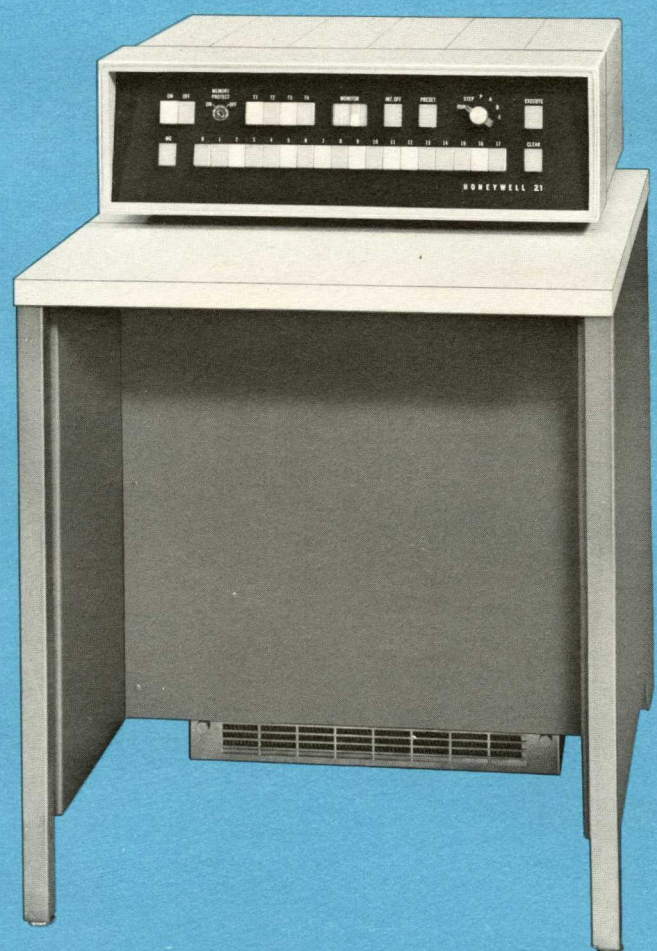
The Honeywell 20 Digital Control System



18-Bit Word Length—plus parity and memory guard bits

Single Word Instructions—provide 8,192 directly addressable memory locations

High Internal Speeds—1.75 microsecond memory cycle time on H22; 6 microseconds on H21

CONTRAN—powerful new language for real-time control

Core Memory Capacity—2,048, 4,096, 8,192, or 16,384 words of memory prewired for field expansion

Multi-Level Priority Interrupt—up to 32 hardware levels, with as many as 144 interrupt lines per level

High Reliability—achieved through microcircuit techniques, low component count and extensive use of passive components

***MagnetiK* Coupler**—provides universal interface for instrumentation input/output circuitry

HONEYWELL 20 SYSTEM FEATURES

Hardware Multiply—a standard feature

Indirect Addressing—may be combined with indexing

Direct Memory Access—provides independent path to memory for external I/O operations on a fully buffered, cycle-steal basis

Three-Address Register Commands—allow three-address arithmetic and/or logical operations with single word, one cycle, instructions

Program Protection—any core location may be protected against accidental modification, providing protected storage for permanent core sub-routines, constants and bootstraps

Hardware Indexing—without increase of normal instruction execution time

Program Toggles—four single-bit registers can be set, reset, and tested under program control

Arithmetic Indicators—four single-bit registers provide sign, zero, overflow and carry indication

Power Failure Protection—provides automatic program shut down and restart without loss of data

The Honeywell 20 Digital Control System brings—for the first time—usable performance to the low-cost computer field. Designed to provide total system capability, the Honeywell 20 System handles the widest range of scientific and industrial applications, from relatively simple engineering computations to large, multi-programmed, on-line control problems.

Reflecting Honeywell's belief that true economy extends beyond the modest initial investment to include genuinely useful performance, the Honeywell 20 System incorporates many hardware and programming features seldom found in low-cost systems. These features put it on-line fast and give it real on-the-job power—even for the inexperienced user.

Advanced circuit and logic techniques help achieve high reliability and performance, at the same time reducing component count and costs. Modular system design and a complete selection of process control peripheral equipment fit the system to your job, regardless of its size or complexity. Communications adapters permit the Honeywell 20 System to be coupled quickly and efficiently to large multi-computer complexes.

But superior hardware is only half the story. To harness the Honeywell 20 Digital Control System to your application, and to give real meaning to their philosophy of "straight-through" economy, Honeywell developed CONTRAN,* a new multi-programmed, event/time consequential programming language, related to, but more advanced than, FORTRAN IV. Tailored expressly to meet requirements of on-line control, CONTRAN allows the programmer (or process engineer) to write real-time control programs in a flexible language based on English and arithmetic statements. CONTRAN control programs can then be compiled and executed on a time-shared basis by a computer simultaneously engaged in on-line activities.

By combining high performance with low cost, the Honeywell 20 System opens the door to applications considered either too difficult or too expensive to be undertaken by computer systems of previous generations. It provides a solution today for the control problems of tomorrow.

With real pride we introduce you to the Honeywell 20 Digital Control System—superior hardware and advanced software. At low cost.

*CONTRAN—Control Translator

H20

CENTRAL PROCESSORS-H21, H22

Two central processors are available for incorporation in the Honeywell 20 Digital Control System. The H21 processor has a core memory cycle time of 6 microseconds while the H22 processor cycle time is 1.75 microseconds. The following information applies to both central processors except where noted.

DESCRIPTION

Type

Binary, 2's complement arithmetic, single address

Circuitry

Hybrid circuit construction employing microcircuit techniques; all semiconductors are silicon

System environmental specification: 32-120° F

Memory

Magnetic core, random access; 1.75 and 6 microsecond cycle times; 2048, 4096, 8192, or 16,384 word capacity

8192 words directly addressable; additional 8192 words indirectly addressable

Non-volatile on power failure

20-bit word; includes parity and memory guard bits

Address Modification

Indexing
Indirect addressing

Parity Checking

ODD parity checked/generated on all memory read/write operations

Parity checked/generated on character input/output operations

ODD parity checked/generated on all direct memory access operations

Typical Operating Speeds

(In microseconds, including memory access and indexing)

	H22	H21
Add	4.8	12.0
Logical	4.8	12.0
Load/Store	4.8	12.0
Multiply	25.0	54.0

Program Protection

Memory guard feature provides "padlocked" protection against accidental modification of guarded magnetic core memory locations. Guarded locations can be "read" by any command. However, only guarded commands can "write" in or alter a protected location.

Input/Output

Both word and character I/O capabilities are provided. Assembly of characters into or from memory words is performed automatically when the I/O register addressed is of the character type.

OPTIONS

Multi-Level Priority Interrupt

Up to 32 levels; priority determination by hardware; a higher level interrupts a lower level; unique core locations for each level.

Direct Memory Access

One core memory cycle required for each I/O transfer of 18 bits plus parity. DMA control unit provides full buffering and control. H21 provides one 83 KC data channel to which eight devices may be connected under program control; H22 provides eight channels through which simultaneous transfer of data can be made at rates up to 71KC per channel. Thus, at maximum rate, transfers of 568,000 words or 1.7 million characters per second are possible.

Power Failure Interrupt

Core memory protection against power transients or failure is a standard feature. In addition, however, a power failure interrupt is available for automatic program shut down and restart.

Auxiliary Drum Memory

Access Time: 8.3 milliseconds average; 16.6 milliseconds max.

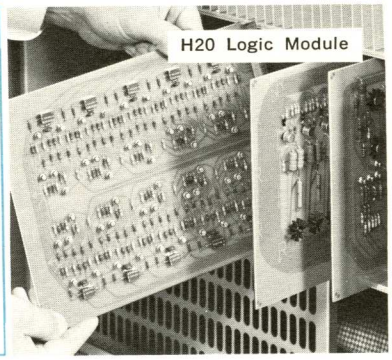
Transfer Rate: 60,000 words (18 bits plus parity) per second

Capacity: 64,000 to 512,000 words in groups of 64,000

Input/Output: via DMA channel; requires one cycle per word transferred

Program Protection: write capabilities can be selectively disabled to provide read-only memory.

Environment: 32-120° F; drum is sealed and purged with inert gas; suitable for industrial environments.



Modular design, micro-circuit techniques and exclusive use of silicon semiconductors provide increased reliability and ease of maintenance.

Honeywell 20 System Central Processors are available in either console or industrial cabinet mountings. Shown above is a console-mounted H21 Central Processor with input/output typewriter.

INSTRUCTIONS

GROUP

1

Memory reference commands provide for load/store, arithmetic, logical, compare, input/output and control operations.

GROUP

2

Shift commands provide double and single register shifts. These may be arithmetic or logical. Shifts of 0 to 31 bits may be specified.

GROUP

3

Test commands are provided for both external devices and internal conditions. Up to 10 conditions may be tested with a single instruction.

GROUP

4

Register operations. This unique and highly significant family of register operation commands allows three-address operations with single-word, one-cycle instructions. They are explained on the next page.

GROUP

5

Control commands provide internal control. Six internal conditions may be set or reset with a single instruction.

GROUP

6

External device control commands allow selection and control of peripheral equipment. A 12-bit field is provided for device designation.

Register Operation (ROP) Commands—In addition to conventional memory reference commands the H20 series central processor contains a unique group of register commands. These commands provide the programmer with an efficient and convenient means of executing various logical and arithmetic operations in the A, B, and X registers.

ROP Command Structure

The operation code may define add (+), subtract (—), logical AND (&), or an exclusive OR (#). The logical OR of operands in fields 1 and/or 2 may also be performed in conjuction with these basic operations.

The various fields are defined as follows:

Operand 1	*Operation Code*	*Operand 2*	*Receiver*
(A)	+	(A)	A
(B)	—	(B)	B
(X)	&	(X)	X
0	#	1	0 (no register)
		0	

A simple notation is used to write ROP commands, permitting any combination of the above operands to be used. For example:

Register Transfers:

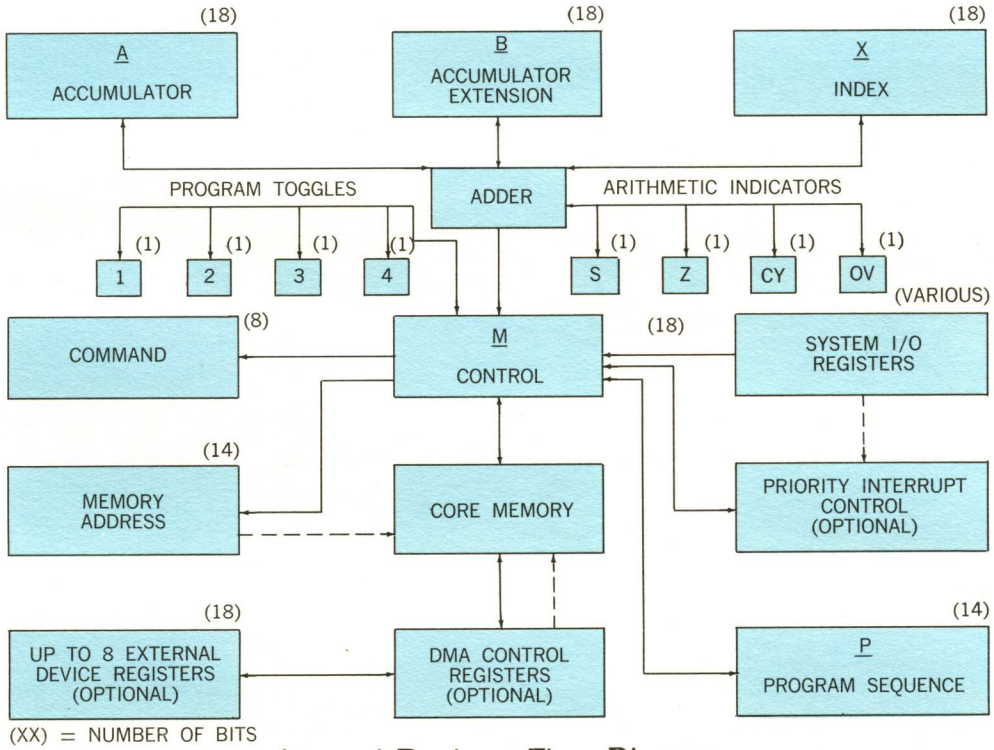
ROP A + O = BX (Transfer the contents of A to registers B and X)

Logical Operations:

ROP A & B = A (Perform the logical AND of (A) and (B) and store in A)

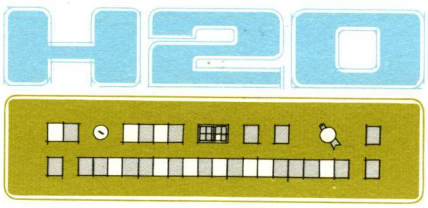
Combined Logical Operations:

ROP AB + 1 = A (Add one to the logical OR of (A) and (B) and store results in A)

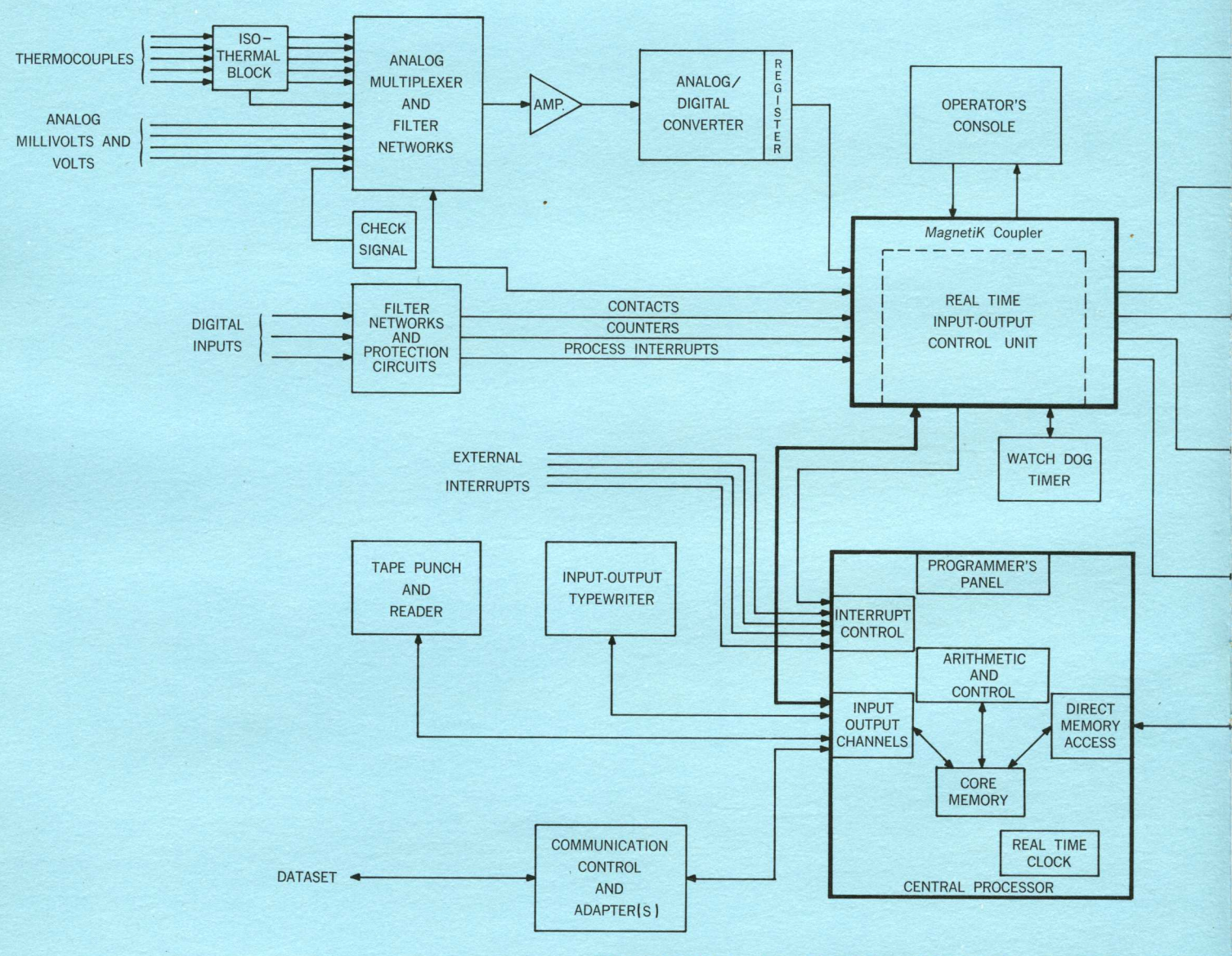


Internal Register Flow Diagram

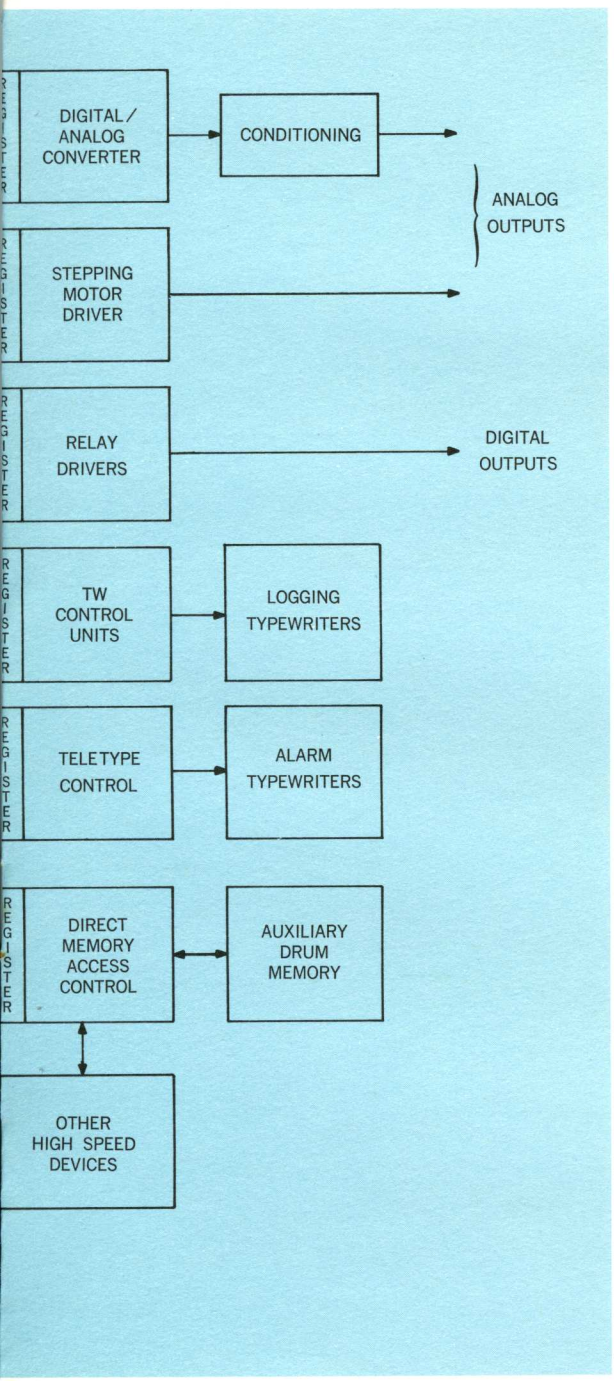
The internal register organization of the H21 Central Processor is shown in the block diagram. Programmed input/output data is transferred in parallel via the M register to or from core memory without disruption of arithmetic registers. Four arithmetic indicators facilitate testing of zero, sign, carry and over-flow conditions. Four program toggles provide a convenient means of setting and checking program flags. The optional direct memory access registers provide an independent path to memory for high speed devices.



DIGITAL CONTROL SYSTEM



HONEYWELL 20 DIGITAL CONTROL SYSTEM
BLOCK DIAGRAM



The Honeywell 20 Digital Control System incorporates a general purpose digital computer with advanced input-output sub-systems to perform real-time data acquisition and control. Operating on-line, it accepts analog and digital signals from remote sensors and produces output signals for control devices. Peripheral equipment provides communication with process operators and other data processing systems.

Process communication is performed through the Real-Time Input/Output Control Unit. Analog millivolt inputs representing process measurements are sampled, converted to digital form and transfered into the computer. Digital inputs in the form of on-off contact closures or voltage levels are entered at computer speeds.

Low-Level Analog Inputs

Scanning Speed: up to 200 points per second, random access

Number: up to 1024

Noise Rejection: Common mode—down 120 db at 60 cps Transverse mode—down 60 db at 60 cps

Overall Accuracy: ±0.05% full scale on 0 to 50 mv range

Resolution: 13 binary bits plus sign (one part in ±8,192)

Input Range: 0-50 mv (bi-polar) is standard. Other ranges up to 50 volts full scall are available.

Signal Conditioning: Thermocouple reference junction
Current input conversion
Voltage dividers

High Level Analog Inputs

Scanning Speed: up to 8,000 points per second, random access

Number: up to 256 inputs in modules of four

Multiplexer: differential input, solid-state

Common Mode Rejection: greater than 60 db from dc to 60 cycles, measured with 10 volts dc or peak ac common mode noise applied

Resolution: 13 binary bits plus sign (one part in ±8,192)

Input Range: 0 to ±1 volt or 0 to ±10 volts

Overall Accuracy: ±0.025% of reading ±1.5mv on 10 volt range (does not include effect of common mode noise)

Input Impedance: 20 megohms minimum, differential or to ground; shunted by a maximum of 1000 pf on selected channel, 250 pf on unselected channel

Digital Inputs

Transfer Speed: up to 360,000 bits per second (contacts or voltage levels)

Protection and Noise Rejection: each input individually filtered, fused and transformer coupled

Number: up to 1440 inputs in modules of six

Pulse Inputs: up to 240 three-stage counters per system

Analog Outputs

Digital-to-Analog Converter: solid-state, 10 bit (1 part in 1,000) resolution. Available with amplifier to provide voltage or current signal output

Number: up to 120 in modules of one

Stepping Motor Driver: solid-state drive and timing control for external motors; 5-wire, 48-volt output

Number: up to 720 drivers in modules of three

Digital Outputs

Transfer Speed: 360,000 solid-state switching operations per second. Each output individually buffered, providing operations at computer speeds

Number: up to 1440 in modules of six

Types: on-off (latching); pulse duration (10 milliseconds to 50 seconds)

Output Rating: 48 volts at 250 ma (non-inductive). Power supply included in standard system

PERIPHERAL EQUIPMENT

Input/Output Typewriter

Teletype Model 33 or 35 ASR with integral paper tape punch and reader. Model 33 is standard feature. 10 character per second speed in all modes, 8-level, ASCII code.

Logging Typewriters

10 cps, up to 30″ carriage widths

Alarm Typewriters

10 cps; Teletype Model 35 with ribbon shift

Paper Tape Reader

Photoelectric; 200 characters per second, 8-level, ASCII code. Tape spooler is standard feature.

Paper Tape Punch

Punches at 0–60 characters per second, 8-level, ASCII code.

Magnetic Tape

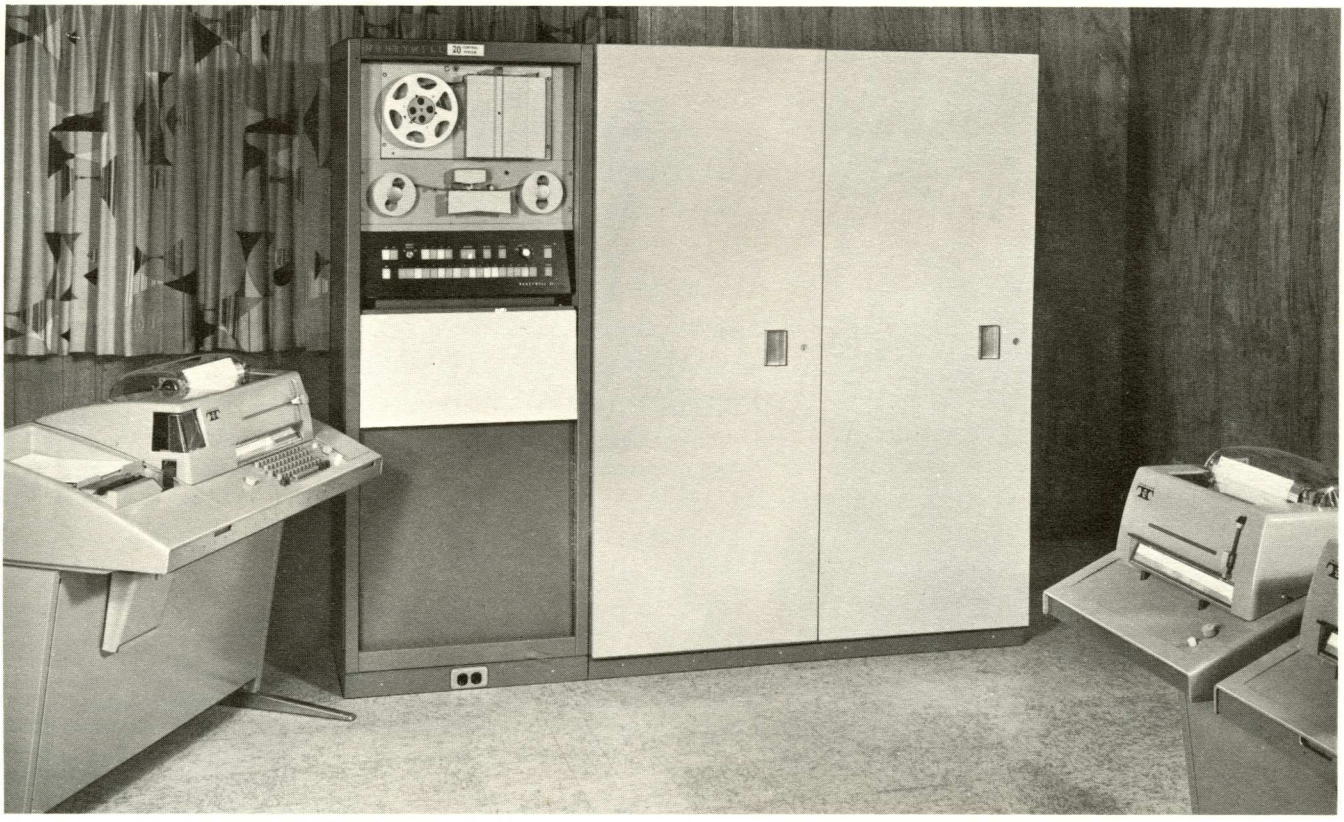
Writes at 7200 characters per second at 200 BPI, or 20,000 characters per second at 555.5 BPI.

Recording Speed: 36 inches per second

Rewind Speed: 2400 feet in approximately three minutes. Single capstan drive, vacuum loop storage control.

Other

Line Printer, Communications Adapter, Card Reader, Card Punch, Oscilloscope Display, Graphic Plotter, Trend Recorder.



Attractive and rugged cabinet enclosures suit the Honeywell 20 System to industrial environments.

CONTROLWARE

The superior hardware features of the Honeywell 20 Digital Control System have enabled the development of a highly advanced software package. This package, called CONTROLWARE, contains an extensive array of programming aids particularly suited to real-time and engineering needs. Among these aids are:

CONTRAN—An advanced compiler-level language which combines the most desirable features of FORTRAN IV and ALGOL 60 to provide a new concept in multi-programmed, time-shared, control programming.

CONTRAN ideally solves the complex programming functions encountered in

a) the use of bulk memory with a time-shared core memory

b) setup and linkages to executive control

c) responses to asynchronous external interrupts

d) real-time input/output

e) inter-program communication, and

f) compilation and debugging while performing on-line control.

CONTRAN allows the engineer—after only a minimum of training—to write compiler-level control programs. Engineers or programmers already versed in FORTRAN techniques will readily adapt to the CONTRAN language.

FORTRAN II—H20 FORTRAN II permits on-line compilation of both engineering calculations and control programs. Additional statements are provided for process control input/output and linkage to the executive routine.

CAP — Control Assembly Program provides a convenient system for assembler-level programming.

EXECUTIVE ROUTINE — for real-time control of assembly level and FORTRAN programs for both core and core-plus-drum configurations.

DIAGNOSTIC ROUTINES — for checking all major sub-systems, including the Central Processor, peripheral devices and instrumentation input/output equipment.

UTILITY ROUTINES — for monitoring, debugging and programmer-machine communication.

MATHEMATICAL LIBRARY — includes floating point, double precision and arithmetic sub-routines.

CONTROL LIBRARY — includes scan, log, operator's console, direct digital control algorithms, etc.

Honeywell can provide all support services required for the complete implementation and maintenance of computer-directed control systems. Contact your local Honeywell office for further information.

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