the application of automatic data collection and information transfer equipment in the electric power industry — both analog and digital telemetering equipment.

A DIGITAL TELEMETRY SYSTEM FOR INDUSTRIAL METER READING AND CONTROL APPLICATIONS

J. Chapsky, Lufkin Research Labs., Inc., Los Angeles, Cal.

This paper will describe a telemetry system for collecting data from residential power, gas, and water meters as well as for remote monitoring of data in industrial plants, oil and gas lines, and oil wells. The system is also capable of control functions.

MESSAGE SWITCHING AND REMOTE DATA PROCESSING

Neil Clark, Control Data Corp., Minneapolis, Minn.

A communication system centered around a general-purpose digital computer programmed to provide message switching will be described. Processing of the data while contained in the system will lead, it is predicted, to total information control systems.

IEEE CONFERENCE ON IMPACT OF BATCH FABRICATION ON FUTURE COMPUTERS

Thunderbird Hotel • Los Angeles April 6-8

Program for April's IEEE conference concerning batch fabrication's impending impact on computers was recently announced, midst early-year forecasts of 20-fold microcircuit increases and radical computer design changes. Seven sessions exploring the ramifications of microelectronics and other batch fabrication processes on computer technology, design, and use are scheduled, according to Program Chairman Samuel Nissim. The national conference will be held at the Thunderbird Hotel, Los Angeles, April 6-8.

Dr. Simon Ramo, president of Bunker-Ramo Corp., Canoga Park, Cal., is the keynote speaker, and Col. Arthur C. Lowell, president of General Micro-Electronics, Inc., Santa Clara, Cal., is the April 7 luncheon speaker. Lowell will discuss "Microelectronics — Fact or Fiction?"

"The electronics industry foresees a $1 billion-plus microelectronics market by 1974, with computers consuming the lion's share of these devices," Nissim said in citing the significance of the conference. "With other batch fabrication advancements in the areas of memories, displays, bulk storage, and input-output, a computer technology revolution may be in the making," he concluded.

Insufficient attention has been given to batch fabrication's effect on logical design, machine organization, systems design, programming, applications, and other broad computer aspects. The sessions are geared to stimulate thinking in these areas.

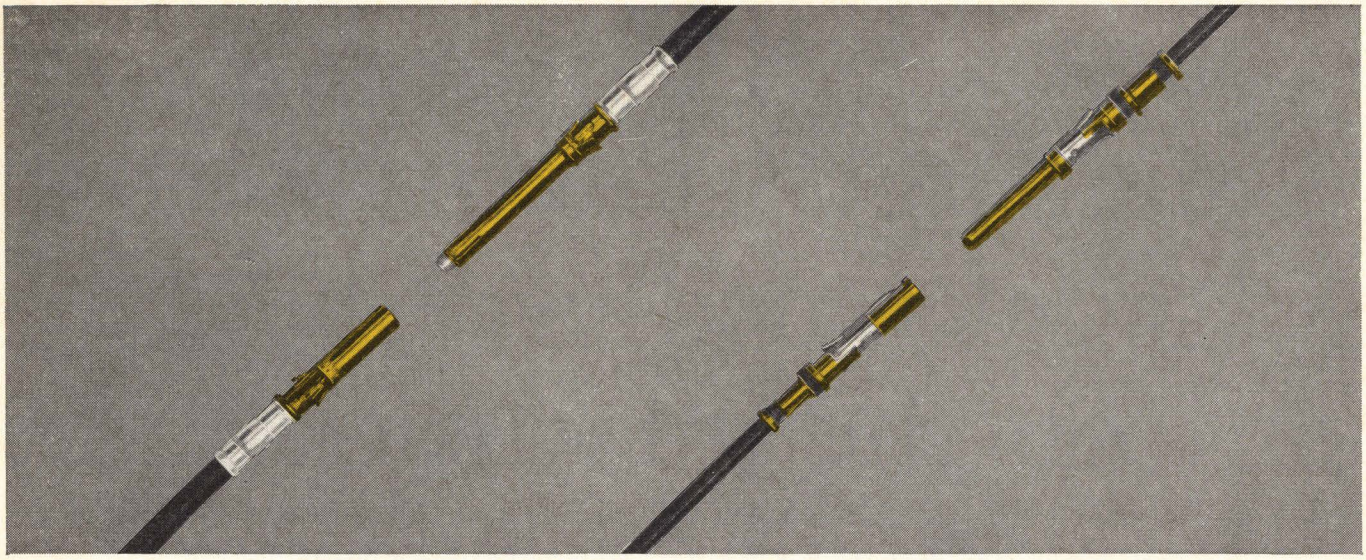
Unlike most conferences, technical papers will not be formally presented. Proceedings are to be distributed to registrants a month in advance for study, and authors will summarize papers before subjects are open for discussion.

"We think this is the key to a productive conference. It permits introduction of new materials, audience interests, and opposing views," Nissim said. To achieve cross-pollination of knowledge and experience, Nissim urges attendees to thoroughly study the proceedings, and prepare critiques and evaluations of papers which affect their areas of interest.

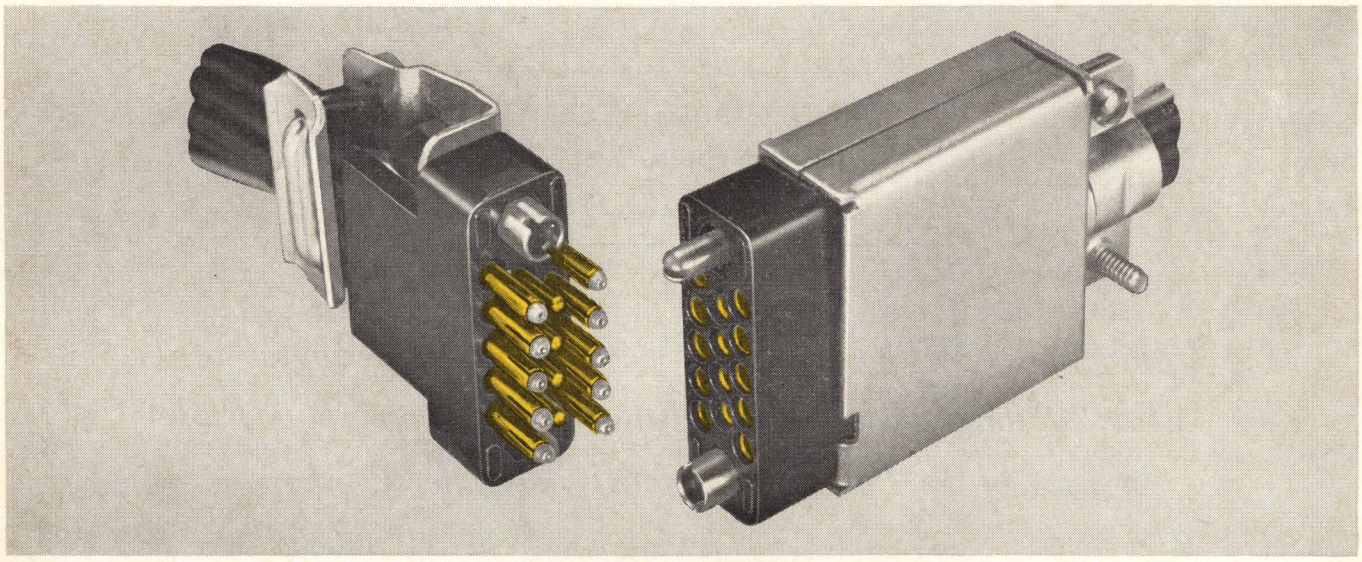
The initial session, "Technologies Amenable to Batch Fabrication," is intended to provide broad surveys of the most significant technologies likely to affect computers of the future. The conference then proceeds to examine the impact of these technologies on successively higher levels of computer design, organization, and implementation, concluding with a look at the computer engineer himself.

Small informal evening sessions are scheduled to supplement the general program, and workshop and epilogue sessions are set the final day for summaries and conclusions.

Advanced registration ($7.50 for members and $10 for non-members) may be made by writing Donald Meier, Registration Chairman, 1401 El Segundo Blvd., Hawthorne, Cal.



Coaxial Pin and Socket



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Now you can bring power and shielded signal circuits through the same connector . . . in any combination! AMP's new subminiature coaxial contacts match any size 16 pin and socket, snap into the same housings wherever your application calls for them.

Both contact styles feature long-life closed-entry design and gold plating. Since they both fit the same diameter cavities, you are not limited to special configurations. And you can select from a variety of connector configurations ranging from 14 to 104 positions in diallyl phthalate or phenolic blocks; as well as types with pre-assembled die-cast aluminum shells. Versatility like this will reduce your inventory problems.

And think of the savings per installed connector! Coaxial contacts are applied with a single stroke of the A-MP★ tool which simultaneously crimps center conductor, braid and cable support—a technique originated and championed by AMP. Their two-piece design includes complete contact assembly and a separate ferrule. Pin and socket contacts, of course, are available in strip form for high-speed automachine application. So . . . whether you mix or match contacts, you get not only quick, easy assembly, but the kind of uniform reliability that eliminates rejects.

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3) Terminate your leads with AMP's matched hand or machine crimping tool
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the largest international conference ever held on the information processing sciences...

IFIP CONGRESS 65
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MAY 24-29, 1965

United States Will Host The Triennial World Congress of the International Federation of Information Processing (IFIP) in Lieu of the 1965 Spring Joint Computer Conference.

TECHNICAL PROGRAM

The technical program will provide a comprehensive view of significant progress in techniques and development in the information sciences. Formal papers will be presented in **general** and **special** sessions. Shorter papers, with more time for informal discussion, will be presented in **symposia** and **panel** sessions.

Some of the topics include:

- Trends in Computer Design
- Automata Theory and Switching Theory
- Artificial Intelligence
- Organization of Large Storages
- Pattern Recognition Devices
- High-Speed and Read-Only Memories
- Microelectronics and Integrated Circuitry
- Digital Automatic Control
- Hybrid Analog-Digital Systems
- Design of Information System
- Electro-Optical Information Processing
- Parallel and Concurrent Systems
- Remote Consoles and Displays
- Message Switching Systems

EXHIBITION — INTERDATA 65

Approximately 35,000 sq. ft. of display area adjacent to the technical meetings in the New York Hilton will contain an international exposition of hardware related to information processing. Displays will include computers, digital communications systems, storages and memories, advanced digital components and circuits, input-output equipment and other related components and systems.

REGISTRATION

Registration fee: By April 1, 1965 ..... $25
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For registration forms write:
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Everybody talks about tape transport reliability.

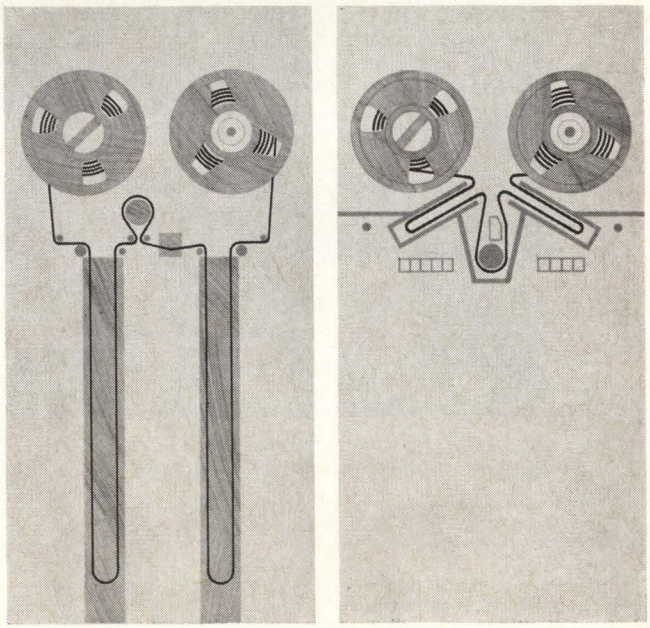
When we say reliability we mean one billion stop/start operations without replacing a single part.

Reason? A simple (but revolutionary) single capstan drive concept that eliminates the rollers that pinch, the critical adjustments—all of the things that have previously made the transport the weak link in a computer system. Heart of the new concept is a single capstan drive and a low-friction tape path. The tape is held in contact with the capstan at all times by uniform tension derived from vacuum columns. Regardless of variations in the friction properties of the tape or mechanism, tape motion over the read/write head directly follows the servo-controlled motion of the capstan surface. The idea is simple. The results are extraordinary. The Ampex single-capstan-drive concept provides a previously-unheard-of MTBF of more than 2000 hours. It delivers 10^9 start/stop operations before minor replacement parts are needed in the drive mechanism.

In tests with data, 33 data blocks of 1024 bits (all "1's" in IBM format) were recorded at 800 bpi and re-read cyclically. *More than 160,000 passes of this one section of tape were made without a single bit error.* Everybody talks about "state-of-the-art" in tape transports. Ampex has delivered it. The new Ampex single-capstan transports are available in two configurations:

The high-speed TM-11 operates at electronically selectable speeds up to 120 ips, and densities of 200/556/800 bpi. The TM-11 meets all data formats. Plug-in 7 or 9 channel heads are available (ASCII compatible with IMB 360). Operator control panel and parity checking are optional. Militarized version available.

The medium-speed TM-7 is completely compatible with IBM tape formats and with other Ampex equipment. Packing density is 200, 556 and 800 bpi. Tape speed is electronically selectable up to 45 ips. Incremental and military versions currently under development. For complete specifications or demonstration, write Ampex Corp., Redwood City, California



AMPEX

CIRCLE NO. 12 ON INQUIRY CARD

PART 3 • A MODULAR BUILDING BLOCK APPROACH

PAUL M. DAVIES, *Abacus Div. of Whittaker Corp., No. Hollywood, Cal.*

The packaging techniques used in aerospace IC systems may be too expensive and time-consuming for non-aerospace digital systems. An alternative approach, described here, is a small set of standard IC modules which were developed to minimize engineering and checkout costs for custom-built non-aerospace digital systems.

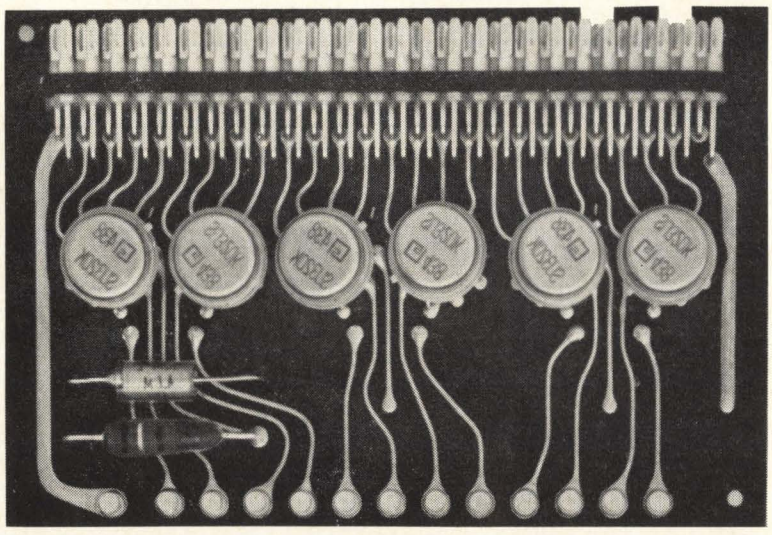


Fig. 3.1 A typical module of the Abacus I Series. This 2" x 3" module contains 6 integrated J-K clocked flip-flops or 12, 3-input NAND gates.

The purpose of this article is to explore some of the implications of using integrated circuits in a broad range of ground support, commercial, and industrial digital systems; and in particular to systems that will not be mass produced. For in these systems, it is especially important to control the engineering and checkout costs, which must be written off on a small number of systems.

We shall discuss each stage in the development of a digital system: system planning, logical design, mechanization, checkout and documentation, and attempt to emphasize the main influences of integrated circuits on each of these areas. The discussion will be based on the I Series of integrated circuit system building blocks developed by Abacus.

IC Building Blocks

Before proceeding with system design considerations, let us briefly summarize the I Series building blocks. The approach most frequently taken in applying integrated circuits to aerospace systems is to work out a logical design, then to do artwork for multi-layer printed circuit boards which reflect the interconnections implied by the logic. This approach to packaging results in extremely high packing density but may be too expensive, time consuming and inflexible for non-aerospace systems. For these reasons, an approach based on a standard

CORRECTION ON PART 2

Part 2 of this series — Interconnecting IC's in Aerospace Applications — which appeared in the last February issue neglected to include the author's byline. The article was written by:

C. F. O'DONNELL, V.P. Research, Engrg. and Reliability Division of Autonetics, Anaheim, Cal.

TABLE 3.1 Abacus I-Series Module Characteristics

Model	Description	Input Load[1] Sink	Input Load[1] Source	Output Drive[1,2] Sink	Output Drive[1,2] Source	Capacitive[3] Drive	Circuit[4] Delay
IF-6	6 J-K Flip-flops			5	12	200	225
	Clock input	¾					
	Enable input	½					
	DC input		1				
IN-12	12 3-input NANDS		1	5	12	200	45
IE-12	12 2-input expandable NAND's		1	5	12	200	45
IG-12	12 3-input gate expanders		1				10
IN-6	6 7-input NANDS		1	5	12	200	45
IO-12	12 3-input OR's	1			10	200	70
IO-6	6 6-input OR's	1			10	200	70
IP-1	Clock Source			5	12	200	70
IP-2	2 Monostable Multivibrators	3	3	5	12	200	60
IP-5A	5 Interfaces (1 to +)		3			100	50
IP-5B	5 Interfaces (+ to 1)			2	5	100	50
IN-5A	5 Interfaces (1 to −)		3			100	50
IN-5B	5 Interfaces (− to 1)			2	5	100	50
ID-2	2 Line Drivers		2	+5	to 75Ω	2000	100
IL-5	5 Lamp Drivers		7	≤32V	≤100ma		500
IN-5	5 Neon Drivers		3	≤250V	≤10ma		100
IR-5	5 Relay Drivers		7	≤32V	≤100ma		500

NOTES:
1. A unit source load is the load of one NAND input, a unit sink load is the load of one OR input.
2. Sink loads, source loads, and stray capacitance can be driven simultaneously.
3. This is the stray C which can be driven in addition to the fan-out load at speeds of 3 mc using up to 1 level of gating or 2.5 mc using up to 3 levels. Units are pf.
4. This is the maximum value of ½ (turn on delay + turn off delay) over the full temperature range with full capacitance and dc load. Units are ns.

set of modules is appealing. A relatively small number of module types can be used to mechanize any desired function. No special artwork is required; interconnections are done by wiring together module connectors in a conventional way. Design changes are easily handled by the addition or deletion of wires or modules.

The decision to take a modular approach immediately raises several questions: Should the modules contain complete general purpose circuits, all of whose inputs and outputs are brought out to the connector pins, or should they contain specialized functions with circuits appropriately interconnected on the module? The functional approach has some advantages especially when the logical organization of the system is known in advance of the design of the modules. However, it results in more module types and greater requirements for documentation and spare parts. In designing the I Series, the general purpose circuit approach was chosen to provide maximum flexibility. However, a high density connector (52 pins in 3 inches) and a small board size (see Fig. 3.1) were chosen so that the board size could be fully utilized.

The modular approach imposes several requirements on the selection of integrated circuits. The capacitive drive should be high to drive interconnecting wire at maximum operating speed. The fan-out should be high to relax logical design restrictions. And, the noise rejection should be high to insure reliable system operation in noisy environments. In considering noise rejection, it is important to consider not only the input threshold levels but also the source impedance of the driving circuit in both states. In the I Series, noise rejection margins of 800 mv are guaranteed over the full temperature range. The output stages present low impedances in both states as a result of the fact that the output is positively switched to one voltage or the other by two transistors.

While the basic logic functions are performed by integrated circuit

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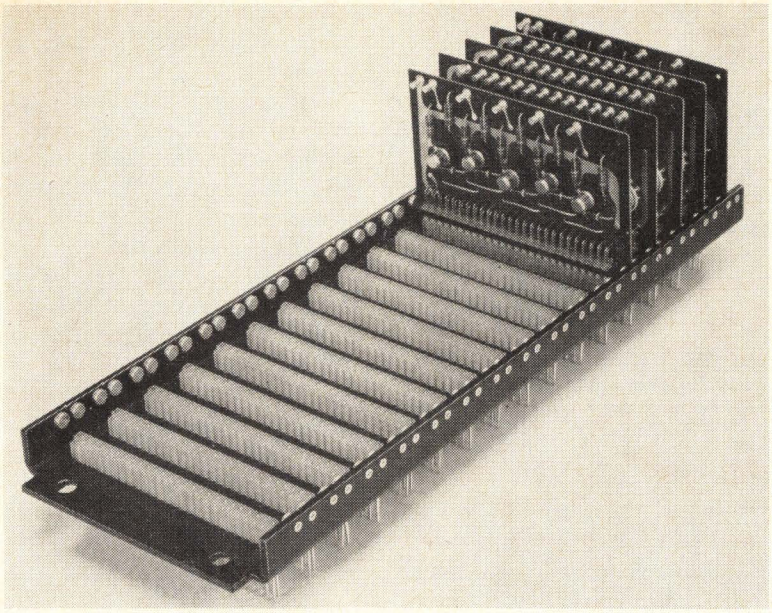


Fig. 3.2 Card cage holding I Series modules.

flip-flops and gates, many of the peripheral circuit functions cannot be conveniently performed in this way. For such requirements as clock sources, monostables, lamp and relay drivers, transmission line drivers, and interface circuits, hybrid of discrete component circuits are used. They are fully silicon, operate from the same single voltage as the integrated circuits, and are packaged on similar modules.

Table 3.1 summarizes the specifications of the I Series circuits and shows the extent to which the design goals of high fan-out and capacitive drive capability were achieved.

Packaging hardware for the I Series is also constructed along modular lines. The basic module is a single piece aluminum card cage which incorporates the connectors integrally. Each connector consists of 52 small nylon inserts which are force fit into two rows of holes bored in the base of the card cage. Each insert contains a receptacle for one pin of the module connector. The receptacles, shaped like miniature tuning forks, securely grip the male blades of the module connector. The "handle" of the tuning fork is a wiring post which extends from the rear surface of the cage. The card cage is provided in various lengths, for example, the full 19" length which mounts in a standard relay rack, taking up 3-½" vertically, holds 38 modules. Fig. 3.2 is a photograph of a typical card cage.

The card cage serves a dual function for it can be used as a ground plane. It provides a low impedance ground for all modules and reduces pickup of the wiring. Normally the cages are isolated from the cabinet when used in this way. Interconnection wiring is done among the wiring posts extending from the connector receptacles. Wiring can be done by wire wrap, welding, thermal compression bonding, or printed circuit board techniques.

The cages carry silk screened nomenclature and the connector inserts are color coded to provide a dual means of identifying the terminals for wiring. Wiring can also be done automatically by programmed wire-wrap machines. The cages are combined vertically to form bays which are hinged to swing out, giving access to the wiring surface. They are combined horizontally in drawers which hold up to five cages, each of which holds 38 connectors, or three cages plus fan and power supplies. These drawers, which are 3-½" high, are mounted on pullout, tilt-up slides. The front panel can be used for controls and displays, the rear panel for connectors. Modular siliconized power supplies are provided with capacities from 2 to 25 amps.

System Design Considerations

System concepts must be strongly altered by the availability of inte-

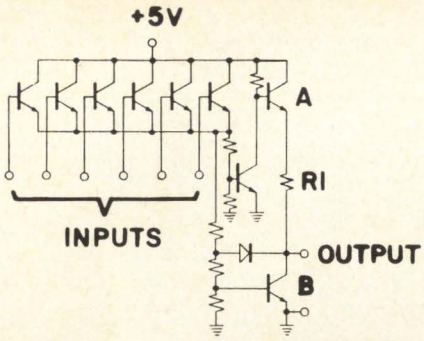


Fig. 3.3(a) The integrated circuit NAND gate made by Signetics (their Utilogic family) is used in the Abacus modules.

grated circuits. Increases in reliability and decreases in size and weight approaching an order of magnitude improvement will alter the thinking of many product planners. For instance, computers which formerly occupied the volume of a desk can now be packaged in a suitcase. This suggests a new approach to computer maintenance, especially since the computer will be substantially more reliable — if the computer is suspect, have the field sales office bring over a spare computer and plug it in. If the computer proves faulty and the cause cannot be determined after a brief diagnosis or if it can not be easily repaired, return the computer to the factory and use the spare until it is returned. Small traffic control computers which control traffic signals in a localized area in response to local traffic data and data from the computers in adjacent locales can be permanently mounted out of doors on service poles or underground because of the decrease in size and increase in reliability.

Perhaps an even more important class of considerations are those dealing with cost reduction. While integrated circuit modules are at present comparable in cost to conventional modules, the cost of hardware and power supplies is decreased substantially. This is often of particular importance in smaller systems. For instance, in a time code generator or analog-to-digital converter, these items are often major components in the cost. Not only are these costs directly reduced, but often the number of channels in a box can be greatly increased and the fixed costs of hardware and supplies amortized over the channels.

Another important system design consideration relates to criteria for design optimization. In any design, it is desirable to know what it is one is trying to maximize or minimize. In vacuum tube days, the popular game was to minimize the number of flip-flops because they cost so much more than gates. Many designers retained that criterion long after it became inappropriate. We may be in danger of making similar mistakes again. The system designer should evaluate the fraction of total cost contributed by the logic. In some cases he may be able to increase the system value substantially with only a small increase in total system cost by increasing the amount of logic. For instance, the power and speed of a small general purpose core memory

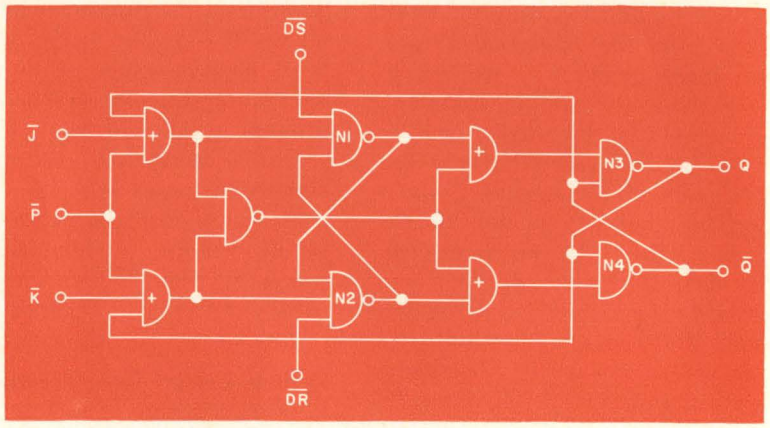
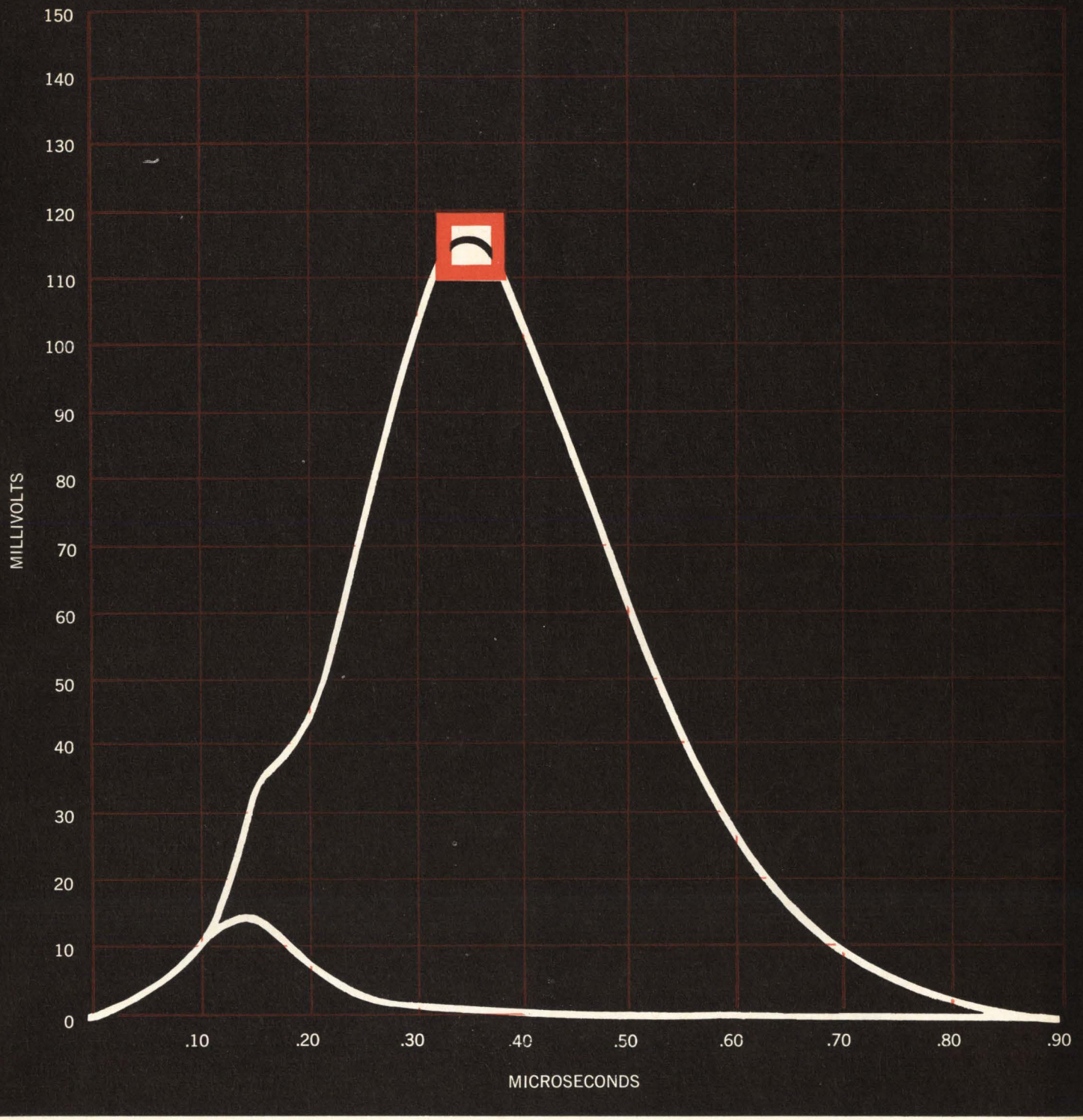


Fig. 3.3(b) Integrated circuit J-K flip-flop.



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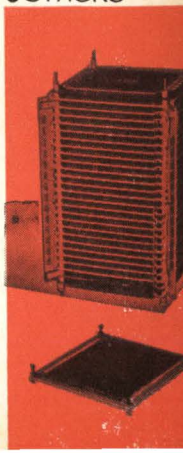

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computer can often be increased substantially by performing parallel arithmetic or by adding flip-flop registers. While it might have been prudent to economize in this area a year ago, it may be imprudent today.

A typical system design question is: *"What is the maximum operating speed that can be achieved with a given set of building blocks?"* The answer involves several other questions such as:

- *Shall operations be done in parallel or serially?*
- *Will the system be synchronous or asynchronous?*
- *What is the maximum number of gating levels between flip-flops?*
- *How much stray capacitance must be driven?*
- *What are the delays in flip-flops and gates?*

Of course, there are trade-offs involved; however, the last two questions are fairly fundamental. In the Abacus I Series, the circuits are designed to drive a highly capacitive load. Fig. 3.3 (a) shows a NAND gate of the Signetics Utilogic family, which are the IC's used in these modules. The two transistors marked A and B which switch the output to one voltage or the other, and insure low output impedance for noise immunity, also enable the circuit to drive highly capacitive loads without impairing waveforms. Resistor R1 (of very low value) provides limiting in case of accidental output grounding. All members of the family are short-circuit proof.

Fig. 3.3 (b) shows the Utilogic clocked J-K flip-flop which is used in the I Series of modules. The flip-flop is broken into its functional parts which are simple diode OR gates and modified NAND's. N1 and N2 are cross-coupled NAND's that form a dc-coupled "master" flip-flop. N3 and N4 form a "slave." When the clock at the $\overline{P}$ input goes positive, the status of $\overline{J}$ and $\overline{K}$ determine the value loaded into the "master." When the clock returns to ground, the contents of the "master" are transferred to the "slave." Since the flip-flop is dc-coupled throughout, it is insensitive to clock waveform degradation thus eliminating any need for tight control on waveshapes or the use of waveshaping circuitry in a system.

It is possible to form a simple toggle flip-flop by cross coupling two NAND gates. These flip-flops can be used if the output is never required at input time. However, additional gates are required to load the flip-flop so that it is ordinarily not competitive with the clocked flip-flop.

The consideration of capacitive drive capability is fundamental in a modular approach to the design of a high-speed system because of the capacitance associated with connectors and wiring. This is particularly true in a system of any complexity where the fan-outs tend to be greater and the wires longer. Table 3.1 summarized the guaranteed worst-case delays of the various circuits in the I Series with full fan-out and stray capacitance load of 200 pf. From this table it can be seen that 6 levels of NAND gates can be used between flip-flops operating at 2 mc clock rate with full capacitive load on every stage. This is conservative since most of the gates will be faster and since few of them will be so heavily loaded. However, such safety factors are the basis of conservative system design.

A system consideration related to that of speed is the desirability of housing a complete system or major subsystem in one bay or drawer. This is often possible because of the high packing density provided by the I Series. For instance, 2280 3-input NAND gates or 1140 J-K flip-flops can be housed in the HD-5 drawer which is only 3-½" high. An HB-20 bay is 70" high, 3-½" deep and holds approximately four times as much circuitry. Thus, a system of substantial size can be housed as a single integral unit. This is very desirable in that it reduces the problems and costs associated with cabling and connectors. It also implies minimum length wires. For still larger units, multiple drawers or multiple bays can be mounted in a single cabinet.

Logical Design

While systems considerations are strongly altered by integrated cir-

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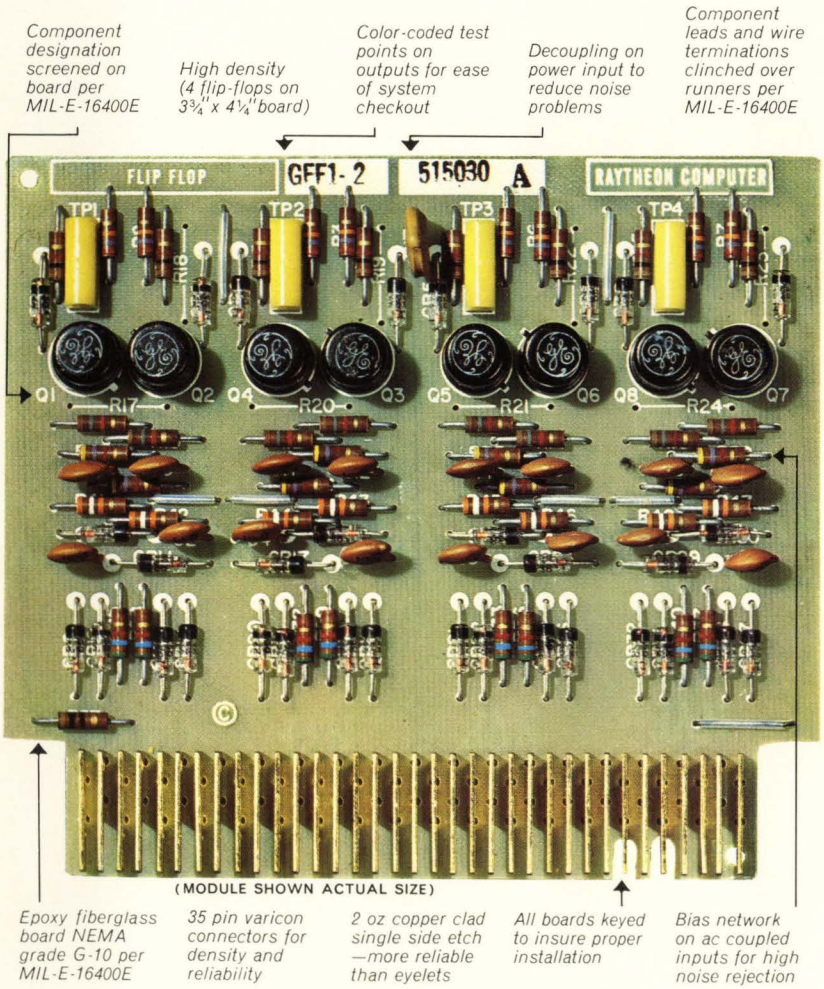

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cuits, logical design techniques are substantially unchanged. The circuits can, for the most part, be characterized by the same logical models as their conventional predecessors. Nevertheless, it may be worthwhile to review how the logic can be treated.

Using the I Series as our model, we can treat the basic gate as either a NAND or a NOR gate depending upon the convention which is chosen for interpretation of voltage levels. Table 3.2 shows the truth table describing a 2-input gate using two different voltage conventions. In the first convention, (OV=1, 5V=0), the gate acts as a NAND gate, $C=A \bullet B=\overline{A}+\overline{B}$. The J-K flip-flop requires 0 signals to operate all inputs. In the second interpretation (OV=0, 5V=1), the gate acts as a NOR gate, $C=A \downarrow B=\overline{A} \bullet \overline{B}$. The J-K flip-flop then requires ONE signals to operate the inputs. In order to avoid the requirement for additional parenthesis in a NAND or NOR expression it is convenient to adopt a convention in which the operator symbol is omitted at every other level of logic. Thus, we write:

AB/CD instead of (A/B)/(C/D) or

AB↓CD instead of (A↓B)↓(C↓D)

The following set of rules can be used to transform any AND/OR expression to a NAND expression.

AND-OR TO NAND TRANSFORMATION RULES

Rule 1. Replace all AND's and OR's by NAND's.

Rule 2. Complement any variable not ANDed with another term in the original expression.

Rule 3. If the entire expression is an AND expression, NAND it with ONE (that is, invert it).

Columns 1 and 2 of Fig. 3.4 illustrate these rules. Since all flip-flop inputs require inverted signals under this convention, it is necessary to either add or delete a final inversion stage from the network which mechanizes the flip-flop SET or RESET conditions. For instance, consider the mechanization of a binary sum flip-flop as illustrated in Columns 1 and 2 of Fig. 3.5.

If we use the second voltage convention, which leads to the NOR interpretation, the following rules are used to convert from AND-OR expressions to NOR expressions.

AND-OR TO NOR TRANSFORMATION RULES

Rule 1. Replace all AND's and OR's by NOR's.

Rule 2. Complement all variables except those which are *not* ANDed with another term in the original expression.

Rule 3. If the entire expression is an OR expression, NOR it with ZERO (that is, invert it).

Applying these conversion rules to the examples cited before, we obtain the third column of Fig. 3.4. Under this convention, flip-flop inputs do not require inverted inputs. Therefore the network which mechanizes the flip-flop SET or RESET conditions are fed directly to the flip-flop inputs (Column 3 of Fig. 3.5).

One convention should not be chosen in preference to the other in the hope of saving gates. In every case, both conventions lead to the same number of gates, even though Fig. 3.4 seems to suggest otherwise. The reason for the apparent disparity is that the networks are not terminated. As soon as it is required to set a flip-flop with one of these networks or produce an output voltage level, inverters would be added or deleted to arrive at identical networks. This is reasonable; for the two conventions are merely two alternative ways of analyzing the same networks. The choice between the conventions really boils down to an aesthetic question. *"Which conversion rules do you prefer?"*

Fig. 3.6 shows several commonly-encountered flip-flop applications. In the two counter applications, one might expect to see the outputs of the flip-flops returned to their own inputs. This would be required if the flip-flops were R-S. Since they are J-K, it is not required; the steering is internal.

Single-rail loading is illustrated in the binary ripple counter. The flip-flops are reset by R at the $\overline{DR}$ inputs; then, a new number is loaded through the NAND gates at the $\overline{DS}$ inputs. The shift register in Fig. 3.6 shows double rail loading.

Mechanization

After the logical design of the system has been accomplished through the use of either logic diagrams or logic equations, the next steps are to check the loading on each circuit (by reference to Table 3.1) to adjust the logic, and to prepare wiring lists.

An efficient approach to this problem, if the logic has been described in terms of equations, is to annotate the equations as shown in Fig. 3.7. This scheme allows trouble-shooting of a system without continual reference to wiring lists or voluminous logic diagrams. All output pins are given a coded notation: E 0314 denotes an output on pin 14 of module 03 in cage E. Input pins are annotated only by the pin number. The module and cage numbers are the same as those of the associated output.

Wiring lists are readily prepared from the equations annotated as in Fig. 3.7. The circuit input or output connected to each of the 52 connector pins is identified on the appropriate one of 52 lines of the wiring list form. The remaining space on each line is reserved for wiring information which is expressed in the form of a sequence of 5-digit wiring post numbers. Preparing lists on vellum, as done at Abacus, has obvious advantages.

Documentation, Checkout, and Maintenance

The use of a small number of general purpose system modules greatly simplifies documentation, checkout, and maintenance. For instance, a system can be documented by a General Description (including Theory of Operation and Operating and Maintenance Procedures), a set of annotated logic equations, wiring lists (actually redundant), and standard documentation on each module (schematic, data sheet, and engineering notes).

Checkout is performed by reference to the annotated logic equations (or annotated logic diagrams if they are preferred). They quickly show the role played by any signal in the logic and also show where each signal can be found in the wiring. The wiring scheme most frequently used with the I Series is wire wrap. The wiring results in,

TABLE 3.2 · Truth Table Showing NAND and NOR Interpretations of Gate

Voltages			NAND 0V = 1, 5V = 0			NOR 0V = 0, 5V = 1		
IN A	IN B	OUT C	IN A	IN B	OUT C	IN A	IN B	OUT C
0V	0V	5V	1	1	0	0	0	1
0V	5V	0V	1	0	1	0	1	0
5V	0V	0V	0	1	1	1	0	0
5V	5V	0V	0	0	1	1	1	0

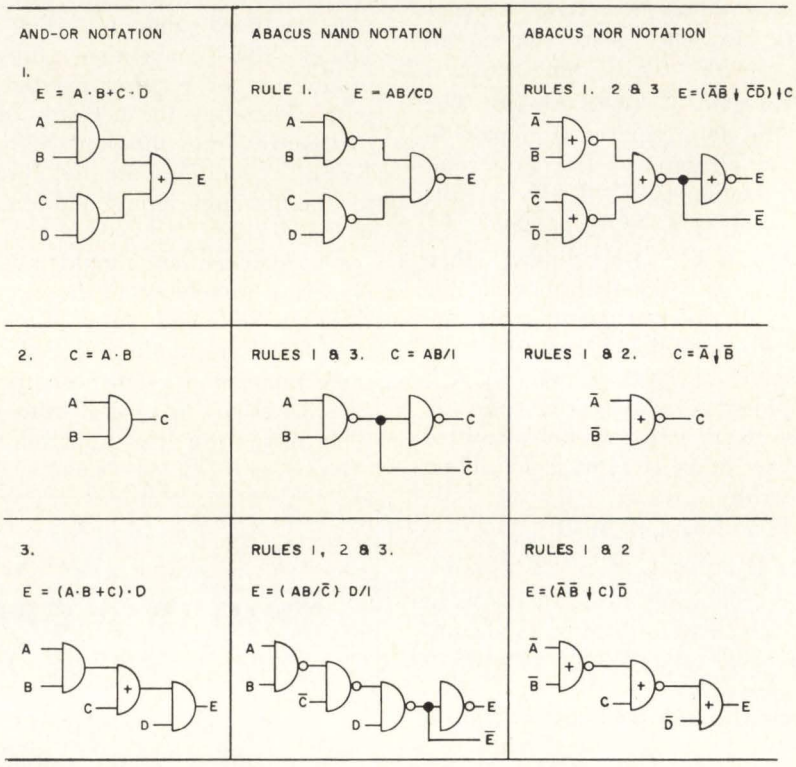


Fig. 3.4 Conversion from AND-OR networks to NAND or to NOR networks.

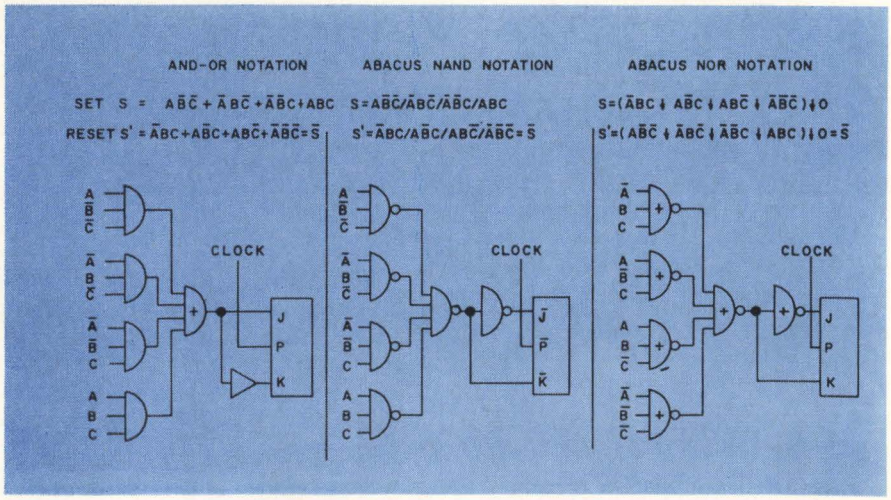
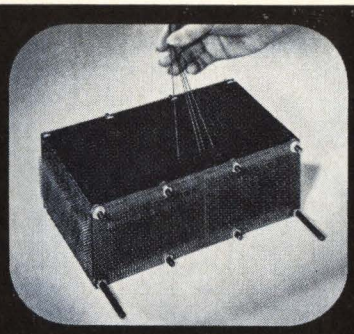
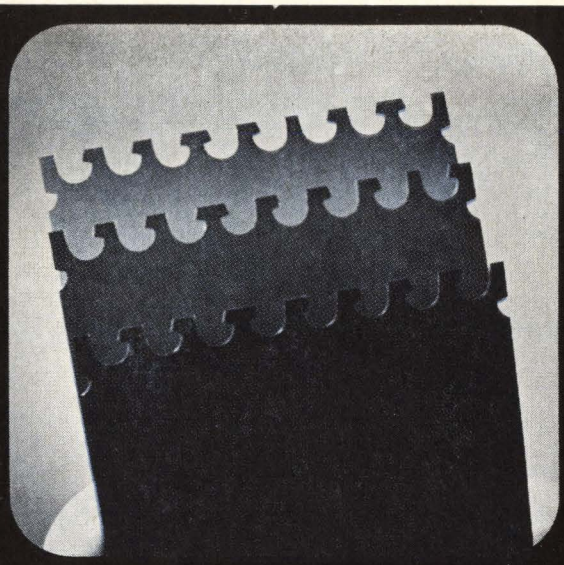
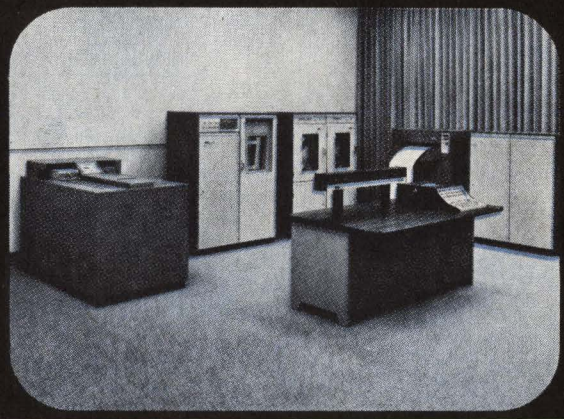


Fig. 3.5 Mechanization of a binary sum flip-flop using AND-OR, NAND, or NOR notation.







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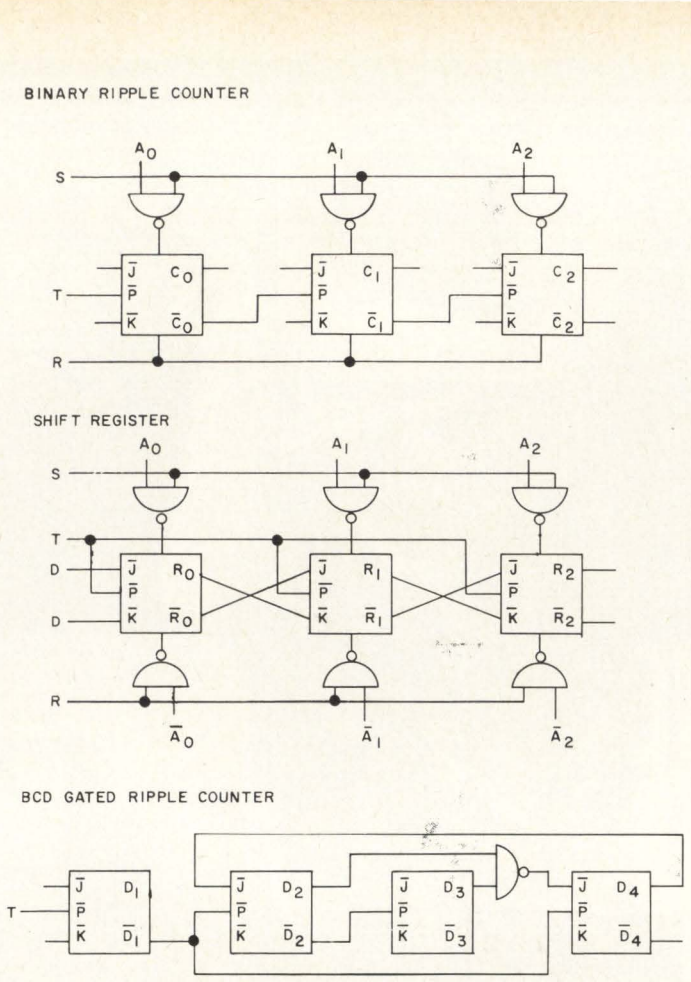


Fig. 3.6 Typical applications of the J-K flip-flop.

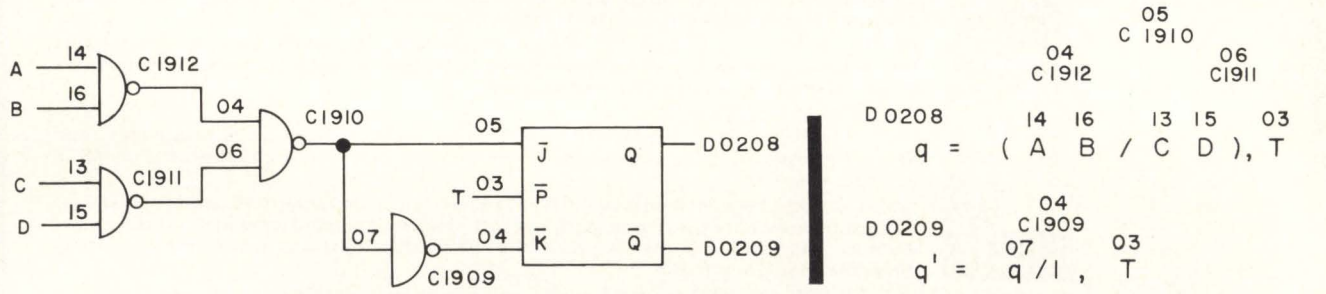


Fig. 3.7 Logic diagram and equations annotated with wiring information.

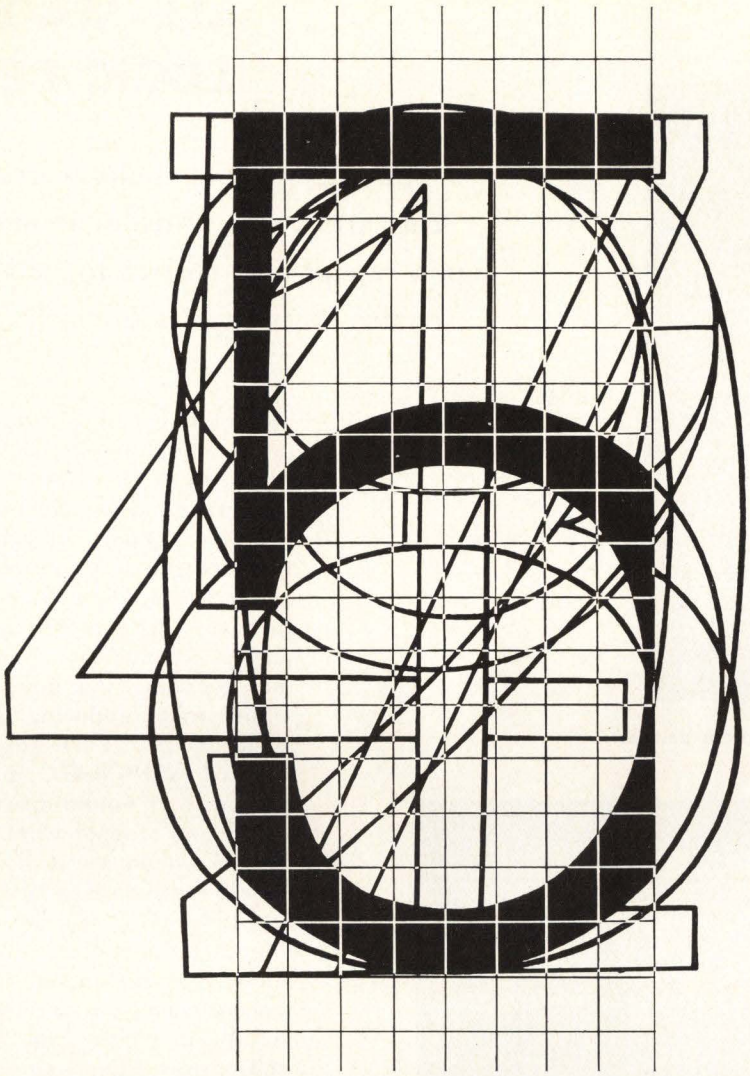
at most, two wraps per wiring post. However, each post accommodates three wraps. During checkout, wires can be deleted simply by cutting them at both ends; wires are added by using the unused portions of the posts. Also wires can be unwrapped by a simple manual tool.

Another technique which is very useful in checkout is for the engineer doing the checkout to perform temporary wiring by means of wires terminated with small caps which are manually fitted over the ends of the wiring posts. This temporary wiring is later replaced by permanent wrapped wiring.

Because of the high reliability of the circuits and interconnections, repair is seldom required in the logic section of an I Series system. When it is required, it is best accomplished by identifying and replacing faulty modules. The annotated logic equations and test points on every module are helpful in this process. Another approach to maintenance is the one mentioned earlier of temporarily replacing an entire system or sub-system by a spare.

Summary

Monolithic integrated circuits offer advantages not only to the aerospace system designer but to his earthbound brother as well, who may be more interested in the total cost of a system than its size, weight, or power consumption, though these may affect total cost. Integrated circuits can contribute to cost reduction in a number of ways. But, their advantages will be quickly cancelled out by increased costs of design, checkout, and maintenance unless careful attention is given to the procedures and techniques which should govern their use.



What tells the machine, "I am a 5"?

Designing recognition logic is a key to developing systems for recognizing handwriting, multifont printing, or magnetic-ink characters. Engineers face the questions: What minimum information must the scanner sense from a character, and what measurements are necessary to ensure accurate recognition?

There are a number of aspects of character recognition you might work on: computer simulation of new recognition logic, investigation of the probability of accurate recognition for different styles of writing or printing, or development of new methods of scanning the characters.

The field of character recognition and associated areas such as document handling could be of great potential for you at IBM. Write to Manager of Employment, Dept. 540C, IBM Corporate Headquarters Armonk, New York, 10504.

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ALL-MAGNETIC LOGIC DEVICES

Simple reliable multi-aperture ferrite core array, that provides an output pulse upon receipt of a correct 16-bit lock word, retains "memory" with power removed.

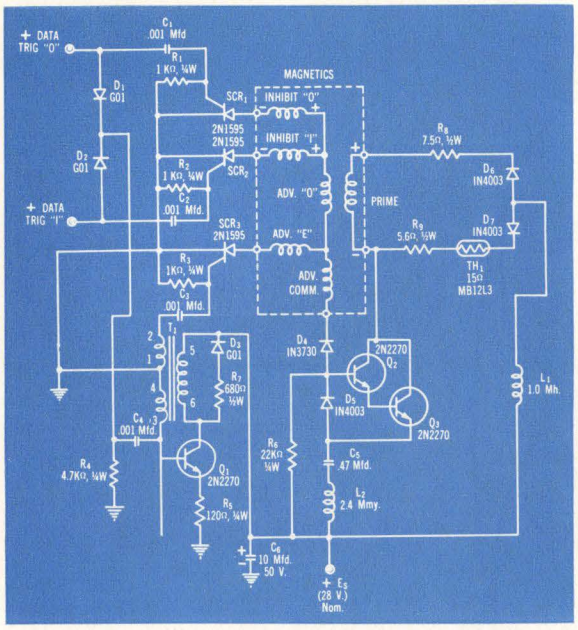


Fig. 1(a) Driver schematic for 16-bit code stream detector.

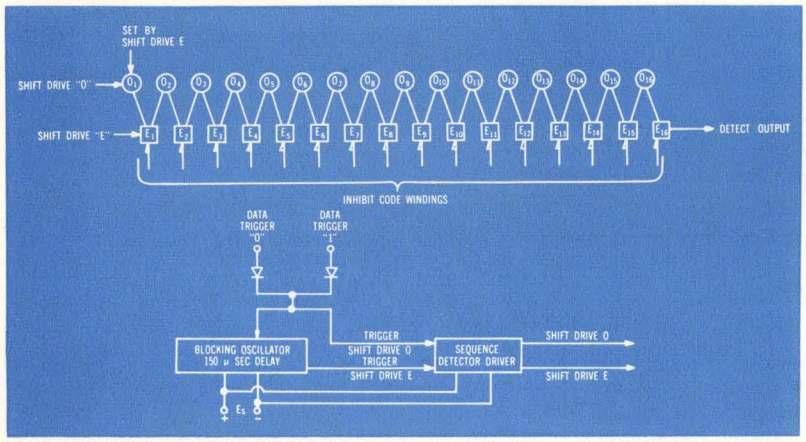


Fig. 1(b) Logic diagram for 16-bit code stream detector.

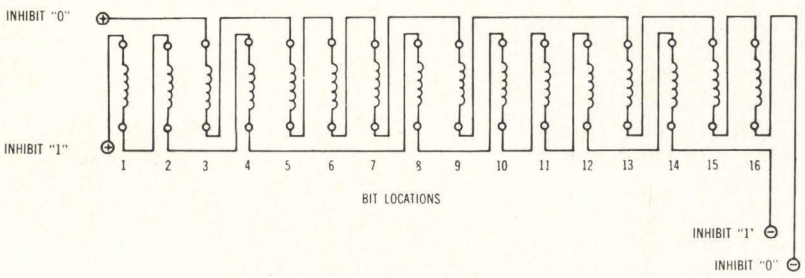


Fig. 2. Code wiring for detection of 0010111010001011.

More and more, digital designers are exploiting the advantages of magnetic logic — low power consumption and low component count. However, many designers would probably be surprised to learn that Amp, Inc. of Harrisburg, Pa., known primarily as one of the country's largest connector manufacturers, has, for some time now, been developing and producing all-magnetic logic devices. These devices, trademarked AMP-MAD, are composed primarily of multi-aperture ferrite cores and copper wire. Semiconductor circuits are used only to provide the drive pulses necessary.

Utilization of special wiring techniques permits the construction of an easily programmable binary sequence detector consisting of one serial shift register and its associated shift driver. The unit does not require input bit counters or a separate clock; input data triggers the shift, logic, and storage circuits.

For purposes of illustration, consider a binary sequence detector which is programmed to recognize a specific 16-bit sequence. In this case a "detect" output is desired upon receipt of the 16th correct input data bit. Fig. 1 (a) is a schematic diagram of the driver circuit used for this detector and Fig. 1 (b) contains a logic diagram of the unit.

In this device, the input data does not enter the shift register nor is it used in any standard type of comparison circuit. Input data is applied via the input lines designated "Data Trigger One" and "Data Trigger Zero." The presence of a pulse on either of these lines triggers its data driver and a blocking oscillator delay circuit. If the sequence of the input data bits matches the lock word that has been wired into the unit, an output voltage pulse is coincident with the arrival of the last data bit. All other outputs from

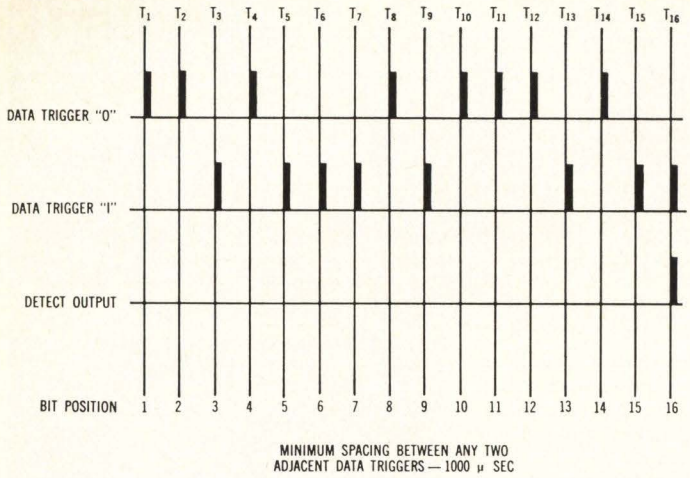


Fig. 3. Timing diagram for binary sequence detection.

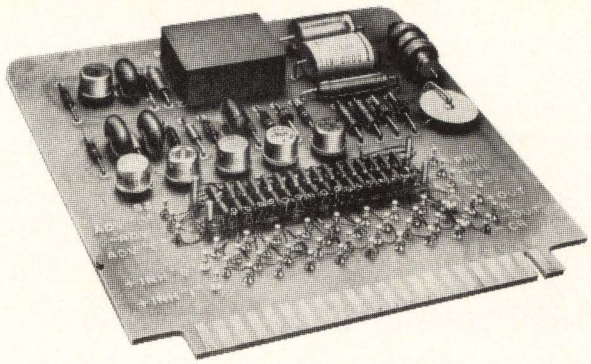


Fig. 4. The detector is mounted on a 4½ x 5 x ¾ inch circuit board. Electrical specs include an input data rate from 0-1 kc, supply voltage from plus 24 vdc to plus 32 vdc, rise and fall times less than or equal to 0.5 usec., and signal-to-noise ratio greater than or equal to 5:1.

the sequence detector will be less than 1/15 of the "detect" output in amplitude.

Shift Register Operation

Considering the device as a 16-bit shift register will illustrate the shifting operation of the unit. The register is a 2 multi-aperture-core-per-bit unit requiring 16 advance drive pulses on each of two drive lines to shift a binary "1" through the register. At the start of the operation, a "1" — called the stored bit — is set in Core O_1. Subsequent alternate applications of Advance O and Advance E drives will shift the stored bit through the register stages. Concurrent with the 16th "Advance Odd" drive, the stored bit will be received by Core E_{16} and a voltage pulse will be induced in the output windings.

Binary Word Detection

To modify the 16-bit register into a binary word detector, it is necessary to make only minor modifications in the shift register and its driver circuits. Inhibit windings are added to each E core in the register, and the Advance Odd driver is split into two halves, one half activated by Data Input One and the other half by Data Input Zero. The sole function of the inhibit windings is to prevent the E cores from receiving the stored bit if the bit sequence of the programmed word is not satisfied. These one and zero inhibit windings are connected in series with the corresponding data section of the Advance Odd Driver.

As an example, if the programmed sequence is such that Core E_1 in the register should receive the stored bit when the first data bit is a zero, the Data One advance drive winding would be wired to the inhibit winding on that core. The appearance of a one, as the first data bit, activates the Data One side of the Advance Odd drive, shifting the stored bit from Core O_1. Simultaneously, the inhibit winding on Core E_1 is pulsed, preventing it from receiving the stored bit being shifted into it from Core O_1. Thus, the stored bit is cleared from the register. Even if all of the subsequent data bits appeared in the proper sequence, there would be no detect output from the register, since the stored bit was lost on the first shift.

The inhibit code wiring to detect a 16-bit word is shown in Fig. 2. Since the E core inhibit drive greatly exceeds the setting drive, only the proper sequence of data bits will permit the stored bit to be shifted through all stages of the register. Further, since the code sequence is wired in, power need not be continuously applied in order to maintain memory of the lock word.

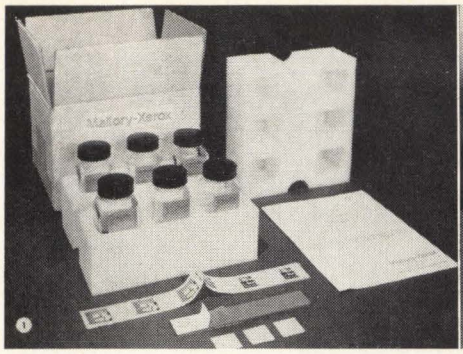
Code Stream Detector

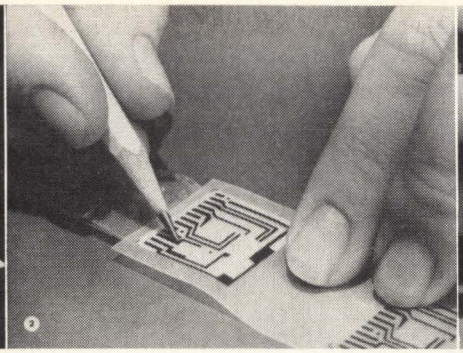
Conversion of the binary word detector to a code stream detector is accomplished by setting a stored bit in Core O_1 prior to the introduction of each new data input bit. This is simply done by wiring the Advance E drive through Code O_1 in the "set" sense. Resetting Core O_1 in this manner means that a new 16-bit pattern is started through the unit with every data input. As a result, the programmed sequence can be detected no matter where it appears in a code stream of any length. A timing diagram illustrating this function is shown in Fig. 3.

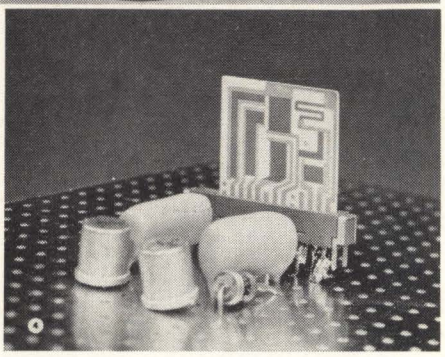
Engineers at Amp described the advantages of this code stream binary sequence detector as follows:

- It requires no standby or non-operating power — even to retain the lock word. Although the unit has the supply voltage continually applied, it draws current only when data is "inputted"
- It is extremely reliable — employs no semiconductors in the register portion and only 3 SCR's, 3 transistors, and 7 diodes in the complete driving network
- It is very small without the cost penalty of miniaturization. The magnetic portion of the detector occupies less than 2 cubic inches (the circuit is shown in Fig. 4)
- It is inherently lightweight — the 16 cores, wire, and terminals in this model weigh less than 4.5 grams.
- It is essentially "tamper-proof" — simultaneous application of both "One" and "Zero" inputs causes all transfers in the register to be inhibited
- It can easily be converted to a binary word detector
- It can be reset either by simultaneous application of One and Zero triggers or external signal.
- It can be rewired by the user to accept a different code — no other modification is necessary.

Circle No. 102 on Inquiry Card







Production of a typical ac amplifier circuit using materials supplied in the new Mallory-Xerox Resistor Board Kit is shown. Photo 1 (upper left) is the complete kit which includes: three 1" x 1" thin-film resistor board wafers, a wafer mounting sheet, a set of three resistor and conductor pattern transfers, the necessary etchants and cleaners, and an instruction book. Photo 2 (center) shows the user transferring conductor pattern to wafer by rubbing with pencil point. In photo 3 (upper right), conductor pattern has been etched and resistor pattern applied to wafer. User is now etching resistor in beaker of solution mixed from two bottles in background. Photo 4 (lower right) shows complete amplifier circuit with externally-mounted components.

CUSTOMER-ETCHED THIN-FILM RESISTOR BOARDS

New technique is less expensive and less complex than metal masks

Ceramic-based thin-film resistor boards designed for low-cost, do-it-yourself production of micro-electronic-resistor-conductor networks without special vacuum equipment are now available on a commercial basis from Mallory-Xerox Corp., Burlington, Mass. The company also is offering special resistor board kits with which users can perform their own evaluation of the production techniques, reliability and other features of the Mallory-Xerox custom-etched thin-film components.

The resistor boards are ceramic substrates, one surface of which has been vacuum coated with thin resistive film. On top of this is deposited a conductor film. To produce his own resistor-conductor networks, the user simply transfers the conductor pattern from a 1:1 photographic image master to the conductive film by silk screen, photographic, decal transfer, or xerographic methods, removes the unwanted material by selectively etching, and repeats the process for the resistor pattern. Resistor boards are available in a variety of substrate sizes from flat-pack or TD-5 configurations to 1" × 1".

According to company officials, the Mallory-Xerox thin-film process gives electronic equipment manufacturers and design engineers a far greater degree of control over their thin-film resistor network production than has ever before been possible. They point out that higher overall yield, greater uniformity and increased economy of operation is assured by the fact that all the critical vacuum and chemical film deposition work is done by Mallory-Xerox specialists under rigidly controlled production conditions. This allows the design engineer to concentrate upon the all-important intra and interconnection problems involved with the use of microelectronic circuits.

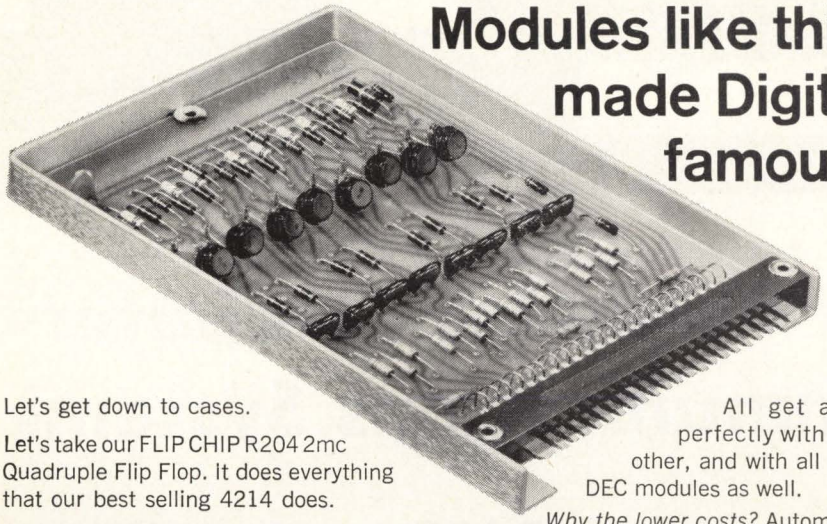
Another advantage of the Mallory-Xerox thin-film process is that circuit design changes can be made simply by revising a tape layout drawing and making a new photographic image master. This relatively rapid, easy and economical change procedure encourages the utilization of wafer substrates during the earlier breadboard phases of design. Previously, it was necessary to accomplish all worst-case design investigations with the aid of conventional component breadboards, and a completely new set of design problems involving capacitive and inductive coupling effects had to be solved after the first waferized and modularized model was constructed.

The design engineer can construct thin-film circuitry by utilizing existing in-house photographic and printed wiring facilities without the need for expensive vacuum equipment, complex fixtures, and costly masks. In most cases, it is a matter of only several hours from the time the draftsman finishes laying out the conductor and resistor patterns until the first completed thin-film resistor networks are ready for use.

Typical applications for the new networks include their use as a base for mounting semiconductor devices and capacitors; in separately-mounted resistor networks for analog-to-digital converters and differential amplifiers; as interconnectors of semiconductor integrated circuits, particularly the analog type where external resistors are required, and as "do-it-yourself" multilayer interconnection boards.

Circle No. 109 on Inquiry Card

Modules like this made Digital famous



Let's get down to cases.

Let's take our FLIP CHIP R204 2mc Quadruple Flip Flop. It does everything that our best selling 4214 does.

And it costs 60 per cent less.

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And it does things the 4214 *can't* do. For one, it is two times faster than its counterpart. For another, it has a much wider temperature range.

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*Quantity discounts available

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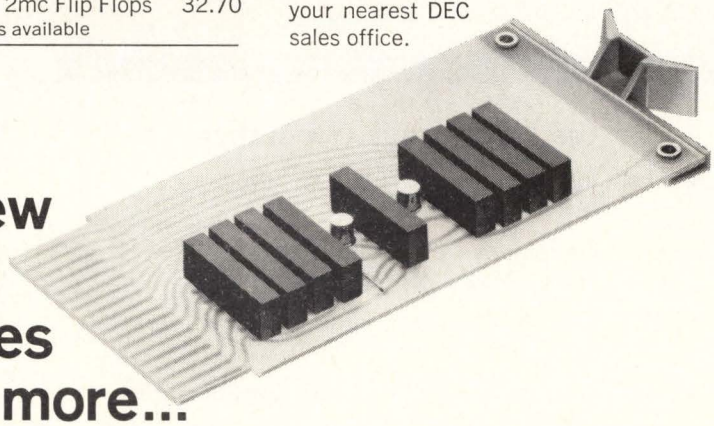

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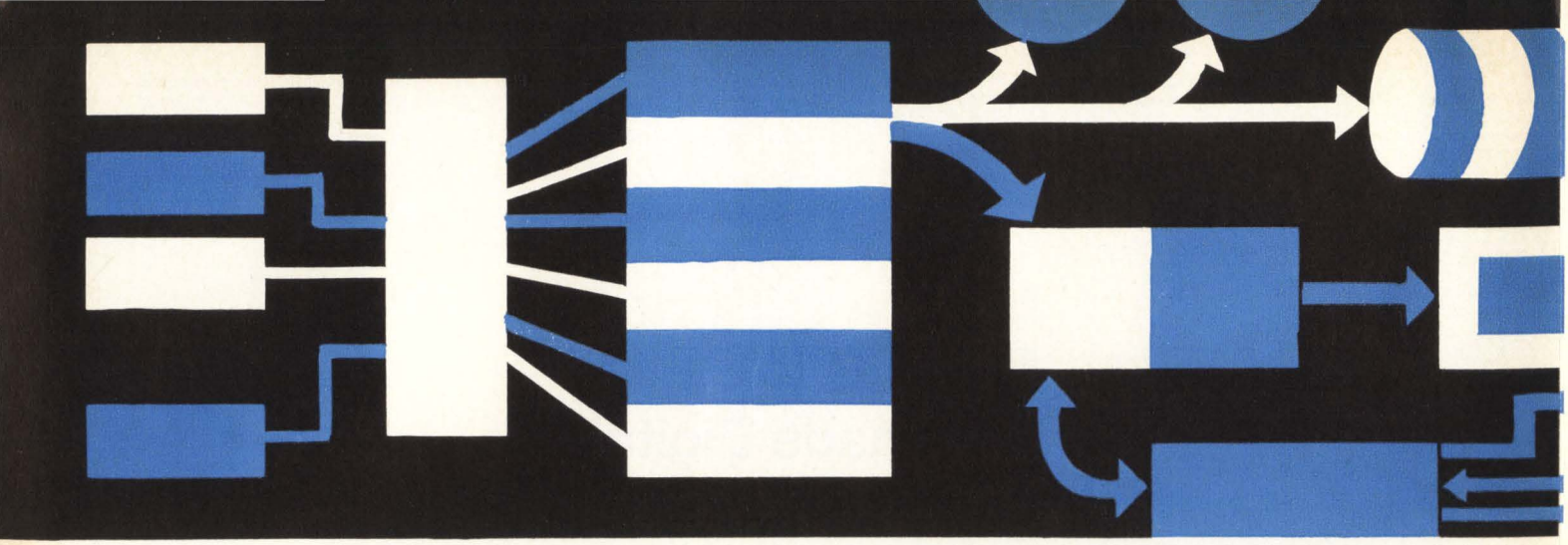


Design Guide for Computer-Communications Systems

PART I — Introduction and Problem Structure

Editor's Note: *As the major common element of real-time system design, the "Communications Environment" presents a substantial and unusual set of design problems to the system designer. This 5-part series will identify the important design problems, describe various solutions, and show how these solutions apply to particular situations. Here in Part 1, the authors introduce the subject giving a brief historical background, delineating the scope of the problem, and describing the basic system concepts and design considerations.*

THE 5-PART SERIES-AT-A-GLANCE

Part 1 — Introduction and Problem Structure
March 1965 issue

Part 2 — Equipment Design and Selection Considerations. May 1965 issue

Part 3 — Program Design — Functional Considerations
June 1965 issue

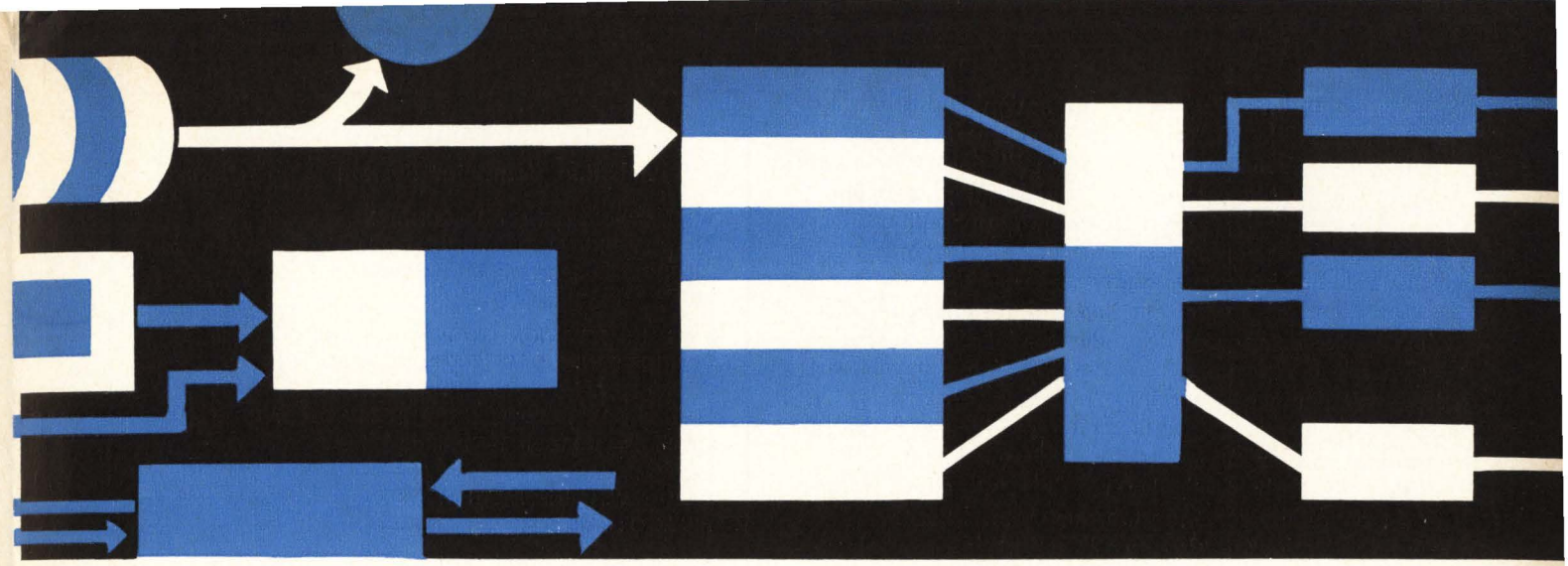
Part 4 — Program Design — Load Considerations
July 1965 issue

Part 5 — General Economic Considerations (plus comprehensive bibliography) August 1965 issue

Real-time computer systems form a burgeoning branch of modern information processing technology. Every day these systems find broader application. They are identified by a variety of names, such as: "command and control", "industrial process control", "data communications", "management information". This acceleration in the use of computers for real-time application is a natural product of the computer revolution. Improvements in equipment efficiency and reliability coupled with better understanding of the capabilities of computers have contributed to increasing acceptance of these systems. However, granting the benefit of all the generally applicable advances in computer technology, real-time systems still present a substantial and unusual design problem. Important questions arise out of the fundamental nature of the real-time environment that do not usually appear in non-real-time application. How well these questions are asked and answered largely determines whether the resulting real-time system will work efficiently or at all.

Initially real-time computer systems were designed and developed as custom projects. Many of the major components of the system were initially developed for the particular projects. Large engineering organizations solved the design problems by force of numbers. These first systems were consequently very costly and limited to a few applications that could stand the bill: military command and control and airline reservations.

It was during the engineering of these first systems that the principal characteristics of the real-time environment came to light. These early experiences showed that there were important distinguishing problems raised by the real-time environment that had a significant effect on the entire system.



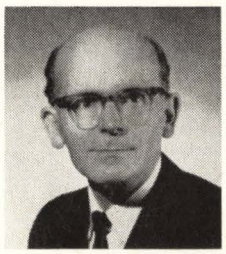
WALTER A. LEVY, Contributing Editor

EDWARD W. VEITCH, Pennsylvania Research Associates

KARL H. BIEGEL, Radio Corporation of America

A contributing and consulting editor to Computer Design, Walter A. Levy is Director of Technical Projects of a Philadelphia-based information sciences consulting organization, Pennsylvania Research Associates, Inc. He is currently responsible for programs involving the development of digital image processing techniques. Mr. Levy has worked in the field of data communication for over six years. For a number of years he was a Project Engineer and System Engineering Consultant at RCA. He was responsible for system engineering of the RCA Communications Telegraph Switching System and contributed to the development of the original AUTODIN System. He conducted product and market planning studies and contributed to the planning of numerous data communications systems. Mr. Levy holds B.S.E.E. and M.S.E.E. degrees from New York University. He is a member of the IEEE and ORSA and he represented RCA on the ASA X3.3 Subcommittee on Data Communications Standards.

Edward W. Veitch (of Veitch Diagram fame) is Manager of Mathematical Analysis and Programming at Pennsylvania Research Associates, Inc., located in Philadelphia. Mr. Veitch has considerable experience in the data processing field, involving both hardware and software design on a multiplicity of data processing projects, many of which involved interfaces among computers and communication links. Before joining PRA he was responsible for Data Communications System Analysis and Programming at RCA's Communications System Division. At RCA, he directed several large simulation programs and system/programming analysis and design of defense and store-and-forward message switching systems. Before joining RCA, Mr. Veitch worked at Burroughs Corp. and was responsible for several projects in the areas of computer programming, logical design, systems design, operations research, and advanced technique study on both commercial and military projects. Mr. Veitch holds A.B., M.A., and M. Eng. Sci. degrees from Harvard University.



Karl H. Biegel is a senior engineer in the Communications System Division of RCA, Camden, N.J., and is active in the design of digital computer systems used in data communications. He was responsible for the design of a line buffer system and was project engineer for the communication interface processor of the computer switching centers of the AF AUTODIN System. Before joining RCA he was a project engineer for vehicular traffic control equipment. He came to the USA in 1957 after several years of design of industrial control equipment and worked as a patent engineer in the field of VF carrier equipment. Other activities include research in photoelectric devices and gemology and the teaching of mathematics, physics, and chemistry. Mr. Biegel has a Dipl. Phys. degree from the Deutsche Karls Universitaet, Prague.

In these early applications the solution of the problems of real-time application required substantial engineering and programming efforts. Much of these costs no longer need be borne by the average real-time system. Computer equipment costs have generally come down while performance and reliability have gone up.

All computer manufacturers now furnish communications interface equipment on a product-line basis. A rich variety of peripheral equipment is now available, permitting efficient "fits" to be obtained without the necessity of special development or integration efforts. Many computer manufacturers now offer standard programs which implement basic communications functions.

All of the above factors contribute to easing the problems of real-time system design to a degree which encourages their wide use. The design problems which remain, however, are quite substantial and it is toward their solutions that this series of articles is addressed. In this series, we will attempt to identify the important design problems of this class of computer applications, describe various solutions, and show how these methods can be applied to particular cases. References to specific manufacturers' equipment will be made where necessary, but so far as possible, problems and solutions will be treated from a general viewpoint.

THE COMMUNICATIONS ENVIRONMENT

Real-time computer systems are being employed in a rich variety of applications. Each type of application has a unique set of characteristics, the study of which

is a major undertaking. Some indication of this variety is given in Table 1.1, which lists representative types of applications. The actual variety is still richer. For example, within the category of "industrial process control" one can find a variety of unique applications such as power plants, refineries, mills, chemical plants, machine tool, and instrumentation systems.

Each type of application has unique characteristics which must be thoroughly understood before a system design can be executed. A comprehensive discussion of the particular characteristics of all these applications is potentially limitless, and tends to produce a detailed handbook rather than a set of design guidelines. Regardless of their particular requirement, all of these applications have an important common element — the "Communications Environment"—and this aspect of system design will be the major subject of this series.

The design problems of managing data traffic in a system are much alike regardless of the particular application. In effect, one might consider the specific requirements of each application to be "imbedded" in the Communications Environment. The Communications Environment is, in fact, precisely what distinguishes real-time from non-real-time system designs. The fundamental characteristics which distinguish a real-time computer system from other information processing systems are three in number:

- The existence of the requirement to service many widely separated elements of the system;
- The necessity of providing satisfactory service at all times to a wide variety of requests for service whose processing cannot be rigidly scheduled;
- The creation of irreversible losses to the user of the system if service is denied for any appreciable period due to failures.

TABLE 1.1

Real-Time Computer System Applications

MILITARY COMMAND AND CONTROL
MILITARY DIGITAL COMMUNICATIONS
MISSILE AND SATELLITE RANGE CONTROL
AUTOMATIC CHECKOUT

AIRLINE RESERVATION INFORMATION AND CONTROL
SAVINGS BANKS (REMOTE DEPOSIT ACCOUNTING)
COMMERCIAL DATA COMMUNICATION
ON-LINE ORDER PROCESSING AND INVENTORY CONTROL
STOCK BROKERAGE ORDER PROCESSING
STOCK MARKET "TICKER" SERVICE
MANAGEMENT INFORMATION SYSTEMS
TRUCK OR RAIL SYSTEMS MANAGEMENT

FACTORY OPERATIONAL CONTROL
INDUSTRIAL PROCESS CONTROL

MULTIPLE-ACCESS SCIENTIFIC COMPUTING SYSTEMS
INFORMATION STORAGE AND RETRIEVAL
TRAINERS AND SIMULATORS

This description of the fundamental distinguishing characteristics of real-time applications is very general. In order to proceed to a discussion of system design problems it is first necessary to describe these characteristics in more tangible terms. Accordingly, we will re-define and develop these three fundamental characteristics as a set of requirements: "The Communications Interface Requirement", "The Flexibility and Responsiveness Requirement", and "The Reliability Requirement".

COMMUNICATIONS INTERFACE REQUIREMENTS

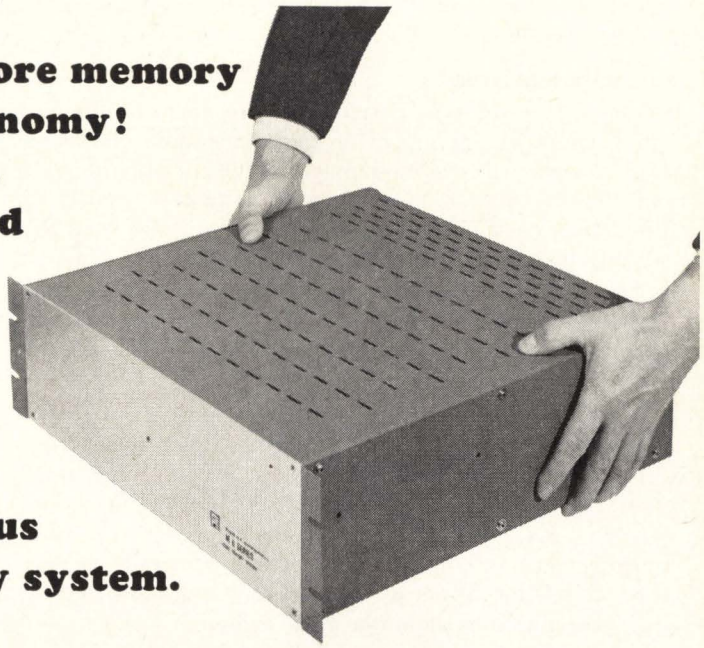
- The computer system must maintain an efficient interface with a very large number of low-data rate terminals at remote locations. Frequently, these terminals are not designed by the computer equipment manufacturer and the distribution of functions between computer system and remote terminals is not necessarily optimum.
- The computer must respond to the demands of the terminals when necessary, not when convenient. The possibility of breakdowns in coordination and lost data must be considered in the system design.

FLEXIBILITY & RESPONSIVENESS REQUIREMENTS

- The system must be capable of responding correctly to the widest foreseeable range of demands without either breakdown or excessive rejection of requests.
- The system must handle input data originated at remote terminals which is not as "clean" as data prepared directly in a computer facility. Data handling procedures must be provided which protect the system against invalid service requests but do not excessively burden the remote terminals with "housekeeping" tasks.
- The system must be provided with "escape" and recovery procedures for situations it is not preprogrammed to handle. Effective supervisory control should be designed into the computer program so that human intervention can be employed for unusual situations.

Introducing:

A standard integrated-circuit core memory system with "off-the-shelf" economy! Standard relay-rack packaging. Interfaces with either integrated or discrete circuits ■ Far less interconnections and components for increased reliability ■ Lower power dissipation, lower cost, and faster delivery than any previous coincident-current core memory system.



If you're looking for an optimized, standard memory system that can be ordered out of a catalog without lengthy specifications, tiresome telephone discussions, and several months of waiting—and have been looking for the economies of integrated-circuits to show up in core memory systems, then this is your answer!

The Fabri-Tek Series MLA5 Integrated-circuit Core Memory System:

Memory-type—coincident-current, random access, ferrite core

Cycle time—5 microseconds

Capacities available—128, 512, 2048 words with from 2 to 26 bits per word in increments of 2 bits.

Relay rack packaging—All capacities are packaged in one relay rack size (5-7/32″ high by 19″ wide)

Circuitry—Integrated circuits used in all sections except where absolutely necessary for efficient memory operation.

Standard options available—address register, power supply, current-accepting input interface, high-power drive output interface.

Delivery time for standard sizes—45 days.

A separate portable exerciser is available to check out Series MLA5 systems.

The Fabri-Tek Series MLA5 memory system has been engineered to provide maximum reliability and economy for a particular set of standard requirements. If you want faster, larger, or more versatile memories, just ask us. There is a Fabri-Tek core memory system to meet every memory problem.

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• The system must respond quickly to all demands. Relative urgency and importance of various types of demands must be given recognition in the form of a priority scheme.

RELIABILITY REQUIREMENTS

• The system must be designed to prevent a failure in either computer equipment or communications channels from causing irreversible damage to the user of the system. The degree of importance given to this need is a function of each particular application and may lead to varying degrees of redundant procedures.

• The system must always be designed to consider the existence of failures. Regardless of the importance of avoiding failures and loss of service, appropriate safety and recovery procedures must be provided.

At first glance it might appear that most of these characteristic requirements could be said to hold equally for any type of computer application. However, when one considers the problems of real-time applications more deeply, it is clear that there then exist specific questions meriting serious considerations which generally never arise in off-line applications. As the discussion develops, these questions should be quite evident.

BASIC CONCEPTS AND PROBLEMS

The basic design of a system ideally begins with a quantitative formulation of the requirements it must meet, proceeds with the proposal of one or more alternate implementations, and concludes when an evaluation has indicated that a satisfactory choice of an implementation can be made. The process may be iterative and sometimes involves compromise of initially-stated requirements in order to find an economically acceptable design. Under ideal circumstances, the designer should enjoy complete freedom to fit the implementation to the requirement. In most practical situations, the choice of implementations is limited to a finite number.

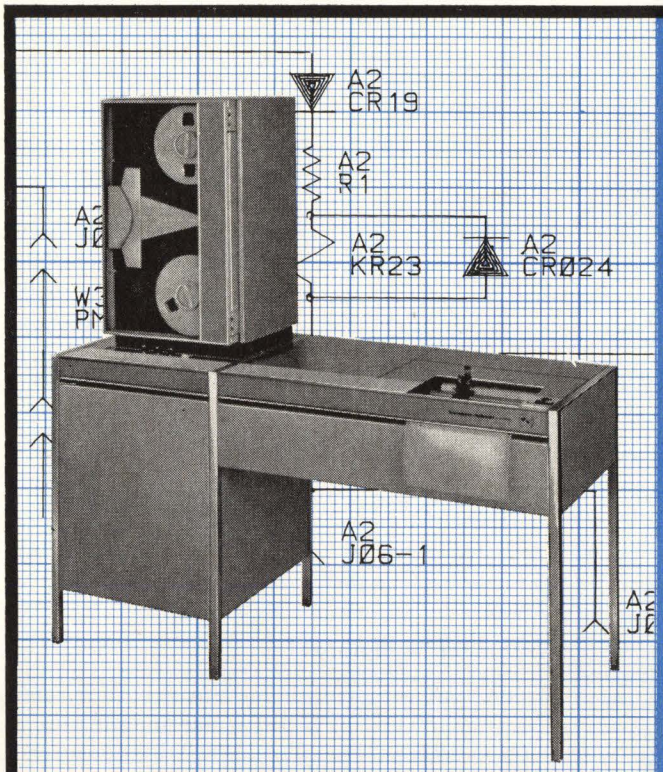
In designing a computer system to function in a communications environment, the quantitative statement of requirements basically takes the form of a traffic load specification. The choice of equipment for the system is essentially limited to selection of one of several feasible computer equipment configurations utilizing a combination of relatively standard elements. Completion of a chosen implementation requires the design of a computer program to operate the equipment. The entire system must be put into operation within a specific budget. The design problem is thus categorized into four basic aspects: load, elements, procedures (or programs), and cost restrictions.

Each of the four basic aspects of the design process presents certain problems. In preparing a traffic load specification, the problem is generally the lack of adequate information. It is frequently necessary for the designer to estimate what the capacity of the system may be if implemented in some particular way rather than be given a direct statement of what is required. In choosing equipment, the problem is generally one of constraints: selecting components from within the product-line of a particular manufacturer; incorporating older equipment into the system for economy even if other equipment is technically preferable (particularly terminal equipment), etc. It is possible, in principle, to select a system whose elements are of mixed manufacture or custom-built, but considering the current state of computer technology, such approaches are difficult to justify. In designing the computer program, the major problem is the possibility of gross error. While there are analytic tools for estimating data storage and flow requirements, none exist for estimating program size and running time: comparisons based on experience and/or detailed problem analysis are the only reliable guides. There are always budget limitations on any system design effort and the usual problems of management are compounded by the complexity of the problem and the general lack of a firm basis for estimates.

Having identified and briefly discussed the four basic aspects of the system design problem, let us now examine them in greater detail. This process will lead to more specific identification of the important questions to be asked and answered in the subsequent discussions of design methods. Specific consideration will be given to the nature of the questions that arise out of each aspect of the system design. Methods for answering these questions will be discussed in later articles of this series.

Traffic Load Specification

The formulation of a system load specification is simple in principle: one identifies the basic elements of work and determines their rate of execution. In off-line computer applications this is a fairly simple process. It is usually sufficient to know the average and peak load rates of major elements of work and select a system



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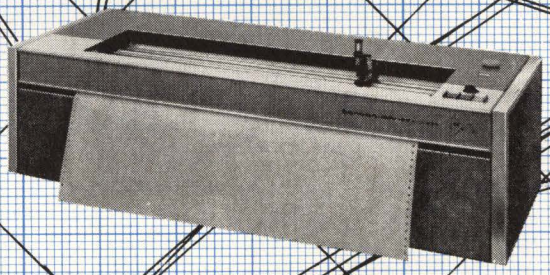

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whose components have sufficient capacity according to some simple test. In off-line computing facilities for both scientific and business application, the scheduling of work through a computer is based on simple job sequencing methods. Each job is transferred from an input file to the computer, given as much time as it needs, and moved to the output file when completed. Where efficiency considerations justify the practice, similar jobs are backlogged and processed in batches. The computer system is normally planned to accommodate a basic work load whose characteristics are well defined and exceptions are processed when convenient (meaning during idle time). An off-line computer system succeeds at handling its work load by virtue of this gross simplification of the scheduling problem: the system is never asked to meet a deadline, only to keep busy doing one job at a time. In real-time applications none of these scheduling conveniences can be found. The jobs arrive at the computer randomly, based on the demands of the users (or instruments). Individual jobs cannot wait for batches to form so the system must treat them singly, regardless of the loss of efficiency. Most importantly, the combination of jobs that may be in process in the system at any given instant is determined by the external demands of the users, not by the system.

From the foregoing it should be clear that preparation of the Traffic Load Specifications for a real-time system is a much more demanding task than for an off-line system. It is necessary to list and quantify every type of demand. It is further necessary to consider every feasible combination of demands. As the formulation of a system design employs statistical methods, it is important that the traffic load specification be prepared using appropriate statistical methods.

The questions that have to be answered for any particular system application are, naturally, quite specific, and have to be developed out of direct case study. While it is impractical to develop a listing of specific questions that would apply to a wide variety of applications, a relatively general checklist, meant to be more suggestive than specific, is provided in Table 1.2. For simplicity, the checklist is limited to questions that arise from consideration of a system with a single computer facility. Extension to multi-computer systems is straightforward.

Where quantitative information on load rates is required, the level of detail that should be sought depends on the expected accuracy and importance of the information. If a load element is both important for system planning and also accurately predictable, then its complete probability distribution may be usefully employed in planning of the system. If either of these two conditions is not met, then the detailed information is either unavailable or unnecessary: an estimate of the average peak rates is sufficient.

Computer Equipment

Computer system elements are generally selected from the product line of a particular manufacturer. Within such a product line there are 3 basic classes of equipment.

- **Main Frame Components** — Computers, high-speed memories, peripheral device control modules, and communications interface control modules.
- **Peripheral Devices** — Magnetic tape stations, magnetic drums, magnetic discs, magnetic card files, printers, punches, paper tape or card readers, and display/inquiry consoles.
- **Remote Terminals.**

Selection of a system from this variety of equipment is subject to 2 basic constraints: availability of components or devices with the desired performance; and compatibility of various elements.

The main frame components are chosen based on the speed and peripheral equipment handling ability of the computer. Except for the size of the high-speed memory, the choice of the remaining main frame components is determined for all practical purposes by the demands of the peripheral devices. With the exception of the Communications Interface Control Module, these elements are all familiar and their characteristics will not be considered here except when specific questions arise. The Communications Interface Control Module is a relatively new element in the product lines of most manufacturers and, as its characteristics are quite important, it will receive extensive evaluation.

The choice of peripheral devices is quite wide. The largest computer manufacturers offer extensive lines of this equipment. Generally speaking, any peripheral device of a given manufacturer is compatible with several main frames. The choice of peripheral equipment is relatively straightforward once the loads have been specified. Data transfer rate, access time, and storage capacity (where applicable) are sufficient information for a first selection. Secondary factors which influence the final choice include timing interrelationships between

TABLE 1.2
Traffic Load Considerations

1. IDENTIFICATION AND DESCRIPTION OF ALL MAJOR FUNCTIONS TO BE PERFORMED BY THE COMPUTER SYSTEM.

2. LOAD CHARACTERISTICS FOR EACH MAJOR FUNCTION.
   - A. Average rate: requests/unit time
   - B. Peak rate: requests/unit time
   - C. Data input per request (average and/or peak)
   - D. Data output per request (average and/or peak)
   - E. Internal data transfer rate per request
   - F. Response time per request average
   - G. Response time per request worst-case
   - H. Relative priorities of different types of functions

3. TRAFFIC LOAD IMPOSED ON EACH COMMUNICATION CHANNEL DUE TO DATA INPUT/OUTPUT FOR REQUESTS FOR FUNCTIONS.
   - A. Average rate: requests/unit time
   - B. Peak rate: requests/unit time
   - C. Average data input per request (should be identical with 2C)
   - D. Average data output per request (should be identical with 2D)
   - E. Peak data input per request
   - F. Peak data output per request
   - G. Average percentage load on communication channel
   - H. Peak percentage load on communication channel

4. STORAGE REQUIREMENTS FOR ALL FUNCTIONS
   - A. Access in microseconds
   - B. Access in 1 to 1000 milliseconds
   - C. Access in seconds
   - D. Accounting and record keeping
   - E. Duplication for protection

5. RELIABILITY REQUIREMENTS
   - A. Acceptable down-time for system: average duration, frequency of outages
   - B. Availability of time for scheduled maintenance
   - C. Acceptable delays in recovery after system failure; security responsibility of system where failure occurs

6. LANGUAGE AND CONTROL
   - A. Formats: variety and "looseness"
   - B. Checking procedures
   - C. Supervisory handling of special problems

peripheral devices, reliability, maintenance requirements, and reserve capacity.

The choice of terminal equipment is directly related to the specified requirements for both quantity and quality of data transmission between central and remote locations. The quantitative requirement dictates the data rate of the terminal and communications channel bandwidth. The quality requirement dictates the need for error detection and correction capability in the terminal and computer interface control.

Computer system configurations for real-time applications are classified in accordance with the following sets of criteria:

- Provision of spare peripheral devices;
- Single vs. multiple computers to handle the load;
- Redundant computers to take overload if a failure occurs.

Redundancy is a costly system feature. It implies considerable extra programming effort and interconnection equipment in addition to the obvious duplication of major equipment elements. However, when continuity of service indicates a need for redundancy, it should be applied in a carefully balanced manner. (For example, there is no point in providing a spare computer with instant switchover if the failure of any single peripheral device causes the system to shut down, or there is no programming provision for data protection during failures.)

Practical considerations such as the foregoing minimize the number of types of system configurations actually employed. Table 1.3 illustrates the basic types of system configurations generally considered.

Program Functions and Load Characteristics

The computer program contains the final detailed implementation of the system design. The program for any application is actually a collection of programs which generally fall in two classes: operational programs and structural programs.

The operational programs cause execution of tasks directly recognizable to an external user of a computer, i.e., solving an equation. The structural programs control the equipment and maintain an orderly sequence of events in the system. The operational functions are determined by the specific needs of each application and accordingly, vary too greatly for a general treatment. The structural functions are more standardized, however, and can be profitably discussed in general terms. They include:

- Operation of all peripheral devices;
- Scheduling and timing of random access storage device operation;
- Controlling the sequence of all operational programs;
- Monitoring the status of the system and initiating action should a failure or unexpected event occur;
- Maintaining coordination between devices external to the system and the operating program (other computers, inquiring devices, etc.).

Design of the computer program is a process which includes the following basic steps.

1. Development of a precise and complete specification of the functions to be implemented.
2. Identification of the principal operational program elements.
3. Establishment of the structural relationships of the system elements: data, programs, device capabilities.
4. Preliminary quantitative estimates of the capabilities and/or requirements of all elements of the system considered singly and within the overall structure.
5. Preparation of a program specification which delineates all programs and indicates equipment requirements. This process naturally may be iterative and can frequently interact with the equipment selection process.

There are no basic constraints on the choice of a programming approach. This potentially limitless range of designs does not minimize the designer's problems. Along with so much freedom of choice, unfortunately, go the risk of a gross error due to failure to consider all possible detailed aspects of the problem. There are two essentially brute force methods for avoiding this risk during the planning of a system: extremely thorough and costly analysis of each alternate approach; or gross overdesign. Neither of these design approaches is likely to lead to an efficient system design.

Experience with real-time computer programming helps identify proven approaches to various aspects of the problem. Furthermore, experience provides a basis

for checking estimates of program complexity developed through problem analysis by comparison with fully executed programs for comparable problems. Lastly, experience provides checklists of things to consider, where oversight might cause difficulties that would only emerge after substantial design work had been done.

Statistical methods are very powerful. Their application to analysis of the data and functional flow can lead to highly efficient utilization of the elements of the system. Without such methods one can either overdesign the system by considering only "worst-cases" or can design for average loads and take a blind chance on the effect of natural variations in load. The use of statistical methods, most notably queuing theory, places this important aspect of design on a firm analytical basis.

General Economic Considerations

There are a number of basic system planning problems requiring analysis. Given an adequate traffic load specification which identifies all functions and their rates of execution there may or may not be much freedom left in the choice of a network. Where freedom exists, one should consider various methods for minimizing total system cost. Factors to consider include:

1. Centralization vs. decentralization of computer facilities;
2. Utilization of different classes of communications channels tailored to the needs of individual users.

The cost of a complex system is made up of a variety of costs, some of which are not obvious at first glance.

TABLE 1.3
Types of System Configuration

Configuration Type	Characteristics: Minimum Peripheral Devices	Minimum Computer	Parallel Computers for Load Sharing	Spare Peripheral Devices	Spare Computers	Notes
A. Minimum Simplex	X	X				Lowest cost
B. Protected Simplex	X	X		X		Minimizes long outages for peripheral device maintenance
C. Minimum Duplex	X	X		X	X	Provides continuity of service regardless of loss of any single element of system
D. Multiplex	X	X	X	X	X	If more than 2 computers share load, multiple failures cause gradual reduction in service but no interruption

Both development and operation costs must be considered and balanced to achieve a minimum total cost. Experience furnishes some guidelines on what to expect on typical projects. Typical development cost elements include:

- initial planning
- equipment procurement
- system analysis
- programming and debugging
- operational testing
- cutover to on-line service
- documentation.

Typical operation costs include:

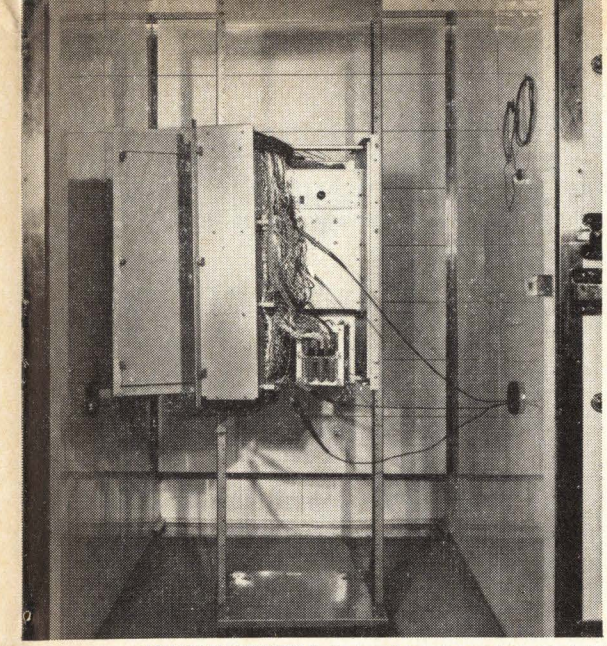
1. Amortization of development costs
2. Daily operation and maintenance arts
3. Sustaining costs; such as training of new personnel, and modifications and improvements to the system.
4. Costs incurred by other activities in user organization due to existence of system.

SUMMARY

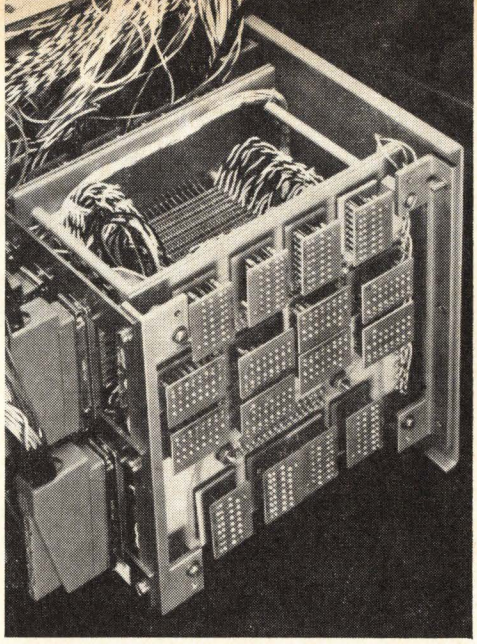
The design of computer-communications systems has been formulated as a problem with four major aspects:

1. Traffic Load Specifications;
2. Equipment Selection;
3. Program Design;
4. Economic Considerations.

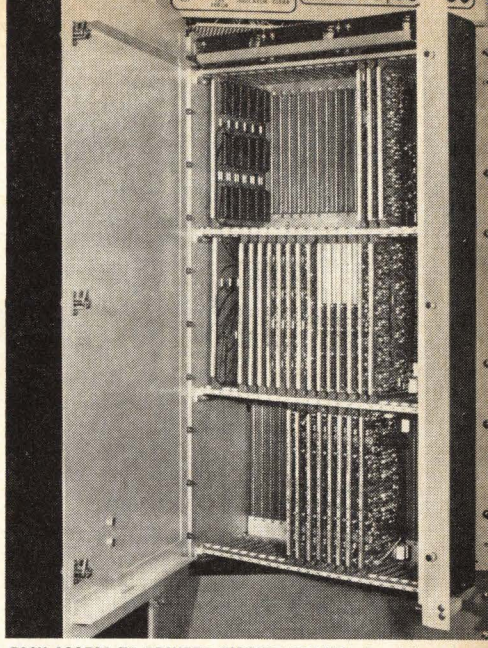
Here in Part 1, the basic characteristics of the design problem have been introduced and the nature of the choices available to the designer discussed. Typical questions that enter into formulation of a traffic load specification have been presented. Part 2 of this series will discuss equipment selection.



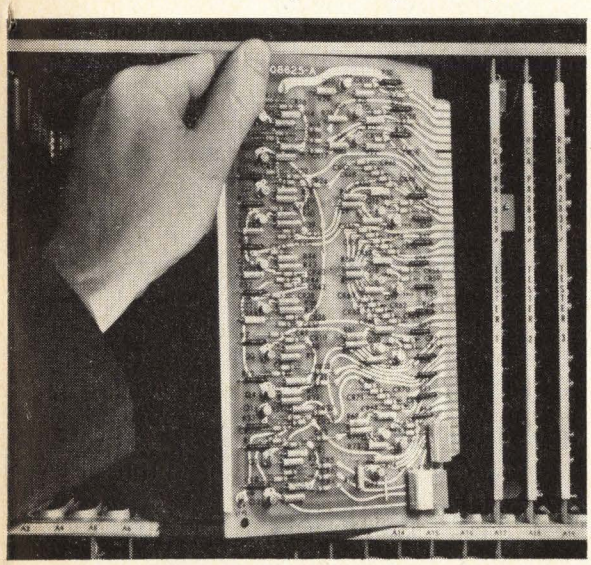
TEMPERATURE STABLE. Each unit worst-case tested in hot/cold chamber over specified temperature range.



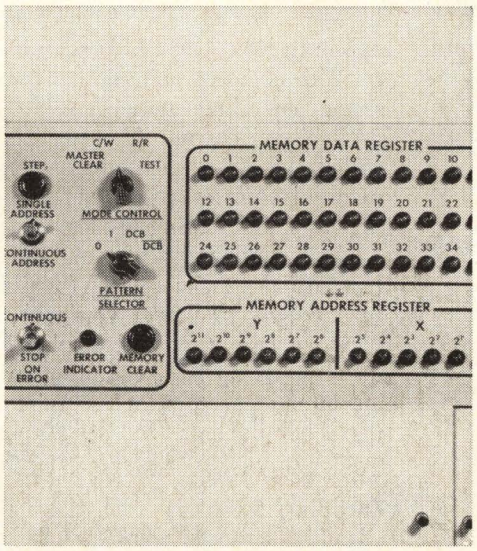
EASY ACCESS TO MEMORY STACK. Stack capacity of 8192 words, 36 bits. Systems available to 32,768 words, 72 bits.



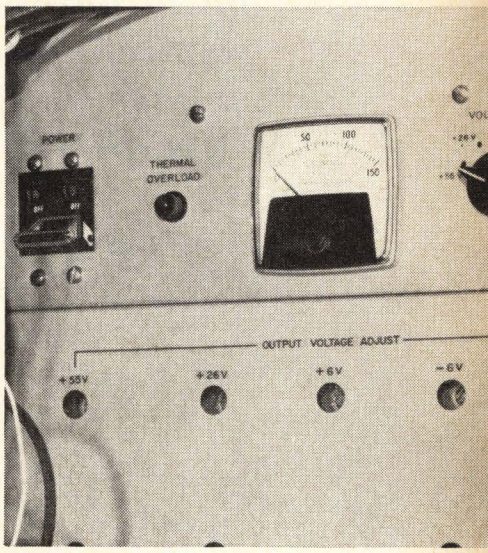
EASY ACCESS TO PRINTED CIRCUIT BOARDS. Provisions for adding many optional features plus system expansion.



EFFICIENT CIRCUIT BOARD DESIGN. Vertical installation provides 86 connections per board, shorter current path.



SELF-TESTING. RCA MS-1 systems can be supplied with built-in tester to locate read-in and read-out errors.



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- *All silicon semiconductor devices* for improved high-temperature performance and increased reliability.
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Similar systems, with operation cycles ranging from 1.5 to 6 usec, are also available. Let us give you a quotation. Call your nearest RCA Field Representative...or write, wire or telephone RCA Electronic Components and Devices, Memory Products Operation, Section F-ZB-3, 64 "A" Street, Needham Heights 94, Mass. Phone (617) HI 4-7200.

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New Switch/Display Matrix System

New flexible keyboard building block concept offers direct encoding by selective wiring — no diode matrices needed for output to logic circuits.

A compact new switch/display matrix featuring unusual layout flexibility and a rugged "box-girder" mounting system has been developed by Micro Switch, a division of Honeywell in Freeport, Ill. It permits up to 256 code combinations from a single encoding switch, using an 8-bit binary output. The new series, called the KB system, uses selective external connections for direct coding, thus eliminating diode matrices.

Key components of the KB system are the switch itself (available in encoding or power versions), indicators, operating and display buttons, mounting bars, encoding strips, insulator-separators, plus miscellaneous components.

Encoding Switches

KB encoding switches are momentary-action switches with sliding trifurcated contacts moving down against stationary contacts that extend through the bottom of the switch housing. These switches are available in two types: one has from one to eight code terminals, a common terminal, a strobe (pulse) terminal and an electrical monitor (which can electrically indicate if two switches have been operated simultaneously); the other switch is similar except one code terminal is replaced with a repeat function.

Because the sliding contacts are different lengths, the common and electrical monitor contacts "make" first before the seven (or eight) bit outputs. The strobe contact is intentionally delayed to insure bounce-free output from the code terminals. So pushing further on the plunger completes this strobe circuit, sending a pulse to, for example, a computer, indicating the switch is ready to be "read." This delay eliminates any false signals because of contact "bounce" or minute differences in code contact lengths.

On the optional model, pressing still further on the switch plunger completes the repeat circuit. To prevent accidental repeating, the plunger engages a second spring, increasing the operating force.

Power Switches

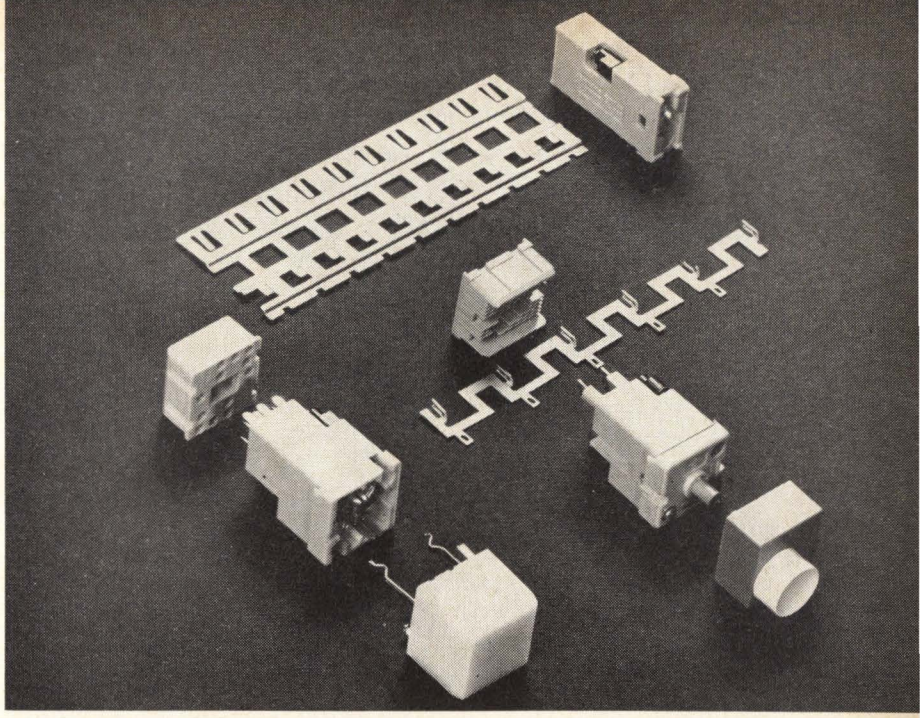
Available in either 2-pole or 4-pole models, KB power switches have momentary (push on, release off) or alternate (push on, push off) action. Power switches are rated 3 amps inductive, 5 amps resistive at 28 volts dc; 5 amps inductive and resistive at 115 or 250 volts ac.

They are available with color-coded lighted display to indicate switch status. Since the lighting circuits can be independent of the switch action, they can show status of a controlled element without requiring switch operation. These illuminated switches take up to 4 miniature (T-1) long-life bulbs. For extra long bulb life the lamp housing remains stationary when the switch is pushed, minimizing deleterious shock and vibration effects. Both transmitted (using a colored button) and projected (using a white button with colored filters over the individual lamps) are available in a wide range of matched shades.

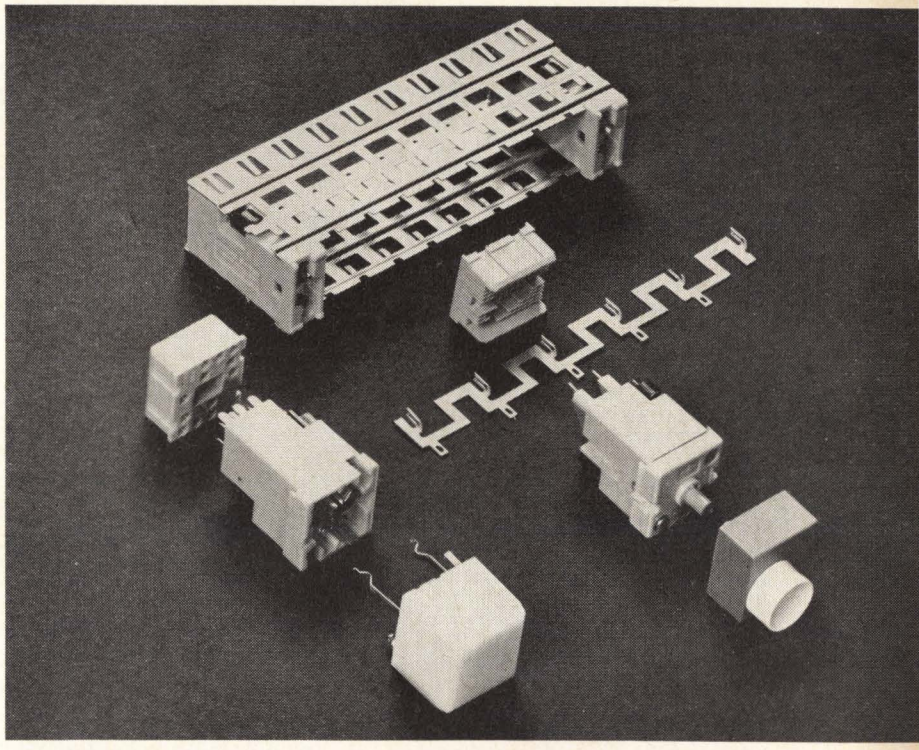
Indicators, Buttons and Bars

Available in a wide variety of shapes (squares, rectangles, triangles, circles, diamonds, others), colors, and sizes, KB buttons and bars fit on top of encoding or power switch plung-

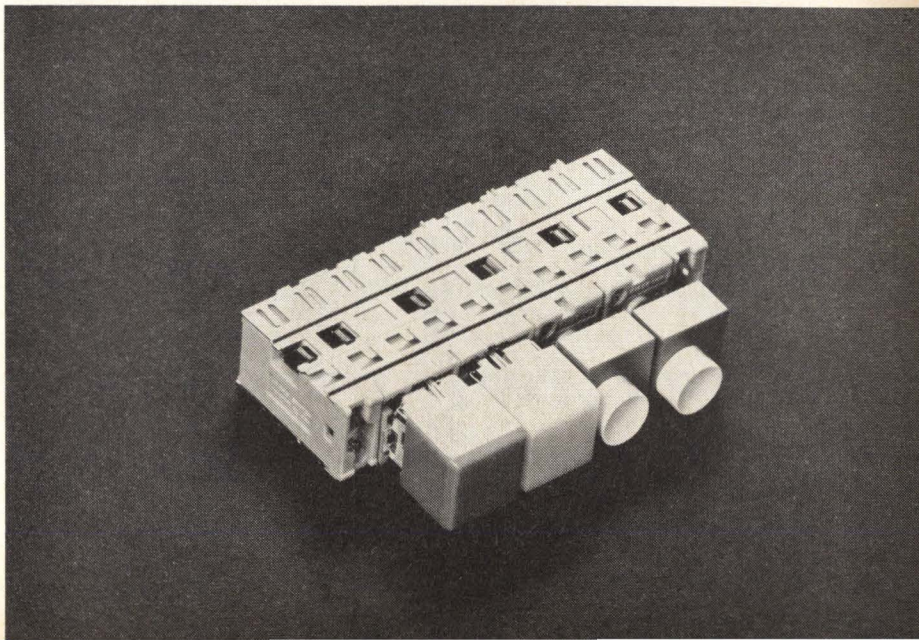
Typical building-block components of Micro Switch's new switch/display system are (at top) stainless-steel mounting bar, and end connector; (left row) connector block, power switch, and lighted single-level pushbutton; (right row) insulator-separator, gold-plated copper-alloy encoding strip, encoding switch, and two-level pushbutton. To build up a KB switch matrix . . .



. . . two mounting bars are locked together by two end connectors. Then insulator-separators (for encoding switches) and connector blocks (for power switches) snap into the mounting bars. Up to 11 encoding strips fit special slots in the insulator-separators, and provide 8 output bits, delayed strobe, and electrical monitor. Last step is plugging . . .



. . . power switches (2 shown at left) into the connector blocks, encoding switches (at right) into the encoding strips. Switches are held in place by swing-out lugs which lock into the mounting bars; screws pull these lugs up snug. Buttons or pushbars then snap into place on switch tops. "Ears" on mounting bars lock together, so hundreds of rows of switches can, in effect, form a rigid one-piece assembly. Yet any individual switch can be removed by simply loosening lug screws, pulling unit out.



ers. Buttons are available in single-level or two-level versions. For greater design flexibility the raised button extension and the base can be different colors; for extra-long legend life, lettering can be put on the lower level where it won't be touched. Buttons are available in 1-unit, 1½-unit, and 2-unit sizes (a unit is the standard ¾-inch modular measurement); pushbars come in 2-, 3-, 4-, or 8-unit lengths.

KB indicators are essentially power switch modules without the switches but with the lamps. As with the power switches, colors can be by transmission or projection.

Connector Blocks

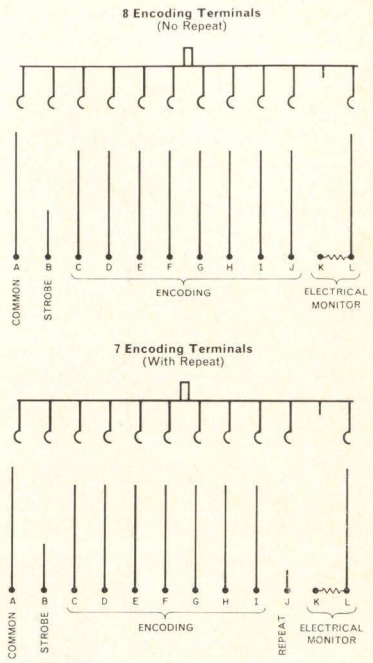
Encoding and power switches plug into plastic connector blocks. Quick-connect terminals fit into slots; on one terminal end, spring clips connect to the switch terminals; the other end has an elongated hole for solder connections. All terminals are on the same plane for easy wiring; the terminals can also connect to printed-circuit boards or flex tape.

When a switch is removed the connector block stays in place; the new switch simply plugs into the same block. This means that during initial assembly all wiring and electrical connections can be made before the switch is put in place, preventing solder and other contaminants falling into the switch. Similarly, subsequent wiring and circuit changes can be made with the switch removed. More important, this means that all the wiring for dozens of switches can be done at the bench, then the entire matrix assembly transferred to a panel.

Encoding Strips and Insulator-Separators

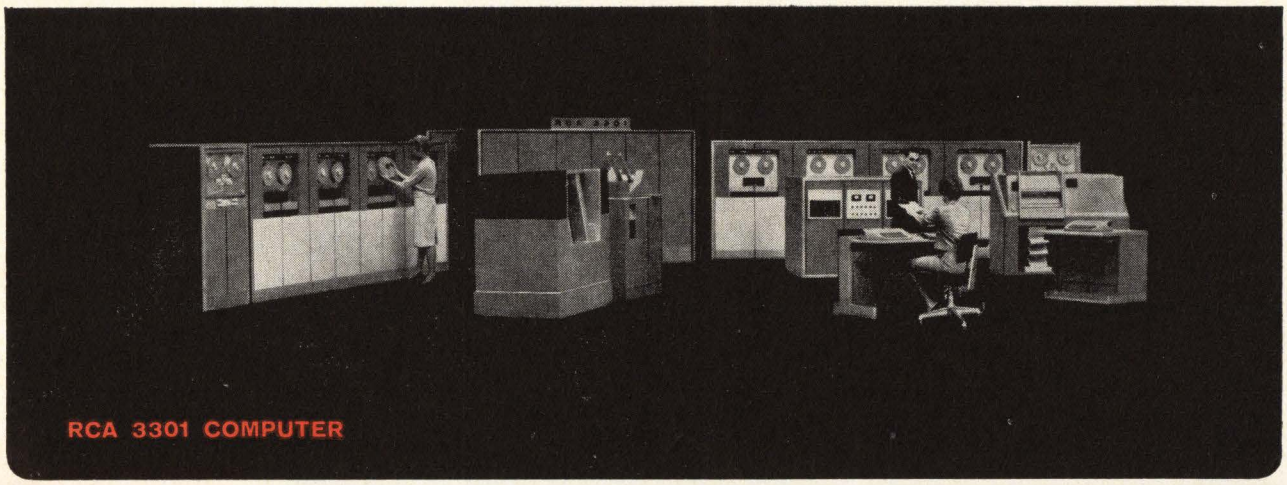
Encoding strips are gold-plated copper-alloy strips used with encoding switches only. U-shaped terminals connect with the stationary contacts of the switches and extend through an insulator-separator. Encoding strips are 16 units (12 inches) long and can be clipped to any length.

The insulator-separators are U-shaped plastic channels which have ribs to hold 12 encoding strips. Like the connector blocks, encoding strip terminals give easy single-plane wiring from the bottom, meaning faster



Circuit diagrams show the two types of KB encoding switches — one with 8 encoding terminals (top), the other with 7 encoding terminals plus a repeat circuit. Both types have a common terminal, a strobe terminal, and an electrical monitor circuit which can be used to determine if two switches have been pushed at the same time by mistake. The common and monitor circuits "make" first, followed by the bit outputs. The strobe circuit is delayed to eliminate bounce and noise from the output bits.

Micro Switch's KB line includes power switches (top row), alpha-numeric encoding switches (on keyboard), pushbars (bottom row), illuminated indicators (right of pushbar). All are available in a wide range of colors and shapes to permit complete design flexibility. Plug-in feature of all elements reduces assembly time and permits easy replacement.



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initial assembly and easy repair. Encoding switches can be encoded two ways: by clipping the stationary contact terminal of the switch or by clipping the encoding-strip terminal.

Mounting Bars

Looking like parts from an erector set, mounting bars are perforated stainless-steel strips that not only hold all the KB components in rigid alinement but also have enough interlocking strength to support a 250-pound man. Because of their brawn, hundreds of KB switches can be installed in a panel opening without requiring any other support or reinforcement than that from the KB mounting system itself. Both encoding and power switches have special lugs that swing out to engage openings in the mounting bars. Turning a mounting screw draws the switch into place, where it adds to the frame strength.

Miscellaneous Parts

A complete line of spacers and barriers in a wide range of colors, heights, and widths fill out rows and panels. This means that switches can be arranged in, for example, a stepped pattern, yet the panel opening can be rectangular. Spacers can also be used to leave space for additional future switch installations.

Modular plunger extensions and mounting bars permit adding mechanical bailing (release) and lockout. With this, one switch holds in until another is pressed; two cannot be pushed at once. These units can be added at any time without increasing the panel area since components fit under switches.

Despite salient advantages, an installed KB system, according to Micro Switch, actually costs less than a conventional switch system, figuring panel fabrication, wiring, required space, diode matrices and the like. In addition, KB offers savings in weight, fast plug-in replacement, as many as 256 code combinations with field-variable 8-bit output from a single switch, and a high degree of design flexibility. Literature available from Micro Switch shows typical configurations and explains how to select KB modules for various applications.

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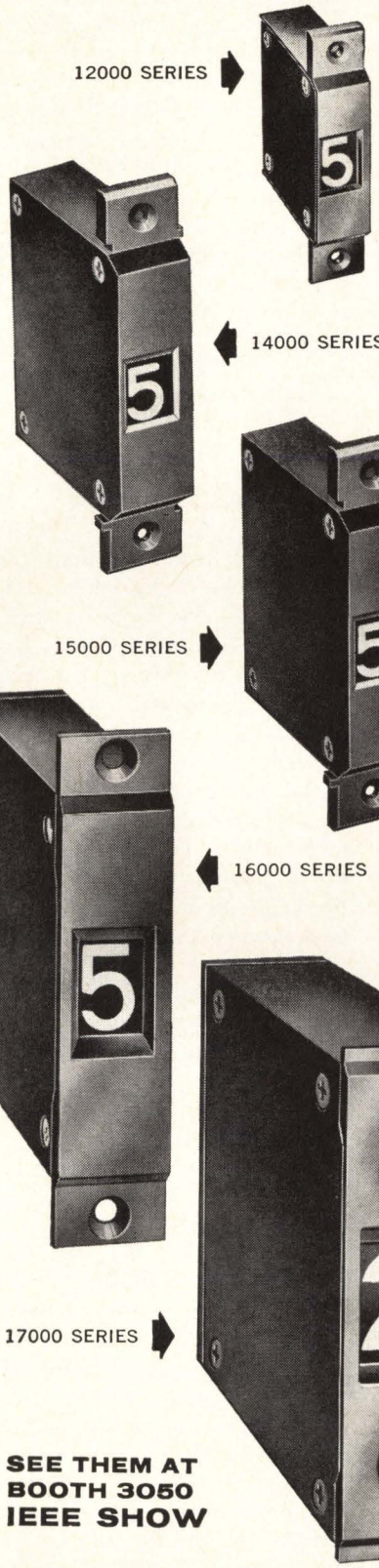
Magneline®

THE INDICATORS WITH INHERENT MEMORY



12000 SERIES

PANEL SPACE.....2 5/64" wide x 1 9/16" high
(2 5/64" x 1" if bracket mounted)
NUMBER OF CHARACTERS....up to 10
NUMBER OF TERMINALS.....5, plus a common*
WATTS.....3
PULSE TIME.....500 milliseconds
DUTY CYCLE.....25% (pulsing same coil)
*Requires switching of lead in conjunction with reversal of polarity to change character

14000 SERIES

PANEL SPACE.....½" wide x 2¼" high
(½" x 1⅝" if bracket or earless mounted)
NUMBER OF CHARACTERS....up to 11
NUMBER OF TERMINALS.....11, plus a common
WATTS.....2.5
PULSE TIME.....500 milliseconds
DUTY CYCLE.....50% (25% if pulsing same coil continuously). Continuous duty available in some voltages.

15000 SERIES

PANEL SPACE.....½" wide x 2¼" high
(½" x 1⅝" if bracket or earless mounted)
NUMBER OF CHARACTERS....up to 10
NUMBER OF TERMINALS.....5, plus a common*
WATTS.....1.5
PULSE TIME.....500 milliseconds
DUTY CYCLE.....50% or continuous (must be specified)
*Requires switching of lead in conjunction with reversal of polarity to change character

16000 SERIES

PANEL SPACE.....⅞" wide x 3¾" high
(⅞" x 2 15/16" if bracket or earless mounted)
NUMBER OF CHARACTERS....up to 12
NUMBER OF TERMINALS.....12, plus a common
WATTS.....3
PULSE TIME.....650 milliseconds
DUTY CYCLE.....50% or continuous (must be specified)

17000 SERIES

PANEL SPACE.....1½" wide x 5" high
NUMBER OF CHARACTERS....up to 12
NUMBER OF TERMINALS.....12, plus a common
WATTS.....3
PULSE TIME.....2 seconds
DUTY CYCLE.....50% or continuous (must be specified)

All MAGNELINE® Indicators are available in 6, 12, 24 or 28 volts (as specified) and the standard operating temperature range is from −20 deg. C to +71 deg. C. Options, at extra cost, include special voltage, broader temperature range, special characters, trim-spacer strips, internal lighting, solder terminals, dust tight–drip proof construction, and dummy models with fixed digit or black window.

SEE THEM AT BOOTH 3050 IEEE SHOW

YOU GET ALL THESE FEATURES WITH MAGNELINE:

Long life • Minimum maintenance cost • Easy readability in all kinds of light • A wide variety of mounting methods to give you best use of panel space.

For complete details and the name of our nearest representative, write to us at Waterbury. Better yet, call us at (203) 756-3636 or get in touch by TWX (203) 753-9341

PATWIN® ELECTRONICS
A DIVISION OF THE PATENT BUTTON COMPANY
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CIRCLE NO. 27 ON INQUIRY CARD

NEW PRODUCTS

LOW LEVEL SWITCHING RELAYS

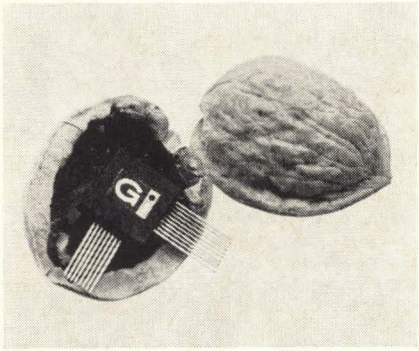
Three new low level switching relays, specifically designed to minimize noise and thermal voltage problems are capable of handling the input switching functions of reasonably high speed, low level data acquisition systems. Choice of three relay-types with different switching speeds, thermal voltage and noise characteristics, and package sizes is offered. Type HGS2MT is an extremely fast, highly sensitive, mercury-wetted contact switch; Type HG2MT is a standard mercury-wetted contact switch offering the best combination of low-level characteristics; and Type MR2MT provides faster switching speeds in a module of minimum size. All of the relays are packaged in metal-enclosed modules for quick, convenient mounting to printed circuit boards. C. P. Clare, Chicago, Ill.

Circle No. 124 on Inquiry Card

COMPUTER TAPE

Featuring full-width pre-testing, a new computer tape is said to give the industry a product which may be used today, and which will also meet the increasing demands of future generations of computers. According to the company, the new tape provides protection against obsolescence in that users will be able to use them readily on the forthcoming 9-track tape drives such as IBM's recently-announced System 360 equipment. Available on a 1.5 mil Mylar base, each track is independently certified for 800 bits per inch. The new tape also utilizes company's "Micro-Plate" process, which combines an oxide formulation with a tough binder system to achieve greater reliability and longer tape and head life, while, at the same time, eliminating shedding and head fouling. Reeves Soundcraft, Danbury, Conn.

Circle No. 197 on Inquiry Card



MICRO-DIODE LOGIC NETS

Microcircuit silicon diode arrays can be used effectively and economically to perform logic functions. The arrays allow the circuit designer a high degree of flexibility since logic or counting function is changed by simply rearranging the diode pattern, with the external circuitry remaining the same in many cases. Standardized leads and package size simplify packaging. External connections are minimized and assembly costs are reduced. At the same time, reliability is increased and since the matrices are ruggedly constructed, they are unusually resistant to shock and vibration. A wide range of parameters are available including a high peak inverse voltage of 300 v; a low reverse leakage of less than 1 ua at 25 v and less than 5 ua at 75 v; switching speeds from 2 usec to 50 nanosec; and a power dissipation of 1 watt. Gulton Industries, Metuchen, N.J.

Circle No. 183 on Inquiry Card

PHOTOVOLTAIC DEVICES

An expanded line of standard and custom design silicon photovoltaic devices was developed for such applications as punched tape and/or card readers, shaft position encoders, high- and low-intensity illumination detectors, position sensors, and other uses. The devices are available with essentially any desired active area configuration and with top, edge, or bottom contacts, allowing the use of various mounting techniques. Units offer high light-generated current, low dark-reverse current, and are available in either N/P or P/N types. Heliotek, Sylmar, Cal.

Circle No. 144 on Inquiry Card

HIGH DENSITY HEADER

A molded header of diallyl phthalate provides dip-solder terminal connections for high density packaging of such components as integrated wafers directly connected to standard miniature printed circuit boards. On one side, these headers provide two rows of right-angle terminals on standard 0.200-inch centers for soldering to miniature circuit boards. On the opposite face of the header, terminals are upright on 0.200-inch centers arranged in two rows 0.5 inch apart. Sixteen standard sizes offer all even numbers of terminals from 6 to 36. Electronic Fittings & Components Div., Curtiss-Wright, Danbury, Conn.

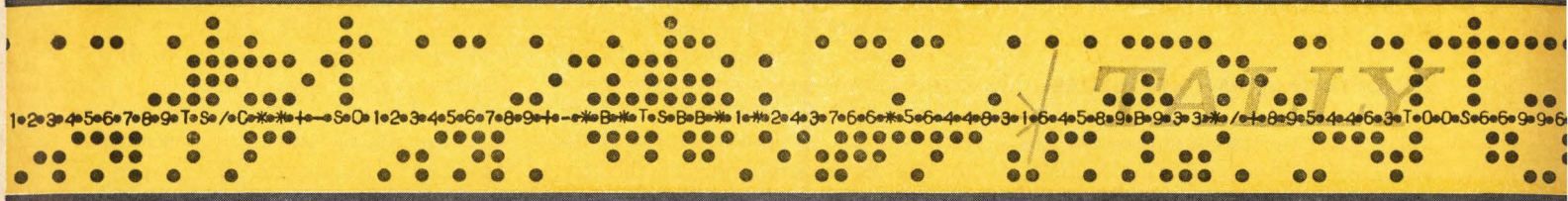
Circle No. 126 on Inquiry Card

COMPUTER TAPE REELS

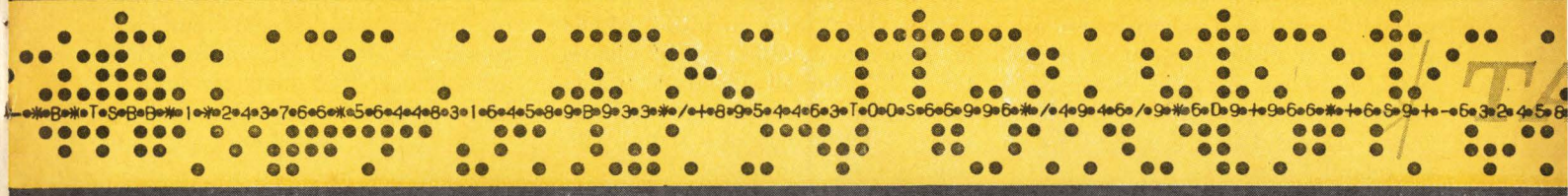
All-aluminum hub tape reels permit aluminum-to-tape contact, greater flange stability and interchangeable color-coding. These reels are said to eliminate cracked hubs and accompanying reel replacement costs, operating interruptions, and tape damage. Precision center aperture provides positive non-shimmy, no-wobble performance. Shock-resistant flanges provide added protection against shipping and handling abuse. Memorex Corp., Santa Clara, Cal.

Circle No. 195 on Inquiry Card

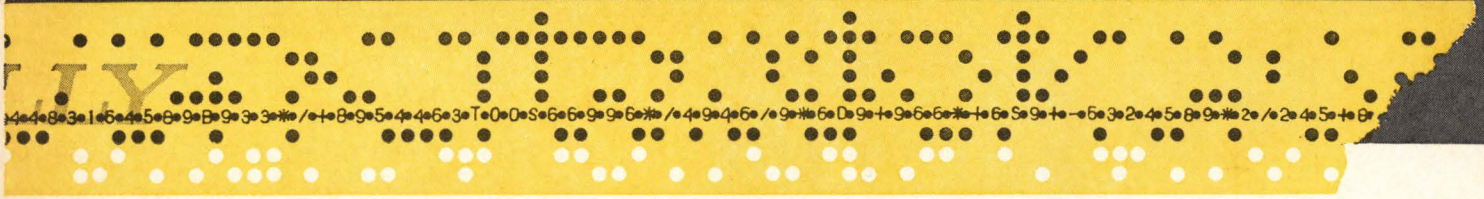
All this programming tape was made



on the new Tally Printing Perforator.



You can make even more!



Model 430 Printing Perforator

Where your perforated tape preparation problems concern numerical control, computer programming, inventory recording, accounting, or data recording, you should see how the new Tally Printing Perforator can work for you.

Here is a versatile, modestly priced approach to all kinds of source data recording. Technically, this new unit is an 8 channel, fixed code, printing perforator which will operate at 8 characters per second with entry provided by a 20 character keyboard consisting of a standard 10 character adding machine keyboard plus 10 additional characters. At the time of punching, the entry is printed directly to the left of the sprocket hole and in line with the coded character. The tape can be automatically positioned for visual verification. You can select any alpha-numeric-symbolic code combination desired at the time of order. A full 1000 foot tape supply is standard. Price is a low $1,395 and quantity discounts apply.

For a demonstration, call your Tally sales representative. For more information, please write Tally Corporation, 1310 Mercer Street, Seattle 9, Washington 98109. In the U. K. and Europe, address H. Ulijohn, Tally Europe Limited, Bromley North, Kent, England.

TALLY®

CIRCLE NO. 28 ON INQUIRY CARD

NEW PRODUCTS

SOLID TANTALUM CAPACITORS

Polar solid tantalum capacitors are available with a new top voltage rating of 125 volts dc. Produced in a capacitance range from 0.0047 to 10 microfarads in four standard size hermetically-sealed cases, ranging in length from 0.25 to 0.78 inches, the J-series capacitors have exceptionally low leakage current, typically less than 1 microampere at 25C, and a dissipation factor of 3 per cent or less over the entire capacitance range. Union Carbide Corp., Linde Div., Kemet Dept., Cleveland, Ohio.

Circle No. 141 on Inquiry Card

INCREMENTAL ENCODER

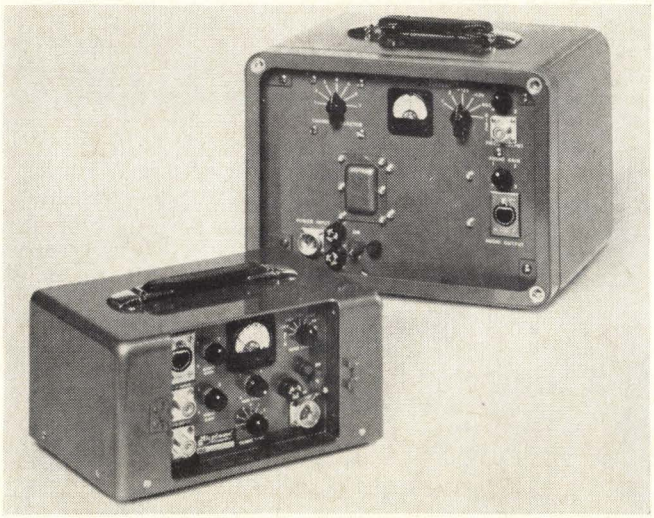
Magnetic incremental encoder may be produced with resolutions up to 4096 equally-spaced pulses in a single turn with an accuracy of $\pm \frac{1}{2}$ bit. Bi-directional operation may be provided for by the generation of both CW and CCW pulses. Integral 80 to 100 kc interrogation carrier accommodates input speeds from zero to over 20 kc with no variation in output amplitude (and optionally to over 50 kc). Either positive or negative 10 volt pulses may be specified as well as a zero reference of one or more points with a separate output line. The standard Model IC 25 contains, within a $2\frac{1}{2}''$ diameter $\times$ $2''$ case, all silicon electronics for operation at 12 vdc and requires 50 ma current. Data-Technology, Inc., Watertown, Mass.

Circle No. 145 on Inquiry Card

DIGITAL DATA RECORDERS

Adaptable digital magnetic tape recorders for scientific data recording applications feature rapid access, non-threading, cartridge-loaded (seven track) tape. Units use low power during the recording cycle and no power during quiescence. The welded solid-state circuitry and mechanical scanner provide a wide variety of format arrangements. The standard scanner records from 2 to 24 tape (6 bit) characters per recording cycle. The recorder's small size meets the package requirements often found in scientific data recording under adverse environmental conditions. It can be contained in a cylinder 6.25″ in diameter and 4″ high, or also in a small rectilinear space. Lufkin Research Labs., Los Angeles, Cal.

Circle No. 154 on Inquiry Card



MICROWAVE DATA RELAY SYSTEM

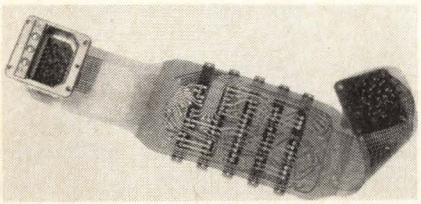
Providing wide band performance for relaying either high-speed computer or video information, a new solid-state FM microwave relay system was developed for digital or analog data applications in the frequency bands of 1710 to 1850 mc/s, 2200 to 2300 mc/s, and 2700 to 2900 mc/s. Subcarriers are optional for voice or other data input. Instantaneous video bandwidth is 8 mc to the 1 db points. Transmitter power output at 1 to 4 watts is available depending on bandwidth. The receiver is crystal-controlled to specified frequencies in the relay band. This superheterodyne receiver is all solid-state (no filaments) with a noise figure of 10 db maximum; or optional 5.5 db maximum noise figure for applications where maximum sensitivity is desired. Total transmitter-receiver weight is under 40 pounds. The equipment is housed in a weatherproof, rugged case for portable field use. All the controls for the transmitter and receiver are on the front panels. Transmitter controls include channel selector, video gain, subcarrier gain, and a multi-position meter monitor input voltage, module voltages, power amplifier and RF output. Receiver controls include channel select, video gain and subcarrier output gain control. A multi-position meter monitors balanced crystal currents, module voltages, AGC (relative RF signal strength) and discriminator voltage. This equipment is now in production and in operational use for military and civil airborne/ground digital and analog relay applications. It also will accept video tape, TV, or other similar inputs for a fully diversified capability. Total power consumption is under 50 watts of unregulated 28 vdc for use in mobile data van and aircraft applications. The complete system, including suitable antennas, is available with relay range to 15 miles line-of-sight. Higher power transmitters are available for increased range to 200 miles. Microwave Associates, Burlington, Mass.

Circle No. 119 on Inquiry Card

RECTANGULAR TRIMMER

Small-size wirewound trimming potentiometer, measuring 1″ L × 0.185″ W × 0.315″ H, features a non-hygroscopic diallyl phthalate housing, end stops with an idler clutch, and has a power rating of 1 watt at 70C over an operating temperature of −65C to +175C. The unit is available with 6″ insulated stranded leads or printed circuit pins extending from either the narrow or broad side 90° from the shaft. Standard resistances range from 10 ohms to 50K ohms. Spectrol Electronics Corp., San Gabriel, Cal.

Circle No. 150 on Inquiry Card



MULTILAYER CIRCUITRY

An advanced multilayer circuit technique is said to produce low cost, high density multilayer circuits with solid copper post interconnection between any layers in a flexible and formable circuit assembly or bonded to a variety of rigid substrates. A significant feature of the new technique is the ability to wave or dip solder components directly to the circuit. According to the company, this feature will enable users to greatly reduce assembly costs of components. In addition, interlayer connections can be made between any layer without surface exposure. Thickness of the dielectric between conductors may be as little as 0.005″ or as great as 0.015″. Conductor thickness may be from less than one ounce to more than six ounce copper. Registration pattern to pattern or layer may be 0.005″ minimum from true position. These flexible multilayer circuits permit fabrication of copper conductors and terminals simultaneously, allowing circuits to start and stop between any layer, thus reducing the number of layers required to handle several hundred terminals. Sanders Assoc., Inc., Electronic Prods. Dept., Nashua, N.H.

Circle No. 176 on Inquiry Card

NEW PRODUCTS

RTL INTEGRATED CIRCUITS

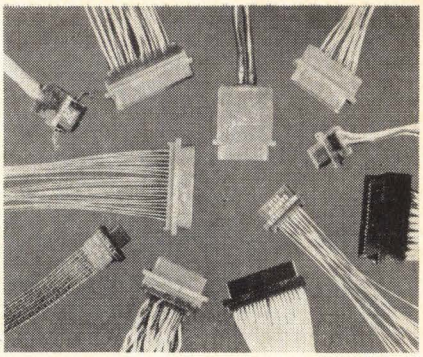
A new line of RTL integral circuits is divided into devices specified from −55 to +125C operation (the NB-1000 Series) and for 0 to +100C applications, (the NB2000 Series). In both categories, flip-flops, three and six-input gates, buffers, half adders, and counter adapters are available. Also available are half shift registers and dual two and three-input gates. All are packaged in low-profile modified TO-5 enclosures with 8 and 10-lead configurations. There are 14 elements in each series which can be combined to provide every NAND/NOR function required for digital systems. They are characterized by high noise immunity and low propagation delay and power dissipation. National Semiconductor Corp., Danbury, Conn.

Circle No. 163 on Inquiry Card

TIMING RELAY

Transistorized time delays employ a new modular assembly with standardized circuits and components which are said to permit more rapid availability and lower cost than would otherwise be possible. The delay interval of each adjustable unit can be set over a 10 to 1 range by connecting the proper resistor across two terminals. Four overlapping ranges cover the span from 0.1 sec. to 30 sec. Fixed timers with timing resistor built in are available in 16 standard time delays. The 900-064 Series is designed for an operating voltage range of 18 to 32 vdc and an ambient temperature range of −55C. to +85C. Fixed delay units are set at 28 vdc and 25C. ambient within ±5% of specified delay. Over the entire voltage and ambient range, the time interval will remain within ±10% of the specified delay. Output contacts are DPDT rated at 2 amp. resistive load or 1 amp. inductive load on 28 vdc or 115 vac. G-V Controls, Inc., Livingston, N.J.

Circle No. 138 on Inquiry Card



CONNECTOR HARNESSES

Rectangular microminiature connectors are available with a variety of special lead wire harnesses. Examples of the versatile harnessing capability include AWG #26 Teflon with additional back potting and shrink tubing jacketed; AWG #30 Teflon, color-coded and brought off at 90°; AWG #28 shielded and unshielded wire; AWG #25 bare, gold-plated copper; AWG #28 color woven-type wire; 5 AWG #22 wires with braided fiberglass jacket; and AWG #26 color-coded, 36″ long. Also, AWG wire sizes from #22 stranded to #30 solid can be terminated to the micro-connector. Within this range, a variety of conductors and insulation materials can be supplied. ITT Cannon Electric, Los Angeles, Cal.

Circle No. 184 on Inquiry Card

COMPUTER CONSOLES

Desks, consoles, control units and similar fixtures custom fabricated from melamine plastic (Formica) are available in any quantity without the high cost of tools and dies. New construction methods cut costs, maintain close tolerance requirements, permit even small quantity production as though units were stock items. All surfaces are highly resistant to heat, acid, scratching or marring, yet easily machined for holes, cut-outs, drawers, doors, racks, etc. One of the chief advantages to instrument manufacturers and makers of computers and data processing equipment is said to be the facility with which changes and modifications can be made at any stage without tooling expense. Warwick Products Co., Cleveland, Ohio.

Circle No. 172 on Inquiry Card

COMPUTER DATAPLOTTER

Compact, solid-state X-Y plotter, which features accurate, high-speed line, alpha-numeric and symbol plotting, provides graphic display of computer-generated information on a 30″ × 30″ or 45″ × 60″ plotting surface. In the off-line plotting mode, information can be fed to the plotter from magnetic tape, punched paper tape or cards, as well as entered manually from a keyboard. In the on-line mode, information can be fed directly from a computer. Tradenamed the 3500 Dataplotter, the unit can draw lines to within 0.015 of an inch between two points and can position points to within an accuracy of ±0.05 per cent. Lines can be drawn by the plotter at speeds in excess of 2,000 per minute — plotting points at the rate of 350 per minute — and labeling and annotating are made at the rate of 180 per minute using an alpha-numeric symbol printer. Other features include "gapless" tape operation with the ability to combine the symbol and coordinate data thereby effecting a considerable saving in computer time and tape, 48-character symbol printer, sequential printouts, segmented vacuum plotting board, and manual and automatic paper advance. Electronic Associates, Inc., West Long Branch, N.J.

Circle No. 123 on Inquiry Card

ENCODER TESTER

Designed to automatically check out shaft encoders, a new testing instrument detects errors in binary, contact type, and shaft-angle encoders with V-scan or M-scan selection logic. With minor modifications, it can evaluate encoders having U-scan gray code or the various binary-to-decimal selection logic. Ideally suited for encoders in the size 8 to 25 range, it has a clock frequency which is variable from 100 to 500 kc and a pulse width variable from 0.2 to 1.0 microseconds. Sampling rate varies from 250 to 5000 cps. The two error detection modes are stop on error and error totalize. Datametrics Corp., N. Hollywood, Cal.

Circle No. 153 on Inquiry Card

NEW PRODUCTS

EPITAXIAL SWITCHING TRANSISTORS

A new series of low-cost transistors designed for logic and memory applications is said to combine extremely high-speed with excellent β hold-up over a wide current range (to I_C = 500 ma). The four new devices — 2N3510, 2N3511, 2N3647, and 2N3648 — are of the npn type and are offered in TO-46 and TO-52 packages. All four have near-flat β characteristics over the usable current range with a guaranteed β_{min} = 25 for the 2N3510 and 2N3647 types and β_{min} = 30 for the 2N3511 and 2N3548 types at I_C = 150 ma, V_{CE} = 1 V. Complete "worst-case" characterization of the devices contains guaranteed maximum and minimum curves for all essential device characteristics. These limit curves are given in addition to the usual typical curves — a combination which gives the engineer sufficient data for the complete worst-case design of switching circuits. The advanced switching capability is said to be largely due to the 9-finger overlay geometry which lowers junction capacitance while maintaining high current capability. Motorola Semiconductor Prods., Inc., Phoenix, Ariz.

Circle No. 136 on Inquiry Card

PROJECTION OSCILLOSCOPE

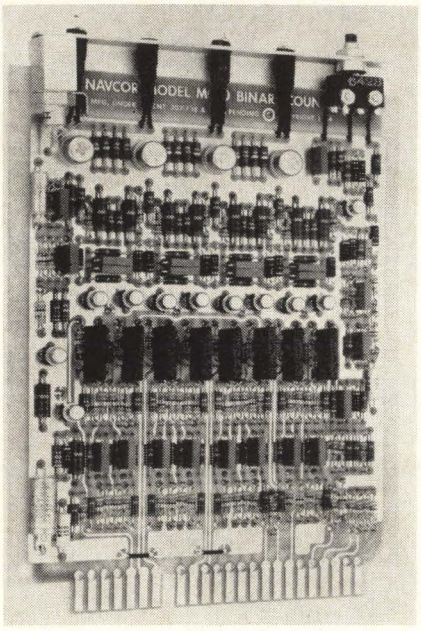
Capable of displaying dynamic wave forms, computer data readout, or any symbol that can be generated on a standard oscilloscope, a new projection oscilloscope can be used for either front or rear screen projection for pictures from 28 inches up to 12 feet wide. Separate inputs are afforded for the X, Y, and Z axes ranging from 0.1 to 100 volts with 100,000 ohm input impedance. Brightness, as measured on a 12 foot standard beaded screen, is 4 foot lamberts, with a line width of approximately 160 mils. Dalto Electronics Corp., Norwood, N.J.

Circle No. 162 on Inquiry Card

MINIATURE COAXIAL CABLE

A new close tolerance 0.070″ O.D., 50 ohm coaxial cable contains a solid OFHC copper outer conductor, Teflon dielectric, and a silverplated, copper-center conductor. The thin-walled outer conductor is said to allow extreme flexibility and minimum attentuation for this diameter cable. A 10′ minimum quantity is available from stock at $20.00. Uniform Tubes, Inc., Collegeville, Pa.

Circle No. 160 on Inquiry Card



PARALLEL BINARY COUNTER

As one of a complete new line of 1-megacycle system logic functions, a new parallel binary counter module is available in both germanium and silicon versions. Designated the Model 10, it is a 4-bit parallel counter in which all flip-flops change state simultaneously, within one flip-flop delay time after the count pulse. Each section has a set of pedestal gates for parallel transfer of data into the module and neon indicators on each flip-flop for continuous readout of the count. A pushbutton on the handle of the module simulates count pulses for manual testing. These modules can be cascaded to provide a parallel counter of any length up to 120 bits and still count at a full megacycle rate. Navigation Computer Corp., Norristown, Pa.

Circle No. 190 on Inquiry Card

A-D CONVERTERS

Solid-state, 3-digit analog-to-digital converter provides decimal visual readout as well as BCD readout. Unit is said to incorporate a number of desirable operating features normally found in converters costing considerably more. Some of the features include a sampling rate of 150 conversions per second (250 cps for positive inputs); front-panel variable sampling rate of ⅓ to 5 cps and hold; automatic polarity switching and indication; voltage accuracy to ±0.1%, ±1 count; and resistance accuracy to ±0.5%, ±1 count. Called the Model 35 Reporter, it is rack mounted and is entirely plug-in card construction. Price is $795. Roback Corp., Instrument Div., Huntingdon Valley, Pa.

Circle No. 169 on Inquiry Card

DTL INTEGRATED CIRCUITS

New family of passivated, monolithic, expitaxial silicon integrated DTL circuits is said to offer improvement in the speed versus power dissipation figure of merit. The noise immunity of these devices is higher than in currently available DTL circuitry, according to the manufacturer. The first two logic elements now available are a dual NAND gate and an RS/JK clocked flip-flop. The dual NAND gate consists of a 2-input plus expander NAND gate and a 3-input NAND gate. These gates operate at 10 mc with typical propagation delays of 20 nanoseconds (VCC = 5 volts, output loading = 15 picofarads, power dissipation = 5 mw per gate). The RS/JK clocked flip-flop features low output impedance in both high and low states to provide high speed even with heavy capacitive loading. It is a direct-coupled circuit requiring a single phase clock and one power supply. This device is level compatible with all saturated DTL and TTL gates. All devices of the family operate over full military temperature range of −55C to +125C and are available in both the 10-pin TO-5 and ¼″ × ¼″ flat packages. Stewart-Warner Microcircuits, Sunnyvale, Cal.

Circle No. 185 on Inquiry Card

NEW PRODUCTS

INFINITE ACCESS FLOORS

Infinite access floors for computer rooms and other areas where underfloor access is important reduce floor thickness to 1¼". The new floor design is said to provide maximum access, eliminate need for stringers, assure panels of identical module size, and minimize cost. Improved pedestal assures lateral stability by locking each 24" × 24" steel panel to adjacent panels with a four-lug grip, making maximum use of the inherent strength of the panel without relying on stringer support. The new design also incorporates a sound-deadening and grounding pad, and panels with the high strength of steel, yet light-weight enough to lift with a 3" suction grip. Tate Engineering, Inc., Baltimore, Md.

Circle No. 174 on Inquiry Card

COMPACT POWER SUPPLIES

Newly-discovered packaging techniques are said to enable company to produce a line of systems power supplies that deliver wattages from 104.5 to as much as 816 in standard rack and half-rack sizes. This new development permits the system designer to use much less panel space for his power supplies than ever possible before, according to company reports. The new line of HS (for half-rack system) and FS (for full-rack system) modules covers the entire voltage range between 5.5 vdc and 51.0 vdc in 26 slot-type units. Currents range from 8.0 amps to 46.0 amps. The company also claims a price schedule that is, unit-for-unit, $100 less than prevailing market prices for this type of power supply. Silicon transistors are used throughout so the modules operate to 75C. They are self-cooled and have optimum airflow for both vented and forced air cabinets. Consolidated Avionics Corp., Westbury, Long Island, N.Y.

Circle No. 198 on Inquiry Card

FAST-RESPONSE STEPPING SERVOMOTOR

Discrete angular steps of 90° in response to a polarity-programmed input of 28 volts dc are provided by a new commercial step-servomotor. The fast response rate of 200 pulses/second, no load maximum, is attributable to the low inertia of the permanent-magnet rotor. The stepping servomotor is said to be ideal for digital control systems where exact speed correspondence and a final shaft position representing the integral of the input signal are needed. Sequential polarity switching of the 28 volts dc, applied to the two center-tapped control windings, provides a 90-degree step angle with no ambiguity as to the location of the initial position. Programming devices to obtain this sequential switching are available or may be supplied by the user. Applications of the step-servomotor include positioning, counting, readout of position, digital-to-analog conversion, and open-loop servo control systems. Diehl Div., The Singer Co., Somerville, N.J.

Circle No. 132 on Inquiry Card

NEW PRODUCTS

AC VOLTAGE STABILIZERS

Voltage stabilizers, rated at 5.0 and 10.0 kva, were designed to maintain exact voltage output in spite of wide fluctuations of line voltage, frequency, load, load power factor, or ambient temperature. They are particularly suited for use with computers and data processing equipment. Called the Stabiltron, the unit operates as follows: deviations from a predetermined output voltage level are sensed by an error detector; the error signal, through a silicon controlled rectifier circuit, augments the action of a magnetic voltage stabilizer and provides almost instantaneous correction of output voltage. The new units have an output voltage range of 118/236, adjustable to ±4 percent, and can handle a variety of input voltages ranging from 95 to 520. Models are available for operation at 47.6-52.2 cps, or 57-63 cps. The 5 kva unit is 28" wide by 26½" high and 14" in depth. It is priced at $1320 in quantities less than five. The 10 kva unit is priced at $2040 in quantities less than five. General Electric Co., Schenectady, N.Y.

Circle No. 189 on Inquiry Card

SHAFT ENCODERS

Analog-to-digital converters digitize shaft position or any other mechanical motion which can, through suitable gearing, be converted to a shaft position. An auxiliary use is as a tachometer with pulse rate counting and/or controlling circuitry. Outputs of these photo-electric, incremental-type pulsers provide, through use of two square waves, information as to incremental changes of shaft position and direction of change. Features include self-contained circuitry, low inertia, frictionless operation, and a wide choice of pulses per revolution. Noble Electronics, Carpinteria, Cal.

Circle No. 180 on Inquiry Card

IEEE SHOW GUIDE

Many of the product and recruitment advertisers in this issue will be in New York during the IEEE. Here is a special listing of the products they will display and the job interviews they will conduct at and during the show. You can bring this guide with you to the Show — just tear out along the dotted line at left.

PRODUCTS ON DISPLAY

AMP, INC. — Booth No. 2527-2531 and 2438

Complete line of electrical connectors, terminals, and patchcord and interconnection systems. Also, programming matrix switches and magnetic-logic devices. (See ad on page 15.)

BURROUGHS CORP. — Booth No. 1211-1217

Solid-state Nixie tube drivers or decoder/drivers with or without memory. Also, microminiature hybrid circuits containing glassivated single-sided semiconductors; uni-directional and bi-directional counters; single-sided glassivated semiconductors; Nixie tubes for numeric or alphanumeric readout; and 20, 30, and 80 mil memory cores, planes and stacks. (See ad on page 23.)

COMPUTER CONTROL CO. — Booth No. 3410-3414

DDP-116 computer, priced at $28,500, includes indexing, multi-level indirect addressing, priority interrupt, and 4 K memory. Performs up to 294,000 computations per second; 16 bit words; 1.7 usecs basic memory cycle; 3.4 usecs add time; and 4 K memory expandable to 32 K. Also, S-PAC logic modules (200 kc, 1 mc and 5 mc); TCM-35 core memory system which features all silicon logic modules, 1.4 to 2 usecs cycle time; and TMC-32 core memory system which features front access to logic and wiring, word capacities from 128 to 4096, word lengths from 8 to 48 bits, and 5 usecs full cycle. (See ad on Cover 2.)

DIGITAL EQUIPMENT CORP. — Booth No. 3927-3929

First exhibit of PDP-8, the $18,000 complete digital computer. Basic PDP-8 has 4096 words of 12-bit core memory, adds in 3.2 microseconds, and transfers data up to 625,000 words per second. Also, "Flip-chip" digital modules which are integrated circuits in epoxy-coated capsules mounted on 5½ by 2½ inch printed circuit boards. Automated, mass-production methods achieve lower module prices and lower system assembly costs. (See ad on page 35.)

FAIRCHILD SEMICONDUCTOR — Booth No. 2703-2711

Microcircuits, transistors, diodes, and test instrumentation. (See ad on Cover 4.)

MALCO MFG. CO. — Booth No. 1112

Modular wirewrap connector with 0.100", 0.125", and 0.150" center-to-center contact spacing, with PC header accessories. Also, chain-form tubular PC board pins for feed-thru and component mounting applications. (See ad on page 57.)

PATWIN ELECTRONICS — Booth No. 3050

New 26000 Series digital indicators with inherent memory and direct readout from 2 out of 5 code. Also, full indicator line. (See ad on page 51.)

RAYTHEON COMPUTER — Booth No. 2606-2614

New integrated circuit multiplexers/analog-to-digital converters combination provides up to 256 data channels per 5¼" high case, 4 times maximum density of discrete component units. New multiplexer samples data at 250 kc with 0.01% accuracy. Cost discounted more than 40% below cost of equivalent discrete component units. Also, digital circuit modules including new 20 megacycle flip-flop. (See ad on pages 25 and 26.)

TECHNIPOWER, INC. — Booth No. 3936

Complete line of modular and laboratory-type power supplies. All solid-state, regulated and unregulated, ac-dc, dc-dc, and dc-ac. Commercial and military types up to 2000 watts. Nine new series of high efficiency, silicon power supplies all full range adjustment. (See ad on page 65.)

WAKEFIELD ENGINEERING, INC. — Booth No. 2904

Dissipators for transistors, rectifiers, etc.; sizes range from 1 watt snap-on dissipators for TO-5, TO-18, etc. to 600 watt dissipators for 650 amp rectifiers. (See ad on page 14.)

WAYNE-GEORGE CORP. — Booth No. 3129

Absolute and incremental shaft position encoders and encoding systems. Also, gyro and inertial test tables and test table systems. (See ad on page 1.)

JOB INTERVIEWS

HONEYWELL EDP — New York Hilton Hotel

Intermediate and senior level opportunities exist across the entire spectrum of advanced computer technology, with emphasis on circuit design, logic design, systems design, memory development, microelectronics packaging, electromechanical engineering, applied research, and advanced development. (See ad on Cover 3.)

IBM CORPORATE HEADQUARTERS — City Squire Motor Inn

Electronic engineers for memory development, semiconductor device development, semiconductor manufacturing process, circuit design, circuit logic and systems engineering, thin-film development, RFI-measurement and interference control techniques, test equipment design, power supply engineering, and space systems engineering. (See ad on page 31.)

NCR ELECTRONICS — New York Hilton Hotel

Interviews for openings in design automation, product engineering, and advanced computer development. (See ad on page 29.)

AND . . . visit COMPUTER DESIGN at Booth H-28

LITERATURE

Power Supplies

A motorized programmer, VIX relay and high voltage isolation booth are among the new products described in a current issue of a power supply company's newsletter. Interesting and unusual applications are treated as well as some new glossary terms. Kepco, Inc., Flushing, N.Y.

Circle No. 234 on Inquiry Card

Remote Control Switches

All data processing machines in any installation can be turned on or off from one location using company's new remote control switches. According to the company, not only does this save time, but it provides safety as well. With these switches, it's no longer necessary to check each individual machine when shutting down at the end of the day. Just push conveniently located control stations and you know all machines, or selected ones, are off. The switches provide safety by enabling turn off of all machines in an emergency. A typical installation, circuit diagrams, and methods of control are described in application literature. Automatic Switch Co., Florham Park, N.J.

Circle No. 239 on Inquiry Card

Stock Relays

The 310 different relays described in an 8-page catalog are said to include the largest selection of mercury-wetted contact and dry reed relays available. Telephone-type relays in subminiature to medium sizes, general purpose relays, latching relays, and other types are also described. Magnecraft Electric Co., Chicago, Ill.

Circle No. 208 on Inquiry Card

Step-Servo Motors

Step-servo motors with response as fast as 1 millisecond are detailed in a new 4-page catalog. Specs, dimensions, graphs, and other data for twelve high performance step-servo models are given. Both permanent magnet 4-phase, and variable reluctance 3-phase motors are described. The steppers are designed for applications such as digital-to-analog conversion, pulse counting, remote positioning and *xy* plotters. IMC Magnetic Corp., Maywood, Cal.

Circle No. 220 on Inquiry Card

Monolithic Capacitors

An 8-page catalog provides detailed technical specs on molded tubular capacitors for cordwood packaging and automatic insertion requirements; units in tantalum "A" case size; and various types of ceramic capacitors. Hi-Q Div., Aerovox Corp., Olean, N.Y.

Circle No. 218 on Inquiry Card

Modular Pushbutton Switches

Data sheet explains how compact design custom pushbutton switches can be built up from interchangeable modular units in a versatile new Series 6 line. All modules are assembled and easily installed, without using special tools. Ninety different pushbutton switches can be assembled by combining three pushbutton actuator units with the 30 possible switch modules. Additional combinations are obtained by utilizing optional facenuts and coil-equipped modules. Micro Switch, Freeport, Ill.

Circle No. 222 on Inquiry Card

Silicon/Germanium Supplies

"The Silicon-or-Germanium Question" is the title of a new technical booklet which discusses and compares the advantages and disadvantages of these two types of transistors as applied to dc power supplies. The booklet describes the advantages of selecting power supply design rather than selection on the basis of either silicon or germanium. Dressen-Barnes Electronics Corp., Pasadena, Cal.

Circle No. 211 on Inquiry Card

Display Lamp Filters

Catalog lists specs for 56 mil-type colored silicone rubber lamp filters for standard miniature lamps used in display devices, plus colored sheet lens material for illuminated word indicator and switching devices. Molded lamp filters, or "boots," are available from stock in seven standard colors and can be formulated to meet any special color requirements. Types are available to fit standard T-1, T-1-¾, T-3¼, and S-6 lamps. Actual samples of filters and lens material are attached to each catalog for evaluation. Master Dynamics, Sunnyvale, Cal.

Circle No. 207 on Inquiry Card

Scientific Computing Systems

4-page fold-out brochure describes the 8400 digital computing system and the 8800 analog/hybrid computing system for scientific applications. The brochure gives details of the two computers, discusses program flexibility, performance characteristics, and breadth of applications. Electronic Associates, Inc., West Long Branch, N.J.

Circle No. 223 on Inquiry Card

Timing Terminal

Timing unit accepts an amplitude-modulated 1 kc carrier serial time code from a landline or radio link, and provides a variety of timing codes, pulse rates, and amplified outputs. A 4-page brochure describes a basic serial-to-parallel time code converter and scanner and discusses methods for adding a variety of amplifiers for various timing signal outputs. Output codes suitable for all types of instrumentation, including strip chart recorders, are presented. Electronic Eng. Co. of Cal., Santa Ana, Cal.

Circle No. 201 on Inquiry Card

Spectra 70 Analysis

New brochure describes and contains excerpts from a comprehensive 150-page analysis of RCA's Spectra 70 computer system. The brochure's excerpts show the scope of the analysis of the Spectra 70, which includes the characteristics, performance, features, and limitations of each item of equipment and software in the new computer line. The analysis also includes an evaluation of Spectra 70's monolithic integrated circuitry and stored-logic control systems. The brochure also explains how the performance measurements in the analysis can be used to develop cost and throughput comparisons between the Spectra 70 and competitive systems. Auerbach Corp., Phila., Pa.

Circle No. 228 on Inquiry Card

Hybrid Computing

A 12-page brochure on a hybrid computing system covers application areas such as aerospace simulation, sampled data and other key areas. The system, called TRICE, is a digital differential analyzer that is said to solve differential equations faster and 100,000 times more accurately than analog computers. Raytheon Computer, Santa Ana, Cal.

Circle No. 200 on Inquiry Card

LITERATURE

Capacitor Design Data

Two additional styles of dipped mica capacitors are incorporated in a new 22-page catalog. Design Data is presented in the form of tables or charts and covers such areas as the dipped coating, dimensions, capacitance values, tolerances, working voltages, styles, characteristics, leads, markings, Q and dissipation factor, dielectric absorption, and insulation resistance. The Electro Motive Mfg. Co., Inc., Willimantic, Conn.

Circle No. 203 on Inquiry Card

Semiconductor/IC Symbols

An up-to-date chart of semiconductor circuit symbols and symbols of integrated circuit logic elements is now available. The chart, which has been folded to 8½ by 11″ size, is on heavy stock, suitable for posting on the wall. Schweber Electronics, Westbury, N.Y.

Circle No. 229 on Inquiry Card

ECG Computer Analysis

A 23-page booklet describes analysis of electrocardiograms by a hybrid computer. It discusses program analysis and important circuits used in analysis. Actual program listing is included. Computer Operations, Beckman Instruments, Inc., Richmond, Cal.

Circle No. 204 on Inquiry Card

Pushbutton Switches

Standard miniature switches with high current switching capacity are described in a 4-page condensed catalog. The catalog lists specs, dimensions, wiring schematics and other information for standard pushbutton, illuminated pushbutton and rotary switches. Staco Inc., Costa Mesa, Cal.

Circle No. 219 on Inquiry Card

Fans and Blowers

Technical descriptions, performance data and electrical specs on a complete line of fans and blowers are contained in a 10-page catalog. The fans and blowers are available for a wide range of airflow capacities and for use with various power sources. Rotron Mfg. Co., Woodstock, N.Y.

Circle No. 217 on Inquiry Card

Four-Layer Diodes

Application bulletin on four-layer diodes is devoted to multivibrator circuits and examples are given of the astable, monostable, bistable, and polarized types. Circuit values are given and temperature compensating suggestions are offered. High-speed switching is covered in a separate section containing methods which allow these circuits to operate 500 kc or higher. National Transistor, Lawrence, Mass.

Circle No. 221 on Inquiry Card

Delay Line Manual

Brochure containing an introduction to electromagnetic delay lines includes a section on definitions reprinted from EIA Standard RS-242 (pre-pulse distortion, post pulse distortion, pulse amplitude distortion, characteristic impedance, tilt, etc.); distributed parameter vs. lumped parameter lines; measurements; applications; and how to specify electromagnetic delay lines. LFE Advanced Components, Laboratory for Electronics, Inc., Waltham, Mass.

Circle No. 206 on Inquiry Card

Magnetic Tape Systems

An 8-page bulletin contains detailed information on a single-capstan drive tape transport. Specs are given and features described. A tape memory system is also covered. Ampex Corp., Redwood City, Cal.

Circle No. 210 on Inquiry Card

LITERATURE

Wire and Ribbon Cable

A new 24-page book describes a firm's line of Teflon and polyester-laminated wire and ribbon cable products. The latest techniques for making and using ribbon-cable harnesses are among the topics covered. W. L. Gore & Assoc., Inc., Newark, Delaware.

Circle No. 215 on Inquiry Card

Digital Signal Simulator

The Model 510 digital signal simulator handles all major telemetry formats, including Saturn, Minuteman, Titan II, and OAO and its completely programmable coded output includes RZ, NRZ, mark and space, bi-phase, or bi-polar. Serial and parallel outputs are available simultaneously. Three different word lengths, from 2 to 33 bits, may be generated simultaneously. The simulator may be programmed to stop on any word in the format, and each bit may then be manually and sequentially read out. Complete information is given. Telemetrics, Inc., Santa Ana, Cal.

Circle No. 216 on Inquiry Card

A/D Converter

Analog-digital converter operates by electronically switching precision resistors into a null-balance network. Laboratory grade accuracy is maintained by a temperature compensated Zener voltage reference. All switching is performed with silicon transistors. Decimal digits are displayed on the front panel of the instrument, and both BCD and/or decimal high level electrical output signals are available. Continuous digitizing of the input signal is achieved in the "Track" mode. Data Sheet D10102 gives full details. Transmation Inc., Rochester, N.Y.

Circle No. 214 on Inquiry Card

ADVERTISERS' INDEX

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The opening of our new Engineering and Research Center in suburban Boston has accelerated Honeywell's pace-setting expansion program, creating a record number of professional opportunities for experienced computer engineers.

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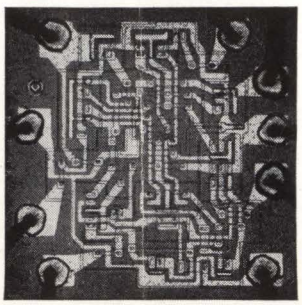
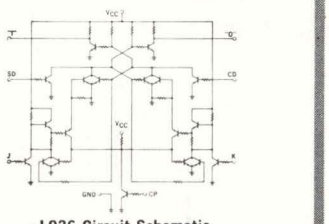
μL 926



NEW MICROLOGIC J-K FLIP FLOP

Complete, General Purpose Storage Unit; Skewing Problems Eliminated



μL926 Circuit Schematic

- Ability to toggle and steer into high capacitive loads
- Typical toggle rate: >20 mc
- High immunity to skewing problems
- Improved noise immunity
- Pre-set and pre-clear inputs available
- Fan-out = 5

A replacement for existing J-K flip flops, the new silicon Planar Epitaxial 926 features overall parameter superiority. Skewing problems are completely eliminated with t_{pd} min −t release specified at ≥20 nanoseconds. Buffered output stages provide increased fan-out and high noise immunity. Available in 10-lead TO-5 type and flat packages. This unit is a low-price replacement for μL916 and μL923 J-K flip flops. For complete specifications, contact your distributor or write for the data sheet.

PRICES FOR TO-5 PACKAGED UNITS

9592621 Military Unit −55°C to +125°C		9592629 Industrial Unit +15°C to +55°C	
1-24	$28.00	1-24	$9.50
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MIX	$19.60	MIX	$6.65

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