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HONEYWELL 400

Honeywell EDP Division

STANDARD EDP REPORTS

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RIP = Report in process.

INTRODUCTION

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The H-400 is a small to medium scale business-oriented computer. It has a fair range of conventional input-output and auxiliary storage units. Only one real option (Multiply/Divide) exists so far as the central processor is concerned, so the computing power of the unit is the same for most configurations. The H-400 was first delivered in 1961 and is mainly used as an independent computer rather than as a supporting satellite for larger systems. The system can be used to support the larger H-800 but such an application is comparatively unusual. Monthly rentals range from $5,000 to $14,000 and typical systems are approximately $8,000.

Compatibility

The H-400 is the smallest of the Honeywell computers. The larger Honeywell systems are the H-800 I and II (502:), the H-1400 (505:) and the H-1800 (503:).

There is complete programming compatibility between the H-400 and H-1400 systems, which also share the same peripheral units, but there is no direct programming compatability between the H-400 and the H-800/1800 systems. However, an H-400 simulator is optionally available for use with the H-800 to permit H-400 programs to be run on the H-800.

Hardware

The basic system, with no optional facilities, operates almost entirely serially (i.e., computation, input, and output are handled one process at a time and do not overlap). Simultaneous tape read and tape write operation is the only exception. Optionally, the printer can be buffered so that the central processor can operate while the printer is operating.

The processor, which has optional multiply/divide capabilities, uses binary or decimal arithmetic. Three address instructions ("ADD A, B, C" means ADD (A) to (B) and place the result in C) are used and operands are in fixed word lengths (12 decimal characters including sign, or 48 binary bits). The instruction repertoire is comprehensive and includes especially good editing commands for translation of the 6-bit alphanumeric codes to and from their decimal and binary equivalents. There is a powerful move command which allows n words to be moved at a time. "n" can be of any size up to 4,095.

No variable length operations are possible. The processor also serves as the input-output controller. The system requires no additional controllers or buffers (beyond the printer buffer) for this reason.

The core storage is available with 1,024, 2,048, 3,072, or 4,096 48-bit words. Each 24-bit half of a word has a parity bit which is checked whenever the data is moved. The store can accept words with incorrect parity from input-output devices. The processor is made aware of this condition by a forced transfer of control to a fixed location. A parity-checking instruction is provided to find the incorrect word and correct its parity. Other instructions are provided to implement techniques to correct the incorrect data. They are part of an internal program-executed system called Orthotronic Control.

Up to eight magnetic tape units can be connected. The three magnetic tape unit models available operate at 32,000 characters or 48,000 digits per second, 64,000 characters or 96,000 digits per second, and 88,666 characters or 133,000 digits per second. These units have pneumatic drives which handle tape more gently than mechanical drives. A feature of the H-400 (Orthotronic Control) enables it to ignore a faulty track when reading a

INTRODUCTION (Contd.)

§ 011.

tape and to regenerate the correct data. Orthotronic Control is an error correction system designed particularly to catch errors caused by tape skew. In contrast to read-after-write error detection systems, Orthotronic Control has the advantage that it can cover errors occurring during or after recording, either in storage or during reading. On the other hand, it does not notice recording errors until later reading.

The printer operates at 900 lines per minute. A print storage option is available for this unit that frees the processor for 98 per cent of the printing time. The IBM 1402 reader/ punch is now the card equipment normally used with the H-400, although some older installations are still using the converted version of the IBM 088 collator. The 1402 reads 800 cards per minute and punches 250 cards per minute.

Punched tape equipment is also available; the reader operates at 500 or 1,000 characters per second, the punch at 110 characters per second.

Software

A number of programming aids are available for the H-400 system. These include:

(1) EASY I, a basic symbolic assembler for systems with 1,024-word stores.

(2) EASY II, a more complete assembler for systems with stores of 2,048 or more words. This includes an input-output macro which is also used in other software systems, such as AUTOMATH and COBOL.

(3) A Sorting Generator and Merging Generator Routine. These are based on the polyphase method, which has been pioneered by Honeywell.

(4) Disc File Programs which are presently under development.

(5) A COBOL-61 compiler for the H-400, which has just been released. This compiles on a 2K machine with a minimum of four tape units. The compilation time is approximately one-half hour, which is good for a machine of this size. The language facilities are fairly complete. The object programs are reported to require approximately the same running time as those produced using normal (EASY II) techniques.

(6) FORTRAN II (called AUTOMATH 400), a FORTRAN II compiler which has also just been released. It includes a non-FORTRAN statement, OVERLAY, which helps to overcome some of the limitations of systems with small storage (like the H-400). It does a small amount of analysis of the coding and its context before creating the machine language and thereby improves the object time speed of the programs. Subscripts are only allowed to two levels and error control of the running program is not as strong as would be liked. Compilation times are very good, approximately one hundred statements per minute. Object running times are slowed down by the need to simulate the floating point arithmetic.

DATA STRUCTURE

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.1 STORAGE LOCATIONS

Name of location	Size	Purpose or use
Character:	6 bits	editing.
Word:	48 bits	instructions, data items.
Record:	1 to 511 words	magnetic tape block.
	64 words	disc storage.

.2 DATA FORMATS

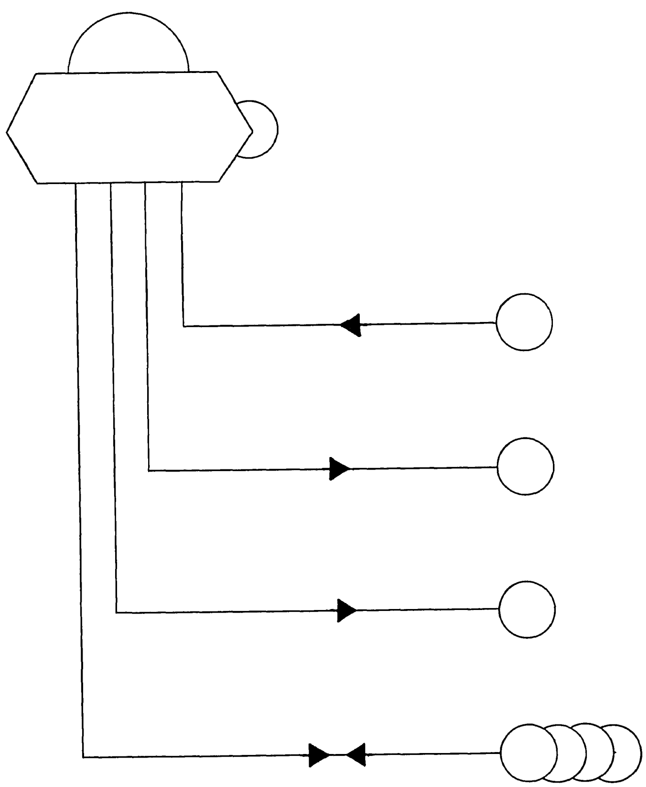
Type of information	Representation
Binary:	48 bits in a word.
Decimal or Hexadecimal:	12 Characters, or sign plus 11 chars in a word.
Alphabetic or Alphameric:	8 Characters in a word.
Instruction:	1 word.

SYSTEM CONFIGURATION

§ 031.

.2 4-TAPE BUSINESS SYSTEM (CONFIGURATION II)

Deviations from Standard System: . . . . magnetic tape is 100% faster.
can read and write simultaneously on magnetic tape.
printer is 80% faster.
card reader is 60% faster.
card punch is 150% faster.
includes indexing and console typewriter.



Equipment	Rental
Core Storage: 1,024 words Processor & Console	$4,215
Card Reader 800 cpm Card Punch 250 cpm	550
Printer 900 lpm	1,050
4 Magnetic Tapes 30,000 cps	1,800

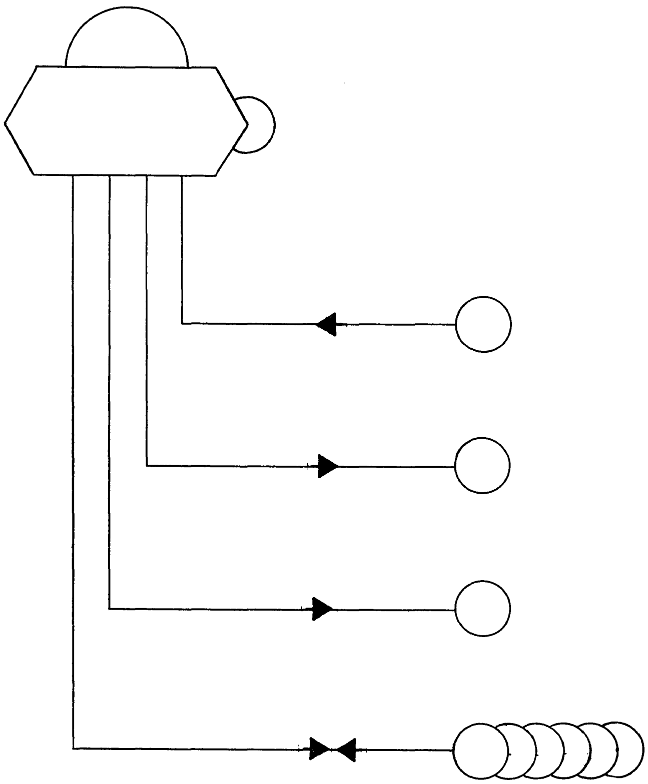
Optional Equipment Includes: . . . . none --

Total $7,615

§ 031.

.3 6-TAPE BUSINESS SYSTEM (CONFIGURATION III)

Deviations from Standard System: . . . . no read/compute or write/compute simultaneity.
printer is 80% faster.
card reader is 60% faster.
card punch is 150% faster.



Equipment	Rental
Core Storage: 2,048 words Processor & Console	$4,865
Card Reader 800 cpm Card Punch 250 cpm	550
Printer 900 lpm	1,050
6 Magnetic Tapes 30,000 cps	2,700

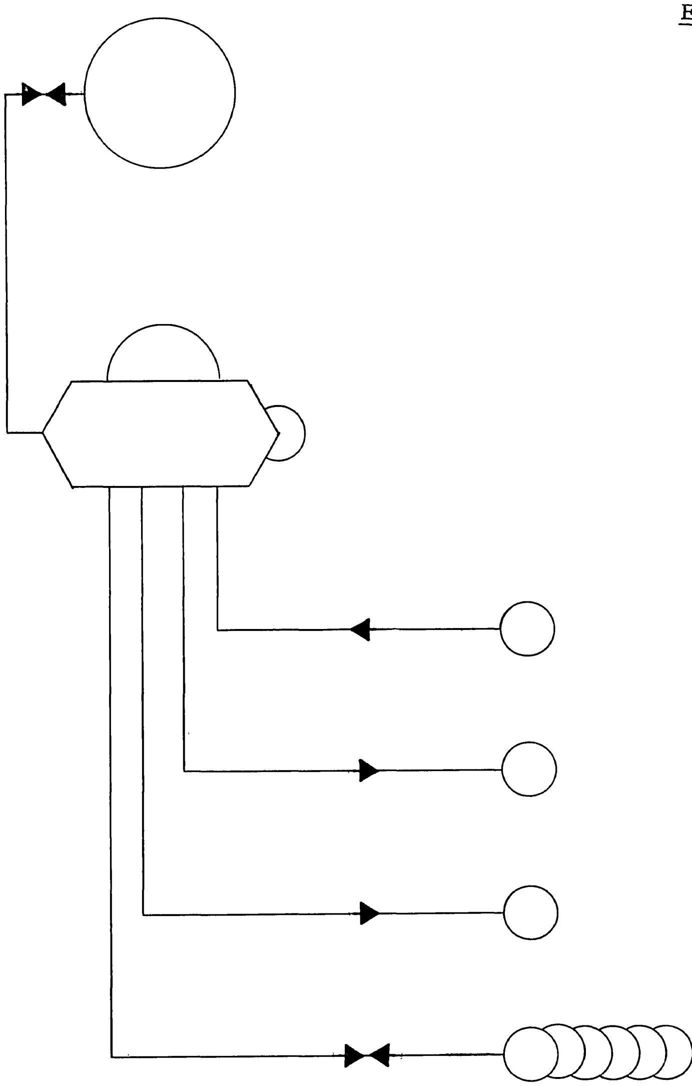
Optional Equipment Includes: . . . .

1. Multiply-Divide	250
2. Print Storage	390
Total	$9,805

§ 031.

.5 AUXILIARY STORAGE SYSTEM (CONFIGURATION V)

Deviations from Standard System: . . . . no read/compute or write/compute simultaneity.
printer is 80% faster.
card reader is 60% faster.
card punch is 150% faster.
auxiliary storage is 25% larger.



Equipment	Rental
Magnetic Disc File: 25 million characters	$2,900
Core Storage: 2,048 words; Processor & Console	4,865
Card Reader 800 cpm; Card Punch 250 cpm	550
Printer 900 lpm	1,050
6 Magnetic Tapes 30,000 cps	2,700

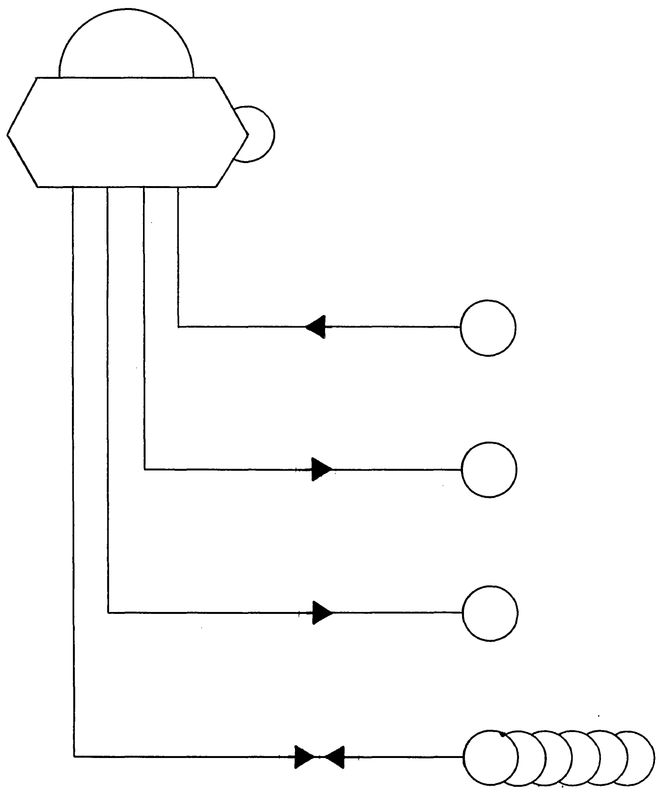
Optional Equipment Includes: . . . .

1. Multiply-Divide	250
2. Print Storage	390
TOTAL	$12,715

§ 031.

.6 6-TAPE BUSINESS/SCIENTIFIC SYSTEM (CONFIGURATION VI)

Deviations from Standard System: . . . . no read/compute or write/compute simultaneity.
printer is 80% faster.
card reader is 60% faster.
card punch is 150% faster.
core storage is 49% smaller.
floating point hardware is not available.



Equipment	Rental
Core Storage: 4,096 words Processor & Console	$6,065
Card Reader 800 cpm Card Punch 250 cpm	550
Printer 900 lpm	1,050
6 Magnetic Tapes 30,000 cps	2,700

Optional Equipment Includes: . . . . 1. Multiply-Divide 250
2. Print Storage 390

TOTAL $11,005

INTERNAL STORAGE: CORE

§ 041.

.1 GENERAL

.11 Identity: . . . . Magnetic Core Storage. 402.

.12 Basic Use: . . . . working storage.

.13 Description

The H-400 core is arranged in 25-bit groups, 2 of which make up a single computer data word or instruction. The cycle time of the core is 9.25 microseconds per half-word, providing an effective word time of 18.5 microseconds.

The standard module of memory is common to all Honeywell 400 systems and contains 1,024 words. One 402-1, -2, or -3 module containing 1,024, 2,048, or 3,072 additional words, respectively, can be added to the system for a total maximum capacity of 4,096 words. Each word contains 48 data bits and two parity bits. Words can be used by instructions: as 48-bit binary words, as sign plus eleven decimal (or hexadecimal) digit words, as twelve decimal (or hexadecimal) digit words, or as eight six-bit character words, or in combinations of these formats. Each instruction also requires one word.

The first 94 words are used for input-output areas, index registers, arithmetic registers, and interrupt jump locations. Most of these areas can be used as normal storage unless they are being reserved for a particular function.

.14 Availability: . . . . . . 9 months.

.15 First Delivery: . . . . December, 1961.

.16 Reserved Storage

Purpose	Number of locations	Locks
Index registers:	1	none.
Arith registers:	11	none.
Logic registers:	0	none.
I/O control:	10	none.
I/O areas:	55	none.
Processing irregularities:	6	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Core diameter: . . . . 0.050 inch.
Core bore: . . . . . . 0.030 inch.
Array size: . . . . . . 32 bits by 64 bits by 25 bits.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by program: . . . . yes.
.242 Data regenerated constantly: . . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.282 Reading method: . . . . coincident current.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Unit of data: . . . . . word.
Conversion factor: . . 48 bits/word.
Data rate: . . . . . . 52,000 words/second.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage			Maximum Storage
Identity:	402-1 or Basic	402-2	402-3	Basic plus 402-3.
Words:	1,024	2,048	3,072	4,096.
Characters:	8,192	16,384	24,576	32,768.
Instructions:	1,024	2,048	3,072	4,096.
Digits:	12,288	24,576	36,864	49,052.
Modules:	1	1	1	4.

.32 Rules for Combining Modules: . . . . a module containing either 1,024, 2,048, or 3,072 words can be added to the basic 1,024-word store.

.4 CONTROLLER: . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads: single access circuit.

.52 Simultaneous Operations: . . . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 6 μsec.
Cycle time: . . . . . . 9.25 μsec.
For data unit of: . . . 0.5 word.

.6 CHANGEABLE STORAGE: . . . . . . none.

.7 PERFORMANCE

.71 Data Transfer

With self: . . . . yes.

§ 041.

.72 Transfer Load Size

With self: . . . . N 48-bit words.

.73 Effective Transfer Rate

With self: . . . . 46.25 + 37N, where N is the number of 48-bit words.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Conflicting commands:	not possible.	
Physical record missing:	not possible.	
Parity error:	yes	processor stop.
Illegal instruction:	yes	processor stop.
Invalid address:	yes	processor stop.

INTERNAL STORAGE: MAGNETIC DISC FILE

§ 042.

.1 GENERAL

.11 Identity: . . . . Magnetic Disc File.
Bryant Series 4000.
H-460.

.12 Basic Use: . . . . auxiliary storage.

.13 Description

This unit consists of a controller plus one disc cabinet. Three, 6, 12, 18, or 24 data discs can be connected, providing a capacity of from 12.5 to 100 million alphameric characters.

There are six zones on each disc face, and each zone has its own read/write head. All the heads move together, so that they are correctly positioned for six physical tracks (or 32 64-word records) on each disc at any one time. The rotational delay for any of the 32 records averages 34 milliseconds, but the data transfer time varies with the zone. The number of records per track also varies with the zone, and the table below shows the situation in detail.

Zone	Number of 64-Word Records per Disc	Transfer Time per Record (milliseconds)
1	3	18.5
2	4	13.3
3	4	11.0
4	6	9.1
5	7	7.8
6	8	6.8

Access to the disc is achieved by addressing data records of 512 alphameric or 768 numeric characters arranged into 64 words. Any record can be addressed independently. Slightly less than 1 per cent of the file (that part over which the heads are positioned) is available in under 52.5 milliseconds, assuming average latency for disc rotation and a maximum of 18.5 milliseconds for data transfer.

To gain access to another band involves waiting an additional 60 to 130 milliseconds for lateral head movement. Thus, random access, including head position changes, averages 139 milliseconds, allowing 430 records per minute to be obtained or stored randomly.

.14 Availability: . . . . . . 9 months.

.15 First Delivery: . . . . April, 1963.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic disc.

.22 Physical Dimensions

.222 Disc
Diameter: . . . . . . 39 inches.
Thickness: . . . . . . thin.
Number on shaft: . . . 4, 7, 13, 19, or 25.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.25 Data Volume Per Band of 6 Physical Tracks

Words: . . . . 2,048.
Characters: . . . . . . 16,384.
Digits: . . . . 24,576 (or 22,576 in signed H-400 words).
Instructions: . . . . . . 2,048.
Records: . . . . 32.

.26 Bands Per Physical Unit: 256 per disc (128 on each side).

.27 Interleaving Levels: . . none.

.28 Access Techniques

.281 Recording method: . . . moving heads.
.283 Type of access

Description of stage	Possible starting stage
Move head to selected band: . . .	yes.
Wait until record is in position:	yes, if a record on the same band of any disc face was previously selected.
Transfer of record:	no, but previous stage time may be zero.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 900 rpm.
Bits/inch/track: . . . variable.
Compound bit rate: . . 615,000 bits/sec.
.292 Peak data rates
Cycling rates: . . . . 27,500 to 75,000 char/sec.
Unit of data: . . . . . word.
Conversion factor: . . 48 bits/word.
Gain factor: . . . . . 1.
Loss factor: . . . . . 1.
Data rate: . . . . . . 3,472 to 9,375 words/sec.
Compound data rate: . 3,472 to 9,375 words/sec.

§ 042.

.3 DATA CAPACITY

.31 Module Size

Discs: . . . . 1.
Words: . . . . 524,288.
Characters: . . . . . . 4,194,304.
Instructions: . . . . . . 524,288.

.32 Rules for Combining Modules: . . . . 3, 6, 12, 18, or 24 Data Discs can be mounted on the single shaft of the unit.

.4 CONTROLLER

.41 Identity: . . . . included in unit.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line: . . . . none.

.43 Connection to System

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 record = 64 words.
.442 Input-output area: . . . none.
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . none.
.448 Testable conditions: . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks

	Model 0	Model 1	Model 2	Model 3	Model 4
Stacks per module:	36	72	144	216	288.
Stacks per yoke:	36	72	144	216	288.
Yokes per module:	1	1	1	1	1.

.512 Stack movement: . . . . across 1 zone of 1 disc face (there are 6 zones on the disc face).
.513 Stacks that can access any particular location: . . . . one.
.514 Accessible locations
By single stack
With no movement: . 1 band = 32 records of 64 words.
With all movement: . 128 bands = 4,096 records of 64 words.
By all stacks
With no movement: . 32N records where N = 6, 12, 24, 36, or 48 depending on Model (i.e., 1/128 of capacity).
.515 Relationship between stacks and locations: . none.

.52 Simultaneous Operations

A: . . . . reading a record.
B: . . . . writing a record.
C: . . . . searching for a record.
D: . . . . internal computation.

Overall System:

$a + b + c \leq 1.$
$a + b + d \leq 1.$
$c + d \leq 2.$

.53 Access Time, Parameters, and Variations

.532 Variation in access time, in μsec.

Stage	Variation	Example
Head positioning: . .	0 or 60,000 to 130,000	95,000.
Waiting for the disc to be in position: .	0 to 67,000	32,000.
Transfer of record:	6,800 to 18,500	12,200.
Total:	6,800 to 215,500	139,200.

.6 CHANGEABLE STORAGE: . . . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possible

With self: . . . . no.
With Main Memory: . yes.
With Control Memory: no.

.72 Transfer Load Size: . . 1 record of 64 words.

.73 Effective Transfer Rate

With Main Memory: . . not yet determined; depends on the timing of the inter-record gap.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none	unpredictable.
Invalid code:	not possible.	
Receipt of data:	read tracking check	forced transfer.
Recording of data:	write tracking check	forced transfer.
Recovery of data:	parity check	forced transfer.
Timing conflicts:	check	system de-activated.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . Honeywell 400.
Central Processor.
401A.

.12 Description

The 401A is the successor to the 401 as the central processor of the H-400 system. A number of 401's are still in the field, and are almost entirely program compatible with 401A (one console type-out location differs). However, it is not practical to change a 401 to a 401A in the field.

The 401A utilizes three-address instructions and has binary and decimal computational facilities. The instruction repertoire is comprehensive and includes strong editing and Boolean operations. The 3 index registers can be incremented by up to 4,096 (the maximum store size). Multiply-Divide instructions are optional. Floating point arithmetic must be handled by subroutines.

Errors and ends of input-output data transfers can cause separate interrupts to occur. An interrupt causes the processor to take its next instruction from a unique location in storage without changing the sequence counter that normally directs the processor to subsequent instructions. Since the sequence counter and the three index registers are contained in a single storage location, they are generally stored and the specific I/O or diagnostic routine is entered. This is done by one instruction. At the end of this routine, the sequence counter and index registers can be restored. Thus only two instructions are required to store and restore the contents of the program registers and to provide entrance and exit for each appropriate routine (two routines are provided to process data from each input/output channel, one for the normal and one for the abnormal end of operation).

Cases involving multiple interrupts have been handled in a convenient manner. When multiple interrupts occur, the processor accepts the interrupt from the source with the highest priority which is defined by built-in hardware.

One particular instruction operation deserves a special explanation. Its name is "SELECT". It is used to cause other instructions to be executed under its control one at a time as in table look-ups. The select operation is recursive and may execute another select instruction. The sequence counter is only affected by select instructions when they cause a jump. The executed address of a select instruction is formed by a logical combination of one address and two masks.

Special input and output areas are fixed for the standard card reader, punch, and printer. Editing instructions are available which work with a binary card image (four 12-bit columns per 48-bit word), or with 6-bit print characters. These can be edited to six-bit alphabetic, four-bit decimal (which can be used computationally), or three-bit octal characters by the editing instructions. Non-valid characters cause a forced transfer. Insertion of specific characters, suppression of leading zeros, and floating of the high order character of a field can be performed automatically.

Simultaneity in operation of the central processor and input-output units is controlled by the method of transfer logic associated with each of the units concerned. Thus, some units (such as the card units) allow overlapped operation of the central processor while the peripheral unit is preparing to make the transfers. This is not possible with the magnetic tape units. The rules for such operations are given in Simultaneous Operations (Section 501:111).

The relatively small core storage capacity of a minimum system (1,024 48-bit words) may well restrict attempts to get higher throughput without expanding the system. In such cases the power of the central processor may not be able to be fully utilized.

.13 Availability: . . . . . . 9 months.

.14 First Delivery: . . . . 1962.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-Subtract:	automatic	10, 2	11D, 48B.
	Multiply			
	Short:	none.		
	Long:	optional	10	11D.
	Divide			
	No remainder:	none.		
	Remainder:	optional	10	11D.
.212	Floating point			
	Add-Subtract:	subroutine	10	-
	Multiply:	subroutine	10	-
	Divide:	subroutine	10	-
.213	Boolean			
	AND:	automatic	binary	48 bits.
	Inclusive OR:	automatic	binary	48 bits
	Exclusive OR:	automatic	binary	48 bits.
	A•B v B•C:	automatic	binary	48 bits.
.214	Comparison			
	Numbers:	2 instructions		11D, sign.
	Letters:	2 instructions		48 bits.
	Mixed:	2 instructions		48 bits.

Collating sequence: 0 to 9 " = : + A to I; .) % ■ –
J to R # $ * " / S to Z @ , (CR.

§ 051.

.215 Code translation

Provision	From	To	Size
automatic	12B card col	6B alpha	0 to 80C.
automatic	12B card col	4B unsigned D	0 to 80D.
automatic	12B card col	4B signed D	0 to 11D.
automatic	12B card col	3B octal	0 to 80D.
automatic	6B alpha	12B card col	0 to 80C.
automatic	4B unsigned D	12B card col	0 to 80D.
automatic	4B signed D	12B card col	0 to 80D.
automatic	3B octal	12B card col	0 to 80D.
automatic	6B alpha	print image	0 to 120C.
automatic	4B decimal	print image	0 to 120C.
automatic	3B octal	print image	0 to 120C.
automatic	4B hexadec	4B decimal	1 word.

Note: B = binary bits.
C = alphameric characters.
D = decimal digits.

.216 Radix conversion: . . . none.

.217 Edit format

	Provision	Comment	Size
Alter size:	subroutine		
Suppress zero:	automatic	9 leading zeros	1 word.
Round off:	subroutine	remainder and LOP * in Std loc.	
Insert point:	automatic.		
Insert any:	automatic.		
Float hex char:	automatic	part of zero suppression	1 word.
Protection:	automatic	part of zero suppression	1 word.

* LOP is Low Order Product, i.e., the least significant digits.

.218 Table look-up: . . . . . none.

.219 Others

	Provision	Comment	Size
Move:	automatic	entire memory	any number of words.

.22 Special Cases of Operands

.221 Negative numbers: . . . 4 binary zeros in first digit of a signed decimal word; all other configurations are positive; absolute value and sign.

.222 Zero: . . . . plus and minus zero can occur and are equal in some comparisons.

.223 Operand size determination: . . . . though generally one word, in editing a character count is used.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout

Part	OP	A I	B I	C I	A	B	C
Size (Bits)	6	2	2	2	12	12	12

.233 Instruction parts

Name	Purpose
OP:	operation code.
AI:	A address index.
BI:	B address index.
CI:	C address index.
A:	A address.
B:	B address, or parameters.
C:	C address.

.234 Basic address structure: . . . . . . 3 address.

.235 Literals
Arithmetic: . . . . . . none.
Comparisons and tests: . . . . 1.
Incrementing modifiers: . . . . . 2.

.236 Directly address operands

.2361 Internal storage type: core.

Minimum size	Maximum size	Volume accessible
6-bit char	entire	entire

.2362 Increased address capacity: . . . . . . none.

.237 Address indexing

.2371 Number of methods: . one.

.2372 Names: . . . . direct.

.2373 Indexing rule: . . . . . the contents of a specified index register are added modulo memory size to the associated address.

.2374 Indexing specification: one of three indices (or none) specified by two bits for each address.

.2375 Number of potential indexers: . . . . 3.

.2376 Addresses which can be indexed

Type of address	Application
Operands:	counting and modification.

.2377 Cumulative indexing: . none.

.2378 Combined index and step: . . . . none.

.238 Indirect addressing: . . none.

.239 Stepping

.2391 Specification of increment: . . . . . in stepping instruction.

.2392 Increment sign: . . . . positive.

.2393 Size of increment: . . 0 to 4095.

.2394 End value: . . . . . . specified in register.

.2395 Combined step and test: . . . . yes.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in bits	Program usage
Index:	3	12	modification.
Sequence:	1	12	program counter.

.242

Category of storage	Total number locations	Physical form	Access time, μsec	Cycle time, μsec
Index & sequence register:	1	core location	6	9.25

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . one.

.312 Arrangement: . . . . . sequence register.

.313 Precedence rule: . . . . interrupts take precedence but do not affect the sequence counter.

.314 Special sub-sequence counters: . . . . none.

.315 Sequence control step size: . . . . instructions, i.e., words.

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.316 Accessibility to program: . . . . addressable.
.317 Permanent or optional modifier: . . optional.

.32 Look-Ahead: . . . . . . none.

.33 Interruption

.331 Possible causes
In-out units: . . . . . end of operation.
end of tape.
In-out controllers: . . faulty transfer.
Processor errors: . . overflow.
editing illegal char.
.332 Program control
Individual control: . . priority of tape file interrupts.
Method: . . . . by instruction.
.334 Interruption conditions: always when cause initiated.
.335 Interruption process
Disabling interruption: none.
Registers saved: . . . all (by convention).
Destination: . . . . . fixed locations, dependent on type of interruption.
.366 Control methods
Determine cause: . . location arrived at.
Enable interruption: . yes.

.34 Multi-running: . . . . . yes; see Introduction (501:011).

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μsec

Decimal (8 digit operands)

.411 Fixed point
Add-subtract: . . . . 111.
Multiply: . . . . 1,258 + 55.5Z. ‡
Divide: . . . . 1,720 + 74Q. ‡

Z = no. of non-zero digits.
Q = sum of quotient digits.

.412 Floating point: . . . . . none.
.413 Additional allowance for
Indexing: . . . . 9.25 per operand.
Indirect addressing: . not available.
Re-complementing: . 64.75
.414 Control
Branch: . . . . 46.
Compare & branch: . 111.
.415 Counter control
Step and test: . . . . . 64 to 101.
.416 Edit: . . . . 74 + 12.5D.
.417 Convert: . . . . none.
.418 Shift: . . . . 65 + 9.25B.

B = Bits or Decimal Digits.
‡ = Using optional Multiply-Divide hardware.

.42 Processor Performance in μsec

.421 For random addresses — Fixed Point
$c = a + b$: . . . . 111.
$b = a + b$: . . . . 111.
Sum N items: . . . . . 111N.
$c = ab$: . . . . 1,260 + 55D. ‡
$c = a/b$: . . . . 1,710 + 72D. ‡
.422 For arrays of data — Fixed Point
$c_i = a_i + b_j$: . . . . . . 305.
$b_j = a_i + b_j$: . . . . . . 305.
Sum N items: . . . . . 210N.
$c = c + a_ib_j$: . . . . . 1,930. ‡
.423 Branch based on comparison
Numeric data: . . . . 203.
Alphabetic data: . . . 203.
.424 Switching
Unchecked: . . . . . . 157.
Checked: . . . . 399.
List search: . . . . . 92 + 138N.
.425 Format control per character
Unpack: . . . . 12.
Compose: . . . . 15.
.426 Table look up per comparison
For a match: . . . . . 203N.
For least or greatest: 250N.
For interpolation point: . . . . 203N.
.427 Bit indicators
Set bit in separate location: . . . . . . 83.
Set bit in pattern: . . 111.
Test bit in separate location: . . . . . . 111.
Test bit in pattern: . . 222.
Test AND for B bits: . 222.
Test OR for B bits: . . 222.
.428 Moving data: . . . . . . 46 + 37N, for N-word transfer.

‡ = Using optional Multiply-Divide hardware.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	interrupt	jump to std location *.
Underflow:	not possible.	
Zero divisor:	interrupt	jump to std location *.
Invalid data:	interrupt	jump to std location *.
Invalid operation:	check	machine halt.
Arithmetic error:	none.	
Invalid address:	check	adjusted modulo memory size.
Receipt of data:	interrupt	jump to std location *.
Dispatch of data:	interrupt	jump to std location *.

* Sequence counter not changed.

INPUT-OUTPUT: PUNCHED TAPE READER

§ 071.

.1 GENERAL

.11 Identity: . . . . Punched Paper Tape Reader and Control 409.
Burroughs Corp. Unit B 141.

.12 Description

The 409 Punched Paper Tape Reader and Control can read strips of paper tape at 500 frames per second, or reels at 1,000 frames per second. Peak speed is only attained after 15 frames have been read without interruptions. During the reading time, the processor is effectively restricted to the read tape instruction. Each data frame is right-justified in twelve-bit sections of 48-bit words and transferred to storage. The reader can handle codes of up to eight bits.

The data read is dependent upon standard subroutines to accomplish conversion to Honeywell 400 codes, but these are fast and simple. The amount of data read is instruction-controlled and can vary from 1 to 256 frames. The effective speed varies from 71 to 492 frames per second in the medium-speed mode and from 142 to 984 frames per second in the high- speed mode.

The reader can read tape either from spools or in strips. It uses swing arms for tension, and spool motor drive control. The read mechanism is photoelectric and the tape is driven by a pinch roller. An automatic rewinding feature is incorporated in the unit.

.13 Availability: . . . . 6 months.

.14 First Delivery: . . . . . July, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arms.
Capacity: . . . . 3 feet.
.213 Feed drive: . . . . servo motor.
.214 Take-up drive: . . . . . servo motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . . none.
.222 Sensing system: . . . . photoelectric.
.223 Common system: . . . . none.

.23 Multiple Copies: . . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . . read.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8 plus sprocket.
Method of use: . . . . . . frame at a time.

.25 Range of Symbols

Numerals: . . . . any 5- to 8-bit code.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
.312 Phenomenon: . . . . . . punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . by row, 10/inch.

.322 Parallel by: . . . . 5 to 8 tracks.
.323 Bands: . . . . none.
.324 Track use
Data: . . . . 5 to 8 tracks.
Redundancy check: . . . any track except sprocket.
Timing: . . . . track 4 (sprocket track).
Control signals: . . . . none.
Unused: . . . . none.
Total . . . . 5 to 8 plus sprocket track.
.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . one character per row, using 5 to 8 bits; any 5-, 6-, 7- or 8-bit code.

.34 Format Compatibility

Other device or system — Code translation
H 401: . . . . translation provided by routine.

.35 Physical Dimensions

.351 Overall width: . . . . . . 11/16; 7/8; 1 inch.
.352 Length: . . . . 8 to 700 ft. by 0.1 inch.
4-foot leader.
4-foot trailer.

§ 071.

.4 CONTROLLER

.41 Identity: . . . . controller contained in reader.

.42 Connection to System

.421 On-line: . . . . up to 5.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to 256 frames.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . none.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . . program.
.447 Synchronizing aids: . . . test busy.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . . 1 to 256 frames.
.512 Block demarcation
Input: . . . . count in instruction.

.52 Input-Output Operations

.521 Input: . . . . 1 to 256 frames.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . unload forward or rewind till end of tape is reached.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . by program.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . . 81.
Rearrangement: . . . . . rearrangement of tracks.

.55 Control Operations

Disable: . . . . disable up to 3 tracks (manual).
Request interrupt: . . . . yes.
Select format: . . . . . . none.
Select code: . . . . none.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . not necessary.
Output lock: . . . . no.
Nearly exhausted: . . . . no.
Busy controller: . . . . no.
End of medium marks: . metallic foil at each end of tape.

.6 PERFORMANCE

.61 Conditions

I: . . . . full speed 1,000 frames/sec.
II: . . . . medium speed 500 frames/sec.

.62 Speeds

621 Nominal or peak speed: I 1,000 frames/sec.
II 500 frames/sec.
522 Important parameters
Full speed: . . . . 1,000 frames/sec.
Medium speed: . . . . . 500 frames/sec.
Start time: . . . . 5 m.sec.
Stop time: . . . . 1 m.sec.
.623 Overhead: . . . . start/stop time.
.624 Effective speeds: . . . . I 1,000 N/(N + 6) frames/sec.
II 500 N/(N + 6) frames/sec.

N = number of frames per read instruction (256 max).

.63 Demands on System

Component	Condition	msec per frame	or	Percentage
Reading 1 frame at a time:				
Processor:	I	0.1	or	10.
	II	0.1	or	5.
Reading 2 or more frames at a time:				
Processor:	I	1	or	100.
	II	2	or	100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comments
Width:	movable tape guides	detents.

.72 Other Controls

Function	Form	Comment
Parity check:	switch	allows checking odd/even or no parity.
Feed control:	switch	allows tape to be fed from reel clockwise (Reel Normal) or counterclockwise (Reel Reverse) or strips (Strip).
Backspace:	lever	moves tape backward one frame.
Rewind:	button	move to end of tape.
Unload:	button	wind forward to end of tape.

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.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	700 feet

.732 Replenishment time: 1 to 2 mins. reader needs to be stopped.

.733 Adjustment time: . . . . . 5 to 10 mins.

.734 Optimum reloading period: . . . . 1.4 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	parity check	stoppage and signal to control
Input area overflow:	none.	
Invalid code:	none.	
Exhausted medium:	tape tension and metallic foil	stoppage, alarm.
Imperfect medium:	sprocket check	stoppage, alarm.
Timing conflicts:	none.	

INPUT-OUTPUT: 410 PUNCHED PAPER TAPE PUNCH AND CONTROL

§ 072.

.1 GENERAL

.11 Identity: . . . . Punched Paper Tape Punch and Control 410. Teletype BRPE Punch.

.12 Description:

The 410-1 is a combination Punched Paper Tape Punch and Control Unit designed to prepare five-channel punched paper tape, ten frames to the inch, at 110 characters per second. The 410-2 is the same, except that it punches six-, seven-, or eight-channel tape. The image to be punched is packed 4 characters to a 48-bit word. The last character to be punched requires about 4.5 milliseconds of processor time and all other characters occupy the processor full time; i.e., nine milliseconds. For this reason, the programming practice may be to punch one character at a time even though up to 256 characters can be punched by one instruction.

Although (unlike the card code conversion) no special edit instructions are available for paper tape, a very simple and fast subroutine is available for accomplishing character (or digit) to punch code conversion. This technique permits the use of any size (up to eight-bit) or configuration of code patterns.

.13 Availability: . . . . 6 months.

.14 First Delivery: . . . . . August, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . sprocket drive pull.
.212 Reservoirs:
Number: . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . 3 feet.
.213 Feed drive: . . . . servo motor.
.214 Take-up drive: . . . . . servo motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . none.
.223 Common system: . . . . none.

.23 Multiple Copies: . . . . . none.

.24 Arrangement of Heads

	410-1	410-2
Use of station:	punch.	punch.
Stacks:	1.	1.
Heads/stack:	5 plus sprocket	8 plus sprocket.
Method of use:	frame at a time	frame at a time.

.25 Range of Symbols

Letters: . . . . 410-1; any five-bit code.
Special: . . . . 410-2; any 6-, 7-, or 8-bit code.
Total: . . . . 410-1; 2^5 symbols.
410-2; 2^8 symbols.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
.312 Phenomenon: . . . . punch holes.

.32 Positional Arrangement

.321 Serial by: . . . . 10 rows/inch.
.322 Parallel by: . . . . 410-1; 5 tracks.
410-2; 8 tracks.
.323 Bands: . . . . none.

.324 Track use

	410-1	410-2
Data:	5	8
Redundancy check: . .	none	none.
Timing:	1	1.
Control signals: . . .	none	none.
Unused:	none	none.
Total:	5 plus sprocket	8 plus sprocket.

.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . 410-1; any 5-bit code.
410-2; any 6-, 7-, or 8-bit code.

.34 Format Compatibility

Other device or system	Code translation
Any compatible punched tape reader:	programmed.

.35 Physical Dimensions

.351 Overall width: . . . . . . 410-1; 11/16".
410-2; 7/8" or 1".
.352 Length: . . . . 6 to 1,000 feet.

.4 CONTROLLER

.41 Identity: . . . . H 410.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line: . . . . none.

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.43 Connection to Device

.431 Devices per Controller: . . . . 2.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of Load: . . . . 1 to 256 frames.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . none.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . . program.
.447 Synchronizing aids: . . . test busy.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . . 8-bit frame.
.512 Block demarcation Output: . . . . counter in instruction.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 to 256 frames.
.523 Stepping: . . . . 1 frame forward.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . by program.

.54 Format Control: . . . . . none.

.55 Control Operations: . . . none.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . not necessary.
Output lock: . . . . no.
Nearly exhausted: . . . . 20 feet.
Busy controller: . . . . . not necessary.
End of medium marks: . no.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: . 110 frames/sec.
.622 Important parameters punch a frame: . . . . . 9.09 m.sec.
.623 Overhead: . . . . none.
.624 Effective speeds: . . . . 110 frames/sec.

.63 Demands on System

Component	Condition	m.sec per frame	Percentage
Processor:	punch 1 frame	4.5	50.
Processor:	punch additional frames	9.1	100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjust guide

.72 Other Controls

Function	Form	Comment
Rewind:	switch	tape must be removed from punch head.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	1,000 ft.

.732 Replenishment time: . . 2 to 5 minutes. punch needs to be stopped.
.734 Optimum reloading period: . . . . 18 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	not possible.	
Input area overflow:	not possible.	
Output block size:	implicit.	
Invalid code:	not possible.	
Exhausted medium:	check	special branching.
Imperfect medium:	none.	
Timing conflicts:	not possible.	

INPUT-OUTPUT: CARD READER 423-2

§ 073.

.1 GENERAL

.11 Identity: . . . . Honeywell 400.
Card Reader.
423-2.

.12 Description

The 423-2 Card Reader is a modified IBM 088 Collator which reads cards at 650 cards per minute. Features of the IBM 088 that have been retained when operating as the 423-2 are blank-column checks, hole-count checks, and character rearrangement and insertion via the plugboard. When the unit is not on-line, it retains all of the features of the IBM 088 and can be used as a Collator. Only one of these units can be connected to the system at one time.

When the 423-2 is reading cards, a binary image of each card column is stored in a twelve-bit section of a 48-bit word. A fixed area of twenty words is used to store this image in card column sequence. The image is a one or zero picture of the punches from row nine to row twelve in the high to low order, respectively, of the twelve-bit section. The processor is occupied for 54 milliseconds of the 92.3 millisecond read cycle. While the processor is thus occupied, no other operations can take place. The remainder of the cycle is broken down into the 33-millisecond acceleration period and the 6-millisecond deceleration period. Central Processor use of the acceleration period is possible, although restricted. Unrestricted use can be made of the deceleration period. Certain system considerations arising from this are discussed in the Simultaneous Operations section, 501:111.

Editing instructions are available for editing a card image, or any part thereof, into a six-bit alphameric code, a four-bit numeric code, or an eight-bit octal code.

.13 Availability: . . . . . . no longer available (replaced by H-427).

.14 First Delivery: . . . . 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brush.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . hole check.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . row at a time.

Use of station: . . . . . read.
Distance: . . . . 20 card rows.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . punch card.
.312 Phenomenon: . . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . row, 12.
.322 Parallel by: . . . . . . column 80.

.33 Coding: . . . . input data is stored in the system in a column binary representation; i.e., 12 bits per column, punch = 1, no punch = 0. (Hollerith codes or direct transcription).

.34 Format Compatibility

Other device or system	Code translation
80-column card compatibility:	none necessary.

.35 Physical Dimensions: . standard 80-column card.

.4 CONTROLLER

.41 Identity: . . . . built into processor.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line use: . . . . . . Collator (IBM 088).

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . only one input device is permitted per run.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 card.
.442 Input-output areas: . . fixed core locations are the input storage area for the card reader.

§ 073.

.443 Input-output area access: . . . . word.
.444 Input-output area lockout: . . . . none; although card reading occupies the computer completely during the actual reading, there is no lockout.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation
Input: . . . . 1 card.

.52 Input-Output Operations

.521 Input: . . . . 1 card at a time.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . edit instructions provide for Hollerith, octal or decimal conversion.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . none.
Rearrangement: . . . . plugboard.
Suppress zeros: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Offset card: . . . . . . no.
Select stacker: . . . . . yes.
Select format: . . . . . no.
Select code: . . . . . . instruction.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . not necessary.
Nearly exhausted: . . . no.
Busy controller: . . . . not necessary.
End of medium marks: no.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: 650 cards per minute.
.622 Important parameters
Cycle time: . . . . . . 92.3 msec.
Acceleration time: . . 33.0 msec.
Data Transfer time: . 52.3 msec.
Terminal time (during which next read order must be given to maintain 650 card per minute reading): . . 6.0 msec.
.623 Overhead: . . . . 1 clutch point.
.624 Effective speeds: . . . 650-C cards per minute.
C = number of clutch points missed per minute.

.63 Demands on System

Component	Condition	msec per card		Percentage
Processor:	controlling reading	52.3	or	56.7.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
51-column hardware:	insert	on primary feed only.

.72 Other Controls: . . . . see IBM 088 manual.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hoppers:	3,600 primary; 1,200 secondary.
Stackers (5):	1,000 each.

.732 Replenishment time: . . 0.5 to 1.0 mins.
.733 Adjustment time: . . . 0.5 to 1.0 mins.
.734 Optimum reloading period: . . . . 5.5 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole-count check	program jump.
Input area overflow:	not possible.	
Invalid code:	not possible.	
Exhausted medium:	check	alarm.
Imperfect medium:	check	alarm.
Timing conflicts:	not possible.	

INPUT-OUTPUT: CARD PUNCH

§ 074.

.1 GENERAL

.11 Identity: . . . . Honeywell 400.
Card Punch.
424-1.
424-2.

.12 Description:

This unit is no longer produced, but is still in use in the field.

The 424-1 or 424-2 Card Punch is a modified IBM 519 Reproducing Punch or IBM 544 Gang Punch. The units punch at 100 and 250 cards per minute, respectively. Most of the normal plugboard features are retained when the units are operating on-line. Off-line, they assume their normal characteristics. Only one of these units at a time can be connected to the system.

Both units punch cards from a twelve-bit binary image of each column. The punch image is stored in a fixed 20-word area in core storage and is represented by a one or zero picture of the punches from row nine to row twelve in the high- to low-order positions, respectively, of the twelve-bit image. The images are stored sequentially by column. The processor is occupied for 500 or 177 milliseconds during the 600-millisecond cycle of the 424-1 or 240-millisecond cycle of the 424-2. While the processor is thus occupied, no other operations may take place.

.13 Availability: . . . . no longer available.

.14 First Delivery: . . . . . 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . pinch roller.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . . brush.
.223 Common system: . . . . none.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

	424-1	424-2
Use of station:	*read	none.
Stacks:	1.	
Heads/stack:	80.	
Method of use:	1 row at a time.	
Use of station:	*read verify	none.
Distance:	14 card rows.	
Stacks:	1.	
Heads/stack:	80.	
Method of use:	1 row at a time.	
Use of station:	punch	punch.
Stacks:	1	1.
Heads/stack:	80	80.
Method of use:	1 row at a time	1 row at a time.
Use of station:	read verify	gang punch.
Distance:	14 card rows	14 card rows.
Stacks:	1	1.
Heads/stack:	80	80.
Method of use:	1 row at a time	1 row at a time.

* Cards being punched do not pass these stations.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . punch card.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . . rows, 12.
.322 Parallel by: . . . . . column, 80.

.33 Coding: . . . . system uses a column binary image generated by edit instruction; 1 = punch, and 0 = no punch (Hollerith code or direct transcription).

.34 Format Compatibility

Other device or system	Code translation
Any 80 column card equipment: . .	none necessary.

.35 Physical Dimensions: . standard 80-column card.

.4 CONTROLLER

.41 Identity: . . . . built into processor.

.42 Connection to System

.421 On-line: . . . . one only.

.43 Connection to Device

.431 Devices per controller: . one.
.432 Restrictions: . . . . . . only one punch may be connected to a controller during any one run.

§ 074.

.44 Data Transfer Control

.441 Size of load: . . . . one card.
.442 Input-output areas: . . . core locations 0112 - 0135 (octal).
.443 Input-output area access: . . . . word.
.444 Input-output area lockout: . . . . implicit, as the processor is completely involved in the punching operation.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . . 1 card.
.512 Block demarcation
Output: . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 card.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . edit instructions.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . . none.
Rearrangement: . . . . . plugboard.
Suppress zeros: . . . . . none.
Insert point: . . . . plugboard.
Insert spaces: . . . . . . plugboard.
Section sizes: . . . . . . plugboard.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . . no.
Offset card: . . . . yes (424-2 only).
Select stacker: . . . . . no.
Select format: . . . . . . no.
Select code: . . . . no.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . not necessary.
Output lock: . . . . no.
Nearly exhausted: . . . . no.
Busy controller: . . . . . not necessary.
End of medium marks: . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . type 424-1.
II: . . . . type 424-2.

.62 Speeds

	I	II
.621 Nominal or peak speed: .	100 cards per min	250 cards per min.
.622 Important parameters		
Cycle time:	600 m.sec	240 m.sec.
Acceleration time: . . .	91 m.sec	55 m.sec.
Punching time:	500 m.sec	177 m.sec.
Terminal time (during which the next punch order must be given to maintain maximum punching speed): . . .	7 m.sec	7 m.sec.

.623 Overhead: . . . . one clutch point.
.624 Effective speeds: . . . . I: 100-C cards per min.
II: 250-C cards per min.
C = number of clutch points missed per minute.

.63 Demands on System

Component	Condition	m.sec per card	Percentage
I Processor:	punching card	500	83.3
II Processor:	punching card	177	73.7.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Comment
424-1:	see IBM 519 Manual.
424-2:	see IBM 544 Manual.

.72 Other Controls

Function	Comment
424-1:	see IBM 519 Manual.
424-2:	see IBM 544 Manual.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity, cards I	II
Hopper:	800	1,200
Stacker:	1,000	1,900

.732 Replenishment time: . . . 0.5 to 1.0 mins. no need to be stopped.
.733 Adjustment time: . . . . 0.5 to 1.0 mins.
.734 Optimum reloading period: . . . . I: 8 mins.
II: 4 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	check	program jump.
Output block size:	fixed.	
Invalid code:	not possible.	
Exhausted medium:	check	program jump.
Timing conflicts:	not possible.	

INPUT-OUTPUT: PRINTER (422-3 AND 422-4)

§ 081.

.1 GENERAL

.11 Identity: . . . . Honeywell 400.
Printer.
422-3.
422-4.

.12 Description:

The 422-3 and 422-4 are essentially identical units except that the 422-3 can print in any 120 out of 160 print positions and is plugboard-wired, whereas the 422-4 has a fixed 120 positions. They are manufactured by Honeywell, but are quite similar to the equivalent Anelex units. The printers can print at up to 900 lines per minute, single spaced. At double and one-inch spacing, the speed drops to 800 and 560 lines per minute respectively. These speeds are due to unclutched operation which permits printing to begin as soon as requested, provided that the unit has completed the previous operation. Printing with a restricted range of symbols may increase the speed up to 1, 200 lines per minute. Paper tape loop control provides automaticor semi-automatic paper spacing.

Options

A print storage option is available which eliminates about 98% of the processor time that is required when the buffer is not used. Without the buffer, the processor is inhibited for 53 milliseconds after a print instruction is initiated, after which computing may resume.

A 6 or 8 line per inch vertical spacing option is also available.

.13 Availability: . . . . . 9 months.

.14 First Delivery: . . . . December, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . sprocket drive push & pull tractors.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . on the fly hammer stroke against engraved drum.

.23 Multiple Copies: . . . . . yes.

.231 Maximum number
Interleaved carbon: . . . 10 (8-pound paper).

.232 Types of master
Multilith: . . . . . . yes.
Xerox: . . . . yes.
Spirit: . . . . yes.

.24 Arrangement of Heads

	Type 422-3	Type 422-4
Use of station:	print	print.
Stacks:	1	1.
Heads/stack:	160 (120 used at a time	120.
Method of use:	line at a time	line at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special*:	20	' = & + ; .) % - # $ " / @ , (* CR : □.
ALGOL set:		yes.
FORTRAN set:		yes.
Basic COBOL set:		yes.
Total:	56.	

* Also, 6 special drums are available with different special symbols.
Model 1 uses the same special characters as the IBM 407 keypunch, but with the following added:
' = +) ("
Model 2 uses the IBM 12F "Selfcheck" font, suitable for use with the optical scanner.
Model 3 and 4 include the pound sterling symbol (£) as well as the dollar sign ($).
Model 5 replaces various commercial symbols with lower case t and o and the following Greek letters:
Δ ∈ ϕ θ λ
Model 6 adds second versions of the following:
- . /
and adds:
¢ and ½
The following are omitted:
" + ;) (

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper.
.312 Phenomenon: . . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . line, 6 or 8 per inch.
.322 Parallel by: . . . . 120 char, 10 per inch.

.33 Coding: . . . . 6 bits per char.

.34 Format Compatibility: . . none.

§ 081.

.35 Physical Dimensions

.351 Overall width: . . . . . . 3.5 to 22 inches.
.352 Length: . . . . indefinite.
.353 Maximum margins
Left: . . . . 3 inches.
Right: . . . . 3 inches.

.4 CONTROLLER

.41 Identity: . . . . 450 Print Storage Option.
418 Off-line Controller (422-4) only.
401A Central Processor.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line

Use	Associated equipment
Printer:	Off-line Controller Type 418 using a Magnetic Tape Type 404-3 and a Printer Type 422-4.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . 120 char.
.442 Input-output areas: . . . fixed in core.
.443 Input-output area access: char or words.
.444 Input-output area lockout: . . . . yes.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . automatic.
.447 Synchronizing aids: . . . interrupt when finished printing, and before spacing.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . . 120 char.
.512 Block demarcation
Output: . . . . fixed.

.52 Input-Output Operations

.522 Output: . . . . 1 line.
.523 Stepping: . . . . print then step, 0 to 63 lines.
.524 Skipping: . . . . paper tape loop; print then skip.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . edit instructions.

.54 Format Control

Rearrangement: . . . . . plugboard.
Insert spaces: . . . . . yes.
Recording density: . . . none.

.55 Control operations

"End of run" light: . . . activate.

.56 Testable Conditions

Disabled: . . . . no
Busy device: . . . . not necessary.
Nearly exhausted: . . . . 30 lines.
Busy controller: . . . . . yes.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: 900 lines per min.
.622 Important parameters
Cycle time: . . . . . . 67 msec.
Printing time: . . . . . 53 msec.
Spacing time first line: . . . . 14 msec.
Spacing time additional line: . . . . 8 msec.
.623 Overhead: . . . . spacing time, operation is unclutched.
.624 Effective speeds: . . . . 60,000/(59 + 8L) lines/min. L = average number of lines skipped per print.

.63 Demands on System

Component	Condition	m.sec per line	or	Percentage
Processor:	print	53.0		79.1.
Processor with print storage option:	print	1.1		1.7.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method
Head of form:	hand-operated vernier screw.

.72 Other Controls

Function	Form
Manual single space: . . .	button.
Manual form space: . . .	button.
Stop at next head of form: .	button.

.73 Loading and Unloading

.731 Volumes handled: . . . . box of forms.
.732 Replenishment time: . . 0.5 to 3 mins. needs to be stopped.
.733 Adjustment time: . . . . 2 to 5 mins.
.734 Optimum reloading period: . . . . ?

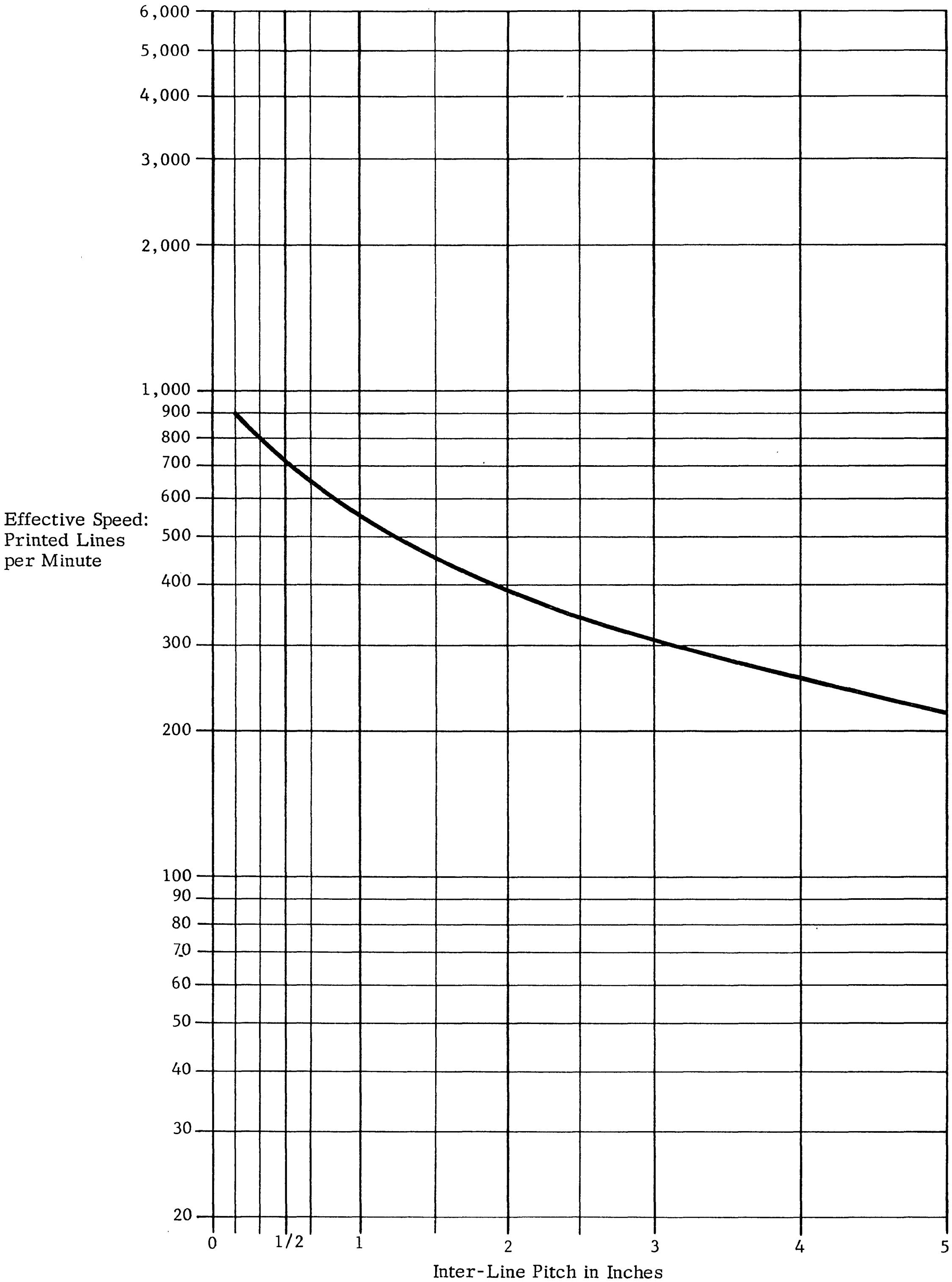
§ 081.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	program jump.
Output block size:	fixed.	
Invalid code:	none.	
Exhausted medium:	interlock	device stoppage with operator indication.
Ribbon Tension:	interlock	device stoppage with operator indication.
Cycle check:	check	device stoppage with operator indication.

§ 081.

EFFECTIVE SPEED
422-3 AND 422-4 PRINTERS



INPUT-OUTPUT: MAGNETIC TAPE

§ 091.

.1 GENERAL

.11 Identity: . . . . Honeywell 400.
Magnetic Tape Unit.
404-1, 404-2, 404-3.

.12 Description

Except in speed, the 404-1, 404-2 and 404-3 Magnetic Tape Units are similar units. The 404-1 and 404-2 pass tape at 120 inches per second and the 404-3 at 60 inches per second. Rewinding speed is three times as fast in each case. A row on any 404 tape consists of ten bits, including eight for data and one each for parity and timing. Each row contains either two digits or one and a third characters; i.e., an eight-bit segment from a 48-bit word. The recording density is 400 rows per inch on the 404-1 and 404-3, and 555 rows per inch on the 404-2. Peak and effective data transfer speeds, in characters per second and digits per second, are shown below.

When card reading is liable to be in process simultaneously with tape operations, tape block lengths must be limited so that no interference occurs between the two operations. This is done by providing an 18-millisecond period before the card reader starts transferring data, during which time no tape read or write operations will be initiated. It is therefore advised that no tape instructions should be allowed which will take longer than this 18 milliseconds to complete. This reduces the effective speed to between one-third and one-half of the peak speed. Details are shown in the table below.

To keep tape running at full speed requires very careful programming. After the data transmission

.12 Description (Contd.)

has ceased, there is time for only 15 simple instructions to be executed before a further tape instruction is given. Since magnetic tape input and output can be overlapped with one another but not with internal processing, programming is geared towards processing a block and then writing it out and reading in the next block at the same time. It is not possible to use the same area for simultaneous input and output.

Orthotronic control words (which consist of 96 parity bits arranged in two words) can be generated by program in the processor and appended to the tape record. Special instructions are also included in the processor to use the Orthotronic words in reconstructing data read from tape with parity errors. When the errors can be traced to a particular track on the tape, a special read instruction is used to regenerate the data. The incorrect track is replaced by a new track generated from the remaining data and parity tracks. The Orthotronic procedures can also be used to verify this data.

These units are equipped with vacuum capstans and brakes which minimize wear by spreading acceleration forces over a larger area of tape than is customary with pinch rollers. The oxide surface of the tape touches only the read-write head. The reels and sections of the tape are accessible even when reading or writing is taking place, although this disrupts the pressurized, air-cleaned environment that is normally maintained over the tape. A write-enable ring can be inserted after tapes have been mounted. A second write interlock is provided by a toggle switch on the control panel.

Performance Characteristics of 404 Tape Units

Condition:	Not Stopping Between Blocks			Stopping Between Blocks		
Model:	404-3	404-1	404-2	404-3	404-1	404-2
Peak Rates:						
Char/sec.	32,000	64,000	89,000	32,000	64,000	89,000
Digits/sec.	48,000	96,000	133,000	48,000	96,000	133,000
Effective Rates (1,000 character blocks):						
Char/sec.	24,200	48,400	58,500	21,400	39,000	47,000
Digits/sec.	36,300	72,600	87,750	32,100	58,850	70,500
Suggested maximum block sizes:						
Characters	400	800	1,120	400	800	1,120
Digits	600	1,200	1,680	600	1,200	1,680
Effective Rates with suggested block sizes:						
Char/sec.	17,400	43,000	60,000	14,500	35,000	49,000
Digits/sec.	26,100	64,500	90,000	21,750	52,500	73,500

§ 091.

.13 Availability: . . . . . . 6 months.

.14 First Delivery: . . . . 404-1 December, 1961.
404-2 1962.
404-3 January, 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . vacuum capstan.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . vacuum.
Capacity: . . . . 7 feet each.
.213 Feed drive: . . . . . . own motor.
.214 Take-up drive: . . . . . own motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . single head.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . D. C. erase.
Stacks: . . . . 1.
Heads/stack: . . . . . . 1.
Method of use: . . . . . full row.

Use of station: . . . . . read/write.
Distance: . . . . 0. 213 inch.
Stacks: . . . . 1.
Heads/stack: . . . . . . 10.
Method of use: . . . . . row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic base magnetizable tape.
.312 Phenomenon: . . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . row, 400 per inch.
.322 Parallel by: . . . . . . 10 tracks, 0. 035 inch.
.323 Bands: . . . . none.
.324 Track use
Data: . . . . 8.
Redundancy check: . . 1.
Timing: . . . . 1.
Total: . . . . 10.
.325 Row use
Data: . . . . 3 to 511 words.
Gap: . . . . 0. 61 inch.

.33 Coding: . . . . 8 bits out of a 48-bit word are recorded in each row; this may be considered two digits or 1-1/3 alpha characters.

.34 Format Compatibility

Other device or system	Code translation
Honeywell 800/1800: . .	compatible.
Honeywell 400 off line printers:	compatible.
Honeywell 1400:	compatible.

.35 Physical Dimensions

.351 Overall width: . . . . . 0. 748 to 0. 750 in.
.352 Length: . . . . 250 to 2, 550 feet.

.4 CONTROLLER

.41 Identity: . . . . built into processor.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line

Use	Associated equipment
Connect H 400 to H 1400/H 800 or other H 400:	H 800 or H 1800 and type 405 switch.
Off-line printer: . .	type 418 off-line controller & type 422-4 printer.

.43 Connection to Device

.431 Devices per controller: 8.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 3 to 511 words.
.442 Input-output areas: . . any core location.
.443 Input-output area access: . . . . any word.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 3 to 511 words.
.512 Block demarcation
Input: . . . . gap.
Output: . . . . count in instruction.

.52 Input-Output Operations

.521 Input: . . . . 1 block forward.
.522 Output: . . . . 1 block forward.
.523 Stepping: . . . . 1 block forward or backward.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

§ 091.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . . not necessary.
Rewind: . . . . yes.
Unload:. . . . . no.

.56 Testable Conditions

Disabled:. . . . . no.
Busy device: . . . . . . not necessary.
Output lock: . . . . . . no.
Nearly exhausted: . . . 1 block writing.
Busy controller: . . . . none.
End of medium marks: implicit.

.6 PERFORMANCE

.61 Conditions

I: . . . . stopping between blocks.
II: . . . . not stopping between blocks.

.62 Speeds

.621 Nominal or peak speed
404-3: . . . . 48,000 digits/sec.
32,000 characters/sec.
404-1: . . . . 96,000 digits/sec.
64,000 characters/sec.
404-2: . . . . 133,000 digits/sec.
89,000 characters/sec.

.622 Important parameters

Parameter	404-3	404-1, 404-2
Start/stop time msec:	3.5/5.0	2.7/3.5
Start/stop distance inches:	0.15/0.24	0.15/0.27
Gap, inches:	0.67	0.67
Min. cross-gap time:	11.1	5.55
Additional time if tapes stop between blocks (msec):	3.9	4.15
Tape speed (ins/sec):	60	120
Pulse density (rows/in):	400	400 (404-1) 555 (404-2)

.623 Overhead: . . . . gap time.
start/stop time.
Orthotronic check word passage time.

.624 Effective speeds
Not stopping between blocks
404-3:. . . . . 48,000N/(556+N) digits/sec.
32,000C/(370+C) char/sec.
404-1:. . . . . 96,000N/(556+N) digits/sec.
64,000C/(370+C) char/sec.
404-2:. . . . . 133,000N/(760+N) digits/sec.
89,000C/(510+C) char/sec.

.624 Effective speeds (Contd.)
Stopping between blocks
404-3:. . . . . 48,000N/(732+N) digits/sec.
32,000C/(488+C) char/sec.
404-1:. . . . . 96,000N/(954+N) digits/sec.
64,000C/(636+C) char/sec.
404-2:. . . . . 133,000N/(1,284+N) digits/sec.
89,000C/(876+C) char/sec.

where N = number of decimal digits per block.
C = number of alphameric characters per block.

.63 Demands on System

Component	Operation	Msec per block	Percentage
Processor:	compute Orthocount	0.12 + 0.0185n, where n = number of words.	100%.
Processor:	read, write, or read and write	variable; does not include stop time of tape	100% of start and data transfer time.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Write release:	write ring	can be done while tape is in motion.

.72 Other Controls

Function	Form	Comment
Tape change:	toggle	3 position automatic rewind unload, load, permit write load, inhibit write (always in read status).

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Spool:	2,550 feet.

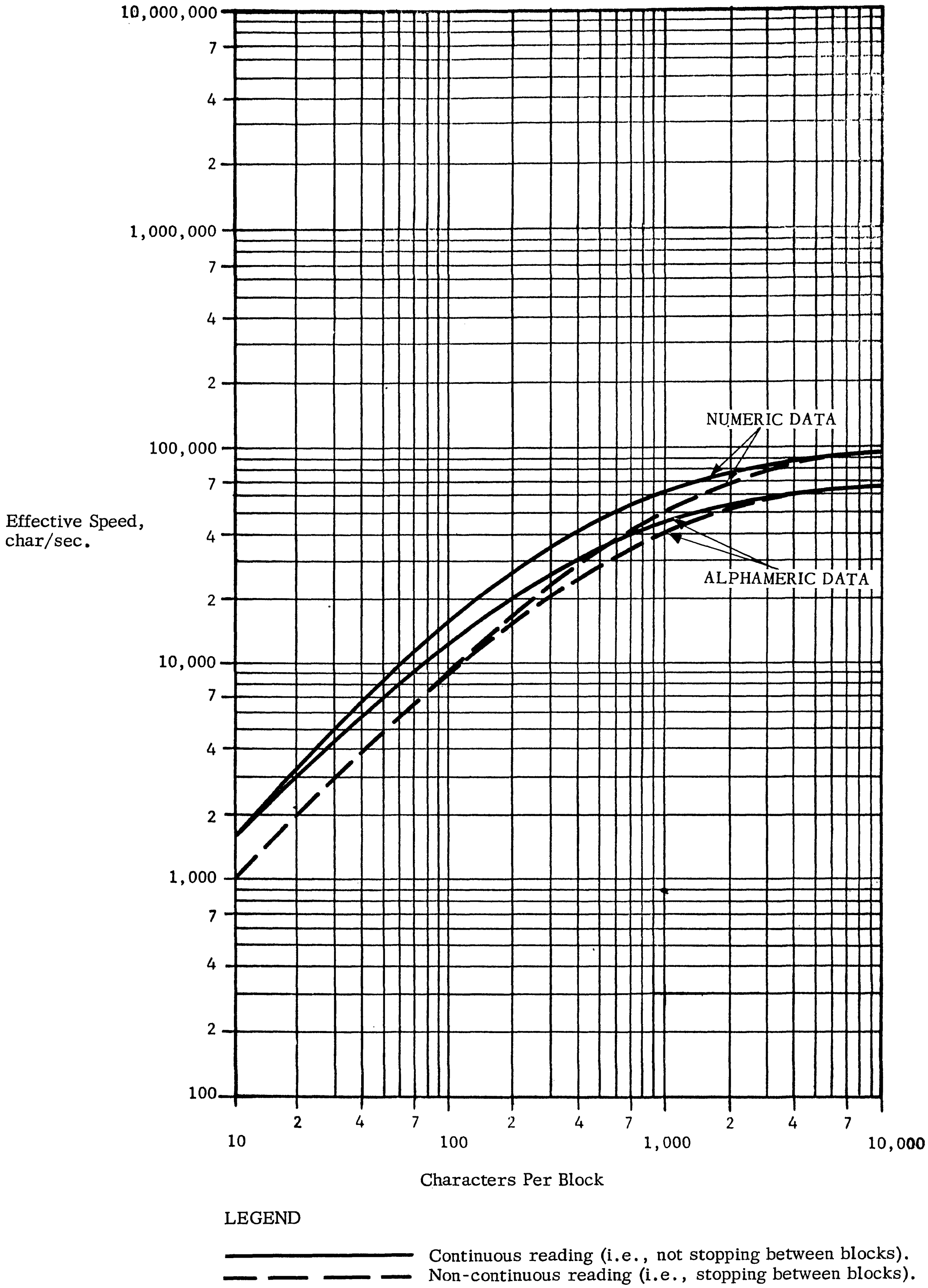
.732 Replenishment time:. . 0.5 to 1.0 min.; needs to be stopped.
.733 Adjustment time: . . . 0.5 to 1.0 min.
.734 Optimum reloading period: . . . . 5.66 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	row parity and Orthocount	program jump.
Input area overflow:	check	program jump.
Output block size:	none.	
Invalid code:	not possible.	
Exhausted medium:	check	program jump.
Imperfect medium:	pre-checked tapes.	
Error correcting:	Orthocount	program.

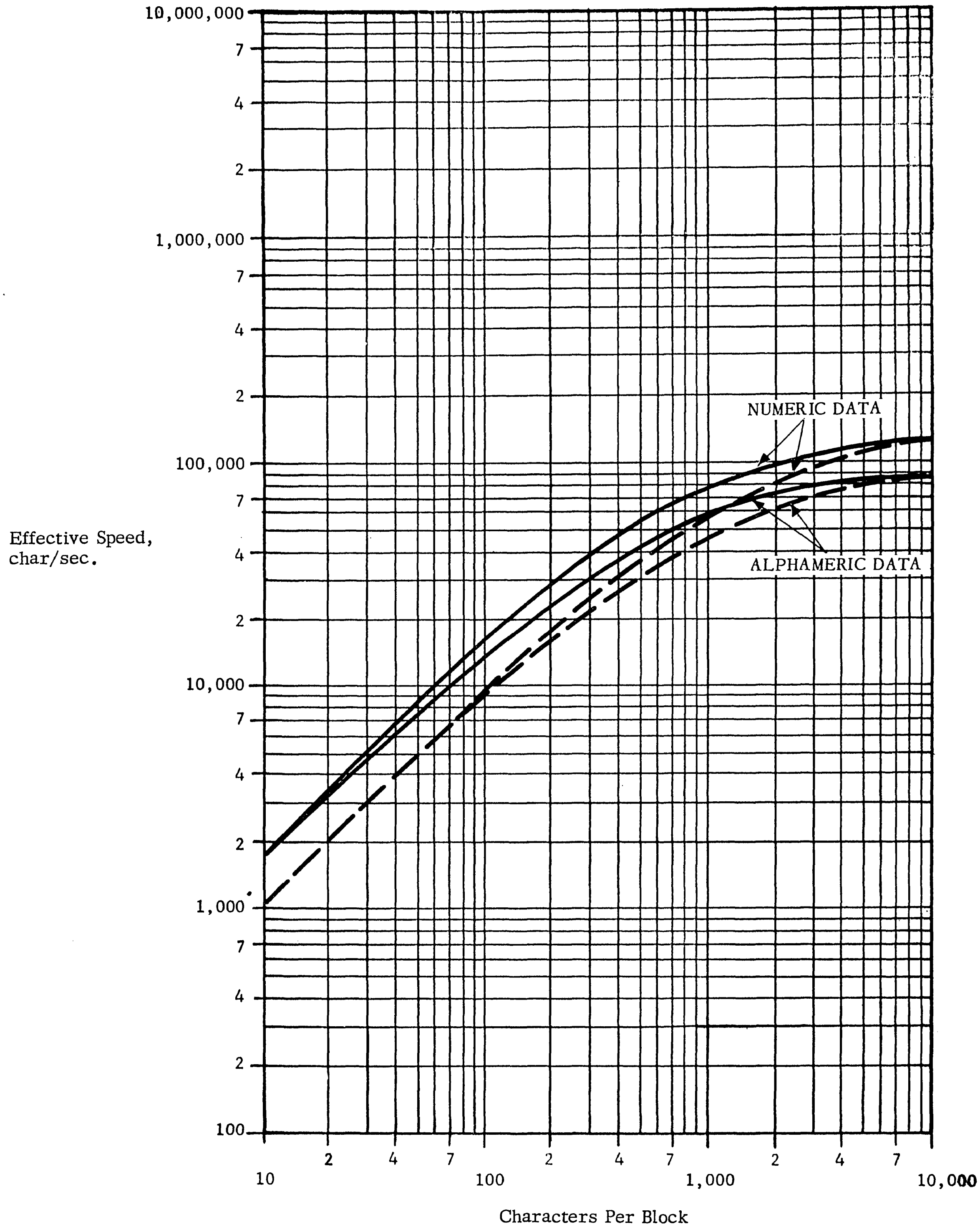
§ 091.

EFFECTIVE SPEED
H-404-1 MAGNETIC TAPE UNIT



§ 091.

EFFECTIVE SPEED
H-404-2 MAGNETIC TAPE UNIT



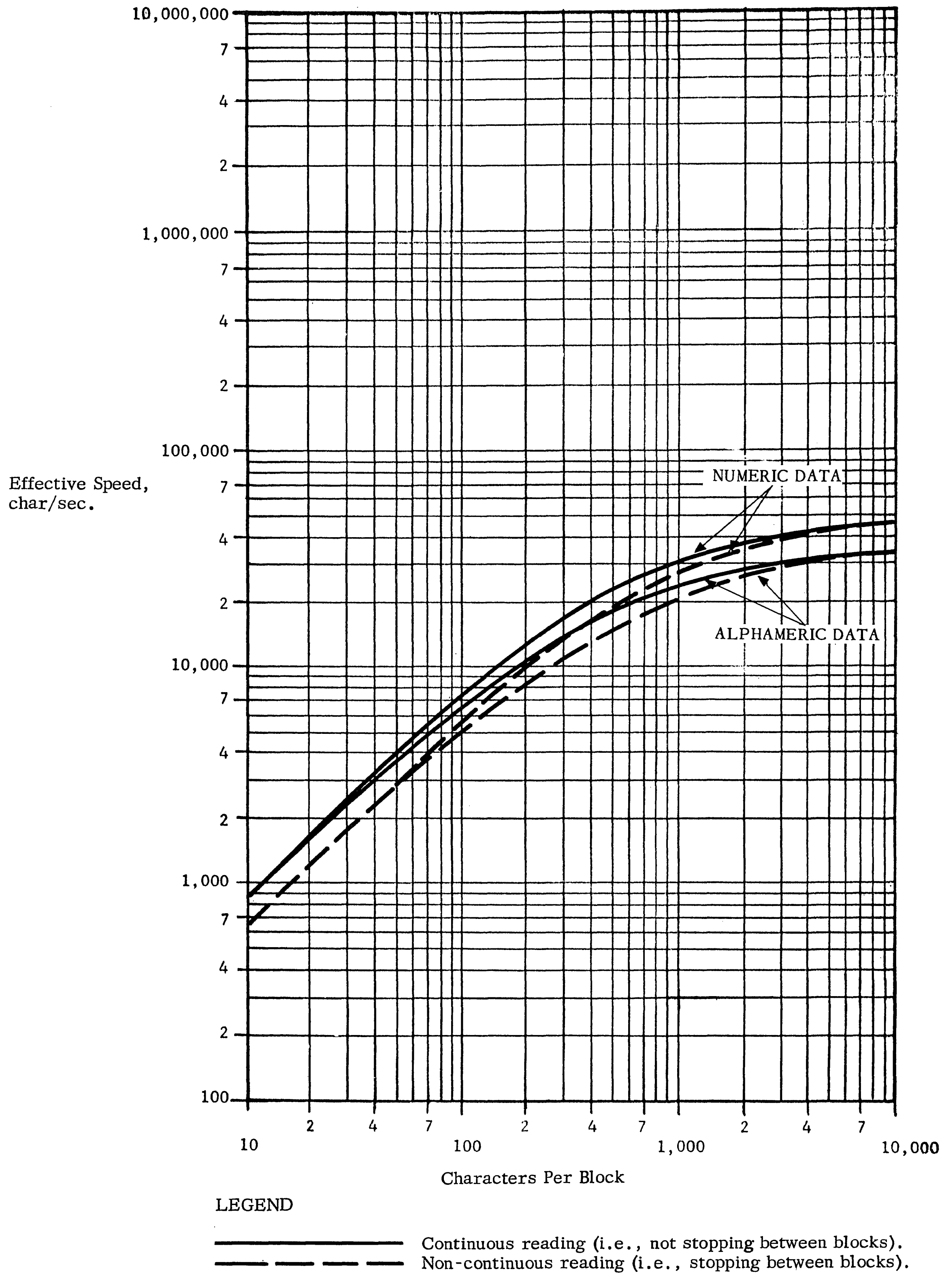
LEGEND

——————— Continuous reading (i.e., not stopping between blocks).

— — — — Non-continuous reading (i.e., stopping between blocks).

§ 091.

EFFECTIVE SPEED
H-404-3 MAGNETIC TAPE UNIT



INPUT-OUTPUT: COMMUNICATIONS CONTROL

§ 101.

.1 GENERAL

.11 Identity: . . . . 480 Communications Control.

.12 Description:

The 480 Communication Control is a 150 eight-bit character buffer and the associated controls that enable it to communicate with another 480, an 880 (a similar unit used with the H-800), an IBM 1009 Data Transmission Unit, or an IBM 7701 Magnetic Tape Transmission Terminal. The 480 can either send or receive data at a speed of 75 or 150 characters per second.
The 480 informs the processor that it has sent or received a block of data by means of an interrupt.

.12 Description (Contd.)

The processor then either sends new data or accepts the accumulated data. The characters are stored, as are punched tape characters; i.e., four characters to a word, right-justified in twelve-bit sections, and the same conversion and checking are necessary under program control. This process requires about 0.7 millisecond per character. It is expected that the 480 can be used continuously, using no more than 30% of the processor's time for all control and conversion operations.

The 480 uses a four-out-of-eight-bit character code for transmission that lessens the chance of leaving errors undetected. This unit connects to commercial transmission services through modulation equipment which is currently available.

INPUT-OUTPUT: TAPE CONTROL UNIT

§ 102.

.1 GENERAL

.11 Identity: . . . . Tape Control Unit. 436-1.

.12 Description

The Model 436-1 Tape Control Unit is an input-output device for the Honeywell 400 system designed to operate with one IBM 729-II magnetic tape transport to permit reading and writing binary coded decimal information on IBM magnetic tape. The Model 436-1 Tape Control Unit and its associated IBM 729-II Tape transport will read tapes which have been written on an IBM 727, 729-II, 729-IV, or 7330 tape unit, and will write tapes which are readable on any of these units. It will not permit simultaneous reading and writing. Only 729-II tape transports can be connected to the Model 436-1 Tape Control Unit, and only BCD information can be read or written, at a density of 200 or 556 characters per inch.

Each IBM 7-bit row (six information bits, one parity) is read into the H-400 as if it were a 9-bit row on Honeywell tape. Channels 1 through 6 correspond directly; IBM channel 7 (parity) is treated as H-400 channel 9 (parity); and H-400 channels 7 and 8 contain zeros. The eight data bits from these rows are positioned in memory, six rows to the word, in

.12 Description (Contd.)

standard H-400 configuration. Translation of these 8-bit groups into the corresponding H-400 6-bit codes is now automatic.

The 436-1 Tape Control Unit accepts and implements the normal H-400 tape instructions.

Error Checking

A. Read Errors

Read checks implemented in the 436-1 Tape Control Unit include row parity and longitudinal parity checks. If an error is detected, a read error condition is stored.

B. Write Errors

Row parity and longitudinal parity are generated within the 436-1 and are checked by the IBM read-after-write checking feature. An echo check is performed with signals generated in the 729-II tape drive during writing. Any attempt to write on a file-protected tape results in a write error.

.13 Availability: . . . . . . 9 months.

.14 First Delivery: . . . . July, 1963.

INPUT-OUTPUT: MAGNETIC TAPE SWITCHING UNIT

§ 103.

.1 GENERAL

.11 Identity: . . . . Model 405 Magnetic Tape Switching Unit.

.12 Description

The Model 405 Magnetic Tape Switching Unit is designed to permit manual switching of one Model 404 or Model 804 Magnetic Tape Unit between any two H-400 or H-800 units that can be connected to a magnetic tape unit. (It should be noted, however, that a magnetic tape unit cannot be switched to a given device unless it is possible to attach it to that device directly.) This unit operates solely as a switching device and performs no logical operations on the information flowing through it. Up to four Model 405 Magnetic Tape Switching Units can be used. Switching units are field installable.

A Model 405 Magnetic Tape Switching Unit is most commonly used to switch a magnetic tape unit between a model 401 central processor and one of the following devices:

1. Another model 401 or 1401 central processor.
2. A model 803 tape control unit.
3. An H-800 off-line peripheral control unit (PCU).
4. A model 418 off-line printer control.

.13 Availability: . . . . 6 months.

.14 First Delivery: . . . . . May, 1962.

SIMULTANEOUS OPERATIONS

§ 111.

A Honeywell 400 system with magnetic tape, punched card equipment, and an on-line printer is capable of only two sets of truly simultaneous operations:

(1) Tape reading simultaneously with tape writing.
(2) Printing and any other operation, if the Print Storage Option is installed.

This configuration can perform no other truly simultaneous operations - neither operations involving the central processor and one of the peripheral units, nor those involving two peripheral units. However, in both cases, a limited amount of effective simultaneity is possible.

Some of the other available units are able to overlap all or part of their mechanical cycles with internal processing. These include the H-460 Magnetic Disc System, which can position its read/write heads while processing continues, and the Communication Control Unit, which is completely buffered.

Central Processor/Peripheral Unit Simultaneity

When a peripheral unit is starting (before the actual data transfer), the central processor can sometimes operate. Table 1 indicates the basic peripheral units with which this feature is possible.

Peripheral Unit/Peripheral Unit Simultaneity

Two magnetic tape units can operate simultaneously, one reading and one writing. If one operation takes longer than the other, the central processor is delayed for the longer time. A paper tape operation which lasts less than 18 milliseconds (the time to punch 1 character or read 6) can be overlapped with the start-up time of the card units.

Printing can operate simultaneously with another input-output operation only if the Print Storage Option is installed.

Other Operations

Rewinding and backspacing of magnetic tapes are not carried out under continuous computer control. After they have been initiated, the central processor is no longer concerned with their operation and becomes available for other functions.

Programming Considerations

These considerations arise in connection with the card reader. While card reading is in process, the programmer has the option of using the start-up time for other work. If he does so, 18 milliseconds before the actual data transmission from the reader starts, a number of specific instructions will be interlocked in order to prevent garbling of the input. It follows that, in these circumstances, no instruction which can engage the central processor longer than 18 milliseconds shall be executed once a card read operation has been initiated.

This restriction particularly affects magnetic tape operations, and limits maximum block lengths to specific sizes, depending on the magnetic tape unit concerned. These are (in alphabetic characters): 400 characters for the H-404-3, 800 characters for the H-404-1, and 1,120 characters for the H-404-2.

Honeywell EDP Division (Training and Research) recommends that this situation be avoided entirely by always using a pre-edit run to transcribe the punched cards to tape, and then processing the card images against the main file.

§ 111.

TABLE 1

Peripheral Unit	Cycle (msec)	Start Time Availability and Time (msec)		Transmission Availability and Time (msec)		Stop Time Availability and Time (msec)	
Card Reader 423-2	93	√	33 to 126[c]	x	54	√	6
Card Reader 427	75	√	23 to 42	x	46	√	6
Card Punch 427	240	√	65 to 305	x	178	√	7
Printer without Print Storage	67 + 8 LS	x	1.3	x	51.7	√	14 + 8 LS
Printer with Print Storage	67 + 8 LS	x	1.3	√	51.7	√	14 + 8 LS
Magnetic Tape 404-3	variable[a]	x	5.0[d]	x	variable	√	10.0[d]
Magnetic Tape 404-1	variable[a]	x	5.0[d]	x	variable	√	4.7[d]
Magnetic Tape 404-2	variable[a]	x	5.0[d]	x	variable	√	4.7[d]
409 Paper Tape Reader:							
Reading 1 character	1	x	0.0	x	0.01	√	1.0
Reading 2 or more characters	C[b]	x	1 to 7	x	(C - 1)	√	1.0
410 Paper Tape Punch	9.1	x	4.0	x	9.1(C - 1)	√	5.1
Console	100	√	0 to 100	√	100		-

√ - time is available for central processor work.
x - time is not available for central processor work.
a - dependent on block length.
b - where C = number of characters read.
c - dependent on the time relative to the clutch point within the card cycle.
d - assuming Magnetic Tape has been stopped between blocks.
LS - number of lines skipped between printed lines.

INSTRUCTION LIST

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
ADD	Decimal Add	Adds (A) to (B), stores result in C; treats operands as signed 11 decimal digits.	111+64.75T(1)
BAD	Binary Add	Adds (A) to (B), stores result in C; treats operands as unsigned binary numbers.	101.75
BST	Backspace Tape	Backspaces specified magnetic tape by one record.	-(2)
BSU	Binary Subtract	Subtracts (B) from (A), stores result in C; treats operands as 48-bit numbers.	101.75
CHP	Check Parity	Checks parity of n words; corrects parity of first bad word then subsequences to C.	92.5+18.5n
COC	Compute Orthotronic Count	Computes the orthocount for n consecutive words, beginning with the word at A. It stores first orthoword in C; second in C + 1.	120.25+18.5n
CPI	Control Peripheral Input	Directs the peripheral device connected to the input trunk specified in B to perform the operation also specified in B. These operations include Start, Halt, Rewind, and Rescan Document.	92.5 + unit mech. time(7)
CPO	Control Peripheral Output	Is the same as CPI, except that it controls a device connected to an output rather than an input peripheral trunk. Possible operations include Start, Stop, Pocket Selection.	92.5 + unit mech. time(7)
DIV	Decimal Divide	Divides (B) by (A), stores result in C, and stores remainder in remainder word; treats operands as signed 11 decimal digits.	Avg. 5.374ms; T = 9.25 $[185+8(Q_1+Q_2+\ldots\ldots Q_n)]$ Q = Magnitude of Quotient.

Entire Instruction List reprinted from Honeywell 400 Summary Description, pp. 31-38.

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
ECA	Card Edit, Alphanumeric	Edits n consecutive characters of alphanumeric data from card area; stores edited data in memory, beginning with specified position in word at A.	74+11.56n C odd 74+13.87n C even
ECD	Card Edit, Signed Decimal	Edits n consecutive characters of decimal data from card area; stores edited data in one word, beginning with specified position in word at A.	83.25+10.8n C odd 83.25+12.34n C even
ECO	Card Edit, Octal	Is the same as ECA, except that data is edited into octal format	74+10.4n C odd 74+11.56n C even
ECU	Card Edit, Unsigned Decimal	Is the same as ECA, except that data is edited into decimal format	74+10.5n C odd 74+12.34n C even
EPA	Print Edit, Alphanumeric	Edits n consecutive alphanumeric characters, beginning with the one specified in word at A, into the print area in consecutive positions, beginning with one specified by C.	74+11.56n
EPD	Print Edit, Decimal	Is the same as EPA, except data is edited from decimal format into print area.	74+11.56n
EPO	Print Edit, Octal	Is the same as EPA, except that data is edited from octal format into print area.	74+11.56n
EXC	Extended Compare	Compares (A) with (B), bit by bit, then (A + 1) with (B + 1), etc., until two operands are found unequal. If "A" operand is less than "B", sequence changes to C.	46.25+74n[3]
EXT	Extract	Places (A) in word at C wherever (B) contains a 1 bit; places 0 bits in all other positions in word at C.	111
HAD	Half Add	Adds (A) to (B) without carries; treats operands as unsigned binary numbers; stores result in C.	92.5
HLT	Halt	Stops the central processor, depending on the setting of the console breakpoint switches and on B.	64.75

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
LAC	Less than or Equal Comparison, Alphanumeric	Compares (A) to (B) bit by bit; sequence changes to C if (A) ≤ (B). Otherwise, continues in sequence.	111
LDA	Locate Disc Address	Directs the random access storage unit on the output trunk specified in B to position the read/write head at the disc address stored in main memory location (A).	111 + unit mech. time(7)
LNC	Less than or Equal Comparison Numeric	Compares (A) and (B); treats operands as signed 11 decimal digit words; sequence changes to C if (A) ≤ (B).	111(4)
LUP	Test Index and Increment	Compares A with contents of index register associated with B. If contents of this index register are less than A, the instruction increments them by B, sequence changes to C.	Jump: IR_i=2: 92.5(5) IR_i=1 or 3: 101.75 No Jump: IR_i=2: 64.75(5) IR_i=1 or 3: 74.0
MPY	Decimal Multiply	Multiplies (A) by (B); treats operands as signed 11 decimal digits; stores result with sign in C, low-order result with sign in low-order product word.	1258+55.5n n = no. of non-zero digits in multiplier
NAC	Inequality Comparison, Alphanumeric	Compares (A) with (B) bit by bit. If (A) ≠ (B), sequence changes to C.	111
NNC	Inequality Comparison, Numeric	Compares (A) with (B); treats operands as signed 11 decimal digits. If (A) ≠ (B), sequence changes to C.	111(6)
NOP	No Operation	Passes to next instruction, performing no other action.	46.25
OFS	Offset Stack	Rejects a card into an alternate pocket.	92.5 + unit mech. time(7)
PCA	Punch Edit, Alphanumeric	Edits n consecutive alphanumeric characters, beginning with the one specified in word at A, into the card punch area in consecutive columns, beginning with the one specified by C.	74+13.87n

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
PCD	Punch Edit, Signed Decimal	Is the same as PCA, except that data is edited from decimal format into punch area, and operates only on one word.	74+13.87n for $n \leq 6$ 83.25+13.87n for $n > 6$
PCI	Punch Card, Interlocked	Punches the contents of the card punch area onto one card. Central processor interlocked until completion of data transfer.	55.5 + unit mech. time(7)
PCO	Punch Edit, Octal	Is the same as PCA, except that data is edited from octal format into punch area.	74+13.87n
PCU	Punch Edit, Unsigned Decimal	Is the same as PCA, except that data is edited from decimal format into card punch area.	74+13.87n
PCW	Punch Card, Without Interlock	Punches the contents of the card punch area onto one card. Central processor not interlocked and central processor operations are possible during acceleration interval.	55.5 + unit mech. time(7)
PDE	Prepare Decimal Edit	Inserts special characters, suppresses leading zeros, floats high characters in (A) according to parameters at B. Stores result in (C).	83.25+18.5n(8)
PRS	Print and Space	Prints the contents of the print area on the high-speed printer, and spaces the form as specified by B.	Without Storage Option 55.5+unit mech. time(2) With Storage Option 1193.25
RCI	Read Card, Interlocked	Reads the contents of one card into the card read area. Central processor is interlocked until the completion of data transfer.	55.5 + unit mech. time(7)
RCW	Read Card, Without Interlock	Reads the contents of one card into the card read area. Central processor not interlocked and so central processor operations are possible during the acceleration interval.	55.5 + unit mech. time(7)

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
RDP	Read Peripheral	Read and transfer n frames of data from the device on the input trunk specified in B to memory location A.	74 + 18.5n + unit mechanical time(7)
RDT	Read Tape	Reads one record from the specified magnetic tape and stores in consecutive locations beginning with A. If tape channel is also specified, it regenerates that channel simultaneously.	-(2)
REJ	Reject Card	Rejects the card currently in the card feed into one of two pockets as specified in B.	92.5 + unit mech. time(7)
RPX	Restore Subsequence Priority	Set the index registers and sequence register to the values specified in (A) (see SPX). Alter or do not alter the contents of the subsequence control register, as specified.	Execution time not available.
RTX	Restore Index Register	Stores the high-order three 12-bit groups of (A) in the index registers 1, 2, 3, respectively; stores low-order 12 bits of (C) in the sequence register.	83.25
RWT	Rewind Tape	Rewinds the specified magnetic tape to its physical beginning.	92.5 + unit mech. time(7)
SCH	Sequence Change	Changes sequence register setting to the address specified by C.	46.25
SCO	Sequence Change on Option	Changes sequence register setting to address specified by A if setting of the console breakpoint switches and (B) coincide. Otherwise set sequence register to the address specified by C.	74
SEL	Select	Modifies C using (A) and (B); then makes a programmed subsequence to the modified address.	120.25
SET	Set Index Register	Adds A to index register specified in Ai and stores result in index register 1; adds B to index register specified in Bi and stores result in index register 2; adds C to	74

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
		index register specified in Ci and stores result in index register 3.	
SLB	Binary Shift Left	Shifts (A) to the left the specified number of bits; the move is cyclic, so that bits shifted off the left end enter the word at the right.	64.75+9.25n(9)
SLP	Decimal Shift Left, Preserving Sign	Shifts (A) to the left n decimal digits, preserving the sign digits. Digits shifted off the left end are lost and replaced by zeros at the right end.	64.75+9.25n
SMP	Superimpose	Places a 0 bit in all positions of (C) where both (A) and (B) contain 0 bits; places 1 bits in all other positions of (C).	111
SPX	Store Subsequence Priority	Store the contents of the three index registers and the sequence register at A. Alter or do not alter the contents of the subsequence control register, as specified. If the subsequence call was caused by an error, jump to C minus one; otherwise, jump to C.	Execution time not available.
SRP	Decimal Shift Right, Preserving Sign.	Same as SLP, except that (A) are shifted to the right.	64.75+9.25n
SST	Substitute	Places (A) in (C) in all positions where (B) contains a 1 bit; leaves remaining bit positions in (C) unchanged.	111
STX	Store Index Register	Stores the contents of the three index registers and the sequence register in A. Sets sequence register to C.	83.25
SUB	Decimal Subtract	Subtracts (B) from (A); treats operands as signed 11 decimal digits; stores result in C.	111+64.75T(1)
SUP	Stall	During the acceleration interval of the card reader and reader-punch,	Stalls until end of data transfer, or

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
		this instruction stalls the central processor; outside this interval, it has the effect of NOP.	70 microseconds
TAC	Type Alphanumeric, Console	Prints (A) on the console printer in alphanumeric form.	100-200ms per character
TDC	Type Decimal, Console	Prints (A) on the console printer in decimal form.	100-200ms per character
TOC	Type Octal, Console	Prints (A) on the console printer in octal form.	100-200ms per character
TSC	Transfer and Sequence Change	Transfers (A) to location B; sequence changes to location C.	83.25
TSN	Transfer n Words	Transfers n words from consecutive memory locations, beginning with word at A, to consecutive memory locations beginning with C.	46.25+37n
WRP	Write Peripheral	Directs the device on the output trunk specified in B to write n frames of data transferred from memory location A.	74 + 18.5n + unit mechanical time(7)
WRT	Write Tape	Writes one record of the specified number of consecutive words from memory, beginning with A, onto tape.	-(2)

NOTES

1. T, a variable factor, is derived from the following table:

Signs of Operands: A	Signs of Operands: B	T: $\|A\| > \|B\|$	T: $\|A\| < \|B\|$	
+	+	0	0	Addition
+	-	1	2	
-	-	0	0	
-	+	1	2	
+	+	0	1	Subtraction
+	-	1	1	
-	-	1	1	
-	+	1	1	

INSTRUCTION LIST (Contd.)

§ 121.

2. For Model 404-1, 5.5 ms plus 0.125n; for Model 404-2, 5.5 ms plus 0.09 n; for Model 404-3, 11.0 ms plus 0.250n. (n is the number of words read, written or backspaced.)

3. n = number of pairs of words compared.

4. If $|A| = |B|$, and the sign of (A) is positive and the sign of (B) is negative, add 64.75 microseconds.

5. IR_i is the number (i.e., 1, 2, or 3) of the index register associated with the B address. Thus, for a Jump, the time is 101.75 microseconds for index registers 1 and 3, and 92.5 microseconds for index register 2. Similarly, for a No jump, the times are 74 and 64.75 microseconds, respectively.

6. If $|A| = |B|$, and the signs of (A) and (B) are different, add 64.75 microseconds.

7. Mechanical time varies with peripheral equipments and with time at which peripheral order is issued.

8. n = number of non-significant decimal zeros outside of sign position.

   If $6 \leq n < 8$, add 9.25 microseconds; if $n < 6$, add 18.25 microseconds. If p_1 is a plus or minus sign, add 9.25 microseconds. If p_2 is F (for floating), add 9.25 microseconds.

9. n = number of shifts; $n = \frac{\text{Number of bits shifted}}{4} + \frac{\text{Remainder}}{2} + \frac{\text{Remainder}}{1}$

DATA CODE TABLE NO. 1: INTERNAL AND PRINTER

§ 141.

.1 USE OF CODE: . . . . . Internal and Printer.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . 4-bit numeric and 6-bit alphameric.

.22 Character Structure

.221 More significant pattern: two bits: values are 16, 32.

.222 Less significant pattern: 4 bits: values are 1, 2, 4, 8.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	+	-	Blank
1	1	A	J	
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10	'	;	#	@
11	=	.	$	,
12	:	)	*	(
13	Blank	%	"	CR
14	Blank	■	Blank	Blank
15	&	Blank	Blank	Blank

DATA CODE TABLE NO. 2: INPUT VIA CARD

§ 142.

.1 USE OF CODE: . . . . . Input via card.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . One column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Blank	+	-	0
12	+	+		
11	-		-	
0	0	Blank	Blank	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2	'	;	#	@
8-3	=	.	$	,
8-4	:	)	*	(
8-5	Blank	%	"	CR
8-6	Blank	■	Blank	Blank
8-7	&			Blank

PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers: . . . . . . H-1400 (in preparation).

.12 Simulation by Other Computers

H-800
Reference: . . . . . . DSI-89.
Data available: . . . . November, 1961.
Description: . . . . . assembly, simulation, and automatic check-out system.

.13 Data Sorting and Merging

EASY SORT II
Reference: . . . . . . DSI-41A; Specs E4-0010, E4-0006.
Record size: . . . . . pre-set; max 511 words.
Block size: . . . . . . pre-set; max 511 words.
Key size: . . . . pre-set; max one full item.
File size: . . . . one reel of tape.
Number of tapes: . . . 3 to 6, + 1 if input tape is not to be used as work tape.
Date available: . . . . January, 1962.
Description:
Two sections: pre-sort and merge. Pre-sort: item-by-item replacement sort, which takes advantage of pre-ordering. Merge: polyphase (Fibonacci) merge technique, the power or "way" being one less than the number of tapes used.

EASY COLLATE
Reference: . . . . . . DSI-41A; Spec E4-0011, E4-0007.
Record size: . . . . . fixed; max 511 words.
Block size: . . . . . . fixed; max 511 words.
Key size: . . . . fixed; max one full item.
File size: . . . . 99 reels of tape.
Number of tapes: . . . 3 to 8 (maximum usable by machine).
Date available: . . . . January, 1962.
Description:
Two or more files of input (each file consisting of one or more tapes) are merged to produce one output file of one or more tapes. Each file can be mounted serially on a single drive or alternatively on a pair of drives. Tape-changing and control information are printed on the console typewriter. The routines handle two-, three-, four-, or five-way merges.

.14 Editing

In addition to the editing instructions of the hardware, a number of editing facilities are available within the EASY assembler. These provide format arrangement and housekeeping subroutines for card, printer, and magnetic tape units. Descriptor cards, prepared by the programmer to describe his input or output file, are interpreted by Assembly to generate all required coding.

.15 Data Transcription: . . none.

.16 File Maintenance

THOR (Tape Handling Option Routine) is a general tape handling and correction routine which positions tape, locates information on tape, copies one tape onto another, and makes corrections to information on tape. It can also compare two tapes and edit information on a tape. The various actions are controlled by parameters which are introduced via the console.

Date available: . . . . . January, 1963.

.17 Other

Mathematical Routines:

Multiply-Divide Option Simulator, in lieu of automatic multiply-divide hardware.

Floating Point Package, for single and double precision decimal operands.

Conversion Routines:

Fixed to Floating Point, Decimal
Degrees to Radians, Fixed Point Decimal
Radians to Degrees, Fixed Point Decimal

Functions:

Natural and Base 10 logarithms
Exponentials
Sine, Cosine, Tangent
Arc-sine, Arc-cosine, Arc-tangent

Statistical:

Multiple Regression
Curve Fitting.

.2 PROBLEM ORIENTED LANGUAGES

.21 H-400 PERT

H-400 PERT can handle 875 randomly numbered events and 1100 activities. It requires a 2,048-word store and is compatible with H-800 PERT.

.22 H-400 Linear Program Package

This requires a 2,048-word store, 4 magnetic tape units, card reader, printer, and the Multiply/Divide

§ 151.

.22 H-400 Linear Program Package (Contd.)

option. The Simplex Algorithm technique is used. Any number of variables and up to 1,000 constraints can be handled, since the approach is a tape oriented one.

Date available: . . . . . June, 1963.

.23 TABSIM

A "load and go" program which simulates the functions of conventional punched card tab equipment on the H-400. TABSIM accepts descriptor cards and generates the machine-coded program necessary to produce the finished reports. The data input may be on punch cards or card images on magnetic tape. Arithmetic operations can be performed on the data fields; totals and sub-totals can be accumulated. Four levels of control are permitted and own-coding can be incorporated.

TABSIM is compatible with IBM 1401 FARGO and will accept FARGO descriptions directly into the program. It requires 1,048 words of core storage, one magnetic tape unit, a card reader, and a printer.

Date available: . . . . . April, 1963.

PROCESS ORIENTED LANGUAGE: AUTOMATH-400

§ 161.

.1 GENERAL

.11 Identity: . . . . Automath-400.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . Automath-400 Reference Manual, Honeywell EDP Publication DS1-167.

.14 Description

Automath-400 is the Honeywell name for FORTRAN II. While certain restrictions exist in the Automath-400 language (see below), the actual meaning of any statement is common to the two languages. The major deficiency is a reduced subscripting ability. Only two levels of subscripting are allowed instead of the usual three levels. This means that any program drawn from the SHARE library or another common source must be carefully checked and sometimes revised before it is compiled and run on the H-400.

A few of the standard FORTRAN II statements are not allowed. These include references to hardware features such as the drum, sense switch, and sense light. In addition, the Chain coding feature has been replaced by an OVERLAY facility which is more comprehensive than the original. In the OVERLAY there are three different segment types: those that are always in storage, those that are only brought into storage when they are specifically called, and those that are held in storage if there is room. As the original FORTRAN Chain feature only allows for the complete replacement of one segment by another, the OVERLAY feature is more useful to a programmer trying to obtain an efficient program on a small machine such as the H-400.

Restrictions and extensions of the Automath-400 language relative to IBM 709/7090 FORTRAN II are summarized below.

Restrictions

(1) Only two levels of subscripting are permitted.

(2) Double precision and complex arithmetic are not permitted.

(3) IF SENSE SWITCH and IF SENSE LIGHT are not permitted.

(4) The following statements have not been implemented: FREQUENCY, READ DRUM, WRITE DRUM.

(5) Tape units must be addressed absolutely - not by logical equivalents.

.14 Description (Contd.)

Extensions:

(1) The following number ranges can be handled:

Floating point: . . 10^{-64} to 10^{+63}
Integer: . . . . . -10^{11} to 10^{11}

(2) Subscripts may be integer constants, integer variables, integer functions, or any fixed point arithmetic expression.

(3) The statements IF (EOF), and IF (PARITY) permit tests for end-of-file conditions, and for parity errors.

.15 Publication Date: . . . . 1963.

.2 PROGRAM STRUCTURE

.21 Divisions: . . . . one division, composed of the following types of statements.

Procedure statements: algebraic formulae.
comparisons and jumps.
input and output.

Data statements: . . . FORMAT: describes the layout, size, scaling, and code of input-output data.
EQUIVALENCE: used to cause two variables to have a common location or to specify synonyms.
COMMON: used to cause a name to be common to more than one segment rather than local to each.
DIMENSION: describes the elements in each dimension of an array or set of arrays.

.22 Procedure Entities

Program: . . . . subroutines and functions.
Subroutine: . . . . . . statements.
Function: . . . . statements.
Statement: . . . . . . characters; blanks are ignored.

.23 Data Entities

Arrays: . . . . all variables.
Item: . . . . integer variable or constant.
floating point variable or constant.
Hollerith item.
alphameric item.
Hollerith item: . . . . alphameric item that can be used only for input and output.

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.23 Data Entities (Contd.)

Alphameric:	alphameric item that can be only input, output, or in FORMAT, CALL, or IF statements.

.24 Names

.241 Simple name formation	
Alphabet:	A to Z, 0 to 9.
Size:	1 to 6 char.
Avoid key words:	no.
Formation rule:	first char must be letter. do not use final F if name is more than 3 char long.
.242 Designators	
Procedures	
Statement label:	unsigned integer.
Function label:	same as variable being defined.
Subroutine label:	none.
Data	
Integer variables:	initial I, J, K, L, M, N.
Floating point variables:	any other initial letter.
Equipment	
Card:	implied by verbs READ, PUNCH.
Magnetic tape:	use key word TAPE, or READ, WRITE.
Printer:	implied by verb PRINT.
Comments:	C in col. 1 of statement.
Translator control:	key words EQUIVALENCE, COMMON.

.25 Structure of Data Names

.251 Qualified names:	none.
.252 Subscripts	
Number per item:	0 to 2.
Applicable to:	all variables.
Class may be Special index variable:	no.
Any variable:	only integers.
Literal:	yes; only integers.
Expression:	any integer expression or function.
Form may be	
Integer only:	yes.
Signed:	no.
Truncated fraction:	no.
Rounded fraction:	no.
.253 Synonyms	
Preset:	EQUIVALENCE statement causes sharing of storage locations.
Dynamically set:	no.

.26 Number of Names

.261 All entities:	no practical limit.
.262 Procedures	
Numbered statements	
Subroutines:	no practical limit.
Functions:	no practical limit.
Others:	no practical limit.
.263 Data	
Files:	no limit.
Record formats:	no practical limit.
Items:	no practical limit.
.264 Equipment	
Tape units:	8.
Card readers:	1.
Card punches:	1.
Printers:	1.

.27 Region of Meaning of Names:	all names are local to the program, subroutine, or function in which they are defined unless specified explicitly or by block name in COMMON statement.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture:	FORMAT statement only.
.312 List by kind:	no.
.313 Qualify by adjective:	no.
.314 Qualify by phrase:	no.
.315 Qualify by code:	first letter of name.
.316 Hierarchy by list:	no.
.317 Level by indenting:	no.
.318 Level by coding:	no.
.319 Others	
Array size:	DIMENSION (4, 7).
Four-digit integer:	FORMAT (I4).
Four-digit integers, 5:	FORMAT (5I4).
Floating point items:	FORMAT (F8.3, E10.4) for +999.999 and +.0000E+99.

.32 Files and Reels:	own coding.

.33 Records and Blocks

.331 Variable record size:	dynamic.
.332 Variable block size:	specified in BUFFER statement.
.333 Record size range:	1 to N blocks.
.334 Block size	
READ TAPE, WRITE TAPE:	no limit (binary format).
READ INPUT TAPE:	80 characters (BCD format).
WRITE OUTPUT TAPE:	up to 120 characters (BCD format).
READ PUNCH:	80 columns.
PRINT:	120 characters.
.335 Choice of record size:	READ, WRITE statement.
.336 Choice of block size:	fixed for READ, PUNCH; READ INPUT TAPE and WRITE OUTPUT TAPE. variable and determined by format statement and data itself for READ TAPE, variable and determined by data for WRITE TAPE.
.337 Sequence control:	own coding.
.338 In-out error control:	own coding, using IF clauses.
.339 Blocking control:	none; 1 or more full blocks per logical record.

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.34 Data Items

.341 Designation of class: . by name.
.342 Possible classes
Integer: . . . . yes.
Fixed point: . . . . . no.
Floating point: . . . . yes.
Logical: . . . . yes.
Alphameric: . . . . . yes.
.343 Choice of external radix: . . . . FORMAT statement.
.344 Possible external radices
Decimal: . . . . yes.
Octal: . . . . yes.
.345 Internal justification: . alpha automatic left justified.
integers automatic right justified.
.346 Choice of external code: FORMAT statement and READ, WRITE statement.
.347 Possible external codes
Decimal: . . . . yes.
Octal: . . . . yes.
Hollerith: . . . . yes.
Alphameric: . . . . . yes.
.348 Internal item size
Variable size: . . . . fixed.
Designation: . . . . . none.
Range
Fixed point numeric: fixed, 1 word.
Floating point numeric: . . . . . fixed, 1 word.
Alphameric: . . . . fixed, 1 word of up to 8 characters.
.349 Sign provision: . . . . . optional.

.35 Data Values

.351 Constants
Possible sizes
Integer: . . . . 10^{-11} to 10^{+11}.
Fixed point: . . . . . none.
Floating point: . . . 10^{-64} to 10^{+63}.
Alphameric: . . . . 120 characters.
Boolean: . . . . 16 octal digits.
Subscriptable: . . . . yes.
Sign provision: . . . . optional.
.352 Literals: . . . . Boolean constants cannot be written as literals; otherwise same as constants.
.353 Figuratives: . . . . . . own coding; e.g., TEN = 10.0.
.354 Conditional variables: . computed GO TO.

.36 Special Description Facilities

.361 Duplicate format: . . . by multiple references to a single FORMAT statement.
.362 Re-definition: . . . . . COMMON statement.
EQUIVALENCE statement.
.363 Table description
Subscription: . . . . . mandatory, in DIMENSION statement.
Multi-subscripts: . . 1 to 3.
Level of item: . . . . variables.
.364 Other subscriptible entities: . . . . none.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator List

+ : . . . . addition, also unary.
- : . . . . subtraction, also unary.
* : . . . . multiplication.
/ : . . . . division.
** : . . . . exponentiation.
= : . . . . is set equal to.
ABSF ( ) ‡ : . . . . . . absolute value.
INTF ( ) ‡ : . . . . . . integer part.
MODF (A, B) ‡ : . . . . remainder A ÷ B.
MAXOF (A,...) ‡ : . . . max value; fixed argument.
MAXIF (A,...) ‡ : . . . max value; floating.
MINOF (A,...) ‡ : . . . min value; fixed argument.
MINIF (A,...) ‡ : . . . min value; floating argument.
DIMF (A,B) ‡ : . . . . . diminish A by B.
SIGNF (A,B) ‡ : . . . . transfer sign of A to B.
FLOATF ( ): . . . . . . float an integer.
XFIXF ( ): . . . . . . fix floating point variable.
LOGF ( ): . . . . natural log.
SINF ( ): . . . . sine.
COSF ( ): . . . . cosine.
EXPF ( ): . . . . exponential.
SQRTF ( ): . . . . . . square root.
ATANF ( ): . . . . . . arctangent.
TANHF ( ): . . . . . . hyperbolic tangent.

‡ denotes function may have prefix X to denote fixed point result.

.412 Operands allowed
Classes: . . . . numeric only.
Mixed scaling: . . . . yes.
Mixed classes: . . . . only in exponentiation and functions.
Mixed radices: . . . . no.
Literals: . . . . yes.
.413 Statement structure
Parentheses
a - b - c means: . . (a-b) - c.
a + b x c means: . . a + (b x c).
a/b/c means: . . . . (a ÷ b) ÷ c.
a^{bc} means: . . . . . illegal; parentheses must be used.
Size limit: . . . . . . 660 char.
Multi-results: . . . . no.
.414 Rounding of results: . . truncation of integers at each step in expression.
.415 Special cases

Special cases	Fixed	Floating
x = -x:	K = -K	X = -X.
x = x+1:	K = K+1	X = X+1.
x = 4.7 Y: . . .	K = 47*K/10	X = 4.7*Y.
$x = 5x10^7 + y^2$:	50000000+L**2	X = 5.E7+Y**2.
x = | y | :	K = XABSF(L)	X = ABSF(Y).

.416 Typical examples: . . . X = (-B+SQRTF(B*B-4.0*A*C))/(2.0*A).

.42 Operations on Arrays

.421 Matrix operations: . . . none.
.422 Logical operations: . . none.
.423 Scanning: . . . . none.

.43 Other Computation: . . subprograms in FORTRAN may reference one another.

§ 161.

.44 Data Movement and Format

.441 Data copy example: . . Y = X.
.442 Levels possible: . . . . items.
.443 Multiple results: . . . . none.
.444 Missing operands: . . . not possible.
.445 Size of operands
Exact match: . . . . . implied, except for alpha or input-output.
Alignment rule
Numbers: . . . . . . right justified or normalized.
Alpha: . . . . left justified.
Filler rule
Numbers: . . . . . . zeros.
Alpha: . . . . blanks.
Truncating rule
Numbers: . . . . . . truncate at left.
Alpha: . . . . truncate at right.
Variable size destination: . . . . no.
.446 Editing possible
Change class: . . . . yes.
Change radix: . . . . yes.
Insert editing symbols
Actual point: . . . . automatic.
Suppress zeroes: . . automatic.
Insert: . . . . automatic point.
Float: . . . . - sign only.
.448 Special moves: . . . . . none.
.449 Character manipulation: none.

.45 File Manipulation

Open: . . . . own coding.
Close: . . . . own coding.
Advance to next record: READ, WRITE, PUNCH, PRINT.
Step back a record: . . BACKSPACE.
Set restart point: . . . none.
Restart: . . . . none.
Start new reel: . . . . . own coding.
Start new block: . . . . implied in each input-output statement.
Search on key: . . . . . none.
Rewind: . . . . REWIND.
Unload: . . . . none.

.46 Operating Communication

.461 Log of progress: . . . . PRINT uses on-line printer.
.462 Messages to operator: . same as log (error messages are automatically typed on console typewriter).
.463 Offer options: . . . . . PAUSE and type octal integer.
PRINT message and PAUSE.
.464 Accept option: . . . . . IF SENSE SWITCH n.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	IF ACCUMULATOR OVERFLOW	own coding.
In-out:	IF PARITY	own coding.
Invalid data:	format checks	own coding.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . statement.
.512 Unconditional jump: . . GO TO N.
.513 Switch: . . . . GO TO M, or
GO TO M, (35, 47, 18).
.514 Setting a switch: . . . . ASSIGN 35 to M.
.515 Switch on data: . . . . . GO TO (35, 47, 18) I.

.52 Conditional Procedures

.521 Designators
Condition: . . . . . . IF.
Procedure: . . . . . . implied.
.522 Simple conditions: . . . expression or variable versus zero.
.523 Conditional relations: . IF (A) n1, n2, n3: If value of expression A is less than, equal to, or greater than zero, respectively, go to statement n1, n2, or n3.
.524 Variable conditions: . . expression always against zero.
.525 Compound conditionals: no.
.528 Typical examples: . . . IF (X**2.0-3.0) 29, 37, 18; go to 29, 37, or 18 if x^2-3 is respectively less than, equal to or greater than zero.

.53 Subroutines

.531 Designation
Single statement: . . . not possible.
Set of statements
First: . . . . SUBROUTINE.
Last: . . . . END.
.532 Use in-line in program: no.
.534 Mechanism
Cue with parameters: CALL XXX (X, Y, Z).
Number of parameters: . . . . no limit.
Cue without parameters: . . . . CALL XXX.
Formal return: . . . . RETURN at least once.
Alternative return: . . none.
.535 Names
Parameter call by value: . . . . yes.
Parameter call by name: . . . . no.
Non-local names: . . use COMMON.
Local names: . . . . . all.
Preserved own variables: . . . . . . all.
.536 Nesting limit: . . . . . 5.
.537 Automatic recursion allowed: . . . . no.

.54 Function Definition by Procedure

.541 Designation
Single statement: . . . same as set.
Set of statements
First: . . . . FUNCTION.
Last: . . . . END.
.542 Level of procedure: . . any number of statements.
.543 Mechanism
Cue: . . . . by name in expression.
Formal return: . . . . RETURN.

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.544 Names
Parameter call by value: . . . . yes.
Parameter call by name: . . . . no.
Non-local names: . . use COMMON.
Local names: . . . . . all.
Preserved own variables: . . . . . . all.

.55 Operand Definition by Procedure: . . . . none.

.56 Loop Control

.561 Designation of loop
Single procedure: . . none.
First and last procedures: . . . . . current place to named end; e.g., DO 173 I = 1, N, 2.
.562 Control by count: . . . none.
.563 Control by step
Parameter
Special index: . . . . no.
Any variable: . . . . integer only.
Step: . . . . positive integers.
Criteria: . . . . greater than.
Multiple parameters: no.
.564 Control by condition: . no.
.565 Control by list: . . . . no.
.566 Nesting limit: . . . . . 10.
.567 Jump out allowed: . . . yes.
.568 Control variable exit status: . . . . . . available.

.6 EXTENSION OF THE LANGUAGE: . . . . . can write new function in library.

.7 LIBRARY FACILITIES

.71 Identity: . . . . Automath-400 function library.

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . yes.

.73 Storage Form: . . . . . magnetic tape; variable length blocks in relocatable binary format. punched card decks.

.74 Varieties of Contents: . subroutines.
functions.
service routines.
compiled object programs.

.75 Mechanism

.751 Insertion of new item: . separate run, using own coding.
.752 Language of new item: . FORTRAN or hand coding.
.753 Method of call: . . . . . named in procedures.

.76 Types of Routines

.761 Open routines exist: . . yes.
.762 Closed routines exist: . yes.
.763 Open-closed is variable: . . . . each case is pre-decided.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . . no.

.82 Optimizing Information Statements

.821 Process usage statements: . . . . . . none.
.822 Data usage statements: COMMON.
EQUIVALENCE.

.83 Translator Environment: . . . . . no.

.84 Target Computer Environment: . . . . . no.

.85 Program Documentation Control: . . . . no.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: . . . . yes, via OVERLAY statement.

.92 Address Allocation: . . none.

.93 Arrangement of Items in Words in Unpacked Form: . . . standard for numerics.

.94 Assignment of Input-Output Devices: specified absolutely in input-output statements.

.95 Input-Output Areas: . . none.

PROCESS ORIENTED LANGUAGE: COBOL-61

§ 162.

.1 GENERAL

.11 Identity: . . . . H-400 COBOL.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . ?

.14 Description

The only major deficiency of H-400 COBOL from Required COBOL-61 is the lack of provision of library facilities. H-400 COBOL does not include any provision for input-output files to have more than one core storage area allocated to them; but this is hardly a deficiency in view of the inability of the system to overlap computation with magnetic tape passing. By comparison with the other operational COBOL compilers, H-400 COBOL is therefore an unusually complete version.

As far as Elective COBOL is concerned, considerable attention has clearly been paid to the needs of the COBOL programmer. The H-400, which has only a small store, needs and has full segmentation facilities. These allow segments of the program to be divided into four types: those that must be maintained in the store at all times; those that should be held in the store if at all possible; those that should be held on tape and can be called in many times; and those that are to be called in only once. The H-400 COBOL needs to economize on instructions and space, so those electives which can be handled simply with generated object code are included, but those COBOL features that merely duplicate other features are not included (except for MOVE CORRESPONDING, which is included). None of the COBOL-61 Extended features (Report Writer, Sort, etc.) are provided in this implementation. The only Honeywell extension is in the field description. The DATA RECORDS clause has been implemented with

.14 Description (Contd.)

a DEPENDING ON . . . option. The details of the deficiencies, electives provided, and electives not provided are listed below.

.141 Availability

Language: . . . . . 1963.
Translator
(Field Test): . . . April, 1963.

.142 Deficiencies with Respect to Required COBOL-61

Reference Format

None. (As a matter of policy it is recommended that Indentation be allowed only to one level.)

Data Division

Neither a File Description nor a Record Description can be copied from a library.

Procedure Division

The Quotient of a division operation cannot be rounded.

Environment Division

Neither the Source Computer nor the Object Computer entry can be taken from a library.

.143 Extensions to COBOL-61: . . . . . DEPENDING ON . . . option of DATA RECORDS clause.

.144 COBOL-61 Electives Implemented in H-400 COBOL (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
2	Semicolon	; , always ignored.
	File Description Clauses	
11	Sequenced-on	gives a list of keys.
	Record Description Clauses/Options	
17	RENAMES	controls storage allocation.
20	Conditional-range	allows a conditional-value to be a range.

§ 162.

.144 COBOL-61 Electives Implemented in H-400 COBOL (see 4:161.3) (Contd.)

Key No.	Elective	Comments
	Verbs	
24	ENTER	non-COBOL computer languages.
26	USE	amplifies I/O error and labeling routines.
	Verb Options	
27	LOCK	locks rewound tapes.
28	MOVE CORRESPONDING	moves and edits relevant records.
30	ADVANCING paper	gives specific paper advance.
34	Relationship	IS UNEQUAL TO, EQUALS, and EXCEEDS.
36	Conditionals	implied objects with implied subjects.
37	Compound conditions	mixed ANDs and ORs allowed.
38	Complex conditional	
39	ON SIZE ERROR	provides extension of error routines.
	Environment Division Options	
41	OBJECT-COMPUTER	allows selective use of previous description.
42	SPECIAL NAMES	specifies names for ACCEPT, WRITE, and DISPLAY verbs.
46	I/O Control	allows programmer control.
	Identification Division	
47	DATE-COMPILED	gives compilation date.
	Special Features	
49	SEGMENTATION	

.145 COBOL-61 Electives NOT Implemented in H-400 COBOL (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
1	Formula characters	+, -, *, /, **, =.
2	Relationship characters	>, <.
4	Long literals	up to 120 characters long only.
5	Figurative Constants	UPPER-BOUND(S); LOWER-BOUND(S).
6	Figurative Constants	HIGH-VALUE(S); LOW-VALUE(S).
	Data Division	
7	Computer-name	no alternative computer names.
	File Description Clauses	
8	Block-size	no range can be specified.
9	FILE CONTAINS	no approximate file size can be shown.
10	Label formats	labels must be standard or omitted. If omitted, they can be handled using own coding.
12	Hashed	hash totals cannot be created.

§ 162.

.145 COBOL-61 Electives NOT Implemented in H-400 COBOL (see 4:161.3) (Contd.)

Key No.	Elective	Comments
	Record Description Clauses/Options	
13	Table-length	only fixed length tables and arrays.
14	Item-length	only fixed length items (see also 19).
15	Bit usage	items cannot be specified in binary.
16	RANGE IS	no value range of item or character can be shown.
18	SIGN IS	no separate signs allowed.
19	Item-length	no variable length items allowed. (see also 16).
21	Label-handling	labels cannot be automatically specified as specific data-names.
	Verbs	
22	COMPUTE	algebraic formulae are not available.
23	DEFINE	new verb definitions cannot be used.
25	INCLUDE	no library routines can be called.
	Verb Options	
29	OPEN REVERSED	tapes cannot be read backwards.
31	STOP	non-alphabetic display provision.
32	Formulas	algebraic formulae.
33	Operand-size	only up to 10 digits.
35	Test	IF { } IS NOT ZERO.
	Special Features	
48	LIBRARY	library routines cannot be called.

.146 Non-Standard Implementations of COBOL-61 Language: . . . . . none.

MACHINE ORIENTED LANGUAGE: EASY I & II

§ 171.

.1 GENERAL

.11 Identity: . . . . EASY.
Efficient Assembly System.

.12 Origin: . . . . Minneapolis-Honeywell.

.13 Reference: . . . . Manual DSI-84A.
DSI-84B EASY I.
DSI-133 EASY II.

.14 Description

There are three slightly different versions of the EASY language: EASY I, EASY II, and EASY-800. These are designed to run on an H-400 with a 1,024-word core store, an H-400 with a 2,048-word core store, and an H-800 computer, respectively. The language described below is EASY II, and the restrictions upon EASY I are listed at the end of this description. EASY 800, which was the original version used before the H-400 was generally available, is no longer commonly used.

The form of EASY is that of three-address instruction codes, simplified by labels instead of absolute addresses, mnemonic versions of the operation codes, etc. Conventional symbols are used for "this address" and an upper boundary address. A small illustrative program appears on Page 501:171.900.

Macro routines, which can be stored on a library tape, add trigometric and floating point facilities to the language.

EASY is integrated system consisting of an assembler, a master tape updating and selection process, an automatic object program operating system, and extensive program diagnostic features, including dynamic dumping. EASY is based on the principle of batch-processing during assembly, checkout, and production running.

EASY is a straightforward 3-address machine oriented language. It has an open-ended macro and subroutine library, and descriptors for card, printer, and tape functions. Details of the library are given in Paragraph .8.

The following EASY II facilities are not available in EASY I:

Segmentation
Sorting
Library Routines.

.15 Publication Date: . . . . December, 1961

.2 LANGUAGE FORMAT

.21 Diagram: . . . . see page 501:171.

.22 Legend

Card Number: . . . . . used to sort input deck (optional, EASY II only).
Location: . . . . absolute or symbolic location for this line of coding.
Command Code: . . . mnemonic instruction code.
constant type code.
assembly control codes.
library pseudo code.
data descriptors.
A, B, or C Address:. . instruction operand address, literals.
control parameters.
constant macro parameter.
data descriptors.
Remarks: . . . . any comments; these do not affect the assembly.
(Note: a special line containing remarks only can be used when R is in columns 9 and 10.)

.23 Corrections: . . . . . . in the same format as specified in 21 if the program is to be reassembled; otherwise, master program tape may be updated with octal corrections.

.24 Special Conventions

.241 Compound addresses: . . $\pm$ symbolic $\pm$ absolute (4 digit), index register.
.242 Multi-addresses: . . . . in control instructions only.
.243 Literals:. . . . . D)xxxx is numeric xxxx.
.244 Special coded addresses: . . . . @ = this address.
245 Other
* : . . . . highest storage address.
%: . . . . common storage pool address.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . unlimited.
.312 Common label formation rule: . . . . . . yes.
.313 Reserved labels: . . . . none.
.314 Other restrictions: . . . none.

§ 171.

.315 Designators
- Alphabetic constant: . . A #.
- Hexadecimal constant: H #.
- Octal: . . . . O #.
- Binary equivalent of decimal constant: . . F #.
- Symbolic address as constant: . . . . T #.

.316 Synonyms permitted: . . yes.

.32 Universal Labels

.321 Labels for procedures
- Existence: . . . . optional.
- Formation rule
  - First character: . . . alphabetic or numeric
  - Last character: . . . alphabetic or numeric.
  - Others: . . . . alphabetic or numeric.
  - Number of characters: . . . . . 1 to 6; one must be alphabetic.

.322 Labels for library routines: . . . . same as procedures.
.323 Labels for constants: . . same as procedures.
.324 Labels for files: . . . . none as such.
.325 Labels for records: . . . none as such.
.326 Labels for variables: . . same as procedures.

.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constants

Integer	Digits
Decimal:	12 digits.
Octal:	16 digits.
Hexadecimal:	12 digits.
Binary:	14 digits.
Fixed numeric	
Decimal:	12 digits.
Octal:	16 digits.
Hexadecimal:	12 digits.
Binary:	14 digits.
Floating numeric	
Decimal:	none.
Octal:	none.
Hexadecimal:	none.
Alphabetic:	29 characters.
Alphameric:	29 characters.

.412 Maximum size literals

Integer	
Decimal:	9 digits.
Octal:	9 digits.
Hexadecimal:	9 digits.
Binary:	9 digits.
Fixed numeric	
Decimal:	9 digits.
Octal:	9 digits.
Hexadecimal:	9 digits.
Binary:	9 digits.
Floating numeric: . . .	none.
Alphabetic:	8 char.
Alphameric:	8 char.

.42 Working Areas

.421 Data layout
- Implied by use: . . . . yes.
- Specified in program: . . . . no.

.422 Data type: . . . . not required.
.423 Redefinition: . . . . . . yes.

.43 Input-Output Areas

.431 Data layout: . . . . implicit.
.432 Data type: . . . . not required.
.433 Copy layout: . . . . . . yes.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
- Existence: . . . . . . yes.
- Number: . . . . 59.
- Example: . . . . ADD X/Y/Z.

.512 Absolute
- Existence: . . . . . . yes.
- Number: . . . . 59.
- Example: . . . . 0 #3300 T#X/T#Y/T#Z.
- Comment: . . . . . . any form of constant because codes are binary.

.52 Macro-Codes

.521 Number available: . . library is open-ended.
- Input-output: . . . . yes.
- Arithmetic: . . . . . yes.
- Math functions: . . . yes.
- Error control: . . . . yes.
- Restarts: . . . . . . yes.
- Ortho correction: . . yes.
- Edit: . . . . yes.
- Number conversion: . yes.

.522 Examples
- Simple: . . . . L, MACNAM.
- Elaborate: . . . . . L, MACNAM P1/P2 . . . . P25/.

.523 New macros: . . . . . written in EASY and inserted in library or at head of program.

.53 Interludes: . . . . . . none.

.54 Translator Control

.541 Method of control
- Allocation counter: . . pseudo operation.
- Label adjustment: . . pseudo operation.
- Annotation: . . . . two methods.

.542 Allocation counter
- Set to absolute: . . . . SETLOC.
- Set to label: . . . . . SETLOC.
- Step forward: . . . . . SETLOC, RESV.
- Step backward: . . . . SETLOC.
- Reserve area: . . . . . RESV.

.543 Label adjustment
- Set labels equal: . . . . EQUALS.
- Set absolute value: . . . EQUALS.
- Clear label table: . . . none.

.544 Annotation
- Comment phrase: . . . remarks field.
- Title phrase: . . . . . R or P in location field.

§ 171.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . . library of scientific subroutines, multiply, divide. floating point package.
.612 Method of call: . . . . . macro or hand code or deck insertion.

.62 Special Functions

.621 Facilities: . . . . trig. functions. log. matrix. differential equations. statistics.
.622 Method of call: . . . . . macro or hand code, or deck insertion.

.63 Overlay Control

.631 Facilities: . . . . all programs divided by delimiter "SEGMENT" into at least one segment. overlay calls must be written in programs.
.632 Method of call: . . . . . under program control by Read Segment macro.

.64 Data Editing

.641 Radix conversion: . . . . decimal to binary only.
Code translation: . . . . not necessary.
.642 Format control: . . . . not necessary.

.65 Input-Output Control

.651 File labels: . . . . standard.
.652 Reel labels: . . . . standard.
.653 Blocking: . . . . variable.
.654 Error control: . . . . . standard.
.655 Method of call: . . . . . library call.

.66 Sorting

.661 Facilities: . . . . . . polyphase sorting (3 to 6 tapes).
.662 Method of call: . . . . library call.

.67 Diagnostics: . . . . . derail technique as controlled by Monitor, specified by programmer.

.7 LIBRARY FACILITIES

.71 Identity: . . . . library.

.72 Kinds of Libraries

.721 Fixed master: . . . . no.
.722 Expandable master: . . yes.
.723 Private: . . . . yes.

.73 Storage Form: . . . . tape.

.74 Varieties of Contents: . mathematical routines. generators. data processing packages.

.75 Mechanism

.751 Insertion of new item: . standard updating program.
.752 Language of new item: . EASY.
.753 Method of call: . . . . L, NAME in Command field.

.76 Insertion in Program

.761 Open routines exist: . . yes.
.762 Closed routines exist: . yes.
.763 Open-closed is optional: . . . . . . yes.
.764 Closed routines appear once: . . . . yes.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Open-ended library. A few examples are shown below.

Code	Description
L, A1DPK1:	single precision package.
L, AXDLI1:	less than or equals comparison.
L, AXDNI1:	inequality comparison.
L, A2DPK1:	double precision package.
L, A3DPK1:	extra precision package.
L, A1FDV1:	fixed point divide.
L, A1FMY1:	fixed point multiply.
L, ACXDR1:	conversion radians to degrees & E^X.
L, AEDEX1:	evaluates E^X.
L, AEDLN1:	finds log to base E of X.
L, AEDLO1:	finds log of X to base E, 2 or 10.
L, A1DSE1:	matrix inversion, solution to equations.
L, AYDSE1:	as above with either single or double precision.
L, AMDPK1:	matrix addition, subtraction or scalar multiplication.
L, ARDSR1:	finds the square root.
L, ATDAT1:	evaluates arc-tangent.
L, ATDSC1:	calculates sine or cosine.
L, A1XDV1:	fixed binary divide.
L, AEDXY1:	evaluates X^y.
L, AVDMV1:	mean, variance & correlation.
L, AVDRN1:	random number generator.
L, ATDTN1:	finds the tangent.
L, AMDTA1:	premultiplication of a matrix by its transpose.
L, AVDMR1:	multiple regression.

§ 171.

.82 Pseudos

Code	Description
SETLOC:	set location counter.
PROGRAM:	header card.
SEGMENT:	subheader card.
REP:	repeats next card "n" times.
EQUALS:	assigns values to labels.
RESV:	reserves storage.
MACBO:	heads macro routine.
MACTER:	ends macro routine.
BEGIN:	initialize indexes and sequence register for object program.
EXIT:	exit from program to monitor.

§ 171.

EASY CODING FORM

PROBLEM SAMPLE PROGRAMMER ____ DATE ____ PAGE ____ OF ____

CARD NUMBER (PAGE / LINE / INSERT)	LOCATION	COMMAND CODE	A ADDRESS	B ADDRESS	C ADDRESS	REMARKS
1 Ø1	NEW	PROGRAM	SAMPLE		S	
1 Ø2		SEGMENT	SAMPLE	PUNCH		
1 Ø3		SETLOC	4ØØ			
1 Ø4	INIT	TSC	H)+1	NUM	@+1	
1 Ø5		TAC	BKPT			
1 Ø6		HLT				SET Δ BKPTS
1 Ø7		TSN	SPACE	1	39	
1 Ø8		TSN	39	14	4Ø	
1 Ø9		PRS		H		
1 1Ø		RCI				
1 11	R,	START Δ	OF Δ LOOP			
1 12	MAIN	RCW				
1 13		NAC	58	ENDID	@+2	
1 14		EXIT				
1 15		TSN	54	2Ø	74	
1 16		SCO	BLANKS	2	@+1	
1 17		PCW				
1 18		SCH			PRINT	
1 19	BLANKS	PCA	SPACE	1,8	1	
1 2Ø		PCU	NUM	10,3	3	
1 21		PCW				
1 22		ADD	H)+1	NUM	NUM	
1 23	PRINT	SCO	@+1	1	MAIN	
1 24		ECA	39	1,8Ø	1,3	
1 25		PRS		E,1		

CARD NUMBER (PAGE / LINE / INSERT)	LOCATION	COMMAND CODE	A ADDRESS	B ADDRESS	C ADDRESS	REMARKS
2 Ø1		SCH			MAIN	
2 Ø2	R,	FILL Δ RESERVED Δ LOCATIONS				
2 Ø3	ØØ17	STX	SAVESR		OVFLW	
2 Ø4	ØØ22	STX	SAVESR+1		CDEDIT	
2 Ø5	ØØ23	STX	SAVESR+2		PRSERR	
2 Ø6	ØØ24	NOP				
2 Ø7	ØØ25	STX	SAVESR+3		CARDRD	
2 Ø8	ØØ26	NOP				
2 Ø9	ØØ27	STX	SAVESR+4		CARDPU	
2 1Ø	ØØ28	NOP				
2 11	ØØ3Ø	SCH			INIT	
2 12	R,	ERROR Δ ROUTINES Δ AND Δ CONSTANTS				
2 13	OVFLW	TAC	OVERFL			
2 14		TOC	SAVESR			
2 15		HLT				
2 16		RTX	SAVESR		SAVESR	
2 17	CDEDIT	TAC	EDIERR			
2 18		TOC	SAVESR+1			
2 19		HLT				
2 2Ø		RTX	SAVESR+1		SAVESR+1	
2 21	PRSERR	TAC	PRIERR			
2 22		TOC	SAVESR+2			
2 23		HLT				
2 24		RTX	SAVESR+2		SAVESR+2	
2 25	CARDRD	REJ				

PROGRAM TRANSLATOR: EASY I & II

§ 181.

.1 GENERAL

.11 Identity: . . . . Honeywell EASY I & II.

.12 Description:

There are 3 EASY Translators, one for an H-800 (EASY-800), one for an H-400 with a 2,048-word core store and 4 tape units (EASY II), and one for an H-400 with a 1,024-word store and 3 tape units (EASY I). Some editing of the input will be needed before an input prepared for one translator can be processed by another. There is no assembler for the H-400 which can assemble on a card system or on a 1- or 2-tape system.

The EASY II translator is designed for use with the EASY Monitor operating system, described in Section 501:191. It translates one-to-one symbolic instructions, library macros, and descriptions for input-output editing. Translation speed is approximately 250 cards per minute. An updating and selection routine maintains a master binary tape using the results of translation and corrections, derails (dump control instructions), and test data. It also prepares an automatic run-to-run tape both for check-out and production purposes.

.13 Originator: . . . . . . Honeywell EDP Division.

.14 Maintainer: . . . . . Honeywell EDP Division.

.15 Availability: . . . . . March, 1962.

.2 INPUT

.21 Language

.211 Name: . . . . EASY I or EASY II.
.212 Exemptions: . . . . . see Description (Paragraph .12).

.22 Form

.221 Input media: . . . . . punched card, or tape.
.222 Obligatory ordering: . no.
.223 Obligatory grouping: . yes, by program segment.

.23 Size Limitations

.231 Maximum number of source statements: . . no limit.
.232 Maximum size source statements: . . . . . instructions or library calls.
.233 Maximum number of data items: . . . . . no limit.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . EASY to H-400 binary language.
.312 Language style: . . . . machine language.
.313 Output media: . . . . magnetic tape or punched cards.

.32 Conventions

.321 Standard inclusions: . . none.
.322 Compatible with: . . . EASY Monitor (Section 501:191).

.33 Documentation

Subject:	Provision
Source program: . . .	listing 1.
Object program: . . .	listing 1.
Storage map:	no.
Restart point list: . .	no.
Language errors: . .	listing 1.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Pass 1: . . . . input editing.
Passes 2, 3: . . . . . optional description processing.
Passes 4, 5: . . . . . optional library processing.
Pass 6: . . . . optional input sort.
Passes 7 - 10: . . . . translation.
Pass 11: . . . . listing.

.42 Optional Modes

.421 Translate: . . . . yes.
.422 Translate and run: . . none.
.423 Check only: . . . . . . no.
.424 Patching: . . . . yes.
.425 Omit list: . . . . no.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . . . no optimizing.
.433 Short translate on restricted program: . . omit optional passes.

.44 Bulk Translating: . . . yes - batch processing.

.45 Program Diagnostics: . handled through monitor operation.

§ 181.

.46 Translator Library

.461 Identity: . . . . library.
.462 User restriction: . . . none.
.463 Form
Storage medium: . . magnetic tape.
Organization: . . . . in routine name sequence.
.464 Contents
Routines: . . . . . . variable.
Functions: . . . . . macros.
Data descriptions: . . no.
Programs: . . . . . yes.
.465 Librarianship
Insertion: . . . . . . yes, library updating routine.
Amendment: . . . . yes.
Call procedure: . . . macro, with or without parameters.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space	Comment
Monitor	80 words	controls batch processing and dynamic diagnostics.
Ortho correction	80 words	corrects read errors off magnetic tape.
In-out	96 words	error sub-sequence, in-out areas.

.512 Space required for each input-output file: . . . twice record size, input. record size, output.
.513 Approximate expansion of procedures: . . . unity, except macros.

.52 Translation Time

.521 Translating from cards: 1.3 minutes + 0.24 sec/card.
.522 Translating from tape: 1.2 minutes + 0.21 sec/card.

.53 Optimizing Data: . . . not necessary.

.54 Object Program Performance: . . . . unaffected.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 2,048-word core (EASY II).
4 magnetic tapes (EASY II).
1 reader.
1 printer.
(EASY I only uses 3 magnetic tape units and 1,024 words of store.)
.612 Larger configuration advantages: . . . . . none.

.62 Target Computer

.621 Minimum configuration: 1,024 word core.
1 magnetic tape or card reader.
.622 Usable extra facilities: all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none	
Unsequenced entries:	yes	listed report.
Duplicate names:	yes	listed report.
Improper format:	yes	listed report.
Incomplete entries:	yes	listed report.
Target computer overflow:	yes	listed report.
Inconsistent program	no.	
Duplicate descriptions:	no.	

.8 ALTERNATIVE TRANSLATORS

Computer	Identity	Date
H-800	Easy 800	June 1961.

PROGRAM TRANSLATOR: AUTOMATH-400

§ 182.

.1 GENERAL

.11 Identity: . . . . Automath-400.

.12 Description

The Automath-400 translator is a compile-and-go translator for the FORTRAN II language. Automath-400 translates the entire Automath-400 language (which, except for only two levels of subscripts, is nearly compatible with IBM 709/7090 FORTRAN II; see section 501:161) into a machine language program which is stored on magnetic tape and/or on punched cards. During compilation, three listings are produced (see specimens in Section 501:131) which show the source and object programs and a storage map. The compiling speed is between 80 and 120 cards per minute.

Subsequent to compilation, the program can be executed under monitor control. During execution, all computation is performed in decimal mode and takes no advantage of the binary features of the machine.

A large resident program block (911 words) must be maintained in storage. Segmentation of the object program is handled by the Automath-400 Monitor.

Floating point operations are simulated by subroutines and take 4 milliseconds for addition or subtraction, 4 milliseconds for multiplication, and 7.2 milliseconds for division. By comparison, the IBM 1410 takes 4, 5, and 8 milliseconds for the same simulations, whereas the IBM 1620 Model II takes either 10, 12, and 24 milliseconds, respectively, when simulating or 0.5, 3.3, and 9.0 milliseconds when using the Automatic Floating Point Feature.

Error conditions are checked, but in many cases the computation is allowed to continue; the only warning given is a console typewriter message. This appears to be a weaker action than is advisable.

Segmentation of the object program is handled well, and communication between the segments and the main program is by means of the COMMON facility. To increase the possible size of the segments, the main program is overwritten if necessary and later recalled into storage from the program tape. Up to 16 subprograms can be incorporated into a single program by regarding them as segments. These can be compiled together or separately. If the segments are compiled separately, there is no library system to collect them, so this must be done manually.

The Automath-400 Compiler operates on a 4-tape, 2,048-word H-400 system with a card reader and printer. A card punch must also be used if compiled programs are to be stored; thus, it is usually a practical necessity. It is not possible to substitute additional tape units for the card equipment or the printer.

The object program can control eight tape units in addition to a card reader, card punch, and printer. The H-460 Random Access Storage cannot be utilized by the program.

An Automath-400 programmer interested in object program efficiency has to consider factors somewhat different from those generally applicable to FORTRAN compilers. The compiler uses a group of 11 locations as temporary storage for subexpressions and uses the 3 index registers for subscripts. If a programmer wishes to avoid reforming subexpressions or subscripts, he can sometimes do so implicitly by arranging them in these temporary storage locations. There is no way in which he can obtain use of the overlapping capabilities of the H-400; these capabilities are themselves restricted to being able to read from one tape unit while writing on the other, so this limitation does not appear to be very important.

.13 Originator: . . . . Honeywell EDP Division.

.14 Maintainer: . . . . . . Honeywell EDP Division.

.15 Availability: . . . . . . Language - April, 1963. Compiler (Field Test) - May, 1963.

.2 INPUT

.21 Language

.211 Name: . . . . Automath-400; see Section 501:161.

.212 Exemptions: . . . . . . none.

.22 Form

.221 Input media: . . . . . . punched cards.

.23 Size Limitations

.231 Maximum number of source statements: . . no limit.

.232 Maximum size source statements: . . . . . . 660 characters.

.233 Maximum number of data items: . . . . . . no limit.

.234 Others
- Non-COMMON fixed and floating point variables: . . . . . . 150.
- Fixed and floating point constant appearances: . . . . 288.

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.234 Others (Contd.)

Variables in COMMON:	100.
Dimensioned and equivalenced variables:	37.
DO's in a nest:	10.
EFNs:	150.
FUNCTION and SUBROUTINE subprograms:	16.
Subscripts in a statement:	31.
Sets of parentheses enclosing input-output list index:	10.
Sets of parentheses enclosing information in an arithmetic statement:	10.
Exits in a computed GO TO:	9.
Functions in a nest:	5.
Subprogram calls in a nest ror preferred subprograms:	6.

.235 Maximum number of subprograms: . . . . 16.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . relocatable binary.
.312 Language style: . . . . H-400 machine code.
.313 Output media: . . . . . magnetic tape and/or punched cards.

.32 Conventions

.321 Standard inclusions: . . Easy II Input-Output macro.
.322 Compatible with: . . . . no other systems or subprograms can be used.

.33 Documentation

Subject	Provision
Source program:	Listing 1.
Object program:	Listing 3.
Storage map:	Listing 2.
Restart point list:	none.
Language errors:	Listing 1.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

The Automath-400 system exists on a library tape as an object program entitled 4TRAN. When the Automath run has been started, Automath begins its activities by reading the input deck for the first job. As the primary control card is read, an execution option key is set up. If the primary control card specifies program compilation with or without subsequent execution, Automath reads and analyzes the TITLE (or SUBROUTINE or FUNCTION), COMMON, DIMENSION and EQUIVALENCE statements, and sets up tables for dimensioned and common variables. The remainder of the source program deck is then read as far as the two END statement cards, and the source program listing, a sample of which is presented in coding specimens, is output to the printer, with asterisks appended to any incorrect statements.

Automath sets up four files on work tapes 1, 2, and 3, as follows: a constant file; a format file; a file of all other statements; and a diagnostic file. When this is completed, all constants are processed, and variable and array tables and a constant error listing are output to the printer. The other statements are processed, and any appropriate information is added to the diagnostic file. Automath * then writes the bootstrap routines and the Automath Monitor (including an input-output package, the Scientific Option Simulator package, etc.,) onto work tape 2, which is to become the run tape. The required library functions are allocated memory space. If diagnostics have been produced earlier in the run, the diagnostic file is printed at this point. The object program is written onto the run tape in binary format, and, if stipulated by the primary control card, a binary program deck is punched. Any required library functions are then loaded from the system tape, relocated, and written onto tape 2. The object program listing is printed at this point, if it was specified on the primary control card.

When the above activities have been completed, Automath reads any binary subprogram decks, relocates them, and writes them onto the run tape. Any preferred subprograms are written in segment 2 of the run tape. Overlay subprograms are written as individual segments, #3 through #n of the tape. If any OVERLAY subprograms overlay the main program, Automath repeats segment 1 following segment #n. When a JOBEND card is encountered, Automath writes an end-of-program and an end-of-information record onto tape 2, and then switches the address of this tape to 0, so that it becomes a program tape, and turns control over to it. The Automath Monitor is then automatically loaded, and it in turn loads segments 1 and 2 of the object program. When a STOP statement signals the completion of the program, control is returned to the Monitor, which switches the run tape address back to logical address 2, and returns control to the Automath IRT. The appropriate procedure is then carried out for the next job in the input deck, as specified by the new primary control card. Automath will eventually stall waiting for a job deck to be loaded into the card reader.

.42 Optional Mode

.421 Translate: . . . . yes.
.422 Translate and run: . . . yes.
.423 Check only: . . . . . . yes.
.424 Patching: . . . . no.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . no.
.433 Short translate on restricted program: . no.

* If the primary control card specifies EXECUTE, Automath activities begin at this point.

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.44 Bulk Translating: . . . yes.

.45 Program Diagnostics

.451 Tracers: . . . . none.
.452 Snapshots: . . . . none.
.453 Dumps: . . . . none.
.454 Other: . . . . a number of errors cause console print-outs at object time. Processing then continues automatically.

.46 Translator Library

.461 Identity: . . . . Automath-400 library.
.462 User restriction: . . . none.
.463 Form
Storage medium: . . . magnetic tape.
.464 Contents
Routines: . . . . open.
Functions: . . . . . . open and closed.
Data descriptions: . . none.
.465 Librarianship
Insertion: . . . . own coding.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead
Name: . . . . Resident, including Automath Monitor, EASY II I/O macro, Floating Point simulator, Scaling routine and Buffer areas.
Space: . . . . 911 words.
Comment: . . . . . . because of the inevitable size of the resident program, space has been saved where possible even at the cost of object performance.
.512 Space required for each input-output file: . . . none in addition to resident program.

.52 Translation Time

.521 Normal translating: . . 100 statements per minute.

.53 Optimizing Data: . . . . none specifically, but knowledge of some of the compilation methods allows stylized writing which improves efficiency.

.54 Object Program Performance

These figures are based on hand coding, using the standard floating point simulation package. If more space were available, a faster package could be used. Addition, subtraction, and multiplication take 4 milliseconds each; division takes 7.2 milliseconds.

Two techniques can be used to improve object program performance time.

(1) Use of temporary storages for data. Eleven locations are allocated cyclically for use as temporary storage in each object program. Before any expression is compiled, the contents of these temporary storages are checked to see if the expression has previously been formed and can be picked from temporary storage directly. This allows the repeated use of common subexpressions in a single expression without increasing the running time of a program.

.54 Object Program Performance (Contd.)

(2) Use of temporary storage for subscripts. Subscripts have the sole use of the three index registers during running time. Normally, each subscript is evaluated whenever used; however, if an index register already holds the subscript, and it is known that it cannot have been altered, then no re-evaluation is undertaken.

Type	Time	Space
Elementary algebra:	unaffected	unaffected.
Complex formulae:	increased	unaffected.
Deep nesting:	unaffected	unaffected.
Heavy branching:	unaffected	unaffected.
Complex subscripts:	doubled	increased.
Data editing:	unaffected	unaffected.
Overlapping operations:	not possible in Automath-400	

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: H-400 with 4 tape units, 2,048 words of store, card reader, printer.
.612 Larger configuration advantages: . . . . . . a card punch or an extra tape unit allows the object program to be stored on cards or tape, respectively.

.62 Target Computer

.621 Minimum configuration: H-400 with 2,048 words of store, 2 tape units.
.622 Usable extra facilities: up to 8 tape units can be utilized.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	entry on listing.
Unsequenced entries:	not needed.	
Duplicate names:	no check.	
Improper format:	check.	
Target computer overflow:	check during loading only.	
Inconsistent program:	check	listing.

Upon detection of object program errors, processing normally continues, even after it is definite that the output is valueless. Further, although the error has been noted by a console typewriter message, no indication is given on the printout. Thus, the bad output can still be used.

This condition occurs whenever a function is improperly utilized (such as asking for the square root or logarithm of a negative number), upon incorrect results from a truncation, or upon exponent errors of various sorts.

OPERATING ENVIRONMENT: EASY MONITOR

§ 191.

.1 GENERAL

.11 Identity: . . . . EASY Monitor.
Minneapolis-Honeywell Regulator Co.
May, 1962.

.12 Description:

Production or test programs to be performed are selected from a Master Program Tape and stored on a run tape. The run tape contains test data, derails (type and point of dumps), and the routines for each program. Distribution of test data, operation of program, dynamic dumping, and sequencing to next program may be automatic or under control of operator type-ins. These functions use 200 words of core storage.

.13 Availability: . . . . . 1962.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Libraries: . . . . . . Master Program Tape.
.212 Independents: . . . . must be incorporated during the preparation of the Run Tape.

.22 Library Sub-Routines: none

.23 Loading Sequence: . . Program sequence may be determined when the run tape is prepared by a set of cards, one card per program. At execution time, there are 2 modes of operation: 1) serial or 2) specific (under control of operator type-ins).

.3 HARDWARE ALLOCATION

.31 Storage: . . . . incorporated in program.

.32 Input-Output Units

.321 Initial assignment: . . . incorporated in program.
.322 Alternation: . . . . . incorporated in program.
.323 Reassignment: . . . . type-ins.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: incorporated in program.

.42 Multi-Running: . . . . own programming, using standard techniques.

.43 Multisequencing: . . . none.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	not possible.	
Allocation impossible:	none.	
In-out error - single:	yes.	automatic recovery.
In-out error - persistent:	yes.	program control.
Overflow:	yes.	forced jump.
Invalid instructions:	interlock.	forced jump.
Program conflicts:	interlock.	wait.

.45 Restarts

.451 Establishing restart points: . . . . control cards designate restart points in routines.
.452 Restarting process: . type-in.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing . . . . only via snapshots.
.512 Snapshots: . . . . . . yes, points selected by programmer.

.52 Post Mortem: . . . . yes, automatic - included in system; may require console forced jump to Monitor.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . yes, console printout.
.612 Action required by operator: . . . . . yes, console printout.
.613 Reporting progress of run: . . . . console printout each time a program is loaded.

.62 Operator's Decision: . breakpoint switches.
console forced jumps.
type-ins.

.63 Operator's Signals

.631 Inquiry: . . . . type-outs.
.632 Change of normal progress: . . . . . type-ins.

.7 LOGGING

.71 Operator Signals: . . . yes - console typewritten.

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.72 Operator Decisions: . yes - console typewritten.

.73 Run Progress . . . . yes - console typewritten.

.74 Errors: . . . . yes - console typewritten.

.75 Running Times: . . . no.

.76 Multi-Running Status: . no.

.8 PERFORMANCE

.81 Program Loading Time: search time + load time. (The search time may be zero.)

.82 Reserved Equipment: . 200 words.

.83 Running Overhead: . . control is transferred from the program to the monitor under four conditions:
1) read error.
2) segment (or overlay) loading.
3) dynamic dumping.
4) program exit.

NOTES ON SYSTEM PERFORMANCE

§ 201.

The format design and blocking of the main file were major considerations during the preparation of the System Performance data. Some of the more unusual factors which were considered were:

(1) The Block Length

The magnetic tape block length had to be short enough for a complete read or write operation to be completed within 18 milliseconds, to avoid the possibility of destroying the data transferred during the card read operations. The blocking factor is thus restricted to 2 on those configurations with the slowest model tape unit (H-404-3).

(2) The Approximate Central Processor Interlock Time for the Magnetic Tape Units

The central processor is interlocked from the time the tape instruction is given until the time the data transfer has been completed. The interlock time consists of the data transfer time itself, the normal start time, and an additional time which is necessary to pass over the remainder of the tape which makes up the inter-block gap.

It is assumed that this distance includes all the gap not passed over during the starting or stopping of the tape. This adds 2.7 milliseconds per block to the time the tape units interlock the central processor.

(3) The Timing of the Card Reader and Printer

Because H-400 input-output and computation operations are performed independently of each other and serially, it was not evident that either the card reader or printer would be able to operate at maximum speed for the entire program. Accordingly, an allowance for the time used waiting for their respective clutch points to be reached was added, whenever appropriate, to their timings. These are reflected in the increased overheads on the Central Processor. A further complication was the probability of additional delay in central processor operation when an interlock might be caused by the execution of one of several types of instructions between the start-up of a card reader and the actual data transfer from it. These instructions are multiply, print, tape read-write, etc., and they automatically interlock the central processor so that data transfers from the card reader are possible. No loading was computed to cover these delays; thus, the central processor time may be slightly understated.

HONEYWELL 400
SYSTEM PERFORMANCE

HONEYWELL 400 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration II		Configuration III		Configuration IV		Reference
1 Input-Output Times	Char/block	(File 1)[a]	432		432		1,104		4:200.112
	Records/block	K (File 1)	2		2		5		
	msec/block	File 1 = File 2	24.5 total		24.5 total		21.1		
		File 3	75.0		75.0		75.0		
		File 4	115.0		115.0		115.0		
	msec/switch	File 1 = File 2	---		---		---		
		File 3	---		---		---		
		File 4	---		---		---		
	msec/penalty	File 1 = File 2	14.6		14.6		16.6		
		File 3	46		46		46		
		File 4	52		1.3		1.3		
2 Central Processor Times	msec/block	a1	1.1		1.1		2.3		4:200.1132
	msec/record	a2	2.8		2.8		2.8		
	msec/detail	b6	0.2		0.2		0.2		
	msec/work	b5 + b9	14.97		8.97		8.97		
	msec/report	b7 + b8	0.4		0.4		0.4		
3 Standard Problem A F = 1.0	msec/block for C.P. and dominant column.	a1	1.1		1.1		2.3		4:200.114
		a2 K	5.6		5.6		14.0		
		a3 K	31.1		19.1		47.4		
		File 1 Master In	16.6		16.6		16.6		
		File 2 Master Out							
		File 3 Details[b]	120.0		120.0		300.0		
		File 4 Reports	104.0	230	8.0	230	20.0	575	
		Total	278.4	230	170.4	230	400.3	575	
4 Standard Problem A Space	Unit of measure	word							4:200.1151
		Std. routines	200		140		140		
		Fixed	94		94		94		
		3 (Blocks 1 to 23)	90		90		90		
		6 (Blocks 24 to 48)	360		360		360		
		Files	156		156		156		
		Working	18		18		18		
		Total	828		768		768		

[a] Expressed as 4-bit characters. Used as a mixture of 4-bit and 6-bit characters in unpacked form.
[b] Includes allowance for 15 milliseconds caused by prohibition of certain instructions during start of card read cycles.

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A Estimates

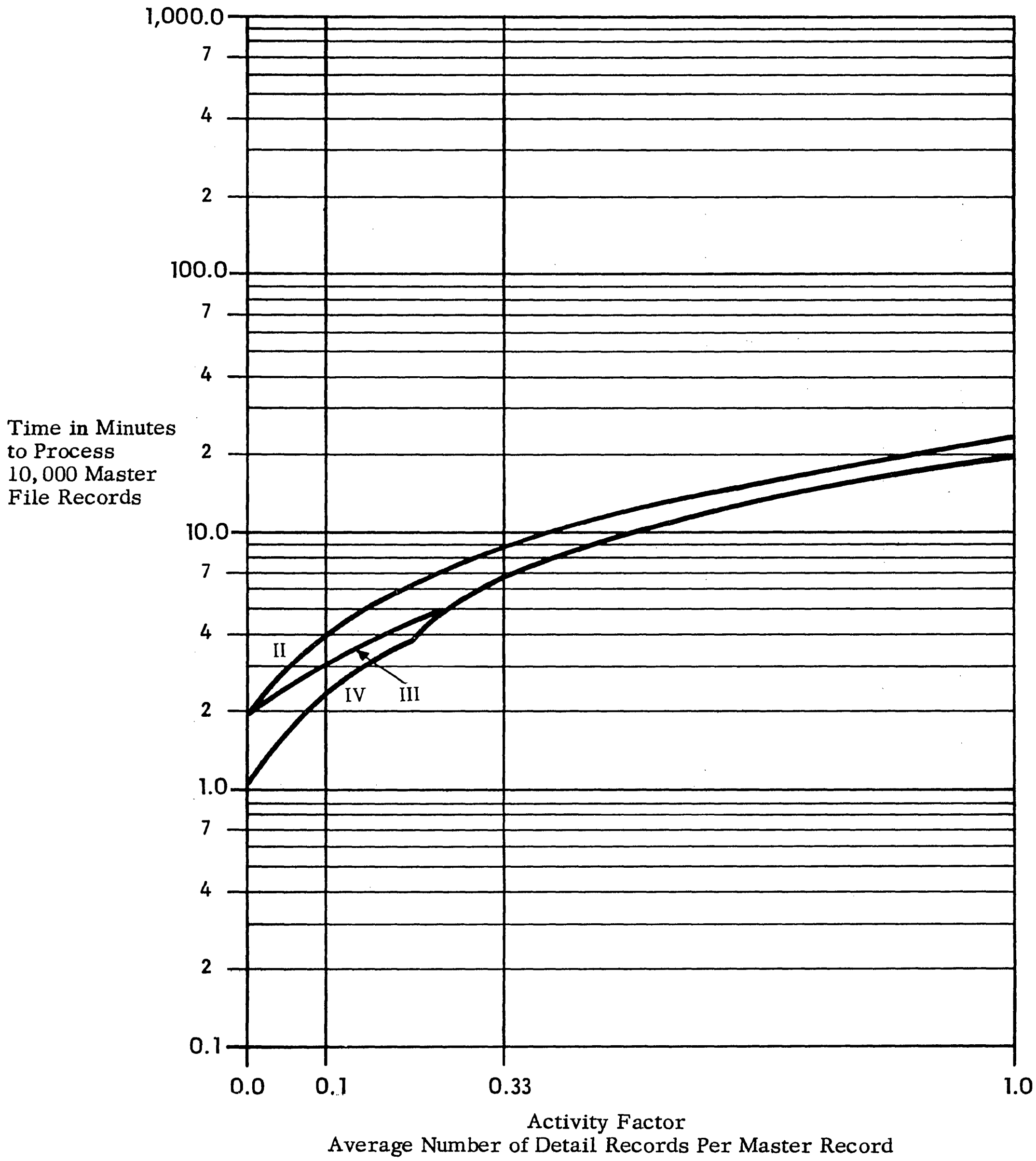
.111 Record Sizes
- Master File: . . . . . 108 characters.
- Detail File: . . . . . 1 card.
- Report File: . . . . . 1 line.

.112 Computation: . . . . . standard.

.113 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage Space Required
- Configuration II: . . . 828 words.
- Configuration III: . . 768 words.
- Configuration IV: . . 768 words.
- Word: . . . . 2 char. 3 digits.

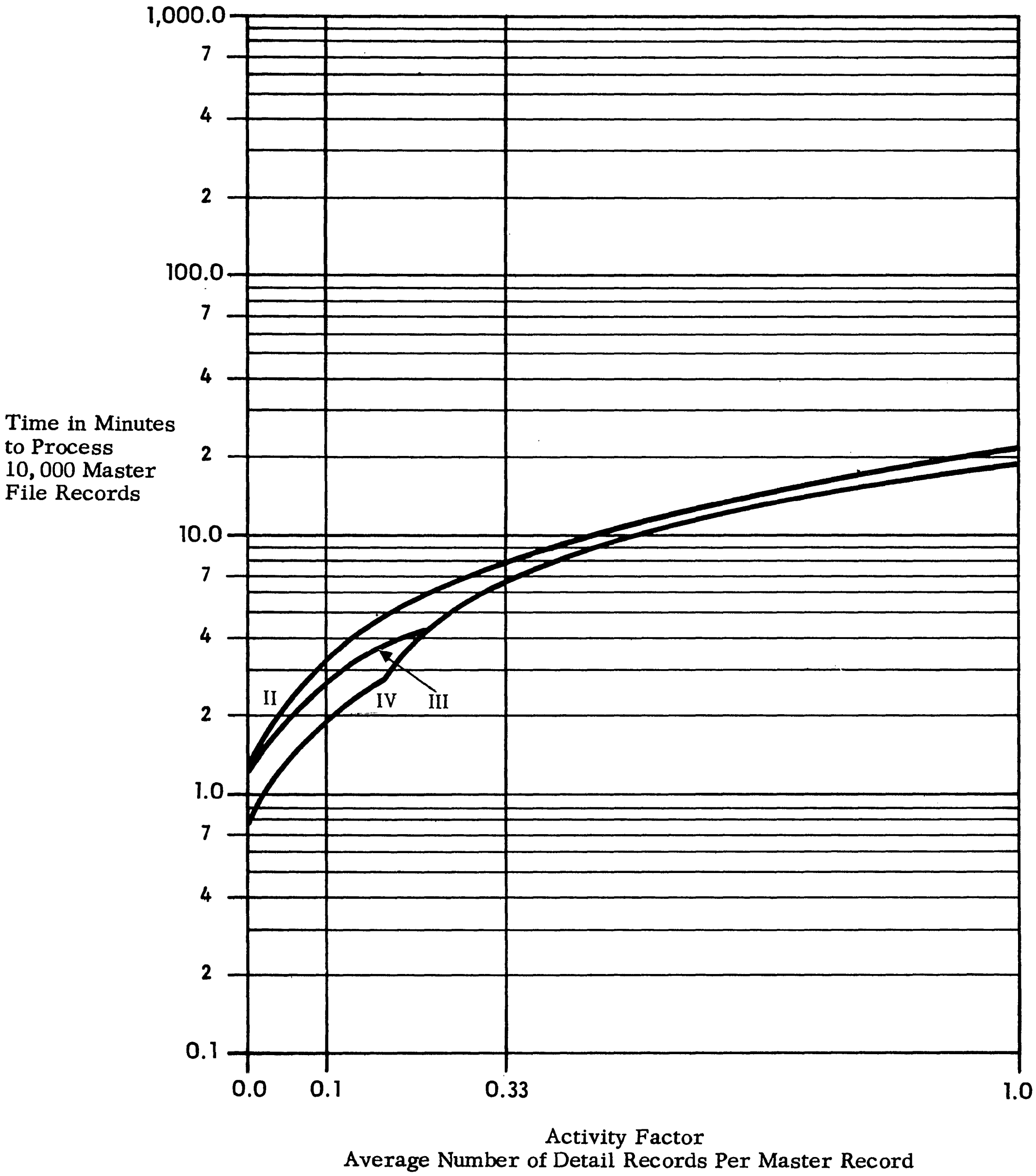


§ 201.

.12 Standard File Problem B Estimates

.121 Record Sizes
Master File: . . . . . 54 characters.
Detail File: . . . . . . 1 card.
Report File: . . . . . . 1 line.

.122 Computation: . . . . . . standard.
.123 Timing Basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . see graph below.



§201.

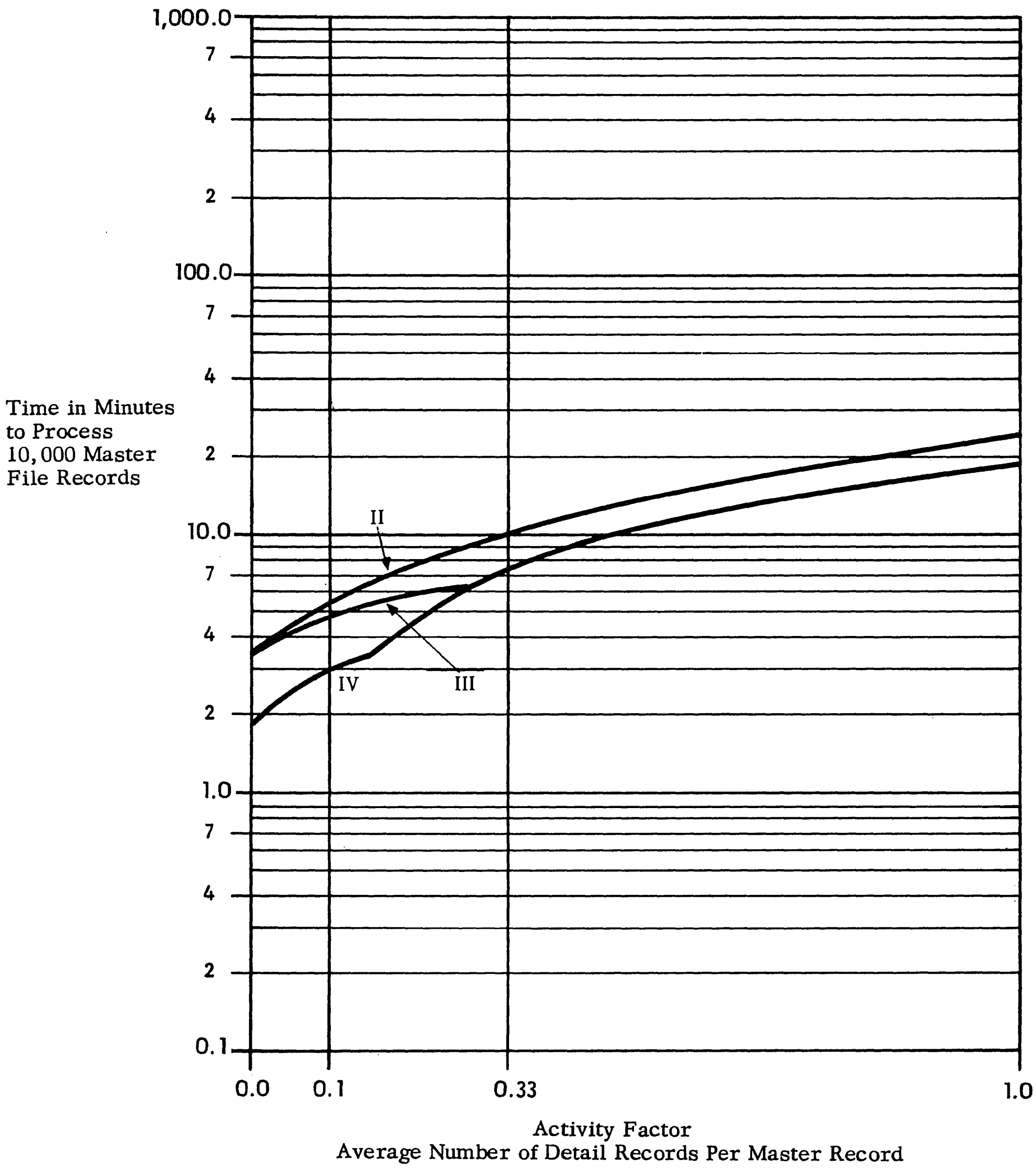
.13 Standard File Problem C Estimates

.131 Record Sizes
Master File: . . . . . 216 characters.
Detail File: . . . . . . 1 card.
Report File: . . . . . . 1 line.

.132 Computation: . . . . . . standard.

.133 Timing Basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.

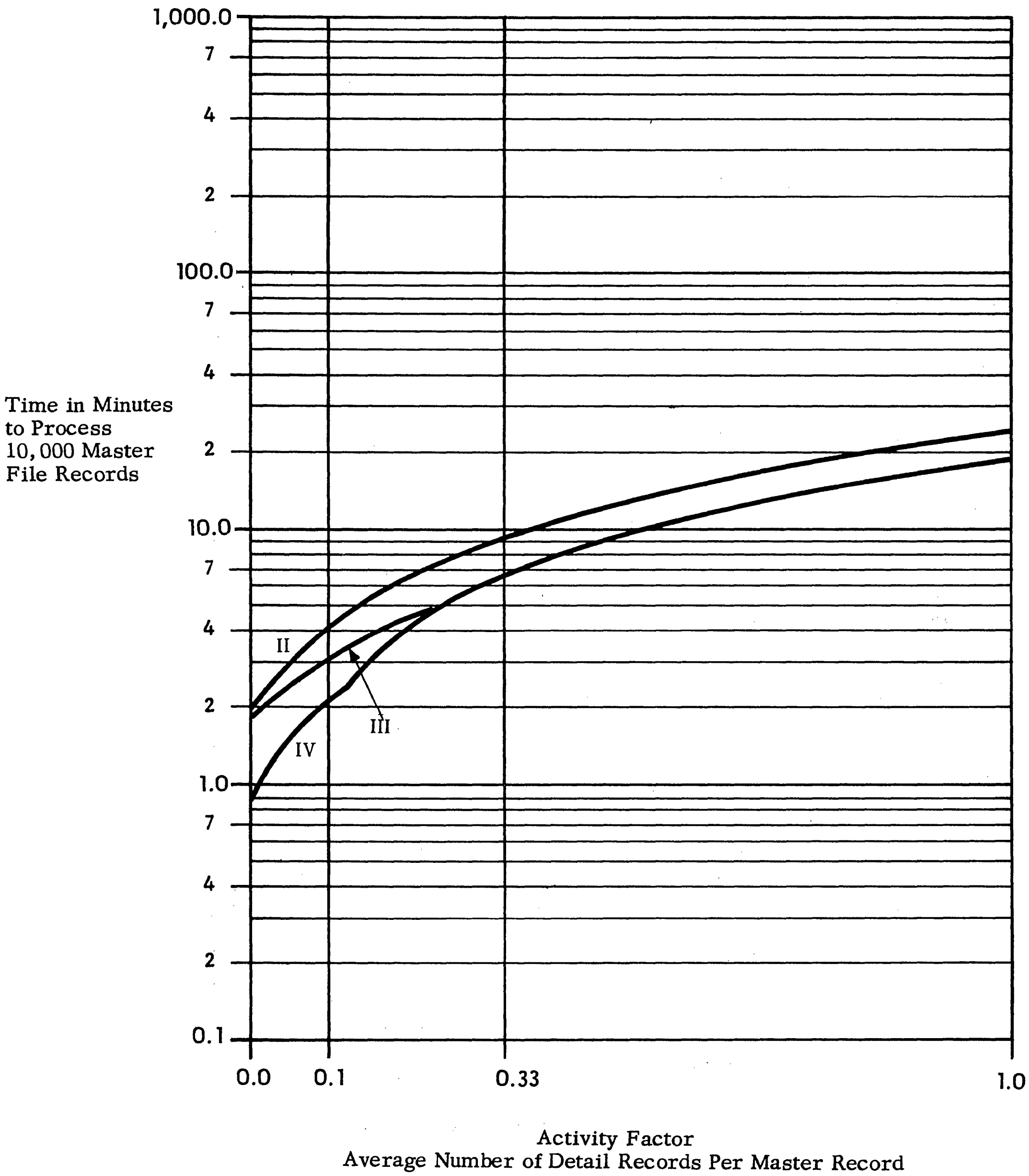


§ 201.

.14 Standard File Problem D Estimates

.141 Record Sizes
Master File: . . . . . 108 characters.
Detail File: . . . . . . 1 card.
Report File: . . . . . 1 line.

.142 Computation: . . . . . . trebled.
.143 Timing Basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . see graph below.



§ 201.

.2 SORTING

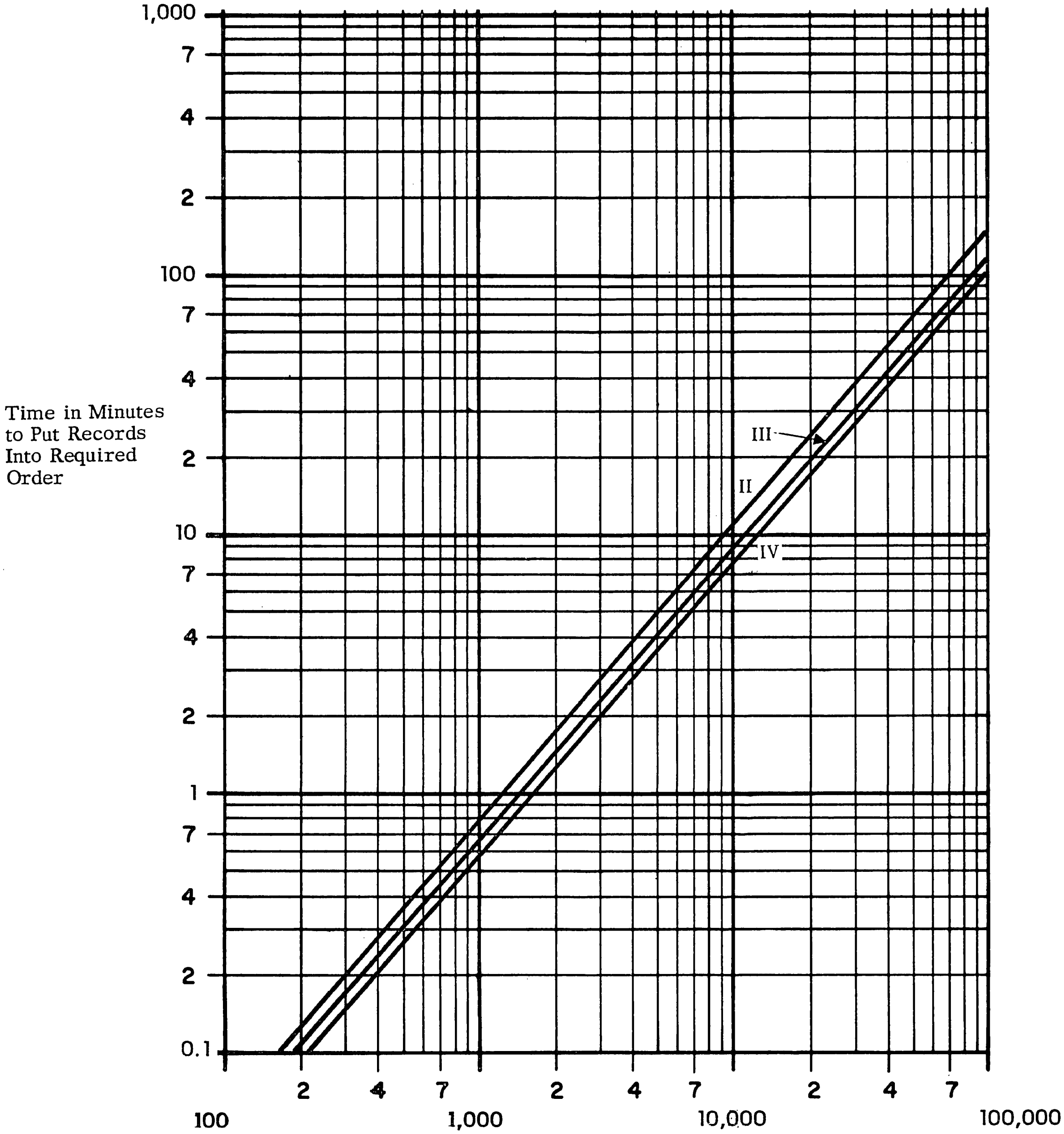
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . . 8 characters.

.213 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.213, corrected non-standard block sizes used in File Problem A.

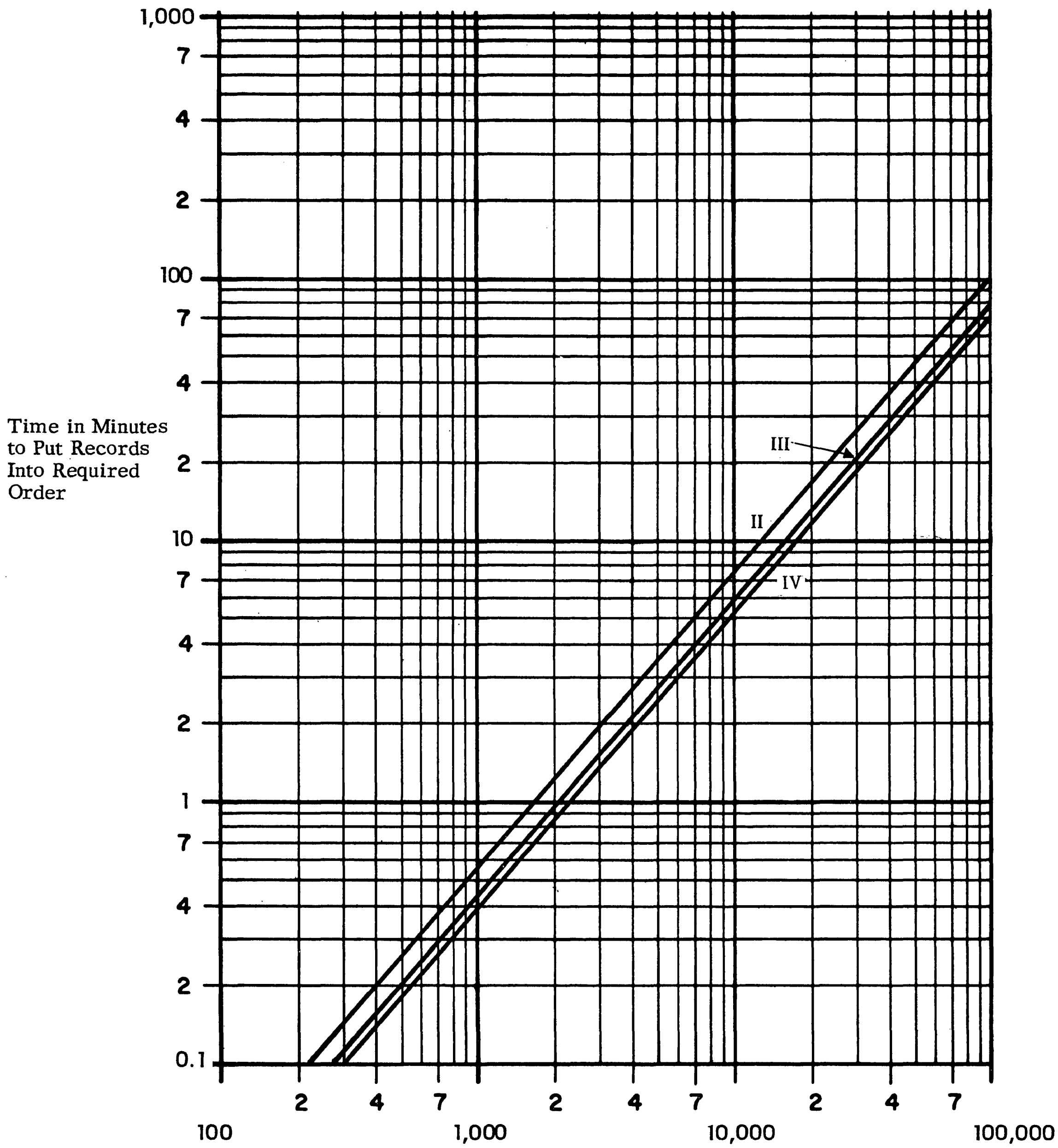
.214 Graph: . . . . see graph below.



Number of records to be sorted, using 2-way merge technique

§ 201.

.215 Graph: . . . . see graph below.



Number of records to be sorted, using 3-way merge technique

§ 201.

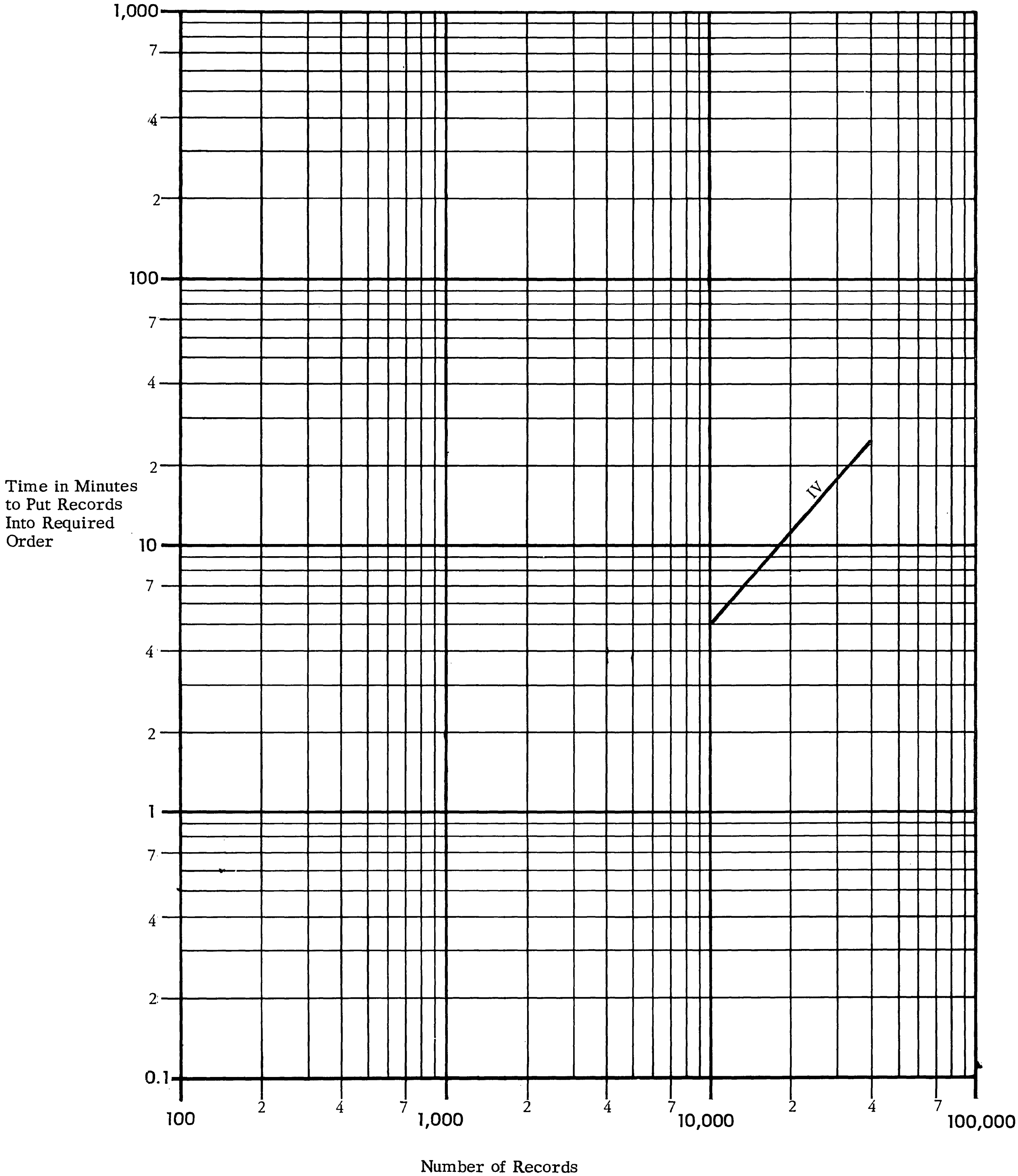
.22 EASY SORT Times

.221 Record size: . . . . . 80 characters.

.222 Key size: . . . . . . 8 characters.

.223 Timing basis: . . . . manufacturers timing graphs.

.224 Graph:. . . . . see graph below.



§ 201.

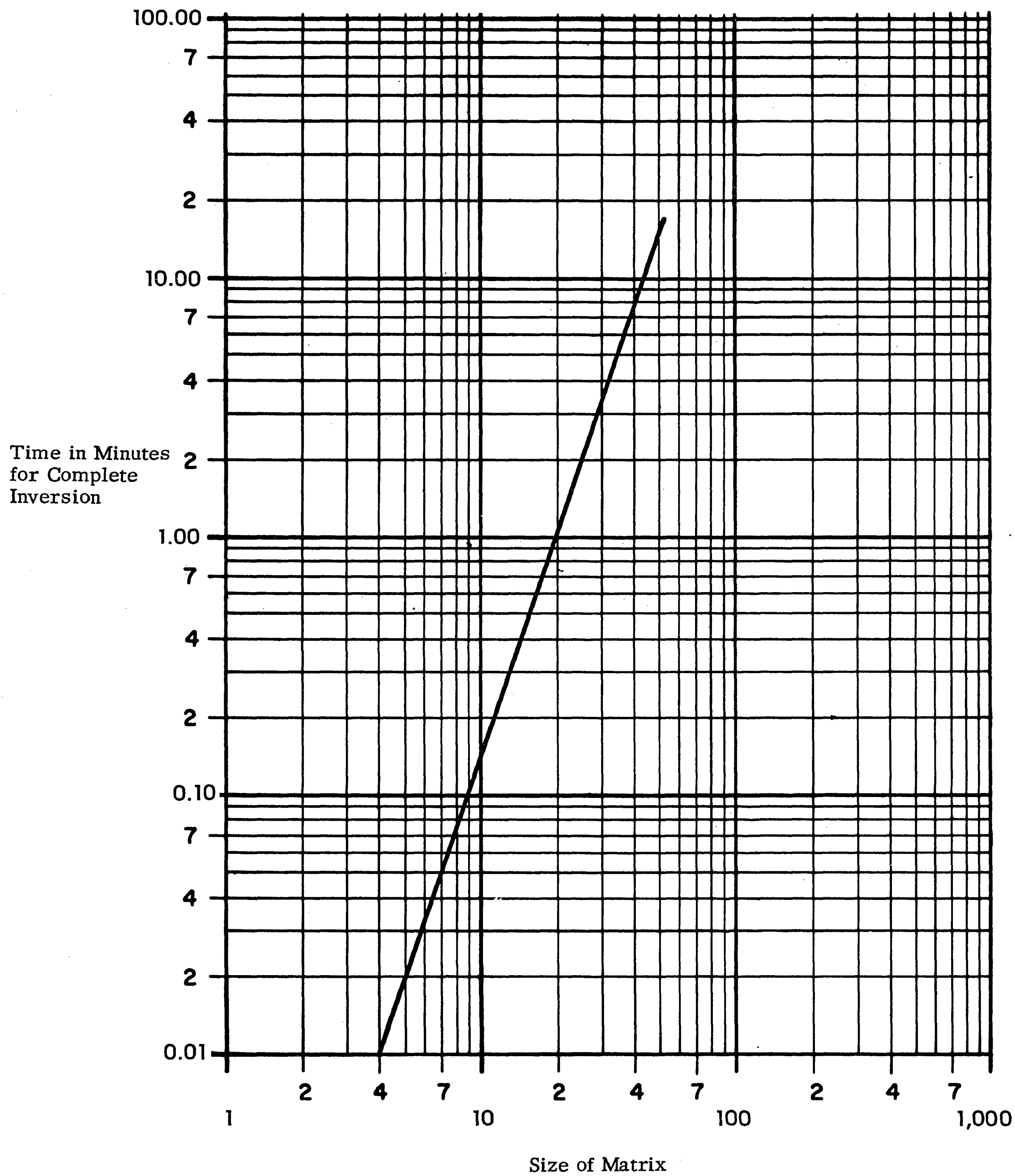
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to 9 decimal digits.

.312 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . see graph below.



HONEYWELL 400
PHYSICAL CHARACTERISTICS

HONEYWELL 400 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Processor	Console	Magnetic Core Storage	Magnetic Disc Storage	Punched Tape Reader	Punched Tape Punch	Card Reader	Card Punch
	Model Number		401	401-C	402-1	460-1	409	410	423-2	424-1
PHYSICAL	Height × width × depth, inches		73 × 127 × 30	37 × 68 × 34	In Processor	52 × 92 × 44	58 × 61 × 36	58 × 61 × 36	58 × 58 × 28	50 × 53 × 25
	Weight, pounds		2,950	300		2,500	750	600	1,500	1,000
	Maximum cable lengths									
	To Processor			100'		100'	100'	100'	100'	100'
	To Power Supply		100'	100'		100'	100'	100'	100'	100'
	To Other Unit		100'			100'				
ATMOSPHERE	Storage Ranges	Temperature, °F.								
		Humidity, %								
	Working Ranges	Temperature, °F.	72° ± 2°	72° ± 2°	72° ± 2°	72° ± 2°	72° ± 2°	72° ± 2°	72° ± 2°	72° ± 2°
		Humidity, %	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum
	Heat dissipated, BTU/hr.		15,231	1,322			2,870	2,770	4,371	3,552
	Air flow, cfm.									
	Internal filters		Yes							
ELECTRICAL	Voltage	Nominal	120	120		208	120	120	208	208
		Tolerance	±10%	±10%		±10%	±10%	±10%	±10%	±10%
	Cycles	Nominal	60 cps	60 cps		60 cps	60 cps	60 cps	60 cps	60 cps
		Tolerance								
	Phases and lines		1φ 3 wire	1φ 3 wire		3φ 4 wire	1φ 3 wire	1φ 3 wire	1φ 3 wire	1φ 3 wire
	Load KVA		1.5	0.4		3.5	0.92	0.92	1.6	1.3
NOTES	Floor strength, at least 220 lbs/sq.ft.									

HONEYWELL 400 PHYSICAL CHARACTERISTICS–Contd.

IDENTITY	Unit Name		Card Punch	Printer	Magnetic Tape	Power Supply	Magnetic Disc Storage	Magnetic Disc Storage	Magnetic Disc Storage	Magnetic Disc Control Unit	Additional Magnetic Core Memory Blocks
	Model Number		424-2	422-3 (3A,4,4A)	404	401-P	460-2	460-3	460-4		402-2, -3
PHYSICAL	Height × width × depth, inches		42×29×35	57×80×36	68×28×28	73×80×33	52×92×44	52×92×44	52×92×44	73×42×30	73×20×30
	Weight, pounds		900	1,600	1,250	1,700	3,000	3,500	4,000	800	400
	Maximum cable lengths										
	To Processor		100'	100'	100'	100'				100'	
	To Power Supply		100'	100'	100'					100'	100'
	To Other Unit			100'	100'	100'				100'	
ATMOSPHERE	Storage Ranges	Temperature, °F.									
		Humidity, %									
	Working Ranges	Temperature, °F.	72° ± 2	72° ± 2	72° ± 2	72° ± 2	72° ± 2	72° ± 2	72° ± 2	72° ± 2	72° ± 2
		Humidity, %	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum	59 maximum
	Heat dissipated, BTU/hr.		3,552	5,320	7,650	4,528					1,451
	Air flow, cfm.										300
	Internal filters			Yes	Yes	Yes				Yes	Yes
ELECTRICAL	Voltage	Nominal	208	208	208	208	208	208	208	120	120
		Tolerance	±10%	±2%	±2%	(Line) ±10%	±10%	±10%	±10%	±10%	±10%
	Cycles	Nominal	60 cps	60 cps	60 cps	60 cps	60 cps	60 cps	60 cps	60 cps	60 cps
		Tolerance									
	Phases and lines		1φ 3 wire	3φ 5 wire	3φ 5 wire	3φ 5 wire	3 phase 4 wire	3 phase 4 wire	3 phase 4 wire	1φ 3 wire	1φ 3 wire
	Load KVA		1.3	1.8	2.8	7.7	3.5	3.5	3.5	0.4	0.2
NOTES											

PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
PROCESSOR	401A-1	Central Processor Standard Equipment: 3 Index Registers 1,024 Words Storage (accepts 404-1 or 404-3 magnetic tape units)	4,215		189,675
	401A-2	Central Processor Standard Equipment: 3 Index Registers 1,024 Words Storage (accepts 404-2 magnetic tape units)	5,215		234,675
		Optional Equipment			
		Additional Storage (1 Max)			
	402-1	1,024 Words	650		29,250
	402-2	2,048 Words	1,300		58,500
	402-3	3,072 Words	1,850		83,250
	451	Multiply-Divide	250		11,250
STORAGE		Magnetic Disc File and Control (1 Max)			
	460-1	25 Million Characters	2,900	580	140,000
	460-2	50 Million Characters	4,000	800	180,000
	460-3	75 Million Characters	5,100	1,010	220,000
	460-4	100 Million Characters	6,200	1,240	260,000
INPUT-OUTPUT		Magnetic Tape (8 Max, one type only)			
	404-1	64,000 CPS or 96,000 DPS	900		43,200
	404-2	89,000 CPS or 133,000 DPS	900		43,200
	404-3	32,000 CPS or 48,000 DPS	450	135	20,250
	405	Magnetic Tape Switching Unit (1 Max, switches one tape unit into and out of a 400 system)	75	5	3,600
	409	Punched Tape Reader and Control (1 Max.)	975	100	46,200
	410	Punched Tape Punch and Control (1 Max.)	725	73	34,800
	418	Off-Line Printer Control	1,550	270	69,750
	422-3	Printer (can be substituted for 422-3) 900 LPM, 120 out of 160 positions	1,950	475	79,800
	422-3A	Optional Equipment:Vertical Spacing, 6 or 8 lines per inch	100	20	4,800
	422-4	Printer (can be substituted for 422-3) 900 LPM, 120 out of 120 positions	1,050	210	47,250
	422-4A	Optional Equipment Vertical Spacing, 6 or 8 lines per inch	100	20	4,800
	450	Print Storage Option (permits simultaneous print and compute)	390	19.50	17,550
	423-2	Card Reader (1 Max.) 650 CPM	325	52.25	14,700

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
INPUT-OUTPUT (CONTD.)	423-2A	Optional Equipment Pocket Select	15	0.30	675
	436-1	Tape Control Unit (1 Max.) for compatibility with other manufacturers' tapes.	1,380	195	62,100
	440	Optical Scanner and Control (1 Max.)	2,530	505	121,440
	480	Communications Control (1 Max.)	790	79	35,550
	427	Card Reader-Card Punch (800 CPM/250 CPM) (1402 Model 1)	550		30,000
	427-2A	Pocket Selection Feature (for the Model 427)	15		675

HONEYWELL 800

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CONTENTS

INA = Information Not Available

CONTENTS (Contd.)

INTRODUCTION

§ 011.

The H-800 is a medium to large computer system designed to process more than one program at a time *. This is an attempt to reduce the inefficiencies of individual programs, which are usually input-output or central processor limited. In any installation, the degree of success of multi-program operations depends upon how well the programs selected balance the sum of the demands on the central processor with the demands on the peripheral units. In practice, installations with time-sharing programs operate an average of two programs at a time, with peaks of five or six. (The hardware is capable of sharing the central processor time among up to eight programs.)

The H-800 rents for between $18,000 and $40,000 a month, depending on the configuration, and size, is intermediate between the H-400 and the new H-1400 on the one hand, and the H-1800 on the other. The H-800 uses the same data-codes as the H-400 and the H-1400, and thus, magnetic tapes can be interchanged between these systems. The H-1800 can run H-800 programs, as the H-800 order code is a subset of the H-1800 code.

The multi-running* feature of the H-800 is particularly valuable where large volume input-output files are processed with either relatively little or peaked internal processing. Typical applications of this character are found in the insurance and utility fields. This approach also permits a program mix which includes a series of scientific (low volume input-output) computation programs.

The manufacturer has undertaken the development of software which should encourage more use of multi-running. A package has been released for controlling up to seven simultaneous conversions between cards, paper tape, magnetic tape, and hard copy. The elimination of the separate "program testing" executive system has been proposed because many installations tend to retain it after testing has been completed rather than convert to the different operating requirements of the standard production executive system.

The H-800 has the capacity to execute 30,000 three-address instructions per second. The computer uses a 48-bit word, either as 44 bits plus sign character, 11 decimal digits plus sign character, or 12 unsigned decimal digits. Alphameric characters can be stored eight to a word, but cannot be used in arithmetic.

Decimal and binary computing facilities are available in the H-800, as are multi-word transfers, which allow economical programming. However, the computer has no facility for easy conversion of external data codes to internal code, or vice versa. All shifts are right end-around shifts, so that editing is costly. An edit generator and several standard routines are available, but most routines appear to be written for individual cases.

The H-800 storage is divided into two parts, a Control Memory with eight "program groups," and a Main Memory which is divided into banks of 2,048 48-bit words. The basic H-800 has two of these banks; larger units can contain up to 14. The eight program groups are included in all cases. Each of these eight groups can control a separate program. A total of 64 (eight per group) index registers are provided. The addressing structure is such that while any program can reach or use any location in storage, it is necessary to use one of a number of special addressing methods when referring to addresses in other program groups or other banks. The index registers have restricted utility in that any base address can be modified by no more than 256 positions.

*"Multi-running" is used in these Reports to describe the operation of a computer that is simultaneously processing two or more independent programs. "Parallel programming" and other terms are currently used to describe the same concept.

§ 011. INTRODUCTION (Contd.)

There are 8 input and 8 output channels, all of which can operate concurrently with each other and the central processor. The peripheral units of the H-800 can be arranged as the user requires, with little restriction as to type or quantity. Honeywell-manufactured units include a 900 line per minute printer (which is very similar to the Anelex Printer) and magnetic tape units with character rates varying from 32,000 to 133,000 alphameric characters per second. Data communication units are being designed but no specifications have been released.

The Honeywell printer is unusual in that it has 160 printing positions, any 120 of which can be used at a time. Character and format selection is by plugboard. A paper tape loop located in the printer provides paper feeding control. These features enable printing two forms side by side and, where appropriate, the use of standardized print routines.

The Honeywell magnetic tape system is designed to allow the recovery of data lost during writing, storage, or upon re-reading. This recovery is effected by forming and checking "orthotronic control words" which are appended to each record on tape. The overheads involved in forming these words place an additional load on the central processor when writing is in process. The size of this additional load varies from $2\frac{1}{2}$ per cent to 10 per cent, depending on the tape unit in use. No additional load is present during reading operations.

Other available peripheral equipment includes: paper tape equipment capable of reading 1,000 characters per second and punching 110 characters per second; card readers which operate at 250, 650, or 800 cards per minute; card punches which punch either 100 or 250 cards per minute, and mass-storage discs with capacities of up to 800 million alphameric characters.

The software provided with the H-800 includes an assembly language (ARGUS), a FORTRAN II translator (AUTOMATH-800), and a business compiler (FACT). A COBOL compiler and FORTRAN IV translator (AUTOMATH-1800) have been announced for 1963. All of these are described in the language and translator sections.

The FACT compiler can handle files arranged as individual items, similar to COBOL files; or files with "hierarchical" structure. This arrangement saves tape space by recording identical data in a number of consecutive items only once instead of a number of times.

A Sort package, using the cascade sorting method, is available for the H-800. Cascade sorting merges strings from all except one of the tape units available, thereby providing faster sorting.

An executive system able to control the operation of all program translators and production programs is provided.

The executive system presently in use is designed for batch processing through assembly, and then running either serially under program testing methods, or in parallel in production. The ordering and control during a production run is controlled by a schedule which is created by a special run, but which relies very considerably upon the human skills of the scheduler who sets up the basic data. The things to be considered vary considerably from one installation to another, and the return which can be obtained from multi-running depends in no small measure on the ability of the scheduler.

Running under the executive system causes no actual loss of time during production running, as the executive program is not operating at this time. However, preparatory runs consume approximately 15 minutes of running time to set up the schedule and program tapes.

H-800-II SUMMARY ANALYSIS

§ 012.

The H-800-II system includes an Input-Output Control System (IOCC) which provides additional buffering capabilities beyond those of the H-800. In all other ways, the system is identical to the H-800. The use of the IOCC permits a reduced number of controllers to achieve simultaneous multi-program running operations.

The IOCC is a three-way switching device between the central computer, a bank of four tape units, and three peripheral units (i.e., card reader, card punch, line printer). This arrangement allows the peripheral units to be used directly on-line with the computer or off-line with the tape units acting as intermediary storage before the final result is produced. The terms "On-Line" and "Off-Line" describe two of the three operational modes of the IOCC. These are supplemented by the term "Simulated On-line Mode," to describe on-line operations which complement their related off-line operation.

The selection of peripheral units which can be connected to the IOCC is restricted to one card reader, one card punch, and one printer. Additional peripherals must be connected by means of appropriate adapters to the normal input-output channels. (No adapters are needed for units connected directly to the IOCC.) Similarly, the tape units are restricted to using card images or line images. It should be noted that it is not necessary for the tapes produced through the IOCC to be used only for off-line work. They can be used as ordinary tape files; however, as such, they are restricted to specific block sizes, the largest of which is only 120 characters.

Three operations can be overlapped at any one time through use of the IOCC. These can be chosen from the nine possible operations listed in Table I. However, only one case of each specific operation is allowed at any one time (i.e., it is not possible to prepare three of the four IOCC tape units for printing simultaneously).

The only overhead involved in these operations occurs while the card or line images are being transferred into and out of core storage. If, as in off-line operations, the core store is not being referred to, then no load on the central processor is involved. Otherwise, in no single case can the load exceed 2 per cent of the total central processor capacity.

The major effect of the introduction of the H-800-II is the reduction of rentals by the removal of the need for some of the adapters. The rental of the central processor is increased to $1,950 per month, and the cost of the control units displaced is normally between $2,900 and $4,900, for a net reduction of $950 to $2,950. The IOCC also reduces the need for additional controllers that are necessary to take maximum advantage of the multi-running capabilities of the H-800.

H-800-II SUMMARY ANALYSIS-(Contd.)

TABLE I

IOCC USE SUMMARY

Equipment connected to an Input/Output Control (IOCC) can be operated in nine possible modes. These nine modes may be applied in any combination. The IOCC and connected equipment are restricted solely to these uses.

	Information Flow
On-Line Mode	
1) Card Reading	Card Reader - IOCC - Main Memory
2) Card Punching	Main Memory - IOCC - Card Punch
3) Printing	Main Memory - IOCC - Printer
Off-Line Mode	
4) Card Reading	Card Reader - IOCC - IOCC Tape
5) Card Punching	IOCC - IOCC - Card Punch
6) Printing	IOCC Tape - IOCC - Printer
Simulated On-Line Mode	
7) Card Reading	IOCC Tape - IOCC - Main Memory
8) Card Punching	Main Memory - IOCC - IOCC Tape
9) Printing	Main Memory - IOCC - IOCC Tape

An IOCC Tape is a tape written by or read on an IOCC which contains either card images or print-line images with one image per tape record. These tapes are exactly like those used by existing H-800 off-line control units.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of location	Size	Purpose or Use
Digit	4 bits	Storage of 1 BCD number.
Character	6 bits	Storage of 1 alphabetic char.
Word	48 bits	instructions. data items.
Item	1 to n words	used for internal Mass Transfers; and optionally for magnetic tape I/O
Record	1 to n words	Used for internal Mass Transfers and for magnetic tape I/O.
Record	64 words	disc storage.

.2 DATA FORMATS

Type of data	Unit	Representation
Binary	1 word	44 bits plus 4-bit sign.
Decimal	1 word	11 decimal digits plus 4-bit sign. 12 decimal digits.
Alphameric	1 word	8 6-bit characters.
Alphameric (compressed)	1 word	any mixture of 4-bit and 6-bit characters adding up to 48 bits.
Instruction	1 word	Operation code and three addresses.
Floating Point Binary number	1 word	40-bit fixed point part with 1-bit sign. 6-bit exponent, with 1-bit sign.
Floating Point Decimal	1 word	10-decimal fixed point part with 1-bit sign. 6-bit exponent with 1-bit sign.

BIT POSITION	1	5	9	13	17	21	25	29	33	37	41	45
DECIMAL	±	1	2	3	4	5	6	7	8	9	0	1
ALPHAMERIC	R	O	B	I	N	S	O	N				
ALPHAMERIC COMPRESSED	C	.	W	E	B	B	1	7	4			
BINARY	±	(44 Binary Digits)										
FLOATING-POINT DECIMAL	±	Exp'nt (7 binary digits)	Mantissa (10 Decimal Digits)									
FLOATING-POINT BINARY	±	Exp'nt (7 binary digits)	Mantissa (40 Binary Digits)									
INSTRUCTION	OPERATION CODE	ADDRESS A	ADDRESS B	ADDRESS C								
SPECIAL REGISTER		±	(15 Binary Digits)									

Honeywell 800 Word Structure

§ 031. SYSTEM CONFIGURATION

All H-800 input-output equipment is treated alike by the central processor. The different features of individual equipment units are handled by controllers.

As an aim of the design philosophy of the system was to allow each installation to balance its input-output to its central processor use, it followed that considerable flexibility has been given to the arrangement of peripheral equipment.

In general, therefore, each unit of equipment has an on-line controller which gives it the use of a single channel on the computer. In some cases, a different on-line controller is used which allows a group of units to operate one at a time.

For off-line work in conjunction with a magnetic tape, another auxiliary unit is used. Sometimes, a special controller is required instead of the on-line controller.

The best controllers for each particular unit are determined by individual installation conditions. Below is a list of units, together with the alternative controllers they require for

1. On-line use with the computer.
2. Off-line with an H-804 tape unit.

Peripheral Units	On-Line Controller	Off-Line Controller
Magnetic Tape Unit H-804	H-803 (various models)	- -
Printers H-822	H-806 or H-811*	H-815 + H-806 or H-817 + H-811* or † H-818
Card Readers	H-807 or H-811*	H-816 + H-807 or H-817 + H-811*
Card Punches	H-808 or H-811*	H-815 + H-808 or H-817 + H-811*
Paper Tape Reader	None	H-816
Paper Tape Punch	None	H-815

† Only usable with the H-822-3, 900-line-per-minute printer.
* Although one card reader, one card punch, and one printer can be connected to this controller at the same time, only one at a time can be operated.

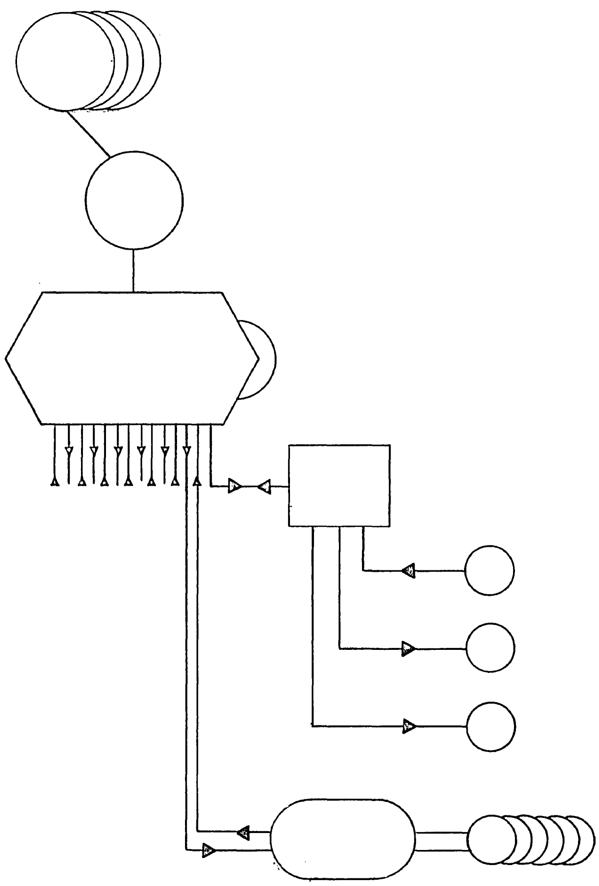
SYSTEM CONFIGURATION

§ 031.

.1 6-TAPE AUXILIARY STORAGE SMALL BUSINESS ORIENTED SYSTEM (CONFIGURATION V)

Deviations from Standard Configuration: . . . . storage larger by 2,096 words (100%).
50 million char auxiliary storage instead of 20 million.
card reading faster by 30%.
printing faster by 80%.
61 additional index registers.

Rental: . . . . $25,329 per month.



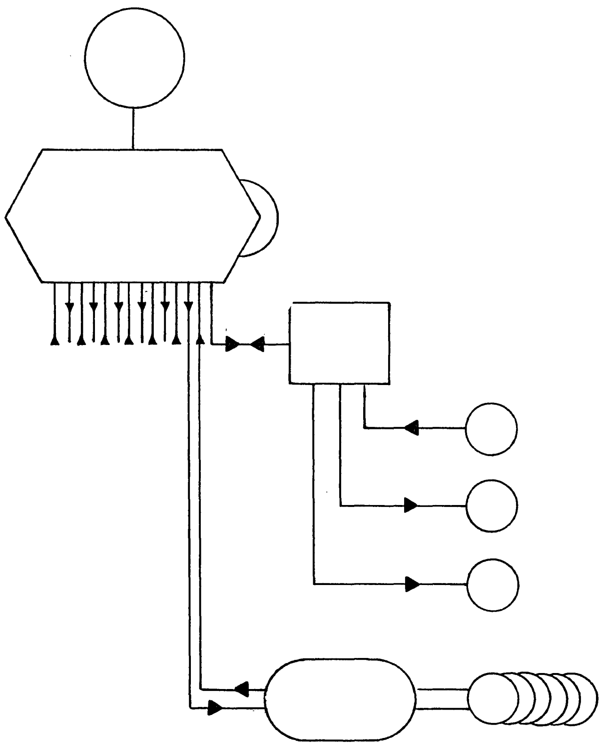
Equipment	Rental
1 Auxiliary Storage Unit 50 million characters.	$ 6,100
Basic Storage of 4,096 words and 256-word Control Memory Central Computer and Console.	8,550
Multiple Terminal Unit Model H-811-3	1,950
Card Reader Model H-823-2 650 cards/min.	1,325
Card Punch Model H-824-1 100 cards/min.	154
High Speed Printer Model H-822 900 lines/min.	1,950
Magnetic Tape Controller Model H-803 with 6 H-804-3 Tape Units (32,000 alphameric char/sec) each.	2,000 3,300
Total:	$ 25,329

§ 031.

.2 6-TAPE BUSINESS/SCIENTIFIC SYSTEM (CONFIGURATION VI)

Deviations from Standard Configuration: . . . . storage smaller by 1, 000 words (20%).
1 additional tape transfer.
card reading faster by 30%.
printing faster by 80%.
61 additional index registers.

Rental: . . . . $20, 329 per month.



Equipment	Rental
Basic Storage of 4, 096 words and 256-word Control Memory; Central Computer and Console	$ 8, 550
Floating Point Option	2, 100
Multiple Terminal Control Model H-811-3	1,950
Card Reader Model H-823-2 650 cards/min.	325
Card Punch Model H-824-1 100 cards/min.	154
High Speed Printer Model H-822-3 900 lines/min.	1,950
Magnetic Tape Controller Model H-803 with	2, 000
6 H-804-3 Tape Units (32, 000 alphameric char/sec each).	3, 300
Total:	$ 20, 329

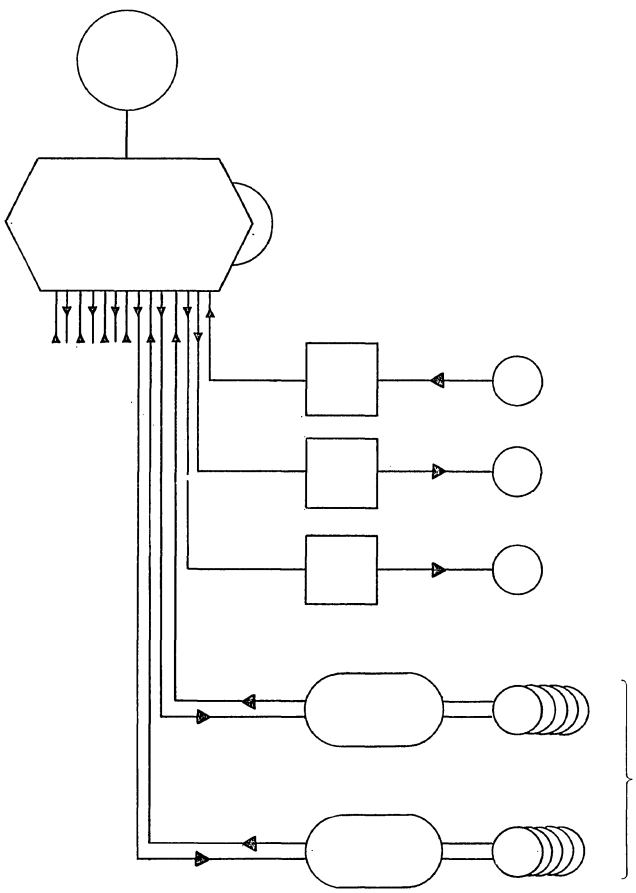
Optional Features Included:. . . . . Scientific Option.

§ 031.

.3 10-TAPE INTEGRATED LARGE BUSINESS-ORIENTED SYSTEM (CONFIGURATION VII A)

Deviations from Standard Configuration: . . . . 2 additional magnetic tape transfers.
card reading faster by 30%.
printing faster by 80%.
1 additional non-magnetic-tape transfer.
48 additional index registers.

Rental: . . . . $36, 079 per month.



Equipment	Rental
Core Storage of 12, 288 words and 256-word Control Memory	$ 6, 400
Central Computer and Console.	8, 550
Floating Point Option.	2, 100
Card Reader Model H-823-2 650 cards/min with	325
Controller H-807-2	1, 100
Card Punch Model H-824-1 100 cards/min with	154
Controller H-808-1	1, 050
High Speed Printer Model H-822-3 900 lines/min with	1, 950
Controller H-806-3	1, 450
2 Magnetic Tape Controllers Model H-803 with	4, 000
5 H-804-1 Tape Units (62, 000 alphameric char/sec) each.	9, 000
Total:	$ 36, 079

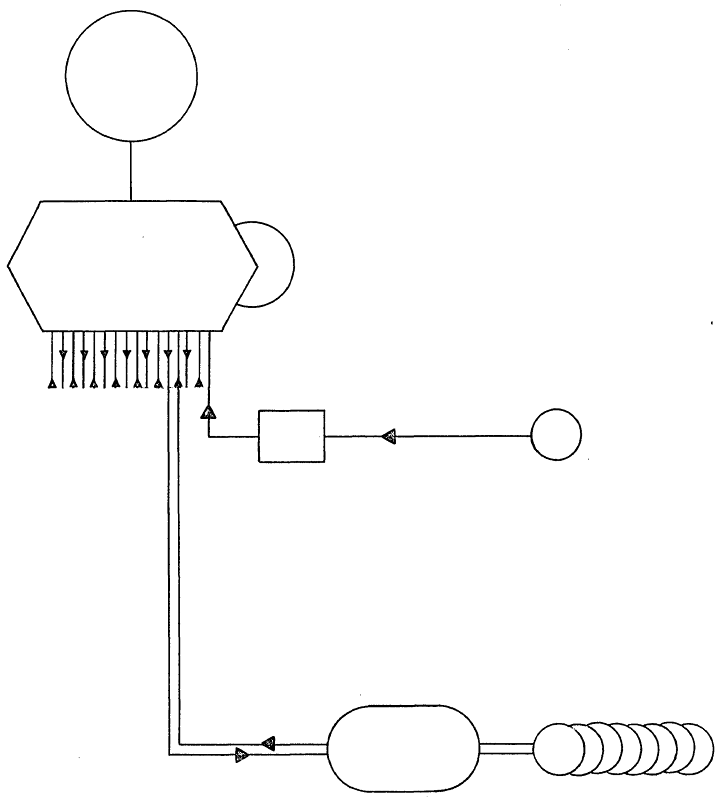
Optional Features Included: . . . . Floating Point Option.
8, 192 words of storage.

§ 031.

.4 10-TAPE PAIRED LARGE BUSINESS-ORIENTED SYSTEM (CONFIGURATION VII B)

Deviations from Standard Configuration: . . . . magnetic tape slower by 3%.
card reading faster by 140%.
1 additional non-magnetic tape transfer.
58 additional index registers.

Rental: . . . . $22,525 per month.



Equipment	Rental
Basic Storage of 8,192 words and 256-word Control Memory	$ 1,600
Central Computer and Console with	8,550
Floating Point Option	2,100
Card Reader Model H-823 240 cards/min	125
Controller H-807-1	950
Magnetic Tape Controller Model H-803 with	2,000
8 H-804-1 Tape Units (62,000 alphameric char/sec)	7,200
Total:	$ 22,525
Total including Off-Line Equipment:	$ 28,475

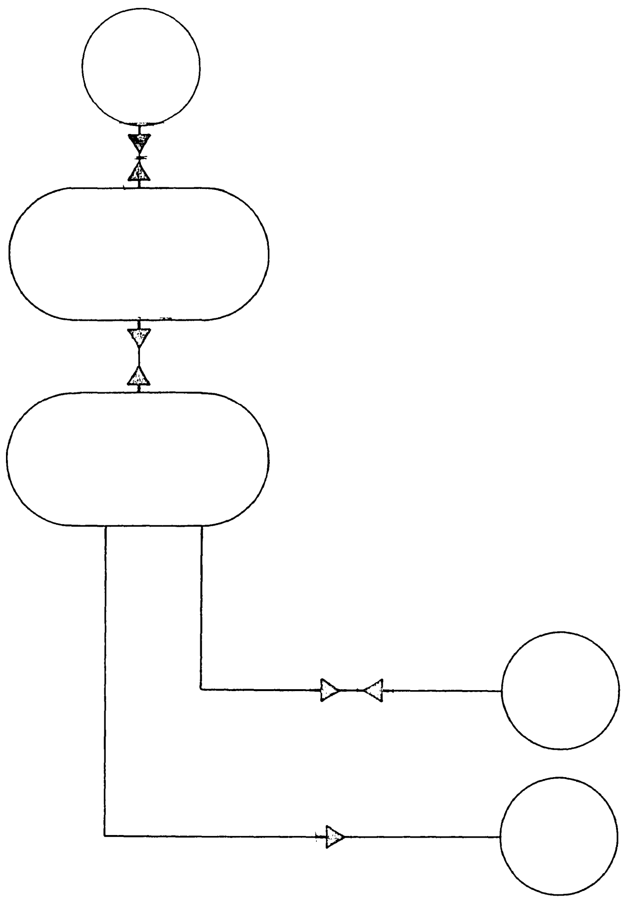
Optional Features: . . . . .Floating Point Option.

§ 031.

.4 10-TAPE PAIRED LARGE BUSINESS-ORIENTED SYSTEM (CONFIGURATION VII B, Contd.)

Deviations from Standard Configurations: . . . . card reading faster by 60%.
card punching faster by 15%.
printing faster by 80%.

Rental: . . . . $5,950.



Equipment	Rental
H-804-3 Economy Tape Unit 30,000 char/sec.	$ 550
H-817 Auxiliary Control	950
H-811-6 Control Unit	1,950
H-827 Card Read/Punch 800 cards/min reading 250 cards/min punching	550
H-822-3 High Speed Printer 900 lines/min.	1,950
Total:	$ 5,950

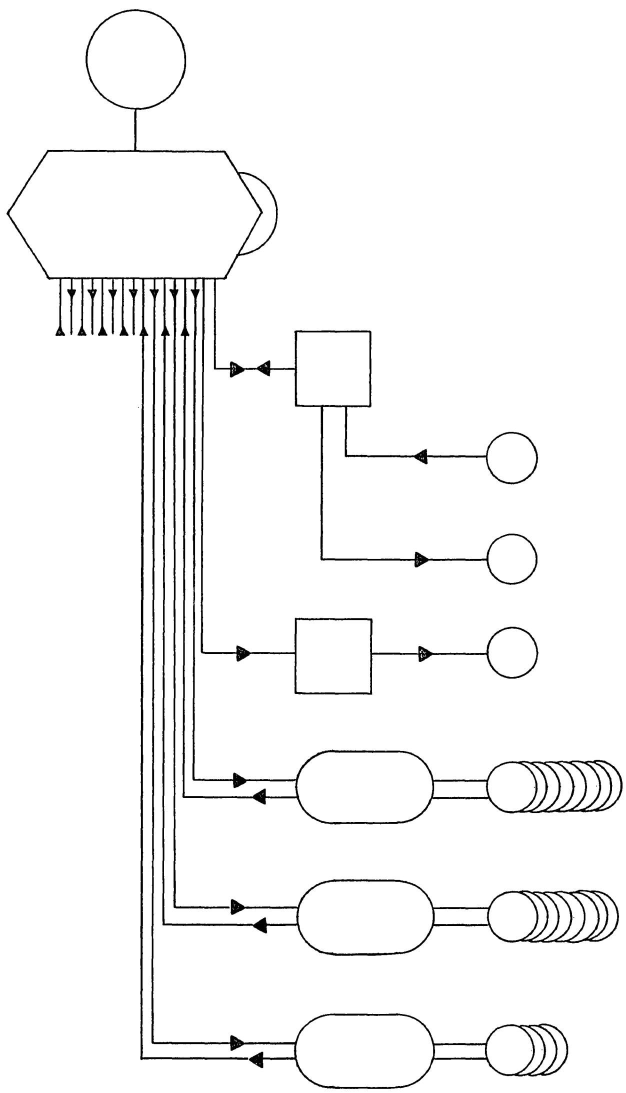
§ 031.

.5 20-TAPE INTEGRATED LARGE BUSINESS-ORIENTED SYSTEM (CONFIGURATION VIII A)

Deviations from Standard Configuration: . . . . .1 additional magnetic tape transfer.
card reading slower by 20%.
printing slower by 10%.
54 additional index registers.

Rental: . . . . $54, 000 per month.

On-Line Equipment



Equipment	Rental
Basic Storage of 24, 576 words and 256-word Control Memory	$ 8, 000
Central Computer and Console.	8, 550
Floating Point Option	2, 100
Model H-807-3 Controller	1, 100
Card Reader Model H-827 800 cards/min; Card Punch Model H-827 250 cards/min	550
High Speed Printer Model H-822 900 lines/min	1, 950
Model H-806-3 Controller	1, 450
3 Magnetic Tape Controllers Model H-803 with 20 H-804-4 Tape Units (133, 000 alphameric char/sec.) each.	30, 300
Total:	$ 54, 000

Optional Features Included: . . . . Floating Point Option.
20, 480 words of store.

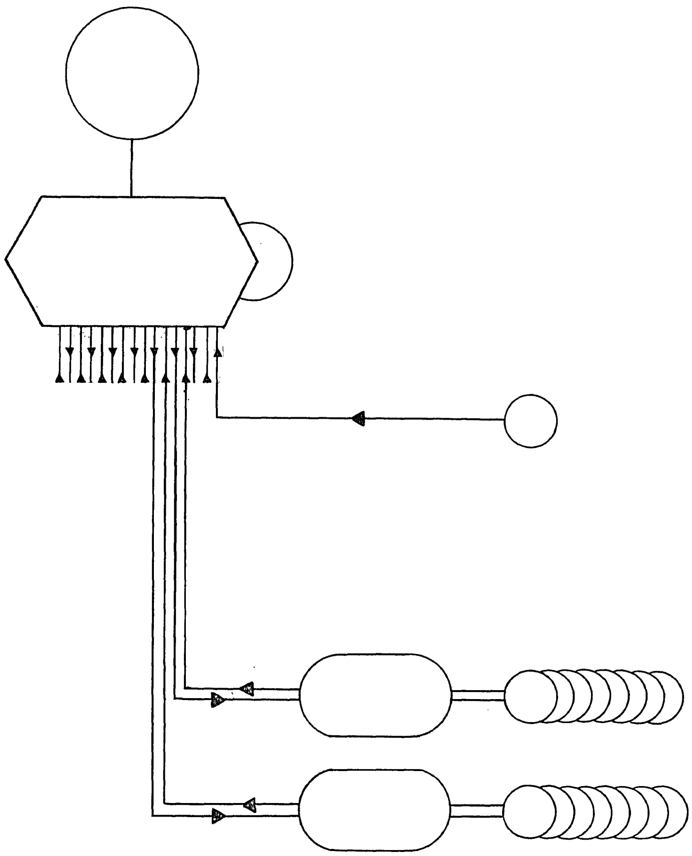
§ 031.

.6 PAIRED 20-TAPE GENERAL SYSTEM (CONFIGURATION VIII B)

On-Line Equipment

Deviations from Standard Configuration: . . . . tape unit 10% faster.
faster card reading (300 instead of 100 cards/min).
54 additional index registers.

Rental . . . . $39, 125 per month.



Equipment	Rental
Basic Storage of 4, 096 words and 256-word Control Memory, plus 3 additional storage units, each of 4, 096 words.	$ 4, 800
Central Computer and Console.	8, 550
Including Floating Point Option.	2, 100
Card Reader Model H-823: 240 cards/ min with	125
Controller H-807-1	950
2 Magnetic Tape Controllers Model H-803-4 with 8 H-804-4 Tape Units (133, 000 alphameric char/sec) each.	8, 200 14, 400
Total:	$ 39, 125
Total including Off-Line Equipment:	$ 46, 925

Optional Features Included: . . . . Floating Point Option.
12, 288 words of storage.

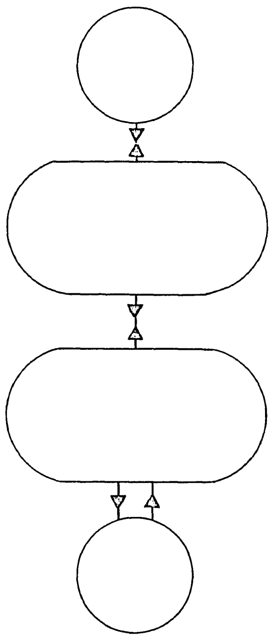
§ 031.

.6 PAIRED 20-TAPE GENERAL SYSTEM (CONFIGURATION VIIIB, Contd.)

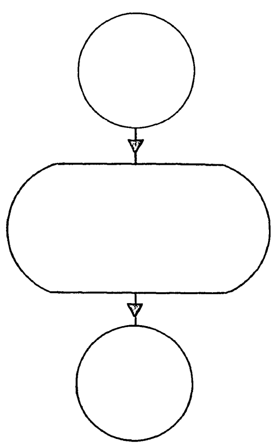
Off-Line Equipment

Deviations from Standard Configuration: . . . . . . card reading slower by 20%.
printing slower by 10%.

Rental: . . . . $7, 800.



Equipment	Rental
H-804-3 Economy Tape Unit 32, 000 char/sec	$ 550
H-817 Auxiliary Control	950
H-811-4 Control Unit	1, 700
H-827 Card Read/Punch Unit 800 cards/min Reading 250 cards/min Punching	550
	$ 3, 750



Equipment	Rental
H-804-3 Economy Tape Unit 32, 000 char/sec	$ 550
H-818 Off Line Printer Control	1, 550
H-822-3 High Speed Printer 900 lines/min	1, 950
	$ 4, 050
Total	$ 7, 800

INTERNAL STORAGE: CONTROL MEMORY

§ 041.

.1 GENERAL

.11 Identity: . . . . Control Memory.

.12 Basic Use: . . . . to hold 8 standard sets of data for programs and for independent pairs of I/O channels.

.13 Description

The function of the Control Memory is to control each of a number of programs. For this reason, it is divided into eight segments, each of which contains sufficient controls and auxiliaries for a single program. The contents of a single segment, listed below, include 8 index registers and 12 or 16 general purpose registers, in addition to sequence, interrupt, and masking facilities.

Each separate register can hold a 16-bit word, and basically contains one address. The first two registers contain counters for handling multiword operations, one for the source and one for the destination. The others control various features of the operation.

Table of Special Register Names, Subaddresses, and Mnemonic Address:

Sub-address	Mnemonic Address	Name
00	AU1	Arithmetic Control Counter No. 1
01	AU2	Arithmetic Control Counter No. 2
02	SC	Sequence Counter
03	CSC	Cosequence Counter
04	SH	Sequence History Register
05	CSH	Cosequence History Register
06	UTR	Unprogrammed Transfer Register
07	MXR	Mask Index Register
08-15	X0-S7	Index Registers
16-23	R0-R7	General Purpose Registers
24-27	S0-S3	General Purpose Registers
28	RAC*	Read Address Counter
29	DRAC*	Distributed Read Address Counter
30	WAC*	Write Address Counter
31	DWAC*	Distributed Write Address Counter

* In those special register groups not associated with active input and/or output channels, RAC, DRAC, and/or WAC, and DWAC are replaced by S4-S7, four General Purpose Registers.

.13 Description (Contd.)

Registers No. 03 through 06 are used for sequence control purposes, and provide for three distinct sequencing arrangements within the same program. For practical purposes, the Sequence and Cosequence counters are similar in function, providing two normal program sequence controls between which the programmer can alternate as he chooses. This provision allows reduction in program length of some 5 to 10 per cent, depending on programming philosophy.

The third sequencing arrangement is the Interrupt system (described in Paragraph .333 of the Central Processor section). In this system, a basic address is stored in the Unprogrammed Transfer Register. This address is incremented to define both the cause of the interruption and the instruction which was in control at the time.

Eight index registers are included in each segment of the Control Memory. These act as base addresses rather than as augmenters. Each index register can contain an address anywhere in storage, but the instruction has only eight bits (i.e., up to 256) to specify the increment or decrement to be applied. This limitation considerably restricts the utility of the index registers; however, indirect addressing is also available (see Central Processor, Paragraph .238).

Because the cycling of the Control Memory is offset by half a cycle from the cycling of the Main Memory, no easy rule is available to show the cost of indexing. The rules for each case of each instruction are spelled out in an Appendix to the Programmers Reference Manual. To illustrate the complexity involved in detailed timing a typical entry from this appendix follows.

Instruction	Basic Time in Memory Cycles	Modification of Basic Time
TS (cont)		1 mc if C is direct special register or indirect memory location address 1 mc if C is indexed
B. Masked 1. If B is inactive, and		
a. A is inactive b. A is active	5 6	Add: 1 mc if A is indexed 1 mc if C is indexed Sub: 2 mc if C is inactive
	6	Add: *1 mc if A is inactive *1 mc if A is inactive and B is indexed *1 mc if A or B is indexed 1 mc if C is indexed

§ 041.

.13 Description (Contd.)

Six special registers are used to control the two input and output channels which may have been connected to each sector. Two control the actual transfer to and from the I/O device, while two control the storage areas being used if the transfers are to be scattered around the store. This latter practice, which doubles the I/O demands on the store, and may introduce a considerable number of I/O restrictions, is not often followed.

Many instructions are available to provide for masking of the operands. The Masking Control Register contains the address, anywhere in storage, of the mask to be used. This mask is used on all the operands in a masked operation.

INTERNAL STORAGE: CORE STORAGE

§ 042.

.1 GENERAL

.11 Identity: . . . . Core Storage in H-801 Processor. Additional H-802 Modules.

.12 Basic Use: . . . . working storage.

.13 Description

The core storage is used as the main computer storage. It is accessed independently, and without lockouts, by each program running in parallel. Some instructions allow for masking of each of the operands. Irrespective of whether one, two, or three operands are referred to by the instruction, the same mask is applied to each. The basic machine has a core storage of 4,096 words, each consisting of 48 data bits and 6 check bits. Six modules, each of 4,096 words, can be connected.

.15 First Delivery: . . . . 1960.

.16 Reserved Storage: . . . none.

Purpose	Number of locations
Index registers: . . .	none.
Arith registers: . . .	none.
Logic registers: . . .	none.
I/O control:	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instruction: . . . . . . yes.
.242 Data regenerated constantly: . . . . . . yes.
.243 Data volatile: . . . . . yes.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.283 Type of access: . . . . all locations available each 6 microsecond cycle.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 133,000 cps.
Unit of data: . . . . . 1 word.
Conversion factor: . . 48 bits/word.
Gain factor: . . . . . 1.
Loss factor: . . . . . 1.
Data rate: . . . . . . 133,000 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	H-802 Module	Maximum Storage
Words:	4,096	4,096	28,672
Characters:	32,768	32,768	219,376
Instructions:	4,096	4,096	28,672

.32 Rules for Combining Modules: . . . . no restriction.

.4 CONTROLLER: . . . . none.

.5 ACCESS TIMING: . . . any 1 word each 6-microsecond cycle.

.6 CHANGEABLE STORAGE: . . . . . . none.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	sequence interrupt.
Receipt of data:	check of 6 bits/word	sequence interrupt.
Recording of data:	generation of 6 bits/word	sequence interrupt.
Recovery of data:	check of 6 bits/word	sequence interrupt.
Dispatch of data:	generation of 6 bits/word	sequence interrupt.
Timing conflicts:	check if any data lost	sequence interrupt.
Physical record missing:	not possible.	
Reference to locked area:	not possible.	
Circuit failure:	check	halt.
Input area overflow	check	sequence interrupt after next word overwritten.

INTERNAL STORAGE: MAGNETIC DISC FILE

§ 043.

.1 GENERAL

.11 Identity: . . . . . . Magnetic Disc file.
Bryant Series 4000.
H-860.

.12 Basic Use: . . . . . auxiliary storage.

.13 Description

This unit consists of a controller plus one or more cabinets of discs. A maximum number of eight disc cabinets can be connected, providing a capacity of from 50 to 805 million alphameric characters.

Access to the disc is achieved by addressing data records, each of 512 alphameric or 768 numeric characters, arranged into 64 words. Any record in a track can be addressed independently. Slightly less than 1 percent of the file (that part over which the heads are positioned) is available within 41 milliseconds, assuming average latency for disc rotation and a constant of 6 milliseconds for data transfer.

To gain access to another track involves waiting the 41 milliseconds for access plus an additional 60 to 130 milliseconds for lateral head movement. Thus, an average access, including head position changes, takes 136 milliseconds, allowing nearly 480 records per minute to be obtained or stored.

As each disc unit of 100 million alphameric character capacity can position its heads independently of the other units, time-sharing is possible with more than one disc unit, and can result in rates of up to 1200 64-character records per minute.

Full specifications for the unit are still to be announced.

.14 • Availability: . . . . 9 months.

.15 First Delivery: . . attached to other computers?
attached to H-800, 1963.

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . magnetic disc.

.22 Physical Dimensions

.222 Drum or Disc
Diameter: . . . . 39 inches.
Thickness: . . . . thin.
Number on shaft: . 12 or 24.

.23 Storage phenomenon: direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . yes.
.242 Data regenerated constantly: . . . . no.
.243 Data volatile: . . . no.
.244 Data permanent: . . no.
.245 Storage changeable: . no.

.25 Data volume per band of 3 tracks

Words: . . . . . . 8,192.
Characters: . . . . 65,536.
Digits: . . . . . . 98,304 (or 90,112 in signed H-800 words).
Instructions: . . . . 8,192.

.26 Bands per physical unit: . . . . . . 256 per disc (128 on each side).

.27 Interleaving Levels: . none.

.28 Access Techniques

.281 Recording method: . moving heads.
.283 Type of access

Description of stage	Possible starting stage
Move head to selected band: .	yes.
Wait until record is in position: .	yes, if a record on the same band of any disc face was previously selected.
Transfer of record:	no, but previous stage time may be zero.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . 900 rpm.
Bits/inch/track: . . variable.
Compound bit rate: . . 615,000 bits/ sec.
.292 Peak data rates
Cycling rates: . . . variable.
Unit of data: . . . . word.
Conversion factor: . . 48.
Gain factor: . . . . . 3.
Loss factor: . . . . 1.
Data rate: . . . . . 4,270 words/sec.
Compound data rate: . 12,812 words/sec. (102,500 alpha char/sec).

§ 043.

.3 DATA CAPACITY

.31 Module and System Sizes

	Model 1	Model 2
Discs:	12	24
Words:	6, 291, 375	12, 582, 875
Characters:	50, 331, 000	100, 663, 000
Instructions:	6, 291, 375	12, 582, 875

System Size	Minimum System	Maximum System
Disc	12	192
Words	6, 291, 375	100, 688, 125
Characters	50, 331, 000	80, 305, 000
Instruction	6, 291, 375	100, 688, 125

.32 Rules for Combining Modules: . . . . . If more than one Disc File unit is to be connected to the control unit, each unit must contain 24 Discs. No more than 8 units can be connected at one time.

.4 CONTROLLER

.41 Identity: . . . . Model H-860 Control Unit.

.42 Connection to System

.421 On-Line: . . . . . . up to 8.
.422 Off-Line: . . . . . . none.

.43 Connection to System

.431 Devices per controller: up to 8.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 record = 64 words.
.442 Input-Output area: . . none.
.445 Synchronization: . . . automatic.
.447 Table control: . . . . none.
.448 Testable conditions: . general error and/or busy check.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks

	Model 1	Model 2	Model 9
Stacks per module:	24	48	386.
Stacks per yoke:	24	48	386.
Yokes per module:	1	1	1.

.512 Stack movement: . . . across one disc face.
.513 Stacks that can access any particular location: . . . . . . one.
.514 Accessible locations
By single stack
With no movement: . 1 band = 32 records of 64 words.
With all movement: . 128 bands = 4, 096 records of 64 words.

.514 Accessible locations (Contd.)
By all stacks
With no movement: . 32 N records per module, where n = 24 (Model 1) = 48 (Model 2) = 386 (Model 9) (i. e. 1/128 capacity).
.515 Relationship between stacks and locations: . none.

.52 Simultaneous Operations

A : . . . . reading a record.
B : . . . . writing a record.
C : . . . . searching for a record.
D : . . . . internal computation.
E : . . . . no. of disc file units.
F : . . . . no. of discs.

Overall System	Each Unit
$a+b+c \leqslant e$	$a+b+c \leqslant 1.$
$a+b+c+d \leqslant e+1$	$a+b+c+d \leqslant 2.$
$e \leqslant 8$	

.53 Access Time, Parameters, and Variations

.532 Variation in access time, in msec.

Stage	Variation	Example
Head positioning: . . .	0 or 60, 000 to 130, 000	95, 000.
Waiting for the disc to be in position:	0 to 67, 000	32, 000.
Transfer of record: . .	6, 000	6, 000.
Total:	6, 000 to 75, 000, or 66, 000 to 203, 000	133, 000.

.6 CHANGEABLE STORAGE: . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possible
With Self: . . . . . no.
With Main Memory: . yes.
With Control Memory: . . . . . no.

.72 Transfer Load Size: . . 1 record of 64 words.

.73 Effective Transfer Rate

With Main Memory: . . . . . not yet determined. this depends on the timing of the interrecord gap.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none	unpredictable
Invalid code:	not possible.	
Receipt of data:	not yet specified.	
Recording of data:	not yet specified.	
Recovery of data:	not yet specified.	
Dispatch of data:	not yet specified.	
Timing conflicts:	not yet specified.	
Physical record missing:	not yet specified.	
Reference to locked area:	not yet specified.	

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . H-801 Central Processor.
H-801B Central Processor.

.12 Description:

The H-801 Central Processor uses three-address instructions. Each operand address, which refers to a word in either Control Memory or Main Memory, can be written in a direct, indexed, or indirect manner. Indirectly addressed operands can themselves be indexed.

Input-output on the H-800 is handled in six-bit alphameric code, whereas the arithmetic instructions work in four-bit numeric requiring pre- and post-arithmetic conversion. No special instructions exist for handling the conversion from one to another; all must be programmed. Editing instructions to allow zero suppression, comma insertion, etc., are not included in the repertoire, and carrying out such functions can take over 500 microseconds per character, depending on the requirements and the programmer.

Some inefficiency in storage utilization can occur as a result of the addressing methods used. These methods divide the storage into two parts: one, a maximum of 2,048 words, which can be directly addressed, and another which requires special addressing through the control memory. While programs remain small, the inefficiencies are probably low, but as the average installation increases its storage size, the inefficiencies increase because a greater number of banks are used by the program(s) running at any one time.

Indexing is performed by adding an increment from the instruction to one of the 64 index registers. (The increment must be less than 256.) In indirect addressing the instruction can also contain an increment (less than 32) which can be added to the address in Main Memory after the instruction is performed, thereby automatically allowing the addresses in a loop to be modified.

Arithmetic is performed on complete words, in either binary or decimal mode. Partial words can be used as operands for some instructions through use of a mask word which is applied to each of the operands in the instruction in turn. The basic machine has facilities for fixed point addition, subtraction, and multiplication, but not division; it has no facilities for floating point operations. The H-801B has facilities for all fixed and floating point operations.

An instruction which checks each of six parity bits associated with a 48-bit data word is available. As part of the orthotronic recovery routine, this instruction is used to locate bad frames after an erroneous "read" operation. Another instruction permits orthotronic control words to be formed and appended to the output records.

The Accumulate instructions repeat themselves n times, adding each time into the accumulator. These instructions permit a number of different operands to be accumulated by one instruction, although signs are not treated arithmetically.

No inter-program protection is automatically available for data, instructions, sequence registers, etc. It is left to individual installations to ensure that time-sharing programs do not interfere with each other.

Instructions can treat data as words, items, or records for the purpose of transferring them into, out of, or within memory. An item is a group of words followed by an "end-of-item" word; a record is a group of words or items followed by an end-of-record word. Each time an end-of-item word is encountered during a transfer, an automatic table look-up operation locates the position in memory which the new item is to occupy.

Interruption can be caused by any of a number of conditions and results in a forced transfer of control. The destination (which is set up relative to a programmer-controlled address) distinguishes seven cases: Parity, Beginning or End of Tape, Input-Output error, Add/Subtract error, Division error, Exponential underflow, Exponential overflow.

.14 First Delivery: . . . 1960.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-Subtract:	automatic	binary or decimal	44 11
	Multiply			
	Short:	automatic	binary or decimal	44 11
	Long:	indirectly (extra digits in processor register)	binary or decimal	88 22
	Divide			
	No remainder:	*automatic	binary or decimal	44 11
	Remainder:	*indirect (extra digits in processor register)	binary or decimal	44 11

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.212 Floating point (available both with and without normalization.)

Add-Subtract:	*automatic	binary or decimal	40 & 7.
Multiply:	*automatic	binary or decimal	40 & 7.
Divide:	*automatic	binary or decimal	40 & 7.

* Scientific Option only.

.213 Boolean

AND:	automatic	binary.
Inclusive OR:	automatic	
Exclusive OR:	automatic	

.214 Comparison

Numbers:	automatic.
Absolute:	automatic.
Letters:	automatic.
Mixed:	none.

.215 Code translation: . . . none.

.216 Radix conversion: . . none.

.217 Edit format

Alter size: . . . . . . none.
Suppress zero: . . none.
Round off: . . . . . . none.
Insert point: . . . . none.
Insert spaces: . . . none.
Insert special character: . . . . none.
Float $: . . . . . none.
Protection: . . . . none.

.218 Table look-up: . . . none.

.219 Others
Accumulate: . . . . automatic.

.22 Special Cases of Operands

.221 Negative numbers: . . in fixed point representation, the sign is stored as 4 bits, but used as 1 bit; in floating point, 1-bit sign representation is used.

.222 Zero: . . . . positive or negative zero possible. These behave differently in alphabetic comparisons.

.23 Instruction Formats

.231 Instruction structure: . 1-word, 3-address instructions.

.232 Instruction layout: . . . Typical areas are shown below.

<table>
<tr><th>BITS</th><th>1</th><th>2 3</th><th>4</th><th>5</th><th>6</th><th>7 8 9 10 11 12</th><th>13 - 24</th><th>25 - 36</th><th>37 - 48</th></tr>
<tr><td rowspan="2">General Instructions Unmasked</td><td rowspan="2">S / C</td><td rowspan="2">1st Part of Op Code</td><td colspan="3">Memory Designator</td><td rowspan="2">2nd Part of Operation Code</td><td rowspan="2">A</td><td rowspan="2">B</td><td rowspan="2">C</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>General Instructions Masked</td><td>S / C</td><td colspan="4">Partial Mask Address</td><td>Operation Code</td><td>A</td><td>B</td><td>C</td></tr>
<tr><td rowspan="2">Peripheral Instructions</td><td colspan="5">Peripheral Address</td><td rowspan="2">Operation Code</td><td rowspan="2">A</td><td rowspan="2">B</td><td rowspan="2">C</td></tr>
<tr><td colspan="2">I/O Channel</td><td colspan="3">Device</td></tr>
<tr><td>Simulator Instructions</td><td>D / I</td><td colspan="5">Remainder of Address   1 1 1</td><td>A</td><td>B</td><td>C</td></tr>
</table>

.233 Instruction parts

Name	Purpose
S/C:	to designate either the Sequence Counter or the Cosequence counter as providing the next instruction.
Op Code:	operation code of 6, or 6 and 2 bits.
Memory Designator:	part of addressing structure of the operands
D/I:	part of addressing structure.
A, B, C:	part of addresses of operands (see below Address Structure).

.234 Basic address structure: . . . . . 3-address.

Honeywell 800 instructions can contain only the actual address of the operand when it is either in the same bank (2, 048 words) of storage or in the control memory. To obtain access to other areas a special register, which can hold a complete address, is used.

.235 Literals
Arithmetic: . . . . no.
Comparisons and tests: . . . . . . no.
Incrementing modifiers: . . . . yes, by use of indirect addressing.

§ 051.

.236 Directly addressed operands

.2361

Internal storage type	Minimum size	Maximum size	Volume accessible
Basic Store:	1 bit	48 bits	2,048 words
Special Register:	1 bit	16 bits	256 words

.2362 Increased address capacity

Method	Volume accessible
Indirect addressing: . .	up to 28,672 words.

.237 Address indexing

.2371 Number of methods: . . . . . one. (However, see indirect addressing, whose increment feature allows index-type operation).

.2372 Names: . . . . . . indexing.

.2373 Indexing rule: . . . up to 256 is added to (or subtracted from) the storage address given in the specified index register. The IR is not modified. The storage address can be either in Main Memory or in the Control Memory and the augmented address obtained can be used directly or indirectly.

.2374 Index specification: . . . within the instruction.

.2375 Number of potential indexers: . . . . 64.

.2376 Address which can be indexed: . . . . any in Basic or Special Memory.

.2377 Cumulative indexing: . . . . none.

.2378 Combined index and step: . . . . . not using index registers, but is available using an index register simply as a special register. See indirect addressing.

.238 Indirect addressing

.2381 Recursive: . . . . no.

.2382 Designation: . . . . special bit in instruction, which then interprets the 11 address bits of the appropriate A, B, or C address as an increment (< 32)and the address of any one of the special registers in any bank.

.2383 Control: . . . . . . absolute address must be contained in an addressed special register.

.2384 Indexing with indirect addressing: . . . modification occurs before the indirect address is determined.

.239 Stepping

Index Registers: . . own coding.

Indirect Addressing:. as specified below.

.2391 Specification of increment: . . . . in instruction.

.2392 Increment sign: . . special register sign.

.2393 Size of increment: . 0 through 31.

.2394 End value: . . . . own coding.

.2395 Combined step and test: . . . . . no.

.24 Special Processor Storage

.241

Category of Storage	Number of locations	Size in Bits	Program usage
Accumulator:	1	44 + 1	accumulate without storage.
Mask register:	1	48	repeated use of mask.
Low-order product register:	1	44 + 1	obtain double-length product.

.242

Category of storage	Total number locations	Physical Form	Access time μ sec	Cycle time μ sec
Accumulator	1	flip-flops	6	6.
Mask Register	1	flip-flops	6	6.
Low-order product	1	flip-flops	6	6.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 16.

.312 Arrangement: . . . . 2 per program, 8 programs in a processor.

.313 Precedence rule (within program): . . continues with one control until instructed to transfer control to other.

Precedence rule (within processor): . cyclically in turn to all active programs unless inhibited.

.314 Special sub-sequence counters: . . . . . none.

.315 Sequence control step size: . . . . . instruction words.

.316 Accessibility to routines: . . . . . yes.

.32 Look-ahead: . . . . none.

.33 Interruption

.331 Possible causes

In-out units: . . . . beginning or end of tape; read or write error.

In-out controllers: . . none.

Storage access: . . . none.

Processor errors: . . parity failure. arithmetic overflow. division error. exponential overflow or underflow.

Other: . . . . none.

.332 Control by routine

Individual control: . . all interrupts within one program; positions relative to a standard special register.

Method: . . . . . . either the sign of the increment or the base of the increment can be adjusted.

.333 Operator control: . . . none.

.334 Interruption conditions: interruption condition arises in program channel.

§ 051.

.335 Interruption process
- Disabling interruption: . . . . main memory cycling stops.
- Registers saved: . . all.
- Destination: . . . . standard distance away from variable base address stored in special register of program channel, depending on interruption cause.

.336 Control methods
- Determine cause: . . given by entry place.
- Enable interruption: . not necessary; the base or sign of the increment can be changed to allow for recognition of repeated interrupts.

.34 Multi-running

.341 Method of control: . . multisequence counters.
.342 Maximum number of programs: . . . 8.
.343 Precedence rules: . . cyclic, first-off, first-on, with cycling inhibition in own coding.
.344 Program protection
- Storage: . . . . . . none.
- In-out areas: . . . . none.
- In-out units: . . . . writing can be inhibited physically; otherwise, none.

.35 Multi-sequencing: . : . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ sec

.411 Fixed point
- Add-subtract: . . . . 18.
- Multiply: . . . . . . 200.
- Divide (Binary): . . . 200 to 690.
- Divide (Decimal): . . 252 to 587.

.412 Floating point (Normalized)
- Add-subtract: . . . 30 to 54.
- Miltiply: (Binary) . . 60 to 108.
- (Decimal) . . 72 to 390.
- Divide: (Binary) . . . 180 to 630.
- (Decimal) . . 240 to 516.

.413 Additional allowance for
- Indexing: . . . . . . 6 } may often be overlapped if two operands involved.
- Indirect addressing: . 6 }
- Re-complementing: . 0 or 6.

.414 Control
- Compare: . . . . . 24.
- Branch: . . . . . . 18.
- Compare and branch: . . . . . . 24.

.415 Counter control
- Step: . . . . (1) not available for index registers. (2) included in use of indirect address.
- Step and test: . . . . not available.
- Test: . . . . 24.

.416 Edit: . . . . not available.
.417 Convert: . . . . not available.
.418 Shift: . . . . 30 + 6 per bit, four-bit or six-bit character shifted.

.42 Processor Performance in μ sec

.421

For random addresses	Fixed point	Floating point
c = a + b:	24	42.
b = a + b:	24	42.
Sum N items:	18 + 6N	42N.
c = ab:	200	100.
c = a/b:	272	400.

.422

For arrays of data	Fixed point	Normalized floating point
$c_i = a_i + b_j$:	48	54 to 78.
$b_j = a_i + b_j$:	48	54 to 78.
Sum N items (if known to be all + or all - :	36 + 6N	36N to 60N.
otherwise:	30 N	
$c = c + a_i b_j$:	240	114 to 186 (binary). 126 to 432 (decimal).

.423 Branch based comparison
- Numeric data: . . . 114.
- Alphabetic data: . . 114.

.424 Switching
- Unchecked: . . . . 30.
- Checked: . . . . . 30 + 48D, where D is no. of decimal digits.
- List search: . . . 72 + 24N, where N is no. of comparisons.

.425 Format control per character
- Unpack: . . . . . 450 (alpha) 550 (numeric).
- Compose: . . . . 500 (alpha) 600 (numeric).

.426 Table look up per comparison
- For a match: . . . 30.
- For least or greatest: . . . . 30 + 48N, where N is no. of changes.
- For interpolation point: . . . . 30.

.427 Bit indicators
- Set bit in separate location: . . . . . 18.
- Set bit in pattern: . . 30.
- Test bit in separate location: . . . . . 18.
- Test bit in pattern: . . 30.
- Test AND for B bits: . 30.
- Test OR for B bits: . 30.

.428 Moving: . . . . 12N, where N is no. of words moved.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	special transfer.
Underflow:	check	special transfer.
Zero divisor:	check	special transfer.
Invalid data:	none.	
Invalid operation:	none.	
Arithmetic error:	check	special transfer.
Invalid address:	check	special transfer.
Receipt of data:	check.	
Dispatch of data:	check.	

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . Operator's Console.

.12 Associated Units: . . . console typewriter built into console desk.

.13 Description

The operators Console is a separate unit consisting of two display panels, a very simple typewriter keyboard which includes four additional control keys, and a built-in console typewriter. The console is specifically designed for monitoring the running of production programs rather than for assisting in the debugging of programs under test or of hardware conditions. The latter functions are handled specifically by software packets and by an engineering console.

The first display board (Figure 1), located directly in front of the operator's position, shows details of each of the eight programs currently being run, indicates control errors, and shows whether console operations are in progress. The second display frame (Figure 2), located to the left of the operator's position, shows the status of each input-output device.

The four control keys, are the Run, Stop, Execute (execute a console-enter instruction) and Cancel (cancel a console-entered instruction which has not been executed) keys. By using combinations of these keys, other functions such as single-instruction running (stepping) can be performed.

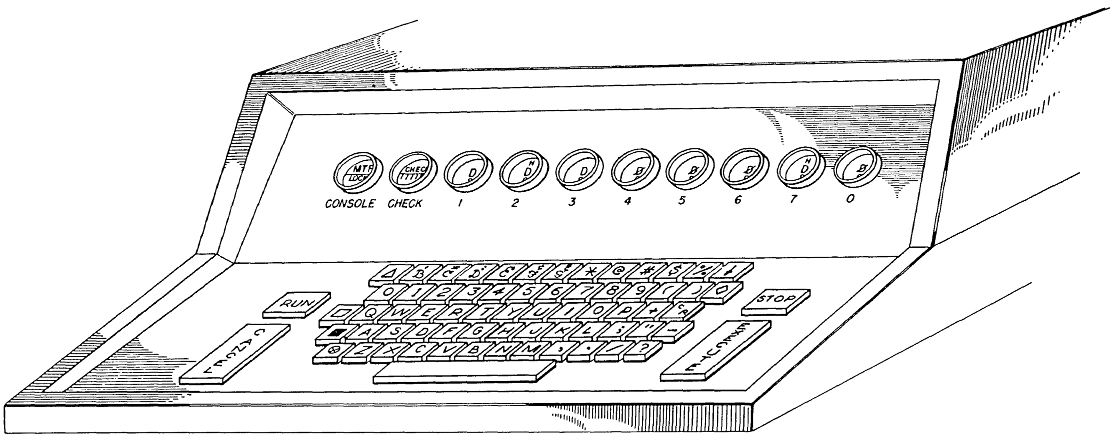


Figure 1. Keyboard and Indicator Lights on Honeywell 800 Console

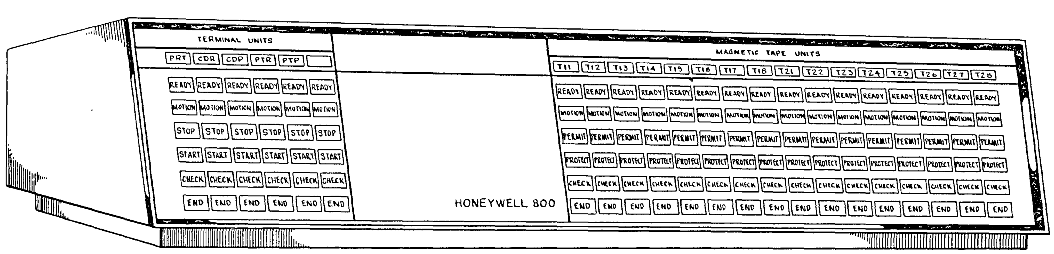


Figure 2. Modular Display Panel

§ 061.

.2 CONTROLS

.21 Power: . . . . none on the operator console.

.22 Connections: . . . . . . none on the operator console.

.23 Stops and Restarts: . . STOP and RUN keys.

.24 Stepping: . . . . STOP and CANCEL keys pressed simultaneously.

.25 Resets: . . . . type-ins from the console are used to perform this function.
The STOP and EXECUTE keys, can be used to obtain access to the computer as needed.

.26 Loading: . . . . standard type-in.

.27 Sense switches: . . . . none.

.3 DISPLAY

.31 Alarms

Central Computer Stall: any one of 16 specific errors causes the top half and an appropriate portion of the bottom half of the CHECK lamp to light red.

Program Stall: . . . . . a small white "H" on the particular program lamp lights when a program is interlocked for any reason.

Peripheral Device Stall: each of the terminal devices has an associated CHECK lamp which lights if an error occurs.
each of the I/O units has a STOP lamp which lights if a standard condition (e.g., stacker full, etc.) has caused the unit to cease functioning.
an END lamp lights if a END-of-FILE word has been sent to a peripheral device.

.32 Conditions: . . . . the lamps are related to on-line functioning of the I/O units.
if the units are being used off-line, the START lamp is disconnected.

.33 Control Registers: . . . special type-ins are required to have the contents of these printed by the console typewriter.

.34 Storage: . . . . see Paragraph .33 (Control Registers) above.

.4 ENTRY OF DATA: . . data must be entered by halting processing, typing in the special instructions and the data, and using the Execute control key. Type-outs indicate the data and instruction which has been performed.

.5 CONVENIENCES

.51 Telephone: . . . . no.

.52 Clock: . . . . no.

.53 Desk Space: . . . . . . yes.

.54 View: . . . . depends on positioning of the console and the equipment.

INPUT-OUTPUT: H-809 PUNCHED PAPER TAPE READER

§ 071.

.1 GENERAL

.11 Identity: . . . . Punched Paper Tape Reader and Control.
Model H-809.
Burroughs Corp. Unit B-141.

.12 Description

The H-809 Punched Paper Tape Reader and Control can operate at either 500 or 1,000 frames per second. Each data frame is right-justified, placed in a separate 48-bit word, and transferred to storage. The reader can handle up to eight-bit codes.

The data read is dependent upon standard subroutines to accomplish conversion to Honeywell 800 codes. The conversion and fitting of the character read into words normally takes approximately 100 microseconds per character. This operation loads the central processor 5 to 10% of its total capacity, depending on the speed to which the paper tape reader is set. The effective speed of the reader is reduced by at least 5 characters per second whenever the tape reader is allowed to halt.

The reader can read tape either from spools or in strips. It uses swing arms for tension, and spool motor drive control. The read mechanism is photoelectric and the tape is driven by a pinch roller. An automatic rewinding feature is incorporated in the unit.

Either paper tape reels or strips can be read; however, if strips are used, reading must be restricted to 500 characters per second. The paper tape should be non-oiled, opaque tape. Metallic tape can be used optionally.

.13 Availability: . . . . . . 1960.

.14 First Delivery: . . . . 9 months.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arms.
Capacity: . . . . 3 feet.
.213 Feed drive: . . . . . . servo motor.
.214 Take-up drive: . . . . . servo motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . photoelectric.
.223 Common system: . . . none.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . read.
Stacks: . . . . 1.
Heads/stack: . . . . . . 9.
Method of use: . . . . . frame at a time.

.25 Range of Symbols

Numerals: . . . . any 5 to 8 bit code.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . non-oiled, opaque paper tape.
.312 Phenomenon: . . . . . . punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . by row; 10/inch.
.322 Parallel by: . . . . . . 6 to 9 tracks.
.323 Bands: . . . . none.
.324 Track use
Data: . . . . tracks 1 to 3, 5 to 9.
Redundancy check: . . any track except sprocket.
Timing: . . . . track 4 (sprocket track).
Control signals: . . . none.
Unused: . . . . none.
Total: . . . . 6 to 9.
.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . one character per row, using 5 to 8 bits; any 5-, 6-, 7-, or 8-bit code.

.34 Format Compatibility: . other paper tape systems.

.35 Physical Dimensions

.351 Overall width: . . . . . 11/16; 7/8; 1 inch.
.352 Length: . . . . 8 to 700 ft.
4-foot leader.
4-foot trailer.

.4 CONTROLLER

.41 Identity: . . . . incorporated in unit.

§ 071.

.42 Connection to System

.421 On-line: . . . . up to 8.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 frame.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . none.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . scatter read.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 frame.
.512 Block demarcation: . . automatic at 1 frame.

.52 Input-Output Operations

.521 Input: . . . . 1 frame.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . unload forward or rewind until end of tape is reached.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . none.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . 81.
Rearrangement: . . . . rearrangement of tracks only.

.55 Control Operations

Disable: . . . . disable up to 3 tracks manual.
Request interrupt: . . . none.
Select format: . . . . . none.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes, provided no other unit is occupying the same channel.
Output lock: . . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: metallic foil at each end of tape.

.6 PERFORMANCE

.61 Conditions

I: . . . . full speed 1,000 frames/sec.
II: . . . . medium speed 500 frames/sec.

.62 Speeds

.621 Nominal or peak speed: I 1,000 frames/sec.
II 500 frames/sec.
.622 Important parameters
Full speed: . . . . . . 1,000 frames/sec.
Medium speed: . . . . 500 frames/sec.
Start time: . . . . . . 5 msec.
Stop time: . . . . . . 0.1 msec.
Time between 2 read instructions to maintain speed: . . . . . under 1 msec.
Delay if 2nd instruction just misses maintaining full speed: . . . . up to 7 msec.
.623 Overhead: . . . . start/stop time.
.624 Effective speeds: . . . I 1,000 N/(N + 6) frames/sec.
II 500 N/(N + 6) frames/sec.

N = number of frames per set of read instructions operated at full speed.

.63 Demands on System

Component	Condition	msec per frame *	or	Percentage
Processor:	I	0.06		6.0
	II	0.03		3.0

* Not including assembly into H-800 words.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustments	Method	Comment
Width:	movable tape guides	detents
Coding:	plugboard.	
Parity Method:	switch.	

.72 Other Controls

Function	Form	Comment
Parity check:	switch	allows checking odd/even or no parity
Feed control:	switch	allows tape to be fed from reel clockwise (Reel Normal) or counter-clockwise Reel Reverse) or strips (strip).
Backspace:	lever	moves tape backward one frame.
Rewind:	button	move to end of tape.
Unload:	button	wind forward to end of tape.

§ 071.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	700 feet.

.732 Replenishment time: . . 1 to 2 min.
reader needs to be stopped.

.733 Adjustment time: . . . 2 to 5 min.

.734 Optimum reloading period: . . . . 1.4 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity check	stoppage and signal to control.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	none.	
Exhausted medium:	tape tension and metallic foil	stoppage, alarm.
Imperfect medium:	sprocket check	stoppage, alarm.
Timing conflicts:	none.	

INPUT-OUTPUT: H-810 PAPER TAPE PUNCH AND CONTROL

§ 072.

.1 GENERAL

.11 Identity: . . . . Punched Tape Punch and Control.
Models H-810-1, -2.
Teletype BRPE Punch.

.12 Description

The H-810-1 is a combination Paper Tape Punch and Control Unit designed to prepare five-channel punched paper tape, ten frames to the inch, at 110 characters per second. The H-810-2 is the same, except that it punches six-, seven-, or eight-channel tape. The image to be punched is taken from right-justified bits of a 48-bit word. The last character to be punched requires about 9 to 13 milliseconds of processor time and all other characters 9 milliseconds.

No edit instructions are available for preparing output suitable for the paper tape punch; however, an approximate figure of 100 microseconds of central processor time per character would cover normal editing requirements. This time represents approximately 4% of central processor capacity.

.13 Availability: . . . . . 1960.

.14 First Delivery: . . . . 9 months.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive pull.
.212 Reservoirs
Number: . . . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . . . 3 feet.
.213 Feed drive: . . . . . servo motor.
.214 Take-up drive: . . . . servo motor.

.22 Sensing and Recording Systems

.211 Recording system: . . die punch.
.222 Sensing system: . . . none.
.223 Common system: . . . none.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

	810-1	810-2
Use of station:	punch.	punch.
Stacks:	1.	1.
Heads/stack:	6.	9.
Method of use:	frame at a time.	frame at a time.

.25 Range of Symbols

Letters: . . . . 810-1 any five-bit code.
Special: . . . . 810-2 any 6-, 7-, or 8-bit code.
Total: . . . . 810-1; 2^5 symbols.
810-2; 2^8 symbols.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
.312 Phenomenon: . . . . . punch holes.

.32 Positional Arrangement

.321 Serial by: . . . . . . 10 rows/inch.
.322 Parallel by: . . . . . 810-1; 6 tracks.
810-2; 9 tracks.
.323 Bands: . . . . none.

.324 Track use	810-1	810-2
Data:	5 tracks; 1 to 3 and 5 to 6.	8 tracks; 1 to 3 and 5 to 9.
Redundancy check: . .	none.	none.
Timing:	1; track 4.	1; track 4.
Control signals: . . .	none.	none.
Unused:	none.	none.
Total:	6.	9.

.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . 810-1 any 5-bit code.
810-2 any 6-, 7-, or 8-bit code.

.34 Format Compatibility

Other device or system: Code translation.
Any compatible punch tape reader: . . . . must be compatible.

.35 Physical Dimensions

.351 Overall width: . . . . 810-1; 11/16".
810-2; 7/8" or 1".
.352 Length: . . . . 6 feet to 1,000 feet on reels.

.4 CONTROLLER

.41 Identity: . . . . incorporated in device.

.42 Connection to System

.421 On-line: . . . . up to 8.
.422 Off-line: . . . . none.

§ 072.

.44 Data Transfer Control

.441 Size of Load: . . . . . 1 frame.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . . none.
.444 Input-output area lockout: . . . . . . none.
.445 Table control: . . . . none.
.446 Synchronization: . . . program.
.447 Synchronizing aids: . . . . test busy.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 8-bit frame.
.512 Block demarcation: . . preset at 1 frame.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 frame.
.523 Stepping: . . . . 1 frame forward.
.524 Skipping: . . . . . . none.
.525 Marking: . . . . . . none.
.526 Searching: . . . . . . none.

.53 Code Translation: . . none.

.54 Format Control: . . . none.

.55 Control Operations: . . none.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . . not necessary.
Output lock: . . . . . no.
Nearly exhausted: . . . 20 feet.
Busy controller: . . . not necessary.
End of medium marks: . . . . no.

.6 PERFORMANCE

.62 Speeds

.621 Normal or peak speed: . . . . 110 frames/sec.
.622 Important parameters punch a frame: . . . 9.09 msec.
.623 Overhead: . . . . . . none.
.624 Effective speeds: . . . 110 frames/sec.

.63 Demands on System

Component	Condition	msec per frame	Percentage
Processor:	punch 1 frame	0.06	0.66
Processor:	punch additional frames	0.06	0.46 to 0.66

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjust guide

.72 Other Controls

Function: . . . . . . rewind.
Form: . . . . switch
Comment: . . . . . . tape must be removed from punch head.

.73 Loading and Unloading

Storage: . . . . reel
Capacity: . . . . . . 1,000 feet.

.732 Replenishment time: . . . . 1 to 2 minutes. punch needs to be stopped.
.734 Optimum reloading period: . . . . 18 min (1,000-foot reels).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Output block size:	implicit.	
Invalid code:	not possible.	
Exhausted medium:	check	special branching.
Imperfect medium:	none.	
Timing conflicts:	not possible.	

INPUT-OUTPUT: H-823 CARD READER

§ 073.

.1 GENERAL

.11 Identity: . . . . Model H-823 Card Reader. There are two versions, the H-823-1, H-823-2. The H-823-1 is adapted from the IBM 085; the H-823-2 is adapted from the IBM 088.

.12 Description

These units are modified IBM collators which retain most of their normal operating characteristics. Only one of the two card feeds is used for cards to be read; the other is used to insert marker cards for certain error-handling procedures. These error-handling procedures involve setting switches manually before running a particular program in order to allow the run to be halted, the error card to be eliminated, a marker card to be inserted, or a combination of these actions to take place whenever an error is detected. The action occurs either during the reading or during transmission of data to Main Memory. The reading check is a hole-count check, but can optionally be a check to ensure that all punching is standard Hollerith.

Card reading is initiated as soon as the previous card-image has been transmitted to Main Memory. Thus, waiting time is reduced during card-reading, and no additional burden is put on the programmer. The maximum reading rate is 250 cards per minute (Model 823-1) or 650 cards per minute (Model 823-2). Reading can occur in standard Hollerith or column binary form, and in no case can it consume more than 0.3 per cent of central processor computing time.

.13 Availability: . . . . . . Model H-823-1, 12 months.
Model H-823-2, 7 months.

.14 First Delivery (with H-800): . . . . Model 823-1, 1960.
Model 823-2, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch-driven rollers.
.212 Reservoirs
Number: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brushes.

.23 Multiple Copies: . . . . not applicable.

.24 Arrangement of Heads

Use of station: . . . . . hole counting.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . reading and hole count check.
Distance: . . . . 12 card rows.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	11	, * / % # $ @ - & . □
FORTRAN set:	no.	
Basic COBOL set: . . .	yes.	
Total:	47.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . standard 80-column punched cards.

.33 Coding: . . . . Hollerith or column binary coding.

.34 Format Compatibility: . compatible with other units using standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . Model H-807 or H-811 Controllers. See also System Configuration, 502:030.

.42 Connection to System

.421 On-line: . . . . up to 8 (1 per channel).
.422 Off-line: . . . . varies, (see System Configuration, Section 502:300).

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

§ 073.

.44 Data Transfer Control

.441 Size of load:	Hollerith mode: 80 characters in 10 H-800 words, plus one control word. Column Binary mode: 960 bit positions in 20 H-800 words, plus one control word.
.442 Input-output areas:	core storage.
.443 Input-output area access:	word or item.
.444 Input-output area lockout:	none.
.445 Table control:	gather-write and scatter-read facilities.
.446 Synchronization:	automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:	80 characters, 960 bits in 20 H-800 words.
.512 Block demarcation Input:	end of card.

.52 Input-Output Operations

.521 Input:	transmit 80 columns (or 20 words) of data plus one control word with error information. Initiate the reading of the next card.

.53 Code Translation: . . . optional.

.55 Control Operations

Disable:	no.
Request interrupt:	no.
Offset card:	no.
Select stacker:	no.
Select format:	no.
Select code:	no (manual control on unit).

(Note: Some of these operations can be specified by preset switches on the unit. The operation occurs only in the case of illegal punches or incorrect data transmission.)

.56 Testable Conditions

Disabled:	no.
Busy device:	yes, if no other input equipment is connected to the channel.
Output lock:	no.
Nearly exhausted:	no.
Busy controller:	yes, if no other input controller is connected to the channel.
End of medium marks:	no.
Hopper empty:	no.
Stacker full:	no.

.6 PERFORMANCE

.62 Speeds

	Model H-823-1	Model H-823-2
.621 Nominal or peak speed:	240	650.
.622 Important parameters		
Cycle time:	250 msec	92 msec.
Number of clutch points:	1	1.

.623 Overhead:	1 clutch point per cycle; however, reading occurs before a read order is received (Anticipatory reading). The overhead depends on the time difference between two read orders.
.624 Effective speeds:	peak speed less clutch points missed.

.63 Demands on System

Component	Condition	msec per card
Central Processor, not using Scatter-Read:	reading Hollerith information	0.066*.
	reading Column Binary	0.126*.

	Percentage of Card Read Time
Model H-823-1, Hollerith data:	0.024*.
Model H-823-2, Hollerith data:	0.065*.
Model H-823-1, Column Binary:	0.57*.
Model H-823-2, Column Binary:	0.130*.

* If Scatter-Read is used, these figures should be doubled.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment:	type of reading.
Method:	3-position switch.
Comment:	allows for reading in normal Hollerith Code or binary code. third position reads any combination of Hollerith-type punches and translates them according to Data Code Table No. 1.

.72 Other Controls

Function	Form	Comment
Program Switch:	9-position switch	used in start operations, under programmer's instruction.
Illegal Punch:	4-position switch	controls action on receipts of non-Hollerith punching.

§ 073.

.72 Other Controls (Contd.)

Function	Form	Comment
Check Process:	4-position switch	controls action on receipt of computer instruction.
Marker Feed:	4-position switch	inserts blank cards in place of or following cards which have illegal punching and/or have been incorrectly read.

.73 Loading and Unloading

.731 Volumes handled

Storage	Input Hopper Capacity	Output Stacker
H-823-1:	800	1,000.
H-823-2:	3,600	1 x 1,000.

.732 Replenishment time: . . 1 to 2 min.
unit does not need to be stopped.

.733 Adjustment time: . . . 1 to 2 min.

.734 Optimum reloading period
Model H-823-1: . . . 3 min.
Model H-823-2: . . . 6 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	check	interrupt.
Input area:	none.	
Exhausted medium:	check common to other conditions	interrupt.
Imperfect medium:	none.	
Stacker full:	check common to other conditions	interrupt.
Invalid code:	optional check	interrupt.

INPUT-OUTPUT: H-827 CARD READ-PUNCH (READER)

§ 074.

.1 GENERAL

.11 Identity: . . . . . . Card Read-Punch (Reader only).
IBM 1402 Model 2.
CR.

.12 Description

While the H-827 consists of a card reader and punch housed in the same cabinet, the two units are independent of one another from the user's viewpoint and are covered in separate sections of this report.

The reader reads standard 80-column cards at a peak speed of 800 cards per minute. Conversion from the card column code to internal BCD code is automatic. A hole-count check is made on each column at a second reading station, and the bit configuration of each character is checked for validity as it is transferred into the read synchronizer for later transmission into core storage. A hopper with a 3,000-card capacity and three stackers with 1,000-card capacities (one shared with the punch unit) can be loaded and unloaded without stopping the reader.

Card reading is initiated as soon as the previous card-image has been transmitted to Main Memory. Thus, waiting time is reduced during card-reading, and no additional burden is put on the programmer. Reading can occur in standard Hollerith or column binary form, and in no case can it consume more than 0.4 per cent of central processor computing time.

.13 Availability: . . . 12 months.

.14 First Delivery: . . 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head . . clutch driven rollers.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brush.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 12 rows of each card, 1 at a time.

.24 Arrangement of Heads (Contd.)

Use of station: . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . . 1.
Heads/stack: . . . 80.
Method of use: . . 12 rows of each card, 1 at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	11	, * / % # $ @ - & . □
FORTRAN set: . .	no.	
Basic COBOL set: .	yes.	
Total:	47.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing
.322 Parallel by: . . . . 80 columns at standard spacing.

.324 Track use
Data: . . . . . . 80.
Total: . . . . . . 80.
.325 Row use
Data: . . . . 12.

.33 Coding: . . . . . Hollerith code or column binary.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards: . .	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLERS

.41 Identity: . . . . . Model H-807 or H-811 Controllers. See also System Configuration, 502:030.

.42 Connection to Device

.421 On-line: . . . . . . up to 8 (1 per channel).
.422 Off-line: . . . . . varies, (see System Configuration, Section 502:300).

§ 074.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . none.

.44 Data Transfer Control

.441 Size of load: . . . Hollerith mode: 80 characters in 10 H-800 words, plus 1 control word.
Column Binary mode: 960 bit positions in 20 H-800 words, plus 1 control word.
.442 Input-output areas: . . . . . . core storage
.443 Input-output area access: . . . word or item.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . gather-write and scatter-read facilities.
.446 Synchronization: . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . 1 card.
.512 Block demarcation Input: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . transmit 80 columns (or 20 words) of data plus 1 control word with error information. Initiate the reading of the next card.

.53 Code Translation: . optional.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . . . . no.
Offset card: . . . . no.
Select stacker: . . no.
Select format: . . no.
Select code: . . . . no.
Unload: . . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . yes, if no other input equipment is connected to the channel.
Output lock: . . . . no.
Nearly exhausted: . no.
Busy controller: . . yes, if no other input controller is connected to the channel.
End of medium marks: . . . . . no.
Hopper empty: . . no.
Stacker full: . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . . 800 cards/min.
.622 Important parameters
Clutch cycle: . . . 75 msec.
.623 Overhead: . . . . . 3 clutch points.
.624 Effective speeds: . 800 cards/min. if processing time per card does not exceed 74.12 msec.

.63 Demands on System

Component	Condition	msec per card
Central Processor, not using Scatter-Read:	reading Hollerith information	0.066*
	reading Column Binary	0.126*

	Percentage of Card Read Time
Hollerith data:	0.08*
Column Binary:	0.16*

* If Scatter-Read is used, these figures should be doubled.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . card width.
Method: . . . . . interchange of hardware.

.72 Other Controls

Function	Form	Comment
End of File:	key	activates circuits signal last-card condition in central processing unit.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	3,000 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . . . 0.25 to 0.50 minutes; reader does not need to be stopped.
.733 Adjustment time: . 10 to 15 minutes.
.734 Optimum reloading period: . . . . 1.25 minutes.

§ 074

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole count	indicator & alarm.
Input area overflow:	none.	
Invalid code:	validity check	indicator & alarm.
Exhausted medium:	check	stop & alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop & alarm.
Stacker full:	check	stop & alarm.
Wrong length record:	check	indicator.
No transfer:	check	indicator.

INPUT-OUTPUT: H:827 CARD READ-PUNCH (PUNCH)

§ 075.

.1 GENERAL

.11 Identity: . . . . H-827 Card Read-Punch (Punch only). IBM 1402.

.12 Description

Housed in the same cabinet as the card reader, this unit punches standard 80-column cards at a peak speed of 250 cards per minute. Conversion from internal BCD representation to the column card code is automatic. A reading station makes a hole-count check on each column. The 1200-card feed hopper and three 1,000-card stackers (1 shared with the reader unit) can be loaded and unloaded without stopping the punch. A punch buffer register in the Input-Output Synchronizer permits the overlapping of punching with other operations.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . checking.
Distance: . . . . 1 card.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . standard 80-column cards.
.312 Phenomenon: . . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . . 80 columns at standard spacing.
.324 Track use
Data: . . . . 80.
Total: . . . . 80.
.325 Row use
Data: . . . . 12.

.33 Coding: . . . . Standard Hollerith.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . Models H-808 or H-811 Controllers (see also System Configuration 502:030).

.42 Connection to System

.421 On-line: . . . . up to 8 (1 per channel).
.422 Off-line: . . . . varies, (see System Configuration 502:030).

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . word or item.
.444 Input-output area lockout: . . . . no.
.445 Table control: . . . . . gather-write and scatter-read facilities.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation
Output: . . . . fixed.

§ 075.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 card forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Offset card: . . . . . . no.
Select stacker: . . . . . yes, 1 or 3.
Select format: . . . . . no.
Select code: . . . . . . no.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: no.
Controller not ready: . yes.
Hopper empty: . . . . . yes.
Stacker full: . . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: 250 cards/min.
.622 Important parameters
Clutch cycle: . . . . . 240 msec.
.623 Overhead: . . . . 3 clutch points.
.624 Effective speeds: . . . 250 cards/min if processing time per card does not exceed 216.62 msec.

.63 Demands on System

Component	msec per block	or	Percentage
Central Processor (not using gather-write):	0.066*	or	0.024*

* If a gather-write is used, these figures should be doubled.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.72 Other Controls: . . . . start and stop only.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . 0.25 to 0.50 minute. punch does not need to be stopped.
.733 Adjustment time: . . . none.
.734 Optimum reloading period: . . . . 4.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	hole count	indicator and alarm.
Output block size:	fixed.	
Invalid code:	parity check	indicator and alarm.
Exhausted medium:	check	stop and alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop and alarm.
Stacker full:	check.	stop and alarm.
Wrong length record:	check	indicator.

INPUT-OUTPUT: H-822 HIGH SPEED PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . High Speed Printer.
Model H-822-3.

.12 Description

The Model H-822-3 High Speed Printer is designed to produce printed output at 900 lines per minute for continuous single-space printing and 800 lines per minute for continuous double-space printing. The printer can operate on- or off-line; however, different control units are required for each of the two modes of operation.

The H-822-3 is a drum-type printer whose printer mechanism (i.e., type roll, ribbon feeder, paper loader and control circuitry) rests on a table-like base. The center of the base is open to permit paper-handling from either the front or the back. One hundred and sixty print positions are provided, of which 120 can be manually selected prior to the printing operation. This printer has the capability for manually selecting vertical spacing at six or eight lines to the inch. Skipping speed in the non-print mode is approximately 20 inches per second. Vertical format is controlled by a control word and a prepunched paper carriage tape. Mechanical adjustments are also provided to adjust the paper form position.

An usual feature of this printer is that 160 character positions are available, any 120 of which can be in use at one time. This facility is used primarily when printing two forms side-by-side simultaneously.

.13 Availability: . . . . . . 7 months.

.14 First Delivery: . . . . 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.
.212 Reservoirs
Number: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . on-the-fly hammer stroke against engraved drum.
.222 Sensing system: . . . . none.
.223 Common system: . . . none.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . original and 8 copies.
Carbon creep: . . . . none.
.233 Types of master
Multilith: . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . 160.
Heads/stack: . . . . . . 1.
Method of use: . . . . . 120 out of 160, chosen manually beforehand by wiring on plugboard.

.25 Range of Symbols

Numerals: 10 0-9
Letters: . . . . 26 A-Z
Special: . . . . 20 , ; : . ' " * ( ) + - = $ & @ # % CR / ■
Alternatives: . . . . . . as requested.
FORTRAN set: . . . . . yes.
Basic COBOL set: . . . yes.
Total: 56

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper.
.312 Phenomenon: . . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . 1 line, at 6 per inch or 1 line at 8 per inch.
.322 Parallel by: . . . . . . 120 out of 160 character positions, 10 per inch.

.33 Coding: . . . . H-800 coding for 56 characters; 8 others print as blank.

.35 Physical Dimensions

.351 Overall width: . . . . . $3\frac{1}{2}$ to 22 inches.
.352 Length
Form (standard): . . . 3 to 17 inches.
Form (with special equipment): . . . . . 3 to 22 inches.
.353 Maximum margins
Left: . . . . 3 inches.
Right: . . . . 3 inches.

.4 CONTROLLER

.41 Identity

On-line: . . . . Model H-806-3 Printer Control or Model H-811-3 Multiple Terminal Control.

Off-line, with Model H-804 Magnetic Tape Unit: . . . . Model H-815 or H-817 Auxiliary Control Unit. (See note on Controllers in Systems Configuration, 502:030).

§ 081.

.42 Connection to System

.421 On-line: . . . . 8 (1 per channel); no restriction of other I/O devices.

.422 Off-line

Use	Associated equipment
Tape-to-Printer transcription: . . .	Model H-804 Magnetic Tape Unit.

.43 Connection to Device

.431 Devices per controller: 1.

.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 16 H-800 words. 120 characters plus vertical format control word.

.442 Input-output areas: . . core storage.

.443 Input-output area access: . . . . word or item.

.444 Input-output area lockout: . . . . none.

.445 Table control: . . . . . none.

.446 Synchronization: . . . . automatic.

.447 Synchronizing aids: . . none.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . fixed at 120 characters.

.52 Input-Output Operations

.522 Output: . . . . print 1 line, then space according to vertical control word.

.523 Stepping: . . . . line feeds as given in vertical control word.

.524 Skipping: . . . . skip forward to top of form or to next point indicated by the prepunched paper carriage tape.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . none.
Rearrangement: . . . . none.
Suppress zeros: . . . . no automatic facilities.
Insert point: . . . . . . no automatic facilities.
Insert spaces: . . . . . no automatic facilities.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes, insofar as only 1 printer per controller.
Output lock: . . . . . . not applicable.
Nearly exhausted: . . . } not as such, but this condi-
Busy controller: . . . . } tion forces on input channel busy; which is testable.

.6 PERFORMANCE

.61 Conditions

.62 Speeds

.621 Nominal or peak speed: 900 lines/min.

.622 Important parameters
Skipping speed: . . . . 20 inches/second.

.623 Overhead: . . . . none (infinite clutch).

.624 Effective speeds: . . . 7,200/(8+N) lines per minute, each line with N blank lines skipped between printed lines (see graph).

.63 Demands on System

Component	Condition	m.sec per line	Percentage
Central Processor:	Straight printing	0.07	0.14
	Gather-write printing	0.13	0.29

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	vernier knob.	
Vertical spacing (optional):	manual switch	6 or 8 lines per inch.
Horizontal alignment:	vernier knob.	
Width:	vernier knob.	
Noise shield:	place over print area.	
Pressure:	stock thickness adjuster	to allow for different number of copies and paper thickness.
Format:	120 plugs to be inserted in nonremovable 160 hole plugboard.	controls active channels to be used for printing.

.72 Other Controls

Function	Form	Comment
Operational mode:	4-way Operation switch	can be in ON-line, Off-line, TEST, or Disconnected modes.
Error action:	2-way CHECK PROCESS switch	forces computer to halt after line with echo or parity check.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Input hopper:	?
Output Receptacle: .	?

.732 Replenishment time: . . 1 to 2 min. printer needs to be stopped.

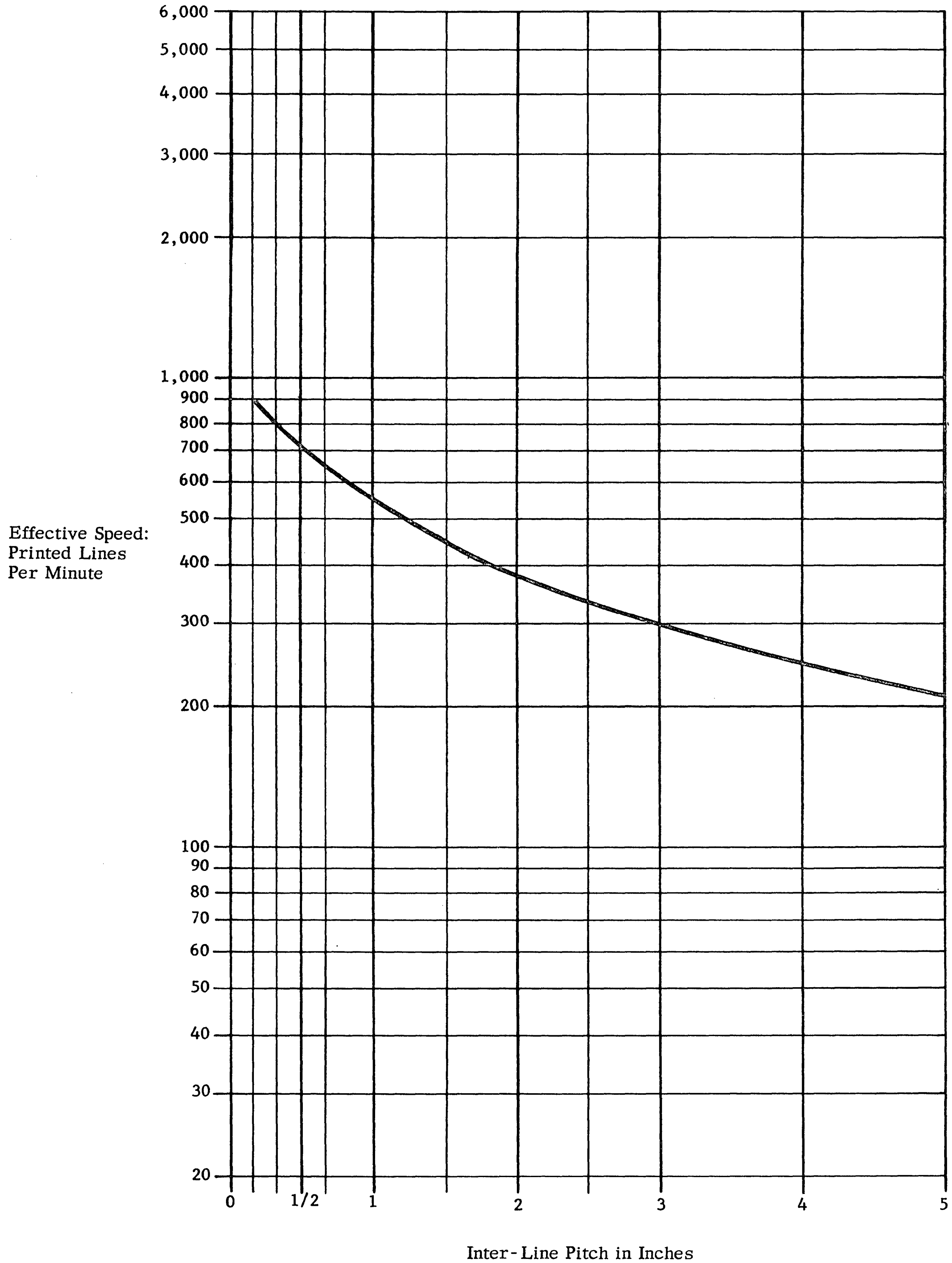
.733 Adjustment time: . . . 2 to 3 min.

.734 Optimum reloading period: . . . . 3 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo or parity check	stipulated by CHECK PROGRESS switch position.
Output block size:	none.	
Invalid code:	none.	blanks printed.
Exhausted medium:	check	stall computer.
Imperfect medium:	check	stock thickness adjuster.
Timing conflicts:	none	conflicts can arise from overwriting storage area before transmission occurs, or from overuse of the I/O facilities by some fast tape units.

MODEL H-822-3 HIGH SPEED PRINTER
EFFECTIVE SPEED



INPUT-OUTPUT: STANDARD PRINTERS

§ 082.

.1 GENERAL

.11 Identity: . . . . H-822-1 Standard Printer.
H-822-2 Bill Feed Printer
(IBM 407 Accounting Machine
IBM 408 Accounting Machine.)

.12 Description

The H-822-1 and H-822-2 printers are effectively the same model with different carriages. Both models print 150 lines per minute, with 120 characters per line. A 12-channel paper tape loop and a plugboard control the format.

.12 Description (Contd.)

The data to be printed is supplied in six-bit characters which are packed eight characters per word. Thus, any numeric data created during computation must be converted from four-bit form, and then packed into the correct position. This takes considerable time, but the over-all loading on the central processor is less than 2 per cent.

The H-806 or H-811 Controllers are used to connect the equipment on-line to the central processor; or alternatively, to a magnetic tape unit via the H-815 or H-817 controller for off-line use.

INPUT-OUTPUT: H-804 MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . H-804 Magnetic Tape Unit.
Model H-804-1.
Model H-804-2.
Model H-804-3.
Model H-804-4.

.12 Description

The four versions of the H-804 tape unit are essentially similar. Each version can read magnetic tapes written by any other or by the H-404 tape units, but cannot read tapes written by non-Honeywell manufactured tape systems. The basic method of tape operation is as follows:

1. A record in main memory is "orthocounted", and two "orthowords" are formed and placed at the end of the record. These orthowords are simply parity-check words on both the odd and the even words of the record.
2. The record, with the orthowords, is recorded on tape by a read/write head. The tape is erased immediately prior to being written on, using full-width erasing. No read-after-write check is made by the equipment, but such a check can be programmed. Two minutes per reel are required to check readability.
3. The tape is read back, and the orthowords and the track parity bits are checked automatically. Errors cause a forced transfer to the error routine. This routine uses the parity bit with each eight data bits to locate the erroneous frames, and a combination of these parity bits and the orthowords to make corrections, if possible. Any one error can always be corrected, and up to 12 errors can be corrected in any one block.

The H-804 tape unit uses vacuum capstans and brakes which minimize wear by spreading acceleration forces over a larger area than is customary with pinch rollers. The tape reels are designed with no openings in their side-guards to safeguard the actual tape. However, this construction prevents the operator from seeing how much tape remains to be processed.

The inter-record gap is 0.67 inch in all cases, and the start and stop times are 0.27 and 0.35 milliseconds respectively. It is not necessary to bring the tape to a stop between records.

Scatter-read and gather-write facilities are available in the central processor under the joint control of end-of-item words recorded with the data, and a table of starting addresses held in the Main Memory.

Peak speeds of the four versions expressed in alphameric characters are: 32,000, 64,000, 88,000, and 124,000 characters per second for each of the four models. Packing densities range from 200 to 777 frames per inch and speeds range up to 120 inches per second.

Use of the scatter-read and gather-write facilities takes up central computer time at a rate which depends on the particular model of tape unit. The H-804-4 can take up 20 to 30 per cent of central computer.

.13 Availability: . . . . . . 7 months.

.14 First Delivery: . . . H-804-1; 1960.
H-804-2; 1960.
H-804-3; 1963.
H-804-4; 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . vacuum capstan.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . vacuum.
Capacity: . . . . approx. 6 feet.
.213 Feed drive: . . . . . . own motor.
.214 Take-up drive: . . . . . own motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . non-return-to-zero. (flux change denotes a "1").
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . yes, this prevents any automatic checking at write time.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . AC erase head.
Stacks: . . . . 1.
Heads/stack: . . . . 1 full width.
Method of use: . . . . . 1 row at a time.
Use of station: . . . . . read/write head.
Distance: . . . . ?
Stacks: . . . . 1.
Heads/stack: . . . . 10.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . 0.75-inch Mylar tape with oxide coding.
.312 Phenomenon: . . . . . . magnetization.

§ 091.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 400, 555, or 777 bits per inch.

.322 Parallel by: . . . . . . 10 tracks at 0.070 inch centers.

.324 Track use
- Data: . . . . 8.
- Redundancy check: . . 1.
- Timing: . . . . 1.
- Control signals: . . . 0.
- Unused: . . . . 0.
- Total: . . . . 10.

.325 Row use
- Data: . . . . 1 to N.
- Redundancy check: . . 2 orthotronic control words per block.
- Timing: . . . . 0.
- Control signals: . . . 0.
- Unused: . . . . 0.
- Gap: . . . . 0.67 inch.

.33 Coding: . . . . 6 rows per H-800 data word. See Data Code Table No. 2.

.34 Format Compatibility

Other device or system	Code translation
H-400:	not necessary.
H-1400:	not necessary.
H-1800:	not necessary.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.75 inch.

.352 Length
- Tape Reel: . . . . . . 2,400 feet.

.4 CONTROLLER

.41 Identity: . . . . H-803 Tape Control.

.42 Connection to System

.421 On-line: . . . . up to 8.

.422 Off-line
- Use: . . . . varies in connection with other I/O equipment. See data in System Configuration, 502:030.

.43 Connection to Device

.431 Devices per controller: 8 tape units per control unit.

.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . N variable length items, both N and the length of each item being data-, not instruction-controlled.

.442 Input-output areas: . . core storage.

.443 Input-output area access: . . . . word.

.444 Input-output area lockout: . . . . none.

.445 Table control: . . . . . gather-write and scatter-read facilities are available.

.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES

.51 Blocks

.511 Size of block: . . . . . 1 through N, N determined by length of reel.

.512 Block demarcation
- Input: . . . . end of record gap.
- Output: . . . . end of record word.

.52 Input-Output Operations

.521 Input: . . . . read 1 block, forward or backward.

.522 Output: . . . . write 1 block forward.

.523 Stepping: . . . . none.

.524 Skipping: . . . . none.

.525 Marking: . . . . end of record gap, 0.67 inch.

.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

- Disable: . . . . no.
- Request interrupt: . . . no.
- Rewind: yes.
- Unload: . . . . yes.

.56 Testable Conditions

- Disabled: . . . . no.
- Busy device: . . . . . . yes.
- Output lock: . . . . . . no.
- Nearly exhausted: . . . yes.
- Busy controller: . . . . no.

.6 PERFORMANCE

.61 Conditions

- I: . . . . H-804-3.
- II: . . . . H-804-1.
- III: . . . . H-804-2.
- IV: . . . . H-804-4.

Note: These are arranged in increasing order of speeds, not in Model No. order. Model No. order reflects only the marketing dates.

.621 Nominal or peak speed	I	II	III	IV
Alphameric char/sec:	32,000	64,000	88,000	124,000.
Decimal char/sec:	48,000	96,000	133,000	188,000.
H-800 words/sec:	4,000	8,000	11,110	15,500.

§ 091.

.622 Important parameters

Start time:	2.7 m.sec.
Stop time:	3.5 m.sec.
Start distance:	0.12 inch.
Stop distance:	0.28 inch.
Gap:	0.67 inch.
Time to pass gap at full speed:	5.6 m.sec.
Additional time if tape brought to stop:	3.3 m.sec.

.623 Overhead: start and stop times, + gap time.
11 m.sec per block (I).
9 m.sec per block (II, III, IV).

.624 Effective speeds: (alphameric char) Data Chars x Peak Speed/Data Chars + Start Stop times + control word times.
(See graph at end of section)

Stopping between blocks

I:	32,000N/(N+248).
II:	64,000N/(N+472).
III:	88,000N/(N+640).
IV:	124,000N/(N+892), where N is the number of alphameric characters in the block.

Not stopping between blocks

I:	32,000N/(N+143).
II:	64,000N/(N+260).
III:	88,000N/(N+350).
IV:	124,000N/(N+500), where N is the number of alphameric characters in 1 block.

Allowance for numeric characters: reduce the number of characters (N) in the record by one-third and use the above formulae.

Allowance for mixed alphameric records: reduce the number of characters (N) in the record by one-third of the numeric characters which can be allocated numeric fields, and use the above formulae.

.625 Demands on System

Operation	Component	Condition	m.sec/block of N alphameric char.	Minimum Percentage
Reading (no scatter-read)	Central Processor	I	0.018 + 0.00075N	2.5
		II	0.018 + 0.00075N	5.0
		III	0.018 + 0.00075N	6.5
		IV	0.018 + 0.00075N	10.0
Writing, including computation of orthocount (no scatter-read)	Central Processor	I	0.094 + 0.0015N	5.0
		II	0.094 + 0.0015N	10.0
		III	0.094 + 0.0015N	13.0
		IV	0.094 + 0.0015N	20.0
Reading (Scatter-read)	Central Processor	I	0.018 + 0.0015N	5.0
		II	0.018 + 0.0015N	10.0
		III	0.018 + 0.0015N	13.0
		IV	0.018 + 0.0015N	20.0

.625 Demands on System (Contd.)

Operation	Component	Condition	m.sec/block of N alphameric char.	Minimum Percentage
Writing, including computation of orthocount (with gather-write)		I	0.018 + 0.00225N	7.5
		II	0.018 + 0.00225N	15.0
		III	0.018 + 0.00225N	20.0
		IV	0.018 + 0.00225N	30.0

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Writing allowed:	write ring	can be done without removing reel or stopping the tape.
Tape unit number:	plugboard	mounted inconveniently away from operator's console. unit numbers are not displayed.

.72 Other Controls

Function: tape change.
Form: toggle.

.73 Loading and Unloading

.731 Volumes handled
Storage: spool.
Capacity: 2,400 feet.

.732 Replenishment time: 1.0 to 2.0 min.
unit needs to be stopped. The head lifts to allow simple threading of the tape underneath it.

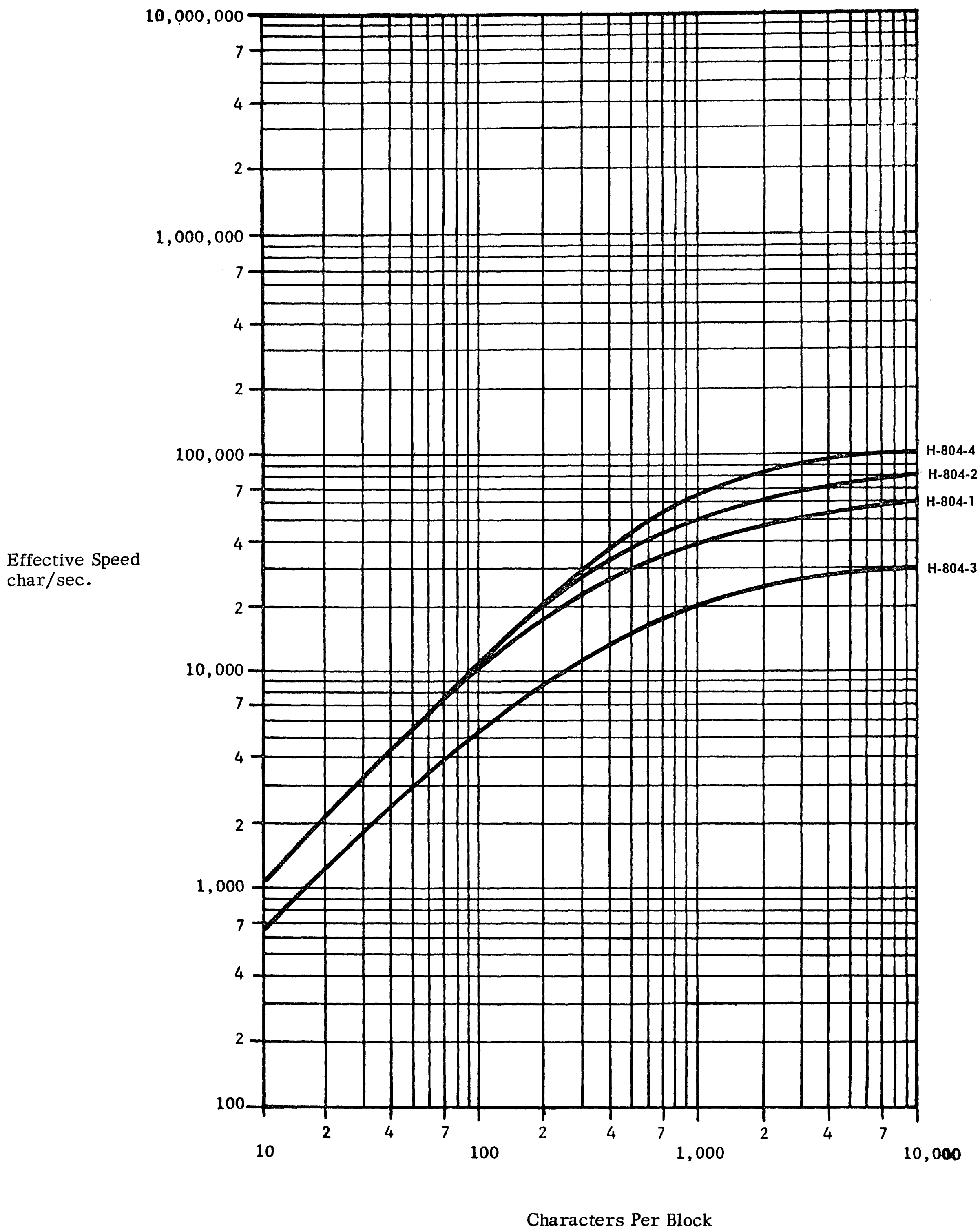
.733 Adjustment time: 0.5 min.

.734 Optimum reloading period: 8 min. (I).
4 min. (II, III, IV).

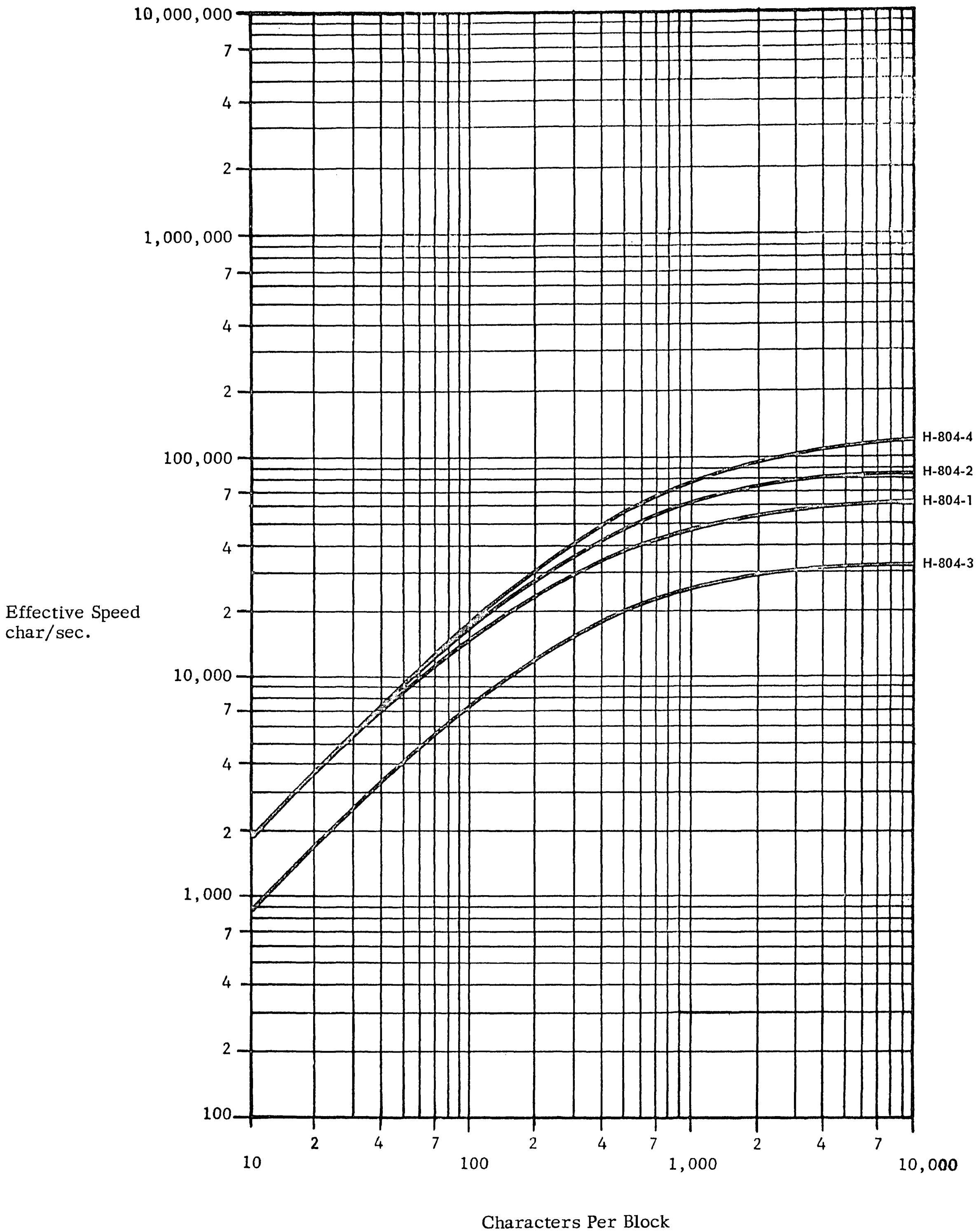
.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none	(The orthotronic control words only provide a check on the data which is received).
Reading:	row and track parity orthotronic control	set indicator.
Input area overflow or underflow:	none	(It is advisable to leave one word blank after each input area).
Invalid code:	none.	
Exhausted medium:	photosense of rear end of tapes.	set indicator.
Imperfect medium:	none.	
Timing conflicts:	none.	

EFFECTIVE SPEED – STOPPING BETWEEN BLOCKS
H - 804 TAPE UNITS



EFFECTIVE SPEED – NOT STOPPING BETWEEN BLOCKS
H - 804 TAPE UNITS



INPUT OUTPUT: H-804 OPTICAL SCANNER

§ 102.

.1 GENERAL

.11 Identity: . . . . H-804.
Farrington Document Optical Scanner.
Model 1D3L.

.12 Description

The H-804 Optical Scanner is set up to read only one line of information from each document. The length of the document, the speed of the scanner, and the maximum number of characters are shown in the following table:

.13 Availability: . . . . . . 1962.

.14 First Delivery

With H-800: . . . . . . 1962.
Otherwise: . . . . 1962.

.15 Organization of this Report

Paragraph 2 of this report conforms to the outline of the entries in the Comparison Chart of the Special Report on Optical Character Readers (23:020. 100). Each of the entries is explained in the Guide to the Comparison Chart (23:020. 2). The remainder of the report conforms to the outline of the Performance; External Facilities; and Error, Checks, and Action paragraphs of Input-Output General sections of reports.

DOCUMENT LENGTH (inches)	MAXIMUM NUMBER OF CHARACTERS PER LINE		
	At 312 Documents Per Minute	At 240 Documents Per Minute	At 196 Documents Per Minute
3	25	25	25
4	28	35	35
5	25	44	45
6	22	41	55
7	18	37	56
8	15	34	53

.2 DETAILS

.21 Document Handling Characteristics

.211 Document Feed: . . . . automatic.
.212 Size of Document
Card Stock: . . . . . . 2.20 x 2.625 to 8.50 x 6.0 inches.
Paper Stock: . . . . . 2.625 x 2.625 to 8.50 x 6.0 inches.
.213 Number of lines per document: . . . . . . 1 only.

.214 Documents per minute: 196, 240, or 312.
.215 Document collection: . Accept or Reject stackers. 5.175 inches deep.
.216 Output devices: . . . . on-line computer only.

.22 Character Reading Capability

.221 Characters per second: 330.
.222 Character set: . . . . . 0-9, H.0, -, •
.223 Type fonts: . . . . Self-Check 12F.

.23 Format Specification

.231 Vertical line: . . . . . 0.10 inch above and below the printing zone.
.232 Horizontal character spacing: . . . . 10 char per inch.
.233 Number of characters per line: . . . . 58.
.234 Information field selection: . . . . external plugboard.

.26 Error Detection and Reject Facilities

.261 Error detection:
Checks resulting in forced transfers: . parity error (control unit or bus parity).
unrecognizable character.
Checks resulting in stop: . . . . . . hopper empty.
double feed.
feed failure.
wrong stacker.
cycle check.

.262 Reject facilities: . . . . program allows documents to be sent to reject stacker.

§ 102.

.3 PERFORMANCE

.31 Conditions

I: . . . . cam providing max. speed of 196 documents/min.

II: . . . . cam providing max. speed of 240 documents/min.

III: . . . . cam providing max. speed of 312 documents/min.

.32 Speeds

.321 Nominal or peak speed: 196, 240, or 312 documents/min.

.322 Important parameters

Mirror scanning speed: . . . . 33 inches/sec.

Character rate 10 char/inch: . . . . 330 char/sec.

Printing area: . . . . 1/4 inch or more from both vertical and nearest horizontal edge 2.187 inches from farthest horizontal edge.

.323 Overhead: . . . . Each system is designed to utilize the maximum speed of the scanner. The speed of the system is a function of the cam kit selected (312, 240, or 196 documents per minute). Selecting the allowable number of characters and document length which ensures that the time to read and feed a document as well as the processing time prior to a feed command is less than or equal to the rated speed for each cam unit ensures operation at effective speeds and loss of overhead.

.324 Effective speeds: . . . 312, 240, or 196 documents per minute. (see description.)

.33 Demands on System

Component: . . . . . Central Processor.

Condition: . . . . . all.

Msec per document: . .012 + .006 D, where D is the number of characters read.

Percentage: 0.1

.4 EXTERNAL FACILITIES

.41 Adjustments

Adjustment	Method	Comment
Field Length:	plugboard	notes where the "end of document" will be signalled; because of necessary tolerances, this signal cannot occur in the middle of printed field.

.42 Other Controls

Function	Form	Comment
Check Indicators:	lamps	identifies the particular cause of a Busy signal.

.43 Loading and Unloading

.431 Volumes handled

Storage	Capacity
Hopper:	6 inches of documents.
Accept stacker: . . .	6 inches of documents.
Reject stacker: . . .	3 inches of documents.

.432 Replenishment time: . . 0.2 to 0.3 minute.

.433 Adjustment time: . . . 7.0 to 8.0 minutes.

.434 Optimum reloading period

Paper: . . . . 4 minutes.

Card: . . . . 3 minutes.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Input area overflow:	none.	
Invalid code:	check	special character transmitted.
Exhausted medium:	check	Unit busy signal.
Timing conflicts:	check	Unit busy signal.
Feed failure:	check	Unit busy signal.

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.12 Description

Simultaneous operations can be considered at two levels:

(1) Simultaneous Programs.

(2) Simultaneous Transfers.

Program Simultaneity

Several programs can be run simultaneously by the H-800. Such operation is mechanized (described under Central Processor, Paragraph :051.3) by executing one instruction in turn from each of several programs. In the core storage, input-output transfers always receive priority over the central processor, taking place at the first available core storage cycle. Interruptions are handled within the program concerned and do not cause any slow-down of the other programs.

Software affects simultaneity only insofar as the operating system allows. In ARGUS, a restriction exists that when loading any sector of any program into storage, all other programs are halted. The length of the halt depends on the position of the tape concerned, and while normally a matter of 20 to 50 milliseconds, it could be a full second in cases where three or four large-scale programs are being run simultaneously.

The following rules show what degree of simultaneous operation is possible at various levels of control in the Central Processor:

Maximum number of programs simultaneously running	8.
Maximum number of interrupts simultaneously being handled	8.
Maximum number of instructions being processed	1.
Maximum number of storage references	1.
Maximum number of other programs running in parallel with the standard executive routine	0.

Transfer Simultaneity

Each H-800 has eight input and eight output channels, each of which can operate simultaneously with all the others and the other Central Processors. Peripheral units are connected to channels via controllers. A variety of controllers are available. In general, it is possible to connect eight units to a controller which is connected to one, or a pair of channels, or to connect eight controllers to one, or a pair of channels, each controller having only one unit.

Usually, one card reader, punch, or printer is connected to one controller to one channel; and several magnetic tape units to one controller to a pair of channels. Therefore, the degree of simultaneity is limited by the types of connections and the limited numbers of channels, controllers, and units. Each simultaneous transfer by a unit monopolizes its channel (wired at installation time), and its controller, or part of its controller.

.2 CONDITIONS

P = Number of output channels to which controllers are connected.
Q = Number of input channels to which controllers are connected.

.3 CLASSES OF OPERATIONS

Class	Operation
A	Read magnetic tape backward or forward.
B	Write magnetic tape
C	Rewind
D	Read a card Read paper tape Read scanner
E	Punch a card Print a line Punch paper tape Transmit to data transmission unit

.4 RULES

.41 Configuration Restrictions

a + d = at most q
b + e = at most p

.42 Access Restrictions

When any tape unit is operating at a higher transfer rate than 32,000 alpha char/sec, further restrictions on the total number of simultaneous input-output transfers exist.
If any tape transfer rate of 124,000 alpha char/sec is in use: a + b + d + e may not exceed 9.
If any tape transfer rate of 88,000 alpha char/sec is in use: a + b + d + e may not exceed 13.
These limits are attainable only with little or no use of Distributed Read-Gather Write facilities.
If these are used, then in the worst cases:
If any tape transfer rate of 124,000 alpha char/sec is in use: a + b + d + e may not exceed 4.
If any tape transfer rate of 88,000 alpha char/sec is in use: a + b + d + e may not exceed 6.
If any tape transfer rate of 164,000 alpha char/sec is in use: a + b + d + e may not exceed 9.

§ 121.

INSTRUCTION LIST

INSTRUCTION				OPERATION
OP Code	A	B	C	
				Arithmetic
DA	a	b	c	(A) + (B) ⟶ C, in decimal, signed binary, or absolute binary mode.
BA	a	b	c	
WA	a	b	c	
DS	a	b	c	(A) - (B) ⟶ C, in decimal, signed binary, or absolute binary mode.
BS	a	b	c	
WD	a	b	c	
HA	a	b	c	(A) + (B) ⟶ C, in binary with no carries.
DT	a	B	c	$a_1 + a_2 \ldots + a_B$ ⟶ C, in binary or decimal mode. Signs are assumed to be all positive or all negative.
BT	a	B	c	
DM	a	b	c	(A) x (B) ⟶ C, in decimal or signed binary mode.
BT	a	b	c	
				Logic
SM	a	b	c	(A) superimposed on (B) ⟶ C (Inclusive OR).
HA	a	b	c	(A) half-add to (B) ⟶ C (Exclusive OR).
EX	a	b	c	Logical AND (A) with (B), result to C.
				Transfers
MT	a	B	c	(A) ⟶ C, B times. A and C can be incremented.
TN	a	B	c	B words, starting at A, moved to B words starting at C.
IT	a	b	c	Move an item starting at A to an area starting at C.
RT	a	b	c	Move a record, starting at A to an area starting at C.
				Shifts
SWS	a	B	c	Right-end-around shift (A) B binary places and store in C. Different orders allow for sign treatment and protection of present contents of C.
SPS	a	B	c	
SWE	a	B	c	
SPE	a	B	c	
SSL	a	B	c	Transfer control to C modified by (A) shifted around B bits.
				Comparison
NA	a	b	c	Jump to C if (A) ≠ (B) when treated alphabetically.
NN	a	b	c	Jump to C if (A) ≠ (B) when treated numerically.
LA	a	b	c	Jump to C if (A) ≤ (B) when treated alphabetically.
LN	a	b	c	Jump to C if (A) ≤ (B) when treated numerically.
TS	a	b	c	Jump to C, and transfer (A) to (B).
				Miscellaneous
CP	a	b	c	Check Parity of (A). If incorrect, jump to C.
CC	a	b	c	Orthocount the record starting at A, ending at C - 1. If required, use scatter read techniques under control of the table stored starting in B. Record the orthocount in C and C + 1.
S	-	-	-	Simulate. Form a memory address (direct or indexed) from the low-order 11 bits of the command code and store this instruction in the location thus specified. Jump under control of the co-sequence counter.
				Scientific Instructions
				Floating Point - Normalized
FBA	a	b	c	(A) + (B) ⟶ C, in binary or decimal mode.
FDA	a	b	c	
FBS	a	b	c	(A) - (B) ⟶ C, in binary or decimal mode.
FDS	a	b	c	
FBM	a	b	c	(A) x (B) ⟶ C, and a special register, in binary or decimal mode.
FDM	a	b	c	

§ 121.

INSTRUCTION LIST–Contd.

INSTRUCTION				OPERATION
OP Code	A	B	C	
				Floating Point - Normalized (Contd.)
FBD	a	b	c	(B) / (A) ⟶ C, in binary or decimal mode.
FDD	a	b	c	
FLN	a	b	c	Jump to C if (A) ≠ (B)
FNN	a	b	c	Jump to C if (A) ≤ (B)
ULD	a	-	c	Store a double-length product into A and C.
				Floating Point - Unnormalized
FBAU	a	b	c	(A) + (B) ⟶ C, in binary or decimal mode.
FDAU	a	b	c	
FBSU	a	b	c	(A) - (B) ⟶ C, in binary or decimal mode.
FDSU	a	b	c	
				Fixed Point
BD	a	b	c	(B) / (A) ⟶ C, in binary or decimal mode. The remainder can be retained.
DD	a	b	c	

INSTRUCTION						OPERATION
I/O Channel	Device	OP Code	A	B	C	
						Peripheral Instructions
X	X	RF	a	b	c	Read forward from peripheral device XX into consecutive locations beginning at A. If distributed read is required, use the table starting at B. Interruption occurs in case of end of file or error in previous block is encountered.
X	X	RB	a	b	c	Read Backwards, otherwise as Read Forward Instruction.
X	X	WF	a	b	c	Write Forward; otherwise as Read Forward.
X	X	RW	a	b	c	Rewind Magnetic Tape or Paper Tape Unit XX. Lock can be specified. Interruption occurs if an error occurred on previous block.
X	X	PRA	a	b		Print the contents of A on the console typewriter. Alphabetic, Decimal, or Octal format can be specified. Format instructions are given in B.
X	X	PRD	a	b		
X	X	PRO	a	b		

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . Collating Sequence and Card Units.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 4 bits (numeric) or 6 bits (alphameric)

.22 Character Structure:. . 4 bits or 6 bits, intermingled in a word.

.23 Character Codes

In ascending sequence, quoted in terms of key punch symbols. (The numeric collating sequence ends after the first 16 symbols.)

Internal Code in Octal	Character or Key Punch	Internal Code in Octal	Character or Key Punch
00	0	40	-
01	1	41	J
02	2	42	K
03	3	43	L
04	4	44	M
05	5	45	N
06	6	46	O
07	7	47	P
10	8	50	Q
11	9	51	R
12	(8, 2)	52	(X, 8, 2)
13	#	53	$
14	@	54	*
15	Space	55	(X, 8, 5)
16	(8, 6)	56	(X, 8, 6)
17	(8, 7)	57	(X, 0)
20	&	60	(8, 5)
21	A	61	/
22	B	62	S
23	C	63	T
24	D	64	U
25	E	65	V
26	F	66	W
27	G	67	X
30	H	70	Y
31	I	71	Z
32	(Y, 8, 2)	72	(0, 8, 2)
33	.	73	,
34	(Y, 8, 4)	74	(
35	(Y, 8, 5)	75	(0, 8, 5)
36	(Y, 8, 6)	76	(0, 8, 6)
37	(Y, 0)	77	(0, 8, 7)

DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . General and Magnetic Tape. Common to all I/O equipment.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: . . . . . . 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: . . . . . . 4 numeric bits; 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	+	-	
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10				
11	=	.	$	,
12		)	*	(
13	blank			
14				
15				

DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . . Standard Printer.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: . . . . . . 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: . . . . . . 4 numeric bits; 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	+	-	-
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10	9	I	R	
11	=	.	$	,
12	-	)	*	(
13	blank	)	*	(
14	=	.	$	,
15	-	0	0	(

DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE: . . . . High Speed Printer.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: . . . . . . 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: . . . . . . 4 numeric bits; 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	+	-	blank
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10	'	;	#	@
11	=	.	$	,
12	:	)	*	(
13	blank	%	"	C_R
14	blank	■	blank	blank
15	$	blank	blank	blank

DATA CODE TABLE NO. 5

§ 145.

.1 USE OF CODE: . . . . Console Typewriter.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: . . . . . . 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: . . . . . . 4 numeric bits; 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	+	-	◇
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10	'	;	#	@
11	=	.	$	,
12	:	)	*	(
13	blank	%	"	C_R
14	¢	■	↓	□
15	&	Δ	?	⊗

PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers

H-400
- Reference: . . . . . . Manual DSI-89, H-400 Easy Programs on the H-800.
- Date available: . . . . July, 1961.
- Description
  An integrated package of routines for assembling, debugging and running of programs written in H-400 Easy Language on the H-800.

H-650
- Reference: . . . . . . Manual, 650 Simulator for the H-800.
- Date available: . . . . August, 1960.
- Description
  A package of routines for simulating input conversion, processing, output conversion of IBM 650 programs.

UNIVAC I & II
- Reference: . . . . . . Manual Honeywell 800 Univac Simulator.
- Date available: . . . . August, 1961.
- Description
  The UNIVAC Simulator package contains two programs. One simulates the central processor of the UNIVAC I or II, the second simulates card conversion and printing.

Scientific Option Simulation
- Reference: . . . . . . ESMESSO1, H-800 Subroutine Library.
- Date available: . . . . February, 1960.
- Description
  A package of routines that simulates scientific option hardware, 801B Floating Point Option.

.12 Simulation by Other Computers: . . . . . . none.

.13 Data Sorting and Merging

Fact Compiler Sort
- Reference: . . . . . . FACT Manual.
- Record size: . . . . . see description.
- Block size: . . . . . . ≤ 28, ≤ 128, ≤ 256 words.
- Key size: . . . . any number of keys.
- File size: . . . . each reel is sorted separately, then merged under manual control.
- Number of tapes: . . . 3 to 5.
- Date available: . . . . 1961.
- Description:

This routine provides sorting on FACT type files where records are not used singly, but as a hierarchy of headers, each of which may have a number of subgroups. A typical file would be an Inventory File consisting of Items, within Product Groups, within Areas. Here each "record" would effectively consist of all the information in the Area header and the Group header, as well as in the individual item.

.13 Data Sorting and Merging (Contd.)

A sort on this type of file does not change the structure (it remains an Inventory File consisting of Items within Product Groups within Areas), but can change the order of each header (Product Groups, Areas, or Items) within itself.

Own coding facilities are provided.

H-800 Sort Package
- Reference: . . . . . . DSI-43A, Sort and Collate Manual.
- Record size: . . . . . variable.
- Block size: . . . . . . variable; preset number of records.
- Key size: . . . . preset; maximum one full item.
- File size: . . . . one reel of tape or equivalent partial reels.
- Number of tapes: . . . 3 to 6.
- Date available: . . . . December, 1960.
- Description
  Two parts, presort and merge sort. Presort builds continuous strings of items in memory taking advantage of any pre-ordering of the Data. Merge sort is of Cascade type, in which the power of sort is one less than the number of tapes used.

H-800 Collate Package
- Reference: . . . . . . DSI-43A, Sort and Collate Manual.
- Record size: . . . . . variable.
- Block size: . . . . . . variable; preset number of records.
- Key size: . . . . preset; maximum one full item.
- File size: . . . . 99 reels of tape.
- Number of tapes: . . . 3 to 13 tapes.
- Date available: . . . . December, 1960.
- Description
  The collate routine can be a 2-way, 3-way, 4-way or 5-way merge. Input in each of the above can be a single input tape or a second or alternate tape. Output can be on one file or an alternate. Included, if desired, is a restart dump tape.

.14 Report Writing

Edit Generator
- Reference: . . . . . . DSI-129, Edit Generator and Tape I/O Manual.
- Date available: . . . . 1961.
- Description
  The Edit Generator is a library routine which may be used to prepare reports. The Edit Generator creates routines which obtain data from a source location, edit it and record it on tape or print it on-line.

Report Writer
- Date available: . . . . 1961.

§ 151.

.15 Data Transcription

Routine Name	Function	Timing (m sec)	Max Central Processor Loading
E1AMCED1	Edits card input	1.3+0.4N	33.3 ms per card.
E1FAMED1 E1MAPED1	Edits output for printer	1.5+0.4N	49.5 per 120 char line.
E1FDC2M1	Edits floating point numbers packed 4 to a card	1.0 per number	1.0 per number.

Card-to-tape routines are presently being prepared for floating decimal and floating binary. No straight transcription routines are included in the H-800 either for card-to-tape or for tape-to-printer.

.16 File Maintenance

FACT Compiler

Description

The FACT Compiler includes File Maintenance provisions. (See under Section Problem Oriented Languages, FACT Compiler).

.17 Other

Double-Precision and Complex Arithmetic Package

Reference: . . . . . . H-800 Subroutine Library.

Date available: . . . . 1960.

Description

A series of packages for double-precision and complex arithmetic have been provided. Separate packages deal with specific changes of operands, such as fixed decimal, floating binary, etc. The timings are summarized in the following table:

.17 Other (Contd.)

Type of Arithmetic	Timings (ms)			
	+	-	x	÷
Double-Precision				
Fixed decimal	0.88	0.92	2.45	4.32
Floating decimal	Package not yet available.			
Fixed binary	No package planned.			
Floating binary	0.9	0.9	1.1	2.1
Complex Arithmetic				
Fixed decimal	0.9	0.9	1.8	3.1
Floating decimal	No package planned.			
Fixed binary	No package planned.			
Floating binary	0.8	0.8	1.1	2.1

Code Conversion Routines

The H-800 has a number of possible ways of representing numbers. A number of routines for converting from one form to another are available and are listed below.

Fixed Decimal to Fixed Binary: . . . . 2.5 msec.
Floating Decimal to Floating Binary: . . 3.8 msec.
Floating Binary to Floating Decimal: . 5.2 msec.
Floating Decimal to Fixed Decimal: . . . . 2.7 msec.
Radians to Degrees, in Fixed Decimal: . . . 0.8 msec.
Degrees to Radians, in Fixed Decimal: . . . 0.9 msec.

PROCESS ORIENTED LANGUAGE: AUTOMATH-800

§ 161.

.1 GENERAL

.11 Identity: . . . . AUTOMATH-800.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . Honeywell EDP Publications DS1-448.

.14 Description

Restrictions and extensions of the AUTOMATH-800 language relative to IBM 709/7090 FORTRAN II are summarized below.

Restrictions:

(1) Double precision and complex arithmetic are not permitted, but can be implemented by entering machine assembly language.

(2) IF SENSE SWITCH and IF SENSE LIGHT test the status of specific core storage locations. The monitor system must be used to alter the settings of these pseudo sense switches.

(3) The following statements have not been implemented: FREQUENCY, READ DRUM, WRITE DRUM.

(4) The CHAIN feature, which facilitates segmentation of programs too large to fit into core storage, has not been implemented. A similar feature, OVERLAY, has been incorporated for this purpose.

Extensions:

(1) The following number ranges can be handled:
Floating point: . . 10^{-76} 10^{+75}
Integer: . . . . . . -2^{44} to $+2^{44}$
Boolean: . . . . . 16 octal digits (48 bits).

(2) Subscripts may be integer constants, integer variables, integer functions, or any fixed point arithmetic expressions.

(3) BUFFER statements allocate areas for the buffered reading or writing of one block on magnetic tape from sequential core storage locations, allowing tape/computation overlap.

(4) The statements IF (EOF), and IF (PARITY) permit tests for end-of-file conditions, and for parity errors.

(5) Two card readers, two card punches, and two printers can be referenced separately by the READ, PUNCH, and PRINT statements.

(6) Assembly code instructions can be interspersed.

.15 Publication Date: . . . . 1960, as algebraic compiler.

.2 PROGRAM STRUCTURE

.21 Divisions: . . . . one division, composed of the following types of statements.

Procedure statements: algebraic formulae.
comparisons and jumps.
input and output.

Data statements: . . . FORMAT: describes the layout, size scaling, and code of input-output data.
EQUIVALENCE: used to cause two variables to have a common location or to specify synonyms.
COMMON: used to cause a name to be common to more than one segment rather than local to each.
DIMENSION: describes the elements in each dimension of an array or set of arrays.

.22 Procedure Entities

Program: . . . . subroutines and functions.
Subroutine: . . . . . . statements.
Function: . . . . statements.
Statement: . . . . . . characters; blanks are ignored.

.23 Data Entities

Arrays: . . . . all variables.
Item: . . . . integer variable or constant.
floating point variable or constant.
Boolean variable or constant.
Hollerith item.
alphameric item.
Hollerith item: . . . . alphameric item that can be used only for input and output.
Alphameric: . . . . . alphameric item that can be only input, output, or in FORMAT, CALL, or IF statements.

.24 Names

.241 Simple name formation
Alphabet: . . . . A to Z, 0 to 9.
Size: . . . . 1 to 6 char.
Avoid key words: . . . no.
Formation rule: . . . first char must be letter.
do not use final F if name is more than 3 char long.

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.242 Designators

Procedures	
Statement label: . .	unsigned integer.
Function label: . . .	same as variable being defined.
Subroutine label: . .	none.
Data	
Integer variables: .	initial I, J, K, L, M, N.
Floating point variables:	any other initial letter.
Equipment	
Card:	implied by verbs READ, PUNCH.
Magnetic tape: . . .	use key word TAPE, or READ, WRITE.
Printer:	implied by verb PRINT.
Comments:	C in col. 1 of statement.
Translator control: .	key words EQUIVALENCE, COMMON.

.25 Structure of Data Names

.251 Qualified names:	none.
.252 Subscripts	
Number per item: . .	0 to 3.
Applicable to:	all variables.
Class may be Special index variable: . . .	no.
Any variable:	only integers.
Literal:	yes; only integers.
Expression:	any integer expression or function.
Form may be	
Integer only:	yes.
Signed:	no.
Truncated fraction: .	no.
Rounded fraction: . .	no.
.253 Synonyms	
Preset:	EQUIVALENCE statement causes sharing of storage locations.
Dynamically set: . . .	no.

.26 Number of Names

.261 All entities:	no practical limit.
.262 Procedures	
Numbered statements:	no practical limit.
Subroutines:	no practical limit.
Functions:	no practical limit.
Others:	no practical limit.
.263 Data	
Files:	no limit.
Record formats: . . .	no practical limit.
Items:	no practical limit.
.264 Equipment	
Tape units:	64.
Card readers:	2.
Card punches:	2.
Printers:	1.

.27 Region of Meaning of Names:	all names are local to the program, subroutine, or function in which they are defined unless specified explicitly or by block name in COMMON statement.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: .	FORMAT statement only.
.312 List by kind:	no.
.313 Qualify by adjective: . .	no.
.314 Qualify by phrase: . . .	no.
.315 Qualify by code:	first letter of name.
.316 Hierarchy by list: . . .	no.
.317 Level by indenting: . .	no.
.318 Level by coding:	no.
.319 Others	
Array size:	DIMENSION (4, 7).
Four-digit integer: . .	FORMAT (I4).
Four-digit integers, 5:	FORMAT (5I4).
Floating point items: .	FORMAT (F8. 3, E10. 4) for +999. 999 and +. 0000E+99.

.32 Files and Reels:	own coding.

.33 Records and Blocks

.331 Variable record size: .	dynamic.
.332 Variable block size: . .	specified in BUFFER statement.
.333 Record size range: . .	1 to N blocks.
.334 Block size	
READ TAPE, WRITE TAPE: . . .	no limit (binary format).
READ INPUT TAPE, WRITE OUTPUT TAPE:	up to 120 characters (BCD format).
READ PUNCH:	80 columns.
PRINT:	120 characters.
.335 Choice of record size: .	READ, WRITE statement.
.336 Choice of block size: .	fixed for READ, PUNCH; READ INPUT TAPE and WRITE OUTPUT TAPE. variable and determined by statement and data itself for READ TAPE, WRITE TAPE.
.337 Sequence control: . . .	own coding.
.338 In-out error control: .	own coding, using IF clauses.
.339 Blocking control:	none; 1 or more full blocks' per logical record.

.34 Data Items

.341 Designation of class: .	by name.
.342 Possible classes	
Integer:	yes.
Fixed point:	no.
Floating point:	yes.
Logical:	yes.
Alphameric:	yes.
.343 Choice of external radix:	FORMAT statement.
.344 Possible external radices	
Decimal:	yes.
Octal:	yes.
.345 Internal justification: .	alpha automatic left justified. integers automatic right justified.
.346 Choice of external code:	FORMAT statement and READ, WRITE statement.

§ 161.

.347 Possible external codes
- Decimal: . . . . yes.
- Octal: . . . . yes.
- Hollerith: . . . . yes.
- Alphameric: . . . . . yes.

.348 Internal item size
- Variable size: . . . . fixed.
- Designation: . . . . . none.
- Range
  - Fixed point numeric: fixed, 1 word.
  - Floating point numeric: . . . . . fixed, 1 word.
  - Alphameric: . . . . fixed, 1 word of up to 8 characters.

.349 Sign provision: . . . . . optional.

.35 <u>Data Values</u>

.351 Constants
- Possible sizes
  - Integer: . . . . 2^{15}.
  - Fixed point: . . . . . none.
  - Floating point: . . . 10^{-77} to 10^{+76}.
  - Alphameric: . . . . 120 characters.
  - Boolean: . . . . 16 octal digits.
- Subscriptible: . . . . yes.
- Sign provision: . . . . optional.

.352 Literals: . . . . Boolean constants cannot be written as literals; otherwise same as constants.

.353 Figuratives: . . . . . . own coding; e.g., TEN = 10.0.

.354 Conditional variables: . computed GO TO.

.36 <u>Special Description Facilities</u>

.361 Duplicate format: . . . by multiple references to a single FORMAT statement.

.362 Re-definition: . . . . . COMMON statement. EQUIVALENCE statement.

.363 Table description
- Subscription: . . . . . mandatory, in DIMENSION statement.
- Multi-subscripts: . . 1 to 3.
- Level of item: . . . . variables.

.364 Other subscriptible entities: . . . . none.

.4 <u>OPERATION REPERTOIRE</u>

.41 <u>Formulae</u>

.411 Operator List

+:	addition, also unary.
-:	subtraction, also unary.
*:	multiplication.
/:	division.
**:	exponentiation.
=:	is set equal to.
ABSF ( )‡:	absolute value.
INTE ( )‡:	entire.
MODF (A, B)‡:	remainder A ÷ B.
MAXOF (A,...)‡: . . .	max value; fixed argument.
MAXIF (A,...)‡: . . .	max value; floating argument.
MINOF (A,...)‡: . . .	min value; fixed argument.
MINIF (A,...)‡:	min value; floating argument.

.411 Operator List (Contd.)

DIMF (A,B)‡:	diminish A by B.
SIGNF (A,B)‡:	transfer sign of A to B.
FLOATF ( ):	float an integer.
XFIXF ( ):	fix floating point variable.
LOGF ( ):	natural log.
SINF ( ):	sine.
COSF ( ):	cosine.
EXPF ( ):	exponential.
SQRTF ( ):	square root.
ATANF ( ):	arctangent.
TANHF ( ):	hyperbolic tangent.
EXCLORF (A,B): . . .	exclusive OR.

‡ denotes function may have prefix X to denote fixed point result.

.412 Operands allowed
- Classes: . . . . numeric only.
- Mixed scaling: . . . . yes.
- Mixed classes: . . . . only in exponentiation and functions.
- Mixed radices: . . . . no.
- Literals: . . . . yes.

.413 Statement structure
- Parentheses
  - a - b - c means: . . (a-b) - c.
  - a + b x c means: . . a + (b x c).
  - a/b/c means: . . . . (a ÷ b) ÷ c.
  - a^{b^c} means: . . . . . illegal; parentheses must be used.
- Size limit: . . . . . . 660 char.
- Multi-results: . . . . no.

.414 Rounding of results: . . truncation of integers at each step in expression.

.415 Special cases

	Fixed	Floating
x = -x:	K = -K	X = -X.
x = x + 1: . . .	K = K + 1	X = X + 1.
x = 4.7 Y: . . .	K = 47*K/10	X = 4.7 * Y.
x = $5x10^7 + y^2$:	50000000+L**2	X = 5.E7+Y**2.
x = |y|:	K = XABSF(L)	X = ABSF(Y).
x = entire (3.5):	K = XINTF(L)	X = INTF(Y).

.416 Typical examples: . . . X = (-B+SQRTF(B*B-4.0*A*C))/(2.0*A).

.42 <u>Operations on Arrays</u>

.421 Matrix operations: . . . none.

.422 Logical operations
- Sizes of operands: . . 48 bits.
- AND: . . . . *
- Inclusive OR: . . . . . +
- Exclusive OR: . . . . EXCLORF.
- NOT: . . . . -
- Designation: . . . . . B in col. 1 of each Boolean statement, or use of EXCLORF.

.423 Scanning: . . . . none.

.43 <u>Other Computation:</u> . . subprograms in FORTRAN, or a restricted ARGUS may reference one another.

44 <u>Data Movement and Format</u>

.441 Data copy example: . . Y = X.
.442 Levels possible: . . . . items.
.443 Multiple results: . . . . none.
.444 Missing operands: . . . not possible.

§ 161.

.445 Size of operands
- Exact match: implied, except for alpha or input-output.
- Alignment rule
  - Numbers: right justified or normalized.
  - Alpha: left justified.
- Filler rule
  - Numbers: zeros.
  - Alpha: blanks.
- Truncating rule
  - Numbers: truncate at left.
  - Alpha: truncate at right.
  - Variable size destination: no.

.446 Editing possible
- Change class: yes.
- Change radix: yes.
- Insert editing symbols
  - Actual point: automatic.
  - Suppress zeroes: automatic.
  - Insert: automatic point.
  - Float: - sign only.

.448 Special moves: none.
.449 Character manipulation: none.

.45 File Manipulation

- Open: own coding.
- Close: own coding.
- Advance to next record: READ, WRITE, PUNCH, PRINT.
- Step back a record: BACKSPACE.
- Set restart point: none.
- Restart: none.
- Start new reel: own coding.
- Start new block: implied in each input-output statement.
- Search on key: none.
- Rewind: REWIND.
- Unload: none.

.46 Operating Communication

.461 Log of progress: PRINT uses on-line printer.
.462 Messages to operator: same as log (error messages are automatically typed on console typewriter).
.463 Offer options: PAUSE and type octal integer.
PRINT message and PAUSE.
.464 Accept option: IF SENSE SWITCH n.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow	IF ACCUMULATOR OVERFLOW	own coding.
In-out	IF PARITY	own coding.
Invalid data	format checks	own coding.
I/O device bring	none.	

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: statement.
.512 Unconditional jump: GO TO N.
.513 Switch: GO TO M, or GO TO M, (35, 47, 18).
.514 Setting a switch: ASSIGN 35 to M.
.515 Switch on data: GO TO (35, 47, 18) I.

.52 Conditional Procedures

.521 Designators
- Condition: IF.
- Procedure: implied.

.522 Simple conditions: expression or variable versus zero.
.523 Conditional relations: IF (A) n1, n2, n3: If value of expression A is less than, equal to, or greater than zero, respectively, go to statement n1, n2, or n3.
.524 Variable conditions: expression always against zero.
.525 Compound conditionals: no.
.528 Typical examples: IF (X**2.0 -3.0) 29, 37, 18; go to 29, 37, or 18 if x^2-3 is respectively less than, equal to or greater than zero.

.53 Subroutines

.531 Designation
- Single statement: not possible
- Set of statements
  - First: SUBROUTINE.
  - Last: END.

.532 Use in-line in program: no.
.534 Mechanism
- Cue with parameters: CALL XXX (X, Y, Z).
- Number of parameters: no limit.
- Cue without parameters: CALL XXX.
- Formal return: RETURN at least once.
- Alternative return: none.

.535 Names
- Parameter call by value: none.
- Parameter call by name: yes.
- Non-local names: use COMMON.
- Local names: all.
- Preserved own variables: all.

.536 Nesting limit: none.
.537 Automatic recursion allowed: no.

.54 Function Definition by Procedure

.541 Designation
- Single statement: same as set.
- Set of statements
  - First: FUNCTION.
  - Last: END.

.542 Level of procedure: any number of statements.
.543 Mechanism
- Cue: by name in expression.
- Formal return: RETURN.

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.544 Names
Parameter call by value: . . . . none.
Parameter call by name: . . . . yes.
Non-local names: . . use COMMON.
Local names: . . . . . all.
Preserved own variables: . . . . . . all.

.55 Operand Definition by Procedure: . . . . none.

.56 Loop Control

.561 Designation of loop
Single procedure: . . none.
First and last procedures: . . . . . current place to named end; e.g., DO 173 I = 1, N, 2.
.562 Control by count: . . . none.
.563 Control by step
Parameter
Special index: . . . . no.
Any variable: . . . . integer only.
Step: . . . . positive integers.
Criteria: . . . . greater than.
Multiple parameters: no.
.564 Control by condition: . . no.
.565 Control by list: . . . . no.
.566 Nesting limit: . . . . . limit specific to each translator.
.567 Jump out allowed: . . . yes.
.568 Control variable exit status: . . . . . . available.

.6 EXTENSION OF THE LANGUAGE: . . . . . can write new function in library.

.7 LIBRARY FACILITIES

.71 Identity: . . . . CPT (Collector Programs Tape).

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . yes.

.73 Storage Form: . . . . . magnetic tape; variable length blocks in relocatable binary format.

.74 Varieties of Contents: . . subroutines. functions. service routines. compiled object programs.

.75 Mechanism

.751 Insertion of new item: . separate run, using AUTOMATH update phase.
.752 Language of new item: . FORTRAN, hand coding, or FORTRAN-ARGUS.
.753 Method of call: . . . . . named in procedures.

.76 Types of Routines

.761 Open routines exist: . . yes.
.762 Closed routines exist: . yes.
.763 Open-closed is variable: each case is pre-decided.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . . some ARGUS assembler statements can be interspersed with FORTRAN statements. They are distinguished by an "A" punched in col. 1.

.82 Optimizing Information Statements

.821 Process usage statements: . . . . . . none.
.822 Data usage statements: COMMON. EQUIVALENCE.

.83 Translator Environment: . . . . . no.

.84 Target Computer Environment: . . . . . no.

.85 Program Documentation Control: . . . . no.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: no.

.92 Address Allocation: . . none.

.93 Arrangement of Items in Words in Unpacked Form: . . . . standard for numerics.

.94 Assignment of Input-Output Devices: . . . specified in input-output statements.

.95 Input-Output Areas: . . BUFFER statements allocate the amount of storage to be used for I/O purposes.

PROCESS ORIENTED LANGUAGE: FACT

§ 162.

.1 GENERAL

.11 Identity: . . . . FACT Language.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . . . FACT Manual, Interim Edition, January, 1961.

.14 Description

FACT, is a system for maintaining and servicing magnetic tape files. These files can be, but are not necessarily, "hierarchical" in the sense that all items on the file have pre-set "levels". When any particular item is being handled, all items senior to it are available for reference. Thus, while a salesman's record is being updated, the area, regional, and national records are also available for reference, although they may be physically far apart on a magnetic tape.

Four separate cycles of process are possible in the system and generally separate facilities are provided for each in the language:

1. Input Editing
2. File Updating
3. File Sorting
4. Report Preparation

Each of these has its own rules; for instance, the Report Writer allows for description to be given by picture, whereas this is not possible in the other types.

The procedures in the language are written in a COBOL-like English Language system, and formulae may be employed in expressions if desired. Conditional statements (IF MANAGERIAL THEN . . .) are allowed, and any group of conditions may be defined and labeled (ELIGIBLE, OFFICER AND AGE LESS THAN 30)

A characteristic of Input Editing and Report Preparation is that a number of different files or Reports can be created from a single input. Thus, an output tape which will hold the details for several reports can be created during a production run.

The Sort facility allows sorting to take place while retaining the "hierarchical" structure of the file. Own coding section can be inserted, in the FACT language, either before or after a sort process.

Standard FACT File conventions are used throughout the system. Housekeeping chores, including label creation and checking, code conversions, etc., are handled automatically.

.2 PROGRAM STRUCTURE

.21 Divisions

File Outline: . . . . . describes the layout of each file and its contents.
Program: . . . . contains the description of the procedures to be executed.
Report Writer: . . . . describes the format of the desired report in semi-pictorial form, including its own file descriptions.
Input Editing: . . . . . defines the input code to be accepted and the action to be taken if incorrect codes are received.
Sorting: . . . . defines the files to be sorted, and their relationship; includes provisions for first and last pass own coding.

.22 Procedure Entities

Procedure: . . . . . . consists of other procedures and paragraphs.
Paragraphs: . . . . . . consists of sentences, perhaps arranged in subparagraphs. If so, a hierarchial arrangement is used, so that a paragraph at any one moment consists of the paragraph header plus the CURRENT sub-paragraph (sons, grandsons, etc.).
Sentences:. . . . . . . words, perhaps arranged in clauses.
Subroutines: . . . . . any namable entity above (i.e., procedure, paragraph, or sentence).

.23 Data Entities

File: . . . . groups.
Primary group: . . . . primary groups and fields.
Secondary groups: . . . primary groups, secondary groups, and fields.
Fields: . . . . characters.
Hierarchy: . . . . . . one group header from each group level within the hierarchy.
Group header: . . . . fields.
Group level: . . . . . . the relationship of a header within a group; e.g., Father and Son.

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.24 Names

.241 Simple name formation
- Alphabet: . . . . . . A-Z, 0-9.
- Size: . . . . 61 characters.
- Avoid key words: . . . yes.
- Formation rules: . . . leading character must be alphabetic.

.242 Designators
- Data
  - Numeric literals: . . numeric leading character.
  - Non-numeric literals: . . . . . . quotes or two dots enclosing character.

.25 Structure of Data Names

.251 Qualified names
- Example: . . . . . . MASTER TOTAL
- Multiple qualifiers: . . yes.
- Complete sequence: . . optional.
- Broken sequence: . . . yes.

.252 Subscripts
- Number per item: . . 3.
- Applicable to: . . . . fields occuring a fixed (preset) number of times in their father group.
- Class may be
  - Special index variable: . . . . not necessary.
  - Any variable: . . . . yes.
  - Literal: . . . . yes.
  - Expression: . . . . . no.
- Form may be
  - Integer only: . . . . . yes.
  - Signed: . . . . no.
  - Truncated fraction: . . . . no.
  - Rounded fraction: . . . no.

.253 Synonyms
- Preset: . . . . yes.
- Dynamically set: . . . yes.

.26 Number of Names

.261 All entities: . . . . . . no limit.
.262 Procedures: . . . . . . no limit.
.263 Data
- Files: . . . . max of 64.
- Record formats: . . . no limit.
- Items: . . . . no limit.
- Data levels: . . . . . no limit.

.264 Equipment: . . . . . . ?

.27 Region of Meaning of Names

.271 Universal names: . . . all, unless dynamically reset during execution of program.

.272 Local names
- Possible entities
  - Data fields: . . . . . can be assigned new names, and both fields are altered each time the new name is used in a procedure. The new name can then be re-assigned. This is used primarily for subroutines.

.272 Local names (Contd.)
- Possible entities (Contd.)
  - Designator: . . . . . . assign statement.
  - Definition: . . . . . . original designation.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

		Input	Tape Files	Reports
.311	Concise item picture:	no	no	yes.
.312	List by kind:	no	no	no.
		Input †	Files ††	Reports †††
.313	Qualify by adjective:	no	no	no.
.314	Qualify by phrase: .	no	no	no.
.315	Qualify by code: . .	yes	yes	yes.
.316	Hierarchy by list: .	yes	yes	yes.
.317	Level by indenting:.	no	yes	no.
.318	Level by coding: . .	yes	no	yes.

.32 Files and Reels

.321	File labels			
	Variable layout: .	no	no	no.
	Control totals: .	no	no	no.
	Identity control: .	yes	yes	no.
	Multi-reel:	yes	yes	yes.
.322	Reel labels			
	Variable layout: .	no	no	no.
	Block count: . . .	optional	yes	no.
	Multi-files: . . .	yes	yes	yes.

.33 Records and Blocks

.331	Variable record size:	no	yes	no.
.332	Variable block size:	yes	yes	yes.
.333	Record size range (in words):	---	2 to 251	---
.334	Block size range (in words):	11 to 104	24 to 251	16 to 124.
.335	Choice of record size:.	---	automatic	---
.336	Choice of block size:	description	automatic	automatic
.338	In-out error control:	description	subroutine	
.339	Blocking control: .	own coding	own coding	own coding.

.34 Data Items

.341	Designation of class:	description	description	description.
.342	Possible classes			
	Integer:	yes	yes	yes.
	Fixed point: . . .	yes	yes	yes.
	Floating point: . .	no	no	no.
	Alphabetic:	yes	yes	yes.
	Alphameric: . . .	yes	yes	yes.
.343	Choice of external radix:	code	code	code.
.344	Possible radices			
	Decimal:	yes.		
	Hexadecimal: . . .	cannot be used arithmetically.		
.345	Justification:	description	automatic	
.346	Choice of code: . .	description	description	description.

† Described in Input Editing Section of the source language.
†† Described in File Outline Section of the source language.
††† Described in Report Writing Section of the source language.

§ 162.

.347 Possible codes:

Mode	Code	Legal Characters
Hollerith	H[1]	Any of the 64 legitimate keypunch combinations
Standard Hollerith	SH[1]	Standard keypunch characters, +0, and -0
Alphabetic or Single Punch	AS[1]	A-Z, 0-9, 11, or 12
Alphanumeric	AN[1]	A-z or 0-9
Alphabetic	A[1]	A-Z
Numeric or Zone	NZ[1]	0-9, 11, or 12
Numeric Hollerith	NH[1]	0-9
Zone Punch	ZP[1]	11 or 12
Octal	OC[1, 5, 6]	0-7
Signed Decimal	D[2, 7]	0-9
Unsigned Decimal	UD[3, 7]	0-9
Unsigned Decimal with Check Digit	CD[3, 7]	0-9
Single Punch Decimal	SP[4, 7]	0-9, 11, or 12
Hexadecimal	HX[5, 8]	0-9 or B-G

Notes

1. Each of these modes is a subset of six-bit Hollerith. These modes may be intermixed to form a single field. The different classifications of six-bit Hollerith are used only for input checking. After cards are read, the distinction between these modes is ignored and all are considered to be Hollerith.

2. A decimal field may contain up to 11 digits and sign. The length of such a field is the number of digits, not including the sign.

3. An unsigned decimal field or a check decimal field may contain up to 12 digits, including the check digit if used.

4. The SP mode is limited to single-column fields. The field is converted as an unsigned decimal field of length two and scale zero. Punches 1-9 become 01-09, a zero punch becomes 10, an 11 punch becomes 11, and a 12 punch becomes 12.

5. A hexadecimal or octal field may be up to 12 hex digits or 16 octal digits.

6. An octal field is forced by the compiler to have an even number of digits by prefixing a zero if necessary. Thereafter, each digit pair is treated as a six-bit Hollerith character.

7. Four-bit modes.

8. A field in this mode cannot be used in arithmetic.

.348 Item size
- Variable size: . . . . preset.
- Designation: . . . . description.
- Range
  - Fixed point numeric: . . . . . . 11 digits signed.
  - Floating point numeric: . . . . . . not available.
- Alphameric: . . . . . 999 characters.

.349 Sign provision: . . . . optional.

.35 Data Values

.352 Literals
- Possible sizes: . . . . 12 digits unsigned; 11 digits signed.
- Designation: . . . . . in description of Report Writer; otherwise within quotes or dots.

.353 Figuratives
- Examples: . . . . . Blank, all cardinal and ordinal numbers; e.g., NINE MILLION EIGHT HUNDRED SEVENTY THOUSAND SIXTY FIVE; TWENTY FIRST; 21ST.

.354 Conditional variables: . . . . yes; symbolic labels allowed.

.36 Special Description Facilities

.361 Duplicate format: . . . yes; at file level.

.362 Re-definition: . . . . yes, by defining as another hierarchy. Can be done at any level. Area sizes need not match.

.363 Table description
- Subscription: . . . . yes.
- Multi-subscripts: . . up to 3, e.g. (P)TH HOUR OF (Q) TH DAY OF MONTH.
- Level of item: . . . any group level.

.364 Other subscriptible entities: . . . . . . none.

.4 OPERATION REPERTOIRE

.41 Formulae

These can be only used as expressions within the English language statement.

.411 Operator list
+
-
*
/
=

.412 Operands allowed
- Classes: . . . . numeric.
- Mixed scaling: . . . yes, in fixed point operation.
- Mixed classes: . . . no.
- Mixed radices: . . . no.
- Literals: . . . . . . yes.
- Figuratives: . . . . yes.

§ 162.

.413 Statement structure

Parentheses

a - b - c means: . . (a - b) - c

a + b x c means: . . a + (b x c)

a / b / c means: . . (a/b)/c

a^{bc} means: . . . . not available.

Size limit: . . . . . . 11 digit numeric.

Multi-results: . . . . yes.

.414 Rounding of results:

.415 Special cases

x = -x: . . . . SET X = 0 - X

x = x + 1: . . . . . SET X = X + 1

x = 4.7 y: . . . . . SET X = 47 * Y/10

x = 5 x 10^7 + y^2: . . SET X = 50000000 + Y * Y.

x = y integer part: . . SET X = Y/10 * n; MAX where n is the number of positions Y possesses to the right of the decimal point.

.42 Operations on Arrays: . none.

.43 Other Computation

.431 Operator list

PLUS:

ADD:

SUBTRACT:

LESS:

MULTIPLIED BY:

TIMES:

DIVIDED BY:

OVER:

EQUALS:

IS EQUAL TO:

.432 Operands allowed

Mixed scaling: . . . . yes.

Mixed classes: . . . . yes.

Mixed radices: . . . . no.

Literals: . . . . yes.

Restrictions: . . . . fields must be wholly fixed point numeric.

.433 Statement

Mixed verbs: . . . . yes within sentence, no within clause.

Multi-results: . . . . yes.

Size limits: . . . . . 100 words per sentence if no group move.

Multi-operand: . . . yes.

Implied results: . . . yes.

.434 Rounding of results: . . description.

.435 Special cases

x = -x: . . . . SET X = (-X).

x = x+1: . . . . . . ADD 1 TO X.

x = x+ y: . . . . . . ADD Y TO X.

x = x÷y: . . . . . . DIVIDE X BY Y.

x = xy: . . . . MULTIPLY X BY Y.

x = remainder x÷y: . not available.

.436 Typical cases

b = b + a }
c = c + a } : . . . . . ADD A TO B AND C.

c = c + a + b: . . . . ADD A AND B TO C.

.44 Data Movement and Format

.441 Data copy example: . . PUT A INTO B.

.442 Levels possible: . . . any group level.

.443 Multiple results: . . . yes. REPLACE A AND B BY C.

.444 Missing operands: . . REPLACE (SECONDARY GROUP A) BY (SECONDARY GROUP B).

.445 Size of operands

Numbers: . . . . . decimal point aligned.

Alpha: . . . . left justified.

Filler rule

Numbers: . . . . . . zeroes.

Alpha: . . . . blanks.

Truncating rule

Numbers: . . . . . decimal points aligned, then truncated at left, optionally rounded or truncated at right.

Alpha: . . . . truncated at right.

.446 Editing possible (in Report Writer)

Change class: . . . . . no

Change radix: . . . . . no

Delete editing symbols: . . . . no

Insert editing symbols

Actual point: . . . . yes

Suppress zeroes: . . . yes.

Insert: . . . . yes.

Float: . . . . yes.

.447 Special moves

Move Corresponding with Exceptions: . . . . PUT A INTO B EXCEPT J.

.448 Code translation: . . . no.

.449 Character manipulation: . . . . yes; any single character can be addressed; groups of characters must be defined before being addressed.

.45 File Manipulation

Open: . . . . implied by word GET for input; OPEN NEW or FILE.

Close: . . . . CLOSE FILE for input; CLOSE NEW for output.

Advance to next record: . . . . GET NEXT (GROUP NAME).

Step back a record: . . not available on input files. REMOVE output group name for output.

Set restart point: . . . . SETRESTART

Restart: . . . . assumed to be automatic.

Start new reel: . . . . END REEL PROCEDURE

Start new block: . . . . not available.

Search on key: . . . . FIND FILE (file name) [SEARCHING BACKWARDS].

Rewind: . . . . REWIND, also included in LOCK.

Unload: . . . . LOCK.

.46 Operating Communication

.461 Log of progress: . . . segment names listed on console as each is loaded.

.462 Messages to operator: none, unless programmed.

.463 Offer options: . . . . own coding only.

.464 Accept option: . . . . entry from console typewriter.

§ 162.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	object program check.	own coding.
In-out:	automatic	orthotronic correction routine, or abort.
Invalid data:	use of IF VALID or IF NO UNCHECKED VALIDITY ERROR	own coding.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . . paragraph, procedure, subroutine.
.512 Unconditional jump: . . implied by END OF (name) PROCEDURE.
DO PROCEDURE (name)
LEAVE PROCEDURE
GO TO
.513 Switch: . . . . none.
.514 Setting a switch: . . . . none.
.515 Switch on data: . . . . IF name GREATER THAN literal USE BRANCH WITH field, 1st para., 2nd para.

.52 Conditional Procedures

.521 Designators
Condition: . . . . . . IF....;
UNLESS
Procedure: . . . . . implied, with OTHERWISE option.
.522 Simple Conditions
Expression v Expression: . . . . yes.
Expression v Variable: . . . . yes.
Expression v Literal: . . . . yes.
Expression v Figurative: . . . . yes.
Expression v Condition: . . . . no.
Variable v Variable: . . yes.
Variable v Literal: . . yes.
Variable v Figurative: . . . . yes.
Variable v Condition: . . . . no.
Conditional value: . . . yes.
.523 Conditional relations
Equal: . . . . EQUALS, IS EQUAL TO, =, IS
Greater than: . . . . IS GREATER THAN
Less than: . . . . . . IS LESS THAN
Greater than or equal: . . . . IS GREATER THAN OR EQUALS

.523 Conditional relations (Contd.)
Less than or equal: . . . . IS LESS THAN OR EQUALS
negated conditions are obtained by replacing IF, by UNLESS, or by inserting NOT, and replacing OR with NOR at the appropriate positions.
.524 Variable conditions: . . none.
.525 Compound conditionals
IF X AND Y: . . . . yes.
IF X OR Y: . . . . . yes.
IF X DO A AND Y DO B: . . . . all conditions must be explicit when separated by imperative sentences. Thus phrasing would be IF X DO A, IF X AND Y DO B.
IF X DO A AND B, OTHERWISE IF Y DO B.
.527 Condition on alternative: . . . . yes
.528 Typical examples: . . . IF X IS 1 OR 6 OR 9 OR GREATER THAN 25 GO TO A.
IF X OF (N)TH Primary-group IS Y PUT 1 INTO X OF (N)TH Primary-group.
IF X IS Y PLUS Z MINUS 1 PUT X INTO Y. OTHERWISE PUT X INTO Z.

.53 Subroutines

.531 Designation
Single statement: . . . yes.
Set of statements
First: . . . . named statement
Last: . . . . determined within subroutine coding.
.532 Possible subroutines: . . procedure, paragraph, subparagraph.
.533 Use in-line in program: . . . . yes.
.534 Mechanism
Cue with parameters: . . . . . . yes, all parameters must be.
Number of parameters: . . . . . . dynamically assigned local names.
Cue without parameter: . . . . no.
Formal return: . . . . not necessary.
Alternative return: . . GO TO.
.535 Names
Parameter call by value: . . . . indirectly.
Parameter call by name: . . . . yes.
Non-local names: . . . no.
Local names: . . . . yes.
Preserved local variables: . . . . . no.
.536 Nesting limit: . . . . . none.
.537 Automatic recursion allowed: . . . . no (?)

§ 162.

.54 Function Definition by Procedure: . . . . . . none.

.55 Operand Definition by Procedure: . . . . . . none.

.56 Loop Control

.561 Designation of loop
Single procedure: . . . DO PROCEDURE A
First and last procedures: . . . . all procedures must be quoted.
.562 Control by count: . . . no.
.563 Control by step: . . . . no.
.564 Control by condition: . . . . no.
.565 Control by list: . . . . no.
.566 Nesting limit: . . . . . indefinite.
.567 Jump out allowed: . . . no.
.568 Control variable exit status: . . . . . indefinite.

.6 EXTENSION OF THE LANGUAGE: . . . . none.

.7 LIBRARY FACILITIES: . . . . none.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . . no.

.82 Optimizing Information Statements

.821 Process usage statements: . . . . none.
.822 Data usage statements: . . . . none.

.83 Translator Environment: . . . . none.

.84 Target Computer Environment: . . . . . none.

.85 Program Documentation: . . . . none.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: . . . . none.

.92 Address Allocation: . . none.

.93 Arrangement of Items in Words in Unpacked Form: . . . . description.

.94 Assignment of Input-Output Devices: . . . description.

.95 Input-Output Areas: . . (?)

PROCESS ORIENTED LANGUAGE: COBOL

§ 163.

.1 GENERAL

.11 Identity: . . . . H-800 COBOL.

.12 Origin: . . . . Codasyl Committee.

.13 Reference: . . . . Introduction to COBOL. Honeywell EDP Document DSI 128.

.14 Description

The COBOL compiler for the H-800 is due to be released during the third quarter of 1963. Presently available information indicates that it will contain all of Required COBOL-61. In addition, the H-800 compiler will implement some electives and an interesting extension which allows the value of an item in a record to determine which of a number of record types on one file is presently being processed.

The extensions, which are listed below, primarily allow free handling of input-output devices and the central processor rather than enriching the language. Thus, rerunning procedures and rewinding WITH LOCK have been implemented, but formulae are not available. Other electives allow COBOL programmers to enter the ARGUS assembly language.

COBOL-61 ELECTIVES TO BE IMPLEMENTED
IN H-800 COBOL

Key No.	Elective	Comments
	Characters and Words	
1	Formula characters	+, -, *, /, **, =.
3	Semicolon	;, always ignored.
5	Figurative Constants	HIGH-BOUND (S); LOW-BOUND (S).
6	Figurative Constants	HIGH-VALUE (S); LOW-VALUE (S).
7	Computer-name	labels data-description.
	File Description Clauses	
8	Block-size	allows a range to be specified.
9	FILE CONTAINS	indicates approximate file size.
10	Label formats	allows new or library formats.
11	Sequenced-on	gives a list of keys.
	Record Description Clauses/options	
15	Bit usage	allows items to be specified in binary.
16	RANGE IS	gives value range of item or character.
*17	RENAMES	controls storage allocation.
*18	SIGN IS	allows separate signs.
20	Conditional-range	allows a conditional-value to be a range.
21	Label-handling	provides free handling of labels.
	Verbs	
22	COMPUTE	algebraic formula.
*23	DEFINE	new verb definition.
*25	INCLUDE	calls library routines.
26	USE	amplifies I-O error and labelling routines.
	Verb Options	
27	LOCK	locks rewound tapes.
28	MOVE CORRESPONDING	moves and edits relevent records.
*29	OPEN REVERSED	allows reading tapes backwards.
*30	ADVANCING paper	gives specific paper advance.
32	Formulas	algebraic formulae.
34	Relationship	IS UNEQUAL TO, EQUALS, and EXCEEDS.
35	Tests	IF { } IS NOT ZERO.
36	Conditionals	implied objects with implied subjects.
38	Complex conditionals	
39	ON SIZE ERROR	provides extension of error routines.

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COBOL-61 ELECTIVES TO BE IMPLEMENTED
IN H-800 COBOL (Contd.)

Key No.	Elective	Comments
	Environment Division options	
40	SOURCE-COMPUTER	allows selective use of previous description.
41	OBJECT-COMPUTER	allows selective use of previous description.
42	SPECIAL NAMES	specifies for ACCEPT, WRITE, and DISPLAY. verbs.
43	File Description	can be taken from library.
45	I-O Control	can be taken from library.
46	I-O Control	allows programmer control.
	Identification Division	
47	DATE	gives compilation date.
	Special Features	
*48	LIBRARY	allows calls of library routines.
*49	SEGMENTATION	

* Will be deferred until 1964.

COBOL-61 ELECTIVES NOT TO BE IMPLEMENTED
IN H-800 COBOL

Key No.	Elective	Comments
	Characters and Words	
2	Relationship characters	=, > , < .
4	Long literals	up to 120 characters long only.
	File Description Clauses:	none.
	Record Description Clauses/options	
13	Table-length	only fixed length tables and arrays.
14	Item-length	only fixed length items (see also 19).
19	Item-length	no variable length items allowed (See also 16.)
	Verbs	
24	ENTER	no Non-COBOL computer languages.
	Verb Options	
33	Operand-size	only up to 10 digits.
37	Compound conditions	no mixed ANDs and ORs allowed.
	Environment Division Options	
44	PRIORITY is	no priorities can be given for multi-programming purposes.
	Identification Division	none.
	Special Features	none.

MACHINE-ORIENTED LANGUAGE: ARGUS

§ 171.

.1 GENERAL

..11 Identity: . . . . ARGUS.

.12 Origin: . . . . Minneapolis-Honeywell.

..13 Reference: . . . . Manual DSI-23 C.

.14 Description

ARGUS is the basic machine oriented language for the H-800, and as such, it reflects the complexities of the H-800 addressing structure. Some instructions have been simplified; e.g., a left shift instruction is introduced which is converted to the appropriate right shift instruction in the translation.

Segmentation of programs can be handled in the assembly, as can the formation of binary, decimal, alphameric, and floating point constants. Symbolic names can be used, but automatic reservation of a location occurs only when the symbolic name is used as a location address. Thus, working space, etc., must be referenced twice: once in its place as an operand, and again to reserve a location for it.

Special control instructions are available to define symbolic tags. These definitions can be in terms of absolute or relative storage addresses, symbolic tags, or complex symbolic tags (e.g., indirect addresses). The definitions can also be allocated to the next available location modulo 2, 4, 8, 16, 32, or 64. Expressions can be used providing they contain no parentheses, and a form of local addressing is available.

A library system is available controlling open and closed subroutines which can be called into the program by name and parameter list. The preparation of a library is a function of each installation.

.15 Publication Date: . . . . 1960.

.2 LANGUAGE FORMAT

.21 Diagram

Name	Location	Command Code	S/C	A Address	B Address	C Address	Remarks
Card Col	1 10	11 22	23	24 37	38 55	56 65	66 80
Example	123TAG	DA	X	C, + 2	X7, TAG+2	N, R3, 9	

.22 Legend

Location: . . . . absolute or symbolic location for this line of coding.
Command Code: . . . . mnemonic instruction code. constant type code. assembly control codes. library pseudo code.
A, B, or C Address: . . instruction operand address, literals. control parameters. constants, macro parameters. data descriptors.
Remarks: . . . . any comments; these do not affect the assembly.

Note: A special line containing remarks only can be used when R, or P, is in columns 1 and 2.

.23 Corrections: . . . . . . no special provision in the language; control cards are available which incorporate amendments into an assembled program.

.24 Special Conventions

.241 Compound Addresses: . yes, the base can be an absolute or symbolic address; or the address contained in either of the sequence counters, or an index register. Augmenters can be literal, symbolic, or contained in index registers of indirect address locations.
.242 Multi Addresses: . . . none.
.243 Literals: . . . . up to 2,047, written in decimal for use in binary.
.244 Special Coded Addresses: . . C, X, the addresses in the Sequence and Cosequence Counters. STOPPER highest address available.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . unlimited.

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.312 Common label formation rule: . . . . yes.
.313 Reserved labels: . . . . none.
.314 Other restrictions: . . none.
.315 Designators
F, tag: . . . . Mask to be used in field instructions.
S, tag: . . . . Mask to be used in shift instructions.
B, tag: . . . . Mask to be used in field or shift instructions.
L, tag: . . . . Tag at start of subsequent segment.
Z, tag: . . . . Special register address.
ALF, n: . . . . alphabetic constant of n words. $1 \leq n \leq 5$.
ALF, a: . . . . alphabetic constant ending with next occurrence of "a". "a" cannot be 0 through 5.
OCT: . . . . octal constant or constants.
DEC: . . . . decimal constant.
FXBIN: . . . . binary constant written in decimal.
FLDEC: . . . . floating point decimal constants.
FLBIN: . . . . floating point binary constants written in decimal.
EBC: . . . . double precision, floating point binary constants written in decimal.
.316 Synonyms permitted: . yes.

.32 Universal Labels

.321 Labels for procedures
Existence: . . . . . . optional.
Formulation rule
First character: . . alphabetic or numeric.
Last character: . . . alphabetic or numeric.
Others: . . . . alphabetic or numeric.
Number of characters: . . . . 1 to 8; one must be alphabetic, spaces are ignored.
.322 Labels for library routines: . . . . same as procedures.
.323 Labels for constants: . same as procedures.
.324 Labels for files: . . . . none as such.
.325 Labels for records: . . none as such.
.326 Labels for variables: . same as procedures.

.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constants

	Digits
Integer	
Decimal:	12 digits.
Octal:	16 digits.
Binary:	14 digits.
Fixed numeric	
Decimal:	12 digits.
Octal:	16 digits.
Binary:	14 digits.

.411 Maximum size constants (Contd.)

Floating numeric	
Decimal:	10 digits.
Octal:	none.
Hexadecimal:	none.
Alphabetic:	29 characters.
Alphameric:	29 characters.

.412 Maximum size literals
Integer
Decimal: . . . . . . 4 digits.
Fixed numeric: . . . . none.
Floating numeric: . . none.
Alphameric: . . . . . none.

.42 Working Areas

.421 Data layout
Implied by use: . . . . yes.
Specified in program: no.
.422 Data type: . . . . not required.
.423 Redefinition: . . . . . . yes.

.43 Input-Output Areas

.431 Data layout: . . . . . . implicit.
.432 Data type: . . . . not required.
.433 Copy layout: . . . . . . no.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . . yes.
Number: . . . . 67.
Example: . . . . DA PRICE AMTDUE AMTDUE. (Decimal Add: Price to Amount Due).
.512 Absolute: . . . . not available in the language.

.52 Macro-Codes

.521 Number available . . . No central library; each installation may provide its own.

.523 New macros: . . . . . . can be written in program and optionally placed in library.

.53 Interludes: . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . yes, detailed below .542.
Label adjustment: . . yes, detailed below .543.
Annotation: . . . . . . yes, detailed below .544.
.542 Allocation counter
Set to absolute: . . . . SETLOC.
Set to label: . . . . . SETLOC, ASSIGN, TAS.
Step forward: . . . . . SETLOC, RESERVE, MODLOC.
Step backward: . . . . SETLOC.
Reserve area: . . . . RESERVE.
.543 Label adjustment
Set labels equal: . . . SETLOC.
Set absolute value: . . SETLOC, EQUALS.
Clear label table: . . none.

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.544 Annotation

Comment phrase: . . remarks field.
Title phrase: . . . . . R, or P, in cols 1 and 2.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . . library of scientific subroutines multiply, divide. floating point package.
.612 Method of call: . . . . . macro in library or in program deck.

.62 Special Functions

.621 Facilities: . . . . trig. functions. log. matrix. differential equations. statistics.
.622 Method of call: . . . . . macro in library or in program deck.

.63 Overlay Control

.631 Facilities: . . . . all programs divided by delimiter SEGMENT or PROGRAM into at least one segment. overlay calls must be written in programs, and all programs are held in abeyance while the overlay takes place.

.64 Data Editing

.641 Radix conversion: . . . none provided.
Code translation: . . . not necessary.
.642 Format control: . . . . not necessary.

.65 Input-Output Control

.651 File labels: . . . . . . standard.
.652 Reel labels: . . . . . . standard.
.653 Blocking: . . . . variable.
.654 Error control: . . . . . standard.
.655 Method of call: . . . . . library call.

.66 Sorting

.661 Facilities: . . . . forward cascade sorting (3 to 6 tapes) single, double, or extra precision.
.662 Method of call: . . . . . library call.

.67 Diagnostics: . . . . . . snapshots specified before assembly; new snapshots require re-assembly.

.7 LIBRARY FACILITIES

.71 Identity: . . . . library.

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . yes.
.723 Private: . . . . yes.

.73 Storage Form: . . . . . tape.

.74 Varieties of Contents: . mathematic routines. generators. data processing packages.

.75 Mechanism

.751 Insertion of new item: . standard updating program.
.752 Language of new item: . ARGUS.
.753 Method of call: . . . . . L, NAME in Command field.

.76 Insertion in Program

.761 Open routines exist: . . yes.
.762 Closed routines exist: . yes.
.763 Open-closed is optional: yes.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Open-ended library.

.82 Pseudos

Code	Description
SETLOC:	set location counter.
PROGRAM:	controls segmentation.
SEGMENT:	controls segmentation.
EQUALS:	assigns values to labels.
RESERVE:	reserves storage.
MACRODEF:	heads macro routine.
FINIS:	ends macro routine.
SCON:	initialize sequence register for object program.
STOP:	exit from program to monitor.

PROGRAM TRANSLATOR: COBOL-800

§ 182.

.1 GENERAL

.11 Identity: . . . . COBOL-800.
CB 8-0002 Revision I.

.12 Description

Although the COBOL-800 translator has not yet been released, certain details regarding the translation process and the object program are available.

The compilation process involves basically three phases: the first phase performs syntactic analyses of the source program; the second phase generates the object code; and the third phase assembles the generated code into a machine program. The Honeywell COBOL 800 System also includes two supporting runs that are optional. First, a pre-compiling run designed to maintain a master file of COBOL Source Programs and select those to be compiled. Second, an edit run that may be executed following all compilations for a particular computer run to print the source program listings and documentation for each program compiled.

The machine program produced is able to run directly on the H-800. The data and the instructions are kept separate to allow dynamic relocation of the object program and thereby to improve overall production when multi-running is in progress. The translating time is estimated at 50 to 75 statements per minute, with the aim of making the efficiency of the object program compare favorably with the efficiency of hand-coding.

With the COBOL-800, the original programmer is able to specify binary or decimal arithmetic, and fixed-point or floating point mode, so that the advantages of these features of the H-800 system can be utilized. The original programmer can also specify, as is standard in COBOL, his data as being DISPLAY or COMPUTATIONAL. Numeric data fields may be specified to occupy four bits per character, and may be packed in a computer word in order to minimize the volume of files. Numeric data may also be specified synchronized in order to permit arithmetic operations to be performed with maximum efficiency. To make advantageous use of the different types of computational which are available requires considerable knowledge of the H-1800 machine code, as produced by the translator.

The compiling computer must have six tape units (any type), 8,192 words of storage, a card reader, and a printer. The object computer must have one tape unit, but otherwise any H-800 system is acceptable. Details are not presently available for the handling of error conditions arising during compilation or object program running.

OPERATING ENVIRONMENT: ARGUS (PRODUCTION RUNNING)

§ 191.

.1 GENERAL

.11 Identity: . . . . ARGUS.
Automatic Routine Generating and Updating System.
Program Selection Process B.
Executive Schedule Run.
Executive Production Run.

.12 Description

The ARGUS system is organized to run programs either serially or in parallel; however, many of the standard programs (including the ARGUS assembler) and all programs under test must run serially. After a program has been tested, it can be run in parallel with other programs. This section describes the method of running such programs.

The advantages to running in parallel under the ARGUS system are:

- Sharing computer usage between programs, some of which are input-output bound.
- Overlapping set-up time with the running of other programs.

The advantages not supplied by the present system which might be gained using multiprogramming are:

- The ability to run unexpected programs in parallel with, but not interfering with, the already operational work-load. (Proposals are being studied which will allow some measure of this kind of operation.)
- The ability to optimize the use of storage and of peripheral devices automatically.
- The ability to provide an accurate account of the amount of central processor time used by each individual program. (The peripherals assigned to the program are known, but the actual cost of running a specific program is not.)

The method adopted in the ARGUS system is:

(1) Edit the program tapes onto a library tape through the use of a special program.

(2) Divide, if desired, the computing system into two or more "portions," allocating specific peripheral devices, control memory, and main storage to each portion.

(3) Batch tape programs to be run by each "portion" in order of probable priority, observing also any necessary order.

.12 Description (Contd.)

(4) Schedule the runs, and prepare a special run program tape, operator documentation, etc., through the use of a special program.

(5) Arrange the program input and output as called for in the schedule and set each program running.

The person functioning as scheduler therefore must decide how many independent "portions" the computing system must be split into for the duration of a run. He also must explicitly decide which programs should be run on which portion, and implicitly, by the order in which he provides details of these programs, the priority which should be given to each program.

Based on this data the computer runs, establish which (if any) programs can be run concurrently in each "portion" of the computing system, produce operating documentation, and organize their loading and supervision as needed. It can be seen that the ability of the human scheduler to make the right decisions greatly affects the over-all efficiency of this production technique.

If a high-priority program has to be introduced into a production run which has already started, all programs must be brought to a halt and the priority program must be run by itself; then the production run can be restarted.

During the actual running of a program or program mix, the supervisor routines take up no time, because the master program is switched off. When more programs or sectors of programs are needed, or when tape errors must be handled, etc., then the master program is activated, and all other programs are switched off.

.14 Originator: . . . . Honeywell EDP Division.

.15 Maintainer: . . . . . . Honeywell EDP Division.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . yes. The Master Relocatable Tape (MRT) consists of a library of all programs and subprograms presently available for production running.

.212 Independent programs: no. These must be incorporated into the MRT library before being used.

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.213 Data: . . . . from any input device under control of I/O routines located in each individual program.

.214 Master routines: . . . . Executive run supervisor, which loads programs, provides operator communication, restart facilities, and the ortho-correction routine.

.22 Library subroutines: . these will have been incorporated with the original program when it was placed on the Master Relocatable Tape during the Program Selection Process B run.

.23 Loading Sequence: . . . controlled by data supplied to the Executive during the Scheduling Run, which immediately precedes Production running. Any changes in priorities after this involve operator intervention, and normally any program brought forcibly to the top of the queue cannot be run in parallel with any other programs.

.24 Interpreter Input: . . . none.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . preset during scheduling run using data produced in Program Selection Run.

.312 Occupation of working storage: . . . allocated in scheduling run.

.32 Input-Output Units

.321 Initial assignment: . . . set by scheduler as input to scheduling run; checked and supplemented if necessary in scheduling run.

.322 Alternation: . . . . . . own coding.

.323 Reassignment: . . . . . own coding.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: yes, one unit physically connected to each channel can be operating.

.42 Multi-programming: . . yes, unless special intervention has been programmed; one instruction is taken from each program in turn.

.43 Multi-sequencing: . . . none.

.44 Errors, Checks and Action

Error	Check or Interlock	Action
Loading input error:	check	orthotronic correction attempted.
Allocation impossible:	check in Schedule Run.	
In-out error:	error signal transmitted along with data; or with next data from same I/O unit.	own coding.
Storage overflow:	no check at run time.	
Invalid instructions:	no check, behavior of system not specified for these cases.	
Program conflicts:		
Internal to specific program:	check	automatic transfer.
Between programs:	no check.	
Arithmetic overflow:	check	automatic transfer.
Underflow:	check	automatic transfer.
Invalid address:	check	automatic transfer.
Reference to absent area:	check	automatic transfer.

.45 Restarts

.451 Establishing restart points: . . . . established by calls written by programmer; all programs must be restartable on initiation.

.452 Restarting process: . . either by program action, usually as a result of an error routine, or by operator intervention. Programs can be restarted individually. A restart area large enough to hold all necessary data is held on the program tape for each active program.

.51 Dynamic: . . . . not available during production runs.

.52 Post Mortem: . . . . . calls written into programmers own coding. dump of entire storage originated by operator.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . standard or programmer provided print-outs.

.612 Action required by operator: . . . . . originated by a print-out on the console typewriter to provide, where necessary, cross referencing between:
(a) Logical references; i.e., Tape Unit C.D.
(b) Physical references; i.e., Tape Unit 7.
(c) Data references; i.e., Reel 2 of Inventory File.
also, to distinguish between different programs.

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.613 Reporting progress of run: . . . . log kept on console typewriter.

.62 Operator's Decisions: . manual actions by operator as specified in appropriate document.

.63 Operator's Signals

.631 Inquiry: . . . . Print Special Registers.

.632 Change of normal progress: . . . . possibly, but normally causes any affected programs to be run singly.

.7 LOGGING

.71 Operator Signals: . . . recorded on console typewriter.

.72 Operator Decisions: . . actions recorded on console typewriter.

.73 Run Progress: . . . . . start and end of each program recorded on console typewriter.

.74 Errors: . . . . recorded by print-outs.

.75 Running Times: . . . . not available.

.76 Multi-running Status: . available only by comparison of schedule documentations and console typewriter type-outs.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: basic H-800 with 4 tape units, card reader, and printer.

.812 Usable extra facilities: any, provided that the appropriate checks are hand-programmed.

.813 Reserved equipment: 1 tape drive and 512 words of store, together with program group 0.

.82 System Overhead

.821 Loading time
Schedule: . . . . 1 to 4 minutes.
Production: . . . . . . 1 second for each program loaded.

.822 Reloading frequency
Schedule: . . . . each batch of programs to be scheduled.
Production: . . . . . . each production run.

.823 Other
To schedule, prepare a Master Relocatable Tape ready for running and to set up the machine for a production run takes from 10 to 15 minutes.

.83 Program Space Available: . . . . . . C - 512, where C is the volume of core storage in the system.

.84 Program Loading Time: 2 to 4 minutes set-up per production run; + n seconds, where n is the number of times any program or segment is loaded from tape.

.85 Program Performance: the operating system is turned off during production runs, and so has no overhead at this stage; 10 to 15 minutes.

HONEYWELL 800
SYSTEM PERFORMANCE

HONEYWELL 800 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		VI	VII A	VIII A	VII B	VIII B	Reference
1 †Input-Output Times	Char/block	(File 1)	970	970	970	970	970	4:200.112
	Records/block	K (File 1)	11	11	11	11	11	
	msec/block	File 1 = File 2	39	22	14	22	14	
		File 3	92	92	75	7.7	6.7	
		File 4	107	107	107	8.7	7.7	
	msec/switch	File 1 = File 2	---					
		File 3	---					
		File 4	---					
	msec penalty	File 1 = File 2	0.8	0.8	0.8	0.8	0.8	
		File 3	0.1	0.1	0.1	0.1	0.1	
		File 4	0.1	0.1	0.1	0.1	0.1	
2 Central Processor Times	msec/block	a1	0.7	0.7	0.7	0.7	0.7	4:200.1132
	msec/record	a2	0.5	0.5	0.5	0.5	0.5	
	msec/detail	b6	4.0	4.0	4.0	4.0	4.0	
	msec/work	b5 + b9	2.05	2.05	2.05	2.05	2.05	
	msec/report	b7 + b8	12.05	12.05	12.05	12.05	12.05	
4 Standard Problem A Space	Unit of measure	(48-bit word)						4:200.1151
		Std. routines	1,400	1,400	1,400	1,400	1,400	
		Fixed	200	200	200	200	200	
		3 (Blocks 1 to 23)	100	100	100	100	100	
		6 (Blocks 24 to 48)	480	480	480	480	480	
		Files	600	600	600	600	600	
		Working	100	100	100	100	100	
		Total	2,880	2,880	2,880	2,880	2,880	

Worksheet	Item		VI CP	VI Printer	VII A CP	VII A Printer	VIII A CP	VIII A Printer	VII B CP	VII B File 2 & 4	VIII B CP	VIII B File 4	Reference
3 Standard Problem A F = 1.0	msec for C.P. and dominant column.	a1	0.7		0.7		0.7		0.7		0.7		4:200.114
		a2 K	5.5		5.5		5.5		5.5		5.5		
		a3 K	199.1		199.1		199.1		199.1		199.1		
		File 1 Master In	0.8		0.8		0.8		0.8		0.8		
		File 2 Master Out	0.8		0.8		0.8		0.8	21.7	0.8		
		File 3 Details	0.1		0.1		0.1		0.1		0.1		
		File 4 Reports	1.1	1,177	1.1	1,177	1.1	1,177	1.1	95.7	1.1	95.7	
		Total	208.1	1,177	208.1	1,177	208.1	1,177	208.1	117.4	208.1	95.7	

† Input/Output times assume that the magnetic tapes pass over the Interblock gap at full speed.

HONEYWELL 800 SYSTEM PERFORMANCE (Contd.)

WORKSHEET DATA TABLE 2								
Worksheet	Item			Configuration				Reference
				V	VI	VII A	VIII A	
5	Fixed/Floating point							
	Unit name	input		H-823/II	H-823-2	H-823-2	H-827	
		output		H-822-3	H-822-3	H-822-3	H-827	
	Size of record	input		1 80 col card	1 80 col card	1 80 col card	1 80 col card	
		output		1 printed line	1 printed line	1 printed line	1 printed line	
Standard Mathematical Problem A	msec/block	input	T1	92	92	92	75	4:200.413
		output	T2	67	67	67	67	
	msec penalty	input	T3	0.1	0.1	0.1	0.1	
		output	T4	0.1	0.1	0.1	0.1	
	msec/record		T5	28.0	28.0	28.0	28.0	
	msec/5 loops		T6	92.0†	6.05	6.05	6.05	
	msec/report		T7	34.0	34.0	34.0	34.0	
7	Unit name			H-804-3	H-804-3	H-804-1	H-804-4	
	Size of block							
	Records/block		B	4	4	4	4	
Standard Statistical Problem A	msec/block		T1	42	42	25	17	4:200.512
	msec penalty		T3	1.0	1.0	1.0	1.0	
	C.P.	msec/block	T5	0.1	0.1	0.1	0.1	
		msec/record	T6	0.3	0.3	0.3	0.3	
		msec/table	T7	0.3	0.3	0.3	0.3	

† Using simulated floating point option.

SYSTEM PERFORMANCE

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.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A (Integrated Configuration)

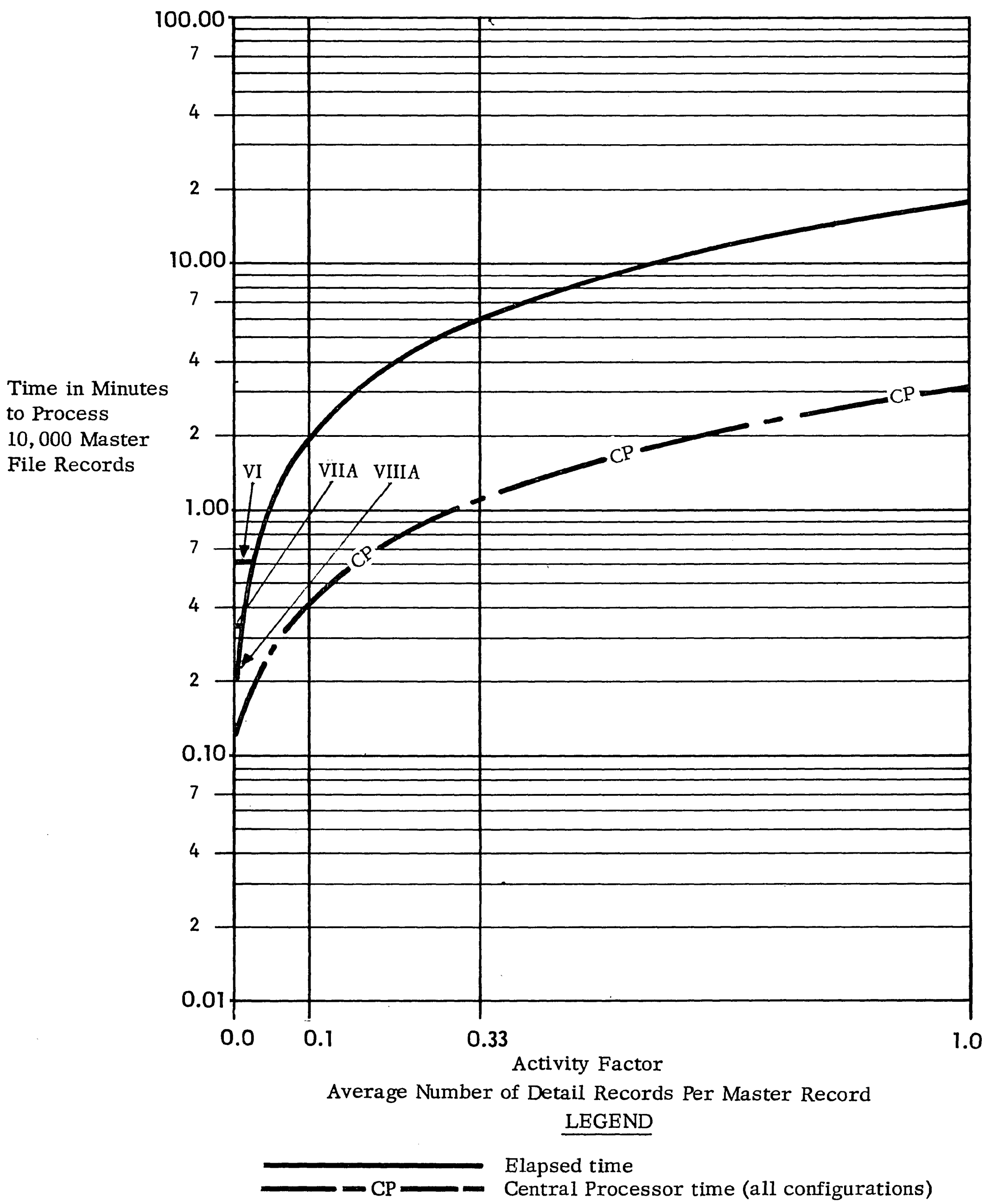
.111 Record Sizes
Master File . . . . . 96 4-bit characters with 24 6-bit characters.

.111 Record Sizes (Contd.)
Detail File: . . . . . 1 card.
Report File: . . . . . 1 line.

.112 Computation: . . . . . . standard.

.113 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.



§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A (Paired Configuration)

.111 Record Sizes

Master File: . . . . . 94 4-bit characters with 24 6-bit characters.

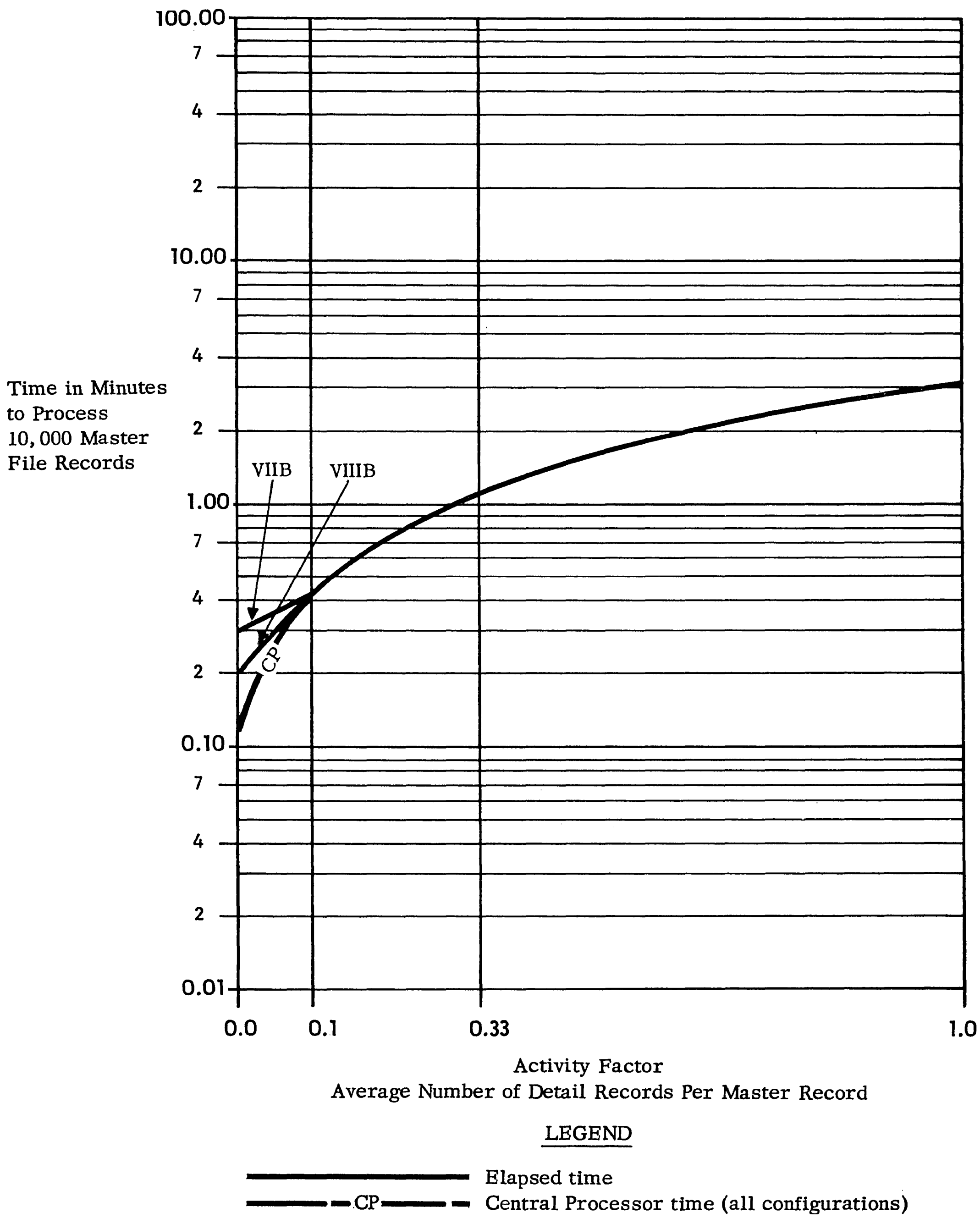
Detail File: . . . . . 1 card.

Report File: . . . . . 1 line.

.112 Computation: . . . . . standard.

.113 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

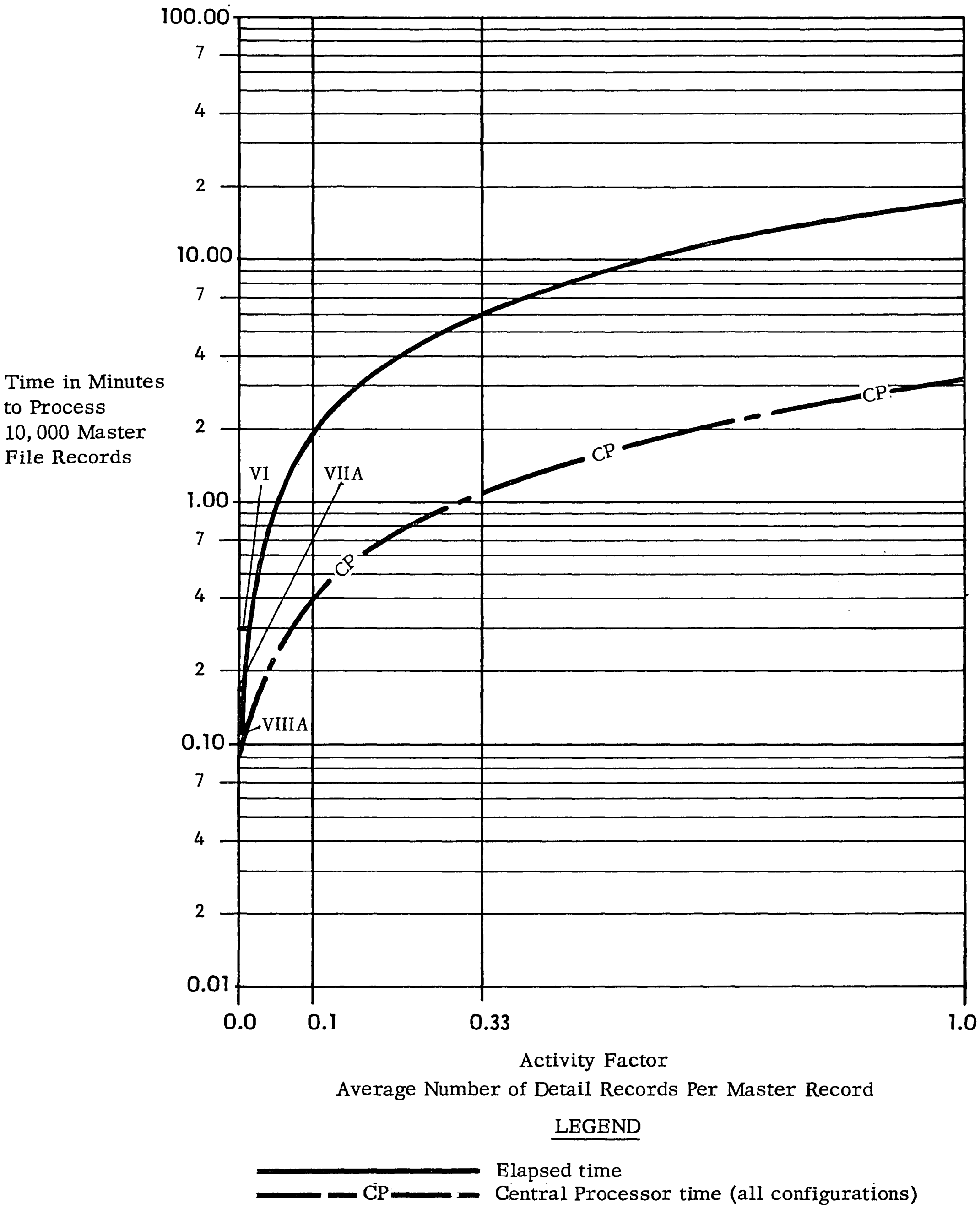


§ 201.

.12 Standard File Problem B (Integrated Configuration)

.121 Record Sizes
Master File: . . . . . 48 4-bit characters with 12 6-bit characters.
Detail File: . . . . . 1 card.
Report File: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . see graph below.

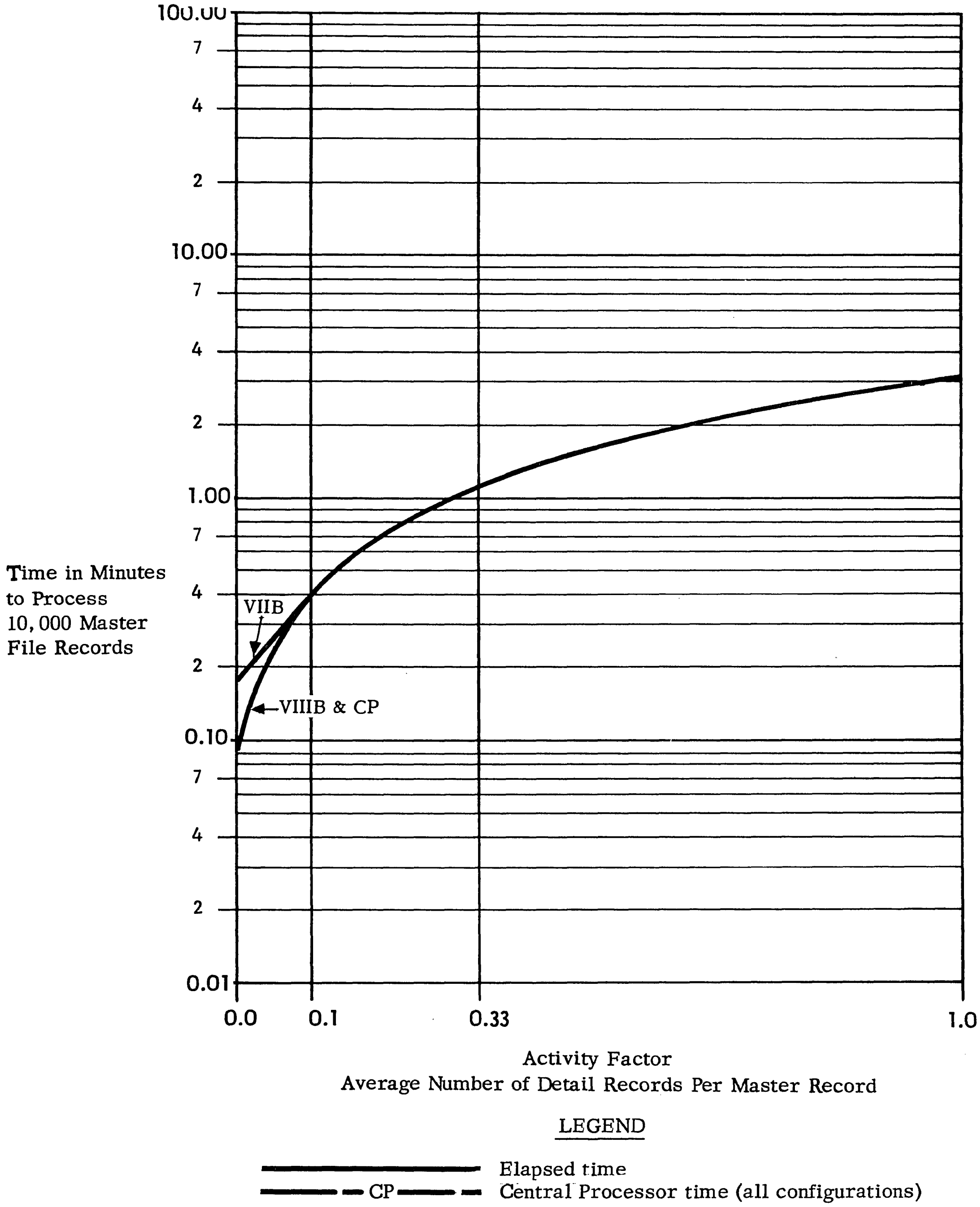


§ 201.

.12 Standard File Problem B (Paired Configuration)

.121 Record Sizes
Master File: . . . . . 48 4-bit characters with 12 6-bit characters.
Detail File: . . . . . . 1 card.
Report File: . . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . see graph below.



§ 201.

.13 Standard File Problem C (Integrated Configuration)

.131 Record Sizes

Master File: . . . . 192 4-bit characters with 48 6-bit characters.

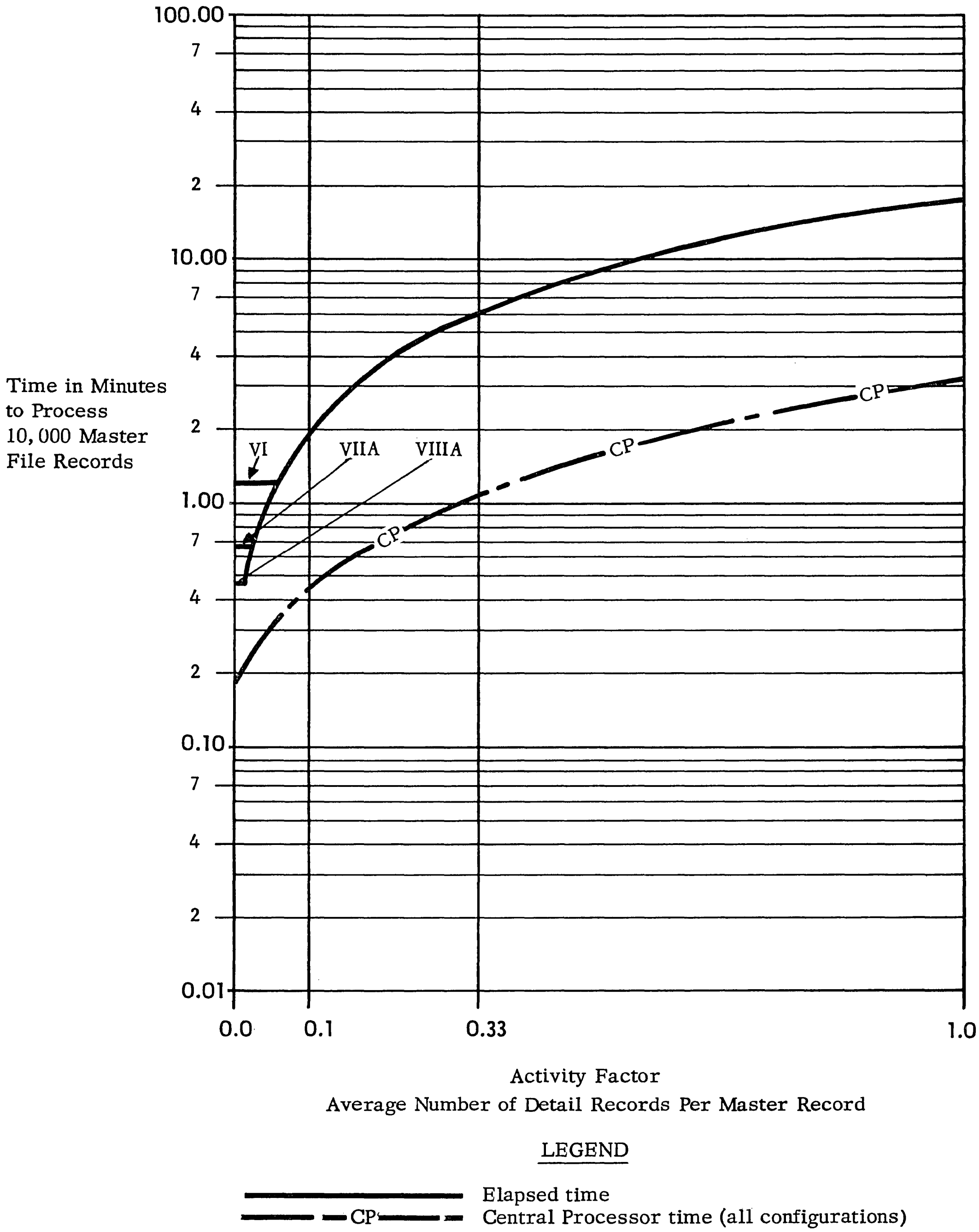
Detail File: . . . . . 1 card.

Report File: . . . . 1 line.

.132 Computation: . . . . . standard.

.133 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



§ 201.

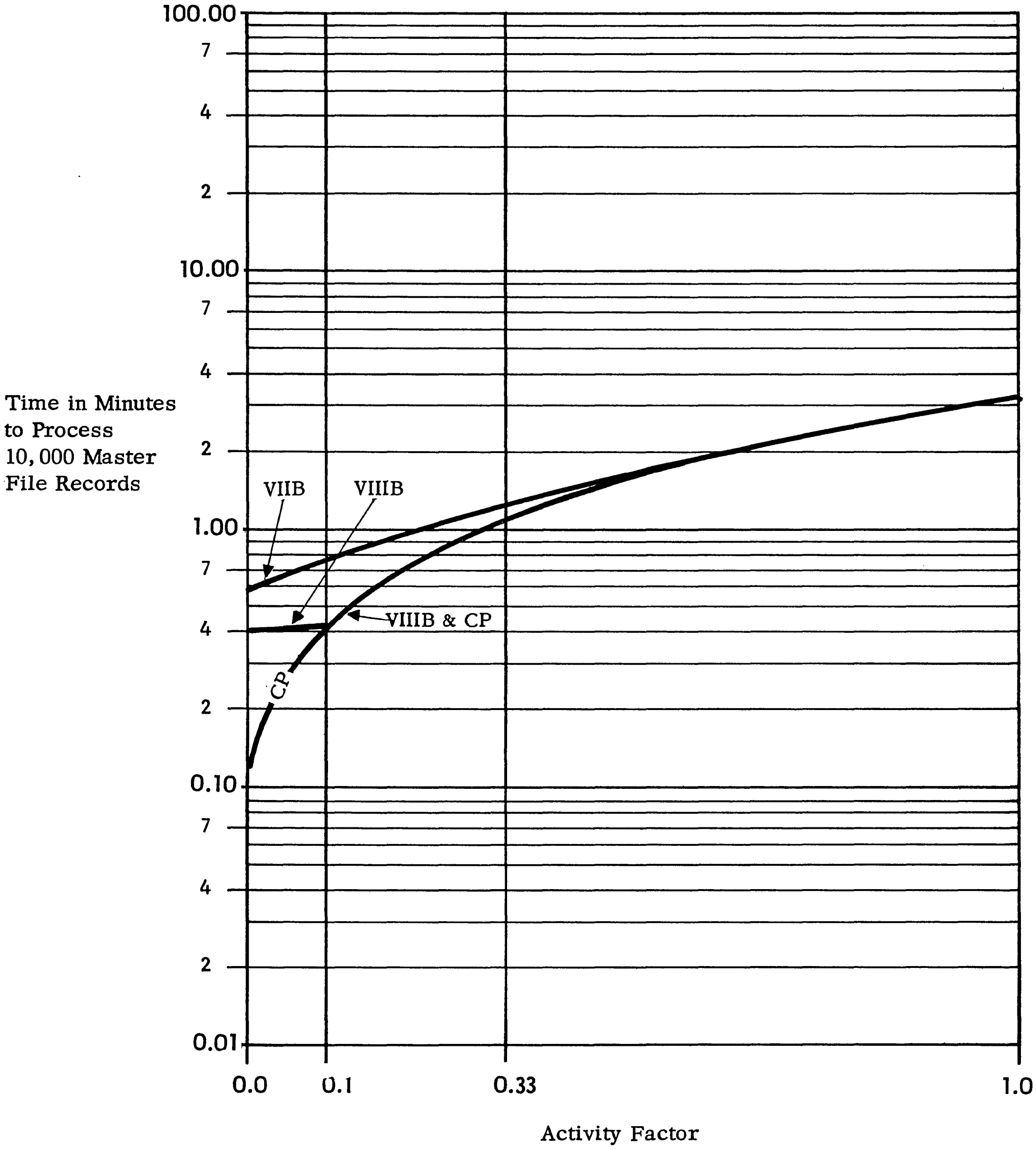
.13 Standard File Problem C (Paired Configuration)

.131 Record Sizes
- Master File: . . . . . 192 4-bit characters with 48 6-bit characters.
- Detail File: . . . . . . 1 card.
- Report File: . . . . . 1 line.

.132 Computation: . . . . . standard.

.133 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



LEGEND

Elapsed time

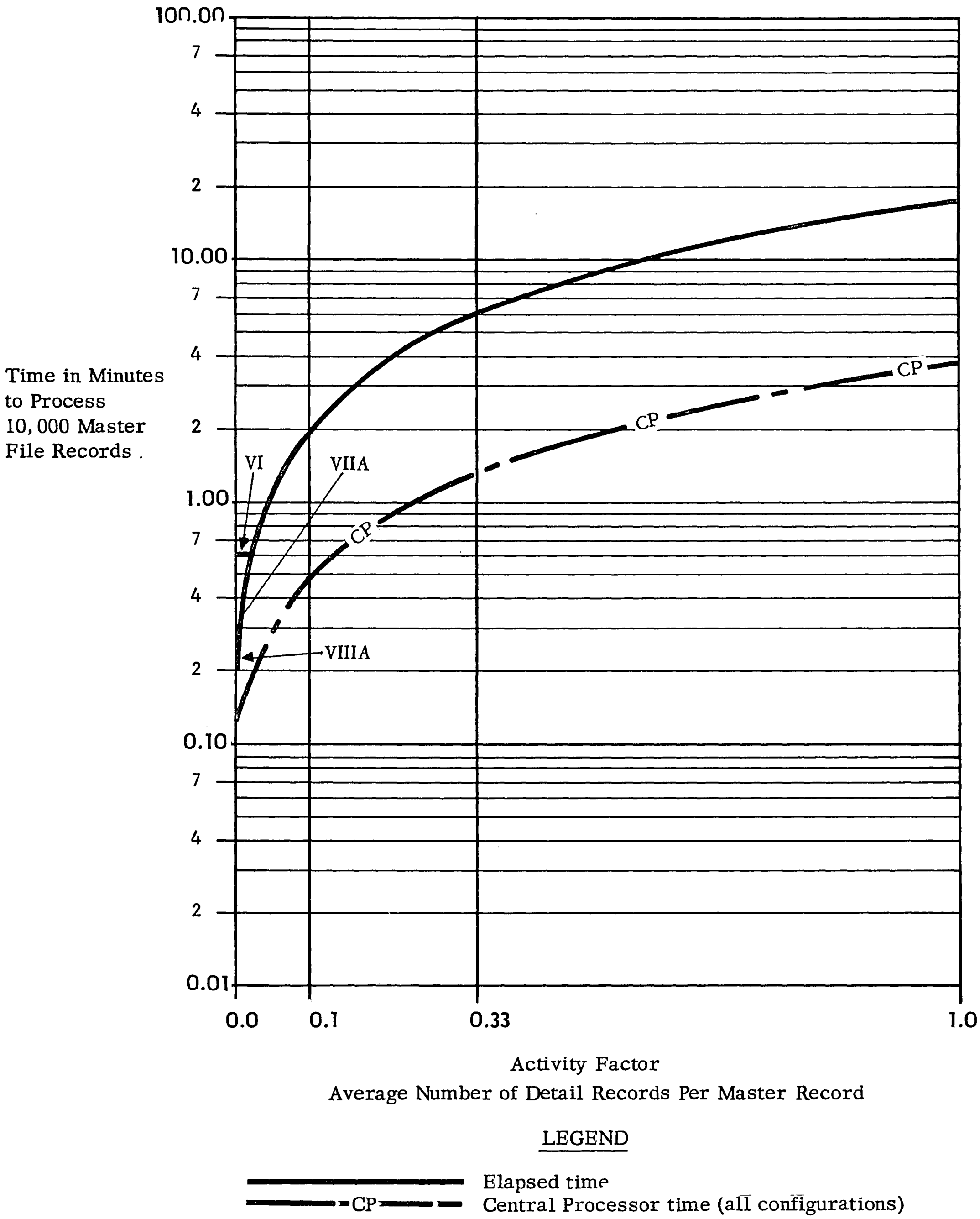
— — CP — — Central Processor time (all configurations)

§ 201.

.14 Standard File Problem D (Integrated Configuration)

.141 Record Sizes
Master File: . . . . 96 4-bit characters with 24 6-bit characters.
Detail File: . . . . . 1 card.
Report File: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.144 Graph: . . . . see graph below.



§ 201.

.14 Standard File Problem D (Paired Configuration)

.141 Record Sizes

Master File: . . . . 96 4-bit characters with 24 6-bit characters.

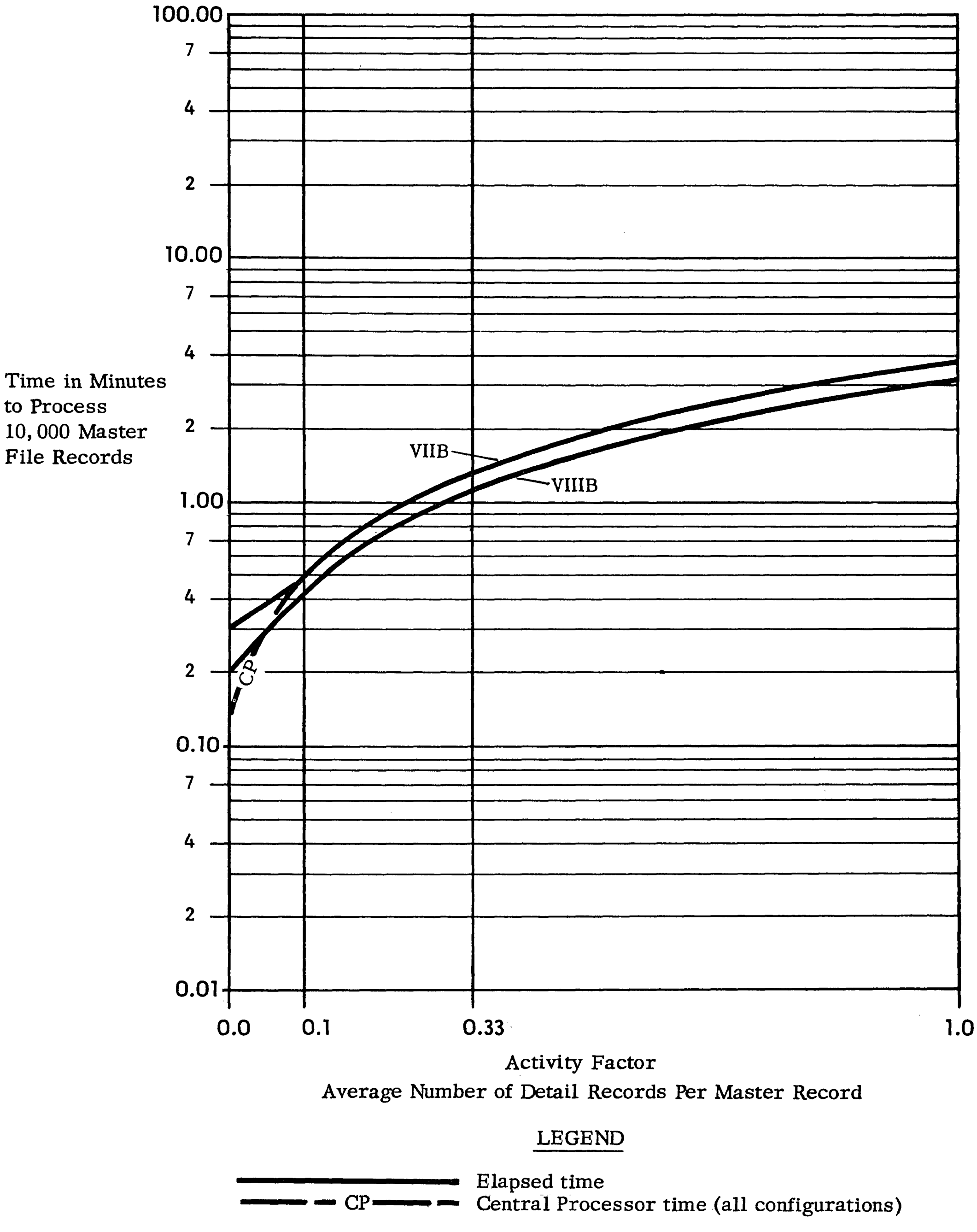
Detail File: . . . . . 1 card.

Report File: . . . . 1 line.

.142 Computation: . . . . . trebled.

.143 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.144 Graph: . . . . see graph below.



§ 201.

.2 SORTING (Two-way merge)

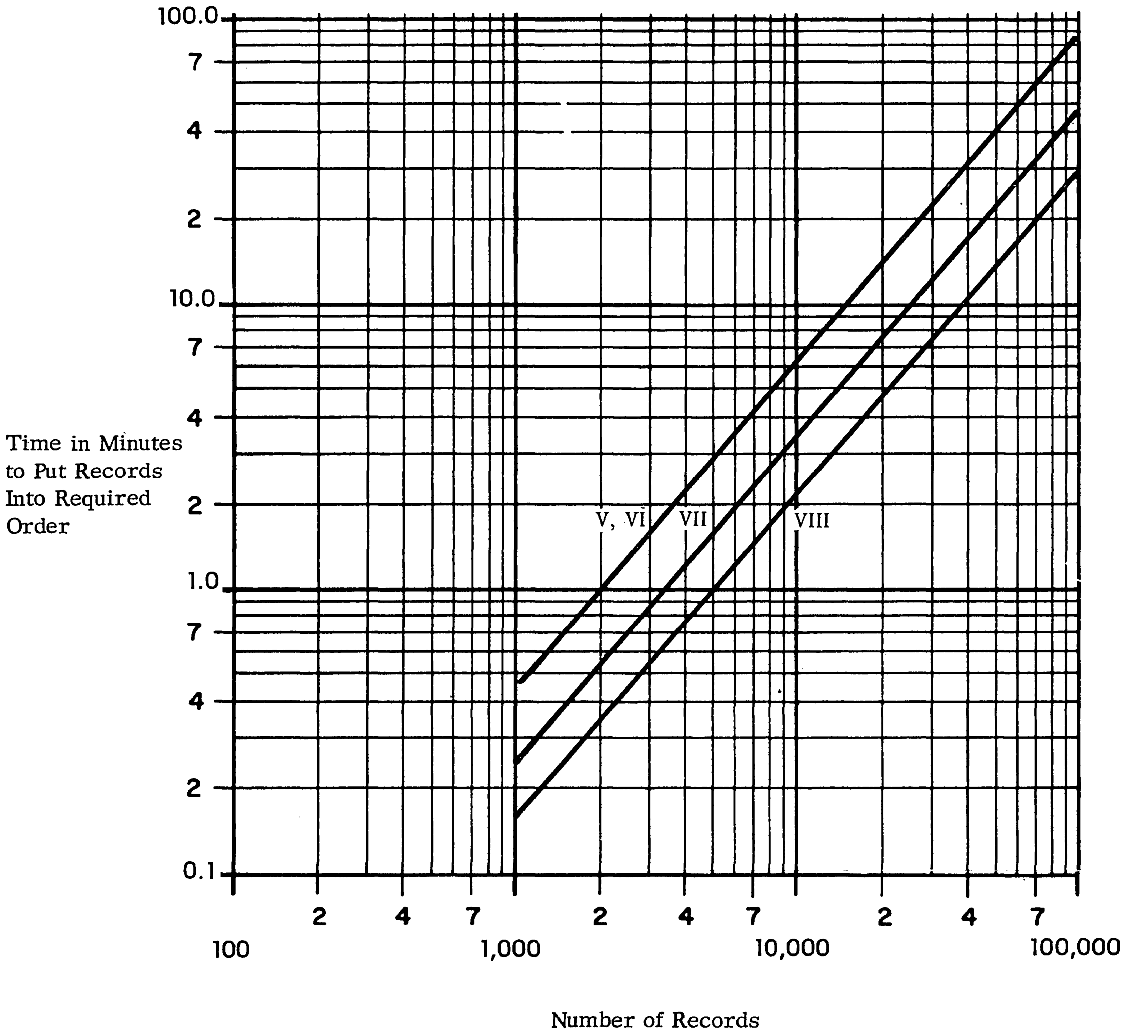
.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.

.212 Key Size: . . . . 8 characters.

.213 Timing Basis . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



(Roman numerals denote standard System Configurations.)

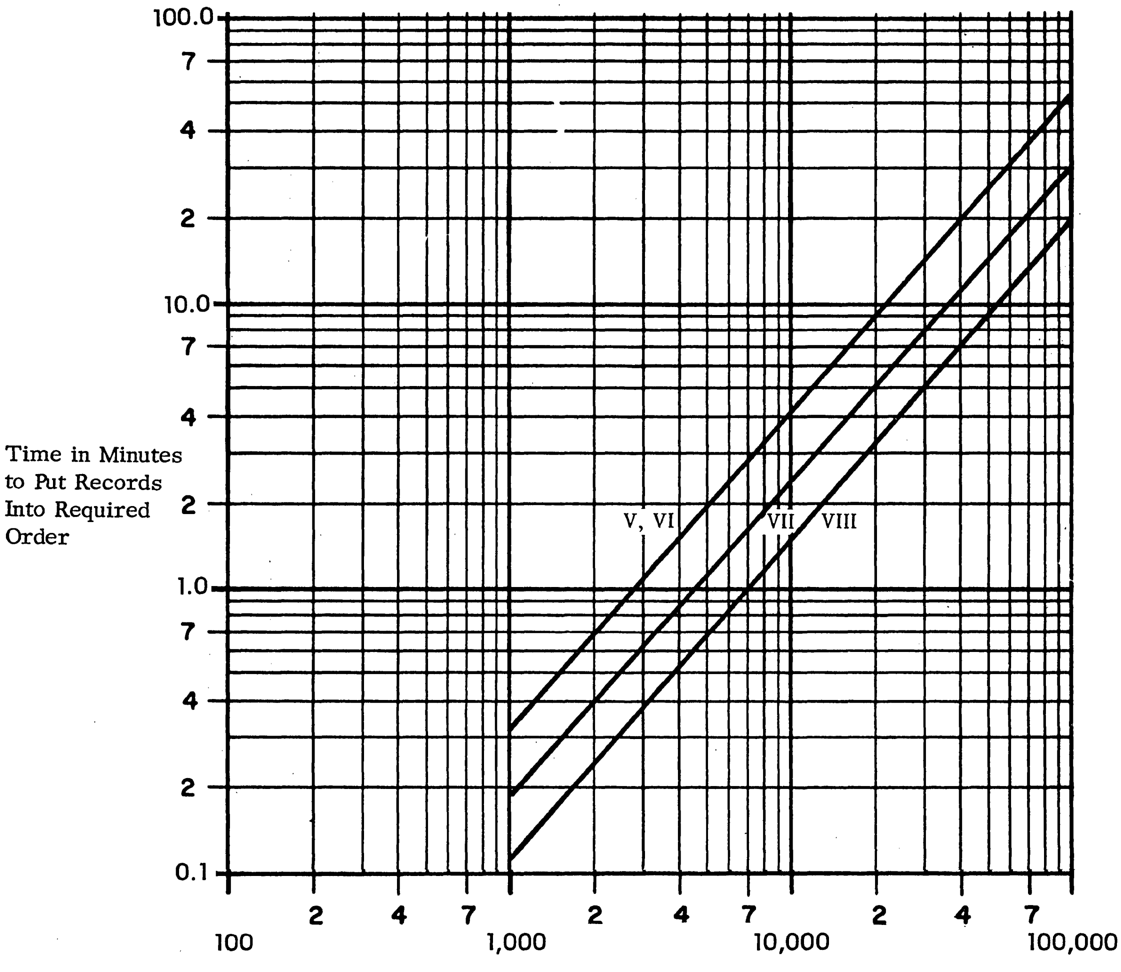
§ 201

.2 SORTING (Three-way merge)

.21 Standard Problem Estimates

.211 Record Size: . . . . 80 characters.
.212 Key Size: . . . . . 8 characters.
.213 Timing Basis:. . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



(Roman numerals denote standard System Configurations.)

§ 201.

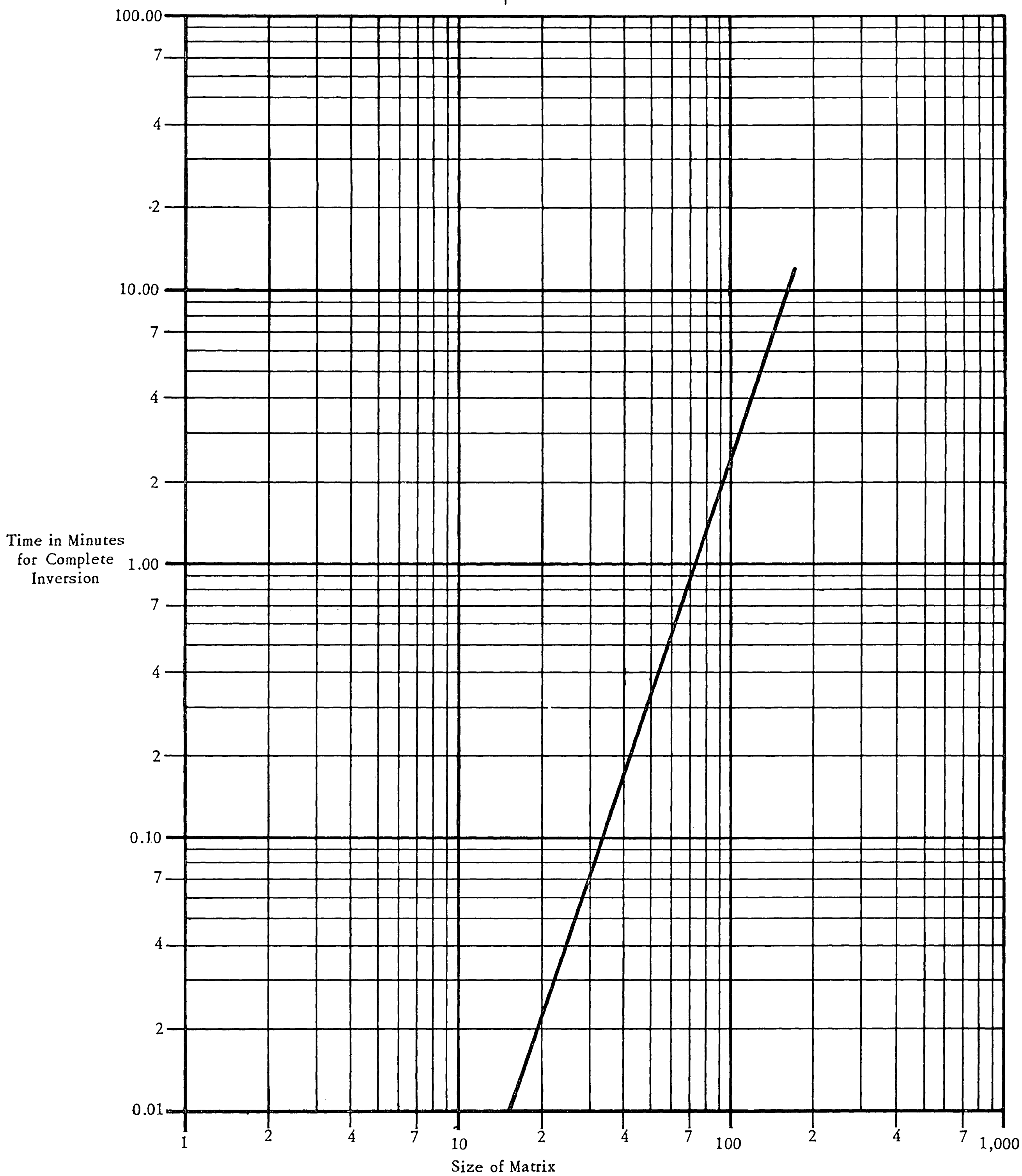
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.312; with Floating Decimal Arithmetic option.

.313 Graph: . . . . see graph below.



§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates (All Configurations)

.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

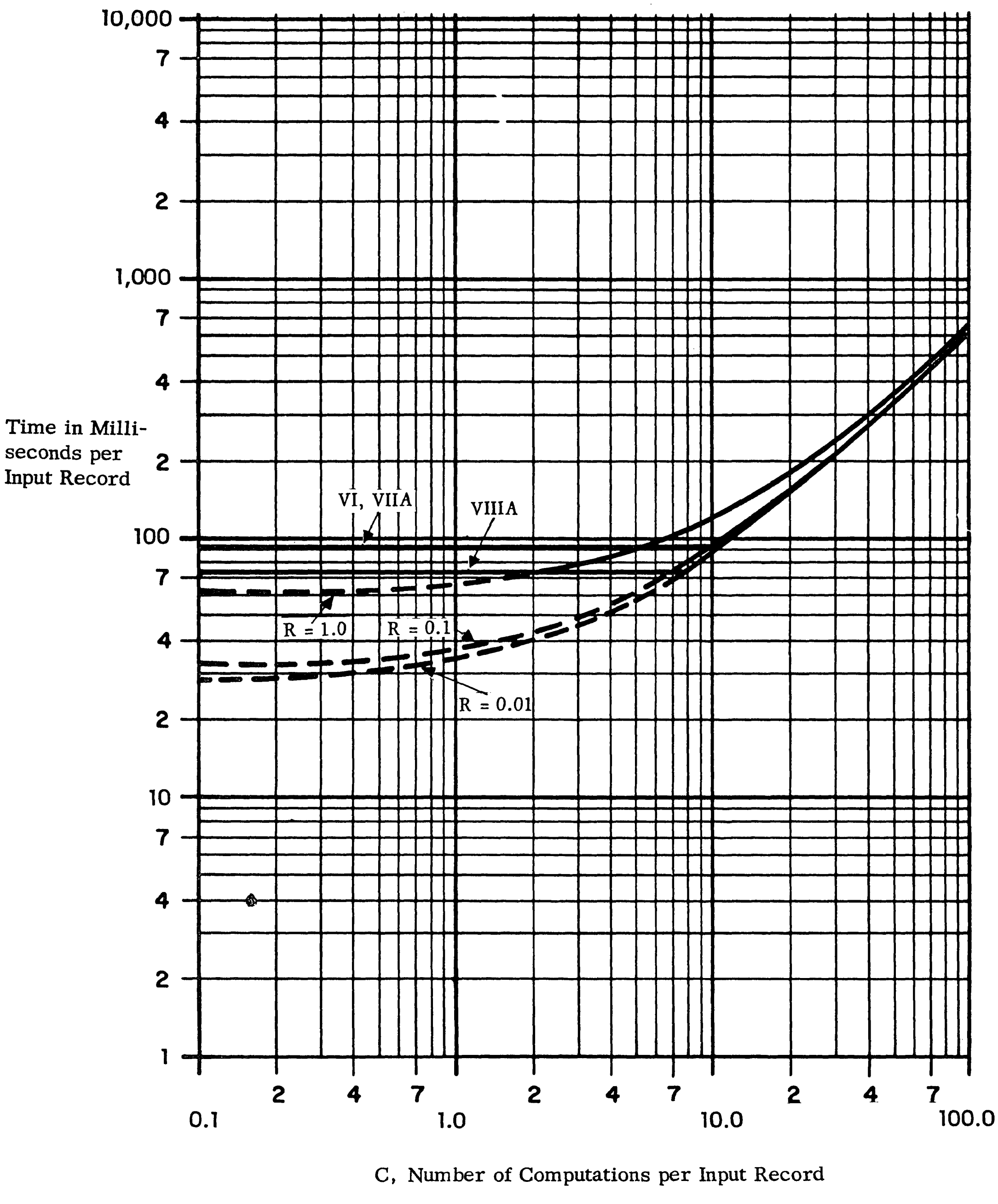
.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.

CONFIGURATION VI, VIIA, VIIIA SINGLE LENGTH (36 DIGIT PRECISION); FLOATING POINT

R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

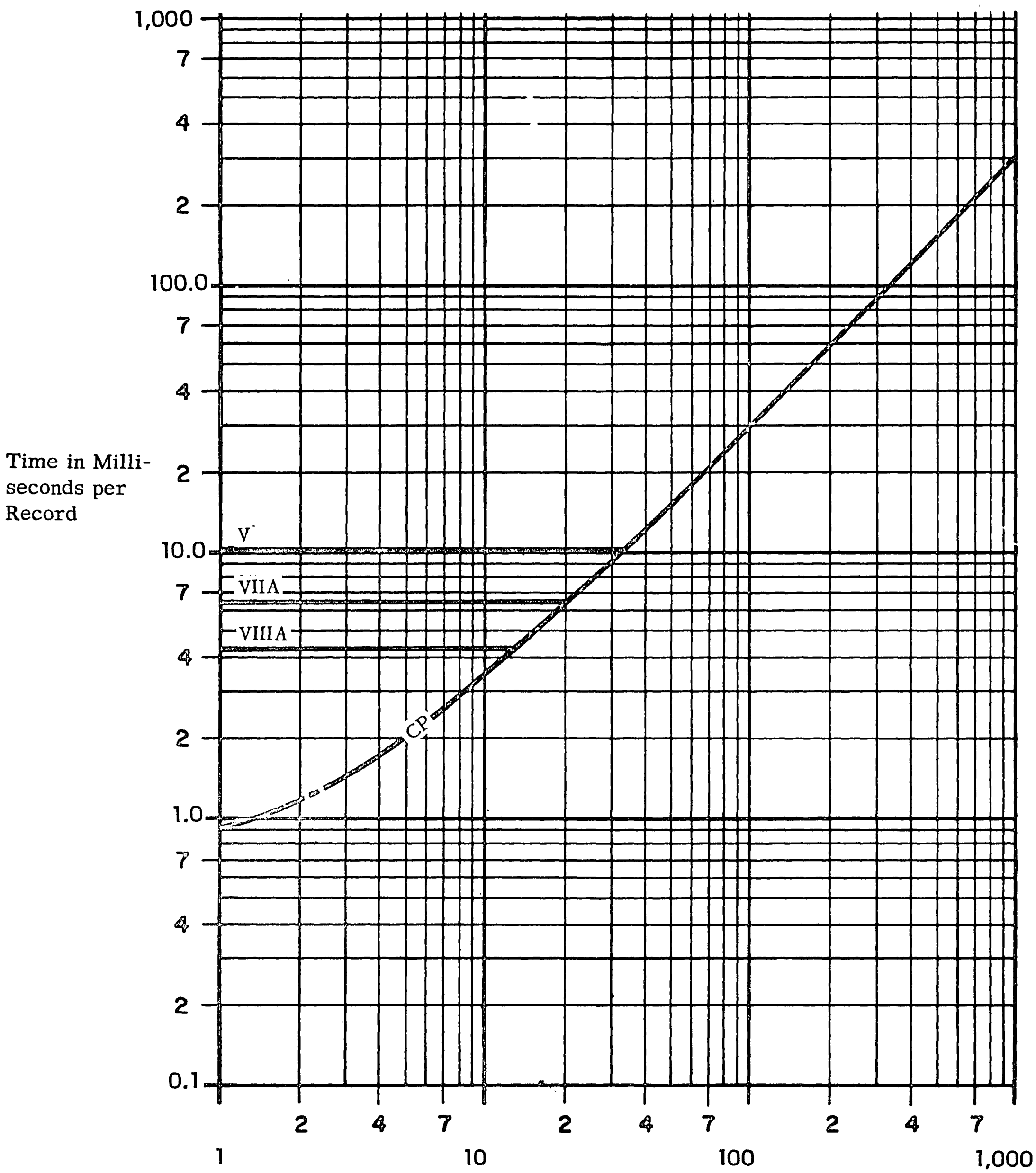
.51 Standard Statistical Problem A Estimates (All Configurations)

.511 Record size: . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . see graph below.



T, Number of Augmented Elements
Roman numerals denote Standard Configurations

HONEYWELL 800
PHYSICAL CHARACTERISTICS

H-800 PHYSICAL CHARACTERISTICS

		Central Processor	Floating Point Option	Console	Power Unit	Additional Memory	Additional Memory	Tape Control Unit	Magnetic Tape Unit	Magnetic Tape Unit
IDENTITY	Unit Name	Central Processor	Floating Point Option	Console	Power Unit	Additional Memory	Additional Memory	Tape Control Unit	Magnetic Tape Unit	Magnetic Tape Unit
	Model Number	801	801-B	801-C	801-P	802-1	802-2	803	804	---
PHYSICAL	Height × Width × Depth, in.	72×216×30	72 × 50 × 30	36 × 92 × 30	72×110×33	72 × 20 × 30	72 × 39 × 30	72 × 50 × 30	67 × 28 × 29	---
	Weight, lbs.	5,200	1,200	300	3,320	400	800	1,200	1,250	---
	Maximum Cable Lengths									
ATMOSPHERE	Storage Ranges: Temperature, °F.	←				50 to 110				→
	Storage Ranges: Humidity, %									
	Working Ranges: Temperature, °F.	←				70 to 74				→
	Working Ranges: Humidity, %									
	Heat Dissipated, BTU/hr.	22,320	6,840	300	20,640	32,480	6,420	6,840	8,538	---
	Air Flow, cfm.			↑						
	Internal Filters	20% efficiency								
ELECTRICAL	Voltage: Nominal	208	208		208, 200 or 440 unregulated	←		208		→
	Voltage: Tolerance	±2%	±2%	Included in 801	208, 200 or 440 unregulated	←		±2%		→
	Cycles: Nominal	60 C.P.S.	60 C.P.S.		60	←		60 C.P.S.		→
	Cycles: Tolerance	±0.5 C.P.S.	±0.5 C.P.S.		---	←		±0.5 C.P.S.		→
	Phases and Lines	3			3					
	Load KVA	3.3	---	↓	32.6	0.6	1.2	2.0	2.8	---
NOTES										

H-800 PHYSICAL CHARACTERISTICS—Contd.

IDENTITY	Unit Name		Magnetic Tape Unit	Printer Control	Card Reader Control	Card Punch Controls	High Speed Paper Tape Reader and Control	Standard Speed Paper Tape Punch and Control	Multiple Terminal Control	Off-Line Output Control	Off-Line Input Control	Off-Line Input-Output Control	Standard Speed Printer	Bill-Feed Printer	High Speed Printer	Standard Speed Card Reader	High Speed Card Reader	Standard Speed Card Punch	High Speed Card Punch	Tape Control	Magnetic Ink Char. Sorter/Reader	Printer Punch Control	Tape Control	Control Unit	12 Disc Storage Module	24 Disc Storage Module
	Model Number		---	806	807	808	809	810	811	815	816	817	822-1	822-2	822-3	823-1	823-2	824-1	824-2	831	833	834	835	860	860-1	860-2 through 9
PHYSICAL	Height × Width × Depth, in.		---	72×54×30	72×54×30	72×54×30	58×61×36	58×61×36	72×85×30	72×20×30	72×20×30	72×20×30	47×71×19	47×71×19	57×80×36	50×42×26	58×58×30	49×53×25	42×29×35	72×51×30	72×51×30	72×51×30	72×51×30	72×51×30	52×70×44	52×70×44
	Weight, lbs.		---	1,200	1,200	1,200	750	600	2,000	400	400	400	2,815	2,815	1,600	715	1,500	1,012	900	---	1,200	1,200	1,200	---	---	6,350
	Maximum Cable Lengths																									
ATMOS-PHERE	Storage Ranges	Temperature, °F.	◁											50 to 110												▷
		Humidity, %																								
	Working Ranges	Temperature, °F.	◁											70 to 74												▷
		Humidity, %																								
	Heat Dissipated, BTU/hr.		---	8,520	5,400	5,160	4,585	3,203	10,440	1,680	1,680	1,680	7,200	7,200	4,918	4,800	4,800	3,960	3,960	---	6,840	6,840	6,840	---	---	---
	Air Flow, cfm.																									
	Internal Filters																									
ELEC-TRICAL	Voltage	Nominal	◁											208												▷
		Tolerance	◁											±2%												▷
	Cycles	Nominal	◁											60 C.P.S.												▷
		Tolerance	◁											±0.5 C.P.S.												▷
	Phases and Lines																									
	Load KVA		---	2.0	2.0	2.0	1.3	0.71	2.0	0.18	0.18	0.18	2.5	2.5	1.8	1.7	1.7	1.5	1.5	---	2.0	2.0	2.0	---	?	3.5
NOTES																										

PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	801	Central Processor (4,096 Words) Console Power Unit	8,550	425	410,400
	801-B	Floating-Point Option	2,100	100	100,800
STORAGE	802	4,096 Word Additional Memory Blocks (Additional memory blocks available in units of 4,096; 8,192; 12,288; 20,480, and 24,576 words)	1,600	80	76,800
	860-1	Random Access Storage and Control (50 million characters)	6,100	1,220	275,000
	860-2	Random Access Storage and Control (100 million characters)	8,100	1,620	365,000
	860-3	Random Access Storage and Control (200 million characters)	12,500	2,500	560,000
	860-4	Random Access Storage and Control (300 million characters)	16,900	3,380	760,000
	860-5	Random Access Storage and Control (400 million characters)	21,300	4,260	960,000
	860-6	Random Access Storage and Control (500 million characters)	25,700	5,140	1,160,000
	860-7	Random Access Storage and Control (600 million characters)	30,100	6,020	1,360,000
	860-8	Random Access Storage and Control (700 million characters)	34,500	6,900	1,560,000
	860-9	Random Access Storage and Control (800 million characters)	38,900	7,780	1,760,000
CARD READERS and PUNCHES	823-1	Standard-Speed Card Reader (240 CPM) (085)	125	15	7,700
	823-2	High-Speed Card Reader (650 CPM) (088III)	325	52	14,700
	824-1	Standard-Speed Card Punch (100 CPM) includes basic unit (519 model II) summary punch feature 45 columns of comparing offset stacker 30 columns double-punch blank-column detection	154	39	7,881
	824 1A	Heavy Duty Power Supply for the Model 824-1 (required for transcription mode punching)	---	---	---
	824-2	High-Speed Card Punch (250 CPM) includes basic unit (544 model I) offset stacker half-time emitter	490	35	22,275
	827	Card Reader--Card Punch (800 CPM/250 CPM) (1402)	550	45	30,000
	807-1	Card Reader Control (for 823-1)	950	50	45,600

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CARD READERS and PUNCHES (Cont'd.)	807-2	Card Reader Control (for 823-2)	1,100	60	52,800
	807-3	Card Reader Control (for 827)	1,100	60	52,800
	808-1	Card Punch Control (for 824-1)	1,050	60	50,400
	808-2	Card Punch Control (for 824-2)	1,150	60	55,200
	808-3	Card Punch Control (for 827)	1,150	60	55,200
PAPER TAPE UNITS	809	Paper Tape Reader and Control (1000 FPS)	975	104	46,200
	810	Paper Tape Punch and Control (110 FPS) (specify model 1 for 11/16" tape or model 2 for 7/8" or 1" tape)	725	73	34,800
PRINTERS	822-1	Standard-Speed Printer (150 LPM) (407)	800	147	42,000
	822-2	Bill-Feed Printer includes basic unit (408 model A1) equal-unequal compare (15 positions) carriage storage (15 positions)	1,175	190	70,125
	822-3	High-Speed Printer (900 LPM)	1,950	475	79,800
	822-3A	Vertical Spacing Option for the Model 822-3 (allows spacing of six lines per inch or eight lines per inch) An installation charge will be made if this feature is field installed.	100	20	4,800
	806-1	Printer Control (for 822-1)	1,050	55	50,400
	806-2	Printer Control (for 822-2)	1,250	125	60,000
	806-3	Printer Control (for 822-3)	1,450	145	69,600
MAGNETIC TAPE UNITS	803-1	Tape Control	2,000	100	96,000
	803-2	High Density Tape Control	3,100	155	148,800
	803-3	Economy Tape Control	2,000	100	96,000
	803-4	Super Density Tape Control	4,100	205	196,800
	804-1	Magnetic Tape Unit	900	180	43,200
	804-2	High Density Magnetic Tape Unit	900	180	43,200
	804-3	Economy Magnetic Tape Unit	550	165	26,400
	804-4	Super Density Magnetic Tape Unit	900	180	43,200
	805	Magnetic Tape Switching Unit	75	5	3,600
ALTERNATIVE CONTROL UNITS	815	Off-Line Output Auxiliary Control	700	50	33,600
	816	Off-Line Input Auxiliary Control	700	50	33,600
	817	Off-Line Input-Output Auxiliary Control	950	70	45,600
	818	Off-Line Printer Control (for use with 822-3 and 804-1, 804-2 or 804-3,	1,550	270	74,400
	811-1	Printer--Card Reader--Card Punch Control (for use with 822-1, 823-1 or 823-2; 824-1 or 824-2)	1,700	85	81,600
	811-2	Printer--Card Reader--Card Punch Control (for use with 822-2; 823-1 or 823-2; 824-1 or 824-2)	1,850	145	88,800
	811-3	Printer--Card Reader--Card Punch Control (for use with 822-3; 823-1 or 823-2; 824-1 or 824-2)	1,950	200	93,600

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
ALTERNATIVE CONTROL UNITS	811-4	Printer--Card Reader--Card Punch Control (for use with 822-1; 827)	1,700	85	81,600
	811-5	Printer--Card Reader--Card Punch Control (for use with 822-2; 827)	1,850	145	88,800
(Cont'd.)	811-6	Printer--Card Reader--Card Punch Control (for use with 822-3; 827)	1,950	200	93,600
MISCELLANEOUS UNITS	833	Magnetic Ink Character Sorter-Reader Input Control Unit	1,300	87	62,400
	870	Inquiry Station Control Unit	750	56	36,000
	871	Inquiry Station	750	150	36,000
	872	Slave Console Typewriter	300	60	14,400
	880	Communications Control Unit	990	99	47,520

HONEYWELL 1800

Honeywell EDP Division

STANDARD EDP REPORTS

AUERBACH INFO, INC.

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HONEYWELL 1800

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CONTENTS

INA = Information Not Available.

§ 001. CONTENTS (Contd.)

Note: All Honeywell 800 software is directly usable on the 1800; it is described in the Honeywell 800 report (Number 502:).

INTRODUCTION

§ 011.

The Honeywell 1800 is a large scale solid-state computer system designed to process more than one program at a time. Based on the fast H-1801 central processing unit, the 1800 is program-compatible with the Honeywell 800 (Computer System Report 502:) and uses the same peripheral devices and software systems. The principal differences between the two systems are that the basic central processing unit is three times as fast on the Honeywell 1800 as on the 800, has twice as much core storage (8,192 words), and has been increased in price by 90 per cent. The increased internal processing capacity (some 90,000 three-address instructions per second) will be particularly useful when the system is simultaneously processing two or more independent programs.

The optional floating point hardware has been redesigned to use significantly fewer memory cycles than its equivalent on the Honeywell 800. This places the Honeywell 1800 in the category of very fast scientific processors, on a par with the IBM 7094 Model II. New instructions are available for conversions between fixed point decimal and floating point binary formats.

The Honeywell 1800 rents for between $30,000 and $60,000 per month, depending upon the system configuration and size. The 1800 uses the same data codes as the smaller Honeywell 400 and 1400 systems, so magnetic tapes can be interchanged between them. There is, however, no program compatibility between the 1800 and the 400 and 1400. The Honeywell 1800 can run Honeywell 800 programs without alteration, because the 800's instruction repertoire is the same as the 1800's repertoire.

An optional central processor, the Honeywell 1800-II, permits four magnetic tape units, a card reader/punch, and a printer to be connected directly to the central processor without intermediate adapters. These units can be used for off-line or on-line transcription. More details on the 1800-II are given in the Summary Analysis which follows this Introduction.

The multi-running* feature of the Honeywell 1800 is an attempt to reduce the inefficiencies of individual programs, which are usually input-output or central processor limited, by processing more than one program at a time. In any installation, the degree of success of multi-program operations depends upon how well the programs selected balance the sum of the demands on the central processor with the demands on the peripheral units. The hardware is capable of sharing the central processor time among up to eight programs. In practice, Honeywell 800 installations with time-sharing programs operate an average of two programs at a time, with peaks of five or six.

The multi-running capabilities are particularly valuable where large volume input-output files are processed with either relatively little or peaked (i.e., unevenly distributed) internal processing. Typical applications of this character are found in the insurance and utility fields. Multi-running also permits efficient processing of a program mix which includes a series of scientific (low volume input-output) computation programs.

The manufacturer has undertaken the development of software which should encourage more use of multi-running. A package has been released for controlling up to seven simultaneous conversions between cards, paper tape, magnetic tape, and hard copy. The elimination of the separate "program testing" executive system has been proposed because many installations tend to retain it after testing has been completed rather than convert to the different operating requirements of the standard production executive system.

The Honeywell 1800 uses a 48-bit word, either as 44 bits plus sign character, 11 decimal digits plus sign character, or 12 unsigned decimal digits. Alphameric characters can be stored eight to a word, but cannot be used in arithmetic.

---

* "Multi-running" is used in these reports to describe the operation of a computer that is simultaneously processing two or more independent programs. "Parallel programming" and other terms are currently used to describe the same concept.

§ 011. INTRODUCTION (Contd.)

Decimal and binary arithmetic facilities and multi-word transfers allow economical programming. However, the computer has no facility for easy conversion of external data codes to internal code, or vice versa. All shifts are right end-around shifts, so that editing is costly. An edit generator and several standard routines are available, but most routines appear to be written for individual cases. Floating point arithmetic hardware is optional.

The H-800 storage is divided into two parts, a Control Memory with eight "program groups," and a Main Memory which is divided into banks of 2,048 48-bit words. The basic Honeywell 1800 has 4 of these banks; larger units can contain up to 32. The eight program groups are included in all cases. Each of these eight groups can control a separate program. A total of 64 index registers (8 per group) are provided. The addressing structure is such that while any program can reach or use any location in storage, it is necessary to use one of a number of special addressing methods when referring to addresses in other program groups or other banks. The index registers have restricted utility in that any base address can be modified by no more than 256 positions.

There are eight input and eight output channels, all of which can operate concurrently with each other and the central processor. The peripheral units can be arranged as the user requires, with few restrictions as to type or quantity. Honeywell-manufactured units include a 900 line per minute printer (which is very similar to the Anelex Printer) and magnetic tape units with character rates varying from 32,000 to 133,000 alphameric characters per second. Data communication units are being designed, but no specifications have been released.

The Honeywell printer is unusual in that it has 160 printing positions, any 120 of which can be used at a time. Character and format selection is by plugboard. A paper tape loop provides paper feeding control. These features facilitate printing of two forms side by side and, where appropriate, the use of standardized print routines.

The Honeywell magnetic tape system is designed to allow the recovery of data lost during writing, storage, or upon re-reading. This recovery is effected by forming and checking "Orthotronic control words" which are appended to each record on tape. The overheads involved in forming these words place an additional load on the central processor when writing is in process. The size of this additional load varies up to 3 per cent, depending upon the tape unit in use. No additional load is present during reading operations.

Other available peripheral equipment includes: paper tape equipment capable of reading 1,000 characters per second and punching 110 characters per second; card readers which operate at 250 or 800 cards per minute; card punches which punch either 100 or 250 cards per minute; and mass-storage discs with capacities of up to 800 million alphameric characters.

The software provided with the Honeywell 800 can also be used with the Honeywell 1800. It includes an assembly language (ARGUS), a FORTRAN II translator (AUTOMATH-800), a FORTRAN IV translator (AUTOMATH-1800), and a business compiler (FACT). A COBOL-61 compiler has been announced for 1963. Software is described in the Honeywell 800 report, Sections 502:161 through 502:191.

The FACT compiler can handle files arranged as individual items, similar to COBOL files, or files with "hierarchical" structure. This arrangement saves tape space by recording identical data in a number of consecutive items only once instead of a number of times.

A Sort package, using the cascade sorting method, is available for the Honeywell 1800. Cascade sorting merges strings from all except one of the available tape units, thereby providing faster sorting. However, even with this increased sorting speed and the fast tape units, it would be very inefficient to sort large files on the Honeywell-1800 unless other programs were proceeding in parallel.

An executive system able to control the operation of all program translators and production programs is provided.

The executive system presently in use is designed for batch processing through assembly, and then running either serially under program testing methods, or in parallel in production. The ordering and control during a production run is controlled by a schedule

§ 011. INTRODUCTION (Contd.)

which is created by a special run, but which relies considerably upon the human skills of the scheduler who sets up the basic data. The things to be considered vary considerably from one installation to another, and the return which can be obtained from multi-running depends in no small measure on the ability of the scheduler.

Running under the executive system causes no actual loss of time during production running, because the executive program is not operating at this time. However, preparatory runs consume approximately 15 minutes of running time to set up the schedule and program tapes.

HONEYWELL 1800-II SUMMARY ANALYSIS

§ 012.

The Honeywell 1800-II system includes an Input-Output Control System (IOCC) which provides additional buffering capabilities beyond those of the H-1800. In all other ways, the system is identical to the H-1800. The use of the IOCC permits a reduced number of controllers to achieve simultaneous multi-program running operations.

The IOCC is a three-way switching device between the central computer, a bank of four tape units, and three peripheral units (i.e., card reader, card punch, line printer). This arrangement allows the peripheral units to be used directly on-line with the computer or off-line with the tape units acting as intermediary storage before the final result is produced. The terms "On-Line" and "Off-Line" describe two of the three operational modes of the IOCC. These are supplemented by the term "Simulated On-line Mode," to describe on-line operations which complement their related off-line operation.

The selection of peripheral units which can be connected to the IOCC is restricted to one card reader, one card punch, and one printer. Additional peripherals must be connected by means of appropriate adapters to the normal input-output channels. (No adapters are needed for units connected directly to the IOCC.) Similarly, the tape units are restricted to using card images or line images. It should be noted that it is not necessary for the tapes produced through the IOCC to be used only for off-line work. They can be used as ordinary tape files; however, as such, they are restricted to specific block sizes, the largest of which is only 120 characters.

Three operations can be overlapped at any one time through use of the IOCC. These can be chosen from the nine possible operations listed in Table I. However, only one case of each specific operation is allowed at any one time (i.e., it is not possible to prepare three of the four IOCC tape units for printing simultaneously).

The only overhead involved in these operations occurs while the card or line images are being transferred into and out of core storage. If, as in off-line operations, the core store is not being referred to, then no load on the central processor is involved. Otherwise, in no single case can the load exceed 1 per cent of the total central processor capacity.

The major effect of the introduction of the H-1800-II is the reduction of rentals. The rental of the central processor is reduced by $1,150 per month, and the cost of the control units displaced is normally between $2,900 and $4,900. The IOCC also reduces the need for additional controllers that are necessary to take maximum advantage of the multi-running capabilities of the H-1800. Because of these advantages, the Model II Central Processor, which contains the IOCC, is used in all of the standard System Configurations (Section 503:031) and in the System Performance calculations (Section 503:201).

When considering the present (August, 1963) price structure of the Honeywell 1800 Models I and II, it should be noted that on the Honeywell 800, Model II is priced higher than Model I, which is reasonable in view of its increased capabilities.

§ 012. HONEYWELL 1800-II SUMMARY ANALYSIS – (Contd.)

TABLE I

IOCC USE SUMMARY

Equipment connected to an Input/Output Control (IOCC) can be operated in nine possible modes. These nine modes may be applied in any combination. The IOCC and connected equipment are restricted solely to these uses.

	On-Line Mode	Information Flow
1)	Card Reading	Card Reader - IOCC - Main Memory
2)	Card Punching	Main Memory - IOCC - Card Punch
3)	Printing	Main Memory - IOCC - Printer
	Off-Line Mode	
4)	Card Reading	Card Reader - IOCC - IOCC Tape
5)	Card Punching	IOCC Tape - IOCC - Card Punch
6)	Printing	IOCC Tape - IOCC - Printer
	Simulated On-Line Mode	
7)	Card Reading	IOCC Tape - IOCC - Main Memory
8)	Card Punching	Main Memory - IOCC - IOCC Tape
9)	Printing	Main Memory - IOCC - IOCC Tape

An IOCC Tape is a tape written by or read on an IOCC which contains either card images or print-line images with one image per tape record. These tapes are exactly like those used by Honeywell 1800 off-line control units.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of location	Size	Purpose or Use
Digit	4 bits	Storage of 1 BCD number.
Character	6 bits	Storage of 1 alphabetic char.
Word	48 bits	instructions. data items.
Item	1 to n words	used for internal Mass Transfers; and optionally for magnetic tape I/O
Record	1 to n words	Used for internal Mass Transfers and for magnetic tape I/O.
Record	64 words	disc storage.

.2 DATA FORMATS

Type of data	Unit	Representation
Binary	1 word	44 bits plus 4-bit sign.
Decimal	1 word	11 decimal digits plus 4-bit sign. 12 decimal digits.
Alphameric	1 word	8 6-bit characters.
Alphameric (compressed)	1 word	any mixture of 4-bit and 6-bit characters adding up to 48 bits.
Instruction	1 word	Operation code and three addresses.
Floating Point Binary	1 word	40-bit fixed point part with 1-bit sign. 6-bit exponent, with 1-bit sign.
Floating Point Decimal	1 word	10-digit fixed point part with 1-bit sign. 6-bit exponent with 1-bit sign.

BIT POSITION	1	5	9	13	17	21	25	29	33	37	41	45
DECIMAL	±	1	2	3	4	5	6	7	8	9	0	1
ALPHAMERIC	R	O	B	I	N	S	O	N				
ALPHAMERIC COMPRESSED	C	.	W	E	B	B	1	7	4			
BINARY	±	(44 Binary Digits)										
FLOATING-POINT DECIMAL	±	Exp'nt (7 binary digits)	Mantissa (10 Decimal Digits)									
FLOATING-POINT BINARY	±	Exp'nt (7 binary digits)	Mantissa (40 Binary Digits)									
INSTRUCTION	OPERATION CODE	ADDRESS A	ADDRESS B	ADDRESS C								
SPECIAL REGISTER		±	(15 Binary Digits)									

Honeywell 1800 Word Structure

§ 031.

SYSTEM CONFIGURATION

All H-1800 input-output equipment is treated alike by the central processor. The different features of individual equipment units are handled by controllers.

As an aim of the design philosophy of the system was to allow each installation to balance its input-output to its central processor use, it followed that considerable flexibility has been given to the arrangement of peripheral equipment.

In general, therefore, each unit of equipment has an on-line controller which gives it the use of a single channel on the computer. In some cases, a different on-line controller is used which allows a group of units to operate one at a time.

For off-line work in conjunction with a magnetic tape, another auxiliary unit is used. Sometimes, a special controller is required instead of the on-line controller.

The best controllers for each particular unit are determined by individual installation conditions. Below is a list of units, together with the alternative controllers they require for

1. On-line use with the computer.
2. Off-line with an H-804 tape unit.

Peripheral Units	On-Line Controller	Off-Line Controller
Magnetic Tape Unit H-804	H-803 (various models)	- -
Printers H-822	H-806 or H-811*	H-815 + H-806 or H-817 + H-811* or † H-818
Card Readers	H-807 or H-811*	H-816 + H-807 or H-817 + H-811*
Card Punches	H-808 or H-811*	H-815 + H-808 or H-817 + H-811*
Paper Tape Reader	None required	H-816
Paper Tape Punch	None required	H-815

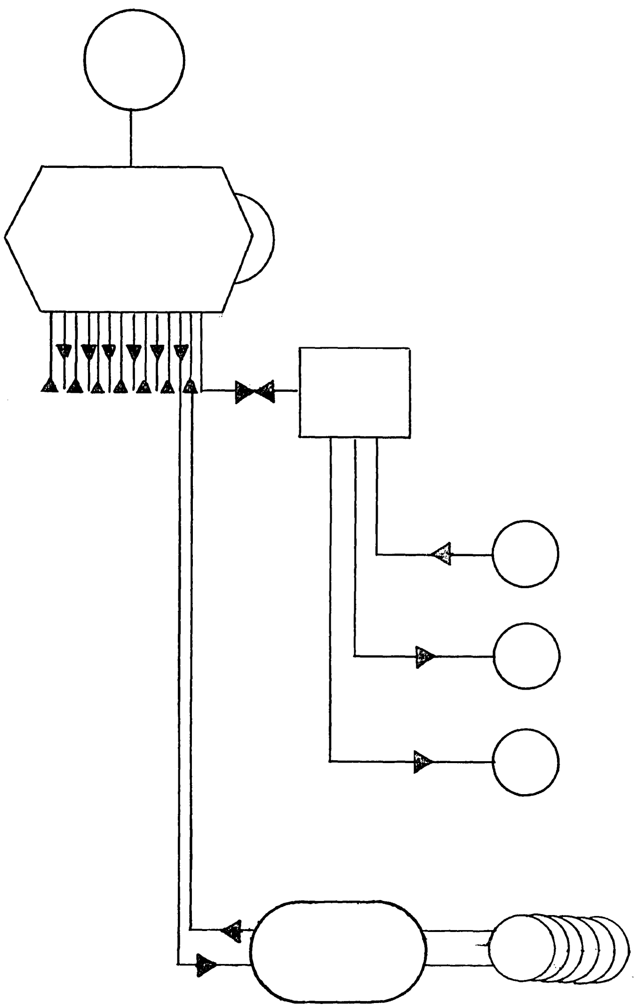
† Only usable with the H-822-3, 900-line-per-minute printer.
* Although one card reader, one card punch, and one printer can be connected to this controller at the same time, only one at a time can be operated.

SYSTEM CONFIGURATION

§ 031.

.1 6-TAPE BUSINESS/SCIENTIFIC SYSTEM (CONFIGURATION VI)

Deviations from Standard Configuration: . . . . storage larger by 3,000 words (60%).
1 additional tape transfer.
card reading faster by 60%.
card punching faster by 150%.
printing faster by 80%.
61 additional index registers.



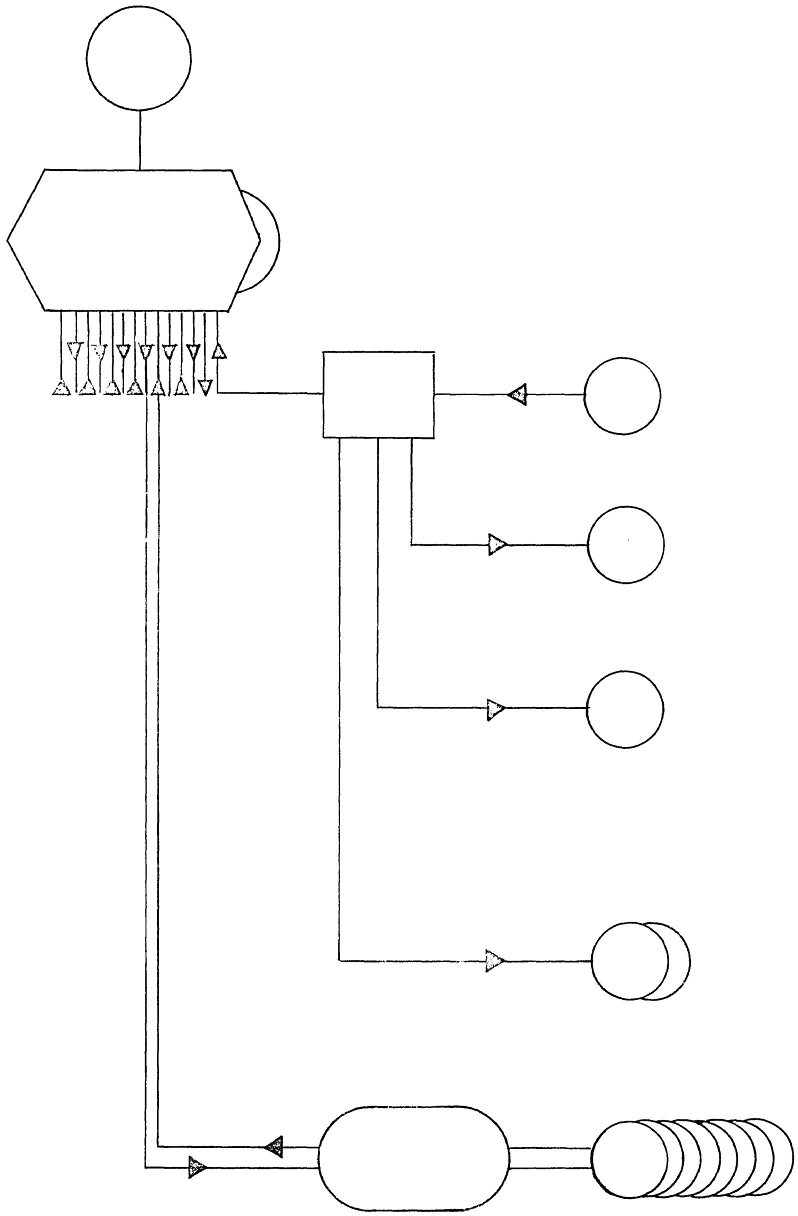
Equipment	Rental
Basic Storage of 8,192 words and 256-word Control Memory; H-1801-II Central Computer and Console	$18,000
Floating Point Option	4,300
IOCC	- - -
Card Reader Model H-827 800 cards/min.; Card Punch Model H-827 250 cards/min.	550
High Speed Printer Model H-822-3 900 lines/min.	1,950
Magnetic Tape Controller Model H-803 with	2,000
6 H-804-3 Tape Units (32,000 alphameric char/sec each).	3,300
Total:	$30,100

Optional Features Included: . . . . Floating Point Option.

§ 031.

.2 10-TAPE INTEGRATED SYSTEM (CONFIGURATION VII A)

Deviations from Standard Configuration: . . . . 2 additional magnetic tape transfers.
card reading faster by 60%.
card punching faster by 150%.
printing faster by 80%.
1 additional non-magnetic-tape transfer.
58 additional index registers.



Equipment	Rental
Core Storage of 16,384 words and 256-word Control Memory	$ 3,200
Central Computer and Console	18,000
Floating Point Option.	4,300
Card Reader Model H-827 800 cards/min., Card Punch Model H-827 250 cards/min.	550
High Speed Printer Model H-822-3 900 lines/min.	1,950
2 Model H-804-1 Tape Units	1,800
Magnetic Tape Controller Model H-803 with	2,000
8 H-804-1 Tape Units (62,000 alphameric char/sec).	7,200
Total:	$37,050

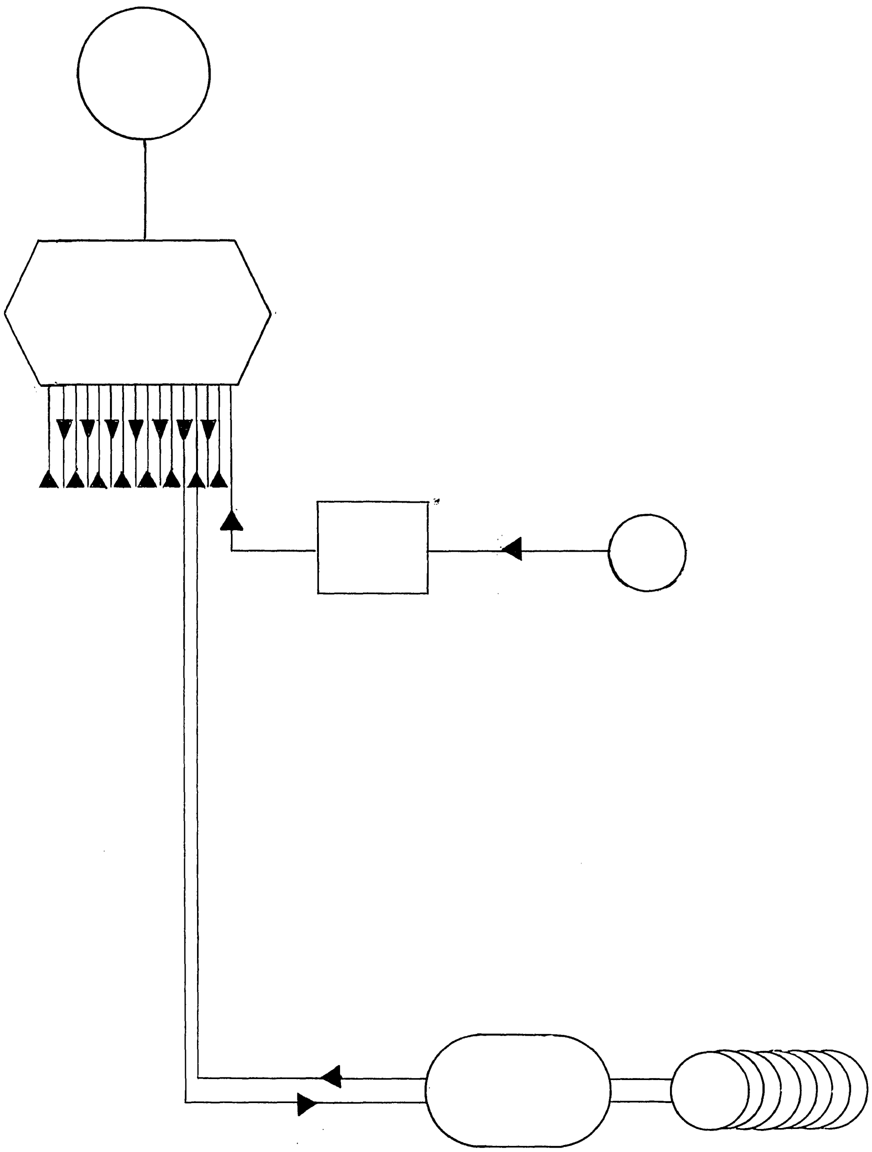
Optional Features Included: . . . . Floating Point Option.
8,192 words of storage.

§ 031.

.3 10-TAPE PAIRED SYSTEM (CONFIGURATION VII B)

Deviations from Standard Configuration: . . . . card reading faster by 140%.
1 additional non-magnetic tape transfer.
58 additional index registers.

On-Line Equipment



Equipment	Rental
Basic Storage of 8,192 words and 256-word Control Memory	- - -
H-1801-II Central Computer and Console	$18,000
Floating Point Option	4,300
Card Reader Model H-823 240 cards/min.	125
Magnetic Tape Controller Model H-803 with	2,000
8 H-804-1 Tape Units (62,000 alphameric char/sec)	7,200
Total:	$31,625
Total including Off-Line Equipment:	$37,575

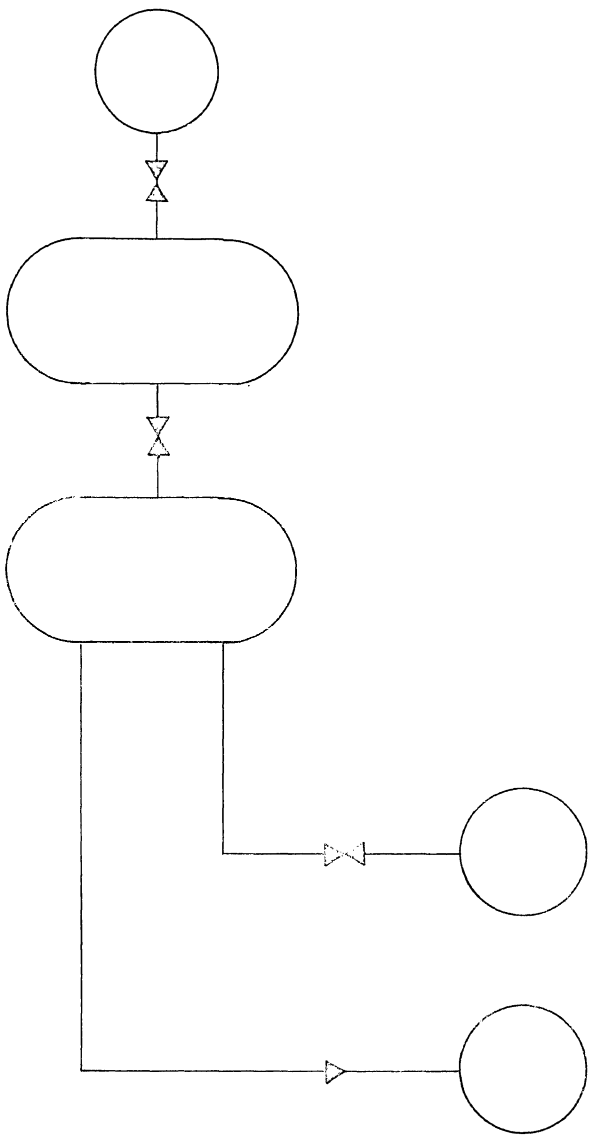
Optional Features: . . . . Floating Point Option.

§ 031.

.3 10-TAPE PAIRED SYSTEM (CONFIGURATION VII B, Contd.)

Deviations from Standard Configurations: . . . . card reading faster by 60%.
card punching faster by 15%.
printing faster by 80%.
only 1 magnetic tape unit.

Off-Line Equipment



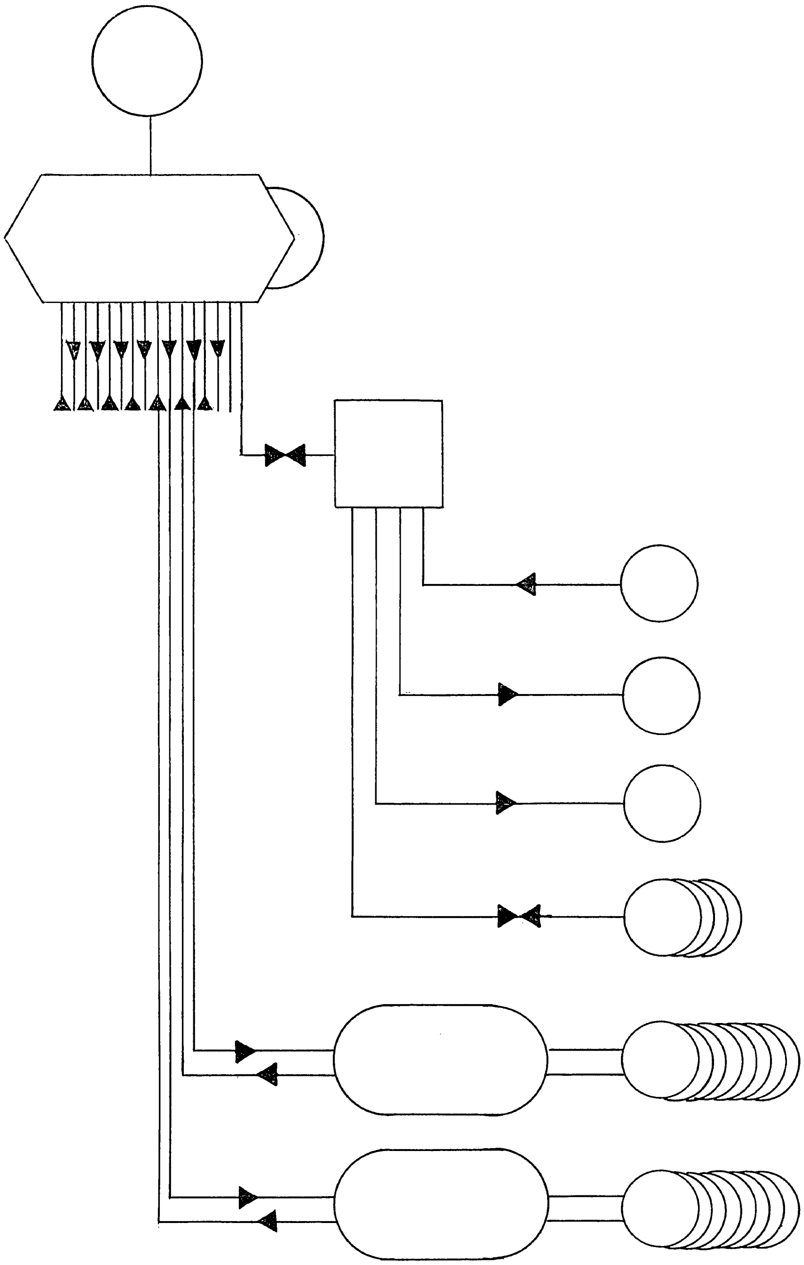
Equipment	Rental
H-804-3 Economy Tape Unit 30,000 char/sec.	$ 550
H-817 Auxiliary Control	950*
H-811-6 Control Unit	1,950*
H-827 Card Read/Punch 800 cards/min reading 250 cards/min punching	550
H-822-3 High Speed Printer 900 lines/min.	1,950
Total:	$5,950

* Not required if printer, read/punch, and tape unit are connected directly to H-1801-II via IOCC.

§ 031.

.4 20-TAPE INTEGRATED SYSTEM (CONFIGURATION VIII A)

Deviations from Standard Configuration: . . . . 1 additional magnetic tape transfer.
card reading slower by 20%.
printing slower by 10%.
54 additional index registers.



Equipment	Rental
Core Storage of 24,576 words and 256-word Control Memory	$ 6,400
H-1801-II Central Computer and Console.	18,000
Floating Point Option	4,300
IOCC	- - -
Card Reader Model H-827 800 cards/min.; Card Punch Model H-827 250 cards/min.	550
High Speed Printer Model H-822 900 lines/min.	1,450
4 H-804-4 Tape Units (133,000 alphameric char/sec)	3,600
2 Magnetic Tape Controllers Model H-803 with	8,200
16 H-804-4 Tape Units (133,000 alphameric char/sec.)	14,400
Total:	$56,900

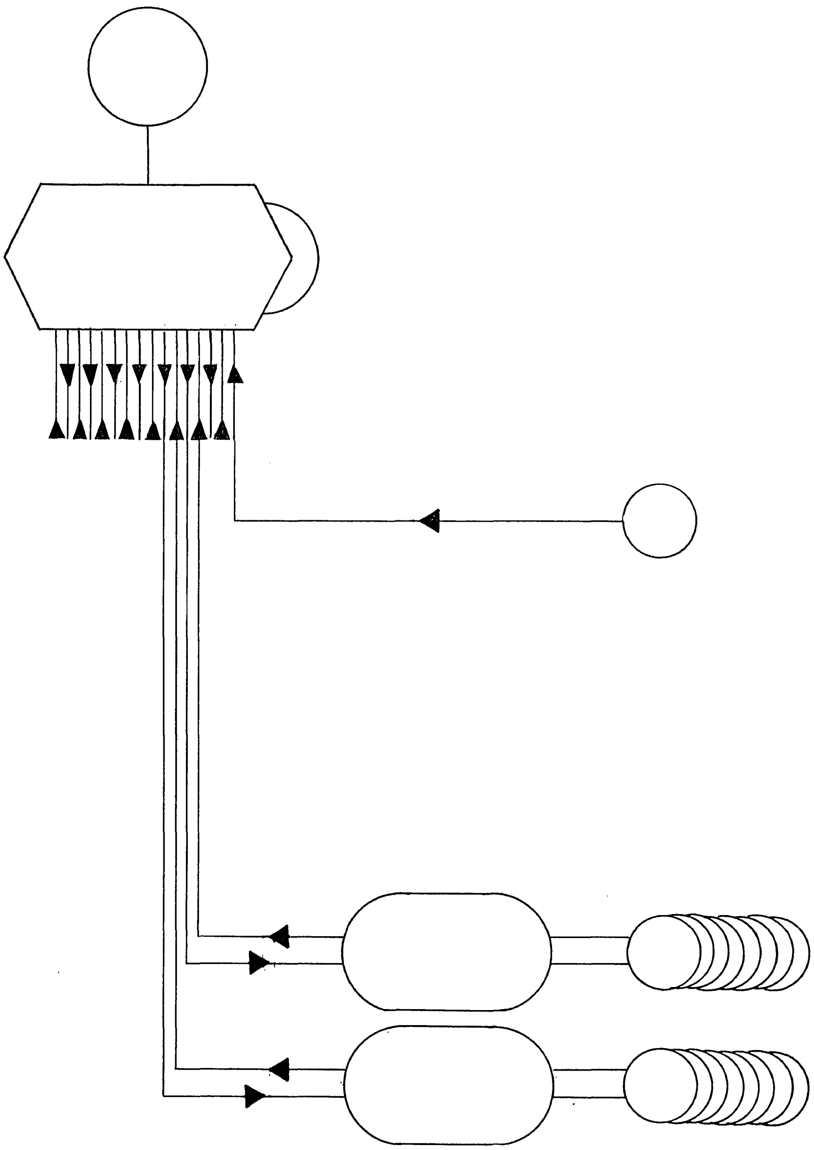
Optional Features Included: . . . . Floating Point Option.
16,384 words of store.

§ 031.

.5 20-TAPE PAIRED SYSTEM (CONFIGURATION VIII B)

On-Line Equipment

Deviations from Standard Configuration: . . . . tape unit 10% faster.
faster card reading (300 instead of 100 cards/min).
54 additional index registers.



Equipment	Rental
Basic Storage of 8,192 words and 256-word Control Memory, plus 1 additional storage unit of 8,192 words	\$ 3,200
H-1801-II Central Computer and Console	18,000
Floating Point Option	4,300
Card Reader Model H-823: 240 cards/min	125
2 Magnetic Tape Controllers Model H-803-4 with 8 H-804-4 Tape Units (133,000 alphameric char/sec)	8,200 14,400
Total:	\$48,225
Total including Off-Line Equipment:	\$56,025

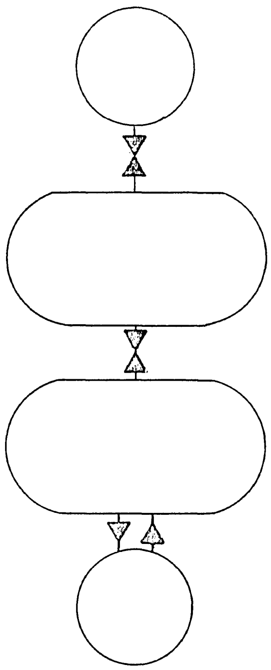
Optional Features Included: . . . . Floating Point Option.
8,192 words of storage.

§ 031.

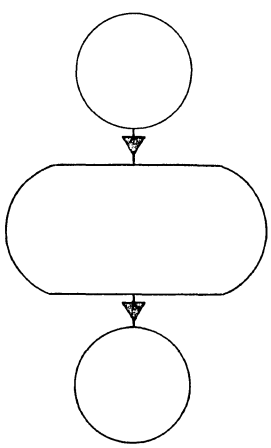
.6 20-TAPE PAIRED SYSTEM (CONFIGURATION VIII B, Contd.)

Off-Line Equipment

Deviations from Standard Configuration: . . . . . . card reading slower by 20%.
printing slower by 10%.
only 2 magnetic tape units.



Equipment	Rental
H-804-3 Economy Tape Unit 32, 000 char/sec	$ 550
H-817 Auxiliary Control	950
H-811-4 Control Unit	1, 700
H-827 Card Read/Punch Unit 800 cards/min Reading 250 cards/min Punching	550
	$ 3, 750



Equipment	Rental
H-804-3 Economy Tape Unit 32, 000 char/sec	$ 550
H-818 Off Line Printer Control	1, 550
H-822-3 High Speed Printer 900 lines/min	1, 950
	$ 4, 050
Total	$ 7, 800

INTERNAL STORAGE: CONTROL MEMORY

§ 041.

.1 GENERAL

.11 Identity: . . . . Control Memory.

.12 Basic Use: . . . . to hold 8 standard sets of data for programs and for independent pairs of I/O channels.

.13 Description

The function of the Control Memory is to control each of a number of programs. For this reason, it is divided into eight segments, each of which contains sufficient controls and auxiliaries for a single program. The contents of a single segment, listed below, include 8 index registers and 12 or 16 general purpose registers, in addition to sequence, interrupt, and masking facilities.

Each separate register can hold a 16-bit word, and basically contains one address. The first two registers contain counters for handling multiword operations, one for the source and one for the destination. The others control various features of the operation.

Table of Special Register Names, Subaddresses, and Mnemonic Address:

Sub-address	Mnemonic Address	Name
00	AU1	Arithmetic Control Counter No. 1
01	AU2	Arithmetic Control Counter No. 2
02	SC	Sequence Counter
03	CSC	Cosequence Counter
04	SH	Sequence History Register
05	CSH	Cosequence History Register
06	UTR	Unprogrammed Transfer Register
07	MXR	Mask Index Register
08-15	X0-S7	Index Registers
16-23	R0-R7	General Purpose Registers
24-27	S0-S3	General Purpose Registers
28	RAC*	Read Address Counter
29	DRAC*	Distributed Read Address Counter
30	WAC*	Write Address Counter
31	DWAC*	Distributed Write Address Counter

* In those special register groups not associated with active input and/or output channels, RAC, DRAC, and/or WAC, and DWAC are replaced by S4-S7, four General Purpose Registers.

.13 Description (Contd.)

Registers No. 03 through 06 are used for sequence control purposes, and provide for three distinct sequencing arrangements within the same program. For practical purposes, the Sequence and Co-sequence counters are similar in function, providing two normal program sequence controls between which the programmer can alternate as he chooses. This provision allows reduction in program length of some 5 to 10 percent, depending on programming philosophy.

The third sequencing arrangement is the Interrupt system (described in Paragraph .333 of the Central Processor section). In this system, a basic address is stored in the Unprogrammed Transfer Register. This address is incremented to define both the cause of the interruption and the instruction which was in control at the time.

Eight index registers are included in each segment of the Control Memory. These act as base addresses rather than as augmenters. Each index register can contain an address anywhere in storage, but the instruction has only eight bits (i.e., up to 256) to specify the increment or decrement to be applied. This limitation considerably restricts the utility of the index registers; however, indirect addressing is also available (see Central Processor, Paragraph .238).

The cycle time is 2 microseconds, the same as the cycle time of the main storage.

Because the cycling of the Control Memory is offset by half a cycle from the cycling of the Main Memory, no easy rule is available to show the cost of indexing. The rules for each case of each instruction are spelled out in an Appendix to the Programmers Reference Manual. To illustrate the complexity involved in detailed timing a typical entry from this appendix follows.

Instruction	Basic Time in Memory Cycles	Modification of Basic Time
TS (cont)		1 mc if C is direct special register or indirect memory location address 1 mc if C is indexed
B. Masked 1. If B is inactive, and a. A is inactive b. A is active	5 6	Add: 1 mc if A is indexed 1 mc if C is indexed Sub: 2 mc if C is inactive
	6	Add: •1 mc if A is inactive •1 mc if A is inactive and B is indexed •1 mc if A or B is indexed 1 mc if C is indexed

§ 041.

.13 Description (Contd.)

Six special registers are used to control the two input and output channels which may have been connected to each sector. Two control the actual transfer to and from the I/O device, while two control the storage areas being used if the transfers are to be scattered around the store. This latter practice, which doubles the I/O demands on the store, and may introduce a considerable number of I/O restrictions, is not often followed.

Many instructions are available to provide for masking of the operands. The Masking Control Register contains the address, anywhere in storage, of the mask to be used. This mask is used on all the operands in a masked operation.

INTERNAL STORAGE: CORE STORAGE

§ 042.

.1 GENERAL

.11 Identity: . . . . Core Storage in H-1801 Processor. Additional H-1802 Modules.

.12 Basic Use: . . . . working storage.

.13 Description

The 1801 Central Processor and the H-1802 Additional Modules are alternatives to the H-800 Central Processor and the H-802 Additional Modules. They differ only in speed (3 times as fast as the original core memory), in module size (8,192 words rather than 4,096 words), and in price.

The core storage is used as the main computer storage. It is accessed independently, and without lock-outs, by each program running in parallel. Some instructions allow for masking of each of the operands. Irrespective of whether one, two, or three operands are referred to by the instruction, the same mask is applied to each. The basic machine has a core storage of 8,192 words, each consisting of 48 data bits and 6 check bits. Three Additional Modules, each of 8,192 words, can be connected.

.15 First Delivery: . . . . 1963.

.16 Reserved Storage: . . . none.

Purpose	Number of locations
Index registers: . . .	none.
Arith registers: . . .	none.
Logic registers: . . .	none.
I/O control:	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instruction: . . . . . . yes.
.242 Data regenerated constantly: . . . . . . no.
.243 Data volatile: . . . . . yes.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.283 Type of access: . . . . all locations available each 2-microsecond cycle.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 500,000 cps.
Unit of data: . . . . . 1 word.
Conversion factor: . . 48 bits/word.
Gain factor: . . . . . 1.
Loss factor: . . . . . 1.
Data rate: . . . . . . 500,000 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	H-1802 Module	Maximum Storage
Words:	8,192	8,192	32,768
Characters:	65,536	65,536	262,144
Instructions:	8,192	8,192	32,768

.32 Rules for Combining Modules: . . . . no restriction.

.4 CONTROLLER: . . . . none.

.5 ACCESS TIMING: . . . any 1 word each 2-microsecond cycle.

.6 CHANGEABLE STORAGE: . . . . . . none.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	sequence interrupt.
Receipt of data:	check of 6 bits/word	sequence interrupt.
Recording of data:	generation of 6 bits/word	sequence interrupt.
Recovery of data:	check of 6 bits/word	sequence interrupt.
Dispatch of data:	generation of 6 bits/word	sequence interrupt.
Timing conflicts:	check if any data lost	sequence interrupt.
Physical record missing:	not possible.	
Reference to locked area:	not possible.	
Circuit failure:	check	halt.
Input area overflow:	check	sequence interrupt after next word overwritten.

INTERNAL STORAGE: MAGNETIC DISC FILE

§ 043.

.1 GENERAL

.11 Identity: . . . . . . Magnetic Disc file. Bryant Series 4000. H-860.

.12 Basic Use: . . . . . auxiliary storage.

.13 Description

This unit consists of a controller plus one or more cabinets of discs. A maximum number of eight disc cabinets can be connected, providing a capacity of from 50 to 805 million alphameric characters.

Access to the disc is achieved by addressing data records, each of 512 alphameric or 768 numeric characters, arranged into 64 words. Any record in a track can be addressed independently. Slightly less than 1 percent of the file (that part over which the heads are positioned) is available within 41 milliseconds, assuming average latency for disc rotation and a constant of 6 milliseconds for data transfer.

To gain access to another track involves waiting the 41 milliseconds for access plus an additional 60 to 130 milliseconds for lateral head movement. Thus, an average access, including head position changes, takes 136 milliseconds, allowing nearly 480 records per minute to be obtained or stored.

As each disc unit of 100 million alphameric character capacity can position its heads independently of the other units, time-sharing is possible with more than one disc unit, and can result in rates of up to 1200 64-character records per minute.

Full specifications for the unit are still to be announced.

.14 Availability: . . . . 9 months.

.15 First Delivery: . . attached to H-800, 1963

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . magnetic disc.

.22 Physical Dimensions

.222 Drum or Disc
- Diameter: . . . . 39 inches.
- Thickness: . . . . thin.
- Number on shaft: . 12 or 24.

.23 Storage phenomenon: direction of magnetization.

.24 Recording Permanence

- .241 Data erasable by instructions: . . . yes.
- .242 Data regenerated constantly: . . . . no.
- .243 Data volatile: . . . no.
- .244 Data permanent: . . no.
- .245 Storage changeable: . no.

.25 Data volume per band of 3 tracks

- Words: . . . . . . 8,192.
- Characters: . . . . 65,536.
- Digits: . . . . . . 98,304 (or 90,112 in signed H-800 words).
- Instructions: . . . . 8,192.

.26 Bands per physical unit: . . . . . . 256 per disc (128 on each side).

.27 Interleaving Levels: . none.

.28 Access Techniques

.281 Recording method: moving heads.

.283 Type of access

Description of stage	Possible starting stage
Move head to selected band:	yes.
Wait until record is in position:	yes, if a record on the same band of any disc face was previously selected.
Transfer of record:	no, but previous stage time may be zero.

.29 Potential Transfer Rates

.291 Peak bit rates
- Cycling rates: . . . 900 rpm.
- Bits/inch/track: . . variable.
- Compound bit rate: . . 615,000 bits/ sec.

.292 Peak data rates
- Cycling rates: . . . variable.
- Unit of data: . . . . word.
- Conversion factor: . . 48.
- Gain factor: . . . . . 3.
- Loss factor: . . . . 1.
- Data rate: . . . . . 4,270 words/sec.
- Compound data rate: . 12,812 words/sec. (102,500 alpha char/sec).

§ 043.

.3 DATA CAPACITY

.31 Module and System Sizes

Module Size	Model 1	Model 2
Discs:	12	24
Words:	6, 291, 375	12, 582, 875
Characters:	50, 331, 000	100, 663, 000
Instructions:	6, 291, 375	12, 582, 875

System Size	Minimum System	Maximum System
Discs:	12	192
Words:	6, 291, 375	100, 688, 125
Characters:	50, 331, 000	80, 305, 000
Instructions:	6, 291, 375	100, 688, 125

.32 Rules for Combining Modules:

. . . . . If more than one Disc File unit is to be connected to the control unit, each unit must contain 24 Discs. No more than 8 units can be connected at one time.

.4 CONTROLLER

.41 Identity: . . . . Model H-860 Control Unit.

.42 Connection to System

.421 On-Line: . . . . . . up to 8.
.422 Off-Line: . . . . none.

.43 Connection to System

.431 Devices per controller: up to 8.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 record = 64 words.
.442 Input-Output area: . . none.
.445 Synchronization: . . . automatic.
.447 Table control: . . . . none.
.448 Testable conditions: . general error and/or busy check.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks

	Model 1	Model 2	Model 9
Stacks per module:	24	48	386.
Stacks per yoke:	24	48	386.
Yokes per module:	1	1	1.

.512 Stack movement: . . . across one disc face.
.513 Stacks that can access any particular location: . . . . . . one.
.514 Accessible locations
By single stack
With no movement: . 1 band = 32 records of 64 words.
With all movement: . 128 bands = 4, 096 records of 64 words.

.514 Accessible locations (Contd.)
By all stacks
With no movement: . 32 N records per module, where n = 24 (Model 1)
= 48 (Model 2)
= 386 (Model 9)
(i. e. 1/128 capacity).
.515 Relationship between stacks and locations: . none.

.52 Simultaneous Operations

A : . . . . reading a record.
B : . . . . writing a record.
C : . . . . searching for a record.
D : . . . . internal computation.
E : . . . . no. of disc file units.
F : . . . . no. of discs.

Overall System	Each Unit
$a+b+c \leqslant e$	$a+b+c \leqslant 1.$
$a+b+c+d \leqslant e+1$	$a+b+c+d \leqslant 2.$
$e \leqslant 8$	

.53 Access Time, Parameters, and Variations

.532 Variation in access time, in msec.

Stage	Variation	Example
Head positioning: . . .	0 or 60, 000 to 130, 000	95, 000.
Waiting for the disc to be in position:	0 to 67, 000	32, 000.
Transfer of record: . .	6, 000	6, 000.
Total:	6, 000 to 75, 000, or 66, 000 to 203, 000	133, 000.

.6 CHANGEABLE STORAGE: . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possible
With Self: . . . . . no.
With Main Memory: . yes.
With Control Memory: . . . . . no.

.72 Transfer Load Size: . . 1 record of 64 words.

.73 Effective Transfer Rate

With Main Memory: . . . . . not yet determined. this depends on the timing of the interrecord gap.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none	unpredictable.
Invalid code:	not possible.	
Receipt of data:	not yet specified.	
Recording of data:	not yet specified.	
Recovery of data:	not yet specified.	
Dispatch of data:	not yet specified.	
Timing conflicts:	not yet specified.	
Physical record missing:	not yet specified.	
Reference to locked area:	not yet specified.	

CENTRAL PROCESSOR

§051.

.1 GENERAL

.11 Identity: . . . . H-1801 Central Processor.
H-1801 B Central Processor.

.12 Description

The H-1801 Central Processor is physically slightly larger than the H-801 processor. This processor also uses the H-1802 storage, which, because it is three times as fast as the H-802 storage (2 microseconds to access a word as opposed to 6 in the H-800), creates an equivalent increase in performance. There are no other differences between the two processors, or the systems for that matter. Both use the same instruction codes, software packages, peripheral units, etc.

A floating point option is available for the H-1800 which treats operands between 10^{-50} and 10^{+49} with a precision of nine decimal digits.

Multi-running appears to be much more practical normally on the H-1800 than on the H-800. This is true not only because the use of the central processor is reduced by two-thirds, but also because the available central processor power is increased three-fold.

The H-1801 Central Processor uses three-address instructions. Each operand address, which refers to a word in either Control Memory or Main Memory, can be written in a direct, indexed, or indirect manner. Indirectly addressed operands can themselves be indexed.

Input-output on the H-1800 is handled in six-bit alphameric code, whereas the arithmetic instructions work in four-bit numeric requiring pre-and post-arithmetic conversion. No special instructions exist for handling the conversion from one to another; all must be programmed. Editing instructions to allow zero suppression, comma insertion, etc., are not included in the repertoire, and carrying out such functions can take longer than 166 microseconds per character, depending on the requirements and the programmer.

Some inefficiency in storage utilization can occur as a result of the addressing methods used. These methods divide the storage into two parts: one, a maximum of 2,048 words, which can be directly addressed, and another which requires special addressing through the control memory. While programs remain small, the inefficiencies are probably low, but as the average installation increases its storage size, the inefficiencies increase because a greater number of banks are used by the program(s) running at any one time.

Indexing is performed by adding an increment from the instruction to 1 of the 64 index registers. (The increment must be less than 256.) In indirect addressing the instruction can also contain an increment (less than 32) which can be added to the address in Main Memory after the instruction is performed, thereby automatically allowing the addresses in a loop to be modified.

Arithmetic is performed on complete words, in either binary or decimal mode. Partial words can be used as operands for some instructions through use of a mask word which is applied to each of the operands in the instruction in turn. The basic machine has facilities for fixed point addition, subtraction, and multiplication, but not division; it has no facilities for floating point operations.

The H-1801 B has facilities for all fixed and floating point operations. The execution speeds of these instructions (3-address binary addition takes approximately 10 microseconds and binary division takes only 32 microseconds) are much faster than the equivalent fixed point instructions, and fast enough to make the H-1801 B a powerful scientific processor. It may also be possible for ingenious and careful commercial programmers to use the floating point instructions in preference to the corresponding fixed point ones in appropriate circumstances. The CONVERT instructions included in the H-1801 B (which convert a fixed point decimal number to floating binary form in 40 microseconds or perform the converse operation in 18 microseconds) will be useful in these circumstances.

An instruction which checks each of 6 parity bits associated with a 48-bit data word is available. As part of the orthotronic recovery routine, this instruction is used to locate bad frames after an erroneous "read" operation. Another instruction permits orthotronic control words to be formed and appended to the output records.

The Accumulate instructions repeat themselves n times, adding each time into the accumulator. These instructions permit a number of different operands to be accumulated by one instruction although signs are not treated arithmetically.

No inter-program protection is automatically available for data, instructions, sequence registers, etc. It is left to individual installations to ensure that time-sharing programs do not interfere with each other.

Instructions can treat data as words, items, or records for the purpose of transferring them into, out of, or within memory. An item is a group of words followed by an "end-of-item" word; a record is a group of words or items followed by an end-of-record word. Each time an end-of-item word is encountered during a transfer, an automatic table look-up operation locates the position in memory which the new item is to occupy.

Interruption can be caused by any of a number of conditions and results in a forced transfer of control. The destination (which is set up relative to a programmer-controlled address) distinguishes seven cases: Parity, Beginning or End of Tape, Input-Output error, Add/Subtract error, Division error, Exponent underflow, Exponent overflow.

.14 First Delivery: . . . 1963.

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.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-Subtract:	automatic.	binary or decimal	44 11
	Multiply			
	Short:	automatic	binary or decimal	44 11
	Long:	indirectly (extra digits in processor register)	binary or decimal	88 22
	Divide			
	No remainder:	•automatic	binary or decimal	44 11
	Remainder:	•indirect (extra digits in processor register)	binary or decimal	44 11
.212	Floating point (available both with and without normalization.)			
	Add-Subtract:	•automatic	binary or decimal	40 & 7.
	Multiply:	•automatic	binary or decimal	40 & 7.
	Divide:	•automatic	binary or decimal	40 & 7.

• with Scientific Option (H-1801 B Processor) only.

.213	Boolean		
	AND:	automatic	binary.
	Inclusive OR:	automatic	binary.
	Exclusive OR:	automatic	binary.
.214	Comparison		
	Numbers:	automatic.	
	Absolute:	automatic.	
	Letters:	automatic.	
	Mixed:	none.	

.215 Code translation: . . . none.
.216 Radix conversion: . . none.

.217 Edit format
Alter size: . . . . . none.
Suppress zero: . . none.
Round off: . . . . . none.
Insert point: . . . . none.
Insert spaces: . . . none.
Insert special character: . . . . . none.
Float $: . . . . none.
Protection: . . . . . . none.

.218 Table lookup: . . . . . none.

.219 Others
Accumulate: . . . . . automatic.

.22 Special Cases of Operands

.221 Negative numbers: . . . in fixed point representation, the sign is stored as 4 bits, but used as 1 bit; in floating point, 1-bit sign representation is used.

.222 Zero: . . . . positive or negative zero possible. These behave differently in alphabetic comparisons.

.23 Instruction Formats

.231 Instruction structure: . . . . . . 1-word, 3-address instructions.

.232 Instruction layout: . . . . Typical areas are shown below. (See also Instruction List, Section 503:121.)

<table>
<tr><th>BITS</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13 - 24</th><th>25 - 36</th><th>37 - 48</th></tr>
<tr><td rowspan="2">General Instructions (Unmasked)</td><td rowspan="2">S / C</td><td colspan="2" rowspan="2">1st Part of Op Code</td><td colspan="3">Memory Designator</td><td colspan="6" rowspan="2">2nd Part of Operation Code</td><td rowspan="2">A</td><td rowspan="2">B</td><td rowspan="2">C</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>General Instructions (Masked)</td><td>S / C</td><td colspan="5">Partial Mask Address</td><td colspan="6">Operation Code</td><td>A</td><td>B</td><td>C</td></tr>
<tr><td rowspan="2">Peripheral Instructions</td><td colspan="6">Peripheral Address</td><td colspan="6" rowspan="2">Operation Code</td><td rowspan="2">A</td><td rowspan="2">B</td><td rowspan="2">C</td></tr>
<tr><td colspan="3">I/O Channel</td><td colspan="3">Device</td></tr>
<tr><td>Simulator Instructions</td><td>D / I</td><td colspan="8">Remainder of Address</td><td>1</td><td>1</td><td>1</td><td>A</td><td>B</td><td>C</td></tr>
</table>

.233 Instruction parts

Name	Purpose
S/C:	to designate either the Sequence Counter or the Cosequence counter as providing the next instruction.
Op Code:	operation code of 6, or 6 and 2 bits.

.233 Instruction parts (Contd.)

Memory Designator:	part of addressing structure of the operands.
D/I:	part of addressing structure.
A, B, C:	part of addresses of operands (see Para. .234, below).

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.234 Basic address structure: . . . . . 3-address.

Honeywell 800 instructions can contain only the actual address of the operand when it is either in the same bank (2,048 words) of storage or in the control memory. To obtain access to other areas a special register, which can hold a complete address, is used.

.235 Literals
Arithmetic: . . . . no.
Comparisons and tests: . . . . . . no.
Incrementing modifiers: . . . . yes, by use of indirect addressing.

.236 Directly addressed operands

.2361

Internal storage type	Minimum size	Maximum size	Volume accessible
Basic Store:	1 bit	48 bits	2,048 words
Special Register:	1 bit	16 bits	256 words

.2362 Increased address capacity

Method	Volume accessible
Indirect addressing: . . .	up to 65,536 words.

.237 Address indexing
.2371 Number of methods: . . . . . . 1. (However, see indirect addressing, whose increment feature allows index-type operation).
.2372 Names: . . . . . . indexing.
.2373 Indexing rule: . . . up to 256 is added to (or subtracted from) the storage address given in the specified index register. The IR is not modified. The storage address can be either in Main Memory or in the Control Memory and the augmented address obtained can be used directly or indirectly.
.2374 Index specification: . . . within the instruction.
.2375 Number of potential indexers: . . . . 64.
.2376 Address which can be indexed: . . . . any in Basic or Special Memory.
.2377 Cumulative indexing: . . . . none.
.2378 Combined index and step: . . . . . not using index registers, but is available using an index register simply as a special register. See indirect addressing.
.238 Indirect addressing
.2381 Recursive: . . . . no.
.2382 Designation: . . . . special bit in instruction, which then interprets the 11 address bits of the appropriate A, B, or C address as an increment (<32) and the address of any one of the special registers in any bank.
.2383 Control: . . . . . . absolute address must be contained in an addressed special register.
.2384 Indexing with indirect addressing: . . . modification occurs before the indirect address is determined.
.239 Stepping
Index Registers: . . own coding.
Indirect Addressing:. as specified below.
.2391 Specification of increment: . . . . in instruction.
.2392 Increment sign: . . special register sign.
.2393 Size of increment: . 0 through 31.
.2394 End value: . . . . own coding.
.2395 Combined step and test: . . . . . no.

.24 Special Processor Storage

.241

Category of Storage	Number of locations	Size in Bits	Program usage
Accumulator:	1	44 + 1	accumulate without storage.
Mask register:	1	48	repeated use of mask.
Low-order product register:	1	44 + 1	obtain double-length product.

.242

Category of storage	Total number locations	Physical form	Access time, μsec	Cycle time, μsec
Accumulator:	1	flip-flops	2	2
Mask Register:	1	flip-flops	2	2
Low-order product:	1	flip-flops	2	2

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 16.
.312 Arrangement: . . . . 2 per program, 8 programs in a processor.
.313 Precedence rule (within program): . . continues with one control until instructed to transfer control to other.
Precedence rule (within processor): . up to eight programs can be processed simultaneously. The central processor executes one instruction from each active program in turn. This contrasts with the more common method of switching from one program to another only when an interrupt occurs. In general, the H-1800 method provides a more uniform distribution of processing capacity.
.314 Special sub-sequence counters: . . . . . none.
.315 Sequence control step size: . . . . . instruction words.
.316 Accessibility to routines: . . . . . yes.

.32 Look-ahead: . . . . none.

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.33 Interruption

.331 Possible causes
- In-out units: . . . . beginning or end of tape; read or write error.
- In-out controllers: . . none.
- Storage access: . . . none.
- Processor errors: . . parity failure. arithmetic overflow. division error. exponent overflow or underflow.
- Other: . . . . none.

.332 Control by routine
- Individual control: . . all interrupts within one program; positions relative to a standard special register.
- Method: . . . . . . either the sign of the increment or the base of the increment can be adjusted.

.333 Operator control: . . . none.

.334 Interruption conditions: interruption condition arises in program channel.

.335 Interruption process
- Disabling interruption: . . . . main memory cycling stops.
- Registers saved: . . all.
- Destination: . . . . standard distance away from variable base address stored in special register of program channel, depending on interruption cause.

.336 Control methods
- Determine cause: . . given by entry place.
- Enable interruption: . not necessary; the base or sign of the increment can be changed to allow for recognition of repeated interrupts.

.34 Multi-running

.341 Method of control: . . multisequence counters.

.342 Maximum number of programs: . . . 8.

.343 Precedence rules: . . cyclic, first-off, first-on, with cycling inhibition in own coding.

.344 Program protection
- Storage: . . . . . . none.
- In-out areas: . . . . none.
- In-out units: . . . . writing can be inhibited physically; otherwise, none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ sec

.411 Fixed point
- Add-subtract: . . . . 6.
- Multiply (Binary): . . 66.
- Multiply (Decimal): . 54.

.411 Fixed point (Contd.)
- Divide (Binary): . . . 24 to 36.*
- Divide (Decimal): . . 40 to 46.*

.412 Floating point (Normalized)
- Add-subtract: . . . . 8 to 14.*
- Multiply: (Binary) . . 10 to 12.*
- (Decimal) . 8 to 24.*
- Divide: (Binary) . . . 24 to 36.*
- (Decimal) . . 40 to 46.*

.413 Additional allowance for
- Indexing: . . . . . . 2 }
- Indirect addressing: . 2 } may often be overlapped if two operands involved.
- Re-complementing: . 0 or 2.

.414 Control
- Compare: . . . . . . 8.
- Branch: . . . . 6.
- Compare and branch: . . . . 8.

.415 Counter control
- Step: . . . . not available for index registers. included in use of indirect address.
- Step and test: . . . . . not available.
- Test: . . . . 24.

.416 Edit: . . . . not available.

.417 Convert (per word)
- Fixed point decimal to floating point binary: 40.*
- Floating point binary to fixed point decimal: 18.*

.418 Shift: . . . . 10 + 2 per bit, 4-bit or 6-bit character shifted.

.42 Processor Performance in μ sec

.421 For random addresses

	Fixed point	Floating point*
c= a + b:	8	10 or 13.
b= a + b:	8	10 or 13.
Sum N items:	6 + 2N	8N or 11N
c= ab:	67	12 or 24.
c= a/b:	30*	32 or 46.

.422 For arrays of data

	Fixed point	Normalized Floating Point*
$c_i = a_i + b_j$:	16	18 or 21.
$b_j = a_i + b_j$:	16	18 or 21.
Sum N items (if known to be all + or all -):	12 + 2N	8N or 11N
Otherwise:	10N	8N or 11N
$c = c + a_ib_j$:	80	25 or 37.

.423 Branch based on comparison
- Numeric data: . . . . . 38.
- Alphabetic data: . . . 38.

.424 Switching
- Unchecked: . . . . . 10.
- Checked: . . . . . . 10 + 16D, where D is no. of decimal digits.
- List search: . . . . 72 + 8N, where N is no. of comparisons.

.425 Format control per character
- Unpack: . . . . 150 (alpha); 183 (numeric).
- Compose: . . . . . . 167 (alpha); 200 (numeric).

.426 Table look up per comparison
- For a match: . . . . 10.
- For least or greatest: 10 + 16N where N is no. of changes.

*With Scientific Option (H-1801 B Processor); otherwise, subroutines must be used. Where two figures are listed, the first is for a binary operation and the second for a decimal operation.

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.426 Table look up per comparison (Contd.)

For interpolation point: . . . . 10.

.427 Bit indicators

Set bit in separate location: . . . . . . 6.

Set bit in pattern: . . . 10.

Test bit in separate location: . . . . . . 6.

Test bit in pattern: . . 10.

Test AND for B bits: . 10.

Test OR for B bits: . . 10.

.428 Moving: . . . . 2N, where N is no. of words moved.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	special transfer.
Underflow:	check	special transfer.
Zero divisor:	check	special transfer.
Invalid data:	none.	
Invalid operation:	none.	
Arithmetic error:	check	special transfer.
Invalid address:	check	special transfer.
Receipt of data:	parity check	special transfer.
Dispatch of data:	parity check	special transfer.

INPUT-OUTPUT: H-809 PUNCHED PAPER TAPE READER

§ 071.

.1 GENERAL

.11 Identity: . . . . Punched Paper Tape Reader and Control.
Model H-809.
Burroughs Corp. Unit B-141.

.12 Description

The H-809 Punched Paper Tape Reader and Control can operate at either 500 or 1,000 frames per second. Each data frame is right-justified, placed in a separate 48-bit word, and transferred to storage. The reader can handle up to eight-bit codes.

The data read is dependent upon standard subroutines to accomplish conversion to Honeywell 1800 codes. The conversion and fitting of the character read into words normally takes approximately 30 microseconds per character. This operation loads the central processor 2 to 3 per cent of its total capacity, depending on the speed to which the paper tape reader is set. The effective speed of the reader is reduced by at least 5 characters per second whenever the tape reader is allowed to halt.

The reader can read tape either from spools or in strips. It uses swing arms for tension, and spool motor drive control. The read mechanism is photoelectric and the tape is driven by a pinch roller. An automatic rewinding feature is incorporated in the unit.

Either paper tape reels or strips can be read; however, if strips are used, reading must be restricted to 500 characters per second. The paper tape should be non-oiled, opaque tape. Metallic tape can be used optionally.

.13 Availability: . . . . . 9 months.

.14 First Delivery: . . . . 1960 (with H-800).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arms.
Capacity: . . . . 3 feet.
.213 Feed drive: . . . . . . servo motor.
.214 Take-up drive: . . . . . servo motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . photoelectric.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . read.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8 plus sprocket.
Method of use: . . . . . frame at a time.

.25 Range of Symbols

Numerals: . . . . Any 5 to 8-bit code.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . non-oiled, opaque paper tape.
.312 Phenomenon: . . . . . . punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . by row, 10/inch.
.322 Parallel by: . . . . . . 5 to 8 tracks.
.323 Bands: . . . . none.
.324 Track use
Data: . . . . 5 to 8 tracks.
Redundancy check: . . any track except sprocket.
Timing: . . . . track 4 (sprocket track).
Control signals: . . . none.
Unused: . . . . none.
Total: . . . . 5 to 8 plus sprocket track.
.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . one character per row, using 5 to 8 bits; any 5-, 6-, 7-, or 8-bit code.

.34 Format Compatibility: . other paper tape systems.

.35 Physical Dimensions

.351 Overall width: . . . . . 11/16; 7/8; 1 inch.
.352 Length: . . . . 8 to 700 ft.
4-foot leader.
4-foot trailer.

.4 CONTROLLER

.41 Identity: . . . . incorporated in unit.

§ 071.

.42 Connection to System

.421 On-line: . . . . up to 8.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 frame.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . word.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . program.
.447 Synchronizing aids: . . test busy.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 frame.
.512 Block demarcation: . . automatic at 1 frame.

.52 Input-Output Operations

.521 Input: . . . . 1 frame.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . unload forward or rewind until end of tape is reached.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . none.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . 81.
Rearrangement: . . . . . rearrangement of tracks only.

.55 Control Operations

Disable: . . . . disable up to 3 tracks; manual.
Request interrupt: . . . none.
Select format: . . . . . none.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes, provided no other unit is occupying the same channel.
Output lock: . . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: metallic foil at each end of tape.

.6 PERFORMANCE

.61 Conditions

I: . . . . full speed: 1,000 frames/sec.
II: . . . . medium speed: 500 frames/sec.

.62 Speeds

.621 Nominal or peak speed: I 1,000 frames/sec.
II 500 frames/sec.
.622 Important parameters
Full speed: . . . . . . 1,000 frames/sec.
Medium speed: . . . . 500 frames/sec.
Start time: . . . . . . 5 msec.
Stop time: . . . . . . 0.1 msec.
Time between 2 read instructions to maintain speed: . . . . . under 1 msec.
Delay if 2nd instruction just misses maintaining full speed: . . . . up to 7 msec.
.623 Overhead: . . . . start/stop time.
.624 Effective speeds: . . . I 1,000 N/(N + 6) frames/sec.
II 500 N/(N + 6) frames/sec.

N = number of frames per set of read instructions operated at full speed.

.63 Demands on System

Component	Condition	msec per frame *	or Percentage
Processor:	I	0.02	2.0
	II	0.01	1.0

* Not including assembly into H-1800 words.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustments	Method	Comment
Width:	movable tape guides	detents
Coding:	plugboard.	
Parity Method:	switch.	

.72 Other Controls

Function	Form	Comment
Parity check:	switch	allows checking odd/even or no parity
Feed control:	switch	allows tape to be fed from reel clockwise (Reel Normal) or counter-clockwise (Reel Reverse) or strips (Strip).
Backspace:	lever	moves tape backward one frame.
Rewind:	button	move to end of tape.
Unload:	button	wind forward to end of tape.

§ 071.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	700 feet.

.732 Replenishment time: . . 1 to 2 min.
reader needs to be stopped.

.733 Adjustment time: . . . 2 to 5 min.

.734 Optimum reloading period: . . . . 1.4 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity check	stoppage and signal to control.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	none.	
Exhausted medium:	tape tension and metallic foil	stoppage, alarm.
Imperfect medium:	sprocket check	stoppage, alarm.
Timing conflicts:	none.	

INPUT-OUTPUT: H-810 PAPER TAPE PUNCH

§ 072.

.1 GENERAL

.11 Identity: . . . . Punched Tape Punch and Control.
Models H-810-1, -2.
Teletype BRPE Punch.

.12 Description

The H-810-1 is a combination Paper Tape Punch and Control Unit designed to prepare five-channel punched paper tape, ten frames to the inch, at 110 characters per second. The H-810-2 is the same, except that it punches six-, seven-, or eight-channel tape. The image to be punched is taken from right-justified bits of a 48-bit word. The last character to be punched requires about 9 to 13 milliseconds of processor time and all other characters 9 milliseconds.

No edit instructions are available for preparing output suitable for the paper tape punch; however, an approximate figure of 30 microseconds of central processor time per character would cover normal editing requirements. This time represents approximately 1 per cent of central processor capacity.

.13 Availability: . . . . . 9 months.

.14 First Delivery: . . . . 1960 (with H-800).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive pull.
.212 Reservoirs
Number: . . . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . . . 3 feet.
.213 Feed drive: . . . . . servo motor.
.214 Take-up drive: . . . . servo motor.

.22 Sensing and Recording Systems

.211 Recording system: . . die punch.
.222 Sensing system: . . . none.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

	810-1	810-2
Use of station:	punch.	punch.
Stacks:	1.	1.
Heads/stack:	6.	9.
Method of use:	frame at a time.	frame at a time.

.25 Range of Symbols

Codes: . . . . 810-1; any five-bit code.
810-2; any 6-, 7-, or 8-bit code.
Total: . . . . 810-1; 2^5 symbols.
810-2; 2^8 symbols.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
.312 Phenomenon: . . . . . punch holes.

.32 Positional Arrangement

.321 Serial by: . . . . . . 10 rows/inch.
.322 Parallel by: . . . . . 810-1; 5 tracks plus sprocket.
810-2; 8 tracks plus sprocket.
.323 Bands: . . . . none.

.324 Track use	810-1	810-2
Data:	5 tracks; 1 to 3 and 5 to 6.	8 tracks; 1 to 3 and 5 to 9.
Redundancy check: . .	none.	none.
Timing:	1.	1.
Control signals: . . .	none.	none.
Unused:	none.	none.
Total:	5 plus sprocket.	8 plus sprocket.

.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . 810-1; any 5-bit code.
810-2; any 6-, 7-, or 8-bit code.

.34 Format Compatibility: . other paper tape systems.

.35 Physical Dimensions

.351 Overall width: . . . . 810-1; 11/16".
810-2; 7/8" or 1".
.352 Length: . . . . 6 feet to 1,000 feet on reels.

.4 CONTROLLER

.41 Identity: . . . . incorporated in device.

.42 Connection to System

.421 On-line: . . . . up to 8.
.422 Off-line: . . . . none.

§ 072.

.44 Data Transfer Control

.441 Size of Load: . . . . . 1 frame.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . . word.
.444 Input-output area lockout: . . . . . . none.
.445 Table control: . . . . none.
.446 Synchronization: . . . program.
.447 Synchronizing aids: . . . . test busy.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 8-bit frame.
.512 Block demarcation: . . preset at 1 frame.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 frame.
.523 Stepping: . . . . 1 frame forward.
.524 Skipping: . . . . . . none.
.525 Marking: . . . . . . none.
.526 Searching: . . . . . . none.

.53 Code Translation: . . none.

.54 Format Control: . . . none.

.55 Control Operations: . . none.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . . not necessary.
Output lock: . . . . . no.
Nearly exhausted: . . . 20 feet.
Busy controller: . . . not necessary.
End of medium marks: . . . . no.

.6 PERFORMANCE

.62 Speeds

.621 Normal or peak speed: . . . . 110 frames/sec.
.622 Important parameters
Punch a frame: . . . 9.09 msec.
.623 Overhead: . . . . . . none.
.624 Effective speeds: . . . 110 frames/sec.

.63 Demands on System

Component	Condition	msec per frame	Percentage
Processor:	punch 1 frame	0.02	0.22
Processor:	punch additional frames	0.02	0.22

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjust guide

.72 Other Controls

Function: . . . . . . rewind.
Form: . . . . switch
Comment: . . . . . . tape must be removed from punch head.

.73 Loading and Unloading

Storage: . . . . reel
Capacity: . . . . . . 1,000 feet.

.732 Replenishment time: . . . . 1 to 2 minutes. punch needs to be stopped.
.734 Optimum reloading period: . . . . 18 min (1,000-foot reels).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Output block size:	implicit.	
Invalid code:	not possible.	
Exhausted medium:	check	special branching.
Imperfect medium:	none.	
Timing conflicts:	not possible.	

INPUT-OUTPUT: H-823 CARD READER

§ 073.

.1 GENERAL

.11 Identity: . . . . Model H-823 Card Reader. There are two versions, the H-823-1, H-823-2. The H-823-1 is adapted from the IBM 085; the H-823-2 is adapted from the IBM 088.

.12 Description

These units are modified IBM collators which retain most of their normal operating characteristics. Only one of the two card feeds is used for cards to be read; the other is used to insert marker cards for certain error-handling procedures. These error-handling procedures involve setting switches manually before running a particular program in order to allow the run to be halted, the error card to be eliminated, a marker card to be inserted, or a combination of these actions to take place whenever an error is detected. The action occurs either during the reading or during transmission of data to Main Memory. The reading check is a hole-count check, but can optionally be a check to ensure that all punching is standard Hollerith.

Card reading is initiated as soon as the previous card-image has been transmitted to Main Memory. Thus, waiting time is reduced during card-reading, and no additional burden is put on the programmer. The maximum reading rate is 240 cards per minute (Model 823-1) or 650 cards per minute (Model 823-2). Reading can occur in standard Hollerith or column binary form, and in no case can it consume more than 0.3 per cent of central processor computing time.

.13 Availability: . . . . . . Model H-823-1, 12 months.
Model H-823-2, 7 months.

.14 First Delivery (with H-800): . . . . Model 823-1, 1960.
Model 823-2, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch-driven rollers.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brushes.

.23 Multiple Copies: . . . . not applicable.

.24 Arrangement of Heads

Use of station: . . . . . hole counting.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . reading and hole count check.
Distance: . . . . 12 card rows.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	11	, * / % # $ @ - & . □
FORTRAN set:	no.	
Basic COBOL set: . . .	yes.	
Total:	47.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . standard 80-column punched cards.

.33 Coding: . . . . Hollerith or column binary coding.

.34 Format Compatibility: . compatible with other units using standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . Model H-807 or H-811 Controllers. See also System Configuration, 503:030.

.42 Connection to System

.421 On-line: . . . . up to 8 (1 per channel).
.422 Off-line: . . . . varies (see System Configuration, Section 503:300).

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

§ 073.

.44 Data Transfer Control

.441 Size of load: . . . . . . Hollerith mode: 80 characters in 10 H-800 words, plus one control word.
Column Binary mode: 960 bit positions in 20 H-800 words, plus one control word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . word or item.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . gather-write and scatter-read facilities.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.

.512 Block demarcation
Input: . . . . end of card.

.52 Input-Output Operations

.521 Input: . . . . transmit 80 columns (or 20 words) of data plus one control word with error information. Initiate the reading of the next card.

.53 Code Translation: . . . optional, from card column code to 6-bit internal character codes.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Offset card: . . . . . . no.
Select stacker: . . . . . no.
Select format: . . . . . no.
Select code: . . . . . . no (manual control on unit).

(Note: Some of these operations can be specified by preset switches on the unit. The operation then occurs only in the case of illegal punches or incorrect data transmission.)

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes, if no other input equipment is connected to the channel.
Output lock: . . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes, if no other input controller is connected to the channel.
End of medium marks: no.
Hopper empty: . . . . . no.
Stacker full: . . . . . . no.

.6 PERFORMANCE

.62 Speeds

		Model H-823-1	Model H-823-2
.621	Nominal or peak speed:	240 cards/min.	650 cards/min.
.622	Important parameters		
	Cycle time:	250 msec	92 msec.
	Number of clutch points:	1	1.
.623	Overhead:	1 clutch point per cycle; however, reading occurs before a read order is received (Anticipatory reading). The overhead depends on the time difference between two read orders.	
.624	Effective speeds: . . .	peak speed less clutch points missed.	

.63 Demands on System

Component	Condition	msec per card
Central Processor, not using Scatter-Read:	reading Hollerith information	0.222 *
	reading Column Binary	0.063 *

	Percentage of Card Read Time
Model H-823-1, Hollerith data:	0.012 *
Model H-823-2, Hollerith data:	0.033 *
Model H-823-1, Column Binary:	0.28 *
Model H-823-2, Column Binary:	0.065 *

* If Scatter-Read is used, these figures should be doubled.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . . type of reading.
Method: . . . . 3-position switch.
Comment: . . . . allows for reading in normal Hollerith Code or binary code.
third position reads any combination of Hollerith-type punches and translates them according to Data Code Table No. 1.

.72 Other Controls

Function	Form	Comment
Program Switch:	9-position switch	used in start operations, under programmer's instruction.
Illegal Punch:	4-position switch	controls action on receipts of non-Hollerith punching.

§ 073.

.72 Other Controls (Contd.)

Function	Form	Comment
Check Process:	4-position switch	controls action on receipt of computer instruction.
Marker Feed:	4-position switch	inserts blank cards in place of or following cards which have illegal punching and/or have been incorrectly read.

.73 Loading and Unloading

.731 Volumes handled, cards

	Input Hopper	Output Stacker
H-823-1:	800	1,000.
H-823-2:	3, 600	1,000.

.732 Replenishment time: . . 1 to 2 min. unit does not need to be stopped.

.733 Adjustment time: . . . 1 to 2 min.

.734 Optimum reloading period
Model H-823-1: . . . 3 min.
Model H-823-2: . . . 6 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole count	interrupt.
Input area:	none.	
Exhausted medium:	check common to other conditions	interrupt.
Imperfect medium:	none.	
Stacker full:	check common to other conditions	interrupt.
Invalid code:	optional check	interrupt.

INPUT-OUTPUT: H-827 CARD READ-PUNCH (READER)

§ 074.

.1 GENERAL

.11 Identity: . . . . . . Card Read-Punch (Reader only).
Model H-827.
IBM 1402 Model 2.

.12 Description

While the H-827 consists of a card reader and punch housed in the same cabinet, the two units are independent of one another from the user's viewpoint and are covered in separate sections of this report.

The reader reads standard 80-column cards at a peak speed of 800 cards per minute. Conversion from the card column code to internal BCD code is automatic. A hole-count check is made on each column at a second reading station, and the bit configuration of each character is checked for validity as it is transferred into the read synchronizer for later transmission into core storage. A hopper with a 3,000-card capacity and three stackers with 1,000-card capacities (one shared with the punch unit) can be loaded and unloaded without stopping the reader.

Card reading is initiated as soon as the previous card-image has been transmitted to Main Memory. Thus, waiting time is reduced during card-reading, and no additional burden is put on the programmer. Reading can occur in standard Hollerith or column binary form, and in no case can it consume more than 0.1 per cent of central processor computing time.

.13 Availability: . . . . 12 months.

.14 First Delivery: . . . 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head . . clutch driven rollers.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brush.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 12 rows of each card, 1 at a time.

.24 Arrangement of Heads (Contd.)

Use of station: . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . . 1.
Heads/stack: . . . 80.
Method of use: . . 12 rows of each card, 1 at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	11	, * / % # $ @ - & . □
FORTRAN set: . .	no.	
Basic COBOL set: .	yes.	
Total:	47.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing
.322 Parallel by: . . . . 80 columns at standard spacing.

.324 Track use
Data: . . . . . . 80.
Total: . . . . . . 80.
.325 Row use
Data: . . . . 12.

.33 Coding: . . . . . Hollerith code or column binary.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards: . .	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLERS

.41 Identity: . . . . . Model H-807 or H-811 Controllers. See also System Configuration, 503:030.

.42 Connection to Device

.421 On-line: . . . . . . up to 8 (1 per channel).
.422 Off-line: . . . . . varies (see System Configuration, Section 503:300).

§ 074.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . none.

.44 Data Transfer Control

.441 Size of load: . . . Hollerith mode: 80 characters in 10 H-1800 words, plus 1 control word.
Column Binary mode: 960 bit positions in 20 H-1800 words, plus 1 control word.
.442 Input-output areas: . . . . . . core storage
.443 Input-output area access: . . . word or item.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . gather-write and scatter-read facilities.
.446 Synchronization: . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . 1 card.
.512 Block demarcation
Input: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . transmit 80 columns (or 20 words) of data plus 1 control word with error information. Initiate the reading of the next card.

.53 Code Translation: . . . optional, from card column code to 6-bit internal character codes.

.54 Format Control: . . . none.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . . . . no.
Offset card: . . . no.
Select stacker: . . automatic alternation.
Select format: . . no.
Select code: . . . . no.
Unload: . . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . yes, if no other input equipment is connected to the channel.
Output lock: . . . . no.
Nearly exhausted: . no.
Busy controller: . . yes, if no other input controller is connected to the channel.
End of medium marks: . . . . . no.
Hopper empty: . . no.
Stacker full: . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . . 800 cards/min.
.622 Important parameters
Clutch cycle: . . . 75 msec.
.623 Overhead: . . . . . 3 clutch points.
.624 Effective speeds: . 800 cards/min. if processing time per card does not exceed 74.12 msec.

.63 Demands on System

Component	Condition	msec per card
Central Processor, not using Scatter-Read:	reading Hollerith information	0.022*
	reading Column Binary	0.042*

	Percentage of Card Read Time
Hollerith data:	0.03*
Column Binary:	0.05*

* If Scatter-Read is used, these figures should be doubled.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . card width.
Method: . . . . . interchange of hardware.

.72 Other Controls

Function	Form	Comment
End of File:	key	activates circuits to signal last-card condition in central processing unit.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	3,000 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . . . 0.25 to 0.50 minutes; reader does not need to be stopped.
.733 Adjustment time: . 10 to 15 minutes.
.734 Optimum reloading period: . . . . 1.25 minutes.

§ 074

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole count	indicator & alarm.
Input area overflow:	none.	
Invalid code:	validity check	indicator & alarm.
Exhausted medium:	check	stop & alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop & alarm.
Stacker full:	check	stop & alarm.
Wrong length record:	check	indicator.
No transfer:	check	indicator.

INPUT-OUTPUT: H:827 CARD READ-PUNCH (PUNCH)

§ 075.

.1 GENERAL

.11 Identity: . . . . H-827 Card Read-Punch (Punch only). IBM 1402.

.12 Description

Housed in the same cabinet as the card reader, this unit punches standard 80-column cards at a peak speed of 250 cards per minute. Conversion from internal BCD representation to the column card code is automatic. A reading station makes a hole-count check on each column. The 1200-card feed hopper and three 1,000-card stackers (1 shared with the reader unit) can be loaded and unloaded without stopping the punch. A punch buffer register in the Input-Output Synchronizer permits the overlapping of punching with other operations.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . checking.
Distance: . . . . 1 card.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . standard 80-column cards.
.312 Phenomenon: . . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . . 80 columns at standard spacing.
.324 Track use
Data: . . . . 80.
Total: . . . . 80.
.325 Row use
Data: . . . . 12.

.33 Coding: . . . . Hollerith code or column binary.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . Models H-808 or H-811 Controllers (see also System Configuration 503:030).

.42 Connection to System

.421 On-line: . . . . up to 8 (1 per channel).
.422 Off-line: . . . . varies (see System Configuration 503:030).

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . word or item.
.444 Input-output area lockout: . . . . no.
.445 Table control: . . . . . gather-write and scatter-read facilities.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation
Output: . . . . fixed.

§ 075.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 card forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Offset card: . . . . no.
Select stacker: . . . . . . yes, 1 of 3.
Select format: . . . . . . no.
Select code: . . . . no.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . . yes.
End of medium marks: no.
Controller not ready: . yes.
Hopper empty: . . . . . . yes.
Stacker full: . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: 250 cards/min.
.622 Important parameters
Clutch cycle: . . . . . . 240 msec.
.623 Overhead: . . . . 3 clutch points.
.624 Effective speeds: . . . 250 cards/min if processing time per card does not exceed 216.62 msec.

.63 Demands on System

Component	msec per block	or	Percentage
Central Processor (not using gather-write):	0.022*	or	0.008*

* If a gather-write is used, these figures should be doubled.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.72 Other Controls: . . . . start and stop only.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . 0.25 to 0.50 minute. punch does not need to be stopped.
.733 Adjustment time: . . . none.
.734 Optimum reloading period: . . . . 4.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	hole count	indicator and alarm.
Output block size:	fixed.	
Invalid code:	parity check	indicator and alarm.
Exhausted medium:	check	stop and alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop and alarm.
Stacker full:	check	stop and alarm.
Wrong length record:	check	indicator.

INPUT-OUTPUT: H-822 HIGH SPEED PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . High Speed Printer.
Model H-822-3.

.12 Description

The Model H-822-3 High Speed Printer is designed to produce printed output at 900 lines per minute for continuous single-space printing and 800 lines per minute for continuous double-space printing. The printer can operate on- or off-line; however, different control units are required for each of the two modes of operation.

The H-822-3 is a drum-type printer whose printer mechanism (i.e., type roll, ribbon feeder, paper loader and control circuitry) rests on a table-like base. The center of the base is open to permit paper-handling from either the front or the back. One hundred and sixty print positions are provided, of which 120 can be manually selected prior to the printing operation. This printer has the capability for manually selecting vertical spacing at six or eight lines to the inch. Skipping speed in the non-print mode is approximately 20 inches per second. Vertical format is controlled by a control word and a prepunched paper carriage tape. Mechanical adjustments are also provided to adjust the paper form position.

An unusual feature of this printer is that 160 character positions are available, any 120 of which can be in use at one time. This facility is used primarily when printing two forms side-by-side simultaneously.

.13 Availability: . . . . . . 7 months.

.14 First Delivery: . . . . 1960 (with H-800).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . on-the-fly hammer stroke against engraved drum.
.222 Sensing system: . . . . none.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . original and 8 copies.

.233 Types of master
Multilith: . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . 1.
Heads/stack: . . . . . . 160.
Method of use: . . . . . 120 out of 160, chosen manually beforehand by wiring on plugboard.

.25 Range of Symbols

Numerals: 10 0-9
Letters: . . . . 26 A-Z
Special: . . . . 20 , ; : . ' " * ( ) + - = $ & @ # % CR / ▩
Alternatives: . . . . . . as requested.
FORTRAN set: . . . . . yes.
Basic COBOL set: . . . yes.
Total: 56

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper.
.312 Phenomenon: . . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . 1 line, at 6 per inch or 1 line at 8 per inch.
.322 Parallel by: . . . . . . 120 out of 160 character positions, 10 per inch.

.33 Coding: . . . . H-800 coding for 56 characters; 8 others print as blank.

.35 Physical Dimensions

.351 Overall width: . . . . . $3\frac{1}{2}$ to 22 inches.
.352 Length
Form (standard); . . . 3 to 17 inches.
Form (with special equipment): . . . . . 3 to 22 inches.
.353 Maximum margins
Left: . . . . 3 inches.
Right: . . . . 3 inches.

.4 CONTROLLER

.41 Identity

On-line: . . . . Model H-806-3 Printer Control or Model H-811-3 Multiple Terminal Control.

Off-line, with Model H-804 Magnetic Tape Unit: . . . . Model H-815 or H-817 Auxiliary Control Unit. (See note on Controllers in Systems Configuration, 503:030).

§ 081.

.42 Connection to System

.421 On-line: . . . . 8 (1 per channel); no restriction of other I/O devices.

.422 Off-line
Use — Associated equipment
Tape-to-Printer transcription: . . . Model H-804 Magnetic Tape Unit.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 16 H-1800 words. 120 characters plus vertical format control word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . word or item.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.
.447 Synchronizing aids: . . none.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . fixed at 120 characters.

.52 Input-Output Operations

.522 Output: . . . . print 1 line, then space according to vertical control word.
.523 Stepping: . . . . line feeds as given in vertical control word.
.524 Skipping: . . . . skip forward to top of form or to next point indicated by the prepunched paper carriage tape.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . none.
Rearrangement: . . . . none.
Suppress zeros: . . . . no automatic facilities.
Insert point: . . . . . . no automatic facilities.
Insert spaces: . . . . . no automatic facilities.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes, insofar as only 1 printer per controller.
Output lock: . . . . . . not applicable.
Nearly exhausted: . . . } not as such, but this condi-
Busy controller: . . . . } tion forces on input channel busy which is testable.

.6 PERFORMANCE

.61 Conditions

.62 Speeds

.621 Nominal or peak speed: 900 lines/min.
.622 Important parameters
Skipping speed: . . . . 20 inches/second.
.623 Overhead: . . . . none (infinite clutch).
.624 Effective speeds: . . . 7,200/(8+N) lines per minute, each line with N blank lines skipped between printed lines (see graph).

.63 Demands on System

Component	Condition	m.sec per line	Percentage
Central Processor:	Straight printing	0.02	0.05
	Gather-write printing	0.04	0.10

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	vernier knob.	
Vertical spacing (optional):	manual switch	6 or 8 lines per inch.
Horizontal alignment:	vernier knob.	
Width:	vernier knob.	
Noise shield:	place over print area.	
Pressure:	stock thickness adjuster	to allow for different number of copies and paper thickness.
Format:	120 plugs to be inserted in nonremovable 160 hole plugboard.	controls active channels to be used for printing.

.72 Other Controls

Function	Form	Comment
Operational mode:	4-way Operation switch	can be in ON-line, Off-line, TEST, or Disconnected modes.
Error action:	2-way CHECK PROCESS switch	forces computer to halt after line, with echo or parity check.

.73 Loading and Unloading

.731 Volumes handled
Storage — Capacity
Input hopper: . . . . ?
Output Receptacle: . ?
.732 Replenishment time: . . 1 to 2 min. printer needs to be stopped.
.733 Adjustment time: . . . 2 to 3 min.
.734 Optimum reloading period: . . . . ?

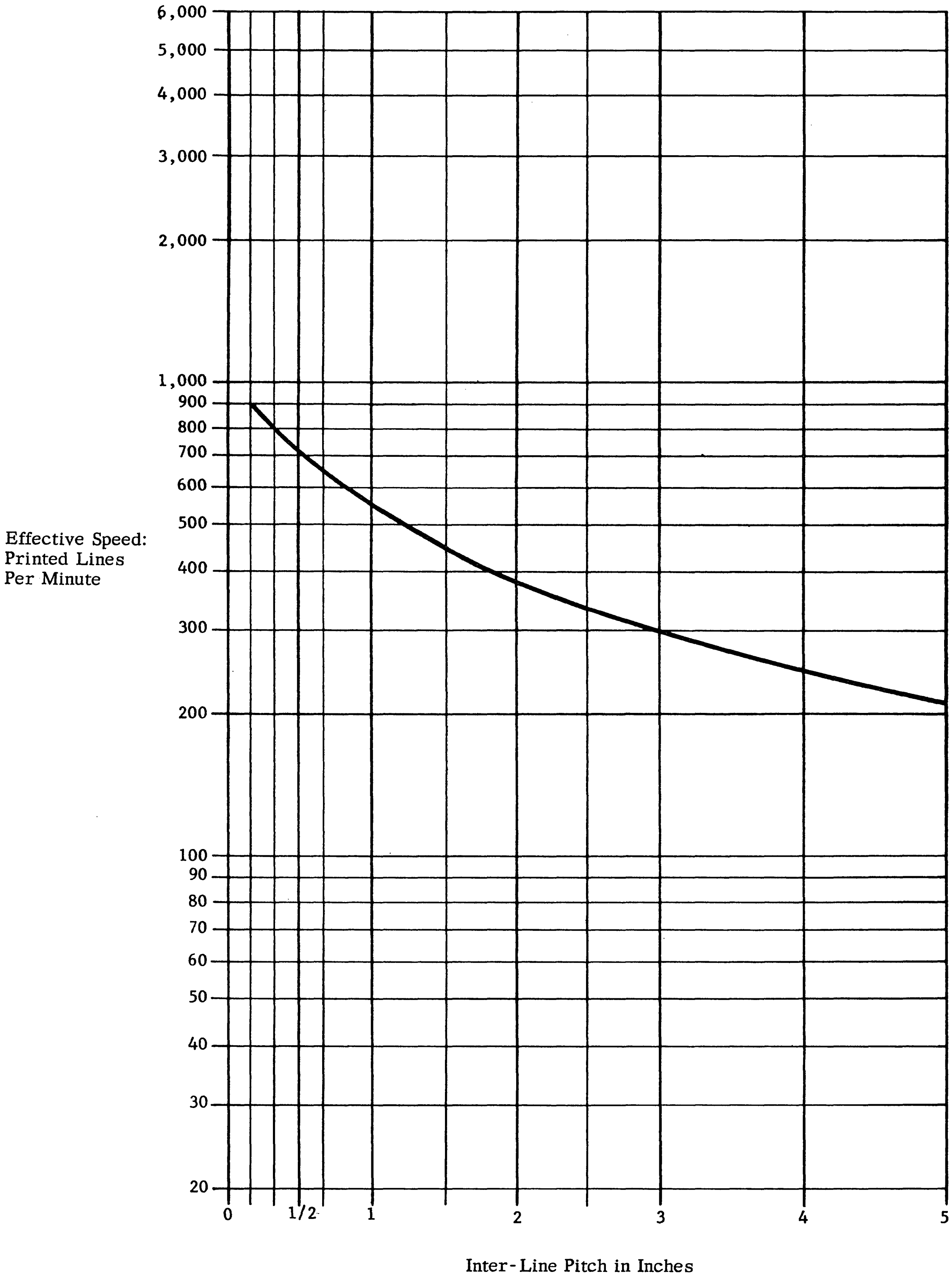
§ 081.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo or parity check	stipulated by CHECK PROGRESS switch position.
Output block size:	none.	
Invalid code:	none.	blanks printed.
Exhausted medium:	check	stall computer.
Imperfect medium:	check	stock thickness adjuster.
Timing conflicts:	none	conflicts can arise from overwriting storage area before transmission occurs, or from overuse of the I/O facilities by some fast tape units.

§ 081.

MODEL H-822-3 HIGH SPEED PRINTER
EFFECTIVE SPEED



INPUT-OUTPUT: STANDARD PRINTERS

§ 082.

.1 GENERAL

.11 Identity: . . . . H-822-1 Standard Printer (IBM 407 Accounting Machine).
H-822-2 Bill Feed Printer (IBM 408 Accounting Machine).

.12 Description

The H-822-1 and H-822-2 printers are effectively the same model with different carriages. Both models print 150 lines per minute, with 120 characters per line. A 12-channel paper tape loop and a plugboard control the format.

.12 Description (Contd.)

The data to be printed is supplied in six-bit characters which are packed eight characters per word. Thus, any numeric data created during computation must be converted from four-bit form, and then packed into the correct position. This takes considerable time, but the over-all loading on the central processor is less than 2 per cent.

The H-806 or H-811 Controllers are used to connect the equipment on-line to the central processor; or alternatively, to a magnetic tape unit via the H-815 or H-817 controller for off-line use.

INPUT-OUTPUT: H-804 MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . H-804 Magnetic Tape Unit.
Model H-804-1.
Model H-804-2.
Model H-804-3.
Model H-804-4.

.12 Description

The four versions of the H-804 tape unit are essentially similar. Each version can read magnetic tapes written by any other or by the H-404 tape units, but cannot read tapes written by non-Honeywell manufactured tape systems. The basic method of tape operation is as follows:

1. A record in main memory is "orthocounted", and two "orthowords" are formed and placed at the end of the record. These orthowords are simply parity-check words on both the odd and the even words of the record.
2. The record, with the orthowords, is recorded on tape by a read/write head. The tape is erased immediately prior to being written on, using full-width erasing. No read-after-write check is made by the equipment, but such a check could be programmed. Two minutes per reel are required to check readability.
3. The tape is read back, and the orthowords and the track parity bits are checked automatically. Errors cause a forced transfer to the error routine. This routine uses the parity bit with each eight data bits to locate the erroneous frames, and a combination of these parity bits and the orthowords to make corrections, if possible. Any one error can always be corrected, and up to 12 errors can be corrected in any one block.

The H-804 tape unit uses vacuum capstans and brakes which minimize wear by spreading acceleration forces over a larger area than is customary with pinch rollers. The tape reels are designed with no openings in their side-guards to safeguard the actual tape. However, this construction prevents the operator from seeing how much tape remains to be processed.

The inter-record gap is 0.67 inch in all cases, and the start and stop times are 2.7 and 3.5 milliseconds respectively. It is not necessary to bring the tape to a stop between records.

Scatter-read and gather-write facilities are available in the central processor under the joint control of end-of-item words recorded with the data and a table of starting addresses held in the Main Memory.

Peak speeds of the four versions expressed in alphameric characters are: 32,000, 64,000, 88,000, and 124,000 characters per second. Packing densities

.12 Description (Contd.)

range from 200 to 777 frames per inch and speeds range up to 120 inches per second.

Use of the scatter-read and gather-write facilities takes up central computer time at a rate which depends on the particular model of tape unit. The H-804-4 can take up to 10 per cent of central computer time.

.13 Availability: . . . . . . 7 months.

.14 First Delivery: . . . H-804-1; 1960, H-804-2; 1960, H-804-3; 1963, H-804-4; 1963 — with Honeywell 800.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . vacuum capstan.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . vacuum.
Capacity: . . . . approx. 6 feet.
.213 Feed drive: . . . . . . own motor.
.214 Take-up drive: . . . . . own motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . non-return-to-zero (flux change denotes a "1").
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . yes; this prevents any automatic checking at write time.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . AC erase head.
Stacks: . . . . 1.
Heads/stack: . . . . . . 1 full width.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . read/write head.
Distance: . . . . ?
Stacks: . . . . 1.
Heads/stack: . . . . . . 10.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . 0.75-inch Mylar tape with oxide coding.
.312 Phenomenon: . . . . . . magnetization.

§ 091.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 400, 555, or 777 bits per inch.
.322 Parallel by: . . . . . . 10 tracks at 0.070 inch centers.
.324 Track use
Data: . . . . 8.
Redundancy check: . . 1.
Timing: . . . . 1.
Control signals: . . . 0.
Unused: . . . . 0.
Total: . . . . 10.
.325 Row use
Data: . . . . 1 to N.
Redundancy check: . . 2 orthotronic control words per block.
Timing: . . . . 0.
Control signals: . . . 0.
Unused: . . . . 0.
Gap: . . . . 0.67 inch.

.33 Coding: . . . . 6 rows per H-1800 data word. See Data Code Table No. 2, 503:142.

.34 Format Compatibility

Other device or system	Code translation
H-400:	not necessary.
H-1400:	not necessary.
H-800:	not necessary.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.75 inch.
.352 Length
Tape Reel: . . . . . . 2,400 feet.

.4 CONTROLLER

.41 Identity: . . . . H-803 Tape Control.

.42 Connection to System

.421 On-line: . . . . up to 8.
.422 Off-line
Use: . . . . varies in connection with other I/O equipment. See data in System Configuration, 503:030.

.43 Connection to Device

.431 Devices per controller: 8 tape units per control unit.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . N variable length items, both N and the length of each item being data-, not instruction-controlled.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . word.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . gather-write and scatter-read facilities are available.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES

.51 Blocks

.511 Size of block: . . . . . 1 through N; N determined by length of reel.
.512 Block demarcation
Input: . . . . end of record gap.
Output: . . . . end of record word.

.52 Input-Output Operations

.521 Input: . . . . read 1 block, forward or backward.
.522 Output: . . . . write 1 block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . end of record gap, 0.67 inch.
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes.
Output lock: . . . . . . no.
Nearly exhausted: . . . yes.
Busy controller: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . H-804-3.
II: . . . . H-804-1.
III: . . . . H-804-2.
IV: . . . . H-804-4.

Note: These are arranged in increasing order of speeds, not in Model No. order. Model No. order reflects only the marketing dates.

.621 Nominal or peak speed

	I	II	III	IV
Alphameric char/sec:	32,000	64,000	88,000	124,000.
Decimal char/sec:	48,000	96,000	133,000	188,000.
H-800 words/sec:	4,000	8,000	11,110	15,500.

§ 091.

.622 Important parameters

Start time:	2.7 msec.
Stop time:	3.5 msec.
Start distance:	0.12 inch.
Stop distance:	0.28 inch.
Gap:	0.67 inch.
Time to pass gap at full speed:	5.6 msec.
Additional time if tape brought to stop:	3.3 msec.

.623 Overhead: start and stop times, + gap time: 11 msec per block (I). 9 msec per block (II, III, IV)

.624 Effective speeds (See graph at end of section)

Stopping between blocks

I:	32,000N/(N+248).
II:	64,000N/(N+472).
III:	88,000N/(N+640).
IV:	124,000N/(N+892), where N is the number of alphameric characters in the block.

Not stopping between blocks

I:	32,000N/(N+143).
II:	64,000N/(N+260).
III:	88,000N/(N+350).
IV:	124,000N/(N+500), where N is the number of alphameric characters in 1 block.
Allowance for numeric characters:	reduce the number of characters (N) in the record by one-third and use the above formulae.
Allowance for mixed alphameric records:	reduce the number of characters (N) in the record by one-third of the numeric characters which can be allocated numeric fields, and use the above formulae.

.625 Demands on System

Operation	Component	Condition	msec/block of N alphameric char.	Minimum Percentage
Reading (no scatter-read)	Central Processor	I	0.006 + 0.00025N	0.8
		II	0.006 + 0.00025N	1.6
		III	0.006 + 0.00025N	2.2
		IV	0.006 + 0.00025N	3.3
Writing, including computation of orthocount (no gather-write)	Central Processor	I	0.03 + 0.0005N	1.6
		II	0.03 + 0.0005N	3.3
		III	0.03 + 0.0005N	4.3
		IV	0.03 + 0.0005N	6.6
Reading (Scatter-read)	Central Processor	I	0.006 + 0.0005N	1.6
		II	0.006 + 0.0005N	3.3
		III	0.006 + 0.0005N	4.3
		IV	0.006 + 0.0005N	6.7

.625 Demands on System (Contd.)

Operation	Component	Condition	msec/block of N alphameric char.	Minimum Percentage
Writing, including computation of orthocount (with gather-write)	Central Processor	I	0.006 + 0.00075N	2.5
		II	0.006 + 0.00075N	5.0
		III	0.006 + 0.00075N	6.7
		IV	0.006 + 0.00075N	10.0

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Writing allowed:	write ring	can be done without removing reel or stopping the tape.
Tape unit number:	plugboard	mounted inconveniently away from operator's console. unit numbers are not displayed.

.72 Other Controls

Function:	tape change.
Form:	toggle.

.73 Loading and Unloading

.731 Volumes handled

Storage:	reel.
Capacity:	2,400 feet.

.732 Replenishment time: 1.0 to 2.0 min. unit needs to be stopped. The head lifts to allow simple threading of the tape underneath it.

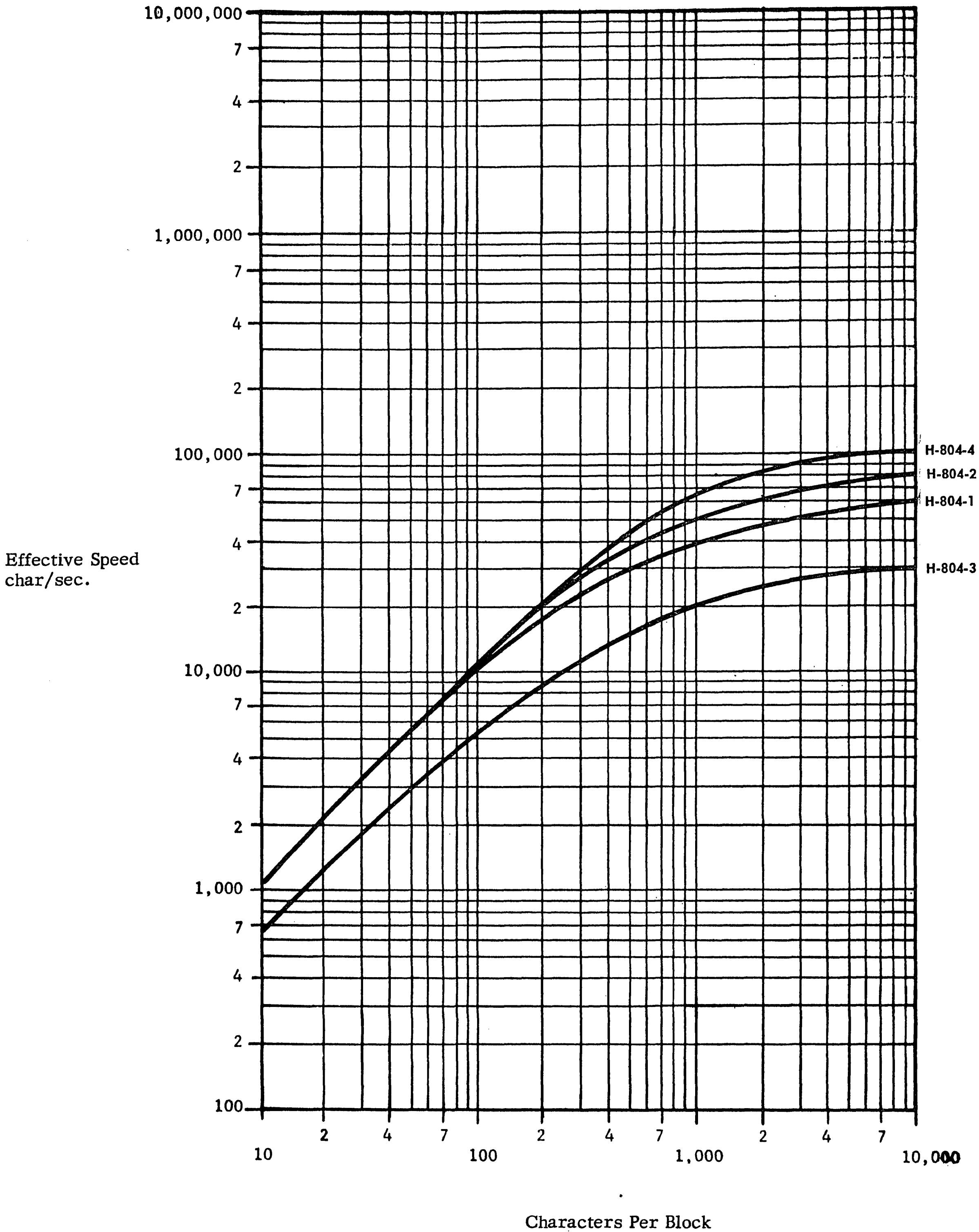
.733 Adjustment time: 0.5 min.

.734 Optimum reloading period: 8 min. (I). 4 min. (II, III, IV).

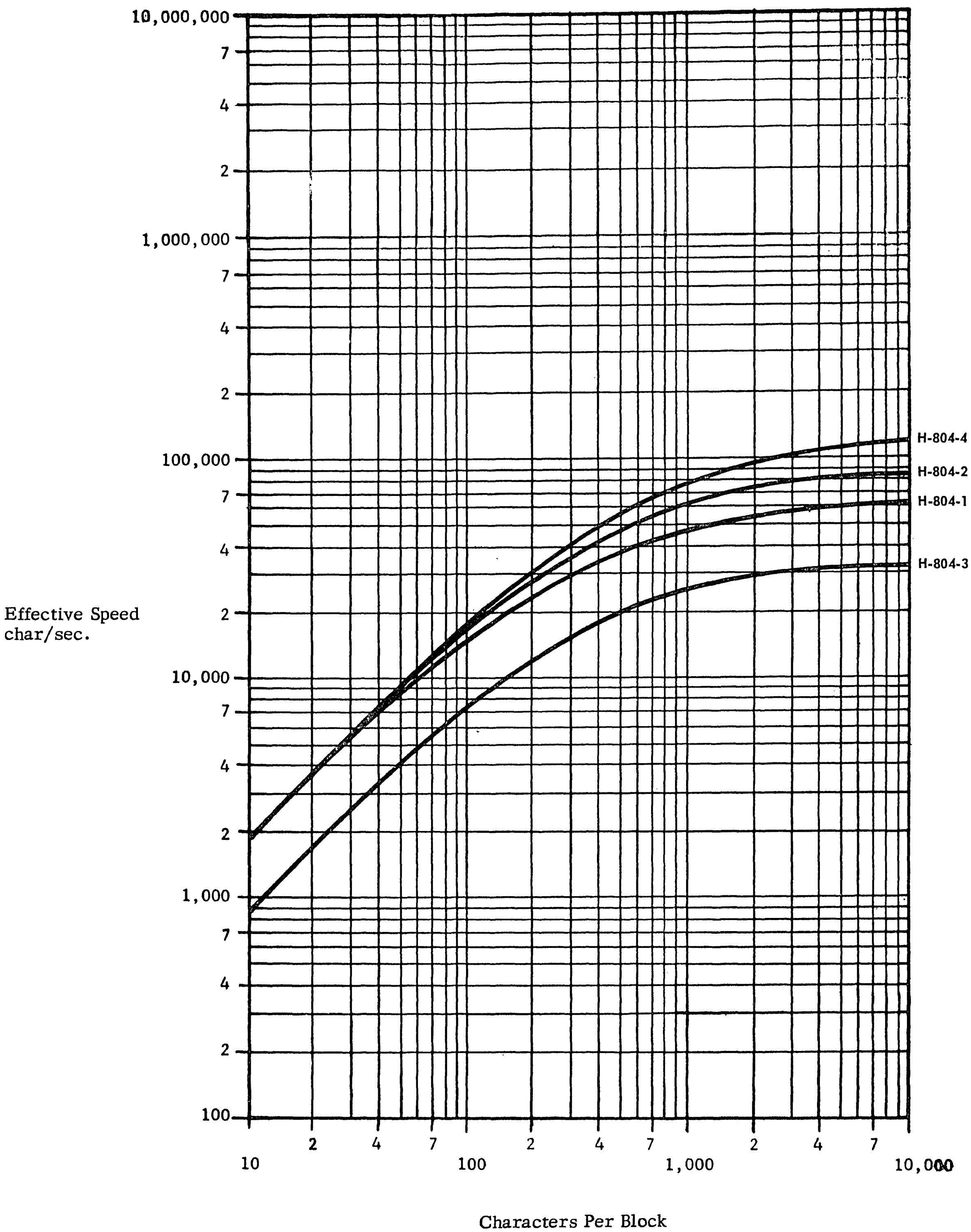
.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none	(The orthotronic control words only provide a check on the data which is received).
Reading:	row and track parity orthotronic control	set indicator.
Input area overflow or underflow:	none	(It is advisable to leave one word blank after each input area).
Invalid code:	none.	
Exhausted medium:	photosense of rear end of tapes.	set indicator.
Imperfect medium:	none.	
Timing conflicts:	none.	

EFFECTIVE SPEED – STOPPING BETWEEN BLOCKS
H - 804 TAPE UNITS



EFFECTIVE SPEED – NOT STOPPING BETWEEN BLOCKS
H - 804 TAPE UNITS



INPUT-OUTPUT: H-840 OPTICAL SCANNER

§ 102.

.1 GENERAL

.11 Identity: . . . . H-840.
Farrington Document Optical Scanner.
Model 1D3L.

.12 Description

The H-840 Optical Scanner is set up to read only one line of information from each document. The length of the document, the speed of the scanner, and the maximum number of characters are shown in the following table:

.13 Availability: . . . . . . 1962.

.14 First Delivery

With H-800: . . . . . . 1962.
Otherwise: . . . . 1962.

.15 Organization of this Report

Paragraph 2 of this report conforms to the outline of the entries in the Comparison Chart of the Special Report on Optical Character Readers (23:020.100). Each of the entries is explained in the Guide to the Comparison Chart (23:020.2). The remainder of the report conforms to the outline of the Performance; External Facilities; and Errors, Checks, and Action paragraphs of the general Input-Output sections.

DOCUMENT LENGTH (inches)	MAXIMUM NUMBER OF CHARACTERS PER LINE		
	At 312 Documents Per Minute	At 240 Documents Per Minute	At 196 Documents Per Minute
3	25	25	25
4	28	35	35
5	25	44	45
6	22	41	55
7	18	37	56
8	15	34	53

.2 DETAILS

.21 Document Handling Characteristics

.211 Document Feed: . . . . automatic.
.212 Size of Document
Card Stock: . . . . . . 2.20 x 2.625 to 8.50 x 6.0 inches.
Paper Stock: . . . . . 2.625 x 2.625 to 8.50 x 6.0 inches.
.213 Number of lines per document: . . . . . . 1 only.

.214 Documents per minute: 196, 240, or 312.
.215 Document collection: . Accept or Reject stackers. 5.175 inches deep.
.216 Output devices: . . . . on-line computer only.

.22 Character Reading Capability

.221 Characters per second: 330.
.222 Character set: . . . . . 0-9, H, O, -, •
.223 Type fonts: . . . . Self-Check 12F.

.23 Format Specification

.231 Vertical line: . . . . . . 0.10 inch above and below the printing zone.
.232 Horizontal character spacing: . . . . 10 char per inch.
.233 Number of characters per line: . . . . 58.
.234 Information field selection: . . . . . . external plugboard.

.26 Error Detection and Reject Facilities

.261 Error detection:
Checks resulting in forced transfers: . . parity error (control unit or bus parity).
unrecognizable character.
Checks resulting in stop: . . . . . . hopper empty.
double feed.
feed failure.
wrong stacker.
cycle check.
.262 Reject facilities: . . . . program allows documents to be sent to reject stacker.

§ 102.

.6 PERFORMANCE

.61 Conditions

I:	cam providing max. speed of 196 documents/min.
II:	cam providing max. speed of 240 documents/min.
III:	cam providing max. speed of 312 documents/min.

.62 Speeds

.621 Nominal or peak speed: 196, 240, or 312 documents/min.

.622 Important parameters
- Mirror scanning speed: 33 inches/sec.
- Character rate at 10 char/inch: 330 char/sec.
- Printing area: 1/4 inch or more from both vertical and nearest horizontal edge; 2.187 inches from farthest horizontal edge.

.623 Overhead: Each system is designed to utilize the maximum speed of the scanner. The speed of the system is a function of the cam kit selected (312, 240, or 196 documents per minute). Selecting the allowable number of characters and document length which ensures that the time to read and feed a document as well as the processing time prior to a feed command is less than or equal to the rated speed for each cam unit ensures operation at effective speeds.

624 Effective speeds: 312, 240, or 196 documents per minute. (see description.)

.63 Demands on System

Component:	Central Processor.
Condition:	all.
Msec per document:	0.004 + 0.002D, where D is the number of characters read.
Percentage:	0.1 max.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Field Length:	plugboard	notes where the "end of document" will be signalled; because of necessary tolerances, this signal cannot occur in the middle of printed field.

.72 Other Controls

Function	Form	Comment
Check Indicators:	lamps	identifies the particular cause of a Busy signal.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	6 inches of documents.
Accept stacker:	6 inches of documents.
Reject stacker:	3 inches of documents.

.732 Replenishment time: 0.2 to 0.3 minute.

.733 Adjustment time: 7.0 to 8.0 minutes.

.734 Optimum reloading period
- Paper: 4 minutes.
- Card: 3 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Input area overflow:	none.	
Invalid code:	check	special character transmitted.
Exhausted medium:	check	Unit busy signal.
Timing conflicts:	check	Unit busy signal.
Feed failure:	check	Unit busy signal.

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.12 Description

Simultaneous operations can be considered at two levels:

(1) Simultaneous Programs.

(2) Simultaneous Transfers.

Program Simultaneity

Several programs can be run simultaneously by the H-1800. Such operation is mechanized (described under Central Processor, Paragraph 503:051.3) by executing one instruction in turn from each of several programs. In the core storage, input-output transfers always receive priority over the central processor, taking place at the first available core storage cycle. Interruptions are handled within the program concerned and do not cause any slow-down of the other programs.

The following rules show what degree of simultaneous operation is possible at various levels of control in the Central Processor:

Maximum number of programs simultaneously running	8.
Maximum number of interrupts simultaneously being handled	8.
Maximum number of instructions being processed	1.
Maximum number of storage references	1.

Transfer Simultaneity

Each H-1800 has eight input and eight output channels, each of which can operate simultaneously with all the others and the other Central Processors. Peripheral units are connected to channels via controllers. A variety of controllers are available. In general, it is possible to connect eight units to a controller which is connected to one, or a pair of channels; or to connect eight controllers to one, or a pair of channels, each controller having only one unit.

Usually, one card reader, punch, or printer is connected to one controller to one channel; and several magnetic tape units to one controller to a pair of channels. Therefore, the degree of simultaneity is limited by the types of connections and the limited numbers of channels, controllers, and units. Each simultaneous transfer by a unit monopolizes its channel (wired at installation time), and its controller, or part of its controller.

.2 CONDITIONS

P = Number of output channels to which controllers are connected.
Q = Number of input channels to which controllers are connected.

.3 CLASSES OF OPERATIONS

Class	Operation
A	Read magnetic tape backward or forward.
B	Write magnetic tape
C	Rewind
D	Read a card Read paper tape Read scanner
E	Punch a card Print a line Punch paper tape Transmit to data transmission unit

.4 RULES

.41 Configuration Restrictions

a + d = at most q
b + e = at most p

.42 Access Restrictions

There are no access restrictions on the number of tape channels which can operate simultaneously. The restrictions which apply to the H-800 system are related to the number of core storage cycles which must be available between successive demands of the fastest unit. With the reduction of the core storage cycle, the number of cycles available has increased sufficiently to lift these restrictions.

§ 121.

INSTRUCTION LIST

INSTRUCTION				OPERATION
OP Code	A	B	C	
				Arithmetic
DA	a	b	c	
BA	a	b	c	(A) + (B)⟶C, in decimal, signed binary, or absolute binary mode.
WA	a	b	c	
DS	a	b	c	
BS	a	b	c	(A) - (B)⟶C, in decimal, signed binary, or absolute binary mode.
WD	a	b	c	
HA	a	b	c	(A) + (B)⟶C, in binary with no carries.
DT	a	B	c	$a_1 + a_2 \ldots + a_B$ ⟶C, in binary or decimal mode.
BT	a	B	c	Signs are assumed to be all positive or all negative.
DM	a	b	c	(A) x (B)⟶C, in decimal or signed binary mode.
BT	a	b	c	
				Logic
SM	a	b	c	(A) superimposed on (B)⟶C (Inclusive OR).
HA	a	b	c	(A) half-add to (B)⟶C (Exclusive OR).
EX	a	b	c	Logical AND (A) with (B), result to C.
				Transfers
MT	a	B	c	(A)⟶C, B times. A and C can be incremented.
TN	a	B	c	B words, starting at A, moved to B words starting at C.
IT	a	b	c	Move an item starting at A to an area starting at C.
RT	a	b	c	Move a record, starting at A to an area starting at C.
				Shifts
SWS	a	B	c	Right-end-around shift (A) B binary places and store
SPS	a	B	c	in C. Different orders allow for sign treatment and
SWE	a	B	c	protection of present contents of C.
SPE	a	B	c	
SSL	a	B	c	Transfer control to C modified by (A) shifted around B bits.
				Comparison
NA	a	b	c	Jump to C if (A) ≠ (B) when treated alphabetically.
NN	a	b	c	Jump to C if (A) ≠ (B) when treated numerically.
LA	a	b	c	Jump to C if (A) ≤ (B) when treated alphabetically.
LN	a	b	c	Jump to C if (A) ≤ (B) when treated numerically.
TS	a	b	c	Jump to C, and transfer (A) to (B).
				Miscellaneous
CP	a	b	c	Check Parity of (A). If incorrect, jump to C.
CC	a	b	c	Orthocount the record starting at A, ending at C - 1. If required, use scatter read techniques under control of the table stored starting in B. Record the orthocount in C and C + 1.
S	-	-	-	Simulate. Form a memory address (direct or indexed) from the low-order 11 bits of the command code and store this instruction in the location thus specified. Jump under control of the co-sequence counter.
				Scientific Instructions
				Floating Point - Normalized
FBA	a	b	c	(A) + (B)⟶C, in binary or decimal mode.
FDA	a	b	c	
FBS	a	b	c	(A) - (B)⟶C, in binary or decimal mode.
FDS	a	b	c	
FBM	a	b	c	(A) x (B)⟶C, and a special register, in binary or decimal mode.
FDM	a	b	c	

§ 121.

INSTRUCTION LIST—Contd.

INSTRUCTION				OPERATION
OP Code	A	B	C	
				Floating Point - Normalized (Contd.)
FBD	a	b	c	(B) / (A) ⟶ C, in binary or decimal mode.
FDD	a	b	c	
FLN	a	b	c	Jump to C if (A) ≠ (B)
FNN	a	b	c	Jump to C if (A) ≤ (B)
ULD	a	-	c	Store a double-length product into A and C.
				Floating Point - Unnormalized
FBAU	a	b	c	(A) + (B) ⟶ C, in binary or decimal mode.
FDAU	a	b	c	
FBSU	a	b	c	(A) - (B) ⟶ C, in binary or decimal mode.
FDSU	a	b	c	
				Fixed Point
BD	a	b	c	(B) / (A) ⟶ C, in binary or decimal mode. The remainder can be retained.
DD	a	b	c	

INSTRUCTION						OPERATION
I/O Channel	Device	OP Code	A	B	C	
						Peripheral Instructions
X	X	RF	a	b	c	Read forward from peripheral device XX into consecutive locations beginning at A. If distributed read is required, use the table starting at B. Interruption occurs in case end of file or error in previous block is encountered.
X	X	RB	a	b	c	Read Backwards; otherwise as Read Forward Instruction.
X	X	WF	a	b	c	Write Forward; otherwise as Read Forward.
X	X	RW	a	b	c	Rewind Magnetic Tape or Paper Tape Unit XX. Lock can be specified. Interruption occurs if an error occurred on previous block.
X	X	PRA	a	b		Print the contents of A on the console typewriter. Alphabetic, Decimal, or Octal format can be specified. Format instructions are given in B.
X	X	PRD	a	b		
X	X	PRO	a	b		

PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers

H-400
Reference: . . . . Manual DSI-89: H-400 Easy Programs on the H-800.
Date available: . . July, 1961.
Description
An integrated package of routines for assembling, debugging and running of programs written in H-400 Easy Language on the H-800.

IBM 650
Reference: . . . . Manual: 650 Simulator for the H-800.
Date available:. . August, 1960.
Description
A package of routines for simulating input conversion, processing, output conversion of IBM 650 programs.

UNIVAC I & II
Reference: . . . . Manual: Honeywell 800 Univac Simulator
Date available: . . August, 1961.
Description
The UNIVAC Simulator package contains two programs. One simulates the central processor of the UNIVAC I or II, the second simulates card conversion and printing.

Scientific Option Simulation
Reference: . . . . ESMESSO1, H-800 Subroutine Library.
Date available: . . February, 1960.
Description
A package of routines that simulates scientific option hardware, 801B Floating Point Option.

.12 Simulation by Other Computers: . . . . none.

.13 Data Sorting and Merging

Fact Compiler Sort
Reference: . . . . FACT Manual.
Record size: . . . see description.
Block size: . . . . ≤28, ≤128, ≤256 words.
Key size: . . . . . any number of keys.
File size:. . . . . each reel is sorted separately, then merged under manual control.
Number of tapes: . . 3 to 5.
Date available: . . . 1961.
Description
This routine provides sorting on FACT type files where records are not used singly, but as a hierarchy of headers, each of which may have a number of subgroups. A typical file would be an Inventory File consisting of Items, within Product Groups, within Areas. Here each "record" would effectively consist of all the information in the Area header and the Group header, as well as in the individual item. A sort of this type of file does not change the structure (it remains an Inventory File consisting of Items within Product Groups within Areas), but can change the order of each header (Product Groups, Areas, or Items) within itself.

Own coding facilities are provided.

H-800 Sort Package
Reference: . . . . . DSI-43A, Sort and Collate Manual.
Record size: . . . . variable.
Block size: . . . . . variable; preset number of records.
Key size: . . . . . . preset; maximum one full item.
File size:. . . . . . one reel of tape or equivalent partial reels.
Number of tapes:. . 3 to 6.
Date available:. . . December, 1960.
Description
Two parts, presort and merge sort. Presort builds continuous strings of items in memory taking advantage of any pre-ordering of the Data. Merge sort is of Cascade type, in which the power of sort is one less than the number of tapes used.

H-800 Collate Package
Reference: . . . . . DSI-43A, Sort and Collate Manual.
Record size: . . . . variable.
Block size:. . . . . variable; preset number of records.
Key size:. . . . . . preset; maximum one full item.
File size:. . . . . . 99 reels of tape.
Number of tapes:. . 3 to 13 tapes.
Date available:. . . December, 1960.
Description
The collate routine can be a 2-way, 3-way, 4-way or 5-way merge. Input in each of the above can be a single input tape or a second or alternate tape. Output can be on one file or an alternate. Included, if desired, is a restart dump tape.

.14 Report Writing

Edit Generator, including Report Writer.
Reference:. . . . . DSI-129, Edit Generator and Tape I/O Manual.
Date available: . . 1961.
Description
The Edit Generator is a library routine which may be used to prepare reports. The Edit Generator creates routines which obtain data from a source location, edit it, and record it on tape or print it on-line.

§ 151.

.14 Report Writing (Contd.)

Each report, each type of line, and all editing needed are previously specified in Standard descriptive terms. During the program macro codes are used to cause the actual preparation of the report itself.

.15 Data Transcription

Routine Name	Function	Timing (msec)	Max Central Processor Loading
E1AMCED1	Edits card input	0.4 + 0.13N	11.1 msec per card.
E1FAMED1 } E1MAPED1 }	Edits output for printer	0.5 + 18N	16.7 per 120 char line.
E1FDC2M1	Edits floating point numbers packed 4 to a card	0.3 per number	0.3 per number.

Card-to-tape routines are presently being prepared for floating decimal and floating binary.

SCOPE Transcription:

This is a single program that allows up to 8 simultaneous transcription operations between punched cards, printers, and magnetic tape units. The operator supplies the parameters for each transcription operation needed.

.16 File Maintenance

FACT Compiler
Description
The FACT Compiler includes File Maintenance provisions. (See under Section 502:162).

.17 Other

Double-Precision and Complex Arithmetic Package
Reference: . . . . . . H-800 Subroutine Library.
Date available:. . . . 1960.
Description
A series of packages for double-precision and complex arithmetic have been provided. Separate packages deal with specific types of operands, such as fixed decimal, floating binary, etc. The timings are summarized in the following table:

.17 Other (Contd.)

Type of Arithmetic	Timings (msec)			
	+	–	x	÷
Double-Precision				
Fixed decimal	0.30	0.31	0.82	1.41
Floating decimal	Package not yet available.			
Fixed binary	No package planned.			
Floating binary	0.3	0.3	0.4	0.7
Complex Arithmetic				
Fixed decimal	0.3	0.3	1.6	1.0
Floating decimal	No package planned.			
Fixed binary	No package planned.			
Floating binary	0.3	0.3	0.4	0.7

Code Conversion Routines

The H-1800 has a number of possible ways of representing numbers. A number of routines for converting from one form to another are available and are listed below. All times are per number converted; number size may not exceed one 48-bit word.

Fixed Decimal to Fixed
Binary: . . . . 0.8 msec.
Floating Decimal to
Floating Binary: . . . 1.3 msec.
Floating Binary to
Floating Decimal: . . 1.7 msec.
Floating Decimal to
Fixed Decimal: . . . 0.9 msec.
Radians to Degrees, in
Fixed Decimal: . . . 0.3 msec.
Degrees to Radians, in
Fixed Decimal: . . . 0.3 msec.

HONEYWELL 1800-II SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration: VII A		VII B		VIII A		VIII B		Reference
1 Input-Output Times	Char/block	(File 1)	970		970		970		970		4:200.112
	Records/block	K (File 1)	11		11		11		11		
	msec/block	File 1 = File 2	21.7		21.7		21.7		21.7		
		File 3	75		6.6		75		6.7		
		File 4	107		7.7		107		6.7		
	msec/switch	File 1 = File 2	---		---		---		---		
		File 3	---		---		---		---		
		File 4	---		---		---		---		
	msec/penalty	File 1 = File 2	0.29		0.29		0.29		0.29		
		File 3	0.02		0.02		0.02		0.02		
		File 4	0.03		0.03		0.03		0.03		
2 Central Processor Times	msec/block	a1	0.23		0.29		0.29		0.29		4:200.1132
	msec/record	a2	0.16		0.16		0.16		0.16		
	msec/detail	b6	1.33		1.33		1.33		1.33		
	msec/work	b5 + b9	0.69		0.69		0.69		0.69		
	msec/report	b7 + b8	4.02		4.02		4.02		4.02		
3 Standard Problem A F = 1.0	msec/block for C. P. and dominant column.	a1	0.23		0.23		0.23		0.23		4:200.114
		a2 K	1.76		1.76		1.76		1.76		
		a3 K	66.44		66.44		66.44		66.44		
		File 1 Master In	0.29		0.29		0.29		0.29		
		File 2 Master Out	0.29		0.29		0.29		0.29		
		File 3 Details	0.22		0.22		0.22		0.22		
		File 4 Reports	0.33	1,177	0.33	84.7	0.33	1,177	0.33	73.7	
		Total	69.56	1,177	69.56	84.7	69.56	1,177	69.56	73.7	
4 Standard Problem A Space	Unit of measure	(words)									4:200.1151
		Std. routines	1,400		1,400		1,400		1,400		
		Fixed	200		200		200		200		
		3 (Blocks 1 to 23)	100		100		100		100		
		6 (Blocks 24 to 48)	480		480		480		480		
		Files	600		600		600		600		
		Working	100		100		100		100		
		Total	2,880		2,880		2,880		2,880		

HONEYWELL 1800-II SYSTEM PERFORMANCE (Contd.)

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration VII A	VII B	VIII A	VIII B	Reference
5 Standard Mathematical Problem A	Fixed/Floating point			Floating*	Floating*	Floating*	Floating*	4:200.413
	Unit name	input		827	804-1	827	804-4	
		output		822	804-1	822	804-4	
	Size of record	input		1 card	1 card image	1 card	1 card image	
		output		1 line	1 line image	1 line	1 line image	
	msec/block	input	T1	75	6.7	75	5.9	
		output	T2	67	7.7	67	6.7	
	msec/penalty	input	T3	0.02	0.02	0.02	0.02	
		output	T4	0.03	0.03	0.03	0.03	
	msec/record		T5	1.30	1.30	1.30	1.30	
	msec/5 loops		T6	1.25	1.25	1.25	1.25	
	msec/report		T7	0.60	0.60	0.60	0.60	
7 Standard Statistical Problem A	Unit name			804-1		804-4		4:200.512
	Size of block			960		960		
	Records/block		B	24		24		
	msec/block		T1	25		17		
	msec/penalty		T3	0.3		0.3		
	C. P.	msec/block	T5	0.02		0.02		
		msec/record	T6	0.28		0.28		
		msec/table	T7	0.10		0.10		

* Using Scientific Option

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

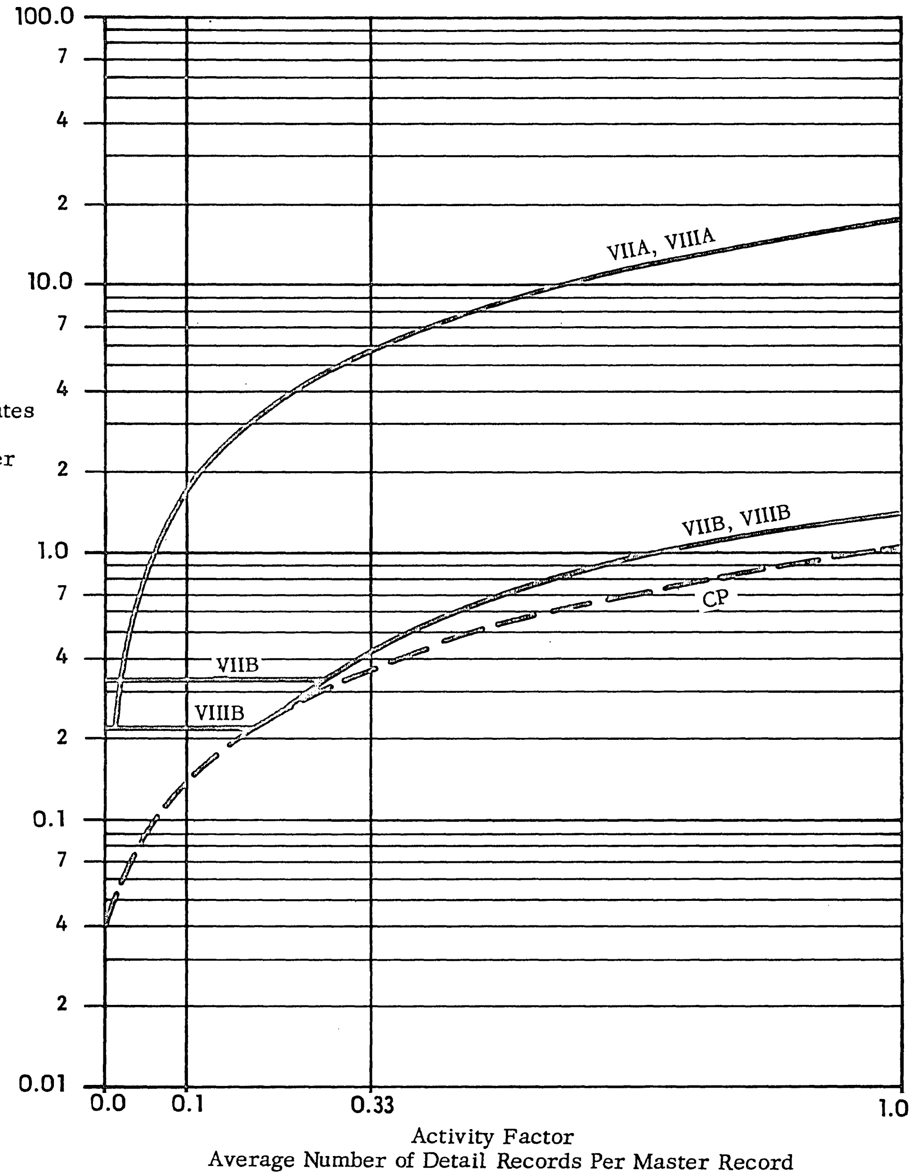
.11 Standard File Problem A

.111 Record sizes
Master file: . . . . . . 108 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.112 Computation: . . . . standard.

.113 Timing Basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.



LEGEND

Elapsed time
Central Processor time (all configurations)

(Roman numerals denote standard System Configurations.)

§ 201.

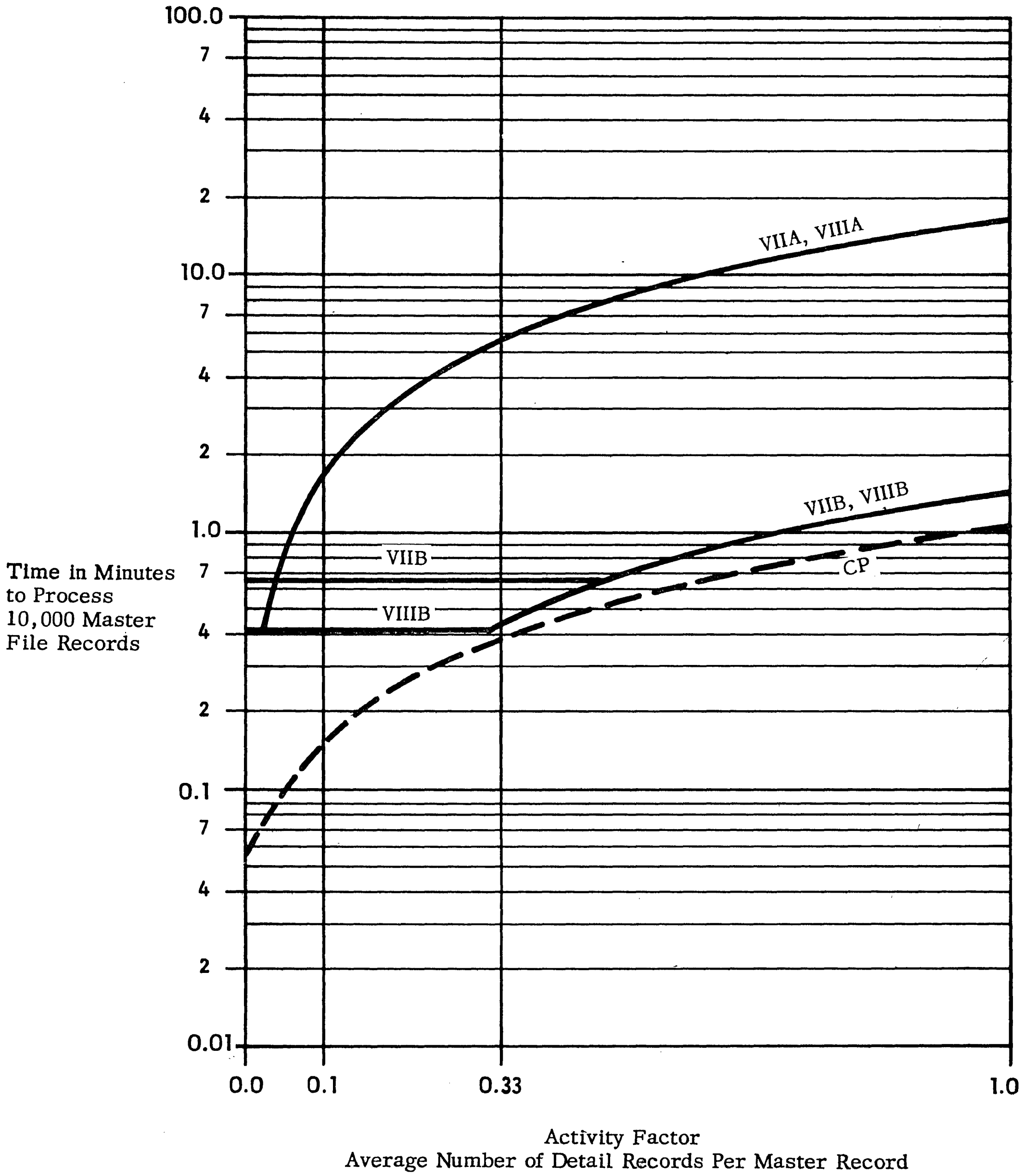
.13 Standard File Problem C.

.131 Record sizes
Master file: . . . . . . 216 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.132 Computation: . . . . standard.

.133 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



LEGEND

———— Elapsed time
— — — — Central Processor time (all configurations)

(Roman numerals denote standard System Configurations.)

§ 201.

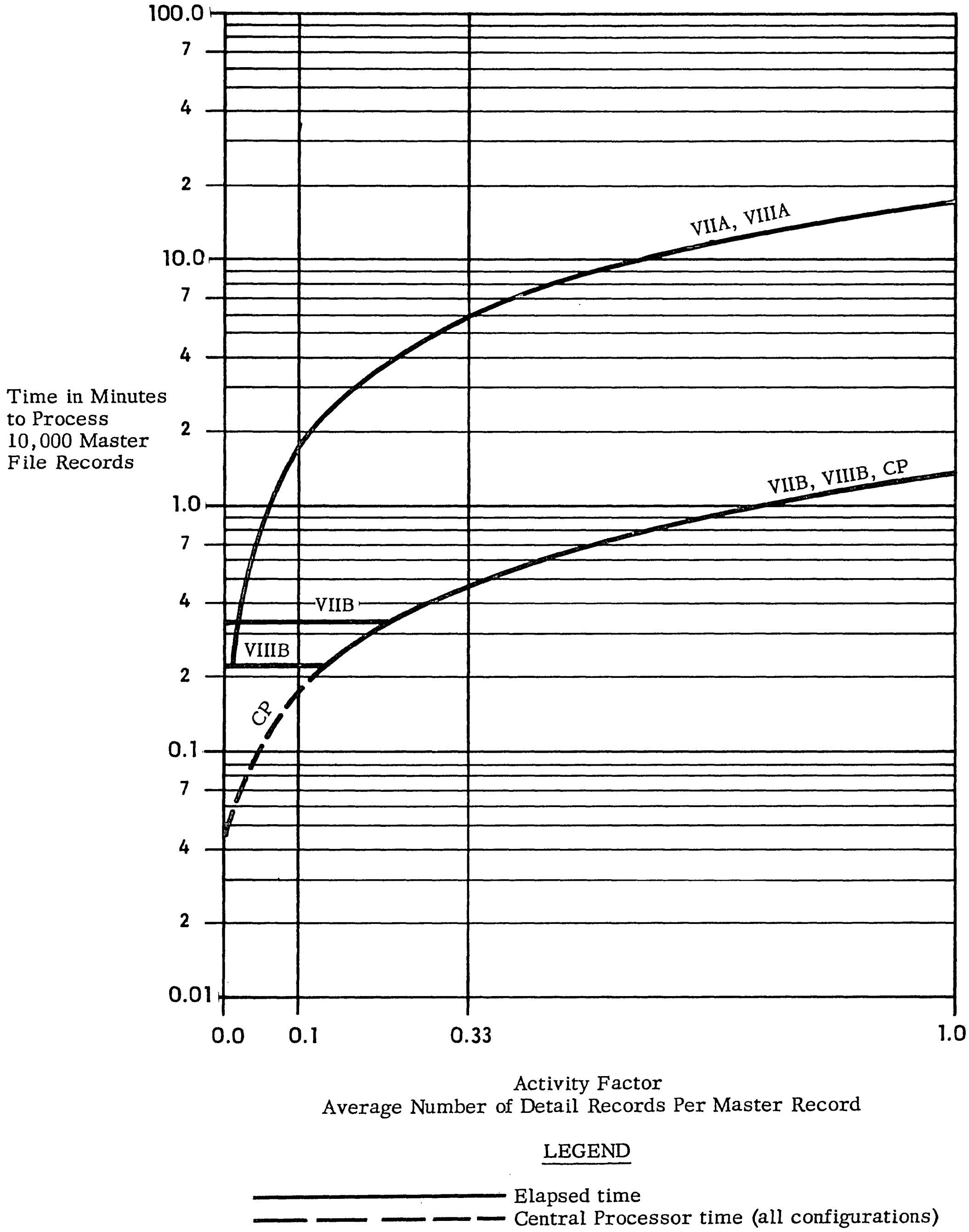
.14 Standard File Problem D

.141 Record sizes
Master file: . . . . . . 108 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.142 Computation: . . . . . . trebled.

.143 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.

.144 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

§ 201.

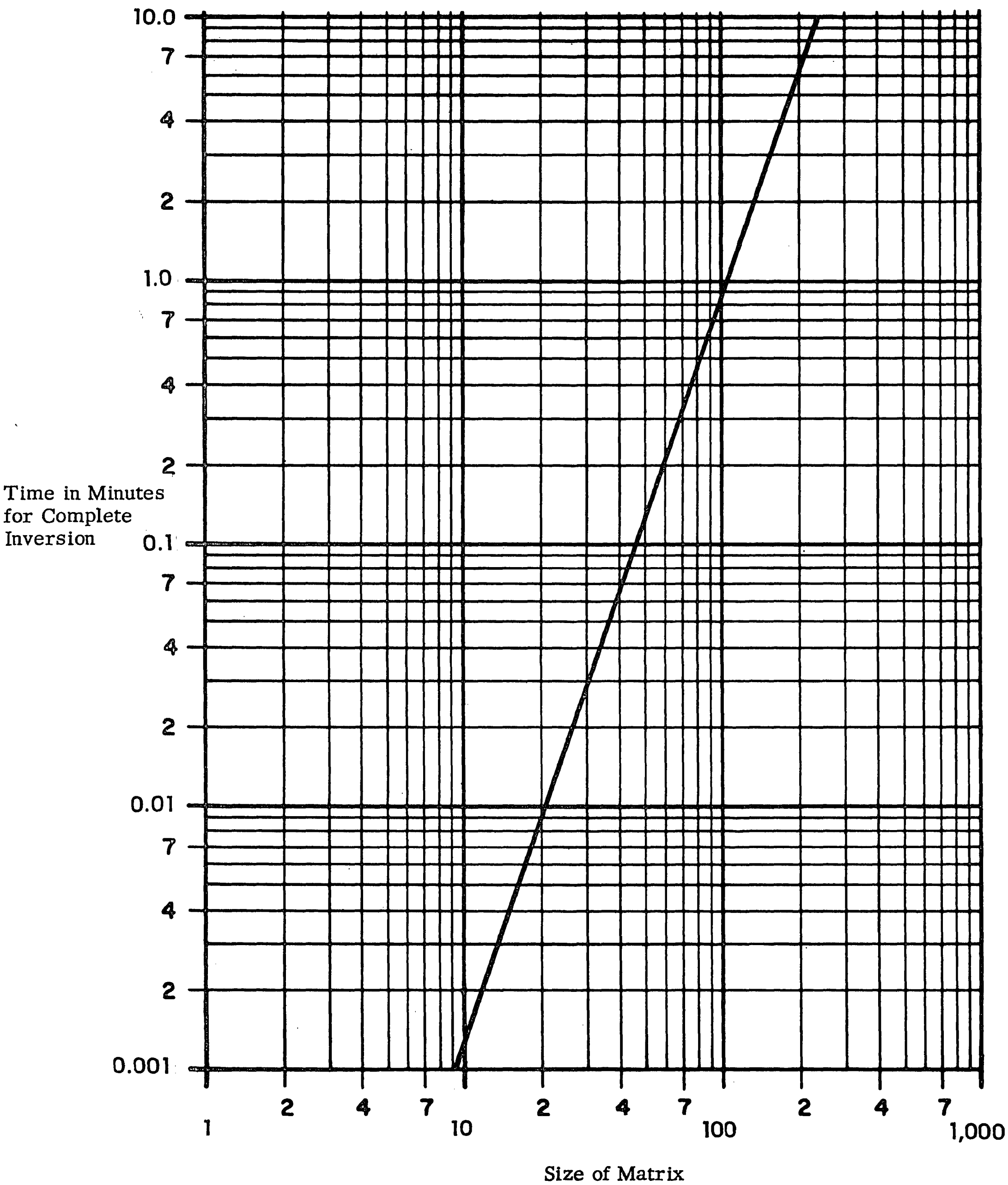
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.312; with optional floating point hardware.

.313 Graph: . . . . see graph below.



§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

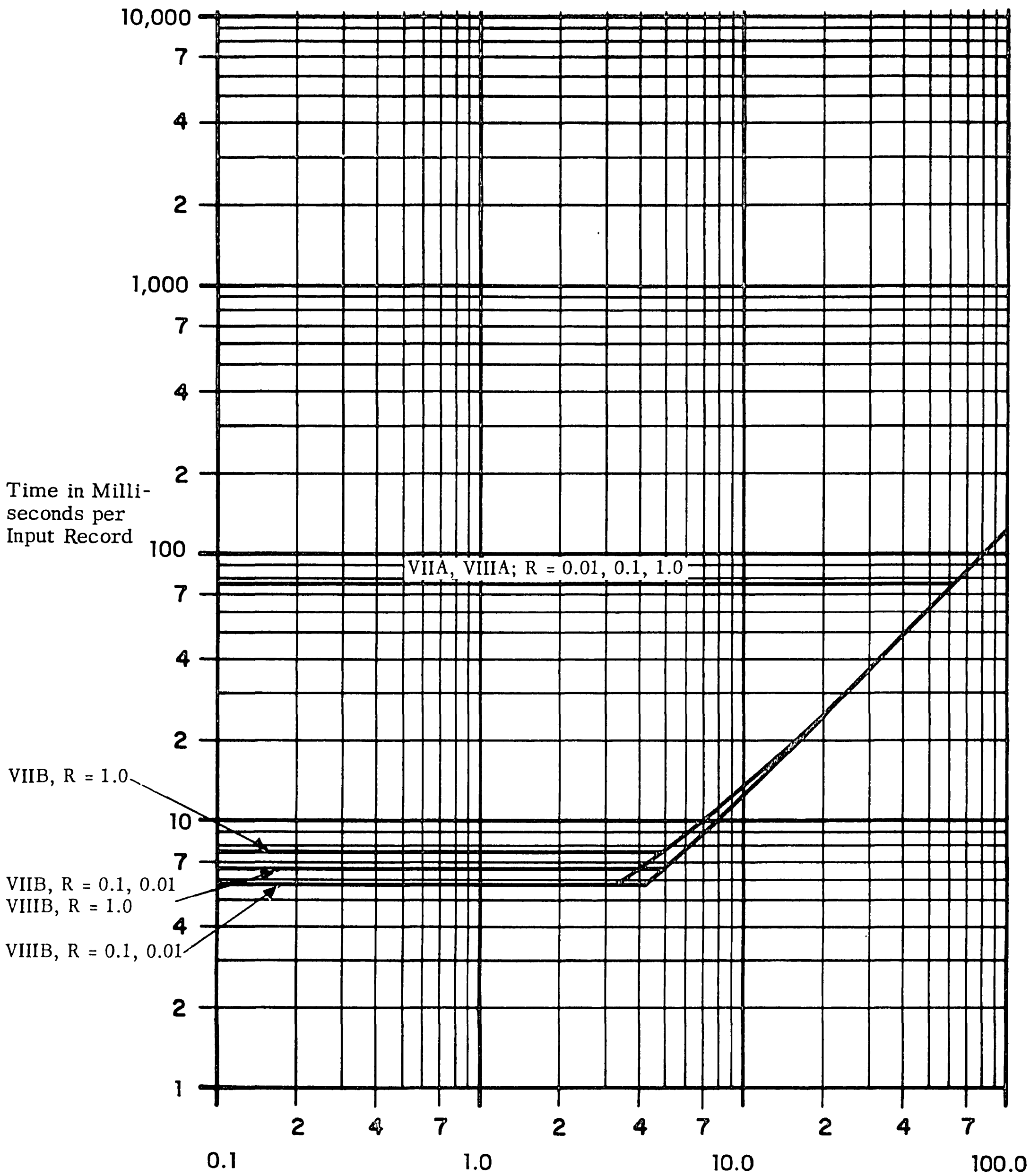
.412 Computation: . . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413; with optional floating point hardware.

.414 Graph:. . . . . see graph below.

CONFIGURATIONS VIIA, VIIB, VIIIA, VIIIB; 40 BIT PRECISION FLOATING POINT

R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



C, Number of Computations per Input Record

(Roman numerals denote standard System Configurations.)

§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

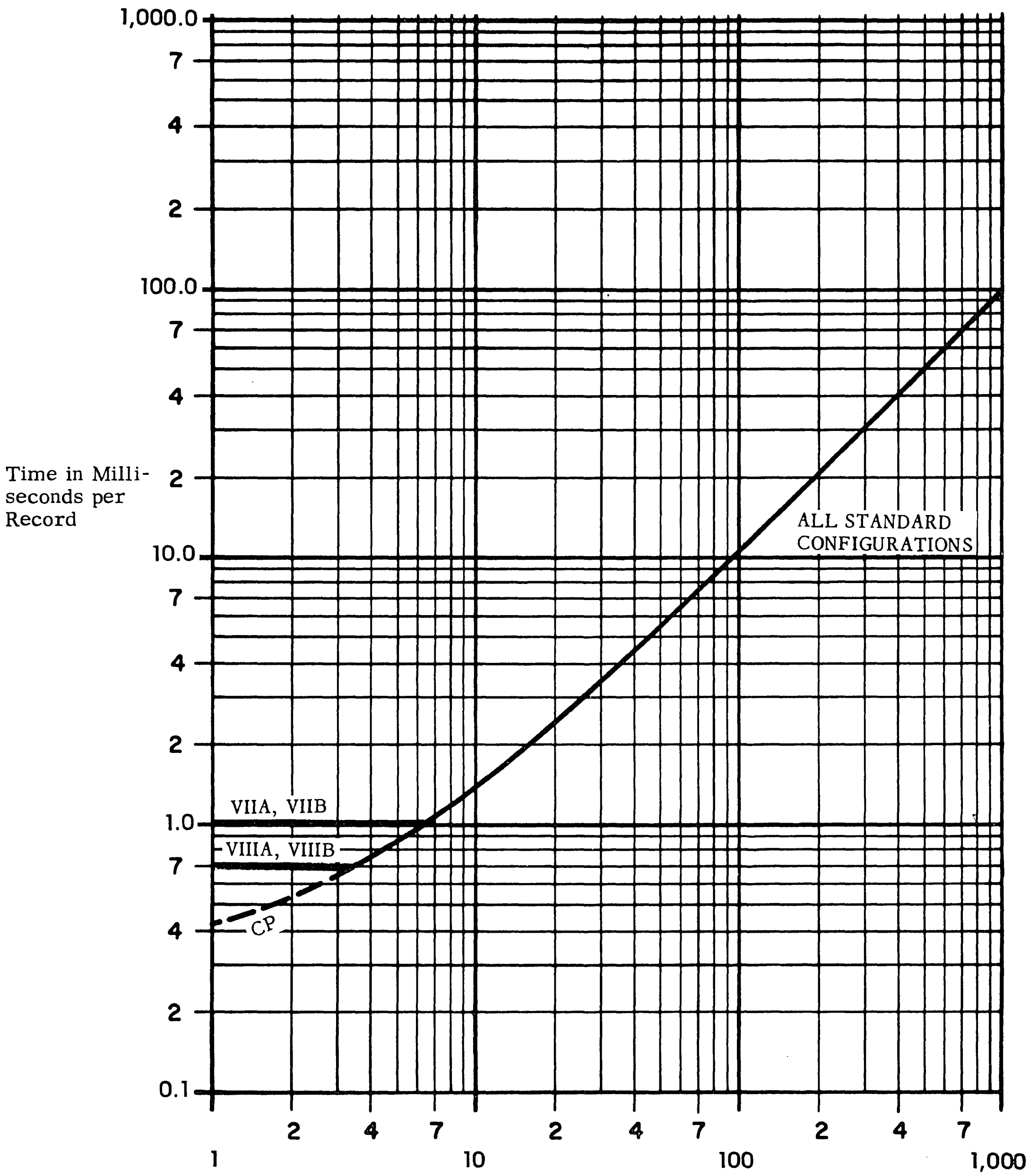
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . see graph below.



T, Number of Augmented Elements

(Roman numerals denote Standard Configurations.)

HONEYWELL 1800
PHYSICAL CHARACTERISTICS

H-1800 PHYSICAL CHARACTERISTICS

			Central Processor	Floating Point Option	Console	Power Unit	Additional Memory	Tape Control Unit	Magnetic Tape Unit	Magnetic Tape Unit
IDENTITY	Unit Name		Central Processor	Floating Point Option	Console	Power Unit	Additional Memory	Tape Control Unit	Magnetic Tape Unit	Magnetic Tape Unit
	Model Number		1801	1801-B	1801-C	1801-P	1802	803	804	---
PHYSICAL	Height × Width × Depth, in.		72×255×30	72 × 50 × 30	36 × 92 × 30	72×110×33	72 × 39 × 30	72 × 50 × 30	67 × 28 × 29	---
	Weight, lbs.		6,000	1,200	300	3,320	800	1,200	1,250	---
	Maximum Cable Lengths									
ATMOS-PHERE	Storage Ranges	Temperature, °F.				50 to 110				
		Humidity, %								
	Working Ranges	Temperature, °F.				70 to 74				
		Humidity, %								
	Heat Dissipated, BTU/hr.		25,500	6,840	200	20,640	6,420	6,840	8,538	---
	Air Flow, cfm.									
	Internal Filters		20% efficiency							
ELEC-TRICAL	Voltage	Nominal	208	208		208, 200 or 440 un-regulated			208	
		Tolerance	± 2%	± 2%	Included in 1801	208, 200 or 440 un-regulated			± 2%	
	Cycles	Nominal	60 C.P.S.	60 C.P.S.		60			60 C.P.S.	
		Tolerance	± 0.5 C.P.S.	± 0.5 C.P.S.		---			±0.5 C.P.S.	
	Phases and Lines		3			3				
	Load KVA		3.6	---		32.6	1.2	2.0	2.8	---
NOTES										

AUERBACH ®

H-1800 PHYSICAL CHARACTERISTICS (Contd.)

		Magnetic Tape Unit	Printer Control	Card Reader Control	Card Punch Controls	High Speed Paper Tape Reader and Control	Standard Speed Paper Tape Punch and Control	Multiple Terminal Control	Off-Line Output Control	Off-Line Input Control	Off-Line Input-Output Control	Standard Speed Printer	Bill-Feed Printer	High Speed Printer	Standard Speed Card Reader	High Speed Card Reader	Standard Speed Card Punch	High Speed Card Punch	Tape Control	Magnetic Ink Char. Sorter/Reader	Printer Punch Control	Tape Control	Control Unit	12 Disc Storage Module	24 Disc Storage Module
IDENTITY	Model Number	---	806	807	808	809	810	811	815	816	817	822-1	822-2	822-3	823-1	823-2	824-1	824-2	831	833	834	835	860	860-1	860-2 through 9
PHYSICAL	Height × Width × Depth, in.	---	72×54×30	72×54×30	72×54×30	58×61×36	58×61×36	72×85×30	72×20×30	72×20×30	72×20×30	47×71×19	47×71×19	57×80×36	50×42×26	58×58×30	49×53×25	42×29×35	72×51×30	72×51×30	72×51×30	72×51×30	72×51×30	52×70×44	52×70×44
	Weight, lbs.	---	1,200	1,200	1,200	750	600	2,000	400	400	400	2,815	2,815	1,600	715	1,500	1,012	900	---	1,200	1,200	1,200	---	---	6,350
	Maximum Cable Lengths																								
ATMOS-PHERE	Storage Ranges: Temperature, °F.												50 to 110												
	Storage Ranges: Humidity, %																								
	Working Ranges: Temperature, °F.												70 to 74												
	Working Ranges: Humidity, %																								
	Heat Dissipated, BTU/hr.	---	8,520	5,400	5,160	4,585	3,203	10,440	1,680	1,680	1,680	7,200	7,200	4,918	4,800	4,800	3,960	3,960	---	6,840	6,840	6,840	---	---	---
	Air Flow, cfm.																								
	Internal Filters																								
ELEC-TRICAL	Voltage: Nominal												208												
	Voltage: Tolerance												±2%												
	Cycles: Nominal												60 C.P.S.												
	Cycles: Tolerance												±0.5 C.P.S.												
	Phases and Lines																								
	Load KVA	---	2.0	2.0	2.0	1.3	0.71	2.0	0.18	0.18	0.18	2.5	2.5	1.8	1.7	1.7	1.5	1.5	---	2.0	2.0	2.0	---	?	3.5
NOTES																									

PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	1801	Central Processor with 8, 192-word core store, power supply, and console	19, 150	960	919, 200
	1801-II	Central Processor with 8, 192-word core store, power supply, and console	18, 000	?	858, 000
	1801-B	Floating-Point Option	4, 300	215	206, 400
STORAGE	1802	8, 192-Word Additional Memory Block (maximum of 3)	3, 200	160	153, 600
	860-1	Random Access Storage and Control (50 million characters)	6, 100	1, 220	275, 000
	860-2	Random Access Storage and Control (100 million characters)	8, 100	1, 620	365, 000
	860-3	Random Access Storage and Control (200 million characters)	12, 500	2, 500	560, 000
	860-4	Random Access Storage and Control (300 million characters)	16, 900	3, 380	760, 000
	860-5	Random Access Storage and Control (400 million characters)	21, 300	4, 260	960, 000
	860-6	Random Access Storage and Control (500 million characters)	25, 700	5, 140	1, 160, 000
	860-7	Random Access Storage and Control (600 million characters)	30, 100	6, 020	1, 360, 000
	860-8	Random Access Storage and Control (700 million characters)	34, 500	6, 900	1, 560, 000
	860-9	Random Access Storage and Control (800 million characters)	38, 900	7, 780	1, 760, 000
CARD READERS and PUNCHES	823-1	Standard-Speed Card Reader (240 CPM) (085)	125	15	7, 700
	823-2	High-Speed Card Reader (650 CPM) (088I II)	325	52	14, 700
	824-1	Standard-Speed Card Punch (100 CPM) includes basic unit (519 model II) summary punch feature 45 columns of comparing offset stacker 30 columns double-punch blank-column detection	154	39	7, 881
	824 1A	Heavy Duty Power Supply for the Model 824-1 (required for transcription mode punching)	---	---	---
	824-2	High-Speed Card Punch (250 CPM) includes basic unit (544 model I) offset stacker half-time emitter	490	35	22, 275
	827	Card Reader--Card Punch (800 CPM/250 CPM) (1402)	550	45	30, 000
	807-1	Card Reader Control (for 823-1)	950	50	45, 600

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CARD READERS and PUNCHES (Cont'd.)	807-2	Card Reader Control (for 823-2)	1,100	60	52,800
	807-3	Card Reader Control (for 827)	1,100	60	52,800
	808-1	Card Punch Control (for 824-1)	1,050	60	50,400
	808-2	Card Punch Control (for 824-2)	1,150	60	55,200
	808-3	Card Punch Control (for 827)	1,150	60	55,200
PAPER TAPE UNITS	809	Paper Tape Reader and Control (1000 FPS)	975	104	46,200
	810	Paper Tape Punch and Control (110 FPS) (specify model 1 for 11/16" tape or model 2 for 7/8" or 1" tape)	725	73	34,800
PRINTERS	822-1	Standard-Speed Printer (150 LPM) (407)	800	147	42,000
	822-2	Bill-Feed Printer includes basic unit (408 model Al) equal-unequal compare (15 positions) carriage storage (15 positions)	1,175	190	70,125
	822-3	High-Speed Printer (900 LPM)	1,950	475	79,800
	822-3A	Vertical Spacing Option for the Model 822-3 (allows spacing of six lines per inch or eight lines per inch) An installation charge will be made if this feature is field installed.	100	20	4,800
	806-1	Printer Control (for 822-1)	1,050	55	50,400
	806-2	Printer Control (for 822-2)	1,250	125	60,000
	806-3	Printer Control (for 822-3)	1,450	145	69,600
MAGNETIC TAPE UNITS	803-1	Tape Control	2,000	100	96,000
	803-2	High Density Tape Control	3,100	155	148,800
	803-3	Economy Tape Control	2,000	100	96,000
	803-4	Super Density Tape Control	4,100	205	196,800
	804-1	Magnetic Tape Unit	900	180	43,200
	804-2	High Density Magnetic Tape Unit	900	180	43,200
	804-3	Economy Magnetic Tape Unit	550	165	26,400
	804-4	Super Density Magnetic Tape Unit	900	180	43,200
	805	Magnetic Tape Switching Unit	75	5	3,600
ALTERNATIVE CONTROL UNITS	815	Off-Line Output Auxiliary Control	700	50	33,600
	816	Off-Line Input Auxiliary Control	700	50	33,600
	817	Off-Line Input-Output Auxiliary Control	950	70	45,600
	818	Off-Line Printer Control (for use with 822-3 and 804-1, 804-2 or 804-3,	1,550	270	74,400
	811-1	Printer--Card Reader--Card Punch Control (for use with 822-1, 823-1 or 823-2; 824-1 or 824-2)	1,700	85	81,600
	811-2	Printer--Card Reader--Card Punch Control (for use with 822-2; 823-1 or 823-2; 824-1 or 824-2)	1,850	145	88,800
	811-3	Printer--Card Reader--Card Punch Control (for use with 822-3; 823-1 or 823-2; 824-1 or 824-2)	1,950	200	93,600

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
ALTERNATIVE CONTROL UNITS	811-4	Printer--Card Reader--Card Punch Control (for use with 822-1; 827)	1,700	85	81,600
	811-5	Printer--Card Reader--Card Punch Control (for use with 822-2; 827)	1,850	145	88,800
(Cont'd.)	811-6	Printer--Card Reader--Card Punch Control (for use with 822-3; 827)	1,950	200	93,600
MISCELLANEOUS UNITS	833	Magnetic Ink Character Sorter-Reader Input Control Unit	1,300	87	62,400
	870	Inquiry Station Control Unit	750	56	36,000
	871	Inquiry Station	750	150	36,000
	872	Slave Console Typewriter	300	60	14,400
	880	Communications Control Unit	990	99	47,520

HONEYWELL 1400

Honeywell EDP Division

STANDARD EDP REPORTS

AUERBACH

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PRINTED IN U. S. A.

CONTENTS

* Refer to indicated section of Honeywell 400 report; all Honeywell 400 software is directly usable on the 1400.

** Refer to indicated section of Honeywell 800 report.

CONTENTS (Contd.)

INTRODUCTION

§ 011.

The Honeywell 1400 is a medium scale computer system oriented primarily toward business data processing applications. Recent hardware developments make it possible to adapt the system to a variety of real-time applications. Monthly rentals for H-1400 systems range from about $9,000 to $18,000 and average around $13,000. Initial customer deliveries were made in January, 1964.

Compatibility

The H-1400's throughput capacity places it in the middle of Honeywell's expanding line of computers. The larger Honeywell systems are the H-800 (Computer System Report 502) and the H-1800 (Report 503). The smaller systems are the H-200 (Report 507) and the H-400 (Report 501).

The Honeywell 400 and 1400 are fully program-compatible and, with a few exceptions, offer the same range of peripheral units. There is no direct program compatibility between H-400/1400 systems and either H-200 or H-800/1800 systems, though a simulation routine permits H-1400 programs to be run on an H-800 or H-1800.

All Honeywell computers can communicate with one another (but not with most competitive equipment) by means of a line of magnetic tape units using three-quarter inch tape.

Hardware

The central processor has facilities for both binary and decimal arithmetic. Both multiply-divide instructions and floating point arithmetic are optional facilities, and all floating point arithmetic is performed in the decimal mode. Three-address instructions are used (e.g., "ADD A, B, C" means "add the contents of A to the contents of B and place the result in location C"). The instruction repertoire is comprehensive and includes especially good editing commands for translation of the 6-bit alphanumeric codes to and from their decimal and binary equivalents. Except for the editing instructions, operand lengths are fixed at one 48-bit word. A Honeywell 1400 word can hold one instruction, eight 6-bit alphanumeric characters, twelve 4-bit decimal digits (or eleven digits plus sign), sixteen octal digits, or a single 48-bit binary data item. A powerful "move" command permits the contents of up to 4,095 word locations to be moved by one instruction.

The effective core storage cycle time, 13 microseconds per 48-bit word, is 30 percent faster than that of the Honeywell 400, providing an internal processing capacity for 10,000 to 12,000 typical three-address instructions per second. Other improvements over the H-400 include an increase in core storage capacity from the H-400 maximum of 4,096 words to the H-1400 maximum of 32,768 words, addition of the Floating Point and Card Storage options, and increases in the number of printers (now 2, previously 1) and magnetic tape units (now 16, previously 8) that can be connected.

The core storage is available in multiples of 4,096 48-bit word locations; maximum size is 32,768 words. Each 24-bit half of a word has a parity bit which is checked whenever the data is moved. The store accepts words with incorrect parity from input-output devices. The processor is made aware of this condition by a forced transfer of control to a fixed location. A parity-checking instruction is provided to find the incorrect word and correct its parity. Other instructions are provided to implement techniques to correct the incorrect data. They are part of a system called Orthotronic Control, which is used primarily with magnetic tape units and disc files.

The central processor serves as the main input-output controller in H-1400 systems, thereby minimizing the need for additional controllers or buffers. A special central processor model, however, must be used with the fastest magnetic tape units (88.666 six-bit characters per second).

§ 011. INTRODUCTION (Contd.)

The basic H-1400 system without optional facilities has very limited capabilities for simultaneous operations. Except for a simultaneous tape reading and writing operation, computation, input, and output are handled one at a time and do not overlap. Optional buffer features called Print Storage and Card Storage permit internal processing to be overlapped with printing and/or card reading or punching.

Up to 16 magnetic tape units can be connected. The three available magnetic tape unit models operate at 32,000 characters (or 48,000 digits) per second, 64,000 characters (or 96,000 digits) per second, and 88,666 characters (or 133,000 digits) per second. These units have pneumatic drives which handle the tape more gently than mechanical drives. The Orthotronic Control feature enables the H-1400 to ignore a faulty track when reading a tape and to regenerate the correct data. In contrast to read-after-write error detection systems, Orthotronic Control can correct errors occurring during recording, in storage, or during reading. On the other hand, it does not notice recording errors until a later reading.

The printer operates at 900 lines per minute. The Print Storage option frees the processor for 98 percent of the printing time. The IBM 1402 Card Read Punch is the card equipment normally used with the H-1400. It reads 800 cards per minute and punches 250 cards per minute. The Card Storage option allows card reading or card punching (but not both) to be overlapped with processing.

Up to 5 input and 4 output general-purpose peripheral trunks are available for connecting any of the following devices:

- Magnetic disc files (random access storage for up to 100 million alphameric characters per file unit).
- Communication controls (process messages to or from remote equipment).
- Paper tape reader (500 or 1,000 characters per second).
- Paper tape punch (110 characters per second).
- Optical scanner (196 to 312 documents per minute).

Real-Time Processing

The basic Honeywell 1400 system is designed primarily for standard batch processing applications. Through the addition of communication controls and magnetic disc files, the H-1400 can handle inquiry, data collection, and management control functions as well. Batch-type production programs can be interrupted as necessary to process incoming messages and transmit the replies.

Three types of communication control units are available. Up to five such control units, in any combination, can be connected to an H-1400. The 484 multi-channel control can accommodate up to 56 communication channels and handle several messages simultaneously to or from remote devices with speeds of up to 300 characters per second. The 481 single-channel control is designed for lower message volumes and handles only one channel. The 480 control handles the transfer of data between an H-1400 and another computer or a high-speed remote device. The central processor's interrupt facility is used to initiate a transfer of data between core storage and a buffer in the communication control whenever the buffer has been filled (during input) or emptied (during output). Priorities can be established so that some routines will be interrupted freely, other routines will be interrupted only to handle selected functions of higher priority, and still other routines will never be interrupted.

A wide variety of remote input-output devices can be used in Honeywell 1400 real-time systems. Virtually any business data transmitter that can be connected to a telephone or teleprinter circuit can be used. The remote equipment can be connected to the computer either through a standard switched telephone network or through leased lines.

Software

Software for the H-1400 is the same as for the program-compatible H-400, with minor modifications. Programs and programming systems available from Honeywell include:

- EASY II, a standard assembler with symbolic addressing and relocatable output. It includes an input-output macro facility which is also used in other systems, such as COBOL-61 and AUTOMATH.

§ 011. INTRODUCTION (Contd.)

- A COBOL-61 compiler which can be used on any H-1400 system with a minimum of four tape units. The compilation time for typical programs is approximately one-half hour, which is good for a machine of this size. The language facilities are fairly complete. The object programs are reported to require approximately the same running time as those produced using normal (EASY II) symbolic coding techniques.

- A FORTRAN II compiler (called AUTOMATH 400) that includes a non-FORTRAN statement, OVERLAY, which helps to overcome some of the limitations of systems with limited internal storage (like the H-400). The compiler does a small amount of analysis of the coding and its context and thereby improves the execution speed of the object programs. Only two levels of subscripting are allowed, and the facilities for detecting and handling errors at execution time are limited. Compilation speed is high: approximately one hundred statements per minute. Object program execution times are slowed down by the need to simulate the floating point arithmetic on all H-400 machines, but should be much improved when the Floating Point option is available on H-1400 computers.

- Sort Generator and Merge Generator Routines. These are based on the polyphase method, which has been pioneered by Honeywell.

- Disc File Programs, which are currently under development to facilitate the programming of disc file operations.

- THOR (Tape Handling Option Routine), a general routine for locating, copying, comparing, editing, and correcting information on magnetic tape.

- TABSIM, a "load-and-go" program that simulates the functions of conventional punched card tabulating equipment, using a source language that is compatible with IBM 1401 FARGO.

- Mathematical and statistical routines, which handle functions, conversions, programmed multiply-divide and floating point arithmetic, and curve fitting.

- PERT and Linear Programming Packages.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of location	Size	Purpose or use
Character:	6 bits	editing.
Word:	48 bits	instructions, data items.
Record:	1 to 511 words	magnetic tape block.
	64 words	disc storage.

.2 DATA FORMATS

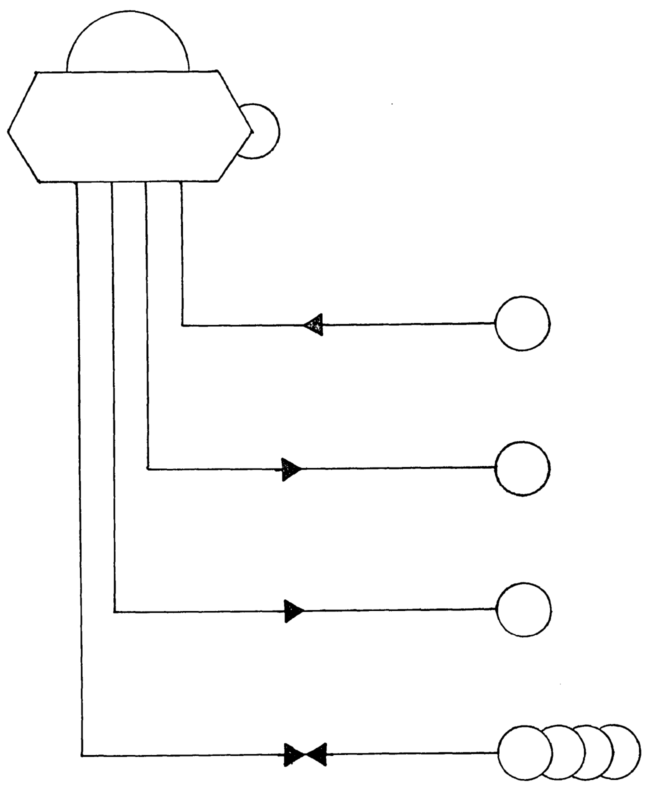
Type of information	Representation
Binary:	48 bits in a word.
Decimal or Hexadecimal:	12 Characters, or sign plus 11 chars in a word.
Alphabetic or Alphameric:	8 Characters in a word.
Instruction:	1 word.

SYSTEM CONFIGURATION

§ 031.

.2 4-TAPE BUSINESS SYSTEM (CONFIGURATION II)

Deviations from Standard System: . . . . magnetic tape is 100% faster.
can read and write simultaneously on magnetic tape.
printer is 80% faster.
card reader is 60% faster.
card punch is 150% faster.
includes indexing and console typewriter.
core storage is 300% larger.



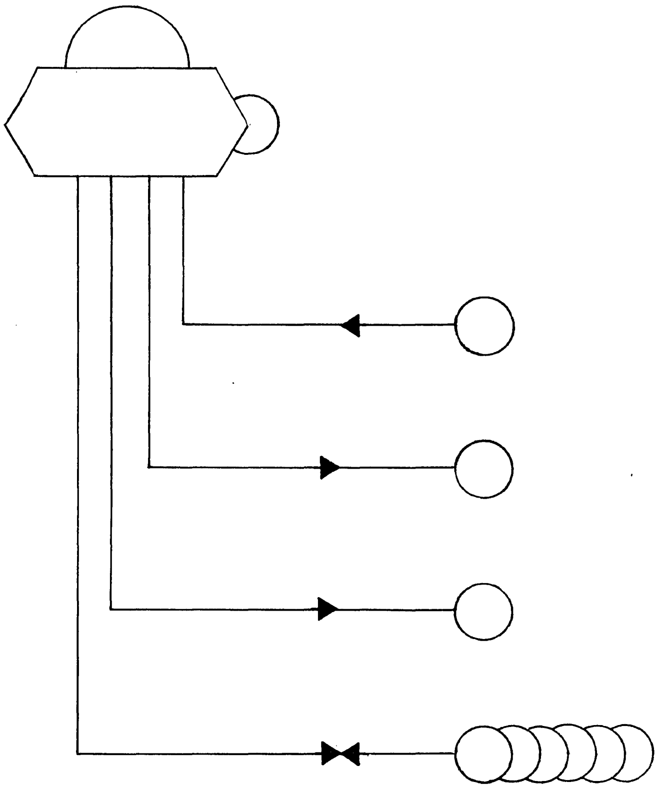
Equipment	Rental
Core Storage: 4,096 words Processor & Console	$ 7,350
Card Reader: 800 cards/minute Card Punch: 250 cards/minute	550
Printer: 900 lines/minute	1,050
Magnetic Tapes (4): 30,000 char/sec.	1,800
	$11,150

Optional Equipment Includes: . . . . none

§ 031.

.3 6-TAPE BUSINESS SYSTEM (CONFIGURATION III)

Deviations from Standard System: . . . . no read/compute or write/compute simultaneity.
printer is 80% faster.
card reader is 60% faster.
card punch is 150% faster.
core storage is 100% larger.



Equipment	Rental
Core Storage: 4,096 words Processor & Console	$ 7,350
Card Reader: 800 cards/minute Card Punch: 250 cards/minute	550
Printer: 900 lines/minute	1,050
Magnetic Tapes (6): 30,000 char/second	2,700

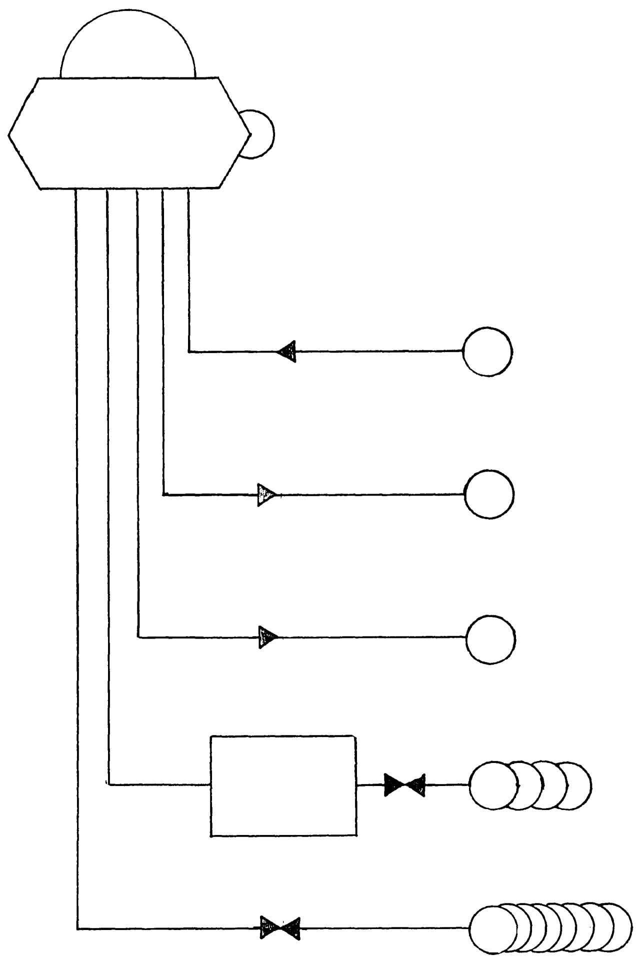
Optional Equipment Includes: . . . .

1.	Multiply-Divide	390
2.	Print Storage	250
		$12,290

§ 031.

.4 12-TAPE BUSINESS SYSTEM (CONFIGURATION IV)

Deviations from Standard System: . . . . no read/compute or write/compute simultaneity.
printer is 10% slower.
card reader is 20% slower.
card punch is 25% faster.



Equipment	Rental
Core Storage: 4,096 words Processor & Console	$ 7,350
Card Reader: 800 cards/minute Card Punch: 250 cards/minute	550
Printer: 900 lines/minute	1,050
Extended Tape Control	100
Magnetic Tapes (12): 64,000 char/second	10,800

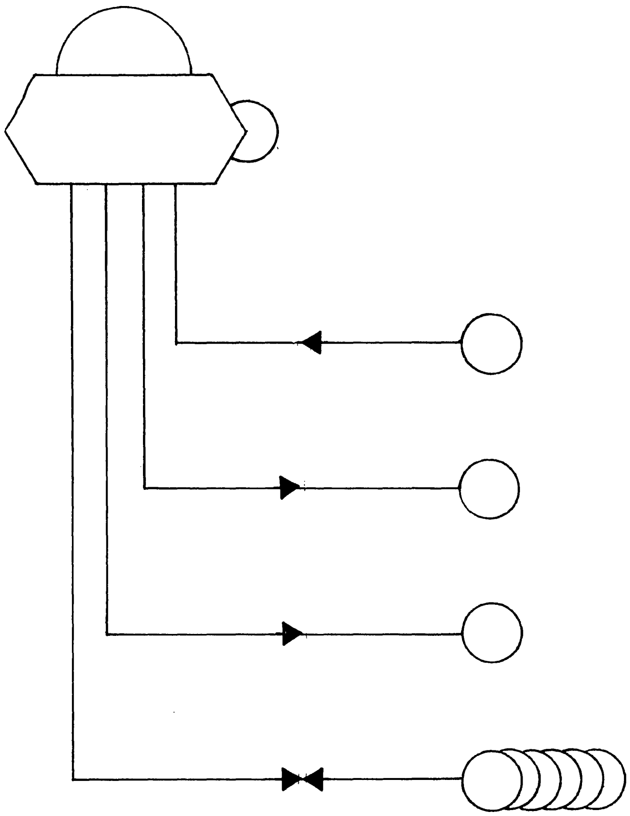
Optional Equipment Includes: . . . .

1. Print Storage	390
2. Multiply-Divide	250
3. Card Storage	490
	$20,980

§ 031.

.6 6-TAPE BUSINESS/SCIENTIFIC SYSTEM (CONFIGURATION VI)

Deviations from Standard System: . . . . no read/compute or write/compute simultaneity.
printer is 80% faster.
card reader is 60% faster.
card punch is 150% faster.



Equipment	Rental
Core Storage: 8,192 words Processor & Console	$ 8,950
Card Reader: 800 cards/minute Card Punch: 250 cards/minute	550
Printer: 900 lines/minute	1,050
Magnetic Tapes (6): 30,000 char/second	2,700

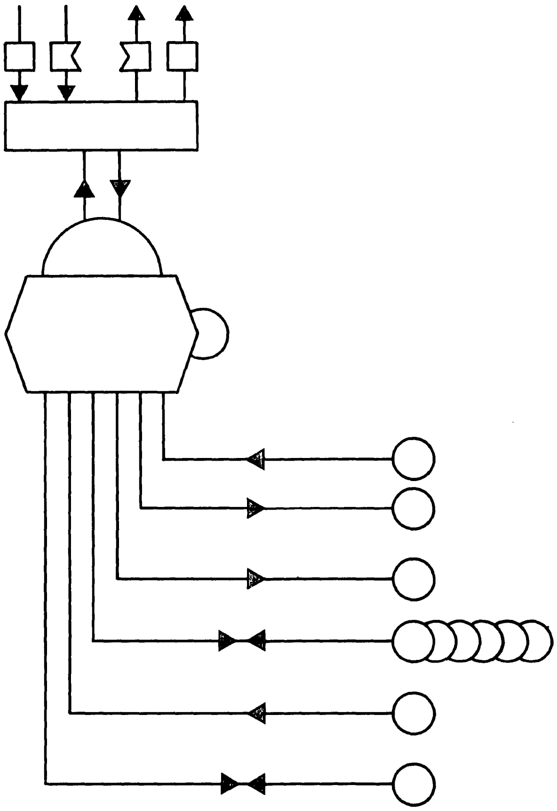
Optional Equipment Includes: . . . .

1. Multiply-Divide Option	250
2. Print Storage Option	390
3. Card Storage Option	490
4. Floating Point Option	150
	$14,530

§ 031.

.7 TYPICAL REAL-TIME SYSTEM

Up to 56 buffered lines; input or output as required.



Equipment	Rental
485 Communication Adapter Units (56 max.)	*
484-2 Communication Control (2 Bays): 14 buffers included	980
Core Storage: 16,384 words; Processor and Console	12,150
Card Reader: 800 cards/minute; Card Punch: 250 cards/minute	560
Printer: 900 lines/minute	1,050
Magnetic Tapes (6): 32,000 char/second	2,700
Real Time Clock	155
460-1 Disc File and Control: 25,000,000 characters	2,490
Optional Equipment Includes: Multiply-Divide	250
Print Storage	390
Card Storage	490
	$21,215*

* Cost of necessary adapter units ($25 to $40 per month each) is not included.

INTERNAL STORAGE: CORE STORAGE

§ 041.

.1 GENERAL

.11 Identity: . . . . Magnetic Core Storage. H-1402.

.12 Basic Use: . . . . working storage.

.13 Description

Each Honeywell 1400 System contains, as standard equipment, an H-1402 Core Storage module which has a capacity of 4,096 words. Seven additional modules are available for extending the storage capacity, in 4,096-word increments, up to a maximum of 32,768 words. Each word contains 48 data bits and 2 parity bits. A word location can hold data represented in any one, or a combination, of the following formats:

- 48-bit data word or instruction.
- 12 decimal digits (or 11 digits plus sign).
- 8 alphameric characters.

The H-1402 core storage is arranged in 25-bit groups, 2 of which make up a single computer data word or instruction. The cycle time is 6.5 microseconds per half-word access, providing an effective operating time of 13.0 microseconds for basic full-word operands.

The first 96 words are normally reserved as input-output areas, index registers, arithmetic registers, and interrupt jump locations. However, if they are not being reserved for a particular function, they can be used for normal storage.

Because of the limited number of bits (12) in each operand address, only the first or basic storage bank of 4,096 words can be addressed directly. To gain access to the additional banks requires use of the Bank Indicator Registers (see Central Processor, 505:051). One of these is associated with the sequence register and one with each of the three index registers. Addresses are then formed relative to the bank indicated; no extension beyond the 4,096 words of each bank boundary is possible.

.14 Availability: . . . . 6 months.

.15 First Delivery: . . . . . January, 1964.

.16 Reserved Storage

Purpose	Number of Locations	Locks
Index and sequence registers:	1	none.
Arithmetic registers:	11	none.
I/O control:	6	none.
I/O areas:	55	none.
Unprogrammed transfer locations:	8	none.
Machine working locations:	15	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Core diameter: . . . . 0.050 inch.
Core bore: . . . . 0.030 inch.
Array size:. . . . . . . 32 bits by 64 bits.
Number of planes: . . 25.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Performance

.241 Data erasable by program: . . . . yes.
.242 Data regenerated constantly: . . . . no.
.243 Data volatile: . . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.282 Reading method: . . . . coincident current.
.283 Type of access: . . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Unit of data: . . . . . . word.
Conversion factor: . . 48 bits/word.
Data rate:. . . . . 77,000 words/second.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	Basic	basic plus 1402-7.
Words:	4,096	32,768.
Characters:	24,576	262,144.
Instructions:	4,096	32,768.
Digits:	36,864	393,216.
Modules:	1	2.

§ 041.

.32 Rules for Combining Modules: . . . . a single module containing either 4, 096, 8, 192, 12, 286, 16, 384, 20, 480, 24, 576, or 28, 672 words can be added to the basic 4, 096-word module.

.4 CONTROLLER: . . . . . no separate controller required.

.5 ACCESS TIMING

.51 Arrangement of Heads: . . . . single access circuit.

.52 Simultaneous Operations: . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Cycle time: . . . . 6.5 μsec.
For data unit of: . . . 0.5 word.

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE

.71 Data Transfer

With self: . . . . yes.

.72 Transfer Load Size

With self: . . . . N 48-bit words.

.73 Effective Transfer Rate

With self: . . . . 31.4 + 26N, where N is the number of 48-bit words transferred.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Illegal instruction:	yes	processor stop.
Invalid address:	yes	processor stop.
Receipt of data:	none.	
Recording of data:	record parity bits.	
Recovery of data:	parity check	processor stop.
Dispatch of data:	send parity bits.	
Invalid character:	validity check	forced transfer.

INTERNAL STORAGE: MAGNETIC DISC FILE

§ 042.

.1 GENERAL

.11 Identity: . . . . Magnetic Disc File. Bryant Series 4000. H-460.

.12 Basic Use: . . . . auxiliary storage.

.13 Description

The H-460 is a random access storage unit that consists of a controller plus one disc cabinet. Three, 6, 12, 18, or 24 data discs can be connected, providing a capacity of from 12.5 to 100 million alphameric characters per unit. The maximum number of H-460 units per system is four.

There are six zones on each disc face, and each zone has its own read/write head. All the heads move together, so that they are correctly positioned over six physical tracks (or 32 64-word records) on each disc at any one time. The rotational delay for any of the 32 records averages 34 milliseconds, but the data transfer time varies with the zone. The number of records per track also varies with the zone, and the table below shows the different values associated with each.

Zone	Number of 64-Word Records per Track	Transfer Time per Record (milliseconds)
1	3	19.4
2	4	14.0
3	4	11.5
4	6	9.5
5	7	7.4
6	8	7.1

Access to the disc is achieved by addressing data records of 512 alphameric or 768 numeric characters arranged into 64 words. Any record can be addressed independently. Slightly less than 1 per cent of the file (that part over which the heads are positioned) is available in under 44 milliseconds, assuming average latency for disc rotation and a weighted average time of 10.4 milliseconds for data transfer.

To gain access to another band involves waiting an additional 60 to 130 milliseconds for lateral head movement. Thus, random access, including head position changes, averages 139 milliseconds, allowing 430 records per minute to be obtained or stored randomly.

Three instructions are used in connection with the H-460 Disc File: Read, Write, and Search. The Read and Write instructions transfer up to 64 words between core storage and a disc track. The

.13 Description (Contd.)

Search instruction initiates an access operation, after which control reverts to the main program in the central processor. An automatic interrupt occurs upon completion of the search operation (two milliseconds prior to the time when reading or writing of the selected record may begin), and the program normally branches to a routine that reads or writes a record. All searching can, therefore, be fully overlapped with internal processing.

.14 Availability: . . . . 9 months.

.15 First Delivery: . . . . . April, 1963.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic discs.

.22 Physical Dimensions

.222 Disc
Diameter: . . . . 39 inches.
Thickness: . . . . thin.
Number on shaft: . . . 4, 7, 13, 19, or 25.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . . yes.
.242 Data regenerated constantly: . . . . no.
.243 Data volatile: . . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.25 Data Volume Per Band of 6 Physical Tracks

Words: . . . . 2,048.
Characters: . . . . 16,384.
Digits: . . . . 24,576 (or 22,576 in signed H-1400 words).
Instructions: . . . . 2,048.
Records: . . . . 32.

.26 Bands Per Physical Unit: . . . . 256 per disc (128 on each side).

.27 Interleaving Levels: . . one (i.e., no interleaving).

.28 Access Techniques

.281 Recording method: . . . moving heads.

§ 042.

.283 Type of access

Description of stage	Possible starting stage?
Move head to selected band: . . .	yes.
Wait until record is in position: . . .	yes, if a record on the same band of any disc face was previously selected.
Transfer of record:	no, but previous stage time may be zero.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . . 900 rpm.
Bits/inch/track: . . . variable.
Compound bit rate: . . 615,000 bits/sec.

.292 Peak data rates
Cycling rates: . . . . . 27,500 to 75,000 char/sec.
Unit of data: . . . . . . word.
Conversion factor: . . 48 bits/word.
Gain factor: . . . . . . 1.
Loss factor: . . . . . . 1.
Data rate: . . . . 3,472 to 9,375 words/sec.
Compound data rate: . 3,472 to 9,375 words/sec.

.3 DATA CAPACITY

.31 Module Size

Discs: . . . . 1.
Records: . . . . 8,192.
Words: . . . . 524,288.
Characters: . . . . . . 4,194,304.
Digits: . . . . 6,291,456.
Instructions: . . . . . . 524,288.

.32 Rules for Combining Modules: . . . . 3, 6, 12, 18, or 24 data discs can be mounted on the single shaft of the unit.

.4 CONTROLLER

.41 Identity: . . . . included in unit.

.42 Connection to system

.421 On-line: . . . . 4.
.422 Off-line: . . . . none.

.43 Connection to System

.431 Devices per controller: 1.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . 1 record = 64 words.
.442 Input-output area: . . . none.
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . . none.
.448 Testable conditions: . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks
(See table below.)

.512 Stack movement: . . . . across 1 zone of 1 disc face (there are 6 zones on the disc face).

.513 Stacks that can access any particular location: . . . . one.

.514 Accessible locations
By single stack
With no movement: . 1 band = 32 records of 64 words each.
With all movement: . 128 bands = 4,096 records of 64 words each.
By all stacks
With no movement: . 32N records where N = 6, 12, 24, 36, or 48 depending on Model. (i.e., 1/128 of capacity).

.515 Relationship between stacks and locations: none.

.52 Simultaneous Operations

All but the last 2 milliseconds of each disc seek operation can be overlapped with internal processing, but reading and writing cannot be overlapped. Only one disc seek, read, or write operation at a time is possible.

.53 Access Time, Parameters, and Variations

.532 Variation in access time, in μsec.

Stage	Variation	Average
Head positioning:	0 or 60,000 to 130,000	90,000.
Waiting for the disc to be in position: . . .	0 to 66,700	33,300.
Transfer of record: . .	7,100 to 19,400	10,400.
Total:	7,100 to 216,100	133,700.

.6 CHANGEABLE STORAGE: . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage units possible

With self: . . . . no.
With core storage: . . yes.

.72 Transfer Load Size: . . 1 record of 64 words.

.73 Effect Transfer Rate

With core storage: . . . not yet determined; depends on the timing of the inter-record gap.

.511 Number of stacks

	Model 0	Model 1	Model 2	Model 3	Model 4
Stacks per module:	36	72	144	216	288.
Stacks per yoke:	36	72	144	216	288.
Yokes per module:	1	1	1	1	1.

§ 042.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	none	unpredictable.
Invalid code:	not possible.	
Receipt of data:	read tracking check	forced transfer.
Recording of data:	write tracking check*	forced transfer.
Recovery of data:	parity check*	forced transfer.
Timing conflicts	check	system de-activated.

* Orthotronic Control is optional. When used, two Orthowords (computed by a single instruction) are appended to each disc record and used to detect and (in many cases) correct recording errors when the data is read back.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . Honeywell 1400.
Central Processor.
H-1401.

.12 Description

The H-1401 Central Processor is 30 per cent faster than the H-400, and can (by means of bank indicators) address eight times as much storage (32,768 versus 4,096). Otherwise, the processors are essentially the same.

The increase in speed causes no complications; in fact, it results directly from the faster storage cycle (6.5 microseconds per half word of 25 bits versus 9.25 for the H-400). However, the increase in storage capacity introduces programming complications for any machine which has more than 4,096 words of storage.

The 1400 utilizes three-address instructions and has binary and decimal computational facilities. The instruction repertoire is comprehensive and includes strong editing and Boolean operations. The 3 index registers can be incremented by up to 4,096. Floating Point and Multiply-Divide instructions are optional. Multiply-Divide is a prerequisite for the Floating Point hardware.

Errors and ends of input-output data transfers can cause separate interrupts to occur. An interrupt causes the processor to take its next instruction from a unique location in storage without changing the sequence counter that normally directs the processor to subsequent instructions. Since the sequence counter and the three index registers are contained in a single storage location, they are generally stored and the specific I/O or diagnostic routine is entered. This is done by one instruction. At the end of this routine, the sequence counter and index registers can be restored. Thus, two instructions are required to store and restore the contents of the program registers and to provide entrance and exit for each appropriate routine. (Two routines are provided to process data from each input-output channel, one for the normal and one for the abnormal end of operation.)

Cases involving multiple interrupts have been handled in a convenient manner. When multiple interrupts occur, the processor accepts the interrupt from the source with the highest priority, which is defined by built-in hardware. Having accepted an interrupt, all further interrupts are disabled for 2 milliseconds. This should be enough time to perform almost all of the diagnostic routines. It is at least sufficient time to prepare for subsequent interrupts.

.12 Description (Contd.)

One particular instruction operation deserves a special explanation: "SELECT." It is used to cause other instructions to be executed under its control one at a time, particularly as in table look-ups. The select operation is recursive and may execute another select instruction. The sequence counter is affected by select instructions only when they cause a jump. The executed address of a select instruction is formed by a logical combination of one address and two masks.

It is possible to have eight storage banks, each of 4,096 words, in H-1400 systems. As the original H-400 addressing systems had space for only 12 bits (i.e., 4,096 possibilities) it became necessary to increase the addressing capacity. There are actually seven types of addresses (the instruction sequence; the A, B, and C addresses; and the three index registers), but only four can be extended with the auxiliary addressing provided in the H-1400. These are allocated to the instruction sequence register and the three index registers. If a programmer wishes to reference an address outside the bank in which the instruction is executed, he must use an index register. This effectively reduces the capacity of the indexing system (which was previously only adequate).

The created addresses are not properly sequential, and addressing cannot be incremented outside the actual bank address to which the index register is set. Thus, if IR 3 contains 0024_8, is set for bank 1, and is used to increment an address 0477_8, the effective address will be 0523_8 in bank 1. However, if it were set to address 7777_8, the effective address would be 0023_8; but it would be in bank 1, not bank 2.

Special input and output areas are fixed for the standard card reader, punch, and printer. Editing instructions are available which work with a binary card image (four 12-bit columns per 48-bit word), or with 6-bit print characters. These can be edited to six-bit alphameric, four-bit decimal (which can be used computationally), or three-bit octal characters by the editing instructions. Non-valid characters cause a forced transfer. Insertion of specific characters, suppression of leading zeros, and floating of the high order character of a field can be performed automatically.

Simultaneity in operation of the central processor and input-output units is controlled by the method of transfer logic associated with each of the units concerned. Thus, some units (such as the card units) allow overlapped operation of the central processor while the peripheral unit is preparing to make the transfers. This is not possible with the magnetic tape units. The rules for such operations are given in Simultaneous Operations (Section 505:111).

§ 051.

.13 Availability: . . . . 9 months.

.14 First Delivery: . . . . . January, 1964.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-Subtract:	automatic	10, 2	11D, 48B.
	Multiply			
	Short:	none.		
	Long:	automatic ‡	10	11D.
	Divide			
	No remainder:	none.		
	Remainder:	automatic ‡	10	11D.
.212	Floating point			
	Add-Subtract:	automatic ‡	10	9 & 2D.
	Multiply:	automatic ‡	10	9 & 2D.
	Divide:	automatic ‡	10	9 & 2D.

‡With optional hardware.

.213 Boolean

	Provision	Radix	Size
AND:	automatic	binary	48 bits.
Inclusive OR:	automatic	binary	48 bits.
Exclusive OR:	automatic	binary	48 bits.
A· B v B· C:	automatic	binary	48 bits.

.214 Comparison

	Provision	Size
Numbers:	2 instructions	11D sign.
Letters:	2 instructions	48 bits.
Mixed:	2 instructions	48 bits.

Collating sequence: 0 to 9 " = : + A to I ; .) %□ - J to R # $ * " / S to Z @ , (CR.

.215 Code translation

Provision	From	To	Size
automatic	12B card col	6B alpha	0 to 80C.
automatic	12B card col	4B unsigned D	0 to 80D.
automatic	12B card col	4B signed D	0 to 11D.
automatic	12B card col	3B octal	0 to 80D.
automatic	6B alpha	12B card col	0 to 80C.
automatic	4B unsigned D	12B card col	0 to 80D.
automatic	4B signed D	12B card col	0 to 80D.
automatic	3B octal	12B card col	0 to 80D.
automatic	6B alpha	print image	0 to 120C.
automatic	4B decimal	print image	0 to 120C.
automatic	3B octal	print image	0 to 120C.
automatic	4B hexadec	4B decimal	1 word.

Note: B = binary bits.
C = alphameric characters.
D = decimal digits.

.216 Radix conversion: . . . none.

.217 Edit format

	Provision	Comment	Size
Alter size:	subroutine.		
Suppress zero:	subroutine	9 leading zeros	1 word.
Round off:	automatic	remainder and LOP* in std. location.	
Insert point:	automatic.		
Insert any:	automatic.		
Float hex char:	automatic	part of zero suppression	1 word.
Protection:	automatic	part of zero suppression	1 word.

* LOP is Low Order Product, i.e., the least significant digits.

.218 Table look-up: . . . . . . none.

.219 Others

	Provision	Comment	Size
Move:	automatic	entire memory	any number of words.

.22 Special Cases of Operands

.221 Negative numbers: . . . 4 binary zeros in first digit of a signed decimal word; all other configurations are positive; absolute value and sign.

.222 Zero: . . . . plus and minus zero can occur and are equal in some comparisons.

.223 Operand size determination: . . . . . though generally one word, in editing a character count is used.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout

Part	OP	A I	B I	C I	A	B	C
Size (Bits)	6	2	2	2	12	12	12

.233 Instruction parts

Name	Purpose
OP:	operation code.
AI:	A address index.
BI:	B address index.
CI:	C address index.
A:	A partial address.
B:	B partial address or parameters.
C:	C partial address.

Note: Partial addresses are used with the index registers to provide access to other core banks.

.234 Basic address structure: . . . . 3 address.

.235 Literals
Arithmetic: . . . . none.
Comparisons and tests: . . . . up to 4,095.
Incrementing modifiers: . . . . . . up to 4,095.

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.236 Directly addressed operands
.2361 Internal storage type: . core.
Maximum size: . . . . 32,768 locations.
Volume accessible: . 4,096 with any one bank setting.
.2362 Increased address capacity: . . . . by use of one of eight bank settings.
.237 Address indexing
.2371 Number of methods: . 1.
.2372 Names: . . . . direct.
.2373 Indexing rule: . . . . . the contents of a specified index register are added modulo 4,096 to the associated address.
.2374 Index specification: . 1 of 3 indices (or none) specified by 2 bits for each address.
.2375 Number of potential indexers: . . . . 3.
.2376 Addresses which can be indexed

Type of address	Application
Operands:	out-of-bank addressing, counting, and modification.

.2377 Cumulative indexing: . . . . none.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . . none.
.239 Stepping
.2391 Specification of increment: . . . . . . in stepping instruction.
.2392 Increment sign: . . . . positive.
.2393 Size of increment: . . 0 to 4,095.
.2394 End value: . . . . specified in register.
.2395 Combined step and test: . . . . yes.

.24 Special Processor Storage

.241

Category of Storage	Number of locations	Size in bits	Program usage
Index registers;	3	12	modification.
Sequence register:	1	12	program counter.

.242

Category of Storage	Total number locations	Physical form	Access time, μsec	Cycle time μsec
Index & sequence registers:	4	core location	6	6.5.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . one.
.312 Arrangement: . . . . . . sequence register.
.313 Precedence rule: . . . . interrupts take precedence but do not affect the sequence counter.
.314 Special sub-sequence counters: . . . . none.
.315 Sequence control step size: . . . . instructions; i.e., words.
.316 Accessibility to program: . . . . addressable.
.317 Permanent or optional modifier: . . . . optional.

.32 Look-Ahead: . . . . none.

.33 Interruption

.331 Possible causes
In-out units: . . . . . . end of operation. end of tape.
In-out controllers: . . faulty transfer.
Processor errors: . . overflow. editing illegal char.
.332 Program control
Individual control: . . as indicated by programmer.
Method: . . . . by instruction and special control register.
.334 Interruption conditions: . . . . always when operation is initiated, unless restricted by special control register settings.
.335 Interruption process
Disabling interruption: . . . . yes; by control register setting.
Registers saved: . . . all.
Destination: . . . . . . fixed locations, dependent on type of interruption.
.336 Control methods
Determine cause: . . . location arrived at indicates cause.
Enable interruption: . yes.

.34 Multi-running: . . . . . normally restricted to one main run and one independent peripheral operation.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μsec

Decimal (8 digit operands)
.411 Fixed point
Add-subtract: . . . . . 78.
Multiply: . . . . 890 + 39Z.†
Divide: . . . . 1210 + 52Q.†

Z = number of non-zero digits.
Q = sum of quotient digits.

.412 Floating point
Add-subtract: . . . . . 130 to 149.‡
Multiply: . . . . 1,014 + 39Z.‡
Divide: . . . . 884 to 4,641.‡

Z = number of non-zero digits in the multiplier.

.413 Additional allowance for
Indexing: . . . . 6.5.
Indirect addressing: . not available.
Re-complementing: . 45.
.414 Control
Branch: . . . . 32.
Compare & branch: . 78.
.415 Counter control
Step and test: . . . . . 45 to 65.

§ 051.

.416 Edit: . . . . 52 to 78D.
.417 Convert: . . . . none.
.418 Shift: . . . . 46 + 6.5B.
B = Bits or decimal digits.

.42 Processor Performance in μsec

	Fixed Point	Floating Point
.421 For random addresses		
$c = a + b$:	78	130 to 149. ‡
$b = a + b$:	78	130 to 149. ‡
Sum N items:	78N	130 to 149N. ‡
$c = ab$:	890 + 39D †	1,014 + 39Z. ‡
$c = a/b$:	1210 + 52D †	884 to 4,641. ‡

	Fixed Point	Floating Point
.422 For arrays of data		
$c_i = a_i + b_j$:	215	280 to 299. ‡
$b_j = a_i + b_j$:	215	280 to 299. ‡
Sum N items:	147N †	280 to 299N. ‡
$c = c + a_i b_j$:	1,360 †	1,483 to 1,814. ‡

.423 Branch based on comparison
Numeric data: . . . . . 142.
Alphabetic data: . . . . 142.
.424 Switching
Unchecked: . . . . 112.
Checked: . . . . 282.
List search: . . . . . . 70 + 112N.
.425 Format control per character
Unpack: . . . . 8.5.
Compose: 10.5

† Using optional Multiply-Divide hardware.
‡ Using optional Floating Point hardware.

.426 Table look-up per comparison
For a match: . . . . . . 142.
For least or greatest: . . . . 177.
For interpolation point: . . . . 142.
.427 Bit indicators
Set bit in separate location: . . . . 58.
Set bit in pattern: . . . 58.
Test bit in separate location: . . . . 78.
Test bit in pattern: . . 56.
Test AND for B bits: 56.
Test OR for B bits: . 56.
.428 Moving data: . . . . 32 + 26N for N-word transfer (8 characters per word).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	interrupt	jump to std location*.
Underflow:	not possible.	
Zero divisor:	interrupt	jump to std location*.
Invalid data:	interrupt	jump to std location*.
Invalid operation:	check	machine halt.
Arithmetic error:	none.	
Invalid address:	check	adjusted modulo memory size.
Receipt of data:	interrupt	jump to std location*.
Dispatch of data:	interrupt	jump to std location*.

* Sequence counter not changed.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . Operator's Console.

.12 Associated Units: . . . . Input Keyboard.
Output Typewriter.

.13 Description

The H-1400 Operator's Console consists of a desk and display panel which contain a small complement of pushbutton switches and indicator lights. An input keyboard, which is built into the desk top, permits direct communication with the central processor. A typewriter located behind the sloping display panel can monitor the system by typing data directly from storage.

The console switches and displays enable the operator to:

- Start and stop execution of the stored program.
- Clear certain registers and reset error indicators.
- Set four independent program control (breakpoint) switches.

.13 Description (Contd.)

- Determine the status of each peripheral device; i.e., check for "ready" or error condition.
- Determine the cause of a processor stop (machine or program fault).

The input keyboard consists of 53 keys in a standard typewriter arrangement. It is used by the operator to perform the following operations:

- Print the contents of a selected storage location.
- Enter data into a selected storage location.
- Load starting address and start processing.
- Select a card or tape unit and start initial loading of a "bootstrap" program.
- Rewind tape on a selected tape unit.
- Type log data without entering it into the computer.

The console typewriter acts as an output device under program control. Three instructions are available to provide for alphameric, octal or decimal printout formats. A one-word console buffer enables other instructions to be processed during the relatively long printing time of 100 to 200 milliseconds per character.

INPUT-OUTPUT: PUNCHED TAPE READER

§ 071.

.1 GENERAL

.11 Identity: . . . . Punched Paper Tape Reader and Control 409. Burroughs Corp. Unit B 141.

.12 Description

The 409 Punched Paper Tape Reader and Control can read strips of paper tape at 500 frames per second, or reels at 1,000 frames per second. Peak speed is only attained after 15 frames have been read without interruptions. During the reading time, the processor is effectively restricted to the read tape instruction. Each data frame is right-justified in twelve-bit sections of 48-bit words and transferred to storage. The reader can handle codes of up to eight bits.

The data read is dependent upon standard subroutines to accomplish conversion to Honeywell 1400 codes, but these are fast and simple. The amount of data read is instruction-controlled and can vary from 1 to 256 frames. The effective speed varies from 71 to 492 frames per second in the medium-speed mode and from 142 to 984 frames per second in the high-speed mode.

The reader can read tape either from spools or in strips. It uses swing arms for tension, and spool motor drive control. The read mechanism is photoelectric and the tape is driven by a pinch roller. An automatic rewinding feature is incorporated in the unit.

.13 Availability: . . . . . . 6 months.

.14 First Delivery: . . . . . July, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arms.
Capacity: . . . . 3 feet.
.213 Feed drive: . . . . . . servo motor.
.214 Take-up drive: . . . . . servo motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . photoelectric.
.223 Common system: . . . none.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . read.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8 plus sprocket.
Method of use: . . . . . frame at a time.

.25 Range of Symbols

Numerals: . . . . any 5- to 8-bit code.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
.312 Phenomenon: . . . . . . punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . by row, 10/inch.
.322 Parallel by: . . . . . . 5 to 8 tracks.
.323 Bands: . . . . none.
.324 Track use
Data: . . . . 5 to 8 tracks.
Redundancy check: . . any track except sprocket.
Timing: . . . . track 4 (sprocket track)
Control signals: . . . none.
Unused: . . . . none.
Total: . . . . 5 to 8 plus sprocket track.
.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . one character per row, using 5 to 8 bits; any 5-, 6-, 7- or 8-bit code.

.34 Format Compatiblity

Other device or system — Code translation
H 401: . . . . translation provided by routine.

.35 Physical Dimensions

.351 Overall width: . . . . . 11/16; 7/8; 1 inch.
.352 Length: . . . . 8 to 700 ft. by 0.1 inch. 4-foot leader. 4-foot trailer.

§ 071.

.4 CONTROLLER

.41 Identity: . . . . controller contained in reader

.42 Connection to System

.421 On-line: . . . . up to 5.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 256 frames.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . none.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . program.
.447 Synchronizing aids: . . test busy.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to 256 frames.
.512 Block demarcation
Input: . . . . count in instruction.

.52 Input-Output Operations

.521 Input: . . . . 1 to 256 frames.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . unload forward or rewind. till end of tape is reached.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . by program.

.54 Format Control

Control: . . . . plugboard.
Format alternatives: . 81.
Rearrangement: . . . . rearrangement of tracks.

.55 Control Operations

Disable: . . . . disable up to 3 tracks manual.
Request interrupt: . . . yes.
Select format: . . . . . none.
Select code: . . . . . . none.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . not necessary.
Output lock: . . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: metallic foil at each end of tape.

.6 PERFORMANCE

.61 Conditions

I: . . . . full speed 1,000 frames/sec.
II: . . . . medium speed 500 frames/sec.

.62 Speeds

.621 Nominal or peak speed: I; 1,000 frames/sec.
II; 500 frames/sec.
.622 Important parameters
Full Speed: . . . . . . 1,000 frames/sec.
Medium speed: . . . . 500 frames/sec.
Start time: . . . . . . 5 msec.
Stop time: . . . . . . 1 msec.
.623 Overhead: . . . . start/stop time.
.624 Effective speeds: . . . I; 1,000N/(N + 6) frames/sec.
II; 500N/(N+6) frames/sec.

N = number of frames per read instruction (256 max).

.63 Demands on System

Component	Condition	msec per frame	or	Percentage
Reading 1 frame at a time:				
Processor:	I	0.07	or	7.
	II	0.07	or	3.5
Reading 2 or more frames at a time:				
Processor:	I	1.0	or	100.
	II	2.0	or	100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comments
Width:	movable tape guides	detents.

.72 Other Controls

Function	Form	Comment
Parity check:	switch	allows checking odd/even or no parity.
Feed control:	switch	allows tape to be fed from reel clockwise (Reel Normal) or counterclockwise (Reel Reverse) or strips (Strip).
Backspace:	lever	moves tape backward one frame.
Rewind:	button	move to end of tape.
Unload:	button	wind forward to end of tape.

§ 071.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	700 feet.

.732 Replenishment time: . . 1 to 2 mins.
reader needs to be stopped.

.733 Adjustment time: . . . 5 to 10 mins.

.734 Optimum reloading period: . . . . 1.4 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	parity check	stoppage and signal to control.
Input area overflow:	none.	
Invalid code:	none.	
Exhausted medium:	tape tension and metallic foil	stoppage, alarm.
Imperfect medium:	sprocket check	stoppage, alarm.
Timing conflicts:	none.	

INPUT-OUTPUT: PUNCHED PAPER TAPE PUNCH

§ 072.

.1 GENERAL

.11 Identity: . . . . Punched Paper Tape Punch and Control 410. Teletype BRPE Punch.

.12 Description

The 410-1 is a combination Punched Paper Tape Punch and Control Unit designed to prepare five-channel punched paper tape, ten frames to the inch, at 110 characters per second. The 410-2 is the same, except that it punches six-, seven-, or eight-channel tape. The image to be punched is packed 4 characters to a 48-bit word. The last character to be punched requires about 4.5 milliseconds of processor time and all other characters occupy the processor full time; i.e., nine milliseconds. For this reason, the programming practice may be to punch one character at a time even though up to 256 characters can be punched by one instruction.

Although (unlike the card code conversion) no special edit instructions are available for paper tape, a very simple and fast subroutine is available for accomplishing character (or digit) to punch code conversion. This technique permits the use of any size (up to eight-bit) or configuration of code patterns.

.13 Availability: . . . . . . 6 months.

.14 First Delivery: . . . . August, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive pull.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . 3 feet.
.213 Feed drive: . . . . . . servo motor.
.214 Take-up drive: . . . . . servo motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . none.
.223 Common system: . . . none.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

	410-1	410-2
Use of station:	punch	punch.
Stacks:	1	1.
Heads/stack:	5 plus sprocket	8 plus sprocket.
Method of use:	frame at a time	frame at a time.

.25 Range of Symbols

Letters: . . . . 410-1; any five-bit code.
Special: . . . . 410-2; any 6-, 7-, or 8-bit code.
Total: . . . . 410-1; 2^5 symbols.
410-2; 2^8 symbols.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
.312 Phenomenon: . . . . . . punch holes.

.32 Positional Arrangement

.321 Serial by: . . . . 10 rows/inch.
.322 Parallel by: . . . . . . 410-1; 5 tracks.
410-2; 8 tracks.
.323 Bands: . . . . none.
.324 Track use

	410-1	410-2
Data:	5	8.
Redundancy check: . .	none	none.
Timing:	1	1.
Control signals: . . .	none	none.
Unused:	none	none.
Total:	5 plus sprocket	8 plus sprocket.

.325 Row use
Data: . . . . all rows.
Gap: . . . . none.

.33 Coding: . . . . 410-1; any 5-bit code.
410-2; any 6-, 7-, or 8-bit code.

.34 Format Compatibility

Other device or system	Code translation
Any compatible punched tape reader:	programmed.

.35 Physical Dimensions

.351 Overall width: . . . . . 410-1; 11/16".
410-2; 7/8" or 1".
.352 Length: . . . . 6 to 1,000 feet.

.4 CONTROLLER

.41 Identity: . . . . H 410.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line: . . . . none.

§ 072.

.43 Connection to Device

.431 Devices per controller: . . . . . . 2.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 256 frames.
.442 Input-output areas: . . core storage
.443 Input-output area access: . . . . . none.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . program.
.447 Synchronizing aids: . . test busy.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 8-bit frame.
.512 Block demarcation Output: . . . . counter in instruction.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 to 256 frames.
.523 Stepping: . . . . 1 frame forward.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . by program.

.54 Format Control: . . . . none.

.55 Control Operations: . . none.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . not necessary.
Output lock: . . . . . . no.
Nearly exhausted: . . . 20 feet.
Busy controller: . . . . not necessary.
End of medium marks: no.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: 110 frames/sec.
.622 Important parameters punch a frame: . . . . 9.09 msec.
.623 Overhead: . . . . none.
.624 Effective speeds: . . . 110 frames/sec.

.63 Demands on System

Component	Condition	msec per frame	Percentage
Processor:			
Processor:	punch 1 frame	4.5	50.
Processor:	punch additional frames	9.1	100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjust guide.

.72 Other Controls

Function	Form	Comment
Rewind:	switch	tape must be removed from punch head.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	1,000 ft.

.732 Replenishment time: . . 2 to 5 minutes. punch needs to be stopped.
.734 Optimum reloading period: . . . . 18 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	not possible.	
Input area overflow:	not possible.	
Output block size:	implicit.	
Invalid code:	not possible.	
Exhausted medium:	check	special branching.
Imperfect medium:	none.	
Timing conflicts:	not possible.	

INPUT—OUTPUT: CARD READER—PUNCH

§ 073.

.1 GENERAL

.11 Identity: . . . . 427-1 Card Reader-Punch (IBM 1402 Card Read-Punch).

.12 Description

The 427-1 Card Reader-Punch utilizes the IBM 1402 Card Read-Punch mechanism, which consists of an 800-card-per-minute reader and a 250-card-per-minute punch housed in the same cabinet. From the user's viewpoint, the reader and punch are completely independent. One 427-1 can be used in a Honeywell 1400 system. The older, 650-card-per-minute model 423-2 Card Reader (see Section 501:073) can be used instead of the 427, although it is no longer available from the manufacturer.

The reader portion of the 427-1 reads standard 80-column cards at a peak speed of 800 cards per minute. A binary image of each card column is stored in a 12-bit section of a 48-bit word. A fixed input area of 20 words (core locations 00054-00073) is reserved for storage of the card image in card column sequence. Special edit instructions can then be used to convert standard Hollerith card codes into any of three internal representations: 6-bit alphameric, 4-bit decimal, or 3-bit octal characters. A hole-count comparison check is made upon each row read from the card, using a second reading station, and the bit configuration of each character is checked for validity after it has been converted to alphameric, decimal, or octal form. If either of these checks discloses an error condition, a forced transfer of control to an error routine will take place.

A hopper with a 3,000-card capacity and 3 stackers with 1,000-card capacities can be loaded and unloaded without stopping the reader. All cards are routed to stacker 3 after they have been read unless a Reject Card instruction specifies that stacker 1 or 2 shall be selected instead. An "Early Card Read" feature is incorporated into the 427-1, providing a 3-point clutch so that card reading can be initiated at 25-millisecond intervals. In addition, an "Interchangeable Feed" feature is available on an optional basis. This feature permits reading of either 80- or 51-column cards by interchanging hardware.

The punch unit punches standard 80-column cards at a peak speed of 250 cards per minute. A fixed output area of 20 words (core locations 00074-00093) is used to store a binary image of the card

.12 Description (Contd.)

to be punched. Punching will usually be preceded by a programmed conversion from internal character code (alphabetic, decimal, or octal) to standard Hollerith code, using special edit instructions. A post-punch reading station permits a hole-count comparison check to be made on the data punched. Any discrepancy results in a forced transfer of control to an error routine after punching is completed on the following card. An Offset Stack instruction can then be used in the error routine to cause the error card to be deposited in the reject stacker. The 1,200-card feed hopper and two 1,000-card stackers (normal and reject) can be loaded or unloaded without stopping the punch.

The 1411 Card Storage Option is available for use with the 427-1 Reader-Punch. The Card Storage Option provides a one-card buffer store which enhances the simultaneous processing capability of the H-1400 system. With this option, either card reading or card punching, but not both, can occur simultaneously with internal processing. Processing is delayed only during the 0.55 millisecond interval that is required to load or unload the card buffer for each card punched or read.

Two types of read and punch instructions are available on the H-1400 system: "interlocked" and "without interlock" instructions. Varying portions of the read and punch cycles are available for simultaneous central processor operations, depending upon whether or not the initiating instruction was interlocked and whether or not the system is equipped with the Card Storage Option. The interlock instruction prevents internal processing during the acceleration period of the reader or punch; if the interlock is removed, then internal processing can proceed during the acceleration period.

During each 75-millisecond card reader cycle, the time available for overlapped internal processing is a minimum 31 milliseconds without interlock and only 6 milliseconds in the interlocked mode. During each 250-millisecond card punch cycle, the time available for internal processing is a minimum 55 milliseconds without interlock and only 10 milliseconds in the interlocked mode. As explained in the preceding paragraph, the Card Storage Option permits better than 99 per cent overlapping of card reading or punching with internal processing.

.13 Availability: . . . . 9 months.

.14 First Delivery: . . . . . January, 1964.

INPUT-OUTPUT: PRINTER (422-3 AND 422-4)

§ 081.

.1 GENERAL

.11 Identity: . . . . Printer.
422-3.
422-4.

.12 Description

The 422-3 and 422-4 are essentially identical units except that the 422-3 can print in any 120 out of 160 print positions and is plugboard-wired, whereas the 422-4 has a fixed 120 positions. They are manufactured by Honeywell, but are quite similar to the equivalent Anelex units. The printers can print at up to 900 lines per minute, single spaced. At double and one-inch spacing, the speed drops to 800 and 560 lines per minute respectively. These speeds are due to unclutched operation which permits printing to begin as soon as requested, provided that the unit has completed the previous operation. Printing with a restricted range of symbols may increase the speed up to 1,200 lines per minute. Paper tape loop control provides automatic or semi-automatic paper spacing.

Options

A print storage option is available which eliminates about 98% of the processor time that is required when the buffer is not used. Without the buffer, the processor is inhibited for 53 milliseconds after a print instruction is initiated, after which computing may resume.

A 6 or 8 line per inch vertical spacing option is also available.

.13 Availability: . . . . . . 9 months.

.14 First Delivery: . . . . December, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive push & pull tractors.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . on the fly hammer stroke against engraved drum.

.23 Multiple Copies: . . . . yes.

.231 Maximum number
Interleaved carbon: . 10 (8-pound paper).

.232 Types of master
Multilith: . . . . yes.
Xerox: . . . . yes.
Spirit: . . . . yes.

.24 Arrangement of Heads

	Type 422-3	Type 422-4
Use of station:	print	print.
Stacks:	1	1.
Heads/stack:	160 (120 used at a time)	120.
Method of use:	line at a time	line at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special*:	20	' = & + ; .) %- # $ ' / @ , (* C_R : □
ALGOL set:		yes.
FORTRAN set:		yes.
Basic COBOL set: . . .		yes.
Total:	56.	

* Also, 6 special drums are available with different special symbols.

Model 1 uses the same special characters as the IBM 407 keypunch, but with the following added:

' = +) ("

Model 2 uses the IBM 12F "Selfcheck" font, suitable for use with the optical scanner.

Model 3 and 4 include the pound sterling symbol (£) as well as the dollar sign ($).

Model 5 replaces various commercial symbols with lower case t and o and the following Greek letters:

Δ ∈ ϕ θ λ

Model 6 adds second versions of the following:

- . /

and adds:

¢ and ½

The following are omitted:

" + ;) (

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper.
.312 Phenomenon: . . . . . . printing.

§ 081.

.32 Positional Arrangement

.321 Serial by: . . . . line, 6 or 8 per inch.
.322 Parallel by: . . . . . . 120 char, 10 per inch.

.33 Coding: . . . . 6 bits per char.

.34 Format Compatibility: . none.

.35 Physical Dimensions

.351 Overall width: . . . . . 3.5 to 22 inches.
.352 Length: . . . . indefinite.
.353 Maximum margins
Left: . . . . 3 inches.
Right: . . . . 3 inches.

.4 CONTROLLER

.41 Identity: . . . . 450 Print Storage Option.
418 Off-line Controller (422-4) only.
1400 Central Processor.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line

Use	Associated equipment
Printer:	Off-line Controller Type 418 using a Magnetic Tape Type 404-3 and a Printer Type 422-4.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 120 char.
.442 Input-output areas: . . fixed in core.
.443 Input-output area access: . . . . char or words.
.444 Input-output area lockout: . . . . yes.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.
.447 Synchronizing aids: . . interrupt when finished printing, and before spacing.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 120 char.
.512 Block demarcation
Output: . . . . fixed.

.52 Input-Output Operations

.522 Output: . . . . 1 line.
.523 Stepping: . . . . print then step, 0 to 63 lines.
.524 Skipping: . . . . paper tape loop; print then skip.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . edit instructions.

.54 Format Control

Rearrangement: . . . . plugboard.
Insert spaces: . . . . . yes.
Recording density: . . . none.

.55 Control Operations

"End of run" light: . . . activate.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . not necessary.
Nearly exhausted: . . . 30 lines.
Busy controller: . . . . yes.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: 900 lines per min.
.622 Important parameters
Cycle time: . . . . . . 67 msec.
Printing time: . . . . 53 msec.
Spacing time first line: . . . . 14 msec.
Spacing time additional line: . . . 8 msec.
.623 Overhead: . . . . spacing time; operation is unclutched.
.624 Effective speeds: . . . 60,000/(59+8L) lines/min.
L = average number of lines skipped per print.

.63 Demands on System

Component	Condition	msec per line	or Percentage
Processor:	print	53.0	79.1.
Processor with print storage option:	print	0.84	1.3

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method
Head of form:	hand-operated vernier screw.

.72 Other Controls

Function	Form
Manual single space: .	button.
Manual form space: . .	button.
Stop at next head of form:	button.

.73 Loading and Unloading

.731 Volumes handled: . . . box of forms.
.732 Replenishment time: . . 0.5 to 3 mins.
needs to be stopped.
.733 Adjustment time: . . . 2 to 5 mins.
.734 Optimum reloading period: . . . . ?

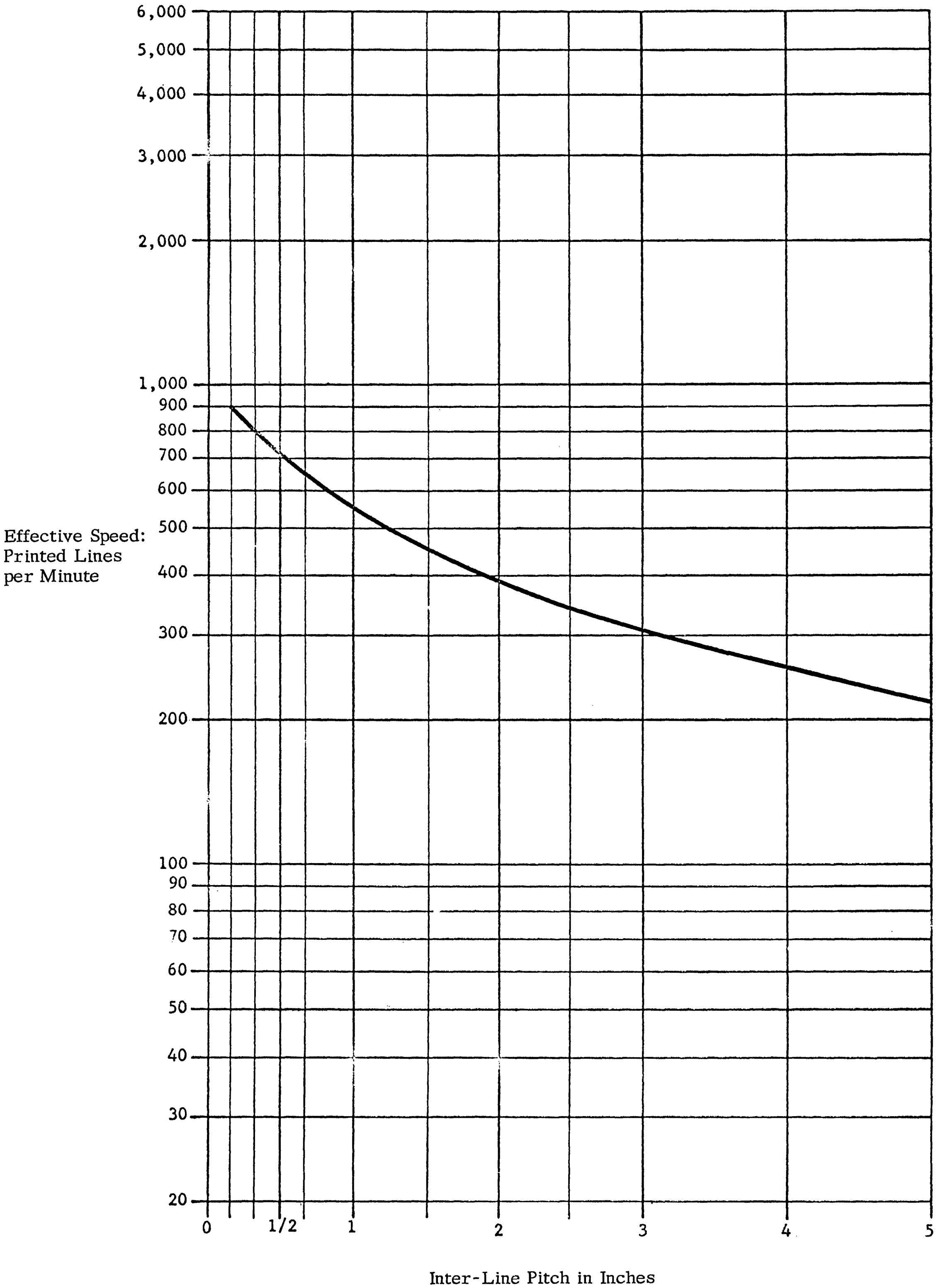
§ 081.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	program jump.
Output block size:	fixed.	
Invalid code:	none.	
Exhausted medium:	interlock	device stoppage with operator indication.
Ribbon Tension:	interlock	device stoppage with operator indication.
Cycle check:	check	device stoppage with operator indication.

§ 081.

EFFECTIVE SPEED
422-3 AND 422-4 PRINTERS



INPUT-OUTPUT: MAGNETIC TAPE

§ 091.

.1 GENERAL

.11 Identity: . . . . Magnetic Tape Unit. 404-1, 404-2, 404-3.

.12 Description

Except in speed, the 404-1, 404-2 and 404-3 Magnetic Tape Units are similar units. The 404-1 and 404-2 pass tape at 120 inches per second and the 404-3 at 60 inches per second. Rewinding speed is three times as fast in each case. A row on any 404 tape consists of ten bits, including eight for data and one each for parity and timing. Each row contains either two digits or one and a third characters; i.e., an eight-bit segment from a 48-bit word. The recording density is 400 rows per inch on the 404-1 and 404-3, and 555 rows per inch on the 404-2. Peak and effective data transfer speeds, in characters per second and digits per second, are shown below.

When card reading is liable to be in process simultaneously with tape operations, tape block lengths must be limited so that no interference occurs between the two operations. This is done by providing an 18-millisecond period before the card reader starts transferring data, during which time no tape read or write operations will be initiated. It is therefore advised that no tape instructions should be allowed which will take longer than this 18 milliseconds to complete. This reduces the effective speed to between one-third and one-half of the peak speed. Details are shown in the table below.

To keep tape running at full speed requires very careful programming. After the data transmission

.12 Description (Contd.)

has ceased, there is time for only 20 simple instructions to be executed before a further tape instruction is given. Since magnetic tape input and output can be overlapped with one another but not with internal processing, programming is geared towards processing a block and then writing it out and reading in the next block at the same time. It is not possible to use the same area for simultaneous input and output.

Orthotronic control words (which consist of 96 parity bits arranged in two words) can be generated by program in the processor and appended to the tape record. Special instructions are also included in the processor to use the Orthotronic words in reconstructing data read from tape with parity errors. When the errors can be traced to a particular track on the tape, a special read instruction is used to regenerate the data. The incorrect track is replaced by a new track generated from the remaining data and parity tracks. The Orthotronic procedures can also be used to verify this data.

These units are equipped with vacuum capstans and brakes which minimize wear by spreading acceleration forces over a larger area of tape than is customary with pinch rollers. The oxide surface of the tape touches only the read-write head. The reels and sections of the tape are accessible even when reading or writing is taking place, although this disrupts the pressurized, air-cleaned environment that is normally maintained over the tape. A write-enable ring can be inserted after tapes have been mounted. A second write interlock is provided by a toggle switch on the control panel.

Performance Characteristics of 404 Tape Units

Condition:	Not Stopping Between Blocks			Stopping Between Blocks		
Model:	404-3	404-1	404-2	404-3	404-1	404-2
Peak Rates:						
Char/sec.	32,000	64,000	89,000	32,000	64,000	89,000
Digits/sec.	48,000	96,000	133,000	48,000	96,000	133,000
Effective Rates (1,000 character blocks):						
Char/sec.	24,200	48,400	58,500	21,400	39,000	47,000
Digits/sec.	36,300	72,600	87,750	32,100	58,850	70,500
Suggested maximum block sizes:						
Characters	400	800	1,120	400	800	1,120
Digits	600	1,200	1,680	600	1,200	1,680
Effective Rates with suggested block sizes:						
Char/sec.	17,400	43,000	60,000	14,500	35,000	49,000
Digits/sec.	26,100	64,500	90,000	21,750	52,500	73,500

§ 091.

.13 Availability: . . . . . 6 months.

.14 First Delivery: . . . . 404-1 December, 1961.
404-2 1962.
404-3 January, 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . vacuum capstan.
.212 Reservoirs
Number: . . . . . . 2.
Form: . . . . vacuum.
Capacity: . . . . . . 7 feet each.
.213 Feed drive: . . . . . own motor.
.214 Take-up drive: . . . . own motor.

.22 Sensing and Recording Systems

.221 Recording system: . . magnetic head.
.222 Sensing system: . . . magnetic head.
.223 Common system: . . . single head.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . D. C. erase.
Stacks: . . . . 1.
Heads/stack: . . . . 1.
Method of use: . . . . full row.

Use of station: . . . . read/write.
Distance: . . . . . . 0.213 inch.
Stacks: . . . . 1.
Heads/stack: . . . . . 10.
Method of use: . . . . row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic base magnetizable tape.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . . row, 400 per inch.
.322 Parallel by: . . . . . 10 tracks, 0.035 inch.
.323 Bands: . . . . none.
.324 Track use
Data: . . . . 8.
Redundancy check: . . 1.
Timing: . . . . . . 1.
Total: . . . . 10.
.325 Row use
Data: . . . . 3 to 511 words.
Gap: . . . . 0.61 inch.

.33 Coding: . . . . 8 bits out of a 48-bit word are recorded in each row; this may be considered two digits or 1-1/3 alpha characters.

.34 Format Compatibility

Other device or system	Code translation
Honeywell 800/1800: .	compatible.
Honeywell 400 off line printers: . . .	compatible.
Honeywell 1400: . . .	compatible.

.35 Physical Dimensions

.351 Overall width: . . . . 0.748 to 0.750 in.
.352 Length: . . . . 250 to 2,550 feet.

.4 CONTROLLER

.41 Identity: . . . . built into processor.

.42 Connection to System

.421 On-line: . . . . 1.
.422 Off-line

Use	Associated equipment
Connect H 400 to H 1400/H 800 or other H 400:	H 800 or H 1800 and type 405 switch.
Off-line printer: . .	type 418 off-line controller & type 422-4 printer.

.43 Connection to Device

.431 Devices per controller: 8.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 3 to 511 words.
.442 Input-output areas: . . any core location.
.443 Input-output area access: . . . . any word.
.444 Input-output area lockout: . . . . . . none.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 3 to 511 words.
.512 Block demarcation
Input: . . . . gap.
Output: . . . . count in instruction.

.52 Input-Output Operations

.521 Input: . . . . 1 block forward.
.522 Output: . . . . 1 block forward.
.523 Stepping: . . . . . . 1 block forward or backward.
.524 Skipping: . . . . . . none.
.525 Marking: . . . . . . none.
.526 Searching: . . . . . . none.

.53 Code Translation: . . matched codes.

.54 Format Control: . . . none.

§ 091.

.55 Control Operations

Disable:	yes.
Request interrupt:	no.
Select format:	no.
Select code:	not necessary.
Rewind:	yes.
Unload:	no.

.56 Testable Conditions

Disabled:	no.
Busy device:	not necessary.
Output lock:	no.
Nearly exhausted:	1 block writing.
Busy controller:	none.
End of medium marks:	implicit.

.6 PERFORMANCE

.61 Conditions

I:	stopping between blocks.
II:	not stopping between blocks.

.62 Speeds

.621 Nominal or peak speed

404-3:	48,000 digits/sec. 32,000 characters/sec.
404-1:	96,000 digits/sec. 64,000 characters/sec.
404-2:	133,000 digits/sec. 89,000 characters/sec.

.622 Important parameters

	404-3	404-1, 404-2
Start/stop time msec:	3.5/5.0	2.7/3.5
Start/stop distance inches:	0.15/0.24	0.15/0.27
Gap, inches:	0.67	0.67
Min. cross-gap time:	11.1	5.55
Additional time if tapes stop between blocks (msec):	3.9	4.15
Tape speed (ins/sec):	60	120
Pulse density (rows/in):	400	400 (404-1) 555 (404-2)

.623 Overhead: gap time.
start/stop time.
Orthotronic check word passage time.

.624 Effective speeds

Not stopping between blocks

404-3:	48,000N/(556+N) digits/sec. 32,000C/(370+C) char/sec.
404-1:	96,000N/(556+N) digits/sec. 64,000C/(370+C) char/sec.
404-2:	133,000N/(760+N) digits/sec. 89,000C/(510+C) char/sec.

.624 Effective speeds (Contd.)

Stopping between blocks

404-3:	48,000N/(732+N) digits/sec. 32,000C/(488+C) char/sec.
404-1:	96,000N/(954+N) digits/sec. 64,000C/(636+C) char/sec.
404-2:	133,000N/(1,284+N) digits/sec. 89,000C/(876+C) char/sec.

where N = number of decimal digits per block.
C = number of alphameric characters per block.

.63 Demands on System

Component	Operation	Msec per block	Percentage
Processor:	compute Orthocount	0.08 + 0.013n, where n = number of words.	100%
Processor:	read, write, or read and write	variable; does not include stop time of tape	100% of start and data transfer time.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Write release:	write ring	can be done while tape is in motion.

.72 Other Controls

Function	Form	Comment
Tape change:	toggle	3 position automatic rewind unload, load, permit write load, inhibit write (always in read status).

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Spool:	2,550 feet.

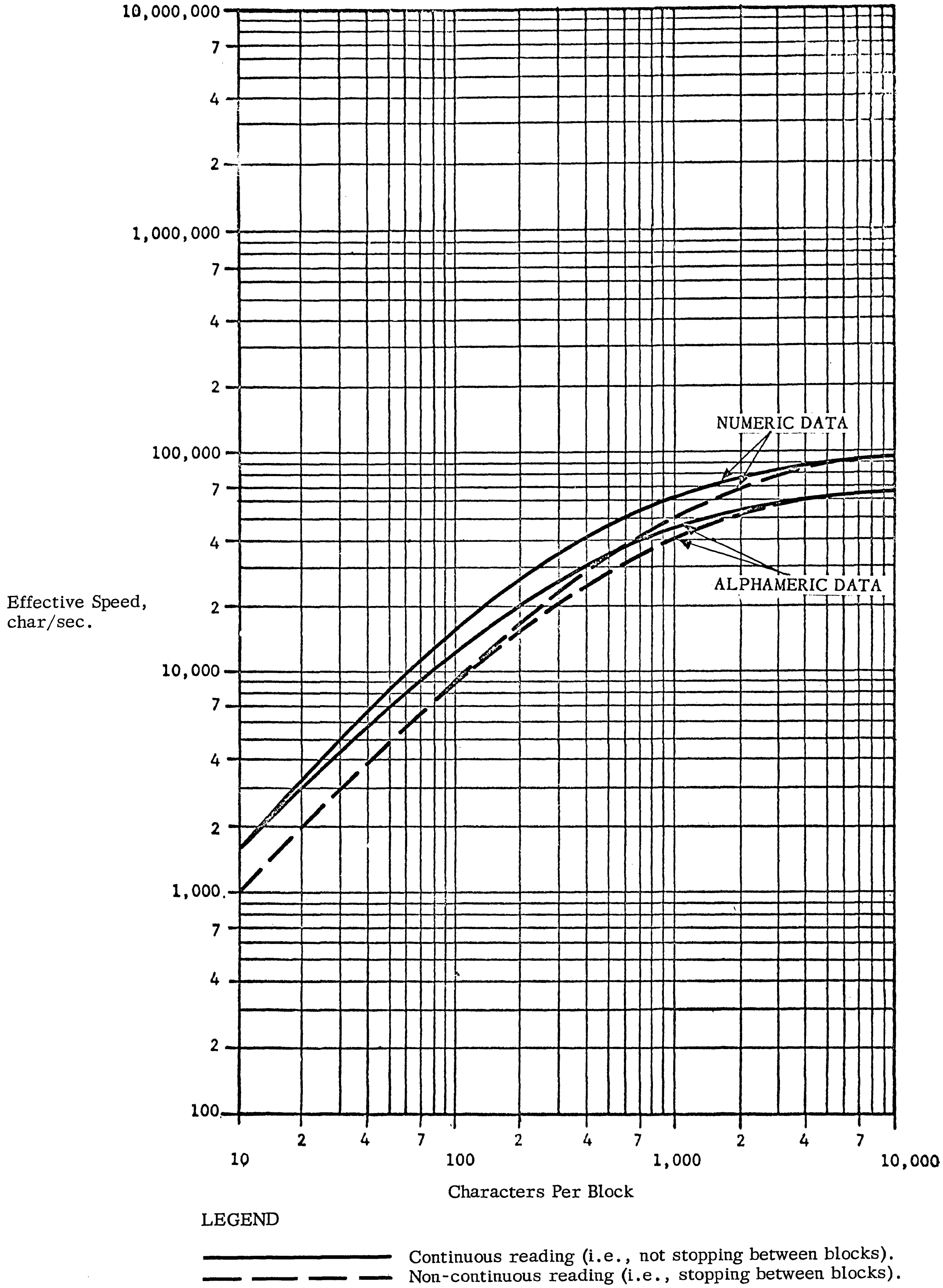
.732 Replenishment time: 0.5 to 1.0 min.; needs to be stopped.
.733 Adjustment time: 0.5 to 1.0 min.
.734 Optimum reloading period: 5.66 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	row parity and Orthocount	program jump.
Input area overflow:	check	program jump.
Output block size:	none.	
Invalid code:	not possible.	
Exhausted medium:	check	program jump.
Imperfect medium:	pre-checked tapes.	
Error correcting:	Orthocount	program.

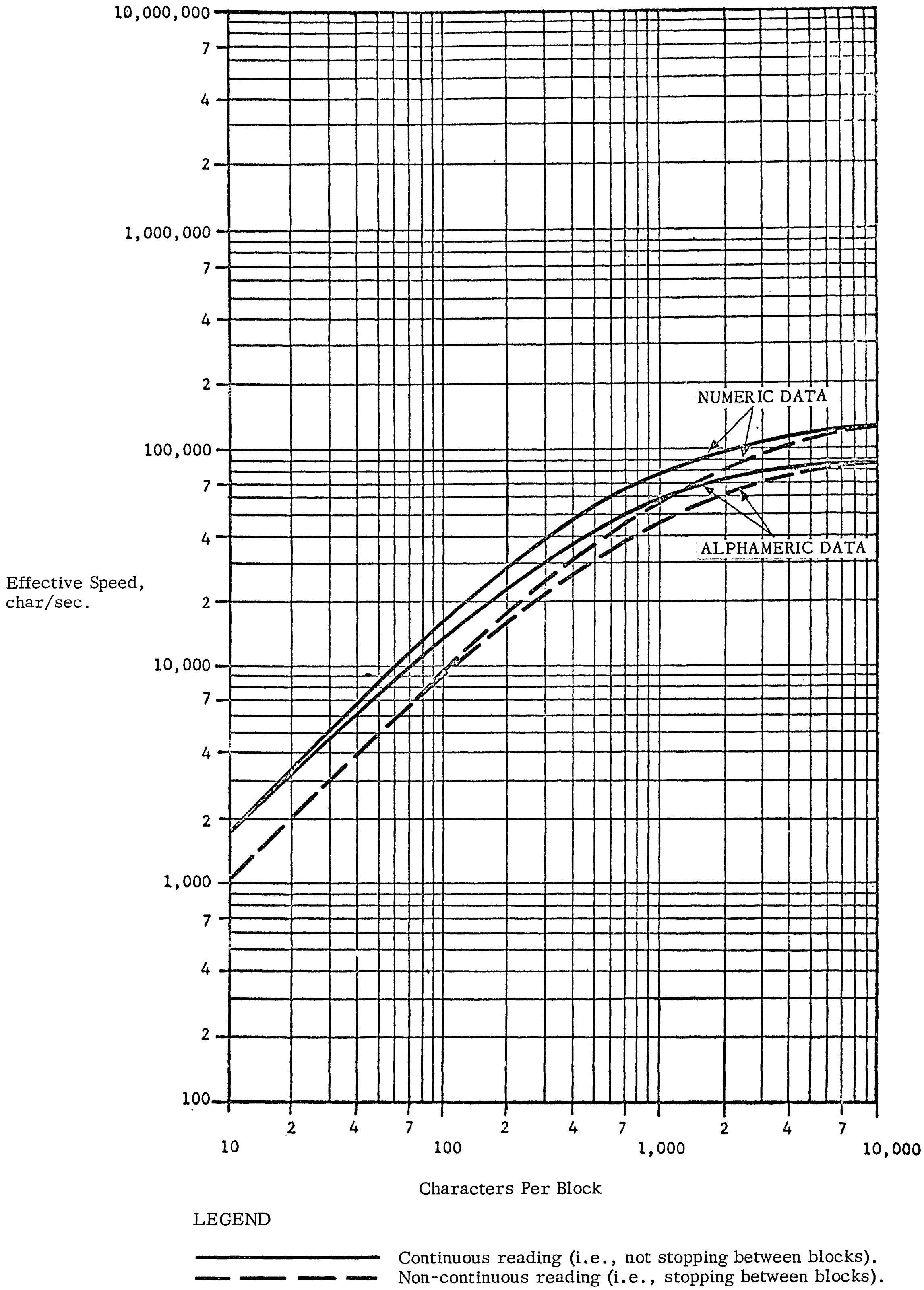
§ 091.

EFFECTIVE SPEED
H-404-1 MAGNETIC TAPE UNIT



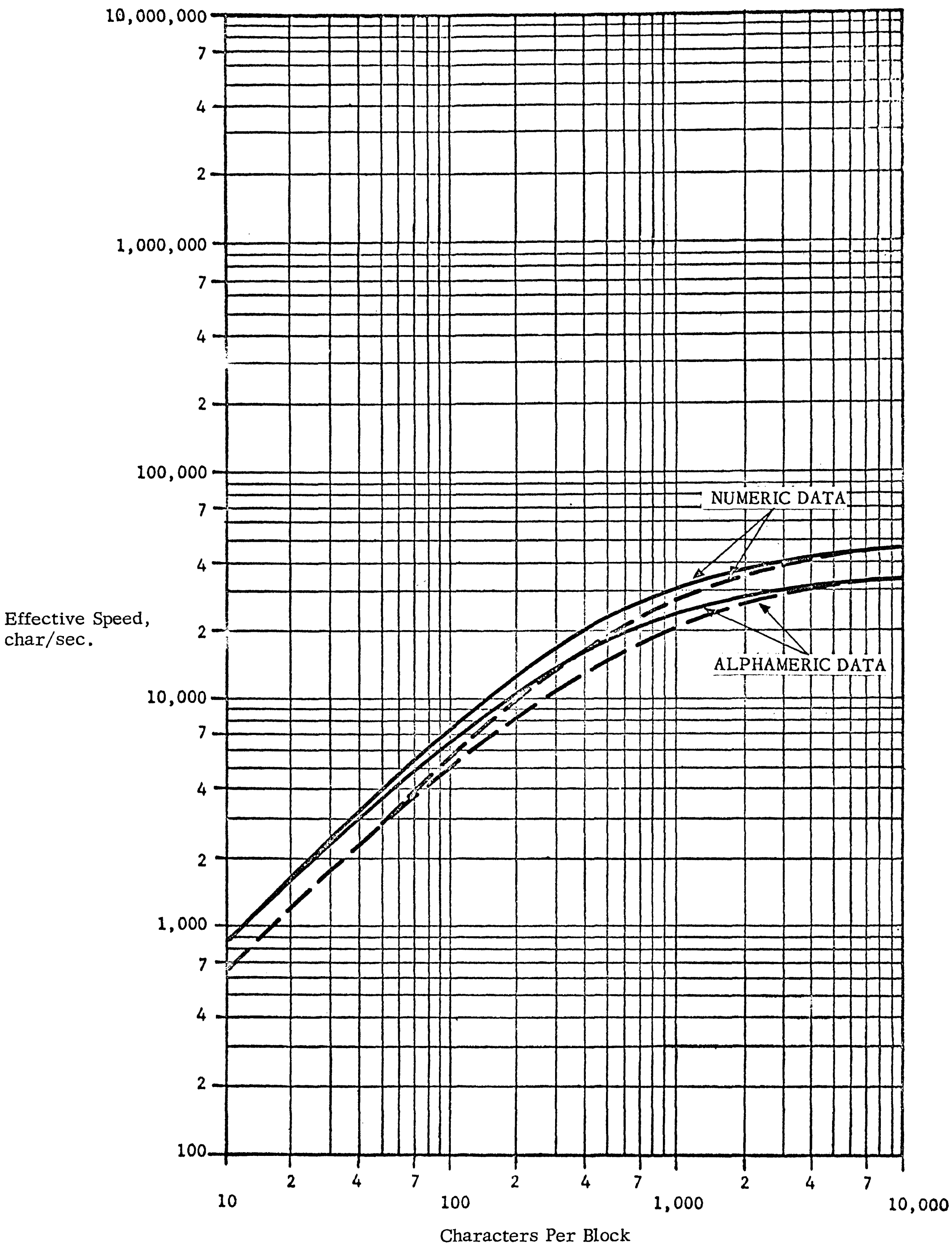
§ 091.

EFFECTIVE SPEED
H-404-2 MAGNETIC TAPE UNIT



§ 091.

EFFECTIVE SPEED
H-404-3 MAGNETIC TAPE UNIT



LEGEND

——— Continuous reading (i.e., not stopping between blocks).
— — — Non-continuous reading (i.e., stopping between blocks).

INPUT-OUTPUT: COMMUNICATIONS CONTROL

§ 101.

.1 GENERAL

.11 Identity: . . . . 480 Communications Control.

.12 Description:

The 480 Communications Control is a 150 eight-bit character buffer and the associated controls that enable it to communicate with another 480, and 880 (a similar unit used with the H-800), an IBM 1009 Data Transmission Unit, or an IBM 7701 Magnetic Tape Transmission Terminal. The 480 can either send or receive data at a speed of 75 or 150 characters per second.

The 480 informs the processor that it has sent or received a block of data by means of an interrupt. The processor then either sends new data or ac-

.12 Description: (Contd.)

cepts the accumulated data. The characters are stored, as are punched tape characters; i.e., four characters to a word, right-justified in twelve-bit sections, and the same conversion and checking are necessary under program control. This process requires about 0.7 millisecond per character. It is expected that the 480 can be used continuously, using no more than 20% of the processor's time for all control and conversion operations.

The 480 uses a four-out-of-eight-bit character code for transmission that lessens the chance of leaving errors undetected. This unit connects to commercial transmission services through modulation equipment which is currently available.

INPUT-OUTPUT: TAPE CONTROL UNIT

§ 102.

.1 GENERAL

.11 Identity: . . . . Tape Control Unit. 436-1.

.12 Description

The Model 436-1 Tape Control Unit is an input-output device for the Honeywell 1400 system designed to operate with one IBM 729-II magnetic tape transport to permit reading and writing binary coded decimal information on IBM magnetic tape. The Model 436-1 Tape Control Unit and its associated IBM 729-II Tape transport will read tapes which have been written on an IBM 727, 729-II, 729-IV, or 7330 tape unit, and will write tapes which are readable on any of these units. It will not permit simultaneous reading and writing. Only 729-II tape transports can be connected to the Model 436-1 Tape Control Unit, and only BCD information can be read or written, at a density of 200 or 556 characters per inch.

Each IBM 7-bit row (six information bits, one parity) is read into the H-1400 as if it were a 9-bit row on Honeywell tape. Channels 1 through 6 correspond directly; IBM channel 7 (parity) is treated as H-1400 channel 9 (parity); and H-1400 channels 7 and 8 contain zeros. The eight data bits from these rows are positioned in memory, six rows to the word, in standard H-1400 configuration. Translation of these 8-bit groups into the corresponding H-1400 6-bit codes is automatic.

The 436-1 Tape Control Unit accepts and implements the normal H-1400 tape instructions.

Error Checking

A. Read Errors

Read checks implemented in the 436-1 Tape Control Unit include row parity and longitudinal parity checks. If an error is detected, a read error condition is stored.

B. Write Errors

Row parity and longitudinal parity are generated within the 436-1 and are checked by the IBM read-after-write checking feature. An echo check is performed with signals generated in the 729-II tape drive during writing. Any attempt to write on a file-protected tape results in a write error.

.13 Availability: . . . . . . 9 months.

.14 First Delivery: . . . . . July, 1963.

INPUT-OUTPUT: MAGNETIC TAPE SWITCHING UNIT

§ 103.

.1 GENERAL

.11 Identity: . . . . Model 405 Magnetic Tape Switching Unit.

.12 Description

The Model 405 Magnetic Tape Switching Unit is designed to permit manual switching of one Model 404 or Model 804 Magnetic Tape Unit between any two H-400, H-1400, or H-800 devices that can be connected to a magnetic tape unit. (It should be noted, however, that a magnetic tape unit cannot be switched to a given device unless it is possible to attach it to that device directly.) This unit operates solely as a switching device and performs no logical operations on the information flowing through it. Up to four Model 405 Magnetic Tape Switching Units can be used. Switching Units are field installable.

A Model 405 Magnetic Tape Switching Unit is most commonly used to switch a magnetic tape unit between a model 401 or 1401 central processor and one of the following devices:

1. Another model 401 or 1401 central processor.
2. A model 803 tape control unit.
3. An H-800 off-line peripheral control unit (PCU).
4. A model 418 off-line printer control.

.13 Availability: . . . . . 6 months.

.14 First Delivery: . . . . May, 1963.

INPUT–OUTPUT: 484 COMMUNICATION CONTROL

§ 104.

.1 GENERAL

.11 Identity: . . . . 484 Communication Control.

.12 Description

The 484 Communication Control is a multi-channel communication control which allows the H-1400 to handle up to 56 messages simultaneously from a variety of remote devices. It is intended primarily for use in inquiry station applications and operates at speeds up to 300 characters per second.

Each channel of the 484 requires a separate 485 Communication Adapter Unit which is tailored for each remote device. Among the devices that can be handled by the 484 are: teletype networks, typewriter inquiry stations, paper tape readers, and specially designed management consoles.

There are four models of the 484 Communication Control, whose buffer storage facilities vary as follows:

- 484-1; up to 7 input-output buffers.
- 484-2; up to 14 input-output buffers.
- 484-3; up to 28 input-output buffers.
- 484-4; up to 56 input-output buffers.

.12 Description (Contd.)

Each buffer can hold up to 16 characters, and each is individually addressable by the program. Simultaneous send-receive operations over the same communications channel can be accommodated by assigning two buffers to that channel.

Code translation between the internal 6-bit code and any of the Baudot or ASA Standard codes is automatic; any other special code translation must be done in the central processor by programming. A parity checking scheme is included for checking the accuracy of incoming and outgoing messages. Error conditions generate an interrupt signal which causes the program to transfer to a special corrective routine. Where applicable, this routine can attempt to have the error message retransmitted.

Interrupt facilities are used to transfer data between core storage and the device whenever a buffer area is filled or emptied. The bit transfer rate is 12 bits every 13 microseconds. Each 484 Communication Control requires one H-1400 I/O trunk, and a maximum of five 484's can be connected.

INPUT–OUTPUT: 481 COMMUNICATION CONTROL

§ 105.

.1 GENERAL

.11 Identity: . . . . 481 Communication Control.

.12 Description

The 481 Communication Control is a single-channel control device which is intended for use in low-volume inquiry traffic. It is also suitable as a supplement to the 484 Communication Control in those situations requiring an additional I-O channel. Except for operating on a smaller scale, the general characteristics of the 481 unit are essentially the same as those described in the preceding section for the 484 unit (Section 505:104). The following list enumerates all significant characteristics which are different for the 481:

- single channel device.
- one 4-character buffer.
- no automatic code translation.
- one 485 Communication Adapter Unit designed for either send or receive operation.
- bit transfer rate is 6 bits every 13 micro-seconds.

INPUT—OUTPUT: 480 COMMUNICATION CONTROL

§ 106.

.1 GENERAL

.11 Identity: . . . . 480 Communication Control.

.12 Description

The 480 Communication Control handles the transfer of data between the H-1400 and another computer or high-speed remote device. It is intended primarily for communication with one of the following:

- H-400 or 1400 system equipped with another 480.
- H-800, 1800, 800-II, or 1800-II system equipped with an 880 Communication Control.
- IBM 1401 or 1410 system equipped with a 1009 Data Transmission Unit.
- IBM 1013 Card Transmission Terminal.
- IBM 7701 or 7702 Magnetic Tape Transmission Terminal.

Data conversion subsets are required at each end of the communication line in order to convert a-c line frequencies to/from digital form. The manufacturer recommends using the Bell System Data-Phone 200 series, which have conversion rates from 1,200 to 2,400 bits per second.

.12 Description (Contd.)

The 480 performs the following functions:

- It establishes synchronization with remote equipment.
- In accordance with read, write, and control instructions issued in the central processor, it controls the flow of data between the H-1400 and the remote equipment.
- It supplies an input-output buffer area of 512 six-bit characters.
- It performs code translations between internal 6-bit code and a 4-out-of-8 transmission code that is designed to improve error detection capability.
- It generates all control codes and performs most control functions automatically.

Each 480 Communication Control requires one H-1400 I/O channel. The 480 informs the processor that it has sent or received a block of data by means of an interrupt. The processor then either sends new data or accepts the accumulated data. The data transfer rate between the 480 and the central processor is 12 bits every 19.5 microseconds. It is expected that the 480 can be used continuously, using no more than 20% of the processor's time for all control and conversion operations.

SIMULTANEOUS OPERATIONS

§ 111.

A Honeywell 1400 system with magnetic tape, punched card equipment, and an on-line printer is capable of only three sets of truly simultaneous operations:

(1) Tape reading simultaneously with tape writing.
(2) Printing and any other operation, if the Print Storage Option is installed.
(3) Card reading or card punching with any other operation, if the Card Storage Option is installed.

This configuration can perform no other truly simultaneous operations - neither operations involving the central processor and one of the peripheral units, nor those involving two peripheral units. However, in both cases, a limited amount of effective simultaneity is possible.

Some of the other available units are able to overlap all or part of their mechanical cycles with internal processing. These include the H-460 Magnetic Disc System, which can position its read/write heads while processing continues, and the Communication Control Unit, which is completely buffered.

Central Processor/Peripheral Unit Simultaneity

When a peripheral unit is starting (before the actual data transfer), the central processor can sometimes operate. Table 1 indicates the basic peripheral units with which this feature is possible.

Peripheral Unit/Peripheral Unit Simultaneity

Two magnetic tape units can operate simultaneously, one reading and one writing. If one operation takes longer than the other, the central processor is delayed for the longer time. A paper tape operation which lasts less than 18 milliseconds (the time to punch 1 character or read 6) can be overlapped with the start-up time of the card units.

Printing can operate simultaneously with another input-output operation only if the Print Storage Option is installed. Card reading or card punching (but not both) can proceed simultaneously with other operation(s) only if the Card Storage Option is installed.

Other Operations

Rewinding and backspacing of magnetic tapes are not carried out under continuous computer control. After they have been initiated, the central processor is no longer concerned with their operation and becomes available for other functions.

Programming Considerations

These considerations arise in connection with the card reader. While card reading is in process, the programmer has the option of using the start-up time for other work. If he does so, 18 milliseconds before the actual data transmission from the reader starts, a number of specific instructions will be interlocked in order to prevent garbling of the input. It follows that, in these circumstances, no instruction which can engage the central processor longer than 18 milliseconds shall be executed once a card read operation has been initiated.

This restriction particularly affects magnetic tape operations, and limits maximum block lengths to specific sizes, depending on the magnetic tape unit concerned. These are (in alphabetic characters): 400 characters for the H-404-3, 800 characters for the H-404-1, and 1,120 characters for the H-404-2.

§ 111.

Programming Consideration (Contd.)

Honeywell EDP Division (Training and Research) recommends that this situation be avoided entirely by always using a pre-edit run to transcribe the punched cards to tape, and then processing the card images against the main file.

TABLE 1

Peripheral Unit	Cycle (msec)	Start Time Availability and Time (msec)		Transmission Availability and Time (msec)		Stop Time Availability and Time (msec)	
Card Reader 423-2 without Card Storage	93	√	33 to 126[c]	x	54	√	6
Card Reader 423-2 with Card Storage	93	√	33 to 126	√	54	√	6
Card Reader 427 without Card Storage	75	√	23 to 42	x	46	√	6
Card Reader 427 with Card Storage	75	√	23 to 42	√	46	√	6
Card Punch 427 without Card Storage	240	√	65 to 305	x	178	√	7
Card Punch 427 with Card Storage	240	√	65 to 305	√	178	√	7
Printer without Print Storage	67 + 8 LS	x	1.3	x	51.7	√	14 + 8 LS
Printer with Print Storage	67 + 8 LS	x	1.3	√	51.7	√	14 + 8 LS
Magnetic Tape 404-3	variable[a]	x	5.0[d]	x	variable	√	10.0[d]
Magnetic Tape 404-1	variable[a]	x	5.0[d]	x	variable	√	4.7[d]
Magnetic Tape 404-2	variable[a]	x	5.0[d]	x	variable	√	4.7[d]
409 Paper Tape Reader:							
Reading 1 character	1	x	0.0	x	0.01	√	1.0
Reading 2 or more characters	C[b]	x	1 to 7	x	(C - 1)	√	1.0
410 Paper Tape Punch	9.1	x	4.0	x	9.1(C - 1)	√	5.1
Console	100	√	0 to 100	√	100		-

√ - time is available for central processor work.
x - time is not available for central processor work.
a - dependent on block length.
b - where C = number of characters read.
c - dependent on the time relative to the clutch point within the card cycle.
d - assuming Magnetic Tape has been stopped between blocks.
LS - number of lines skipped between printed lines.

INSTRUCTION LIST

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
ADD	Decimal Add	Adds (A) to (B), stores result in C; treats operands as signed 11 decimal digits.	78 + 45.5T(1)
BAD	Binary Add	Adds (A) to (B), stores result in C; treats operands as unsigned binary numbers	71.5
BST	Backspace Tape	Backspaces specified magnetic tape by one record.	-(2)
BSU	Binary Subtract	Subtracts (B) from (A), stores result in C; treats operands as 48-bit numbers.	71.5
CHP	Check Parity	Checks parity of n words; corrects parity of first bad word then subsequences to C.	65 + 13n
COC	Compute Orthotronic Count	Computes the orthocount for n consecutive words, beginning with the word at A. It stores first orthoword in C; second in C + 1.	84.5 + 13n
CPI	Control Peripheral Input	Directs the peripheral device connected to the input trunk specified in B to perform the operation also specified in B. These operations include Start, Halt, Rewind, and Rescan Document.	65 + unit mech. time(7)
CPO	Control Peripheral Output	Is the same as CPI, except that it controls a device connected to an output rather than an input peripheral trunk. Possible operations include Start, Stop, Pocket Selection.	65 + unit mech. time(7)
DIV	Decimal Divide	Divides (B) by (A), stores result in C, and stores remainder in remainder word; treats operands as signed 11 decimal digits.	Avg. 3.77ms; T = 6.5 $[185+8(Q_1+Q_2+\ldots\ldots Q_n)]$ Q = Magnitude of Quotient
ECA	Card Edit, Alphanumeric	Edits n consecutive characters of alphanumeric data from card area; stores edited data in memory, beginning with specified position in word at A.	52+8.13n C odd 52+9.75n C even
ECD	Card Edit, Signed Decimal	Edits n consecutive characters of decimal data from card area; stores edited data in one word, beginning with specified position in word at A.	58.5+7.67n C odd 58.5+8.65n C even
ECO	Card Edit, Octal	Is the same as ECA, except that data is edited into octal format	52+7.3n C odd 52+8.13n C even

Entire Instruction List reprinted from Honeywell 1400 Summary Description, pp. 31-38.

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
ECU	Card Edit, Unsigned Decimal	Is the same as ECA, except that data is edited into decimal format	52+7.35n C odd 52+8.65 C even
EPA	Print Edit, Alphanumeric	Edits n consecutive alphanumeric characters, beginning with the one specified in word at A, into the print area in consecutive positions, beginning with one specified by C.	52+8.13n
EPD	Print Edit, Decimal	Is the same as EPA, except data is edited from decimal format into print area.	52+8.13n
EPO	Print Edit, Octal	Is the same as EPA, except that data is edited from octal format into print area.	52+8.13n
EXC	Extended Compare	Compares (A) with (B), bit by bit, then (A + 1) with (B + 1), etc., until two operands are found unequal. If "A" operand is less than "B", sequence changes to C.	32.5+52n(3)
EXT	Extract	Places (A) in word at C wherever (B) contains a 1 bit; places 0 bits in all other positions in word at C.	78
FPA	Floating-Point Add	Adds (A) to (B), stores result in C; treats operands as normalized, floating-point words composed of a 1-digit sign, 2-digit exponent, and a 9-digit mantissa.	130-149(11)
FPS	Floating-Point Subtract	Subtracts (B) from (A), stores result in C; treats operands as normalized, floating-point words composed of a 1-digit sign, 2 digit exponent, and a 9-digit mantissa.	130-149(11)
FPM	Floating-Point Multiply	Multiplies (A) by (B), stores result in C; treats operands as normalized floating-point words.	1014+39n(11) n = no. of non-zero digits in multiplier.
FPD	Floating-Point Divide	Divides (B) by (A), stores result in C; treats operands as normalized floating-point words.	884-4641(11)
FLT	Float	Converts Fixed-point decimal word in B to normalized floating-point decimal word under control of exponent in A, stores result in C.	76+13n(11) n = no. of digit shifts

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
HAD	Half Add	Adds (A) to (B) without carries; treats operands as unsigned binary numbers; stores result in C.	65
HLT	Halt	Stops the central processor, depending on the setting of the console breakpoint switches and on B.	45.5
LAC	Less than or Equal Comparison, Alphanumeric	Compares (A) to (B) bit by bit; sequence changes to C if (A) ≤ (B). Otherwise, continue in sequence.	78
LDA	Locate Disc Address	Directs the random access storage unit on the output trunk specified in B to position the read/write head at the disc address stored in main memory location (A).	78 + unit mech. time(7)
LNC	Less than or Equal Comparison Numeric	Compares (A) and (B); treats operands as signed 11 decimal digit words; sequence changes to C if (A) ≤ (B).	78(4)
LUP	Test Index and Increment	Compares A with contents of index register associated with B. If contents of this index register are less than A, the instruction increments them by B, sequence changes to C.	Jump: IR_i=2: 65(5) IR_i=1 or 3: 71.5 No Jump: IR_i=2: 45.5(5) IR_i=1 or 3: 52
MPY	Decimal Multiply	Multiplies (A) by (B); treats operands as signed 11 decimal digits; stores result with sign in C, low-order result with sign in low-order product word.	884+39n n = no. of non-zero digits in multiplier
NAC	Inequality Comparison, Alphanumeric	Compares (A) with (B) bit by bit. If (A) ≠ (B), sequence changes to C.	78
NNC	Inequality Comparison, Numeric	Compares (A) with (B); treats operands as signed 11 decimal digits. If (A) ≠ (B), sequence changes to C.	78(6)
NOP	No Operation	Passes to next instruction, performing no other action.	32.5
OFS	Offset Stack	Rejects a card into an alternate pocket.	65 + unit mech. time(7)
PCA	Punch Edit, Alphanumeric	Edits n consecutive alphanumeric characters, beginning with the one specified in word	52+9.75n

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
		at A, into the card punch area in consecutive columns, beginning with the one specified by C.	
PCD	Punch Edit, Signed Decimal	Is the same as PCA, except that data is edited from decimal format into punch area, and operates only on one word.	$52+9.75n$ for $n \leq 6$ $58.5+9.75n$ for $n > 6$
PCI	Punch Card, Interlocked	Punches the contents of the card punch area onto one card. Central processor interlocked until completion of data transfer.	Without Storage Option 39+unit mech. time(7) With Storage Option 1098.5
PCO	Punch Edit, Octal	Is the same as PCA, except that data is edited from octal format into punch area.	52+9.75n
PCU	Punch Edit, Unsigned Decimal	Is the same as PCA, except that data is edited from decimal format into card punch area.	52+9.75n
PCW	Punch Card, Without Interlock	Punches the contents of the card punch area onto one card. Central processor not interlocked and central processor operations are possible during acceleration interval.	Without Storage Option 39+unit mech. time(7) With Storage Option 1098.5
PDE	Prepare Decimal Edit	Inserts special characters, suppresses leading zeros, floats high characters in (A) according to parameters at B. Stores result in (C).	58.5+13n(8)
PRS	Print and Space	Prints the contents of the print area on the high-speed printer, and spaces the form as specified by B.	Without Storage Option 39+unit mech. time(7) With Storage Option 838.5
RCI	Read Card, Interlocked	Reads the contents of one card into the card read area. Central processor is interlocked until the completion of data transfer.	Without Storage Option 39+unit mech. time(7) With Storage Option 1098.5
RCW	Read Card, Without Interlock	Reads the contents of one card into the card read area. Central processor not interlocked and so central processor operations are possible during the acceleration interval.	Without Storage Option 39+unit mech. time(7) With Storage Option 1098.5
RDP	Read Peripheral	Read and transfer n frames of data from the device on the input trunk specified in B to memory location A.	52+13n + unit mechanical time(7)

§ 121.

INSTRUCTION LIST (Contd.)

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
RDT	Read Tape	Reads one record from the specified magnetic tape and stores in consecutive locations beginning with A. If tape channel is also specified, it regenerates that channel simultaneously.	-(2)
REJ	Reject Card	Rejects a card currently in the card reader feed into one of two pockets as specified in B.	65 + unit mech. time(7)
RPX	Restore Subsequence Priority	Set the index registers and sequence register to the values specified in (A) and (C). Then reset the four bank indicator registers to the values specified in (A + 1). Alter or do not alter the contents of the subsequence control register, as specified in Bi.	71.5
RTX	Restore Index Register	Stores the high-order three 12-bit groups of (A) in the index registers 1, 2, 3, respectively; stores low-order 12 bits of (C) in the sequence register.	58.5
RWT	Rewind Tape	Rewinds the specified magnetic tape to its physical beginning.	65 + unit mech. time(7)
SCH	Sequence Change	Changes sequence register setting to the address specified by C.	32.5
SBI	Set Bank Indicators	Set the bank indicator registers specified in A to the values specified in B. Reset the sequence register to C.	32.5
SCO	Sequence Change on Option	Changes sequence register setting to address specified by A if setting of the console breakpoint switches and (B) coincide. Otherwise set sequence register to the address specified by C.	52
SEL	Select	Modifies C using (A) and (B); then makes a programmed subsequence to the modified address.	84.5
SET	Set Index Register	Adds A to index register specified in Ai and stores result in index register 1; adds B to index register specified in Bi and stores result in index register 2;	52

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
		adds C to index register specified in Ci and stores result in index register 3.	
SLB	Binary Shift Left	Shifts (A) to the left the specified number of bits; the move is cyclic, so that bits shifted off the left end enter the word at the right.	45.5+6.5n(9)
SLP	Decimal Shift Left, Preserving Sign	Shifts (A) to the left n decimal digits, preserving the sign digits. Digits shifted off the left end are lost and replaced by zeros at the right end.	45.5+6.5n
SMP	Superimpose	Places a 0 bit in all positions of (C) where both (A) and (B) contain 0 bits; places 1 bits in all other positions of (C).	78
SPX	Stores Subsequence Priority	Store the contents of the four bank indicator registers and the subsequence control register at location A+1. Set the bank indicator registers to the values specified in B. Store the contents of the three index registers and the sequence register at A. Alter or do not alter the contents of the subsequence control register, as specified in Bi. If the subsequence call was caused by an error, jump to C minus one; otherwise, jump to C.	117 if SCR is not changed (12) 130 if SCR is changed(12)
SRP	Decimal Shift Right, Preserving Sign.	Same as SLP, except that (A) are shifted to the right.	45.5+6.5n
SST	Substitute	Places (A) in (C) in all positions where (B) contains a 1 bit; leaves remaining bit positions in (C) unchanged.	78
STX	Store Index Register	Stores the contents of the three index registers and the sequence register in A. Sets sequence register to C.	58.5
SUB	Decimal Subtract	Subtracts (B) from (A); treats operands as signed 11 decimal digits; stores result in C.	78 + 45.5T(1)
SUP	Stall	During the acceleration interval of the card reader and reader-	Stalls until end of data transfer, or

INSTRUCTION LIST (Contd.)

§ 121.

Mnemonic Operation Code	Instruction	Description	Basic Time in Microseconds
		punch, this instruction stalls the central processor; outside this interval, it has the effect of NOP.	45.5 microseconds
TAC	Type Alphanumeric, Console	Prints (A) on the console printer in alphanumeric form.	100-200ms per character(10)
TDC	Type Decimal, Console	Prints (A) on the console printer in decimal form.	100-200ms per character(10)
TOC	Type Octal, Console	Prints (A) on the console printer in octal form.	100-200ms per character(10)
TSC	Transfer and Sequence Change	Transfers (A) to location B; sequence changes to location C.	58.5
TSN	Transfer n Words	Transfers n words from consecutive memory locations, beginning with word at A, to consecutive memory locations beginning with C.	32.5+26n
UNF	Unfloat	Converts floating-point decimal word in B to fixed-point decimal word under control of exponent in A, stores result in C.	76+13n(11) n = no. of digit shifts
WRP	Write Peripheral	Directs the device on the output trunk specified in B to write n frames of data transferred from memory location A.	52+13n + unit mechanical time(7)
WRT	Write Tape	Writes one record of the specified number of consecutive words from memory, beginning with A, onto tape.	-(2)

NOTES

1. T, a variable factor, is derived from the following table:

	Signs of Operands A	Signs of Operands B	T: |A| > |B|	T: |A| < |B|	
	+	+	0	0	Addition
	+	-	1	2	Addition
	-	-	0	0	Addition
	-	+	1	2	Addition
	+	+	0	1	Subtraction
	+	-	1	1	Subtraction
	-	-	1	1	Subtraction
	-	+	1	1	Subtraction

INSTRUCTION LIST (Contd.)

§ 121.

2. For Model 404-1, 5.5 ms plus 0.125n; for Model 404-2, 5.5 ms plus 0.09 n; for Model 404-3, 11.0 ms plus 0.250n. (n is the number of words read, written or backspaced.)
3. n = number of pairs of words compared.
4. If $|A| = |B|$, and the sign of (A) is positive and the sign of (B) is negative, add 45.5 microseconds.
5. IR_i is the number (i.e., 1, 2, or 3) of the index register associated with the B address. Thus, for a Jump, the time is 71.5 microseconds for index registers 1 and 3, and 65 microseconds for index register 2. Similarly, for a No jump, the times are 52 and 45.5 microseconds, respectively.
6. If $|A| = |B|$, and the signs of (A) and (B) are different, add 45.5 microseconds.
7. Mechanical time varies with peripheral equipments and with time at which peripheral order is issued.
8. n = number of non-significant decimal zeros outside of sign position.

   If $6 \leq n < 8$, add 6.5 microseconds; if $n < 6$, add 13 microseconds. If p_1 is a plus or minus sign, add 6.5 microseconds. If p_2 is F (for floating), add 6.5 microseconds.
9. n = number of shifts; $n = \frac{\text{Number of bits shifted}}{4} + \frac{\text{Remainder}}{2} + \frac{\text{Remainder}}{1}$
10. Central processor operations may continue after approximately 0.7 milliseconds for alphanumeric typeouts, 1 millisecond for decimal typeouts, and 1.3 milliseconds for octal typeouts.
11. Add 13.0 microseconds for each indexed address.
12. Add 6.5 microseconds if the subsequence call was caused by an error.

DATA CODE TABLE No. 1: INTERNAL AND PRINTER

§ 141.

.1 USE OF CODE: . . . . . Internal and Printer.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . 4-bit numeric and 6-bit alphameric.

.22 Character Structure

.221 More significant pattern: two bits: values are 16, 32.

.222 Less significant pattern: 4 bits: values are 1, 2, 4, 8.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	+	-	Blank
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10	'	;	#	@
11	=	.	$	,
12	:	)	*	(
13	Blank	%	"	C_R
14	Blank	■	Blank	Blank
15	&	Blank	Blank	Blank

DATA CODE TABLE No. 2: INPUT VIA CARD

§ 142.

.1 USE OF CODE: . . . . . Input via card.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . One column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH None	OVERPUNCH 12	OVERPUNCH 11	OVERPUNCH 0
None	Blank	+	-	0
12	+	+		
11	-		-	
0	0	Blank	Blank	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2	'	;	#	@
8-3	=	.	$	,
8-4	:	)	*	(
8-5	Blank	%	"	CR
8-6	Blank	■	Blank	Blank
8-7	&			Blank

NOTES ON SYSTEM PERFORMANCE

§ 201.

The format design and blocking of the main file were major considerations during the preparation of the System Performance data. Some of the more unusual factors which were considered were:

(1) The Block Length

The magnetic tape block length had to be short enough for a complete read or write operation to be completed within 18 milliseconds, to avoid the possibility of destroying the data transferred during the card read operations. The blocking factor is thus restricted to 2 on those configurations with the slowest model tape unit (H-404-3).

(2) The Approximate Central Processor Interlock Time for the Magnetic Tape Units

The central processor is interlocked from the time the tape instruction is given until the time the data transfer has been completed. The interlock time consists of the data transfer time itself, the normal start time, and an additional time which is necessary to pass over the remainder of the tape which makes up the inter-block gap.

It is assumed that this distance includes all the gap not passed over during the starting or stopping of the tape. This adds 2.7 milliseconds per block to the time the tape units interlock the central processor.

HONEYWELL 1400
SYSTEM PERFORMANCE

HONEYWELL 1400 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration II		Configuration III		Configuration IV		Reference
1	Char/block	(File 1)[a]	432		432		1,104		
	Records/block	K (File 1)	2		2		5		
	msec/block	File 1 = File 2	24.5		24.5		21.1		
		File 3	75.0		75.0		75.0		
		File 4	115.0		115.0		115.0		
Input-Output Times	msec/switch	File 1 = File 2							4:200.112
		File 3							
		File 4							
	msec/penalty	File 1 = File 2	14.6		14.6		16.6		
		File 3	46		46.0		3.0		
		File 4	52		1.3		1.3		
2	msec/block	a1	0.7		0.7		1.6		
	msec/record	a2	1.9		1.9		1.9		
Central Processor Times	msec/detail	b6	0.1		0.1		0.1		4:200.1132
	msec/work	b5 + b9	10.5		6.7		6.7		
	msec/report	b7 + b8	0.3		0.3		0.3		
3	msec/block for C.P. and dominant column.	a1	0.7		0.7		1.6		
		a2 K	3.8		3.8		9.5		
		a3 K	21.6		13.5		33.5		
Standard Problem A		File 1 Master In	14.6		14.6		16.6		
F = 1.0		File 2 Master Out							4:200.114
		File 3 Details[b]	120.0		120.0		15.0		
		File 4 Reports	104.0	230	8.0	230	20.0	575	
		Total	264.1	230	160.6	230	92.6	575	
4	Unit of measure	48-bit word							
		Std. routines	200		140		140		
		Fixed	94		94		94		
		3 (Blocks 1 to 23)	90		90		90		
Standard Problem A Space		6 (Blocks 24 to 48)	360		360		360		4:200.1151
		Files	156		156		156		
		Working	18		18		18		
		Total	828		768		768		

[a] Expressed as 4-bit characters. Used as a mixture of 4-bit and 6-bit characters in unpacked form.
[b] Includes allowance of 15 milliseconds caused by prohibition of certain instructions during start of card read cycles.

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

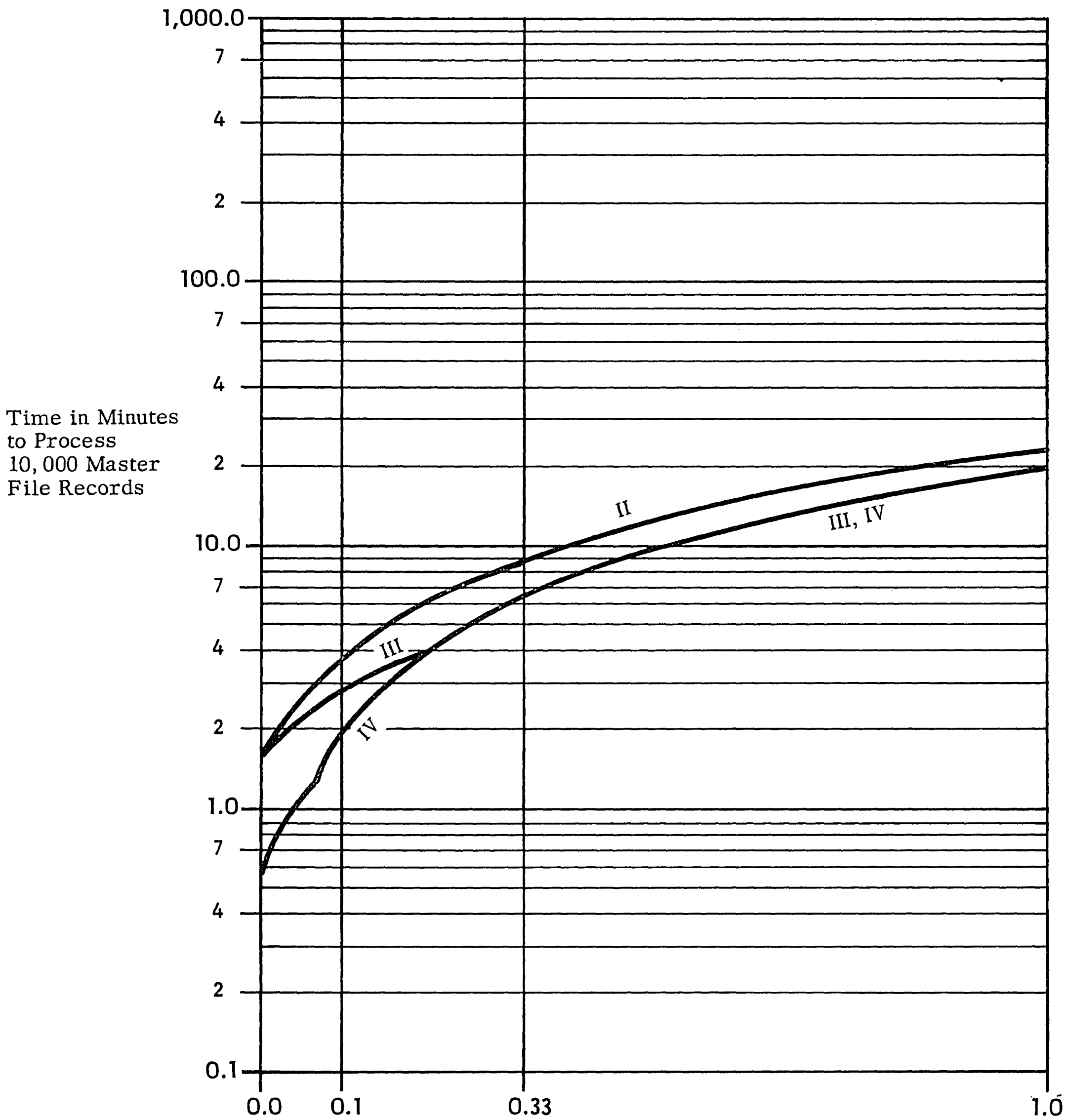
.111 Record sizes
- Master file: . . . . . 108 characters.
- Detail file: . . . . . 1 card.
- Report file: . . . . . 1 line.

.112 Computation: . . . . . standard.

.113 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage space required
- Configuration II: . . . 828 48-bit words.
- Configuration III: . . . 768 48-bit words.
- Configuration IV: . . . 768 48-bit words.



Activity Factor
Average Number of Detail Records Per Master Record

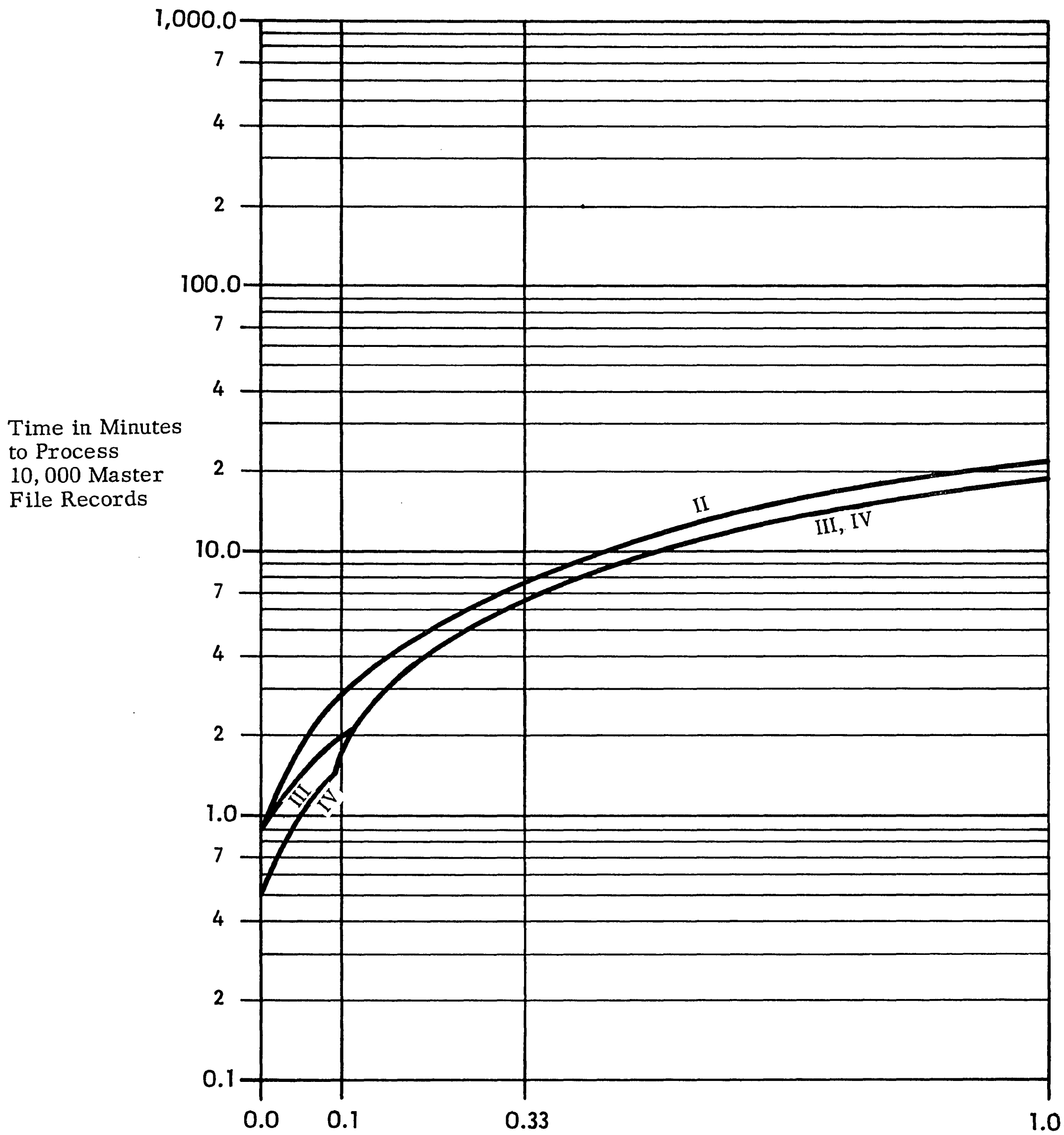
(Roman numerals denote standard System Configurations)

§ 201.

.12 Standard File Problem B

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . see graph below.



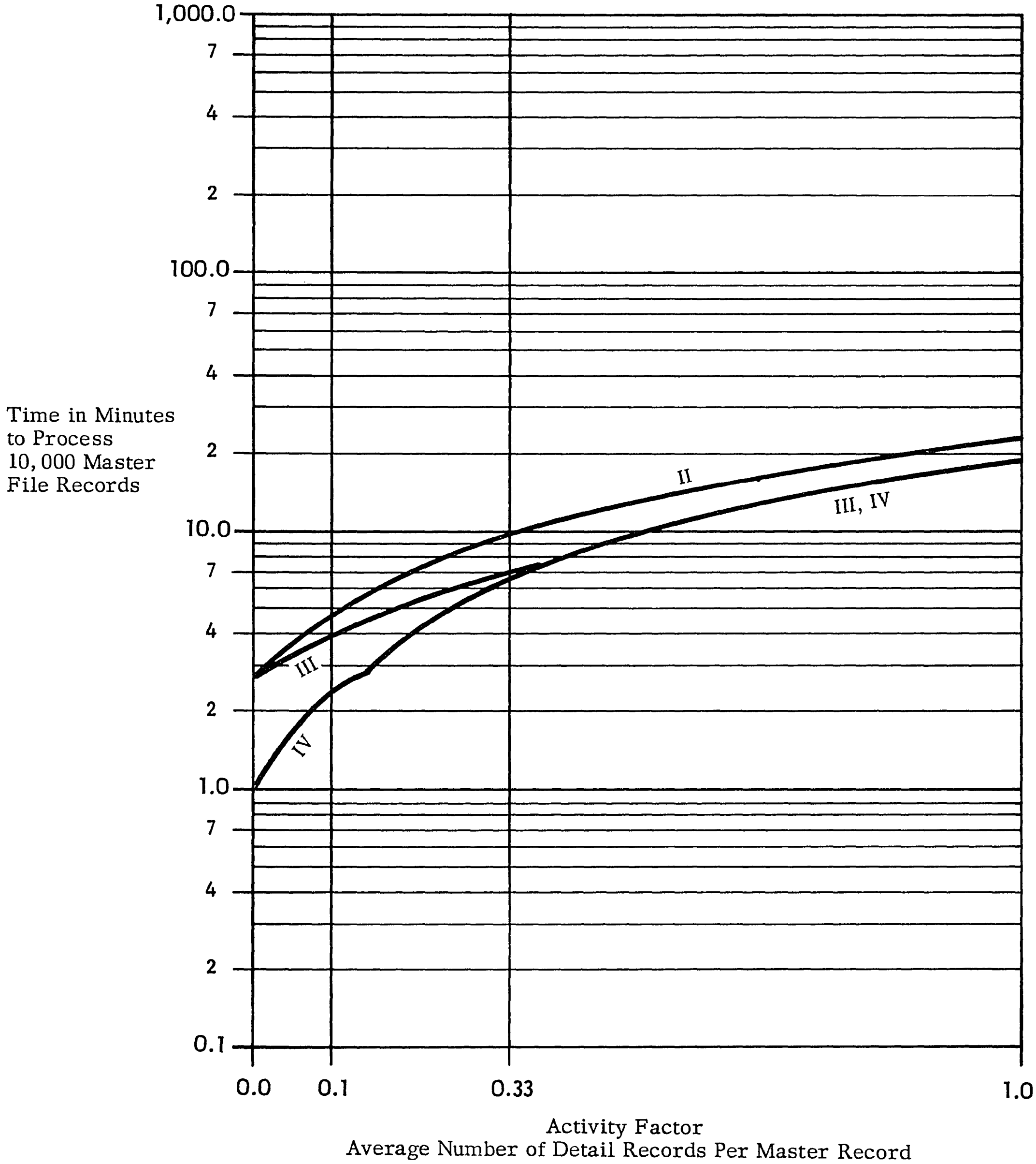
Activity Factor
Average Number of Detail Records Per Master Record

§ 201.

.13 Standard File Problem C

.131 Record sizes
Master file: . . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . see graph below.

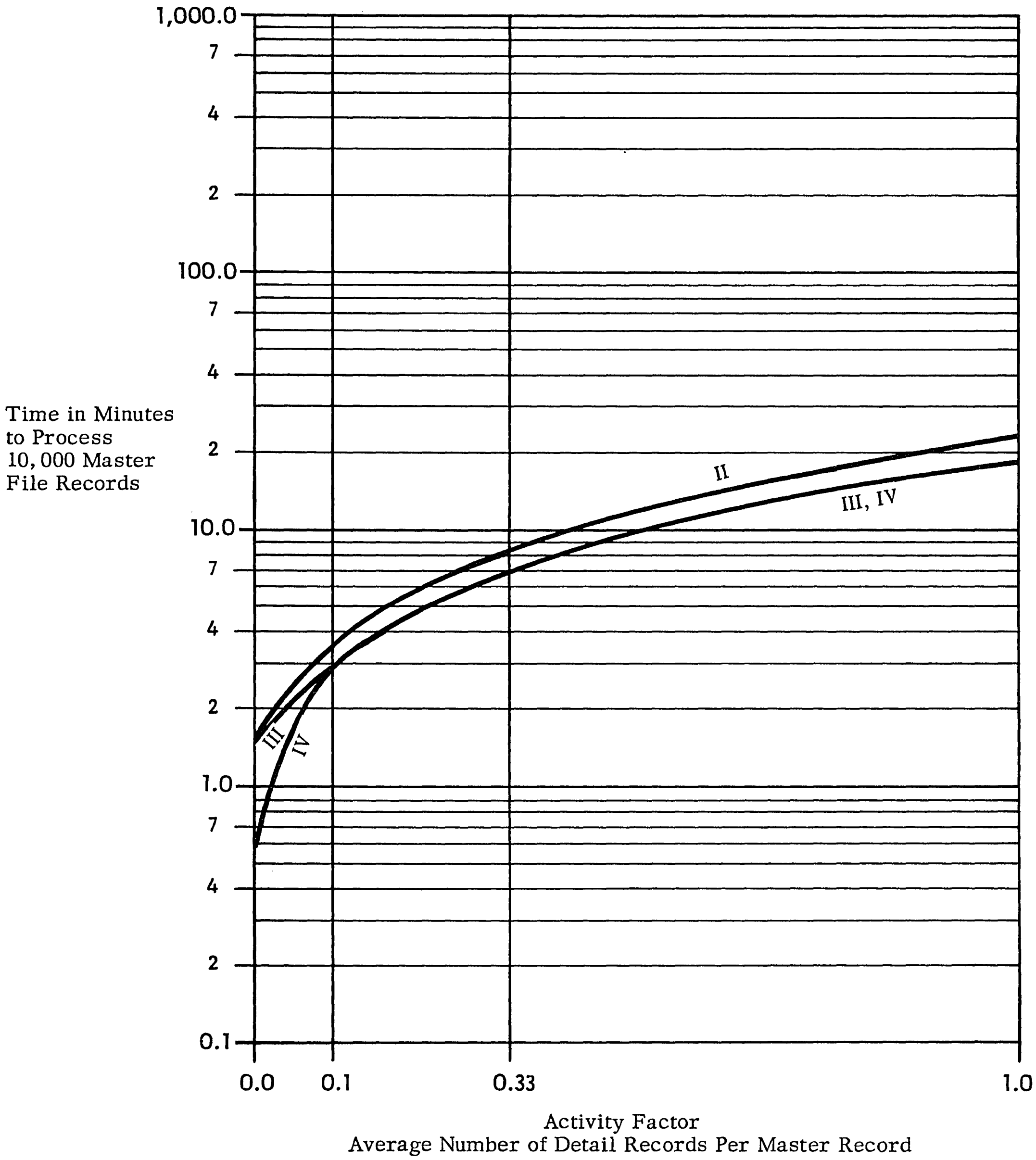


§ 201.

.14 Standard File Problem D

.141 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . see graph below.

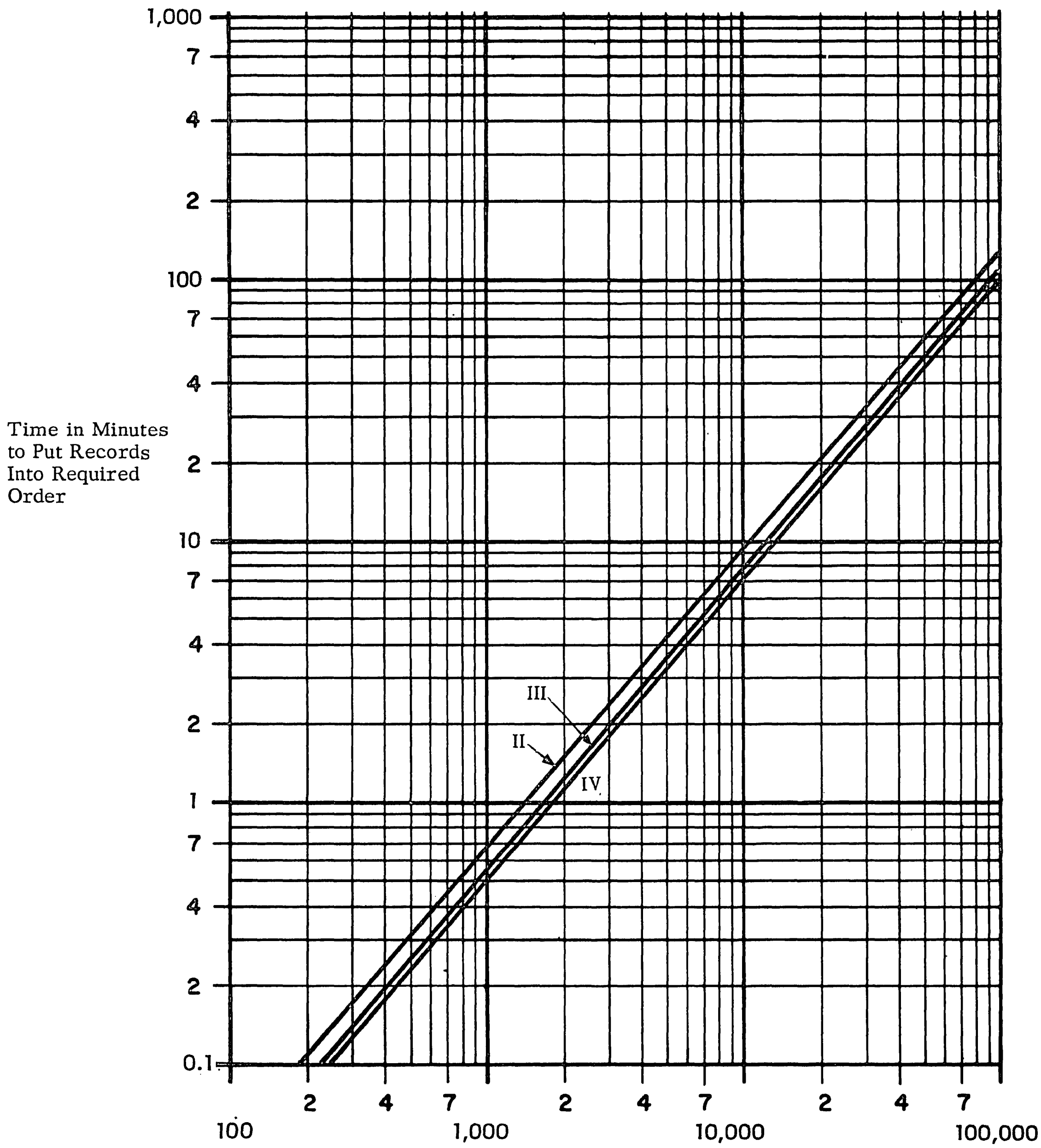


§ 201.

.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.
.212 Key size: . . . . . . 8 characters.
.213 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.213, corrected for non-standard block sizes used in File Problem A.
.214 Graph: . . . . see graph below.

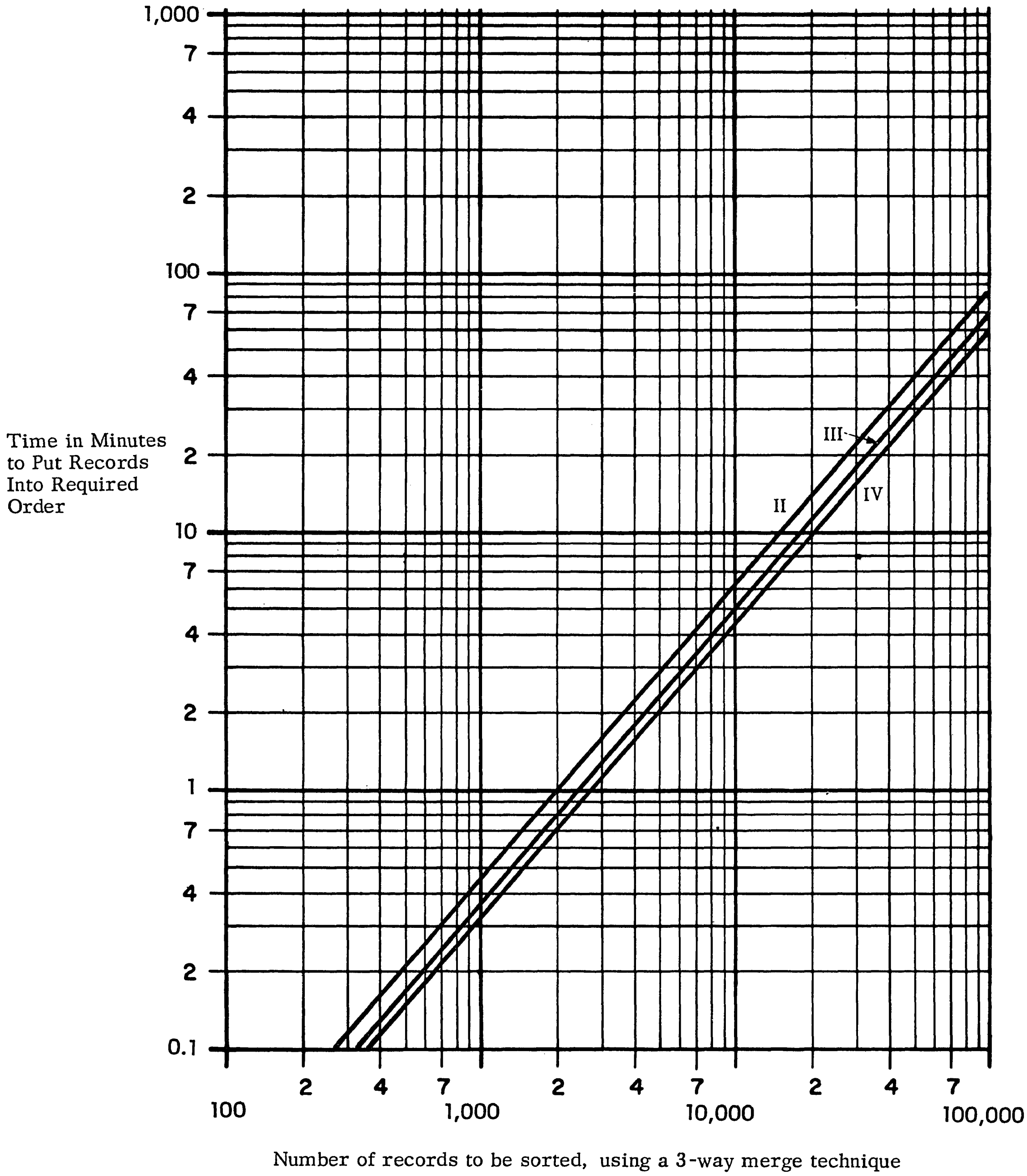


Number of records to be sorted, using a 2-way merge technique

(Roman numerals denote standard System Configurations)

§ 201.

.215 Graph: . . . . see graph below.



§ 201.

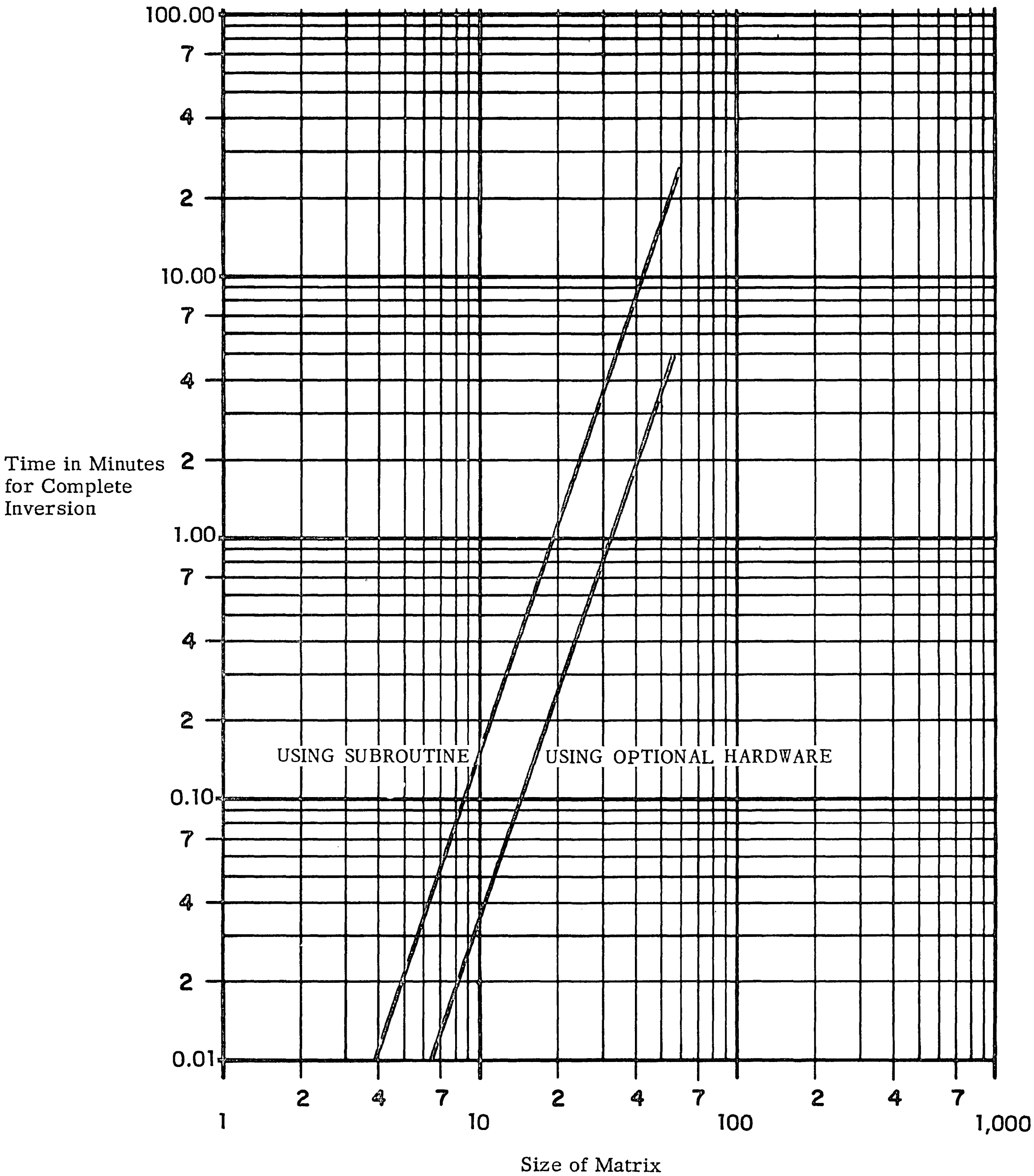
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to 9 decimal digits.

.312 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . see graph below, showing times for both floating point subroutines and optional floating point hardware.



PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance* $	Purchase $
CENTRAL PROCESSOR	1401-1	Central Processor Standard Equipment: 3 Index Registers 4,096 Words Storage (accepts 404-1 or 404-3 magnetic tape units)	7,350	588.00	330,750
	1401-2	Central Processor Standard Equipment: 3 Index Registers 4,096 Words Storage (accepts 404-2 magnetic tape units)	8,100	648.00	364,500
		Optional Equipment			
	1401-B	Floating-Point Option (requires 451 option)	150	12.00	6,750
		Additional Core Storage			
	1402-1	4,096 Words	1,600	80.00	72,000
	1402-2	8,192 Words	3,200	160.00	144,000
	1402-3	12,288 Words	4,800	240.00	216,000
	1402-4	16,384 Words	6,400		288,000
	1402-5	20,480 Words	8,000		360,000
	1402-6	24,576 Words	9,600		432,000
	1402-7	28,672 Words	11,200		504,000
	451	Multiply-Divide Option	250	12.50	11,250
	1413-3	Elapsed Time Clock	35	3.00	1 575
	1413-4	Real Time Clock	155	12.50	6,975
INTERNAL STORAGE		Magnetic Disc File and Control (4 max.)			
	460-0	12.5 million characters	1,990		89,550
	460-1	25 million characters	2,490	580.00	112,050
	460-2	50 million characters	3,680	800.00	165,600
	460-3	75 million characters	5,100	1,020.00	220,000
	460-4	100 million characters	6,200	1,240.00	260,000
INPUT-OUTPUT		Magnetic Tape (8 or 16 max., one type only)			
	404-1	64,000 CPS or 96,000 DPS	900	155.00	43,200
	404-2	89,000 CPS or 133,000 DPS	900	155.00	43,200
	404-3	32,000 CPS or 48,000 DPS	450	100.00	20,250
	405	Magnetic Tape Switching Unit	75	5.00	3,600
		Paper Tape			
	409	Punched Tape Reader and Control (5 max.)	540	54.00	24,300
	410	Punched Tape Punch and Control (4 max.)	540	54.00	24,300

§ 221. **PRICE DATA (Contd.)**

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance* $	Purchase $
INPUT-OUTPUT (Contd.)		Printer (2 max.)			
	418	Off-Line Printer Control	1,550	270.00	69,750
	422-3	Printer (can be substituted for 422-4) 900 LPM, 120 out of 160 positions.	1,550		74,400
	422-3A 422-4A	Optional Equipment: Vertical Spacing, 6 or 8 lines per inch	100	20.00	4,800
	422-3B 422-4B	Optional Equipment: Two-Speed Printing (600 or 900 LPM)	40		1,920
	422-4	Printer (can be substituted for 422-3) 900 LPM, 120 fixed positions	1,050	210.00	47,250
	1450	Print Storage Option	390	19.00	17,550
		Card			
	423-2	Card Reader — 650 CPM (1 max.)	325	52.25	14,700
	1423-2A	Pocket Select	15	0.30	675
	427-1	Card Reader-Card Punch — 800 cpm/250 cpm (1 max.)	560	45.00	30,215
	1427-2A	Pocket Select	15	0.30	675
	1411	Card Storage Option (to be used with Model 423-2 or 427)	490	39.00	22,050
	440	Optical Scanner and Control (5 max.)	2,530	380.00	121,440
	441	Orthoscanner	1,990	300.00	89,550
	442-1	Orthoscanner Control Unit — Off-Line	1,490	120.00	67,050
		Communication Controls			
	480	Single-Channel — high speed remote devices	790	79.00	35,550
	481	Single-Channel — low speed remote devices	300	24.00	13,650
	484-1	Multi-Channel (7 buffers)			
		2 Bays	940	94.00	42,300
		3 Bays	1,020	102.00	45,900
	484-2	Multi-Channel (14 buffers)			
		2 Bays	980	98.00	44,100
		3 Bays	1,060	106.00	47,700
		4 Bays	1,140	114.00	51,300
		5 Bays	1,225	112.50	55,125
	485-1R	Communication Adapter Unit	25	2.50	1,125
	485-1T	Communication Adapter Unit	25	2.50	1,125
	485-IH	Communication Adapter Unit	30	3.00	1,350
	485-2R	Communication Adapter Unit	30	3.00	1,350
	485-2T	Communication Adapter Unit	30	3.00	1,350
	485-2H	Communication Adapter Unit	40	4.00	1,800
CONTROL-LERS		Controllers			
	1403	Extended Tape Control (for 9th through 16th tape units)	100	8.00	4,500
	1406	Storage and Control for Second Printer (for on-line operation; requires 1450 option on first printer)	625	50.00	28,125
	436-1	Tape Control Unit (1 max.) — controls one IBM 729 II Magnetic Tape Unit	1,380	195.00	62,100

* Monthly maintenance charges shown here apply for the first 36 months after installation.

HONEYWELL SERIES 200

Honeywell EDP Division

STANDARD EDP REPORTS

AUERBACH

AUERBACH INFO, INC.

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HONEYWELL SERIES 200

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STANDARD EDP REPORTS

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CONTENTS

INTRODUCTION

.1 SUMMARY

The Honeywell Series 200 line of computers consists of five program-compatible central processors — Models 120, 200, 1200, 2200, and 4200. The sixth processor in the Series, the large-scale Honeywell 8200, offers compatibility not only with other members of the Series 200, but also with the earlier Honeywell 800 and 1800 systems. Peripheral device compatibility within the series is provided through the use of a common input-output interface.

The Series 200 family of computer systems — with the exception of the Model 8200 — is based upon an improved version of the original Honeywell 200 system, first delivered in July 1964. The Honeywell 2200 system was the second entry in what has since become the Series 200 family. Announced in 1964, the 2200 was first delivered in December 1965. The Honeywell 120, 1200, and 4200 systems were announced in February 1965, and the 120 and 1200 systems are currently being delivered. Delivery of the first 4200 system is not expected until October 1967. The model number of each computer system reflects its relative position in the series.

The Honeywell 8200 joined the Series in June 1965. It provides compatibility with the H-800 and H-1800 systems through use of a 48-bit word processing subsystem. The word processor in the Model 8200 provides the hardware capability to run up to eight independent user programs concurrently. A second 8200 subsystem, the variable-length-field (VLF) processing subsystem, provides compatibility with other members of the Series 200. Throughout the remainder of this Computer System Report, all general statements concerning the Series 200 refer to the H-8200's VLF processor only. Separate paragraphs are devoted to descriptions of the word processor and to the overall performance of the Honeywell 8200.

The Honeywell 200, and the computer family that grew from it, had as a major marketing goal the replacement of the slower, "second generation" IBM 1400 Series systems. With such a goal, certain advances in computer system design, such as 8-bit character codes and extensive multiprogramming facilities, were not seen as necessary inclusions in the line. To a large extent, the instruction complement of the 1400 Series was incorporated in the Honeywell 200 Series, and software routines were developed to resolve the minor incompatibilities between the instruction sets of the two series.

The key software package released with the original Honeywell 200 centered around a program called Bridge, the "Liberator" for 1400 Series users. This program accepted IBM 1401 object programs as input and generated Series 200 object programs after a fairly straightforward translation process. Linkages to simulation subroutines were generated to resolve most discrepancies between the two machines.

This unique approach to the problem of converting problem programs for use on a new system was successful within the scope of its design, but it proved unsatisfactory in two principal areas. First, the process of program translation from one machine language to another within a limited amount of core storage generally lacks flexibility, resulting in some program elements that cannot be translated or else are error-prone. Such was the case with Honeywell's "Bridged" programs. Second, the object code output of the translation process is difficult to maintain, since it is in machine-language form.

Recognizing these problems, Honeywell currently stresses a symbolic assembly language translator program called Easytran as an alternative to the Bridge translator approach to conversion of IBM 1400 Series programs. Through use of Easytran, almost 100 per cent of the 1400 Series source language statements can be correctly translated to Honeywell's Easycoder assembly language, which can be readily modified as part of normal program maintenance. Honeywell maintains that programs so translated from IBM 1400 Series assembly languages will operate on Honeywell Series 200 systems at least 80 per cent as efficiently as programs originally written for execution on Series 200 systems. Honeywell's current Easytran translator converts IBM 1401 and 1460 programs for use with any Series 200 system; a similar translator will be provided by Honeywell during the third quarter of 1966 for translating IBM 1410 and 7010 assembly language programs for use with Models 1200, 2200, and 4200. IBM 1440 assembly language programs and other 1400 Series programs that utilize the IBM 1311 Disk Storage Drives will be subject to the Easytran liberation technique during the second quarter of 1967.

.1 SUMMARY (Contd.)

A user of IBM 1400 Series equipment who wants to "trade up" to new equipment is faced with many important considerations when comparing offerings by Honeywell in its Series 200 and by IBM in its System/360. Among these considerations are the following:

- Much of the newly-designed System/360 peripheral equipment offers higher performance than similar Series 200 devices and at virtually equivalent prices.
- Decimal arithmetic in Honeywell Series 200 processors is in many cases faster than that in comparable processor models of the IBM System/360.
- System/360 computer systems that have over 65K bytes of core storage have extensive multiprogramming capabilities, whereas similar-sized Series 200 systems have limited hardware/software multiprogramming control facilities that generally cannot go beyond performing one "background" and one "foreground" program concurrently. (Honeywell's new Model 8200 system will provide excellent multiprogramming control facilities for users of medium-to-large-scale equipment, as described in Paragraph .26 below).
- Conversion to Honeywell Series 200 computer systems can be accomplished with little reprogramming via the program translation process — without sacrificing many processing facilities in the new system. Conversion to IBM System/360 computers can involve either total reprogramming or "emulation" of the 1400 Series object programs. With the emulation technique, the full potential of the emulating system cannot be utilized (although it is paid for), and the 1400 Series programs must be maintained in machine language.
- The Series 200 offers a wide selection of time-proven software. System/360 software, by contrast, is still relatively new — although it is potentially more comprehensive and powerful than the Honeywell offerings.
- The equipment delivery period for a Series 200 is generally shorter than for a System/360.
- The retraining of personnel familiar with 1400 Series equipment will be minimal when converting to Series 200 equipment, since the processors within this series use the same data structure and largely the same instruction sets as the IBM 1400 Series processors. Use of the System/360 will require extensive retraining of personnel.

This general Computer System Report (510:) discusses the characteristics of the Honeywell Series 200 that are common to all computer systems within the family. Included in the general report sections are descriptions of the data structure (based on the 6-bit character), configuration rules, peripheral devices, compatibility with the IBM 1400 Series, pricing schedules, and software systems. This general report is followed by individual subreports (511: through 518:) on each of the six current Series 200 processor models, analyzing specific configuration possibilities, performance characteristics, capacity for simultaneous operations, specialized software (in the case of the Honeywell 8200), and other details which vary from model to model within the series.

In this Introduction, a number of important topics are discussed. Each topic is independent, and can be read separately if desired. The topics are:

.1 Summary.
.2 Central Processors.
.3 Peripheral Units.
.4 Software.
.5 Compatibility with the IBM 1400 Series.
.6 Compatibility within the Honeywell Series 200 and with the Honeywell 800 and 1800.
.7 Pricing Policy.

.2 CENTRAL PROCESSORS

Six central processors currently form the nucleus of the Honeywell Series 200. Honeywell considers that these processors — Models 120, 200, 1200, 2200, 4200 and 8200 — span a range equivalent to that spanned by the IBM System/360 Models 20 through 65. Listed in Table I are certain central processor tasks and the times required to perform these tasks for each Series 200 processor. Comparable execution times for the System/360 processors can be found in Table I of the IBM System/360 report, Section 420:011.

(Contd.)

TABLE I: ARITHMETIC EXECUTION TIMES FOR THE SERIES 200 PROCESSORS

TASK (Times expressed in microseconds)	CENTRAL PROCESSOR MODEL					
	120	200	1200	2200	4200	8200**
Fixed Point Binary						
c=a+b	123	84	63	51	16	1.8 to 3.0
c=axb	#	480	360	244	92	5.0
c=a/b	#	1,148	900	600	233	14.0
Fixed Point Decimal						
c=a+b	123	84	63	51	16	1.8 to 3.0
c=axb	3,100 (s)	480	360	244	92	5.0
c=a/b	3,700 (s)	1,148	900	600	233	14.00
Floating Point Binary						
c=a+b	#	#	84*	56*	31*	2.3 to 5.5*
c=axb	#	#	120*	81*	44*	<5.0
c-a/b	#	#	149*	99*	46*	<13.0
Radix Conversion						
Decimal to Binary	#	#	60*	40*	16*	<17.8
Binary to Decimal	#	#	60*	40*	15*	<9.5

(s) Subroutine times; hardware facility not available.
Hardware facility not available; subroutine times not provided.
* With optional feature.
** Times are for 8200 Word Processor Subsystem; range of times reflects the use of maximum memory bank interleaving to the use of no interleaving.

Note: All decimal operands are considered to be five digits in length.

.2 CENTRAL PROCESSORS (Contd.)

All of the character-oriented Series 200 central processors use add-to-storage logic. There is no addressable accumulator. Both instructions and operands can be of variable length. Operand lengths are not specified in Series 200 instructions; instead, most operations are terminated when the processor senses a word mark, item mark, or record mark in the operand field. Table II summarizes the principal distinguishing characteristics of the six central processors of the Series 200.

.21 Model 120

The Honeywell Model 120 is a card- or tape-oriented computer system with the ability to control two or three input-output operations concurrently with processing. Automatic processor interrupt facilities are also provided. The Model 120 has 6 index registers and a core storage capacity of 2,048 to 32,768 characters. Core storage cycle time is 3 microseconds per character. The Model 120 Processor can be connected to any of the Series 200 peripheral devices, to another Series 200 computer, or to a data communications network.

The Model 120 is a general-purpose data processing system, able to operate either as an independent, stand-alone system or as a satellite in an integrated operation. The rental for typical Model 120 systems ranges from about $1,900 per month for a 4K card system to about $4,000 per month for a 16K, 4-tape system. Deliveries of the Model 120 Processor started in March 1966.

The Model 120 contains built-in peripheral device control units to regulate the operations of a 450-line-per-minute printer, a 400-card-per-minute reader, and a 100 to 400 card-per-minute card punch. A built-in magnetic tape control unit is optionally available to control up to four 13.3KC magnetic tape units. In addition to the control units already mentioned, either of two optional features permits the connection of up to six more standard Series 200 peripheral device control units.

.22 Model 200

The Model 200 is a card- or tape-oriented computer system with the ability to control either three or four input-output operations concurrently with processing. It has 15 index registers and a core storage capacity of 4,096 to 65,536 characters. Core storage cycle time is 2 microseconds per character. The Model 200 Processor can be connected to any of the Series 200 peripheral devices, to another Series 200 computer, or to a data communications network.

TABLE II: SUMMARY OF SERIES 200 PROCESSOR CHARACTERISTICS

Processor Model	Main Memory Speed (cycle time)	Memory Capacity (thousands of characters)	Maximum Number of Peripheral Controllers Accepted	Max. No. of I/O Operations Simultaneous with Computing	Advanced Programming Instructions	Financial Edit Instruction	Multiply and Divide Instructions	Scientific Processing Instructions	Memory Protect Facility
120	3 microseconds per character	2 to 32	9	3	*	*	—	—	—
200	2 microseconds per character	4 to 65	16	4	*	*	Standard	—	—
1200	1.5 microseconds per character	16 to 131	16	4	Standard	Standard	Standard	*	*
2200	1 microsecond per character	16 to 262	32	8	Standard	Standard	Standard	*	*
4200	188 nanoseconds per character	65 to 524	48	16	Standard	Standard	Standard	*	*
8200 word processor	94 nanoseconds per character	131 to 1,048	96	32	—	—	Standard	*	Standard

— Feature not available on this model.
* Feature optionally available.

.22 Model 200 (Contd.)

The Model 200 is suitable for use either as an independent, stand-alone system or as a satellite system in an integrated operation. The rental for typical Model 200 systems ranges from about $2,600 per month for a 4K card system to $9,800 per month for a 24K, 8-tape system. Deliveries of the new Model 200 Processor began in November 1965. The noteworthy changes between the original Model 200 Processor and this version are the inclusion of automatic interrupt facilities, an 8-bit compatibility feature, and multiply/divide instructions as standard equipment.

.23 Model 1200

The Model 1200 is a tape-oriented computer system with the ability to control four input-output operations concurrently with processing. It has 15 or 30 index registers, an automatic interrupt system, and a core storage capacity of 8,192 to 131,072 characters. Core storage cycle time is 1.5 microseconds per character. A floating-point arithmetic option is available. The Model 1200 Processor can be connected to any of the Series 200 peripheral devices, to another Series 200 computer, or to a data communications network.

The Model 1200 is a general-purpose data processing system, able to operate either as a stand-alone system or as part of a larger, integrated operation. The rental for typical Model 1200 systems falls between $7,800 per month for a 32K, 6-tape system and $16,000 per month for a 131K, 12-tape system. Deliveries of the Model 1200 Processor began in February 1966. Compared to the Model 200 Processor, the Model 1200 offers increased core storage speed and capacity, the optional availability of floating-point instructions for scientific applications, optional table look-up facilities that permit IBM 1410 "Liberation," and a Memory Protect facility that provides 15 additional index registers.

.24 Model 2200

The revised Model 2200 is primarily a tape-oriented computer system with the ability to control either four or eight input-output operations concurrently with processing. It has either 15 or 30 index registers, an automatic interrupt system, and a core storage capacity of 16,384 to 262,144 characters. Core storage cycle time is 1 microsecond per character. All options currently available with the Model 1200 are also available with Model 2200. The Model 2200 Processor can be connected to any of the Series 200 peripheral devices, to another Series 200 computer, or to a data communications network.

The Model 2200 is a general-purpose system, able to operate either as a stand-alone system or as part of a larger, integrated operation. The rental for typical Model 2200 systems ranges from about $9,400 per month for a 32K, 6-tape system to $20,000 per month for a 196K, 12-tape system. Deliveries of the Model 2200 Processor started in December 1965.

(Contd.)

.25 Model 4200

The Honeywell Model 4200 is a tape-oriented computer system with the ability to control either 8 or 16 input-output operations concurrently with processing. It has either 15 or 30 index registers, automatic interrupt capabilities, and a core storage capacity of 32,768 to 524,288 characters. The core storage cycle time is 0.75 microsecond, and 4 characters are accessed in parallel. All options currently available with the Models 1200 and 2200 are also available with the Model 4200, although the table lookup instructions are included as standard equipment with the 4200. The Model 4200 Processor can be connected to any of the Series 200 peripheral devices, to another Series 200 computer, or to a data communications network.

The Model 4200 is designed as a general-purpose system, able to operate either as a stand-alone system or as the master system in an integrated operation. The rental for typical Model 4200 systems falls between $16,400 per month for a 32K, 8-tape system and $25,500 per month for a 196K, 12-tape system. Deliveries of the Model 4200 Processor will start in October 1967.

.26 Model 8200

The 8201 Central Processor consists of five independent functional units: a 48-bit word-oriented processor, a variable-length-field (VLF) processor, a memory subsystem, an input/output controller, and a hardware/software master control facility which coordinates the activity of the other units. Communication between units is effected by means of program interrupts and control instructions.

The word-oriented processor performs three-address instruction at an average rate of 400,000 per second. By comparison, the older Honeywell 800 processor can execute up to 30,000 instructions per second, and the Honeywell 1800 processor can execute up to 90,000 instructions per second. This performance increase results from the faster memory cycle time of the Model 8200 (750 nanoseconds vs. 6 and 2 microseconds for the 800 and 1800, respectively) and from the use of interleaved memory accesses between up to eight independent memory modules.

Eight independent groups of control registers, with 32 registers per group, permit up to eight independent user programs to be run concurrently, with minimal switching time required when transferring control between programs. Such transfer of control can often be performed entirely by hardware, with no central processor delay imposed. The 24-bit length of all control registers enables explicit referencing of all main memory locations (from 131,072 to 1,048,576 characters), and also provides facilities for indexed and/or indirect addressing.

The master control facility of the Honeywell 8200 is the ninth group of control registers. Master control consists of independent, specialized control registers that, together with the master control program, coordinate the overall activities of the system. The master control facility controls and monitors the interactions of the word and VLF processing subsystems and the input-output controller. This facility also sets memory partitions so as to allocate blocks of memory (512 words or 4,096 characters) to individual program control groups as part of an effective memory protect scheme. In addition, the master control facility supervises the issuing of peripheral commands and device assignments, diagnoses program and memory usage violations, and maintains identification information regarding protected memory areas.

The variable-length-field (VLF) processor within the 8201 Central Processor qualifies the 8200 as a multiprocessor system whose facilities are shared by the two main (word and character) processors. The VLF processor is identical in most respects with the Honeywell 4200 Processor (see .25 above) and provides the only real relationship with the remainder of the Honeywell Series 200. Model 4200 programs that are not time-dependent can be executed directly by the Model 8200 VLF processor without reassembly or recompilation. The VLF processor contains a single group of program control registers, and permits the concurrent operation of two character-oriented programs through interrupt-controlled multiprogramming. The VLF processor can serve the 8200 word processor by controlling all input-output operations in a data communications system in the manner of a powerful data communications controller. Except for this case, Honeywell does not expect the Model 8200 word and VLF processors to work in constant communication while executing a single program. However, it is entirely possible and highly desirable for all slow-speed input-output data transfers and associated character-manipulation operations to be performed by the VLF processor. The powerful processing capabilities of the word processor can then be better utilized by handling input-output data batched on high-speed magnetic tape or mass storage devices.

One of Honeywell's design goals for the Model 8200 is to provide a powerful "third generation" system for users of its earlier 800 and 1800 computer systems. However, its powerful multiprogramming facilities and the concurrent, independent operations of its major system components have already attracted new Honeywell customers. The rental prices for typical Model 8200 systems are expected to parallel those of the IBM System/360 Model 65 (i.e., between $30,000 and $50,000 per month). Deliveries of the Model 8200 system will start in January 1968.

.3 PERIPHERAL UNITS

The main peripheral units available for use in Honeywell Series 200 systems are listed in Table III. Any of the peripheral devices can be used with any of the Series 200 processors. Each peripheral device or controller requires one or two input-output trunks: one trunk for input or output only; two trunks for two-way data transfers. Table II shows the maximum number of peripheral controllers accepted by each processor model.

Two different series of magnetic tape units are available for Series 200 systems. The 204A Series units are compatible with the 3/4-inch tape used in Honeywell 400, 1400, 800, and 1800 systems, while the 204B Series units provide compatibility with the 1/2-inch, 7-track tape used in IBM 1400 and 7000 Series systems. No 1/2-inch, 9-track tape units (such as those used in the IBM System/360) have been anounced to date for the Series 200.

TABLE III: PRINCIPAL SERIES 200 PERIPHERAL UNITS

PERIPHERAL TYPE	MODEL NO.	NAME	CHARACTERISTICS
Random Access Storage	250 Series	Mass Memory Files	See text (preceding page).
	250 Series	Disk Storage Drives	2.6 million to 2.5 billion characters; 97.5 msec average access time.
	270	Random Access Drum	2.6 to 20.4 million characters; 25 msec average access time
Punched Card Equipment	227	Card Reader/Punch	reads 800 cpm; punches 250 cpm.
	223	Card Reader	reads 800 cpm.
	224	Card Punch	punches fully-punched cards at 50 or 88 cpm; increased speeds for partial punching; has optional card reading capability.
	214-1	Card Punch	punches 100 to 400 cpm.
	214-2	Card Reader/Punch	reads 400 cpm; punches 100 fully-punched cpm.
Punched Paper Tape Equipment	209	Paper Tape Reader	reads 600 char/sec.
	210	Paper Tape Punch	punches 110 char/sec.
Printers	222 Series	Printers	print 450, 650, or 950 lpm.
Magnetic Tape Units	204A Series	Magnetic Tape Units	use 3/4-inch tape; compatible with H-400/1400 and H-800/1800 systems; transfer rates of 32, 64, and 88 KC.
	204B Series	Magnetic Tape Units	use 1/2-inch tape; compatible with IBM 729 series; transfer rates of 7.2 to 96 KC.
Communication Controls	281	Single-Channel Communication Control	controls 1 half-duplex line at up to 5,100 char/sec.
	286	Multi-Channel Communication Control	controls up to 63 lines, at up to 300 char/sec per line; maximum aggregate data rate is 7,000 char/sec.

* "Disk Pack" units, Models 256, 258, 259, and 259A, were announced in July 1966. The model 256 is the IBM 2311 Disk Storage Drive; the other units are basically the Control Data 853 and 854 Disk Drives.

.3 PERIPHERAL UNITS (Contd.)

The punched card and printing equipment is conventional in design, but the Series 200 line includes three peripheral units that seem to merit special discussion: the Model 250 Mass Memory Files, the Model 288 Data Station, and three models of visual display equipment.

Three types of magnetic strip transports are available for use with the interchangeable-cartridge Model 250 Mass Memory File: Type 251, which holds 15 million characters and has an average access time of 95 milliseconds; Type 252, which holds 63 million characters and has an average access of 150 milliseconds; and Type 253, which holds a total of 317 million characters in five on-line cartridges and has an average access time of 225 milliseconds. A maximum of eight transports, in any combination of types, can be connected to one Model 250 Mass Memory File.

Honeywell's mass storage unit, while not original in concept, is interesting both for its comparatively fast access times and for its prices, which are below presently existing standards. Two noteworthy physical features are the fast rotational speed (17 milliseconds) of the read-write drum and the circular arrangement of the cartridges around the read-write drum in the multi-cartridge Type 253 transport. (The Model 260 Random Access Disc Storage units have been withdrawn from the standard line of peripheral devices for the Series 200, leaving only the Model 250 Mass Memory File and the Model 270 Drum to serve the needs of users requiring mass storage facilities.)

The Model 288 Data Station consists of a remote terminal that can provide console typewriter input and output, paper tape equipment, and card and optical code readers. Its function is to connect remote locations directly to the computer room and, potentially, to provide direct connections between the computer itself and programmers or operators at the remote locations. Such a data communications link, which permits the processing of considerable volumes of data without involving the costs of a full computer system at the remote location, clearly can be used in many ways and can lead to major changes in a firm's data processing operations. The implications of this unit in any particular situation require special consideration on a systems level.

The new display equipment available for the Series 200 is manufactured by Bunker-Ramo Corporation and marketed by Honeywell. The line consists of three principal Display Stations, Models 303, 311, and 312, featuring keyboard input and cathode-ray tube alphameric data display capabilities. Editing features permit a non-destructive cursor or entry marker to be moved to any character position on the display screen for character correction or deletion purposes. From 32 to 768 characters can be displayed at one time, with the exact display size determined by unit model number and display arrangement. Each displayed character is regenerated on the screen more than 40 times per second.

The data communications equipment available for the Series 200 includes single-line and multi-line communication controls compatible with TELEX, TWX, and voice-grade lines. Although the Series 200 uses 6-bit characters as its basic data format, a special pair of instructions in all processors allows for the use of ASCII (7-bit) codes or other codes with up to 12 bits per character. Instruction facilities are also available for defining message control characters at the time the message is being transmitted. This permits simple matching of codes with most currently available data communications equipment.

.4 SOFTWARE

Software for the Honeywell Series 200 is currently organized in four principal levels of support, which are designated, in order of increasing power and comprehensiveness: Basic Programming System, Operating System — Mod 1, Operating System — Mod 2, and Operating System — Mod 8. Within each of these four major levels of software, several system control routines, language processors, and service routines are included. Moreover, there are in many cases several versions of the same basic software program within each major level. One reason for this latter situation is because the Honeywell Series 200 can utilize two-, three-, or four-character addresses within its instructions, depending on the number of core storage locations that must be accessed in a particular system. As a result, the same assembly language, for example, can have one or more assembler programs associated with it, depending on the size of the instruction addresses to be generated. Users of small-scale systems can choose to use exclusively software programs that generate two-address instructions, and thus they can conserve core storage space by always using instructions of relatively short length.

Most of the component programs of the Basic Programming System and the magnetic tape version of Operating System — Mod 1 have been available and in steady use with Series 200 systems for a year or more. However, in view of the new and powerful software facilities that its competitors are currently developing and delivering, Honeywell has also begun providing expanded software capabilities. Versions of the Operating System — Mod 1 and Operating System — Mod 2 are being implemented to take advantage of the flexibility inherent in auxiliary mass storage devices. The all-new Operating System — Mod 8 software will provide extensive multiprogramming and multiprocessing facilities for use with the large-scale Model 8200 system.

.41 Basic Programming System

Programs within the Basic Programming System are designed to operate within from 4K to 12K characters of core storage; these programs can utilize up to 32K characters of core storage. Versions of the component programs are provided in either the two- or three-character addressing mode. The Basic Programming System is designed for punched card-oriented Series 200 users. Operator intervention is generally required to effect transition from one program to the next.

The principal programs offered with the Basic Programming System are listed below.

- A software system called Easytab permits efficient transition from off-line tabulating equipment to a Series 200 computer system. Easytab consists of a number of utility routines that perform common functions of unit record equipment, and a "built-in" compact COBOL compiler that operates in an 8K-character storage environment.
- The Bridge and Easytran program translators, described in Paragraph .5, provide program compatibility with the IBM 1401.
- The Easycoder Assemblers provide close source-language compatibility with the assembly programs offered with the larger Series 200 operating systems. Eventual transition to the larger operating systems is therefore simplified.
- The Simultaneous Media Conversion A program permits the concurrent operation of up to three data transcription routines. Use of this program increases the efficiency of small Series 200 systems that serve as satellites to larger computer systems. File-to-file transcription facilities are included for the following devices: both 3/4-inch and 1/2-inch magnetic tape units, line printers, punched card units, and paper tape equipment.
- A Report Program Generator (RPG) provides report-writing capabilities that are similar to those provided with IBM 1401 Report Generators. The report format specification sheets are also similar to those used with the 1401 system.

.42 Operating System — Mod 1

The Honeywell Series 200 Operating System — Mod 1 functions within from 12K to 65K characters of core storage. Honeywell currently provides two significantly different versions of this software package.

The magnetic tape-oriented version was announced with the original H-200 system as a package called PLUS (Program Loading, Updating, and Selection System). The presently available version of Tape Resident Operating System — Mod 1 contains many more facilities than the original PLUS package. Independent programs are included within this new software to control automatic job sequencing, program retrieval and loading, overlay handling, and program library maintenance. Some programs within the Operating System — Mod 1 are supplied in two or three versions. This variety is provided because of the three- and four-character addressing options, the presence or absence of floating-point hardware (for FORTRAN processors), and the desire to make available a choice of language facilities at various program design levels. COBOL D, for example, operates in a 16K-character memory environment and offers 270 language elements; COBOL H, by contrast, operates in a 32K environment and offers 346 language elements.

The second and newer version of Operating System — Mod 1 makes extensive use of an auxiliary mass storage device in its centralized software control system. The core-resident portion of the Mass Storage Resident Operating System — Mod 1 requires only 1,500 characters of core storage. Approximately 2.9 million characters of random-access auxiliary storage are also required to utilize this system.

Provided with the Mass Storage Resident version of Honeywell's "Mod 1" software are assemblers, COBOL and FORTRAN language processors, and general utility programs that are comparable to offerings in the Tape Resident version of the same operating system. The chief difference between the two versions lies in the fact that the Mass Storage Resident operating system provides integrated system control routines. Among the functions performed by these routines are the following:

- Program loading.
- Automatic job stacking.
- Data management of sequential, indexed sequential, and direct access files.
- Generation of common output from all assemblers and compilers.

(Contd.)

.42 Operating System — Mod 1 (Contd.)

Release date for the first phase of the Mass Storage Resident system is fourth quarter 1966. Extensions to the system, including a limited multiprogramming facility, are due for release during the first quarter of 1967.

.43 Operating System — Mod 2

This large-scale software system will operate with Models 1200, 2200, and 4200 computer systems that have at least 49K characters of core storage and Honeywell's Optional Instruction Package. Mod 2 can utilize two main types of system environments, either all magnetic tape (using a minimum of five magnetic tape units) or combined tape and mass storage (using a minimum of one mass storage device and three magnetic tape units).

Operating System — Mod 2 is an integrated software system that provides expanded versions of many of the same facilities provided with the Mass Storage Resident Mod 1 software. FORTRAN and COBOL compilers and an assembler are provided in improved versions with Mod 2, offering additional language facilities and efficiencies that are possible only with large core memories. The output of all system programs is produced in common-format relocatable program blocks. Mod 2 also supplies an Easytran translator program that converts IBM 1410 and 7010 assembly language programs into Honeywell Series 200 assembly language. In addition, Operating System — Mod 2 provides a high-performance sort routine for use on magnetic tape or mass storage devices, and several utility routines to facilitate the use of mass storage devices.

The control components of Operating System — Mod 2 include a System Monitor and an Input-Output File Control System. Directed by job control cards, the System Monitor schedules jobs for execution in a sequential or multiprogramming mode, and also assigns peripheral devices, loads program segments, and supervises program execution. The Input-Output File Control System handles file access and file control functions for the following data file organizations: sequential, partitioned, direct access, indexed sequential, and communications access.

Honeywell will release the first phase of Operating System — Mod 2 software during the third quarter of 1966.

.44 Operating System — Mod 8

The fourth level of software available for Honeywell Series 200 systems is designated the Operating System — Mod 8. Mod 8 is specially designed for use with the hybrid Model 8200 system. Facilities included within the Mod 8 control system will supervise the operations of both the word processor of the Model 8200 and the variable-length-field (VLF) character processor (which bears close resemblance to a Model 4200 processor). Mod 8 will function exclusively as a mass storage resident system, requiring at least 15 million characters of mass storage. The system also requires the use of about 8,000 48-bit words of internal core storage for permanent residence.

Among the more important functions of the Operating System — Mod 8 are the following:

- Multiprogramming control for up to ten user programs.
- Dynamic scheduling of computer usage according to job priorities and equipment availability.
- Automatic allocation of memory, special register groups, and peripheral equipment to the scheduled programs.
- Loading and relocation of program segments.

Release of the Operating System — Mod 8 software is scheduled to coincide with the initial deliveries of the Model 8200 computer system in January 1968.

.5 COMPATIBILITY WITH THE IBM 1400 COMPUTER SERIES

The IBM 1400 Series of computers, consisting of the 1401, 1410, 1440, and 1460 processors, is still the most widely-used computer family in the world. All of the 1400 Series processors use a similar data format and instruction set, although each system has certain peculiarities designed to make it more suitable for particular functions; e.g., the larger memory size and overlapping operations of the 1410, the orientation toward removable "Disk Pack" cartridges of the 1440, and the higher internal speed of the 1460 relative to the basic 1401.

In the Series 200, Honeywell uses a basic instruction set that is largely identical with the basic IBM 1400 Series instruction set. Honeywell has also adopted the 6-bit character structure used in the 1400 Series, but uses eight bits plus a parity bit to store each 6-bit character. The added bit provides improved punctuation facilities (record marks and item marks in addition to the 1400 Series word marks).

Execution of an IBM 1400 Series program on a Honeywell Series 200 processor can be performed by means of a machine-aided conversion of the program and a subsequent manual checking operation. Normally, the program can then be run on any equivalent Series 200 system that has at least 4,096 extra core storage locations beyond those used by the original IBM 1400 Series

.5 COMPATIBILITY WITH THE IBM 1400 COMPUTER SERIES (Contd.)

program. Production programs, compilers, assemblers, and industry packages can all be converted in this manner. Sorts, data transcription operations, report programs compiled by means of Report Program Generators, and COBOL and FORTRAN programs are more commonly converted by using the original source programs or control cards to derive the necessary input to the equivalent Honeywell software routines; this allows for more efficient use of the capabilities of the Honeywell Series 200 hardware.

Two major types of machine-aided program conversion routines are available from Honeywell: the Bridge and Easytran systems. Bridge conversions can be performed only upon machine-language 1401 or 1460 programs. The program is loaded into the Series 200 computer's core storage in the normal way and is then processed by the special Bridge program. This results in the production of a new program input deck and supporting documentation. The new deck replaces the old program deck when the program is run on the Honeywell system, and otherwise operation continues as before.

By contrast, Easytran conversions are performed upon assembly-language programs. The IBM assembly input deck is processed and converted into a Honeywell assembly-language (Easycoder) deck, and a supporting diagnosis of possible incompatibilities and other problems is produced. After these potential problems have been investigated and the necessary actions have been taken, the amended assembly deck is assembled by the standard Easycoder assembler. The resulting Series 200 program can then be run in the normal manner. Honeywell currently recommends the Easytran conversion process rather than the Bridge machine-language translation technique.

Both Bridge and Easytran conversion routines have already been widely and successfully used for converting IBM 1401 and 1460 programs into Series 200 programs. Easytran routines that will enable IBM 1410 and 7010 programs to be run on Honeywell 1200, 2200, and 4200 systems are in preparation and will be available early in 1967. Easytran routines that will convert IBM 1440 programs have recently been announced; they will be available during the second quarter of 1967.

When IBM 1401 programs are converted by Easytran and run on a Honeywell Series 200 system, the average increase in overall performance (i.e., system throughput) experienced to date has been about 60 per cent. On individual programs, the increase in performance naturally varies widely, from a low of essentially no improvement (for programs limited by the speed of a single peripheral device) to a high of nearly 400 per cent (for programs with a minimum of input and output). The converted 1401 programs typically achieve about 80 per cent utilization of the Honeywell 200's processing capabilities. The only additional hardware required in the Honeywell system is 4,096 storage locations beyond the storage required by the original 1401 program, which adds about $250 per month to the rental price of the Series 200 equipment configuration.

For detailed discussions of the performance, limitations, and costs of these two basic conversion methods, refer to the Program Translator sections on Bridge (Section 510:181) and Easytran (Section 510:183), and also to the Program Compatibility section (510:131) of this Computer System Report.

.6 COMPATIBILITY WITHIN THE HONEYWELL SERIES 200

Basically, all the character-oriented computer systems in the Series 200 use the same data format, the same instructions, the same peripheral units, and the same software. As a result, there is a fairly high degree of upward-downward program compatibility, subject to the usual limitations such as the availability of sufficient memory, peripheral equipment, and input-output trunks, and the degree of time-dependency within the programs.

Three areas of potential incompatibility do exist:

- The addressing system. Different Series 200 processors use two-, three-, or four-character addressing. This provides economies in both storage space and execution time when addressing memory locations with short absolute addresses. However, in moving a program from a small processor to a larger one — particularly when the operating system requires the program to be relocatable — all address sizes and all address constants may need to be changed by hand if the user wishes to make use of the extra storage space for larger tables or other purposes.
- The index registers. Different Series 200 processors may have 6, 15, or 30 index registers, depending on the model, the size of core memory, and the inclusion of certain optional features. No provision has been made for simulating the operation of index registers not present in the hardware, so this factor may lead to incompatibilities in moving programs from a larger system to a smaller one.

(Contd.)

.6 COMPATIBILITY WITHIN THE HONEYWELL SERIES 200 (Contd.)

- The instruction repertoire. A number of instructions are unavailable in the small systems, optional in the medium-price systems and standard in the larger systems. Any program written for a system that includes these instructions may be unable to run on a Series 200 system that either cannot or does not have all the necessary instructions provided in the hardware. No provision has been announced for automatically "trapping" these instructions and using software routines to perform their functions.

The Honeywell Model 8200 computer system is compatible with the rest of the Series 200 systems to the extent that its VLF character-oriented processor can execute directly most non-time-dependent programs that were originally written for execution on a Model 4200 system. The 8200 VLF processor does not have hardware for floating-point arithmetic operations. Therefore, when Model 4200 programs attempt to perform floating-point arithmetic on a Model 8200 system, the instructions involved will be trapped and their operations simulated by software.

In addition, the Model 8200 provides direct machine-language program compatibility with the earlier Honeywell 800 and 1800 computer systems. All non-I/O instructions in H-800/1800 programs can be executed directly by the word processor of the Model 8200; all H-800/1800 input-output instructions are trapped and interpreted by the master control facility of the Model 8200 and reissued in a format acceptable to the 8200.

.7 PRICING

In November 1965, Honeywell announced a major revision in its pricing policies for the Series 200 equipment in a move designed to encourage either immediate purchase or long-term lease contracts. The essential elements of the new policy can be summarized as follows.

For users who wish to purchase equipment, a discount that averages about 7.5 per cent of list price is given for outright purchase. Those who purchase during the first year of equipment installation receive a 5 per cent discount off list price, and either 100 per cent credit on rental payments already made (if the decision to purchase is made during the first six months after installation), or 80 per cent credit on rental payments (if this decision is made during the second six months after installation). Those deciding to purchase during the second year after installation receive no reduction in purchase price, but do get a 60 per cent credit on rentals paid to date. After the end of the second year, there are no purchase price reductions nor credit allowances on rental payments made during the previous years.

For users who wish to rent equipment, signing a five-year lease contract results in an average reduction of 7.5 per cent in monthly rental payments. Four-year lease plans reduce the monthly rental costs by about 2.5 per cent. Those who contract to rent their equipment for a three-year period receive no reduction in standard Honeywell Series 200 rental fees, and those who choose to lease for "short term" periods pay approximately 2.5 per cent more than the "standard" rental prices. However, all lease contracts permit up to 200 hours of equipment usage per month — an increase over the conventional 176-hour monthly usage allotment.

Honeywell also increased its Series 200 maintenance charges as part of the revised pricing policy. The increases averaged from 10 per cent to 15 per cent, depending on the type of equipment maintained.

DATA STRUCTURE

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Character:	6 data bits + 1 parity bit + 2 punctuation bits	basic addressable storage unit; holds 1 letter, numeral, or special symbol.
Row (204A magnetic tape):	10 bits (8 data bits)	8 characters per 6 rows.
Row (204B magnetic tape):	7 bits (6 data bits)	holds 1 character.
Row (punched tape):	5 to 8 bits	holds 1 character.
Column:	12 positions	punched cards; holds 1 character.
Line:	96, 108, 120 or 132 positions	high-speed printer line of print.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	1 character.
Letter or special symbol:	1 character.
Instruction:	1 to 12 characters.
Field:	1 to N characters, ended by a word mark.
Item:	1 to N characters, ended by an item mark.
Record:	1 to N characters, ended by a record mark.
Floating-point operand:	35-bit-plus-sign fraction with 11-bit-plus-sign exponent, occupying 8 character positions.

SYSTEM CONFIGURATION

The configuration rules for the Honeywell Series 200 computers vary only slightly from model to model. Each system has a single processor which includes a core storage bank and two or more input-output channels. The minimum and maximum number of input-output channels and trunks that can be connected to each processor can be summarized as follows:

	INPUT-OUTPUT CHANNELS		INPUT-OUTPUT TRUNKS	
	Minimum	Maximum	Minimum	Maximum
Model 120	2	3	3	15
Model 200	3	4	8	16
Model 1200	4	4	16	16
Model 2200	4	8	16	32
Model 4200	8	16	32	48
Model 8200	16	32	48	96

In these Honeywell systems, there is no direct relationship between the number of channels and the number of input-output trunks. In general the number of trunks defines the physical maximum number of peripheral units or controllers that can be connected, while the number of channels indicates the number of simultaneous input-output operations that can take place. Any of the input-output channels can be used to service any of the connected peripheral devices; the connections between the peripheral units or their controllers and the channels are established during program execution rather than when the equipment is installed.

Current Honeywell Series 200 literature de-emphasizes the use of the previous "input-output trunk" terminology when treating the subject of configuration rules and requirements. Substituted are the concepts of power requirements ("unit power loads") and address assignment needs of the various input-output units, together with the varying potential of the specific central processor models to handle these requirements. Certain peculiarities in the method of input-output control in processor Models 120 and 200 have necessitated these more complex considerations. Despite this shift in terminology, the I/O trunk requirements of each peripheral device and the maximum trunk availability in the various processor models still appear to be good, working guides in determining possible system configurations. (The Simultaneous Operations section of the subreport on each Series 200 processor model provides additional information on the specific input-output control characteristics of the various processors).

For diagrams and prices of the Series 200 systems in representative standard configurations (as defined in Section 4:030 of the Users' Guide), see the System Configuration sections of the subreports on the individual models:

Model 120: . . . . Section 511:031
Model 200: . . . . Section 512:031
Model 1200: . . . . Section 513:031
Model 2200: . . . . Section 514:031
Model 4200: . . . . Section 516:031
Model 8200: . . . . Section 518:031

The peripheral devices in the Honeywell Series 200 and their input-output trunk requirements can be summarized as follows:

- 250 Mass Memory File Control — requires 2 input-output trunks, and can control 1 to 8 Type 251, 252, and/or 253 Mass Memory Transport Units.
- 270 Random Access Drum Storage and Control — requires 2 input-output trunks, and can control 1 to 8 drums.
- 227 Card Reader-Card Punch — requires 2 input-output trunks; 207 Card Reader Control is required for Card Reader, and 208 Card Punch Control is required for Card Punch.
- 223 Card Reader and Control — requires 1 input-output trunk.
- 224 Card Punch — requires 1 input-output trunk; 208-1 or 208-2 Card Punch Control is required.
- 214-1 Card Punch — requires 1 input-output trunk; 208-1 Control is required for connection to all processors except Model 120.

- 214-2 Card Reader-Card Punch — requires 2 input-output trunks; 208-2 Control is required for connection to all processors except Model 120.
- 123 Card Reader — Requires 1 input-output trunk; available for Model 120 systems only.
- 222 Printer and Control — requires 1 input-output trunk.
- 204A Magnetic Tape Subsystem (three-quarter inch tape) — requires 2 input-output trunks. Consists of 1 to 4 204A Series Magnetic Tape Units, connected to 1 203A Tape Control Unit.
- 204B Magnetic Tape Subsystem (one-half inch tape) — requires 2 input-output trunks. Consists of 1 to 8 204B Series Magnetic Tape Units, connected to 1 203B Tape Control Unit.
- 209 Paper Tape Reader and Control — requires 1 input-output trunk.
- 210 Paper Tape Punch and Control — requires 1 input-output trunk.
- 286 Multi-Channel Communication Control — requires 2 input-output trunks. Serves 2 to 63 half-duplex communication lines. One 285 Communication Adapter Unit is required per line used.
- 220 Console and Teleprinter — requires 2 input-output trunks.

The following special equipment is available:

- 212 On-Line Adapter (for connection to H-800/1800) — requires 1 input-output trunk.
- 212-1 On-Line Adapter (for interconnection of any two Series 200 processors) – requires 2 input-output trunks.
- 233 MICR Control Unit — requires 1 input-output trunk.
- 205 Magnetic Tape Switching Unit.
- 215 Communications Switching Unit.
- 288 Data Station (remote communications terminal; controls a group of low-speed input-output devices).

Other peripheral units from other manufacturers' lines, including the IBM 1400 Series, can be connected via the Honeywell PA2A General Purpose Peripheral Adapter.

INTERNAL STORAGE: CORE STORAGE

.1 GENERAL

.11 Identity: . . . . contained in the Series 200 Processors.

.12 Basic Usage: . . . . working storage in all models.
index register and arithmetic register storage in some models.
input-output controls in some models.

.13 Description

The 55 currently-available models of the Series 200 Processors differ in their core storage capacity, speed, and number of characters accessed per cycle, as well as in their processing capabilities. The principal core storage characteristics of the available models are summarized in Tables I and II. It is notable that Honeywell is offering a number of intermediate-size memories that eliminate the need for doubling the total memory capacity whenever a user needs more storage. Thus, a user who finds that a 32,768-character store is not large enough does not necessarily need to install another 32,768 characters; he can add 8,192, 16,384, or 24,576 more characters if the smaller increments will be adequate for his needs.

The core storage units of the Model 8200 Processor differ significantly from those used in the other processor models in the Series 200. Therefore, the characteristics of the 8200 core storage units are described in Section 518:041 of the computer system subreport on the Model 8200. The general characteristics of the 8200 storage modules are included in Tables I and II of this section.

Each character consists of eight bits, made up of six data bits representing an alphanumeric character and two punctuation bits which control the definition of operands in storage. A parity bit associated with each character location is used to check the accuracy of data transfers to and from core storage.

The Storage Protect feature (optional in the Honeywell 1200, 2200, and 4200 Processors) prevents instructions in the part of core storage on one side of a movable logical boundary from affecting the contents of any storage location on the other side of the boundary.

It is not currently possible to share core storage between different Series 200 Processors so that more than one processor can address a single main store.

.15 First Delivery

Model 120: . . . . February 1966.
Model 200: . . . . July 1964.
Model 1200: . . . . February 1966.
Model 2200: . . . . December 1965.
Model 4200: . . . . December 1966.
Model 8200: . . . . January 1968.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic cores.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . . yes.
.242 Data regenerated constantly: . . . . no.
.243 Data volatile: . . . . . . no.
.244 Data permanent:. . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.283 Type of access: . . . . . uniform.

.29 Potential Transfer Rates: . . . . see Table I.

TABLE I: POTENTIAL TRANSFER RATES

Series 200 Model:	120	200	1200	2200	4200	8200
Characters per storage access	1	1	1	1	4	4 (character processing) 8 (word processing)
Cycle time, microseconds	3.0	2.0	1.5	1.0	0.75	0.75
Cycling rate, cycles/second	333,333	500,000	666,666	1,000,000	1,333,333	1,333,333
Peak data rate, characters/second	333,333	500,000	666,666	1,000,000	5,333,333	5,333,333 (character processing) 10,666,666 (word processing)

.3 DATA CAPACITY

.31 Module and System Sizes: . . . . available processor models and their capacities are indicated in Table II.

.32 Rules for Combining Modules

In the Series 200 computer family, each processor model includes its own core storage. Any model can be upgraded by the addition of further core storage modules, in which case ths suffix of its model number is changed as shown in the table.

.4 CONTROLLER: . . . . . control unit is an integral part of each processor.

.5 ACCESS TIME: . . . . . see cycle times in Table I.

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE: . . . . varies with individual models; please see Table I.

.8 ERRORS, CHECKS, AND ACTION

Error	Check	Action
Invalid address:	check	stop and indicate error.
Receipt of data:	parity check	set indicator.
Recording of data:	record parity bit	set indicator.
Recovery of data:	parity check	set indicator.
Dispatch of data:	send parity bit.	

TABLE II: SERIES 200 PROCESSOR MODELS AND STORAGE SIZES

Core Storage Capacity, Characters	SYSTEM MODEL					
	120	200	1200	2200	4200	8200
2,048	121-1	-	-	-	-	-
4,096	121-2	201-2-1	-	-	-	-
8,192	121-3	201-2-2	-	-	-	-
12,288	121-4	201-2-3	-	-	-	-
16,384	121-5	201-2-4	1201-1	2201-1	-	-
20,480	121-6	201-2-5	-	-	-	-
24,576	121-7	201-2-6	-	-	-	-
28,672	121-8	201-2-7	-	-	-	-
32,768	121-9	201-2-8	1201-2	2201-2	-	-
40,960	-	201-2-9	-	-	-	-
49,152	-	201-2-10	1201-3	2201-3	-	-
57,344	-	201-2-11	-	-	-	-
65,536	-	201-2-12	1201-4	2201-4	4201-1	-
81,920	-	-	1201-5	2201-5	-	-
98,304	-	-	1201-6	2201-6	4201-2	-
114,688	-	-	1201-7	2201-7	-	-
131,072	-	-	1201-8	2201-8	4201-3	8201-1
163,840	-	-	-	2201-9	-	-
196,608	-	-	-	2201-10	4201-4	-
229,376	-	-	-	2201-11	-	-
262,144	-	-	-	2201-12	4201-5	8201-2
327,680	-	-	-	-	4201-6	-
393,216	-	-	-	-	4201-7	-
458,752	-	-	-	-	4201-8	-
524,288	-	-	-	-	4201-9	8201-3
786,432	-	-	-	-	-	8201-4
1,048,576	-	-	-	-	-	8201-5

INTERNAL STORAGE: 270 RANDOM ACCESS DRUM STORAGE

.1 GENERAL

.11 Identity: . . . . Random Access Drum Storage. Model 270.

.12 Basic Use: . . . . auxiliary storage.

.13 Description

The Model 270 Drum provides low-cost random access auxiliary storage where speed rather than large capacity is the primary requirement. Each Model 270 Drum Control Unit requires two input-output trunks (and two peripheral address assignments), and can control a maximum of eight drum units. Each drum can store 2.6 million alphameric characters.

The peak data transfer rate is 102,000 characters per second. Access time is 0 to 50 milliseconds, with an average of 25 milliseconds. A fixed read/write head serves each track, so there are no delays due to repositioning of a movable access mechanism as in most disc files. Each drum has 512 data tracks, and each track can hold up to 5,120 characters arranged in 40 sectors of 128 characters each. Two separate tracks contain sector addresses and clock information.

Instructions to read from and write into drum storage are provided. From one to N characters can be transferred, where N is limited by the capacity of core storage. The drum unit can be tested for a busy or error condition.

The average demand on the central processor during drum input-output data transfers varies from 30.6% on the 120 Processor to 8.0% on the 4200. Details are given in the individual subreports.

.14 Availability: . . . . 12 months.

.15 First Delivery: . . . . December, 1964.

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . drum.

.22 Physical Dimensions

.222 Drum
Diameter: . . . . . . 20 inches.
Length: . . . . 25 inches.
Number on shaft: . . 1.

.23 Storage Phenomenon: magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . no.
.245 Storage changeable: . no.

.25 Data Volume per Band of 1 Track

Words: . . . . variable.
Characters: . . . . . . 5,120.
Digits: . . . . 5,120.
Instructions: . . . . . . variable.
Sectors: . . . . 40.

.26 Bands per Physical Unit: . . . . 512.

.27 Interleaving Levels: . 1.

.28 Access Techniques

.281 Recording method: . . fixed heads (one per track).
.283 Type of access —
Description of stage: wait for selected address.
Possible starting stage: . . . . yes.

.29 Potential Transfer Rates

.291 Peak bit rates —
Cycling rates: . . . . 1,200 rpm.
Bit rate per track: . 728,000 bits/sec/track.

.292 Peak data rates —
Unit of data: . . . . . character.
Conversion factor: . 7 bits.
Gain factor: . . . . . 1.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum per Control
Drums:	1	8
Control Units:	1	1
Characters:	2,621,440	20,971,520
Digits:	2,621,440	20,971,520
Instructions:	variable.	
Sectors:	20,480	163,840
Tracks:	512	4,096

.32 Rules for Combining Modules: . . . . 1 to 8 drums per control unit; each control unit requires 2 input-output trunks and 2 peripheral address assignments.

.4 CONTROLLER

.41 Identity: . . . . Model 270 Drum Control Unit.

.42 Connection to System

.421 On-line: . . . . each Drum Control Unit requires 2 input-output trunks.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . . maximum of 8 drums.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to N characters, limited by available core storage.
.442 Input-output area: . . core storage.
.443 Input-output area access: . . . . each character.
.444 Input-output area lockout: . . . . none.
.445 Synchronization: . . . automatic.
.447 Table control: . . . . none.
.448 Testable conditions: . busy or error condition.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks —
Stacks per drum: . . 512 (1 per track).
Stacks per system: . maximum of 32,768 (64 drums).
.512 Stack movement: . . . none; fixed heads.
.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations —
By single stack: . . . 5,120 chars.
By all stacks: . . . . 2,621,440 chars per drum.
.515 Relationship between stacks and locations: address specifies drum, zone, track, and sector (stack corresponds to track).

.52 Simultaneous Operations: . . . . . only one operation per Drum Control Unit at any one time — read or write.

.53 Access Time Parameters and Variations

.532 Variation in access time —

Stage	Variation (msec)	Average (msec)
Wait for selected record:	0 to 50	25.
Total:	0 to 50	25.

.6 CHANGEABLE STORAGE: . . . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage unit possibilities —
With self: . . . . no.
With core storage: . yes.
With control memory: . . . . . . no.

.72 Transfer Load Size

With core storage: . . 1 to N chars, limited by size of core storage.

.73 Effective Transfer Rate

With core storage: . . 94,800 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	set indicator.
Invalid code:	none.	
Receipt of data:	parity check	set indicator.
Recording of data:	parity generated.	
Recovery of data:	parity check	set indicator.
Dispatch of data:	send parity bit.	
Timing conflicts:	check	stop and indicate error.

INTERNAL STORAGE: MASS MEMORY FILES

.1 GENERAL

.11 Identity: . . . . Type 250 Mass Memory File Control.
Types 251, 252, and 253 Mass Memory Transport Units.

.12 Basic Use: . . . . auxiliary storage.

.13 Description

Honeywell's Mass Memory File System provides random access to a relatively large volume of on-line data. The data storage capacity of a system can range from approximately 15 million to 2.5 billion 6-bit characters. Data is stored on magnetic strips which are housed in interchangeable cartridges.

A basic Mass Memory File System consists of a Type 250 Control Unit and one of three transport units, Types 251, 252, or 253. The transport unit models have different access times and data handling capabilities, as summarized in Table I. A maximum of eight transports, in any combination of models, can be connected to one Model 250 Control Unit.

Each interchangeable cartridge contains 512 magnetic Mylar-coated strips whose dimensions approximate those of a punched card. A strip has 32 or 128 data tracks, depending on the type of transport used (see Table I). Each track has a data capacity of 968 characters.

The top edge of each strip is cut out in a unique pattern of notches representing the strip's file address. Selector rods pass through the notches of all the strips. A strip address specified in a Mass Memory File instruction positions the selector rods so as to allow the release of the designated strip onto a platform prior to being pushed onto a moving raceway. The strip is then transferred to a read/write drum for the input or output data transfer operation. After completion of the I/O operation, the strip is decelerated and returned to its proper cartridge as illustrated in Figure 1. Wear and damage are expected to be minimized by the use of air pressure to control strip manipulations.

Programming of the Mass Memory File is performed by two general-purpose peripheral device instructions: Peripheral Data Transfer (PDT) and Peripheral Control and Branch (PCB). The Peripheral Data Transfer instruction controls address register data manipulation, data record transfer, and file formatting operations. The Peripheral Control and Branch instruction initiates control, test, and interrupt operations.

Honeywell recommends that the programmer follow the following guidelines when organizing data in the Mass Memory File:

- Reserve a spare magnetic stip in each cartridge for possible use as a replacement;
- Store a file table on one or more strips if more than one file is stored in a Mass Memory File cartridge; and
- Set aside one or more tracks on a strip for read error recovery procedures.

.14 Availability: . . . . 12 months.

.15 First Delivery: . . . . . Types 251 and 252—1966.
Types 253—1967.

.16 Reserved Storage: . . . none, although it is recommended that one strip per cartridge be saved for use as a spare.

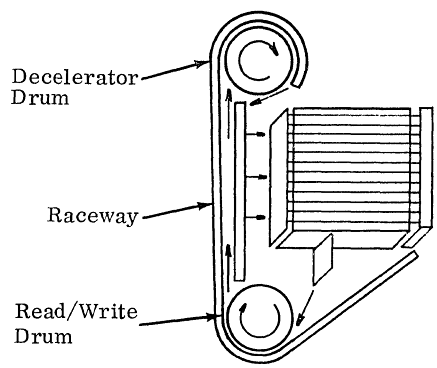


Figure 1: Logical Diagram of the Honeywell Mass Memory File

TABLE I: MASS MEMORY FILE CHARACTERISTICS

Type	Access Time	Millions of Data Characters per Transport (Nominal)	Cartridges per Transport	Transports per 250 Control	Millions of Data Characters per 250 Control (Nominal)	Data Characters per Track (Maximum)	Tracks per Strip	Strips per Cartridge
251	95 msec	15.8	1	8	126.8	968	32	512
252	150 msec	63.4	1	8	507.5	968	128	512
253	225 msec	63 to 317.1	1 to 5	8	2,537.5	968	128	512

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic Mylar strips.

.22 Physical Dimensions

.223 Magnetic strip —
Length: . . . . 7.375 inches.
Width: . . . . 3.25 inches.
Number: . . . . 512 strips/cartridge.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . . yes.
.242 Data regenerated constantly: . . . . no.
.243 Data volatile: . . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . yes, in units of 512 strips (1 cartridge).

.25 Data Volume per Band of 1 Track

Characters: . . . . 968.
Digits: . . . . 968.
Instructions: . . . . variable.

.26 Bands per Physical Unit: . . . . 32 (Type 251) or 128 (Types 252, 253).

.27 Interleaving Levels: . . none.

.28 Access Techniques

.281 Reading and recording method: . . . . movable magnetic heads align with beginning of selected track on magnetic strip that revolves on read/write drum.

.283 Type of access —

Description of stage	Possible starting stage
Select card:	yes.
Extract card to raceway:	yes.
Move card and mount on drum:	no.
Leading edge of record approaches heads:	yes, if required card was already on drum.

.29 Potential Transfer Rates

.291 Peak bit rates —
Cycling rates: . . . . . 3,600 rpm (16.7 msec/rev.).
Track/head speed: . . 600 inches/sec.
Bits/inch/track: . . . 1,000.
Bit rate per track: . . 600,000 bits/sec/track.
.292 Peak data rates —
Unit of data: . . . . . . alphanumeric character.
Conversion factor: . . 6 data bits/character.
Data rate: . . . . 100,000 char/sec.

.32 Rules for Combining Modules: . . . . up to eight Type 251, 252, and/or 253 Files, in any combination, can be connected to a single Type 250 Control.

.4 CONTROLLER

.41 Identity: . . . . Type 250 Mass Memory File Control.

.42 Connection to System: . one read/write channel and two input/output trunks are required for each Control. (See Section 510:031, System Configuration, for maximum number of channels and trunks per Series 200 system.)

.43 Connection to Device

.431 Devices per controller: 1 to 8 Type 251, 252, and/or 253 Transports in any combination.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to 968 characters.
.442 Input-output area: . . . main core storage.
.443 Input-output area access: . . . . each character.
.444 Input-output area lockout: . . . . each record location can be protected against over-writing by writing record-protect bits with the data record. Attempted record-protect violations as detected by the Type 250 Control.
blocks of 4,096 characters in core storage can be protected against overwriting by data from the Mass Memory File. This hardware storage protect feature is not available on the Models 120 and 200 Processors, and is optional on the larger Series 200 processors.
.445 Synchronization: . . . . automatic.
.446 Table control: . . . . none.
.447 Testable conditions: . . unit available; unit busy.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks —
Stacks per module: . . 1 per 251, 252, or 253 Mass Memory Transport Unit.
Heads per stack: . . . 32 — 16 pairs of read/write heads.

.3 DATA CAPACITY

	Minimum Storage			Maximum Storage per Controller
Identity:	Type 251	Type 252	Type 253	8 Type 253's
Cartridges:	1	1	5 (max.)	40
Strips:	512	512	2,560 (max.)	20,480
Characters:	15,859,712	63,438,848	317,194,240	2.536 billion
Instructions:	variable	variable	variable	variable

(Contd.)

.512 Stack movement: . . . . across strip width to any of either 2 (Type 251) or 8 (Types 252 and 253) stack positions.

.513 Stacks that can access any particular location: . . . . 1.

.514 Accessible locations:
By single stack —
With no movement: . 16 tracks of the strip on the read/write drum (1 cylinder).
With all movement: 32 tracks (Type 251) or 128 tracks (Types 252 and 253) of the strip on the read/write drum.

.52 Simultaneous Operations: . . . . seek operations can take place simultaneously in all (up to 8) transports connected to the same control unit; only one data transfer operation can be performed per control unit at any one time, but this operation can be overlapped with multiple seek operations.

.53 Access Time Parameters and Variations: . . . . varies according to transport type, as shown in Figure 2.

.6 CHANGEABLE STORAGE

.61 Cartridges

.611 Cartridge capacity —
Type 251: . . . . 15.8 million characters.
Type 252: . . . . 63.4 million characters.
Type 253: . . . . 63 to 317 million characters.

.612 Cartridges per module: . . . . one with Types 251 and 252 transports; one to five with Type 253 transports.

.613 Interchangeable: . . . . the physical cartridge and tape strips are identical for each transport type, and cartridges are therefore interchangeable between transports of the same and different types; however, the 32-track data format of the Type 251 Transport is not directly compatible with the 128-track format of the Types 252 and 253 Transports.

.623 Approximate change time: . . . . 30 seconds.

.624 Bulk loading: . . . . no; 1 cartridge at a time.

.7 PERFORMANCE

.72 Transfer Load Size

With core storage —
Single track: . . . . . . 1 to 968 characters.
Cylinder: . . . . up to 15,488 characters (16 tracks per cylinder).

.73 Effective Transfer Rate

With core storage: . . . 42,300 char/sec using Type 251 Transport.*
49,500 char/sec using Type 252 Transport.*
47,600 char/sec using Type 253 Transport.*

* Based on transferring the entire contents of the Honeywell 2201-12 core storage unit (262,144 characters) to consecutive tracks of randomly-accessed cards.

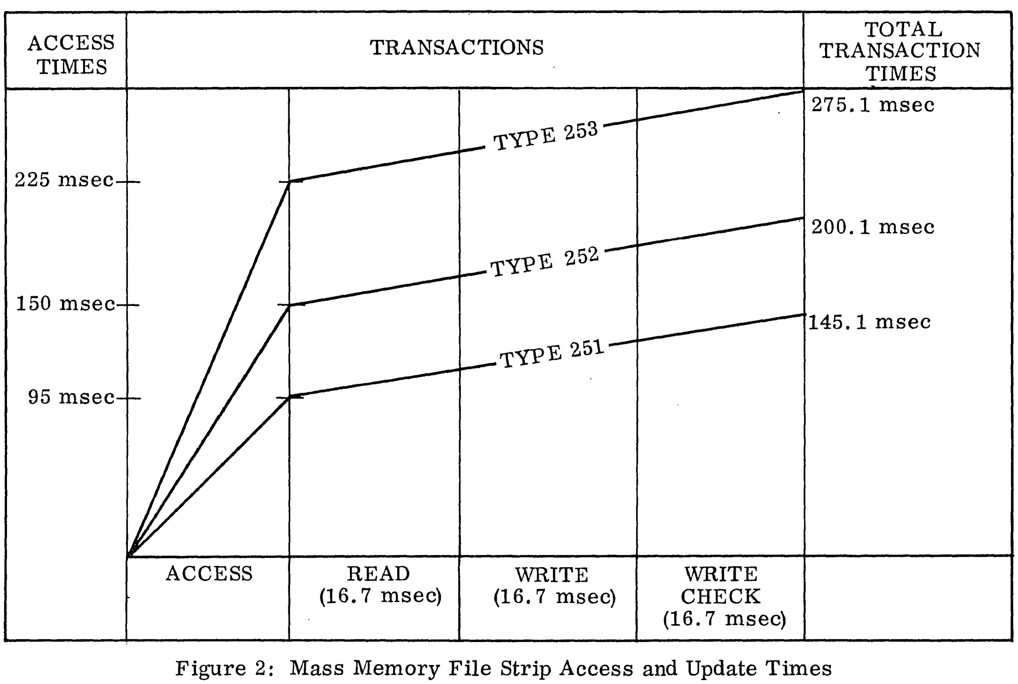


Figure 2: Mass Memory File Strip Access and Update Times

.74 Update Cycle Rate

Type 251 Transport:. . 6.8 references/sec.
Type 252 Transport:. . 5.0 references/sec.
Type 253 Transport:. . 3.5 references/sec.

Note: Based on random accessing of 1 strip and one 968-character record on that strip; reading, updating, and rewriting that record; and rereading for verification of recording accuracy.

.75 Read-Only Reference Cycle Rate

Type 251 Transport:. . 8.3 references/sec.
Type 252 Transport:. . 6.0 references/sec.
Type 253 Transport:. . 4.1 references/sec.

Note: Based on random accessing of 1 strip and one 968-character record on that strip, and reading the record into core storage with no updating.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	set instruction incomplete bit.
Invalid code:	check	set read check bit.
Receipt of data:	check	set read check bit.
Recording of data:	check	set write check bit.
Recovery of data:	check	set read check bit.
Dispatch of data:	check	set read check bit.
Timing conflicts:	check	set device error bit.
Physical record missing:	check	set instruction incomplete bit.
Reference to locked area:	check	set protection violation bit.

CENTRAL PROCESSORS

Although there is a great deal of similarity among the Models 120, 200, 1200, 2200, and 4200 central processors within the Honeywell Series 200, there are also significant differences beyond the anticipated differences in speeds. These differences include:

- The standard and optional instruction repertoires.
- The physical arrangement of the processor registers.
- The number of index registers.
- The handling of input-output operations.

Moreover, the Model 8200 central processor includes many concepts and facilities that are entirely unrelated to the other Series 200 processors. Therefore, each of the currently-announced Series 200 central processors is discussed in detail in its appropriate Computer System Subreport, which also provides performance details. The instruction repertoires of the six processors are tabulated and compared in Section 510:121.

The references for the individual processor models are:

CONSOLE

.1 GENERAL

.11 Identity: . . . . Control Panel (included as part of Central Processor).
Console, Models 220-1, 220-2, and 220-3.

.12 Associated Units: . . . . a keyboard Teleprinter is available with the 220 Consoles.

.13 Description

Any one of four different devices can be used in a Honeywell 200 system for operator control:

(1) A basic, stand-up Control Panel atop the central processor cabinet.

(2) A console desk with Teleprinter, using software to provide operational control (Model 220-1 Console).

(3) A console desk with control panel and Teleprinter, with hardware connections between the Teleprinter and computer memory (Model 220-2 Console).

(4) A console desk that includes all of the features of the Model 220-2 Console, but which also includes control panel indicators for use with the Storage Protect and Sense Switch features of the 1200, 2200, and 4200 computer systems (Model 220-3 Console). This 220-3 Console will replace the Model 220-2 Console in all new Series 200 installations.

.131 Control Panel

The Control Panel is a rectangular box containing buttons and display lights which is situated on top of the Central Processor Power Unit. Included in the Control Panel are switches and lights which permit the operator to:

- Start or stop execution of the stored program.
- Turn the power supply on or off.
- Clear all indicators.
- Load information from peripheral units into core storage.
- Alter or display the instruction counter setting.
- Execute single instructions.
- Interrogate and load core storage locations and control memory registers.
- Control execution of programs by means of four sense switches.

.132 220-1 Console

The 220-1 Console includes a Control Panel (see Paragraph .131) and a Teleprinter. The Teleprinter does not duplicate control panel functions. Certain control panel functions can be simulated from the Teleprinter by a program in core memory. The Teleprinter operates in two modes:

- Peripheral mode — as a peripheral device, utilizing a Read-Write Channel under program control to operate as an input or output device.
- Logging mode — as a manual Teleprinter logically disconnected from the computer system, for use by the operator in making notes.

The 220-1 includes a separate desk mounting for the Teleprinter and can be a maximum of ten feet from the Central Processor. The console requires two input-output trunks.

.133 220-2 and 220-3 Consoles

The 220-2 and 220-3 Consoles include a Teleprinter and most of the functions of the Control Panel. They are similar to the 220-1 except that the Console can operate in any of three distinct modes:

- Peripheral mode — as a peripheral device utilizing a Read-Write Channel under program control.
- Control mode — as a control panel utilizing the Teleprinter keyboard for direct access to core memory and control memory. The Teleprinter makes a printed record of all memory "entries" and "displays."
- Logging mode — as a manual Teleprinter logically disconnected from the computer system.

Operator-initiated manual type-ins and type-outs cannot be accomplished while the program is running, but logging can be accomplished at the risk of delaying the program.

.134 Cabinetry

The Honeywell 200 system is highly modular and can be arranged in a wide variety of physical configurations. The Central Processor Power Unit, which contains the Control Panel described above, is a rectangular cabinet 36 inches wide by 30 inches deep by 42 inches high. Most of the electronic components of the system are housed in vertical drawers which tilt out of their logic cabinets for easy access. Each logic cabinet houses four drawers and has the same dimensions (36 by 30 by 42 inches) as the Power Unit, with a flat top that provides a convenient work surface. The number of drawers required to house various system components are listed in Section 510:211, Physical Characteristics.

INPUT-OUTPUT: 227 CARD READER

.1 GENERAL

.11 Identity: . . . . Card Reader-Card Punch (Reader only). Model 227.

.12 Description

The Model 227 Card Reader is housed in the same cabinet as the Model 227 Card Punch, but the two devices are functionally independent. The reader reads standard 80-column cards at a peak speed of 800 cards per minute. Reading normally includes automatic translation from Hollerith card code to machine code, but an optional feature, Direct Transcription, allows column binary cards to be read. It is not possible to read part of a card in binary and part in Hollerith code except by intricate programming.

Instructions to read or reject cards are provided, as well as instructions to test the status of the device (busy, error, inoperable) and to set the control unit to perform specific functions (accept or reject error cards, read Hollerith code, etc.).

A card can be read during one 75-millisecond cycle. Time between clutch points is 25 milliseconds, which means that reading of successive cards can be initiated at intervals of 75, 100, 125, 150, . . . etc. milliseconds. The demand on the central processor during operation of the card reader is normally 960 memory cycles per card. Details as to how much overlapped operation is possible are given in the Simultaneous Operations sections of the subreports on the individual processor models.

Reading operations are controlled by the 207 Card Reader Control, which translates from standard Hollerith card codes to Series 200 six-bit central processor codes. The control can be equipped to transfer data without translation in the optional Direct Transcription mode (binary 1 = punched position; 0 = unpunched position). In the Direct Transcription mode, the contents of each card fill 160 consecutive core storage positions.

Transcription mode (binary 1 = punched position; 0 = unpunched position). In the Direct Transcription mode, the contents of each card fill 160 consecutive core storage positions.

Hopper capacity is 3,000 cards; the normal and reject stackers have capacities of 1,000 cards each. The input area can be any group of consecutive core storage locations. Reading is terminated by a record mark or by completion of an 80-character transfer. Card reading is checked by comparing the hole counts obtained at the two reading stations. An optional illegal card code check is available. Failure of any check automatically sets a program-testable indicator. This unit, unlike the Honeywell 223 Card Reader, cannot initiate program interrupts.

The 227 Card Reader-Card Punch utilizes the IBM 1402 Card Read-Punch mechanism, with the Early Card Read feature included as standard equipment. See Section 401:071 for a more detailed description of this reader as used in the IBM 1401 system.

Different Honeywell Series 200 processor models can have between 5 and 96 peripheral address assignments; see System Configuration, Section 510:031, for details. The maximum number of card readers that can be connected to a particular system depends upon the number of available addresses. Each 227 Card Reader-Card Punch requires the exclusive use of two address assignments — one for the reader and one for the punch.

Optional Features

Stacker Select: Provides the ability to select the middle output stacker by program control.

Direct Transcription: Permits transfer of data without translation.

INPUT-OUTPUT: 227 CARD PUNCH

.1 GENERAL

.11 Identity: . . . . Card Reader-Card Punch (Punch only). Model 227.

.12 Description

The Model 227 Card Punch, which is housed in the same cabinet as an 800-card-per-minute reader, is capable of punching standard 80-column cards at a peak speed of 250 cards per minute. Automatic translation from internal machine code to 80-column Hollerith card code is normally performed, but an optional feature, Direct Transcription, allows column binary cards to be punched. It is not possible to punch part of a card in binary and part in Hollerith code except by intricate programming.

Instructions to punch or reject cards are provided, as well as control instructions for testing the device and setting the control unit to perform specific functions.

A card can be punched during one 240-millisecond cycle. Time between card clutch points (at which a punching operation can be initiated) is 60 milliseconds. The demand on the central processor during operation of the card punch is normally 960 memory cycles per card. Details as to how much overlapped operation is possible are presented in the Simultaneous Operations sections of the subreports on the individual processor models.

Punching operations are controlled by the 208 Card Punch Control, which translates from H-200 six-bit internal codes to standard Hollerith card codes. The control can be equipped to transfer data without translation in the optional Direct Transcription mode (binary 1 = punched position; 0 = unpunched position). In the Direct Transcription mode, the contents of 160 consecutive core storage positions will be punched into each card.

Hopper capacity is 1,200 cards; the normal and reject stackers have capacities of 1,000 cards each.

The output area can be any group of consecutive core storage locations. Punching is terminated by a record mark or by completion of an 80-character transfer. The facility to check the punched output by reading it back and making a hole count check is, inexplicably, an optional feature. Failure of any check automatically sets a program-testable indicator. This unit, unlike the Honeywell 224 Card Punch, cannot initiate program interrupts.

The 227 Card Reader-Card Punch utilizes the IBM 1402 Card Read-Punch mechanism. See Section 401:072 for a more detailed description of this punch as used in the IBM 1401 system.

Different Honeywell Series 200 processor models can have between 5 and 96 peripheral address assignments; see System Configuration, Section 510:031, for details. The maximum number of card punches that can be connected to a particular system depends upon the number of available addresses. Each 227 Card Reader-Card Punch requires the exclusive use of two address assignments — one for the reader and one for the punch.

Optional Features

Punch Feed Read: Allows reading of cards prior to punching, making it possible to read information from a card and punch additional information into the same card. Installation of the Punch Feed Read feature involves addition of a pre-punch read station in the punch unit and modification of the punch control unit to allow transmission of data from this read station into core storage.

Stacker Select: Provides the ability to select the middle output stacker by program control.

Hole Count Check: Provides a check upon the accuracy of the punched output by reading it back and counting holes.

Direct Transcription: Permits transfer of data without translation; i.e., a binary image of the data in 160 consecutive core storage positions is punched into each card.

INPUT-OUTPUT: 209 PAPER TAPE READER

.1 GENERAL

.11 Identity: . . . . Paper Tape Reader and Control. Model 209.

.12 Description

The Type 209 Paper Tape Reader and Control reads 5-, 6-, 7-, or 8-level punched tape at the rate of 600 rows (characters) per second. The tape can be 11/16, 7/8, or 1 inch in width. Chadded (fully perforated) tape in reels of up to 1000 feet or in strips can be used. The tape can be Mylar, metallic coated, or dry or oiled paper. The reader is manufactured by NCR.

Instructions to read paper tape forward or backward and to rewind or run out the tape are provided. Tape can also be rewound or run out manually on the reader. The input areas may be any size and may be located anywhere in core storage. In the normal mode, reading is terminated by a record mark in main memory. In the alternate (bootstrap) mode, reading is terminated by a special punch in one channel used to terminate punching. The tape stops within the length of a single row at the end of a reading operation, so that the first and last rows of each tape record can be read reliably.

Reading is performed in the "direct transcription mode," without code translation; i.e., a binary 1 in memory corresponds to a punched position in the tape, while a 0 corresponds to an unpunched position. The control unit can be conditioned by a programmed instruction to process either codes of 5 to 6 levels or codes of 7 to 8 levels; each row read from 7- or 8-level tape is stored in two consecutive core positions.

Data transfer from the reader to core storage involves the central processor for only one memory cycle per 5- or 6-level tape row or two cycles per 7- or 8-level row. The resulting central processor demand for each of the individual models of the Series 200 is included in the Simultaneous Operations section of the appropriate subreport.

An automatic row parity check (odd or even, as specified by instruction) is provided. If the check fails, a program-testable indicator is set.

Different Honeywell Series 200 processor models can have from 5 to 96 peripheral address assignments; for details, please see the System Configuration Sections of the individual subreports. The number of 209 Paper Tape Readers that can be connected to a particular system depends upon the number of available addresses; each reader requires the use of one address assignment.

INPUT-OUTPUT: 210 PAPER TAPE PUNCH

.1 GENERAL

.11 Identity: . . . . Paper Tape Punch and Control.
Model 210.

.12 Description

The Type 210 Paper Tape Punch and Control punches 5-, 6-, 7-, or 8-level tape at the rate of 120 rows (characters) per second. Tape width can be 11/16, 7/8, or 1 inch; strips or standard 1000-foot rolls can be used. The punch is the National Cash Register Model EM-B1 Unit.

An instruction is provided to punch tape until a record mark in core storage is sensed. Tape can be run out manually. The output area may be any size and may be located anywhere in core storage.

Punching is performed in the "direct transcription mode," without code translation; i.e., a binary 1 in memory corresponds to a punched hole in the tape, while a 0 corresponds to an unpunched position. The control unit can be conditioned by a programmed instruction to process either codes of 5 to 6 levels or codes of 7 to 8 levels; 2 consecutive core positions are used to store each 7- or 8-level tape code.

Data transfer from core storage to the punch involves the central processor for only one memory cycle per 5- or 6-level tape row or two cycles per 7- or 8-level row. Thus, the central processor is free during more than 99.9% of a paper tape punch operation to perform computations and to direct other input-output operations.

Row parity can be generated by programmed instructions in preparation for punching. There is no check upon the accuracy of the punched codes.

Different Honeywell Series 200 processor models have from 5 to 96 peripheral address assignments; for details, please see the System Configuration sections of the individual subreports. The number of 210 Paper Tape Punches that can be connected to a particular system depends upon the number of available addresses; each punch requires the use of one address assignment.

INPUT-OUTPUT: 223 CARD READER

.1 GENERAL

.11 Identity: . . . . Card Reader and Control, Model 223.

.12 Description

The Honeywell Model 223 Card Reader is an 800-card-per-minute photoelectric reader with a single 2,500-card stacker and a 3,000-card feed hopper. A check upon the legality of card characters can be made during the read operation, and any illegal (non-Hollerith) punching causes the card to be rejected. A rejected card is offset when placed into the output stacker. When this occurs, the program is notified by means of a testable indicator, and subsequent action is determined by the program itself.

Cards are fed from the hopper by means of a picker knife and transported to the read station by pinch rollers. Reading is a column-by-column operation, using 12 photo-sensors. The card is then forwarded to the stacker. Offsetting occurs while the card is in motion toward the stacker.

Standard 80-column Hollerith cards are normally used; with an optional feature, 51-column stub cards can be read. The input area can be anywhere in main core storage. Translation from Hollerith code to H-200 internal code is performed automatically during the transfer of the card image. With the optional Direct Transcription feature, a binary card image can be transferred to core storage with no translation. In this mode, two core storage locations are used for each card column. Cards can either be read in Hollerith code and translated during the read operation, or read in binary without translation. It is not possible to read part of a card in the Hollerith mode and part in binary.

Different Honeywell Series 200 processor models can have from 3 to 64 input-output trunks; for details, please see the System Configuration sections of the individual subreports. The number of Model 223 Card Readers that can be connected to a particular system depends upon the number of available trunks; each reader requires the exclusive use of one trunk.

There are no delays due to the need to wait for discrete clutch points, and a card read operation can be initiated at any point in time. The central processor is delayed only during the actual storing of the data into core storage: one memory cycle per location stored.

An interrupt signal can be generated at the end of each card read operation, provided that the computer is equipped to handle interrupts. In addition, an indicator, testable by the Peripheral Control and Branch instruction, is set to show the cause of the interrupt. Conditions that can be distinguished are unit busy, illegal punch, and cycle error.

Safeguards against errors consist of checks upon proper operation of the equipment, rather than upon reading the card twice and comparing the results. The photo-sensors are tested twice during each card cycle, one "light" test and one "dark" test being used. Input area overflow or underflow is not considered to be a problem - the transfer of the full 80 (or 160) characters is initiated automatically, and the transfer of the correct number of characters into core storage occurs unless a word mark is found in the input area.

The Model 223 Card Reader is designed and manufactured by Honeywell. It was announced in April 1964, and was initially installed on a Honeywell 200 system in January 1965. It is available on a six-month delivery basis.

Optional Features

Direct Transcription: Permits binary cards to be read, without translation, into 160 consecutive core storage locations.

51-Column Reading: Permits reading of short 51-column stub cards.

INPUT-OUTPUT: 224 CARD PUNCH

.1 GENERAL

.11 Identity: . . . . Models 224-1 and 224-2 Card Punch Units.

Models 208-1 and 208-2 Card Punch Controls.

.12 Description

The 224 Card Punch Units are column-by-column punches which start at column 1 and continue punching a column at a time until no further punching is required on the card. The punching speed depends upon the number of columns punched, or, more precisely, upon the number of columns between column 1 and the last column on the card which requires punching. Model 224-1 punches at speeds between 50 cards per minute (when all 80 columns are punched) and 179 cards per minute (when only 10 columns are punched per card). Model 224-2 punches from 91 cards per minute (80 columns) to 270 cards per minute (10 columns per card).

The Card Punch Controls, Models 208-1 and 208-2, each connect one card punch to the computer. Each control normally requires one input-output trunk. If the Model 208-2's Punch Feed Read facility is used, two input-output trunks are required.

Different Honeywell Series 200 processor models can have from 3 to 64 input-output trunks; for details, please see the System Configuration sections of the individual subreports. The number of Model 224 Card Punches that can be connected to a particular system naturally depends upon the number of available trunks.

The 224 Card Punch Units have a single 1,200-card input hopper and one or two radial 1,300-card output stackers. (The second stacker is optional on Model 224-1.) Diversion of a card into the second stacker can be set to occur automatically when an error is noted. When there is only a single output stacker, it is normally necessary to stop the equipment when an error occurs, because no other means (such as offsetting of the error card) is provided to mark which card is in error.

During the punching operation, each column is punched from the contents of a single core storage location. Because the columns are punched sequentially, this takes no more than three microseconds per column, so the load on the central processor is less than 0.5% even in the worst circumstances.

The effective speeds of the Model 224-1 and 224-2 Card Punches are shown in the following table.

Number of Columns Punched, P	Cards/minute, Model 224-1	Cards/minute, Model 224-2
1:	270	360
10:	179	270
20:	130	210
40:	84	146
80:	50	88
Formula:	$\frac{60,000}{12.5P+210}$	$\frac{60,000}{6.25P+160}$

Error checks include a check upon the activation of the proper punches and a comparison of these with the data specified for punching. Checks are also made on the physical operation of the punch, including card jam, clutch failure, and card feed failure conditions. These checks activate a light on the card punch control panel and cause the unit to remain in the "busy" status until the trouble is cleared.

If the Punch Feed Read facility is added (see Optional Features below), further checks are made for illegal input characters and upon the physical position of the card as it passes the read station.

The Honeywell 224-1 and 224-2 Card Punches are adaptations of the IBM 1442 Card Read Punch Unit, which is fully described in the IBM 1440 Computer System Report, Page 414:071.100. They are available on a six-month delivery basis, and first deliveries with the Honeywell 200 computer system occurred in January 1965.

Optional Features

Model 224-1 can be fitted with a second output stacker, which is standard in Model 224-2.

Model 224-2 can be fitted with the Punch Feed Read Option, which permits data to be read from a card before new data is punched into it.

INPUT-OUTPUT: 214 CARD UNITS

.1 GENERAL

.11 Identity: . . . . 214-1 Card Punch.
214-2 Card Reader/Punch.

.12 Description

The Honeywell 214 card units are available in two models. The 214-1 is a card punch, and the 214-2 is a combined reader/punch. The reading speed of the 214-2 is 400 cards per minute. The punching speed of each unit varies from 100 up to 400 cards per minute, depending on the position of the last card column punched. If column 80 is to be punched, the speed is 100 cards per minute, while if column 60 is the last column punched, the speed increases to 136 cards per minute. The maximum speed of 400 cards per minute is attained when only the first 8 columns (or fewer) of each card are punched.

214-1 Card Punch

The 214-1 features a dual punching head, which punches two columns at a time. Punching errors are detected by a check on the punching dies activated. Recognition of an error sets an indicator which may be tested by a programmed instruction; mispunched cards are offset-stacked. The capacities of the input hopper and output stacker are 1,200 and 1,300 cards, respectively.

Hollerith and "special" code conversion modes are standard; the special mode provides 64 legal card character codes. The Direct Transcription (binary image) mode is available as an option.

In the Honeywell 120, the control unit for the 214-1 is included in the central processor. For all other models of the Series 200, the 208-1 Card Punch Control is required.

214-2 Card Reader/Punch

The 214-2 Card Reader/Punch performs card processing in one of three operational modes: it reads, punches, or reads cards and punches additional information into the cards during the same pass. Punching speed is 100 to 400 cards per minute, depending upon the number of columns punched. Reading speed is 400 cards per minute when reading only. When reading and punching in the same pass, the 214-2 operates at its punching speed.

The physical characteristics of the 214-2 are the same as those of the 214-1. The reader/punch requires the 208-2 Card Punch Control when used with all models of the Series 200 except the 120. The Honeywell 120 Processor includes a built-in control unit for any of the 214 card units.

End-feed operation (column-by-column) is used by all of the 214 card units to enable simultaneous operation of the associated central processor during approximately 99% of each card processing cycle. Demand feeding, or asynchronous operation, eliminates clutch-point timing considerations.

An optional feature, High-Speed Skip, can significantly increase the punching throughput of a 214-1 or 214-2 in applications where two or more non-contiguous fields must be punched into each card. This is accomplished by speeding up the passage past the punching head of the columns that do not require punching. For example, if columns 1 through 10 must be punched, columns 11 through 70 skipped, and columns 71 through 80 punched, the punching rate will be 209 cards per minute with the High-Speed Skip feature and only 100 cards per minute without it.

The 214 card units, which are functionally similar to the IBM 1442 Card Read Punch units, are manufactured by Honeywell. They were announced in February 1965 and initially installed in January 1966.

INPUT-OUTPUT: 123 CARD READER

.1 GENERAL

.11 Identity: . . . . 123 Card Reader.

.12 Description

The Honeywell 123 Card Reader, used exclusively with the Honeywell 120 computer system, reads standard 80-column cards at a maximum rate of 400 cards per minute. The 80 card columns are read serially starting with column one; column data is read in parallel by 12 photoelectric cells. A card operation is terminated when the full card has been read or when a column mark is sensed in memory.

Card reader control functions are performed by a built-in controller. The controller automatically converts the card Hollerith code to Honeywell 200 6-bit internal code.

The reader's hopper capacity is 3,000 cards and the stacker capacity is 2,500 cards. Cards can be added to or removed from the card reader without interrupting card processing.

The single card read operation requires 150 milliseconds; during this time, the following actions occur:

- A card is moved from the hopper to the wait station and another card is moved from the wait station to the read station. This operation requires 26 milliseconds.
- Data transfer is initiated when the first card column arrives at the read station. Ninety-two milliseconds are required to transfer the 80 columns of data. During this time, central processing activity is suspended for a total of 240 microseconds — one 3-microsecond memory cycle for each character transferred. An additional memory cycle is required to place the data storage address in the assigned read/write channel.
- Card deceleration and other terminal card read operations are performed during the remaining 32 milliseconds. If maximum card reader speed is to be maintained, the next card read instruction must be issued during this time. Some internal processing and programmed reader error checking can be performed during the final card read operation. The possible error conditions that can be checked by a single card read instruction include photoelectric cell malfunction, invalid data, and device busy.

Programming the card reader is straightforward, requiring the use of only two instructions. The Peripheral Data Transfer (PDT) instruction contains storage and channel address information. Issuing this instruction causes one card to be read. The Peripheral Control and Branch (PCB) instruction controls a conditional program branch based on the status of specified device control bits.

INPUT-OUTPUT: 650-LPM PRINTERS

.1 GENERAL

.11 Identity: . . . . 650-lpm Printer and Control: Models 222-1, 222-2, and 222-3.

.12 Description

The Type 222-1, 222-2, and 222-3 Printers operate at 650 lines per minute at single-line spacing when a set of no more than 51 different characters is used. When the full 63-character set is used, printing speed is reduced to 550 single-spaced lines per minute. The total character set consists of 10 numeric, 26 alphabetic, and 27 special characters. The operator selects printing at six or eight lines per inch.

The only differences between these three models are in the number of print positions provided per line: Model 222-1 has 96 character positions on a line, Model 222-2 has 108, and Model 222-3 has 120 or 132. (The Model 222-4 Printer, described on page 510:083.100, has a higher printing speed of 950 lines per minute, while the Model 222-5, described on page 510:084.100, operates at 450 lines per minute.)

Interchangeable print drums allow different character sets to be used with a single printer. For example, the drum with the Numeric Print feature enables the printers to print numeric digits and seven special characters at 1300 lines per minute. Each of the digits and the special characters . , - + * / and $ appears in two character rows on the print drum; each of the 26 letters and the special characters CR % #) (and = appears in one character row, giving 66 character rows of 49 different characters. Thus, two lines of numeric printing can be printed during one revolution of the print drum.

The print drum's speed of 650 rpm sets the maximum printing rate at 650 lines per minute unless the Numeric Print feature is installed. Whether printing occurs at this speed depends on the number of lines spaced per line printed and the number of contiguous character rows spanned by the character set actually used. After a line is printed 17 milliseconds are needed to space the paper one line. The interval required for each additional line space decreases until a peak advance rate of 18 milliseconds per inch is reached. This peak rate occurs during paper advances exceeding one inch between printed lines. Effective printing speeds at various line spacings are shown in the table at right.

Different Honeywell Series 200 processor models can have from 3 to 64 input-output trunks; for details, please see the System Configuration sections of the individual subreports. The number of Model 222 Printers that can be connected to a particular system depends upon the number of available trunks; each printer requires the exclusive use of one trunk.

Printing occurs by hammer strokes which bring the paper and ribbon against a continuously rotating print drum. Only the paper directly over the activated print hammers is brought against the drum, and only at the time when the required character row is rotating past the print hammers. The paper forms must be continuous, with sprocket holes in both margins. The forms can be perforated and can be from 4-15/16 inches to 20-1/16 inches wide. They can have a maximum of seven plys plus the required number of carbon tissues. Tab and post card stock can be used.

Forms control is handled by a paper tape loop. The program can initiate a paper advance of either a specific number of lines (up to 15) or to the next punched position in a specified channel on the paper tape loop.

The data transmission load on the central processor is comparatively high because all characters in the printer output area are scanned each time a character on the print drum is in a proper position for printing. For instance, a 120-character line using all 63 printable characters would use 120 x 63 memory cycles, or between 5.76 and 22.5 milliseconds per line, depending upon the particular processor model involved. Details regarding the exact demands upon each of the individual processor models are included in the Simultaneous Operations sections of the appropriate subreports.

Error checks are made for code disc parity, shift register operation, paper present, and ribbon feed operational, as well as for various fuses being intact and exciter lamps lit. Error conditions are signalled by an error indicator which must be tested prior to the initiation of further print operations.

The Model 222 Printers, Types 222-1, 222-2, and 222-3, are designed and manufactured by Honeywell. First customer deliveries occurred in December 1964.

EFFECTIVE SPEED OF
222-1, 222-2, & 222-3 PRINTERS

Lines Advanced per Line Printed	Printed Lines per Minute Using 46-character Set
1	650
2	540
3	517
4	485
5	457
6 (1 inch)	437
12 (2 inches)	380
18 (3 inches)	340
24 (4 inches)	309
30 (5 inches)	283

INPUT-OUTPUT: 950-LPM PRINTER

.1 GENERAL

.11 Identity: . . . . 950-1pm Printer and Control: Model 222-4.

.12 Description

The Type 222-4 Printer operates at 950 lines per minute at single-line spacing when a set of no more than 46 characters is used. When the full 63-character set is used, printing speed is reduced to 750 single-speed lines per minute. The total character set consists of 10 numeric, 26 alphabetic, and 27 special characters. The maximum width of the print line is either 120 or 132 characters, horizontally spaced at ten characters per inch.

The operator has three available options when the 222-4 Printer is being used. He can:

(1) Set the line spacing to either 6 or 8 lines per inch.

(2) Set the drum rotational speed to either 950 or 633 rpm. The lower speed produces printing of appreciably superior quality.

(3) Interchange print drums. This allows different character sets to be used with a single printer. For example, the drum with the Numeric Print feature enables the printers to print numeric digits and seven special characters at 1266 lines per minute. Each of the digits and the special characters . , - + * / and $ appears in two character rows on the print drum; each of the 26 letters and the special characters CR % ≠) (and = appears in one character row, giving 66 character rows of 49 different characters. Thus, two lines of numeric printing can be printed during one revolution of the print drum.

The print drum's speed of 950 or 633 rpm sets an upper limit of 950 or 633 lines per minute on the practical printing speed unless the Numeric Print feature is installed. Whether printing occurs at this speed depends on the number of lines spaced per line printed and the number of contiguous print drum character rows spanned by the character set actually used. After a line is printed, 17 milliseconds are needed to space the paper one line; intervals for additional spacing decrease until a peak advance rate of 18 milliseconds per inch is reached. Effective printing speeds at various line spacings are shown in the table at right.

Different Honeywell Series 200 processor models can have from 3 to 64 input-output trunks; for details, please see the System Configuration sections of the individual subreports. The number of Model 222 Printers that can be connected to a particular system depends upon the number of available trunks; each printer requires the exclusive use of one trunk.

Printing occurs by hammer strokes which bring the paper and ribbon against a continuously rotating print drum. Only the paper directly over the activated print hammers is brought against the drum, and only at the time when the required character row is rotating past the print hammers. The paper forms must be continuous, with sprocket holes in both margins. The forms can be perforated and can be from 4-15/16 inches to 20-1/16 inches wide. They can have a maximum of seven plys plus the required number of carbon tissues. Tab and post card stock can also be used.

Forms control is handled by a paper tape loop. The program can initiate a paper advance of either a specific number of lines (up to 15) or to the next punched position in a specified channel on the paper tape loop.

The data transmission load on the central processor is comparatively high because all characters in the printer output area are scanned each time a character on the print drum is in a proper position for printing. For instance, a 120-character line using all 63 printable characters would use 120 x 63 memory cycles, or between 5.76 and 22.5 milliseconds per line, depending upon the particular processor model involved. Details regarding the exact demands upon each of the individual processor models are included in the Simultaneous Operations sections of the appropriate subreports.

Error checks are made for code disc parity, shift register operation, paper present, and ribbon feed operational, as well as for various fuses being intact and exciter lamps lit. Error conditions are signalled by an error indicator which must be tested prior to the initiation of further print operations.

The type 222-4 Printer is designed and manufactured by Honeywell. First customer deliveries occurred in December, 1964.

EFFECTIVE SPEED: 222-4 PRINTER AT 950 RPM

Lines Advanced per Line Printed	Printed Lines per Minute Using 46-character Set
1	950
2	822
3	750
4	690
5	645
6 (1 inch)	605
12 (2 inches)	575
18 (3 inches)	490
24 (4 inches)	430
30 (5 inches)	380

INPUT-OUTPUT: 450-LPM PRINTER

.1 GENERAL

.11 Identity: . . . . 450-lpm Printer and Control; Model 222-5 (or Model 122 with the Honeywell 120).

.12 Description

The Type 222-5 Printer operates at a maximum rate of 450 lines per minute at single-line spacing when a set of no more than 55 characters is used. When the full 63-character set is used, printing speed is reduced to 400 single-spaced lines per minute. The total character set consists of 10 numeric, 26 alphabetic, and 27 special characters. The Model 222-5 can have either 120 or 132 printing positions, horizontally spaced at ten characters per inch. The operator selects printing at six or eight lines per inch.

The print drum's speed of 450 rpm sets an upper printing limit of 450 lines per minute. Whether printing occurs at this speed depends on the number of lines spaced per line printed and the number of contiguous character rows spanned by the character set actually used. After a line is printed, 17 milliseconds are needed to space the paper one line. The interval required for each additional line space decreases until a peak advance rate of 18 milliseconds per inch is reached. This peak rate occurs during paper advances exceeding one inch between printed lines. Effective printing speeds at various line spacings are shown in the table at right.

Printing occurs by hammer strokes which bring the paper and ribbon against a continuously rotating print drum. Only the paper directly over the activated print hammers is brought against the drum, and only at the time when the required character row is rotating past the print hammers. The paper forms must be continuous, with sprocket holes in both margins. The forms can be perforated and can be from 4-15/16 inches to 20-1/16 inches wide. They can have a maximum of seven plys plus the required number of carbon tissues. Tab and post card stock can be used.

Format control is handled by a paper tape loop which is inserted into the printer by the operator. The tape has eight channels, two of which are conventionally reserved for the head-of-form and end-of-form positions; the other six channels are available for punching as required. The program can initiate a paper advance of either a specific number of lines (up to 15) or to the next punched position in a specified channel on the paper tape loop.

The data transmission load on the central processor is comparatively high because all characters in the printer output area are scanned each time a character on the print drum is in a proper position for printing. For instance, a 120-character line using all 63 printable characters would use 120 x 63 memory cycles. Details regarding the exact demands on each of the processor models are included in the Simultaneous Operations sections of the appropriate subreports.

An interrupt signal occurs at the end of the printing cycle so that the program can execute a further printing instruction during the paper advance time, thus keeping the printer operating at full speed.

Error checks are made for code disc parity, shift register operation, paper present, and ribbon feed operational, as well as for various fuses being intact and exciter lamps lit. Error conditions are signalled by an error indicator which must be tested prior to the initiation of further print operations.

The Type 222-5 Printer is designed and manufactured by Honeywell. First customer deliveries occurred in February 1966.

EFFECTIVE SPEED: 222-5 PRINTER

Lines Advanced per Line Printed	Printed Lines per Minute Using 46-character Set
1	450
2	450
3	450
4	382
5	368
6 (1 inch)	355
12 (2 inches)	316
18 (3 inches)	281
24 (4 inches)	259
30 (5 inches)	240

INPUT-OUTPUT: 204A MAGNETIC TAPE UNITS

.1 GENERAL

.11 Identity: . . . . Magnetic Tape Units. Models 204A-1, 2, and 3.

.12 Description

The 204A Series Magnetic Tape Units utilize three-quarter inch tape in a format compatible with Honeywell 800/1800 and 400/1400 systems. Both 203A Controls for three-quarter inch tape units and 203B Controls for one-half inch tape units (see Section 407:092) can be included in the same system. Data transfer rates are 32,000, 64,000, and 88,800 characters per second for Models 204A-1, 204A-2, and 204A-3, respectively. Recording density for Models 204A-1 and 204A-2 is 533 characters per inch; for Model 204A-3 it is 740 characters per inch. Model 204A-1 has a read-write tape speed of 60 inches per second, while Models 204A-2 and 204A-3 have a speed of 120 inches per second.

Each control unit requires two input-output trunks (and two peripheral address assignments), and can control up to four 204A Series tape units. The number of trunks (and therefore the number of tape controls which can be connected) varies with each processor model. Tape operations can be executed simultaneously with internal processing. Unlike the 204B Series, simultaneous reading and writing by two 204A Series units on the same control are not possible. Tape transport is by pneumatic capstans.

Check for the presence of write-head power and the absence of the write protect condition are made while writing, but there is no read-after-write check to detect recording errors at the time they occur. Row and track parity are checked during reading. Detection of any error sets a program-testable indicator. Instructions are provided to read forward, write forward, backspace, rewind and release, and "read, regenerating channel" (Orthotronic Control).

The Orthotronic Control feature allows software correction of any one error per block. It uses a 96-bit parity count which is generated by consecutive half-add instructions prior to writing each tape block, an operation which effectively doubles the load on the central processor during tape write operations. The Orthotronic parity count is recorded with the data, checked when the data is read back, and used for subsequent correction of errors if they occur.

In systems delivered before October 1965, the magnetic tape units cannot initiate program interrupts. Later systems are able to do so.

.13 Availability: . . . . not specified.

.14 First Delivery: . . . . . July 1964.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pneumatic capstan.
.212 Reservoirs—
Number: . . . . 2.
Form: . . . . vacuum.
.213 Feed drive: . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . . yes.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . . erasing.
Stacks: . . . . 1.
Heads/stack: . . . . 1.
Method of use: . . . . . . 1 row at a time.

Use of station: . . . . . . reading and writing.
Stacks: . . . . 1.
Heads/stack: . . . . . . 10.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . Mylar-base, oxide-coated tape.
.312 Phenomenon: . . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 6 to N rows at 400 or 556 rows/inch (533 or 740 characters/inch).
.322 Parallel by: . . . . 10 tracks.
.324 Track use—
Data: . . . . 8.
Redundancy check: . . 1.
Timing: . . . . 1.
Control signals: . . . . 0.
Unused: . . . . 0.
Total: . . . . 10.
.325 Row use—
Data: . . . . 6 to N, where N is a multiple of 6.
Redundancy check: . . 12 (2 Orthotronic control words per block).
Timing: . . . . 0.
Control signals: . . . . 0.
Unused: . . . . 0.
Inter-block gap: . . . 0.67 inch.

(Contd.)

.33 Coding: . . . . eight 6-bit characters per six tape rows; as in Data Code Table, Section 510:141.

.34 Format Compatibility

Other device or system	Code translation
H-400/1400:	not necessary.
H-800/1800:	not necessary.

.35 Physical Dimensions

.351 Overall width: . . . . . . 0.75 inch.
.352 Length: . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . Tape Control Unit. Models 203A-1, 2, and 3.

.42 Connection to System

.421 On-line: . . . . each control requires 2 input-output trunks.

.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . . up to four 204A-1 Tape Units per 203A-1 Control. up to four 204A-2 Tape Units per 203A-2 Control. up to four 204A-3 Tape Units per 203A-3 Control.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . 8 to N characters, limited by available core storage (where N is a multiple of 8).
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . each character.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 8 to N characters, limited by available core storage (where N is a multiple of 8).

.512 Block demarcation —
Input: . . . . gap on tape or limiting mark in core storage.
Output: . . . . limiting mark in storage.

.52 Input-Output Operations

.521 Input: . . . . 1 block forward. 1 block forward, regenerating channel.
.522 Output: . . . . 1 block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . 1 block backward (backspace).
.525 Marking: . . . . no special marks.
.526 Searching: . . . . none.

.53 Code Translation: . . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . disabled after unloading.
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . . . no.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes.
Output lock: . . . . . . no.
Nearly exhausted: . . . . yes.
End of medium marks: . . . . yes.
Error: . . . . yes.
Beginning of medium marks: . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . . performance varies with model number as indicated below.

.62 Speeds

.621 Nominal or peak speed —
Model 204A-1: . . . . 32,000 char/sec.
Model 204A-2: . . . . 64,000 char/sec.
Model 204A-3: . . . . 88,800 char/sec.

.622 Important parameters:
Density —
Models 204A-1 and 2: . . . . 533 char/inch (400 rows/inch).
Model 204A-3: . . . 740 char/inch (556 rows/inch).
Tape speed —
Model 204A-1: . . . 60 inches/sec.
Models 204A-2 and 3: . . . . 120 inches/sec.
Rewind speed —
Model 204A-1 . . . . 80 inches/sec.
Models 204A-2 and 3: . . . . 360 inches/sec.
Cross gap time —
Model 204A-1: . . . . 11.0 msec.
Models 204A-2 and 3: . . . . 5.5 msec.
Inter-block gap: . . . . 0.67 inch in all models.

.623 Overhead —
Model 204A-1: . . . . . 11.0 msec.
Models 204A-2 and 3: . . . . 5.5 msec.

.624 Effective speeds (assuming no deceleration between blocks)—
- Model 204A-1: . . . . . 32,000N/ (N + 352) char/sec.
- Model 204A-2: . . . . . 64,000N/ (N + 352) char/sec.
- Model 204A-3: . . . . . 88,800N/ (N + 488) char/sec, where N = no. of characters per block (see graph).

.63 Demands on System

- Component: . . . . Central Processor.
- Condition: . . . . all.
- Msec per block: . . . . . 1 core storage cycle per 4 characters in Models 4200 and 8200; 1 cycle per character in all other models.
- Percentage of data transfer time: . . . . . see Simultaneous Operations section of the subreport on the appropriate processor model.

.7 EXTERNAL FACILITIES

.73 Loading and Unloading

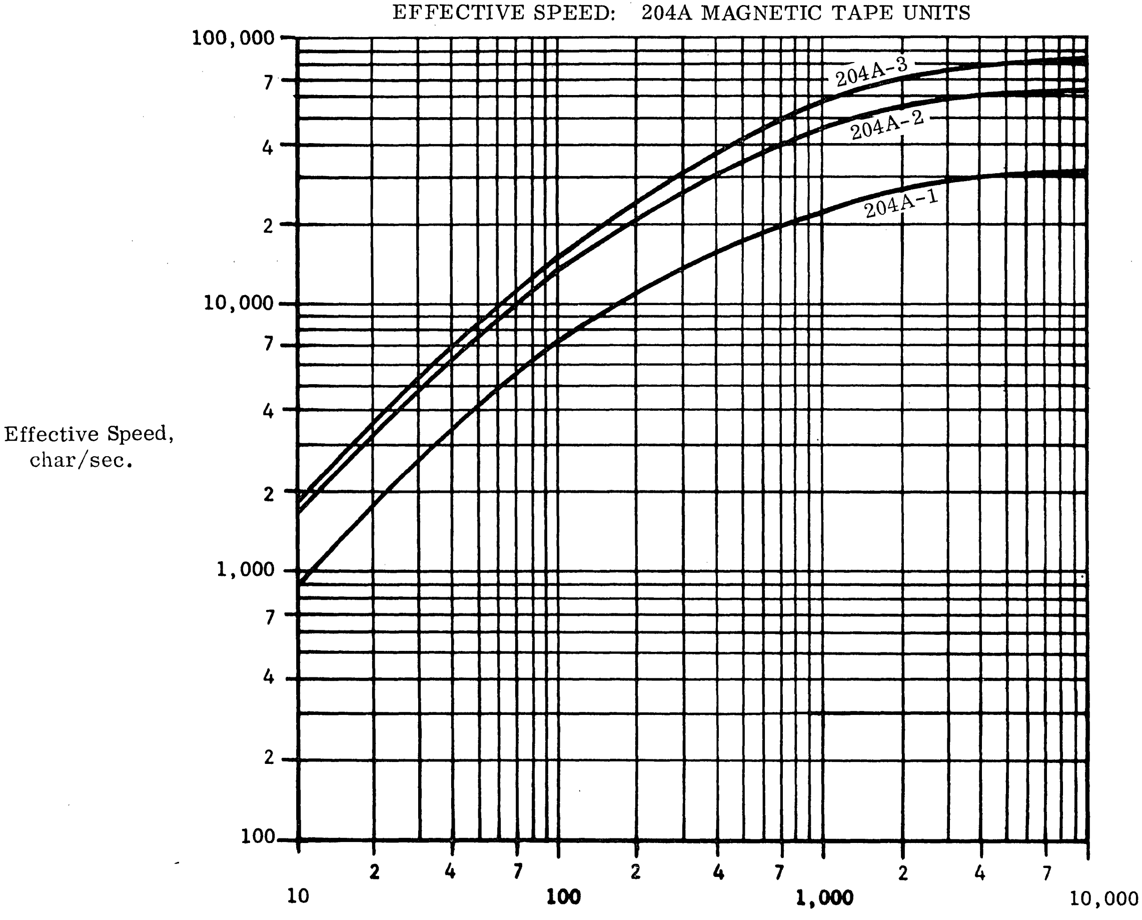
.731 Volumes handled: . . . . 2,400 feet per reel.
.732 Replenishment time: . . 0.5 to 1.0 minute; tape unit needs to be stopped.

.734 Optimum reloading period —
- Model 204A-1: . . . . . 8 minutes.
- Model 204A-2: . . . . . 4 minutes.
- Model 204A-3: . . . . . 4 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	track and row parity checks	set indicator.
Input area overflow:	record mark in core storage terminates data transfer.	
Invalid code:	all codes valid.	
Exhausted medium:	check	set indicator.
Timing conflicts:	check for busy device	set indicator.
Write-head power failure:	check	set indicator.

EFFECTIVE SPEED: 204A MAGNETIC TAPE UNITS



INPUT-OUTPUT: 204B MAGNETIC TAPE UNITS

.1 GENERAL

.11 Identity: . . . . Magnetic Tape Units. Models 204B-1 through 204B-12.

.12 Description

Two distinct types of magnetic tape units are offered for the Honeywell Series 200. The 204A Series tape units use three-quarter-inch tape, have limited error-recovery abilities, and are compatible with the tape units used in Honeywell 400/1400 and 800/1800 systems; they are described in the preceding report section (510:091).

The Honeywell 204B Series tape units are compatible with the IBM 729 and 7330 tape drives. All models provide read-after-write checking, allow for backward reading, and can be connected to, or manually switched between, any members of the Honeywell Series 200 computer family. The length of the tape gap can be reduced, in most cases, from the industry-standard 0.75-inch length, providing appreciably improved performance (relative to other tape drives with identical peak speeds and recording densities) where short block-lengths are needed. (Details of the effective performance of these units are listed in Table II and illustrated in the graphs at the end of this section.)

The 204B Series is currently composed of three basic groups of models. These groups are:

- Models 1 through 5: densities of 200 and 556 characters per inch; data transfer rates of 7,200 to 83,300 characters per second.
- Models 7 through 9: densities of up to 800 characters per inch; data transfer rates of 7,200 to 96,000 characters per second.
- Models 11 and 12: densities of 200 and 556 characters per inch; data transfer rates of 13,333 characters per second; simultaneous read-write on same control not available; no rewind and release.

Details of the tape speeds, available densities, gap lengths, and data transfer rates are shown in Table I.

Honeywell 204B tape units with peak speeds of less than 45,000 characters per second and maximum densities of 556 characters per inch are part of "economy" tape systems. In these systems, part of the logical circuitry in the first tape unit connected to each controller is used by all of the connected tape units. The resulting savings in cost are reflected in the pricing structure. Naturally, this arrangement means that a breakdown in

TABLE I: CHARACTERISTICS OF 204B SERIES MAGNETIC TAPE UNITS

Tape Drive Model	Control Unit Model	Tape Speed, inches/sec	Densities, char/inch	Minimum Inter-Block Gap Length, inches #	Data Transfer Rate, char/sec
204B-1, -2*	203B-1	36	556 200	0.45	20,000 7,200
204B-3, -4*	203B-1	80	556 200	0.60	44,400 16,000
204B-5	203B-2	120	556 200	0.70	66,700 24,000
204B-7	203B-4	36	800 556 200	0.45	28,800 20,000 7,200
204B-8	203B-4	80	800 556 200	0.60	64,000 44,400 16,000
204B-9	203B-6	120	800 556 200	0.70	96,000 66,700 24,000
204B-11, -12*	203B-5**	24	556 200	0.45	13,333 4,800

* In these units, the primary tape drive connected to each controller has special circuitry and bears a different model number from any other connected tape drives. The operational characteristics are identical for both models.

\# Industry-standard gap lengths of 0.75" are also possible under program control.

** The Honeywell 120 uses the 103 Non-Simultaneous Tape Control Unit, which includes one 204B-11 Tape Unit.

.12 Description (Contd.)

the primary tape unit such that the shared circuitry can no longer operate will effectively prevent the use of all of the tape units connected to the controller.

All controllers for the 204B Series tape units, except the 203B-5, can handle simultaneous reading and writing. The optional backward-read facility stores the data into core memory in the same manner as does a forward read. The tape control units maintain either even or odd row parity, as desired, and even track parity for checking purposes.

Eight tape units can be connected to each controller, except for the 203B-5 (13KC) control, which can be connected to a maximum of four tape units. The number of tape controls allowed in each Series 200 system is described in the System Configuration section of the appropriate subreport.

Optional Features

IBM Format and IBM BCD Code options are available and are fitted into the Tape Control Units. Both these options are required to achieve full compatibility between IBM 7-track tape units and the Honeywell 204-B Series tape units.

.13 Availability: . . . . 3 months.

.14 First Delivery

Models 204B-1 through -5, and 204B-7 and -8: July 1964.
Model 204B-9: . . . . . . September 1966.
Models 204B-11, -12: . January 1966.

TABLE II: PERFORMANCE OF 204B SERIES MAGNETIC TAPE UNITS

Model	Nominal or Peak Speed, char/sec	Density, char/inch	Tape Speed, inches/sec	Rewind Speed, inches/sec	Inter-block Gap, inches	Overhead (cross-gap time), msec/block: Short Gap	Long Gap	Effective Speeds, char/sec* (where N = no. of characters per block): Short Gap	Long Gap
204B-1, -2	7,200 or 20,000	200 or 556	36	108	0.45 or 0.75	12.5	20.8	7,200N/(N + 90) or 20,000N/(N + 250)	7,200N/(N + 150) or 20,000N/(N + 417)
204B-3, -4	16,000 or 44,400	200 or 556	80	240	0.60 or 0.75	7.5	9.4	16,000N/(N + 120) or 44,400N/(N + 333)	16,000N/(N + 150) or 44,400N/(N + 417)
204B-5	24,000 or 66,700	200 or 556	120	360	0.70 or 0.75	5.8	6.3	24,000N/(N + 140) or 66,700N/(N + 387)	24,000N/(N + 150) or 66,700N/(N + 417)
204B-7	20,000 or 28,800	556 or 800	36	108	0.45 or 0.75	12.5	20.8	20,000N/(N + 250) or 28,800N/(N + 360)	20,000N/(N + 417) or 28,800N/(N + 600)
204B-7	7,200 or 28,800	200 or 800	36	108	0.45 or 0.75	12.5	20.8	7,200N/(N + 90) or 28,800N/(N + 360)	7,200N/(N + 150) or 28,800N/(N + 600)
204B-7	7,200 or 20,000	200 or 556	36	108	0.45 or 0.75	12.5	20.8	7,200N/(N + 90) or 20,000N/(N + 250)	7,200N/(N + 150) or 20,000N/(N + 417)
204B-8	44,400 or 64,000	556 or 800	80	240	0.60 or 0.75	7.5	9.4	44,400N/(N + 333) or 64,000N/(N + 480)	44,400N/(N + 417) or 64,000N/(N + 600)
204B-8	16,000 or 64,000	200 or 800	80	240	0.60 or 0.75	7.5	9.4	16,000N/(N + 120) or 64,000N/(N + 480)	16,000N/(N + 150) or 64,000N/(N + 600)
204B-8	16,000 or 44,400	200 or 556	80	240	0.60 or 0.75	7.5	9.4	16,000N/(N + 120) or 44,400N/(N + 480)	16,000N/(N + 150) or 44,400N/(N + 600)
204B-9	66,700 or 96,000	556 or 800	120	360	0.70 or 0.75	5.8	6.3	66,700N/(N + 387) or 96,000N/(N + 557)	66,700N/(N + 417) or 96,000N/(N + 605)
204B-9	24,000 or 96,000	200 or 800	120	360	0.70 or 0.75	5.8	6.3	24,000N/(N + 140) or 96,000N/(N + 557)	24,000N/(N + 150) or 96,000N/(N + 605)
204B-9	24,000 or 66,700	200 or 556	120	360	0.70 or 0.75	5.8	6.3	24,000N/(N + 140) or 66,700N/(N + 387)	24,000N/(N + 150) or 66,700N/(N + 417)
204B-11, -12	4,800 or 13,333	200 or 556	24	144	0.45 or 0.75	18.7	31.2	4,800N/(N + 90) or 13,300N/(N + 248)	4,800N/(N + 150) or 13,300N/(N + 417)

* Assuming no deceleration between blocks.

(Contd.)

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the Head: . . pneumatic capstan.
.212 Reservoirs —
Number: . . . . 2.
Form: . . . . vacuum.
.213 Feed drive: . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording systems: . . magnetic head.
.222 Sensing system: . . . . . magnetic head.
.223 Common system: . . . . 2-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . . recording.
Stacks: . . . . 1.
Heads/stack: . . . . . . 7.
Method of use: . . . . . 1 row at a time.
Use of station: . . . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . Mylar-base, oxide-coated tape.
.312 Phenomenon: . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 200, 556, or 800 rows/inch: N limited by available core storage.
.322 Parallel by: . . . . 7 tracks.
.324 Track use —
Data: . . . . 6.
Redundancy check: . . 1.
Timing: . . . . 0 (self-clocking).
Control signals: . . . . 0.
Unused: . . . . 0.
Total: . . . . 7.
.325 Row use —
Data: . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . 0.
Control signals: . . . . 0.
Unused: . . . . 0.
Gap: . . . . 0.45 to 0.75 inch, depending on tape speed. See Table I for a tabulation of each unit's capabilities.

.33 Coding: . . . . as in Data Code Table 510:141.100.

.34 Format Compatibility

Other device or system	Code translation
IBM 727 Magnetic Tape Units:	IBM format and code compatibility are optional features.
IBM 729 Series Magnetic Tape Units:	IBM format and code compatibility are optional features.
IBM 7330 Magnetic Tape Units:	IBM format and code compatibility are optional features.

Note: Only format compatibility is available for the 203B-5 Tape Control.

.35 Physical Dimensions

.351 Overall width: . . . . . . 0.50 inch.
.352 Length: . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . Tape Control Unit Models 203-1, 203B-2, and 203B-4 through 203B-6. See Table I for allowable combinations of tape drives and control units.

.42 Connection to System

.421 On-line: . . . . depends on number of trunks available; each control requires 2 input-output trunks and 2 address assignments.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . up to 8 tape drives per controller (4 per 203B-5).
.432 Restrictions: . . . . . . all tape units connected to a given control unit must have the same data transfer rate.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N characters, limited by available core storage.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . each character.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . . 1 to N characters, limited by available core storage.
.512 Block demarcation —
Input: . . . . gap on tape or limiting mark in core storage.
Output: . . . . limiting mark in storage.

.52 Input-Output Operations

.521 Input: . . . . 1 block forward.
1 block backward (optional). During the backward-read operation, data is stored in core memory as in a forward read.
.522 Output: . . . . 1 block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . 1 block backward (backspace).
erase 3.5 inches forward (to skip defective tape areas).
1 block forward (space forward).

.525 Marking: . . . . interblock gap. end-of-file mark (tape mark).

.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes; optional feature for translation between IBM BCD tape code and Honeywell Series 200 internal code.

.54 Format Control: . . . . . none.

.55 Control Operations

Disable: . . . . disable after unloading (except the 204B-11, -12).
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . odd or even parity only.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . . yes.
Output lock: . . . . no.
Nearly exhausted: . . . yes.
Busy controller: . . . . yes; "busy reading" and "busy writing" can be tested separately.
End of medium marks: . . . . yes.
Error: . . . . yes.
Beginning of medium marks: . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . performance varies with model number as indicated in Table II.

.62 Speeds: . . . . See Table II.

.63 Demands on System

Components: . . . . Central Processor.
Condition: . . . . all.
Msec per block: . . . . 1 core storage cycle per 4 characters in Model 4200; 1 cycle per character in all other models.
Percentage of data transfer time: . . . . . see Simultaneous Operations section of the subreport on the appropriate processor model.

.7 EXTERNAL FACILITIES

.73 Loading and unloading

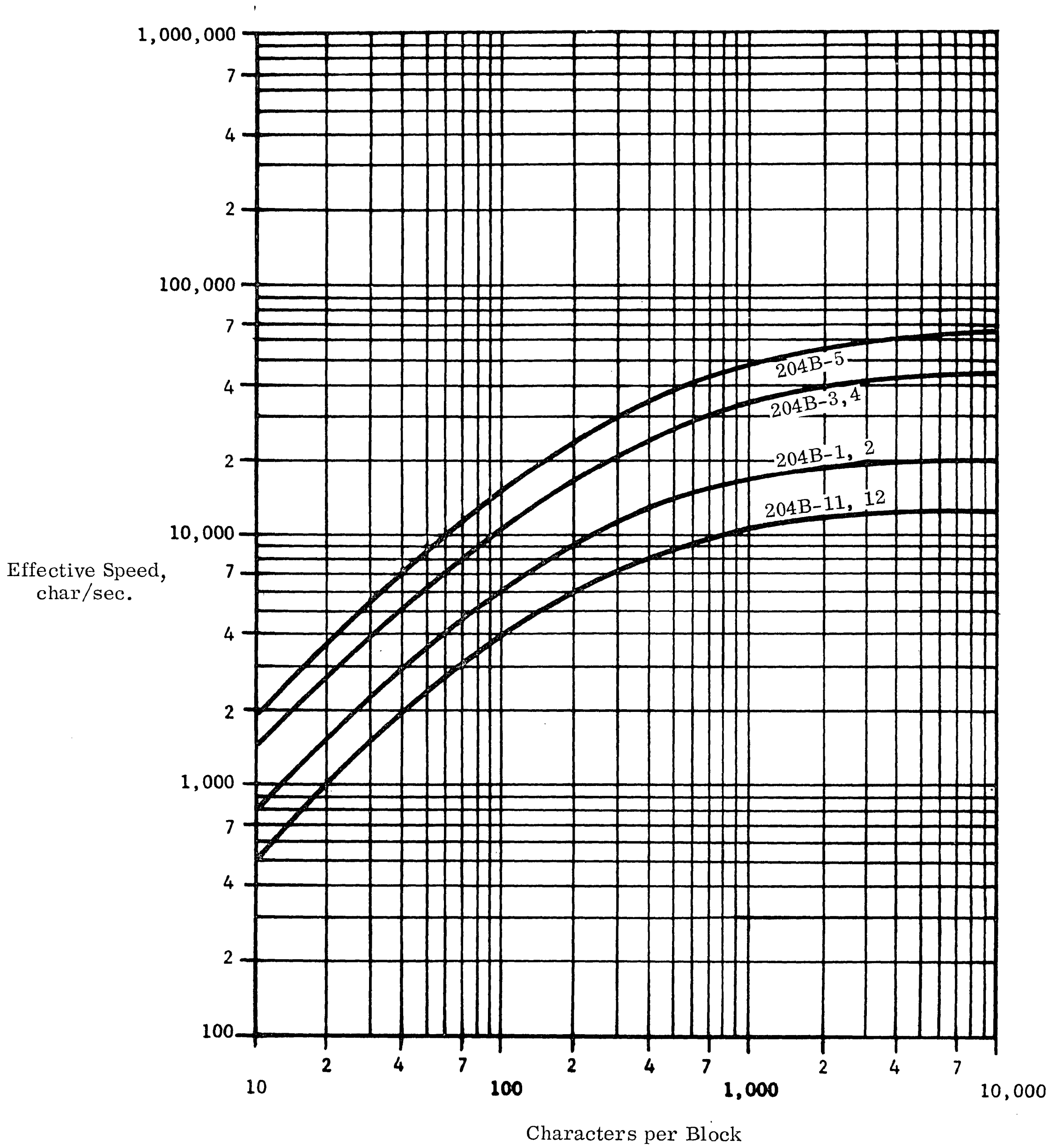
.731 Volumes handled: . . . 2,400 feet per reel.
.732 Replenishment time: . . 0.5 to 1.0 minute; tape unit needs to be stopped.
.734 Optimum reloading period —
Model 204B-1,-2 . . . 13 minutes.
Model 204B-3,-4 . . . 6 minutes.
Model 204B-5 . . . . . 4 minutes.
Model 204B-7 . . . . . 13 minutes.
Model 204B-8 . . . . . 6 minutes.
Model 204B-9 . . . . . 4 minutes.
Model 204B-11,-12 . 20 minutes.

.8 ERRORS, CHECKS AND ACTION

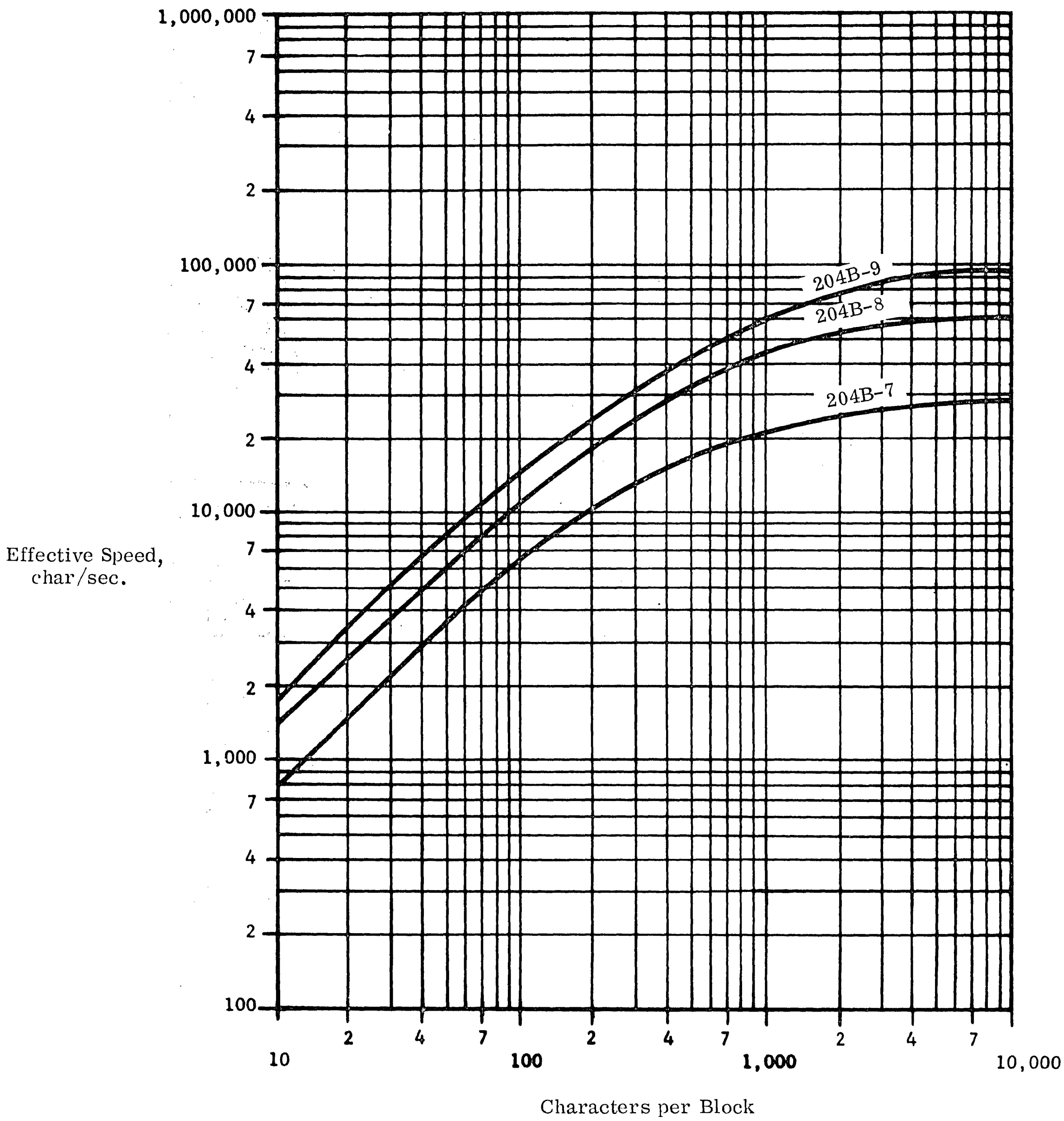
Error	Check or Interlock	Action
Recording:	read-after-write parity check	set indicator.
Reading:	track and row parity check	set indicator.
Input area overflow:	record mark in core storage terminates data transfer.	
Invalid code:	all codes valid.	
Exhausted medium:	sense reflective spot	set indicator.
Timing conflicts:	check for busy device	set indicator.

(Contd.)

EFFECTIVE SPEED: 204B-1 THROUGH 204B-5 AND 204B-11, -12
MAGNETIC TAPE UNITS
556 Characters per Inch
Short Inter-block Gaps



EFFECTIVE SPEED: 204B-7, -8, AND -9 MAGNETIC TAPE UNITS
800 Characters per Inch
Short Inter-block Gaps



INPUT-OUTPUT: FAMILY INTERFACE COMPONENTS

.1 GENERAL

.11 Identity: . . . . Computer/Computer Interface: Model 212-1 On-line Adapter.

Peripheral/Peripheral Interface: Model 205 Magnetic Tape Switching Unit.

.12 Description

Honeywell currently provides several interface units that permit the interconnection of its Series 200 computer systems and allow Series 200 communication with its older 800 and 1800 computer systems. Interface units are also provided to switch magnetic tape units between controllers in the same or different Series 200 computer systems, and to permit two Series 200 systems to share a common group of communication lines. Described below are the Model 212-1 On-Line Adapter for linking Series 200 processors, and the Model 205 Magnetic Tape Switching Unit. The Model 215 Communication Switching Unit is described in Section 510:106 of this report, and the Model 212 On-Line Adapter for linking Series 200 processors and Honeywell 800 or 1800 systems is described in Section 510:107.

.121 Model 212-1 On-Line Adapter

The highest level at which two Honeywell Series 200 computer systems in a single installation can share facilities is through a direct memory-to-memory connection between them. This is made possible by the Model 212-1 On-Line Adapter, which links together two input-output channels — one from each computer. The computer initiating a data transfer operation treats the other computer as an ordinary input-output unit; data transfers between the two computers are initiated and monitored under program control through the use of standard input-output instructions.

The actual transfer of data takes place at 167,000 characters per second, irrespective of the computers involved. During memory-to-memory data transfers, one core memory cycle in each computer is used for each character transferred. For the Honeywell 200, with its two-microsecond memory, the resulting central processor load is 33%.

.122 Model 205 Magnetic Tape Switching Unit

The Model 205 Switching Units are used to switch magnetic tape units from one controller to another. Different versions handle the switching of three-quarter-inch (204A Series) tape and half-inch (204B Series) tape units.

A single magnetic tape unit can be connected to the basic Model 205 Switching Unit; additional tape units can be connected by using one 052 Feature per connected additional tape unit. A maximum of three 052's can be connected to the Model 205A (three-quarter-inch) Switching Unit, or seven 052's to the Model 205B (for half-inch tapes). Where, as in the case of the 203B-1 Tape Control Unit, one of the tape units is acting as a primary unit while others are acting as secondary units, any units which are not switched along with the primary unit become inoperable and cannot be used by either system.

Switching can be between controllers on the same or different computer systems. In the case of the Model 205A switching unit, three-quarter-inch tape drives can be switched from a Honeywell Series 200 computer system to the appropriate control unit of the Honeywell 400/1400 or 800/1800 computer families.

.14 First Delivery

Model 212-1 On-line Adapter: . . . . March 1965.
Model 205 Magnetic Tape Switching Unit: . . . . January 1965.

.15 Availability: . . . . 6 months for Models 212-1 and 205.

INPUT-OUTPUT: 281 SINGLE-CHANNEL COMMUNICATION CONTROL

.1 GENERAL

.11 Identity: . . . . Single-Channel Communication Control. Models 281-1, -2, -3, and -4.

.12 Description

The 281 Single-Channel Communication Control enables the transmission and reception of messages over toll and leased communication lines. Data can be in 5- to 8-level codes and can be transmitted at rates of up to 5,100 characters per second. The 281 is a single-channel, half-duplex control that sends or receives either by single character or by whole message. Additional 281 Controls can be added to a Series 200 system in order to provide full duplex or multiple-channel operation. Each 281 Control requires two input-output trunks.

By means of the Model 281 and/or 286 Communication Controls and appropriate communication networks, a Honeywell 200 system can communicate with a wide variety of remote devices, such as:

- Other Honeywell Series 200 computers.
- Honeywell 400, 1400, 800, or 1800 computers.
- Teleprinters used with AT&T and Western Union telegraph services.
- IBM System/360 computers equipped with 2701 Data Adapter Units, or 2702 and 2703 Transmission Controls.
- IBM 1401 or 1410 computers equipped with 1009 Data Transmission Units.
- IBM 1013 Card Transmission Terminals.
- IBM 7701 or 7702 Magnetic Tape Transmission Terminals.
- Digitronics DIAL-O-VERTER equipment.
- UNIVAC 1004 equipment.
- Teletype Dataspeed equipment.
- UNIVAC 1004 Series equipment.
- Circuit switching systems.
- Paper tape readers and punches.
- Keyboards and printers.

There are four basic models and a number of variations in the 281 series. The characteristics of each model (type of communication service and terminals, transmission speed, and data-set requirements) are summarized in Table I.

The program can test for the presence of incoming data or for readiness of the control to transmit data. The Program Interrupt facility can perform the same tests and interrupt the execution of the stored program automatically. Data being transmitted and received by a Communication Control is protected by three different methods: checks for transmission lapses, an optional character parity check, and a semi-automatic message-receipting system. Failure of a transmission or parity check sets a program-testable indicator. When desired, a transmitting control can interrogate the status of the receiving control to insure that the previous message was correctly received.

The normal turn-around time between messages ranges from 20 to 400 milliseconds, depending on line characteristics.

Under program control, the 281 can transmit a single character or an entire message from core storage to a remote device, or it can accept a single character or an entire message from a remote device and transfer it into core storage. Data transfers engage the Central Processor for two microseconds per character in 5- or 6-level codes and four microseconds per character in 7- or 8-level codes.

TABLE I: CHARACTERISTICS OF THE 281 COMMUNICATION CONTROL MODELS

Single-Channel Control Type	Terminal	Service & Line	Dataset (2)	Transmission Speed
281-1H	AT&T Dataspeed 2	Voice-grade private line DDD	202D 202C	105 cps
281-3A	AT&T Dataspeed 5 Receivers	Voice-grade private line DDD	402C	75 cps
281-4A	AT&T Dataspeed 5 Send Units	Voice-grade private line DDD	402D	75 cps
281-2C	Digitronics DIAL-O-VERTER	Voice-grade private line DDD	202D 202C	150 cps
281-2E	Digitronics Type 1 DIAL-O-VERTER	Voice-grade private line DDD	201B 201A	300 cps 250 cps
281-2B	Honeywell Series 200 Computer (1)	Voice-grade private line DDD	201B 201A	300 cps 250 cps
281-2F		Telpak A 48 KC broad-band channel	301B	5100 cps
281-1M	Honeywell Data Station	Voice-grade private line DDD	202D 202C	120 cps
281-1R	Honeywell Display Stations	Voice-grade private line	202D 202C	180 cps 120 cps
281-2R			202B 202A	250 cps 300 cps
281-1S		Direct-connect		120 cps
281-2S				300 cps
High-Speed Control Interface		High-speed direct connect		41,600 cps
281-1E	IBM 1050 Data Communication System	W. U. 180 baud Tel. Co. 150 baud Voice-grade private line	1181.1A* 816 103F	14.8 cps 14.8 cps
281-1K		Tel. Co. TWX-CE Tel. Co. DDD	103A 103A	14.8 cps 14.8 cps
281-2A	IBM Standard STR Series (7702, 1013, 1009, etc.)	Voice-grade private line DDD	202D 202C	150 cps
281-2D		Voice-grade private line DDD	201B 201A	300 cps 250 cps
281-1C	Teletype 15, 19, 28	5-Level TTY circuit	- -	60,66,75, or 100 wpm
- - 281-1B 281-1D 281-1B	Teletype 33, 35	TWX TWX-CE Tel. Co. 150 baud DDD	811B 103A 816 103A	100 wpm
281-1D	Teletype 33,35, 37 Model 1	Voice-grade private line W.U. 180 baud	103F 1181.1A*	100 wpm
281-2E	UNIVAC 1004/DLT2	Voice-grade private line DDD	201B 201A	300 cps 250 cps
281-2F	UNIVAC 1004/DLT2B	Telpak A 48 KC broad-band channel	301B	5100 cps
281-1A	W.U. TELEX	W.U. Telex	W.U. Adapter*	66 wpm

(1) Type 281-2F single-channel control in Honeywell-to-Honeywell service is available in half-duplex and full-duplex forms.

(2) Except where indicated by an asterisk, Dataset designations refer to Bell System Data-Phone Datasets.

INPUT-OUTPUT: 286 MULTI-CHANNEL COMMUNICATION CONTROL

.1 GENERAL

.11 Identity: . . . . Multi-Channel Communication Control, Types 286-1 through 286-5.
285 Series Adapter Units.

.12 Description

The 286 Multi-Channel Communication Control can control the transmission and reception of messages over as many as 63 communication lines. A Type 285 Communication Adapter Unit (CAU) is required as an interface between the 286 and each line being used. Table I lists the various 285 Adapter Unit models and the remote terminal units that can be connected to these adapters. Data can be transferred by the 286 Multi-Channel Communication Control at rates of up to 300 characters per second in individual lines.

The five available models of the 286 Multi-Channel Control fall into two logical groups, depending on whether they operate in character mode or message mode.

The character-mode models (Types 286-1, -2, and -3) require that the transmission or reception of each character in the message be individually controlled. A total character transmission rate of 2,500 characters per second can be maintained in the character mode, a figure that includes allowances for the input-output programming that accomplishes each operation.

The message-mode models (Types 286-4 and -5) maintain the current input-output area address for each of the connected communication lines and automatically control the data flow for the duration of the message transmission. A program interrupt is generated only at the end-of-message. The demand on the central processor is limited to the actual data transfer time between the Type 286-4 or -5 Multi-Channel Control and the core storage of the associated Series 200 processor. A total throughput capacity of 7,000 characters per second can be maintained with the message-mode Multi-Channel Control models.

Each 286 Communication Control requires two Series 200 input-output trunks. The total number of communication lines serviced by these two trunks varies according to the model of the 286 Control, as follows:

Type	Number of Lines Controlled
286-1	2 to 13
286-2	4 to 15
286-3	16 to 63
286-4	2 to 32
286-5	32 to 63

The Central Processor must be equipped with the Advanced Programming feature in order to use the 286 Communication Control. Data is stored in the input-output area in the same bit configuration as it appears on the transmission lines. Code conversion is facilitated by the Move and Translate instruction which is included in the Advanced Programming feature package.

Data transmission is protected by three methods: checks for transmission lapses, an optional character parity check, and a semi-automatic message-receipting system. A "long," longitudinal parity check is also available. Failure of a transmission or parity check automatically sets an indicator. Whenever desired, a transmitting control unit can interrogate the status of the receiving control unit to insure that the previous message was correctly received.

Optional Features

Parity Check and Generation, Option 086.
Long Check (longitudinal parity check), Option 087.

TABLE I: CHARACTERISTICS OF MODEL 285 ADAPTER UNITS

Adapter Unit Type(1)	Terminal	Service & Line	Dataset (2)	Transmission Speed
285-1H	AT&T Dataspeed 2	Voice-grade private line DDD	202D 202C	105 cps
285-3A	AT&T Dataspeed 5 Receivers	Voice-grade private line DDD	402C	75 cps
285-4A	AT&T Dataspeed 5 Send Units	Voice-grade private line DDD	402D	75 cps
285-2C	Digitronics DIAL-O-VERTER	Voice-grade private line DDD	202D 202C	150 cps
285-2E	Digitronics Type 1 DIAL-O-VERTER	Voice-grade private line DDD	201B 201A	300 cps 250 cps
285-2B	Honeywell Series 200 Computer	Voice-grade private line DDD	201B 201A	300 cps 250 cps
- -		Telpak A 48 KC broad-band channel	301B	5100 cps
285-1M	Honeywell Data Station	Voice-grade private line DDD	202D 202C	120 cps
285-1R	Honeywell Display Stations	Voice-grade private line	202D 202C	180 cps 120 cps
285-2R			202B 202A	250 cps 300 cps
285-1S		Direct-connect		120 cps
285-2S				300 cps
High-Speed Control Interface		High-speed direct connect		41,600 cps
285-1E	IBM 1050 Data Communications System	W. U. 180 baud Tel. Co. 150 baud Voice-grade private line	1181.1A* 816 103F	14.8 cps 14.8 cps
285-1K		Tel. Co. TWX-CE Tel. Co. DDD	103A 103A	14.8 cps 14.8 cps
285-2A	IBM Standard STR Series (7702, 1013, 1009, etc.)	Voice-grade private line DDD	202D 202C	150 cps
285-2D		Voice-grade private line DDD	201B 201A	300 cps 250 cps
285-1C	Teletype 15, 19, 28	5-Level TTY circuit	- -	60, 66, 75, or 100 wpm
285-1N 285-1B 285-1D 285-1B	Teletype 33, 35	TWX TWX-CE Tel. Co. 150 baud DDD	811B 103A 816 103A	100 wpm
285-1D	Teletype 33, 35, 37 Model 1	Voice-grade private line W. U. 180 baud	103F 1181.1A*	100 wpm
285-2E	UNIVAC 1004/DLT2	Voice-grade private line DDD	201B 201A	300 cps 250 cps
- -	UNIVAC 1004/DLT2B	Telpak A 48 KC broad-band channel	301B	5100 cps
285-1A	W. U. TELEX	W. U. Telex	W. U. Adapter*	66 wpm

(1) References to adapter units imply Type 286 communication controls, since a 285 adapter interfaces each line connected to a multi-channel control.

(2) Except where indicated by an asterisk, Dataset designations refer to Bell System DATA-PHONE Datasets.

INPUT-OUTPUT: 233 MICR CONTROL UNIT

.1 GENERAL

.11 Identity: . . . . MICR Control Unit, Models 233-1, -2.

.12 Description

Honeywell does not manufacture or supply MICR equipment, but does provide MICR Control Units which link the Series 200 systems with either the Burroughs B 102 or B 103 Sorter/Readers or the IBM 1419 Magnetic Character Reader.

Delivery of the MICR Control Units is available 15 months after receipt of order.

.121 Burroughs B 102 Sorter/Reader

The Burroughs B 102 Sorter/Reader reads magnetically-encoded paper documents at a peak speed of 1,560 documents per minute for documents with the minimum allowable length of 5.94 inches. The effective rate for documents of other lengths, including allowances for slippage and interdocument gaps, can be calculated by dividing 9,000 by the average document length, in inches. A 9-inch document, for example, would be read at a rate of 1,000 documents per minute.

A single line of magnetic-ink characters printed in Font E-13B can be read. During reading the central processor is interrupted for only one memory cycle per character.

After a document has been read, at least 5.0 milliseconds remain before the pocket selection signal need be given to guide the document into the appropriate pocket. Further time is available, if needed, when documents under the maximum length of 9.06 inches are used, or when the end of data occurs before the extreme right-hand end of the document being read.

One H-200 input-output trunk is connected to the MICR Control Unit. Because no multiple-tape-listing printers are currently available with the Honeywell 200 system, it is not normally practical to operate the Burroughs reader at speeds higher than the peak printer operating speed if on-line listing of the documents is desired.

Features and characteristics of the Burroughs B 102 Sorter/Reader are presented as part of the Burroughs B 100/200/300 Computer System Report, on page 201:102.100.

.122 Burroughs B 103 Sorter/Reader

The Burroughs B 103 Sorter/Reader is substantially the same as the B 102, described above, except that it may optionally include an endorsing station. The B 103 therefore requires two Honeywell 200 input-output trunks to be connected to the MICR Control Unit.

.123 IBM 1419 Magnetic Character Reader

The IBM 1419 Magnetic Character Reader reads magnetically-encoded paper documents at a peak rate of 1600 documents per minute for documents with the minimum allowable length of 6.0 inches. The effective rate for documents of other lengths, including allowances for slippage and 2.5-inch interdocument gaps, can be calculated by dividing 9,600 by the average document length, in inches. An 8-inch document, for example, would be read at a rate of 1,200 documents per minute.

A single line of magnetic-ink characters printed in Font E-13B can be read from each document. During reading, the central processor is interrupted for only one memory cycle per character.

After a document has been read, at least 13 milliseconds remain before the pocket selection signal need be given to guide the document into the appropriate pocket. Further time is available, if needed, when documents under the maximum length of 8.75 inches are used, or when the end of the data to be read occurs before the extreme right-hand end of the document being read.

Features and characteristics of the IBM 1419 Magnetic Character Reader are presented as part of the IBM 1401 Computer System Report, on page 401:103.100.

INPUT-OUTPUT: 215 COMMUNICATION SWITCHING UNIT

.1 GENERAL

.11 Identity: . . . . Communication Switching Units, Models 215-1 and 215-2.

.12 Description

The 215-1 and 215-2 Communication Switching Units allow two computers to share a group of communication lines and enable one computer to switch between different groups of lines. The Model 215-1 is used with 285-1 and 285-2 Adapter Units, and the Model 215-2 is used with 285-3 and 285-4 Adapter Units (each line having one Adapter Unit). See Section 510:104 for a list of the characteristics of the Model 285 Adapter Units.

The basic Communication Switching Units can be used to switch a group of up to eight lines between two 286 Communication Controls (each of which is connected to a computer) or to switch one 286 Communication Control between two groups of eight lines each. By adding the appropriate 083 or 084 Expansion Features, the group switching capability can be expanded (in increments of eight lines per expansion feature) to handle up to 63 lines. All lines connected to any one switching device are switched simultaneously.

The switching unit is housed in a central processor drawer which must be mounted in the cabinet as an "end" unit; a manual selector on the unit's front panel controls and indicates the switch setting. The computers must be stopped by their STOP keys and the STOP indicators must be on before the switch setting is changed.

INPUT-OUTPUT: 212 ON-LINE ADAPTER

.1 GENERAL

.11 Identity: . . . . On-Line Adapter. Model 212.

.12 Description

The On-Line Adapter is analagous to a peripheral control unit for both Series 200 and H-800/1800 data processing systems. It is a device which enables an H-800 or H-1800 to communicate on-line with a Series 200. Information transferred through the On-Line Adapter requires 66 microseconds for each 48 bit word.

A software package called LINK is provided to facilitate usage of a Series 200 system as a satellite to a larger H-800 or H-1800 system. See Section 510:151.15 for the capabilities of the LINK package.

The On-Line Adapter contains the following registers and flip-flops:

- One-word (48-bit) data buffer — successively filled by the H-800/1800 and emptied by the Series 200 program during write (WF) operations, and vice versa during read (RF and RB) operations.
- Six-bit ID Register — stores an identification character that defines the H-800/1800 operation to be performed.
- Device Busy and Error flip-flops — can be set by the H-200 program and sensed by the H-800/1800 hardware if the peripheral device requested is unavailable or has a stored error indication.
- Transfer, Busy, Error and Incomplete flip-flops — automatically set by the On-Line Adapter hardware, and can be sensed by H-200 Peripheral Control and Branch instructions.

The Peripheral Data Transfer and Peripheral Control and Branch instructions are used by the Series 200 program to respond to H-800/1800 peripheral orders and to set and test the various registers and flip-flops of the On-Line Adapter. The H-800/1800 peripheral instruction which defines the operation to be performed is encoded and stored in the On-Line Adapter. The 200 interrogates the On-Line Adapter, interprets the operation requested, and initiates appropriate responses depending upon the nature and type of equipment available and the conditions present.

A tape produced previously on the H-800/1800 which contains mixed modes of 4-bit and 6-bit characters can be transferred directly into the H-800/1800 without need for editing. Information transmitted from the H-800/1800 through the On-Line Adapter to tape can also be in mixed mode. Information from the H-800/1800 which is to be used for printing or punching on the 200, however, must be in 6-bit mode throughout.

IBM tapes can also be used as input to the H-800/1800 through the On-Line Adapter. The data must be converted into Honeywell code and format by either the translation hardware in the Tape Control Unit or by the Move and Translate instruction.

All data which is to be processed by a Series 200 system in decimal mode after being read in from Honeywell tapes must be converted to 6-bit format. This involves using the Extract and Substitute instructions on each character.

In general, communication between the Series 200 system and the H-800/1800 is carried out by the following steps:

- The LINK program tests the ID Register with a PCB (Peripheral Control and Branch) instruction.
- The input-output device corresponding to the ID Register setting is started by the 200 system.
- At the same time, the 200 issues a response to the H-800/1800 or turns off the Busy and Incomplete latches. This causes an unprogrammed transfer in the H-800/1800, and information is transmitted from the 200 core to the H-800/1800 core.

INPUT-OUTPUT: DATA STATION

.1 GENERAL

.11 Identity: . . . . 288-1 Central Control Unit. (See list of Data Station input-output devices in Table I.)

.12 Description

The Honeywell 288 Data Station consists of a group of comparatively slow input-output devices which are connected together by a central control unit. These input-output devices can operate together to perform data transcription functions (card to printer, paper tape to punched cards, etc.) or they can be connected, via Bell System Dataphone subsets, with another system at a remote location. Usually, but not necessarily, the remote system will be a Honeywell Series 200 computer. Communication to and from the Data Station can occur at up to 120 characters per second, in one direction at a time.

The Data Station input-output devices can be selected from the devices listed in Table I. At least four of these devices, in any combination, can be connected to a central control unit to form a Data Station.

In the following description of the Data Station, the central control unit and communication facilities are described first, followed by a description of each of the currently-available peripheral devices.

.121 Central Control Unit and Communication Facilities

The Data Station is a multi-purpose remote terminal device that transmits and receives data asynchronously, in half-duplex mode, at a maximum rate of 120 characters per second over toll or leased lines. A Bell System Dataphone 202C or 202D subset is required to convert data signals used by the communication units to signals acceptable for transmission over communication networks. To communicate with the Data Station, Honeywell Series 200 computers can use either the 281-1M Single-Channel Communication Control Unit or the 286 Multi-Channel Communication Control Unit with a 285-1M Adapter Unit.

The 288-1 Central Control Unit performs the functions of device selection and activation, generation and checking of parity codes, error correction, and transmission control. The basic control unit can handle up to four of the peripheral devices listed in Paragraph .123.

The Data Station can operate in two modes: Remote and Local. In the Remote mode, the data station exchanges data with a computer over standard telephone lines and is normally controlled by the computer; however, control can be retained by the Data Station operator if desired. In the Local mode, the Data Station can be used for data preparation and editing activities, such as data transcription, off-line printing, etc. In either the Local or Remote mode, several output devices can simultaneously punch or print data received from any one input device (including the computer).

The Data Station uses an eight-bit code (seven-level ASCII plus one parity bit). Hollerith punched-card code and the five-level bar code are automatically converted into the eight-bit code.

Transmission errors are detected by row parity and longitudinal (channel) parity checking. Detected errors cause immediate retransmission of the incorrect block, provided the Buffer Option is included. As an alternative, an optional backup feature is available with the 120-cps paper tape reader; this feature enables the reader to move the tape backward one block to permit retransmission.

An interrupt feature enables the Data Station operator to regain control of the Data Station during a computer-controlled transmission. When the Branch button on the control panel is depressed, the Data Station completes transmission or reception of the current block of data and then requests the computer to service the operator-initiated interrupt. While the interrupt is being serviced, all devices except those required for the execution of the interrupting operation are momentarily deactivated. Interlocks protect the data of the interrupted operation so that no mixing of data or loss of sequence will occur. The interrupt feature provides the ability to interrupt lengthy transmissions in order to send urgent inquiries to the computer.

TABLE I: DATA STATION INPUT-OUTPUT DEVICES

Device	Speed, char/sec	Model No.
Card Reader	120	289-7
Paper Tape Reader	120	289-4
Paper Tape Punch	120	289-5
Optical Bar Code Reader	50	289-8
Page Printer and Keyboard	10	289-2
Keyboard Data Entry	operator-dependent	289-2A
Page Printer and Keyboard	40	289-3

.122 Optional Features

Buffer Option: Provides two 132-character buffers, allowing immediate and automatic error correction through retransmission, and enabling a transmission rate of 120 characters per second to be maintained regardless of the speed of the peripheral devices involved. This feature is required when either the optical bar code reader or the card reader is included in the system.

Extended Operation Option: includes the following five features —

- Alarm Feature: Turns on an alarm (light and/or buzzer) in the event of error detection or line failure. The buzzer may be used in preference to the light to alert the operator when his attention is required. The alarm should be responded to and turned off by the operator; alternatively the computer can be programmed to turn off the alarm after a predetermined interval of time.
- Telephone: Permits the computer and Data Station operators to contact one another for voice conversations.
- Party Line: Permits the Data Station to monitor the communication line for any message bearing its address. Thus, several stations can share the same line.
- Repeat-Last-Acknowledge: Permits the Data Station to send a second Acknowledge signal to the computer if for some reason the first signal was not received. Inclusion of this feature prevents unnecessary retransmission of an entire message in cases where the first Acknowledge signal is missed.
- Buffer Bypass: Permits bypassing of the Data Station Buffer in remote or local mode and allows transmission of messages of improper format or excess length.

.123 Peripheral Devices

The Data Station offers a selection of seven peripheral devices. At least four of these devices can be connected to the basic Data Station control unit, and, with additional power, several more devices can be added. The Data Station requires a keyboard. This can be obtained either by using the 289-2A Keyboard or by connecting a Model 289-2 or 289-3 Page Printer. The keyboard has four banks and includes conventional alphabetic and numeric keys plus control keys. It uses the 7-bit ASCII code.

- 289-2 Page Printer and Keyboard: Operates in character-at-a-time fashion, at the rate of 10 characters per second, and prints lines up to 74 characters in length. Paper rolls 5 inches in diameter and 8.5 inches in width are used.
- 289-2A Keyboard Data Entry: permits an operator to send messages of up to 132 characters to the Data Station Central Control Unit. The 289-2A is an input device, with no output capabilities. Its keyboard contains a 65-character set.
- 289-3 Page Printer and Keyboard: Operates at 40 characters per second, using a 61-character set, and prints lines up to 72 characters in length. Paper stock can be in either 5-inch rolls or fanfold, both 8.5 inches in width. Paper can be fed by friction or sprockets. The higher speed of this printer makes it suitable for use as a direct, on-line printer for the central computer.
- 289-4 Paper Tape Reader: Operates at 120 characters per second, thus fully utilizing the Data Station's transmission capability. An optional retransmission capability enables the reader to back up the tape one block and retransmit the block. The code used is 7-bit ASCII plus parity. Subsets of ASCII (5- or 6-level codes) can be accommodated. Oiled, dry, or Mylar tape of 1, 7/8, or 11/16 inch widths can be used.
- 289-5 Paper Tape Punch: Like the 289-4 Paper Tape Reader, this 120-character-per-second paper tape punch provides maximum utilization of the Data Station's transmission capability. Code and tape characteristics are the same as those of the 289-4 Reader. No read-after-punch check is performed upon the accuracy of the punched data.
- 289-7 Card Reader: Reads Hollerith-coded data from punched cards at the rate of 120 characters per second. Automatic feeding from the 500-card input hopper can be halted to permit entry of from 1 to 15 cards. The card reader stops when the hopper is empty. A program disc enables the reading of selected card fields. Reading time is 8.3 milliseconds per column. The reading mechanism consists of star wheels. This unit requires use of the Buffer Option on the 288 Central Control Unit.
- 289-8 Optical Bar Code Reader: Reads printed 5-level bar code (4 data bits and 1 parity bit) at the rate of 50 characters per second. Card or paper documents 3.5 inches wide by 5 to 8 inches long can be used. Printing density is 10 characters per inch. Only one line of coded printing per document is permitted. The bar code can be printed by Honeywell high-speed computer printers or, where the data is constant, by lithography. Check digits can be incorporated into the coded information. The reader includes an input hopper and an output stacker. Either 20-pound paper stock or 80-pound card stock can be handled. Documents must be white in color and must have greater than 75% reflectance.

Two modes of data transmission are possible with the 289-8 Bar Code Reader. The modes are Continuous and Single Block. In Continuous Mode, one character at a time is read and sent to the Data Station Control Unit. In Single Block Mode, the data from 1 to 7 documents can be stored and transmitted as a single block. This feature can improve line utilization appreciably by reducing the number of required Acknowledge messages.

As an option, the Optical Bar Code Reader can read a two-bit mark-sense code; this makes it possible to enter variable information manually at the point of a transaction entry. For example, a salesgirl might mark on a bar-coded document any combination of the two bits to represent "cash", "credit", "partial payment", or "full payment."

The Buffer Option is required on the 288 Central Control Unit when the Optical Bar Code Reader is attached.

INPUT-OUTPUT: DISPLAY STATIONS

.1 GENERAL

.11 Identity . . . . Model 303 Display Station.
Model 311 Display Station.
Model 312 Display Station.

Model 322 Universal Control Unit.
Model 323 Universal Control Unit.

Model 331 Communication Module.
Model 332 Communication Module.
Model 355 Polling Control Module.

.12 Description

The Honeywell Series 200 now includes in its product line an array of "Visual Information Projection" (VIP) facilities — most of which are manufactured by the Bunker-Ramo Corporation. Three Display Stations, featuring keyboard input and cathode-ray tube alphameric data display capabilities, are the principal components of Honeywell's new line of display equipment. These devices can be used as local units for operator communication or as terminal units in a remote data communications network.

Models 303, 311, and 312 Display Stations are operationally and functionally similar. The selection of a particular model Display Station is based primarily on keyboard input requirements and display screen capacities (see Table I).

The viewing screen of these devices is a cathode-ray tube that utilizes a high-contrast, low-persistence, emerald green phosphor. Each displayed character is composed of a 7 x 5 dot matrix and can be adjusted for brightness, focus, and size. The available range of character sizes extends from approximately typewriter size up to 1/4-inch. The displayed data is regenerated more than 40 times per second, producing a character display which appears steady to the human eye.

An Entry Marker or cursor indicates the current writing position on the viewing screen; it steps to the next position as each character is entered. Optional editing features permit the cursor to be moved to any line and any character position for character deletion or correction purposes.

Message data is entered via the keyboard of the Display Station. It is immediately displayed on the screen and simultaneously stored in the station's Universal Control Unit buffer. Nothing is transmitted to the local or remote central processor until the TRANSMIT key is depressed. A Carriage Return/Line Feed key, as well as Erase and Clear keys, are also provided to facilitate message preparation. Function keys are included to call for user-specified functions at the central computer site. Responses from the central computer can be displayed in addition to or in place of the input query.

Described below are the three models of Honeywell Series 200 Display Stations. The models can be intermixed on a single control unit, provided that each model is installed with the same data display capacity (i.e., the same maximum number of lines and characters per line displayed). The great variety of data display capacities that can be selected with each model Display Station is summarized in Table I.

.121 Model 303 Display Station

Model 303 provides a 5.5-inch by 7.75-inch display viewing area on a screen that can be separated from the keyboard input device. The data display capacity is 32, 64, 128, 256, 384, or 768 characters, arranged in various numbers of lines, as shown in Table I. The keyboard of the Model 303 Display Station is a 4-row, Teletype-style unit that includes 26 alphabetic and 10 numeric characters in addition to 3 fixed special symbols and 15 variable special symbols (whose function can be specified by the user). Special keys for message editing can also be provided as optional features.

.122 Model 311 Display Station

Model 311 is a combined keyboard/display unit that includes a 4.75-inch by 3.75-inch viewing screen, four special symbol keys, and a block of ten numeric input keys. Twelve other keys are provided for user-specified special functions and message editing operations. The 311's data display capacity is 32, 64, 128, 256, or 384 characters, arranged in a set number of line combinations.

.123 Model 312 Display Station

The Model 312 is also a combined keyboard/display unit with a 4.75-inch by 3.75-inch viewing screen. The screen can display 32, 64, 128, 256, or 384 characters arranged in a set number of line combinations, as shown in Table I. The keyboard contains 26 alphabetic and 10 numeric characters, as well as 4 fixed special symbols and 12 user-specified function keys.

.124 Display Control

The Display Stations described above require a Model 322 or 323 Universal Control Unit to provide individual, local buffering of data during message preparation and reply transmission. The Universal Control Units also provide the power supply, message generation, and general control facilities for one or more of the three Display Station models.

The basic Universal Control Unit contains a buffer storage capacity of 768 characters. This basic storage capacity can serve the following number and types of Display Stations:

- One Display Station of 768 characters (Model 303 only).
- Two Display Stations of 384 characters.
- Three Display Stations of 256 characters.

TABLE I: DATA ARRANGEMENT ON VIEWING SCREEN

Display Capacity (Characters)	Display Station Model			Number of Lines Displayed	Number of Characters/Line
	311	312	303		
32	x	x	x	1	32
32	x	x	x	2	16
64	x	x	x	2	32
64	x	x	x	4	16
128	x	x	x	4	32
256	x	x	x	8	32
*378	x	x	x	9	42
384	x	x	x	12	32
768			x	12	64

*Considered as 384 from standpoint of control unit storage requirements.

.124 Display Control (Contd.)

- Six Display Stations of 128 characters.
- Twelve Display Stations of 64 characters.
- Eighteen Display Stations of 32 characters.

Expansion modules are available for extending the basic buffer storage capacity of the Universal Control Units in increments of 768 characters. The Model 322 Universal Control Unit can be expanded to include 2 Expansion Modules, giving a total buffer storage capacity of 2,304 characters. The 323 Universal Control Unit can add 8 Expansion Modules, providing a total buffer storage capacity of 6,912 characters.

In addition to controlling the operations of the Display Stations, the Universal Control Units can control on-line receive-only printers, paper-tape or card readers and punches, and Model 33 or 35 Teletype Keyboard Send-Receive (KSR) Page Printers as components in a remote data communications system. For each input-output device that is connected, a special Control Module must be added to the Universal Control Unit.

Included within the Universal Control Unit cabinet is a Model 331 or Model 332 Communication Interface Module. These modules are required as data interface units to either a communications line or to a local central processor. The Model 331 Interface unit provides a 1,200-bit-per-second data transmission speed over half-duplex, 2- or 4-wire lines; the Model 332 Interface unit provides a 2,400-bit-per-second transmission rate, also over half-duplex, 2- or 4-wire lines. In addition, Honeywell is developing a High Speed Interface unit that will transfer data at 41,600 characters per second.

All data transmission in a Honeywell Visual Information Projection system uses the 7-level ASCII character code with single-bit parity. Data is transferred between processor and Universal Control Unit either in an asynchronous serial-by-bit mode (using a 10-level character that includes start and stop bits in addition to the basic 8-level character) or in a synchronous serial-by-bit mode (using the basic 8-level character).

When the Display Stations form part of a remote communications network, Bell System Data-Phone Data Sets 201A, 201B, 202C, or 202D are used as interfacing units at both ends of the communications lines. Final linkup with the central processor is accomplished by a Model 281 or Model 286 Communication Control Unit. These single- and multi-line communication control units are described in Report Sections 510:103 and 510:104.

When the Display Stations are used as local input-output devices, the Universal Control Unit and its Communication Interface unit connect directly to a Model 281 or 286 Communication Control Unit and then to the central processor. No data sets are required in this configuration. The central processor can be located up to 200 feet from the Display Stations' Universal Control Unit. (Each Display Station is connected to the Universal Control Unit by an individual cable with a nominal length of up to 1,000 feet.)

.125 Optional Features

The following special features are available for Models 322 and 323 Universal Control Units:

- 341/342/343 Expansion Modules: described in Paragraph .124 above, these modules provide increased buffer storage capacity for the Universal Control Units.
- 351 Message-Editing Module: provides the display Stations with STEP-Left and SCAN-Left editing facilities, permitting the cursor to be moved to any line and any character position.
- 352 Multi-Message Transactions Module: provides the capability to retain several inquiry and response messages on the viewing screens of any Display Station controlled by the Universal Control Unit in which this feature is installed.
- 355 Polling Control Module: enables the central processor to control the transmission of all messages within the Visual Information Projection system.

.126 Programming

According to Honeywell, all programming facilities required to utilize the Display Stations are included in Communications I/O C, the software package provided for the control of all communications devices connected to a Model 286 Communication Control Unit. The user must code in detail only his message display formatting routine, a task that appears to be similar to coding printer formatting routines.

.127 Availability

All of the Display Station Models are currently in production. They can be delivered within a 6-month period after placement of order.

SIMULTANEOUS OPERATIONS

All Honeywell Series 200 processors can handle concurrent input-output operations on each of the available input-output channels in conjunction with continuing processing of the stored-program instructions. Full use can generally be made of these capabilities for concurrent operations because the connections between the peripheral units or controllers and the input-output channels are left flexible and established during program execution. (In most competitive systems these connections are established when the equipment is installed, so that only one or two channels can service any given peripheral unit.)

One significant restriction concerns the "auxiliary" data channels. An auxiliary channel is normally the fourth of a set of four channels. In fact, the auxiliary channel is not a separate channel at all, but is one half of the first channel of the set which has been divided into two logically distinct subchannels. Each of these two subchannels has only half the capacity of the original channel and may be unable to handle the data transfer rates of certain peripheral devices.

For details about the capabilities for simultaneous operations of each of the Series 200 processor models, please refer to the Simultaneous Operations sections of the individual subreports:

Honeywell 120: .... Section 511:111
Honeywell 200: .... Section 512:111
Honeywell 1200: .... Section 513:111
Honeywell 2200: .... Section 514:111
Honeywell 4200: .... Section 516:111
Honeywell 8200: .... Section 518:111

INSTRUCTION LIST

Certain basic instructions are standard in all of the Honeywell Series 200 central processor models; other instructions are standard in the large models and either optional or not available in the smaller models. The following table lists each of the instructions in the Series 200 repertoire and indicates its availability (standard, optional, or not available) in each of the processor models.

There is a close and highly important relationship between the machine instruction repertoires of the Honeywell Series 200 and the IBM 1400 Series. Therefore, two additional columns have been added to the Instruction List to indicate which Series 200 instructions are also available in the IBM 1401 and 1410 computer systems.

The list of instructions on the following pages also includes the instruction timing formulas for Honeywell processor models 120, 200, 1200, 2200, and 4200. See page 510:121.104 for the meanings of the symbols used in the timing formulas. Timing formulas for the significantly different Model 8200 Word Processor are presented in Section 518:121 of the Model 8200 subreport.

Legend

S: Standard instruction, included in all versions of the processor model.
O: Optional instruction, included in some versions of the processor model.
NA: Not available in any version of the processor model.

INSTRUCTION NAME	AVAILABILITY IN PROCESSOR								TIMING FORMULAS (Memory Cycles)	
	Honeywell						IBM		120/200/1200/2200 (1)	4200
	120	200	1200	2200	4200	8200	1401	1410	FIXED-POINT ARITHMETIC INSTRUCTIONS	
Decimal Add	S	S	S	S	S	S	S	S	No Recomplement (2) $N_i + 2 + N_w + 2N_b$ Recomplement (2) $N_i + 2 + N_w + 4N_b$	No Recomplement $W_i + .5N_{ww} + 2.5N_{bw} + 4.5$ Recomplement $W_i + .5N_{ww} + 5N_{bw} + 4.5$
Decimal Subtract	S	S	S	S	S	S	S	S	No Recomplement (2) $N_i + 2 + N_w + 2N_b$ Recomplement (2) $N_i + 2 + N_w + 2N_b$	No Recomplement $W_i + .5N_{ww} + 2.5N_{bw} + 4.5$ Recomplement $W_i + .5N_{ww} + 5N_{bw} + 4.5$
Decimal Multiply	NA	S	S	S	S	S	O	S	see individual Central Processor subsections for timing	see individual Central Processor subsections for timing
Decimal Divide	NA	S	S	S	S	S	O	S	see individual Central Processor subsections for timing	see individual Central Processor subsections for timing
Binary Add	S	S	S	S	S	S	NA	NA	$N_i + 1 + N_w + 2N_b$	$W_i + .5N_{ww} + 2.5N_{bw} + 4.5$
Binary Subtract	S	S	S	S	S	S	NA	NA	$N_i + 1 + N_w + 2N_b$	$W_i + .5N_{ww} + 2.5N_{bw} + 4.5$
Zero and Add	S	S	S	S	S	S	S	S	$N_i + 1 + N_w + N_b$	$W_i + N_{ww} + N_{bw} + 4.5$
Zero and Subtract	S	S	S	S	S	S	S	S	$N_i + 1 + N_w + N_b$	$W_i + N_{ww} + N_{bw} + 4.5$
									SCIENTIFIC PROCESSING INSTRUCTIONS (3)	
Floating Add	NA	NA	O	O	O	O	NA	NA	$N_i + 13 + [n/4]$	$W_i + 11.5 + n/6$
Floating Add	NA	NA	O	O	O	O	NA	NA	$11 + [n/4]$	$W_i + 6.5 + n/6$
Floating Subtract	NA	NA	O	O	O	O	NA	NA	$N_i + 13 + [n/4]$	$W_i + 11.5 + n/6$
Floating Subtract	NA	NA	O	O	O	O	NA	NA	$11 + [n/4]$	$W_i + 6.5 + n/6$
Floating Multiply	NA	NA	O	O	O	O	NA	NA	$N_i + 21 + [N_i/2] + [n/4]$	$W_i + 16.5 + 5G/6 + K/3 + n/6$
Floating Multiply	NA	NA	O	O	O	O	NA	NA	$19 + [N_i/2] + [n/4]$	$W_i + 11.5 + 5G/6 + K/3 + n/6$
Floating Divide	NA	NA	O	O	O	O	NA	NA	$N_i + 40 [n/4]$	$W_i + 16.5 + p/3 + r/3 + n/6$
Floating Divide	NA	NA	O	O	O	O	NA	NA	$38 + [n/4$	$W_i + 11.5 + p/3 + r/3 + n/6$
Store Floating Accumulator	NA	NA	O	O	O	O	NA	NA	$N_i + 10$	$W_i + 6.5$
Load Floating Accumulator	NA	NA	O	O	O	O	NA	NA	$N_i + 11$	$W_i + 7.5$
Load Floating Accumulator	NA	NA	O	O	O	O	NA	NA	8	$W_i + 4$
Floating Test and Branch on Accumulator Condition	NA	NA	O	O	O	O	NA	NA	$N_i + 4$ (No branch) $N_i + 6$ (Branch)	$W_i + 3.8$ (No branch) $W_i + 4.5$ (Branch)
Floating Test and Branch on Indicator	NA	NA	O	O	O	O	NA	NA	$N_i + 2$ (No branch) $N_i + 4$ (Branch)	$W_i + 3$ (No branch) $W_i + 3.7$ (Branch)
Decimal to Binary	NA	NA	O	O	O	O	NA	NA	$N_i + 24$	$W_i + 12.5 + N$
Binary to Decimal	NA	NA	O	O	O	O	NA	NA	$N_i + 23$	$W_i + 11.5 + N$
Store Low-Order Result	NA	NA	O	O	O	O	NA	NA	$N_i + 9^{(3)}$	$W_i + 7.5$
Store Low-Order Result	NA	NA	O	O	O	O	NA	NA	$6^{(3)}$	$W_i + 3.5$
Load Low-Order Result	NA	NA	O	O	O	O	NA	NA	$N_i + 9^{(3)}$	$W_i + 8.5$
Load Low-Order Result	NA	NA	O	O	O	O	NA	NA	$6^{(3)}$	$W_i + 3.5$
Binary Mantissa Shift	NA	NA	O	O	O	O	NA	NA	$9 + [N_{sh}/4]^{(3)}$	$W_i + 4.5 + N_{sh}/6$
Binary Integer Multiply	NA	NA	O	O	O	O	NA	NA	$N_i + 20 + [N_1/2]^{(2)}$	$W_i + 12.5 + 5G/6 + K/3$

Notes (1) through (9) are explained on page 510:121.103

(Contd.)

INSTRUCTION NAME	AVAILABILITY IN PROCESSOR								TIMING FORMULAS (Memory Cycles)	
	Honeywell						IBM		120/200/1200/2200[1]	4200
	120	200	1200	2200	4200	8200	1401	1410	LOGIC INSTRUCTIONS	
Extract	S	S	S	S	S	S	NA	NA	$N_i + 1 + 3N_w$	$W_i + 3N_{ww} + 4.5$
Half Add	S	S	S	S	S	S	NA	NA	$N_i + 1 + 3N_w$	$W_i + 3N_{ww} + 4.5$
Substitute	S	S	S	S	S	S	NA	NA	$N_i + 4$	$W_i + 6.85$
Compare	S	S	S	S	S	S	S	S	$N_i + 2 + N_w + N_b$[4]	$W_i + 1.5N_{ww} + N_{bw} + 4.5$
Branch (Unconditional)	S	S	S	S	S	S	S	S	$N_i + 2$	$W_i + 4$
Branch on Condition Test	S	S	S	S	S	S	S	S	$N_i + 2$	$W_i + 4$
Branch on Character Condition	S	S	S	S	S	S	S	S	$N_i + 4$	$W_i + 5.5$
Branch if Character Equal	S	S	S	S	S	S	S	S	$N_i + 4$	$W_i + 5.5$
Branch on Bit Equal	O	O	S	S	S	S	O	S	$N_i + 4$	$W_i + 5.5$
									GENERAL CONTROL INSTRUCTIONS	
Set Work Mark	S	S	S	S	S	S	S	S	$N_i + 3$[5]	$W_i + 4.5$
Set Item Mark	S	S	S	S	S	S	NA	NA	$N_i + 3$[5]	$W_i + 4.5$
Clear Word Mark	S	S	S	S	S	S	S	S	$N_i + 3$	$W_i + 4.5$
Clear Item Mark	S	S	S	S	S	S	NA	NA	$N_i + 3$	$W_i + 4.5$
Halt	S	S	S	S	S	S	S	S	$N_i + 2$[4]	$W_i + 4.5$
No Operation	S	S	S	S	S	S	S	S	3[6]	$W_i + 3.5$
Change Addressing Mode	S	S	S	S	S	S	NA	NA	$N_i + 2$[6]	$W_i + 3.5$
Change Sequencing Mode	O	O	S	S	S	S	NA	NA	$N_i + 3$[6]	$W_i + 3.5$
Store Control Registers	S	S	S	S	S	S	O	S	$N_i + 5$[4]	$W_i + N + 3.5$
Load Control Registers	O	O	S	S	S	S	NA	NA	$N_i + 5$[4]	$W_i + N + 3.5$
Load Index/Barricade Register	NA	NA	O	O	O	O	NA	NA	$N_i + 3$	$W_i + N + 4$
Store Index/Barricade Register	NA	NA	O	O	O	O	NA	NA	$N_i + 3$	$W_i + N + 3.5$
									INTERRUPT CONTROL INSTRUCTIONS	
Monitor Call	NA	NA	O	O	O	O	NA	NA	$N_i + 2$[6]	$W_i + 3.5$
Store Variant and Indicators	S	S	S	S	S	S	NA	NA	$N_i + 1 + N_s + N_j$[7]	$W_i + N_{ws} + N_{wj} + 5.5$
Restore Variant and Indicators	S	S	S	S	S	S	NA	NA	$N_i + 2 + N_r$[6]	$W_i + N_{wr} + 4.5$
Resume Normal Mode	S	S	S	S	S	S	NA	NA	$N_i + 3$[8]	$W_i + 4$
									DATA MOVE INSTRUCTIONS	
Move Characters to Word Mark	S	S	S	S	S	S	S	S	$N_i + 1 + 2N_w$	$W_i + 2N_{ww} + 4.5$
Load Characters to A-Field Word Mark	S	S	S	S	S	S	S	S	$N_i + 1 + 2N_a$	$W_i + N_{aw} + 4.5$
Extended Move	O	O	S	S	S	S	O	S	$N_i + 1 + 2N_a$	$W_i + 2N_{aw} + 4.5$
Move and Translate	O	O	S	S	S	S	NA	NA	$N_i + 3N_a$[9]	$W_i + N_{ct} + 2N_{aw} + 5.1$
Move Item and Translate	O	O	S	S	S	S	NA	NA	$N_i + N_a + 2N_{ic}(NB_u)$	$W_i + N_{ia} + N_{ib} + N_{ic} + 6$
									EDIT INSTRUCTION	
Move Characters and Edit	O	O	S	S	S	S	S	S	$N_i + 1 + N_a + 2N_b + 2Z + 2\$$	$W_i + N_{aw} + 2.3N_{bw} + 2Z_w + 2\$_w + 5.5 + X_0 + Y_0$
									INPUT/OUTPUT INSTRUCTIONS	
Peripheral Data Transfer	S	S	S	S	S	S	S	S	Variable	Variable
Peripheral Control and Branch	S	S	S	S	S	S	S	S	Variable	Variable

Notes (1) through (9) are explained on page 510:121.103

FOOTNOTES

(1) Add one memory cycle to these formulas when calculating Model 2200 times, except where the formula is followed by footnote (4), (7), (8), or (9).

(2) Subtract one memory cycle from this formula if the instruction is being executed in the Model 120 or 1200 processor.

(3) These formulas apply only to the Models 1200 and 2200 processors; the scientific unit is not available with the Models 120 and 200.

(4) Add two memory cycles to this formula if the instruction is being executed in the Model 2200 processor.

(5) Subtract one memory cycle from this formula if the instruction is being executed in the Model 1200 processor in the format Op Code/A, B.

(6) Subtract one memory cycle from this formula if the instruction is being executed in the Model 1200 processor.

(7) Add one memory cycle to this formula if the instruction is being executed in the Model 1200 processor; add two cycles to the formula if the instruction is executed in the Model 2200 processor.

(8) Add two memory cycles to this formula if the instruction is being executed in the Model 2200 processor; subtract one cycle from the formula if the instruction is executed in the Model 1200 processor.

(9) Add four memory cycles to this formula if the instruction is being executed in the Model 2200 processor.

SYMBOL	MEANING
S	Standard instruction, included in all versions of the processor model.
O	Optional instruction, included in some versions of the processor model.
NA	Not available in any version of the processor model.
N_i	Number of characters in the instruction.
N_a	Number of characters in the field indicated by A.
N_b	Number of characters in the field indicated by B.
N_w	The number of characters in the A- or B-operand field, whichever is shorter.
N_s	Number of characters stored.
N_j	Number of character locations bypassed to reach the next sequential op code.
N_r	Number of characters referenced.
N_{ic}	Number of information units (6-bit or 12-bit characters) to be translated.
NB_u	Number of six-bit character locations occupied by each B-item information unit (1 or 2).
Z	Number of characters scanned during zero suppression.
$	Number of characters scanned during dollar-sign insertion.
W_i	Number of four-character words used to store one more than the total number of characters in the instruction.
N_{aw}	Number of words in the field indicated by A.
N_{bw}	Number of words in the field indicated by B.
N_{ww}	Number of words in the A- or B-operand field, whichever is shorter.
N	Number of words used to store the data.
N_{ws}	Number of words stored.
N_{wj}	Number of words bypassed to reach the next sequential op code.
N_{wr}	Number of words referenced.
N_{ct}	Number of characters translated.
N_{ia}	Number of words in the item to be translated.
N_{ib}	Number of words in the result item.
N_{ic}	Number of information units (6 or 12-bit characters) to be translated.
Z_w	Number of words scanned during zero suppression.
$\$_w$	Number of words scanned during dollar-sign insertion.
X_0	Zero if no second scan (zero suppression); 1 if the scan is performed.
Y_0	Zero if no third scan (dollar sign insertion); 1 if the scan is performed.
n	Number of bit positions shifted for automatic formatting.
N_1	Number of binary ones in a multiplier.
N_{sh}	Number of shifts.
G	Number of groups of two or more consecutive ones in the multiplier.
K	Number of single ones in the multiplier.
p	Total number of ones in the quotient.
r	Number of 01 groups in the quotient.

COMPATIBILITY WITH IBM 1400 SERIES

.1 SUMMARY AND PURPOSE

Honeywell has developed conversion routines that allow programs originally written for IBM 1400 Series computer systems to be run on Honeywell Series 200 systems. The essence of the Honeywell method for facilitating computer changeovers is to allow an IBM user to convert all his programs by means of these conversion routines and to train his programmers in the Honeywell languages and his operators in the Honeywell operating methods. Then, using the converted programs and writing his new programs in the Honeywell programming languages, the user can continue operations indefinitely without any need for complete reprogramming.

The converted programs will, in most cases, operate faster than they did on the IBM equipment, and they can be patched, when necessary, without having to go back to the IBM system or the IBM software. Reprogramming will become necessary only if and when the user needs to obtain more efficient utilization of the improved capabilities of the Honeywell system (not all of which are normally available to programs not written specifically for the system) or if he wants to run the converted programs on a Honeywell Series 200 system which does not have the necessary facilities.

The Honeywell Series 200 processor normally must have at least 4,096 additional core storage positions beyond the core storage used by the program to be converted. It must have an equivalent set of peripheral units (and there are no current Honeywell equivalents for some IBM peripheral units). It must have special compatibility features on the magnetic tape controllers if the original magnetic tape files are to be left unconverted. It must have a number of special optional features. Still other optional features, if available, will help to improve the performance of converted programs. All of these options are available for all of the Series 200 processors.

There are two main methods of handling the conversion process. One, Easytran, is a program which uses an IBM 1400 Series symbolic card deck as input and produces a Honeywell assembly-language deck as output. The output deck includes the comments written in the original program and has been converted, as far as possible, into a working program deck that simply requires reassembly. The conversion will rarely be complete, and a desk check is always required. This process will take an average of roughly one man-day per program. After the desk check, the corrected Honeywell assembly deck can be assembled by the Easycoder assembly program and run as usual. The IBM program deck can now be discarded.

In the second conversion method, Bridge, the input consists of the IBM 1401 machine-code deck for a program. The output, the Bridge program deck, is executed in a partially interpretive mode. This program deck is loaded into the Series 200 processor when needed and operated as it would have been operated on the original system. In this case, the IBM program deck continues to be the effective source program deck to which alterations will be made, so it should never be discarded.

Bridge-converted programs do not normally operate as efficiently as Easytran-converted programs. Also, program patches to Bridge-converter programs must be made in machine language, whereas the Easytran conversion technique permits patching after translation in Honeywell's Easycoder assembly language. For these reasons, Honeywell currently emphasizes the use of the Easytran assembly-language-to-assembly-language translation technique when converting IBM 1400 Series programs.

Both Bridge and Easytran have been operational, with considerable success, since 1964. Detailed information on the Bridge and Easytran routines is presented in Sections 510:181 and 510:183, respectively. From the point of view of a user considering the overall problem of conversion to a Honeywell system, both methods are useful tools, but neither represents a complete, automatic solution.

.2 CONVERSION OF DATA

.21 Punched Card Data

Punched card data is handled and interpreted in essentially the same way in Series 200 systems as in IBM 1400 Series systems. An exception may occur where a non-standard character which was rejected or otherwise specially treated by the IBM system may not be rejected by the Honeywell system. This can happen because the Honeywell card readers regard as valid characters all of the 256 punch combinations recently defined by the ASCII code — and some of these combinations were regarded as mispunches in 1400 Series systems.

.22 Magnetic Tape Files

Both the Honeywell Series 200 and IBM 1400 Series systems use identical 1/2-inch magnetic tape on reels which can be used on either manufacturer's magnetic tape units. Use of the IBM format on the magnetic tape (which is necessary unless the whole magnetic tape archives are to be converted) requires a special compatibility feature on each Honeywell tape control unit. Where it is practical to convert to the Honeywell tape format, this can be done by copying all the user's magnetic tape files from one tape unit to another tape unit on a system which has two tape control units, one of which is equipped with the special feature.

.23 Paper Tape Files

No change in the form of the data on punched tape is normally needed.

.24 Collating Sequences

The collating sequences of the IBM 1400 Series and the Honeywell Series 200 are different. (IBM puts Blank lowest, followed by the special characters, then the alphabetics, and then the numerics; Honeywell leads off with the numerics, followed by Blank and the alphabetics, interspersed with special characters.)

Users converting to a Honeywell system can retain their present collating sequence and use either a software routine or a special-purpose Foreign Compare option to make the comparison, or they can resort all their files into Honeywell order and subsequently use the Honeywell collating sequence. In the latter case, where blanks, special characters, or mixed alphanumeric characters appear in a key, reports produced on the two systems will be in a different internal order. Often this will not be important, but in some cases it may lead to erroneous use of two parallel reports when they are being compared by hand.

.3 CONVERSION OF PROGRAMS

.31 Machine-Language Programs

Conversion of machine-language programs can be accomplished in most cases where equivalent peripheral units and an additional 4,096 positions of core storage are available on the target computer. The conversion program, Bridge, runs on the Honeywell Series 200 system and produces an input card deck for the 200 system from the input card deck for the IBM system. For details of the Bridge routine, see Section 510:181.

.32 Assembly-Language Programs

Conversion of Autocoder or SPS assembly-language programs written for IBM 1401 or 1460 systems is handled by the Easytran program described in Section 510:183. This program can be run on a four- or five-tape IBM 1401 or Honeywell Series 200 system which has certain specific optional features. The Easytran program converts the IBM assembly input deck into an Easycoder deck and provides diagnostic assistance to allow certain possible ambiguities in the program to be quickly resolved by hand checking.

A different Easytran program is available to handle conversions from IBM 1410 systems to some Honeywell Series 200 systems in a similar manner. This program is also described in Section 510:183.

Honeywell has recently announced an IBM 1440 Easytran program, deliverable in mid-1967.

.33 Report Program Generator Programs

Input decks for the IBM Report Program Generators can also be used for the Honeywell Series 200 Report Program Generators. Some changes are needed, such as renaming the Sense Switches.

.34 Sorting Programs

The control cards which are used with the Honeywell Polyphase Sort are entirely different from those used with the various IBM sort routines. These cards must be changed by hand at the start of the conversion process, and the new control cards can then be used whenever necessary.

.35 COBOL Programs

The COBOL implementations for the IBM 1400 Series and the Honeywell Series 200 are generally not identical with respect to the facilities included. (See Sections 510:161 and 510:162 for a description of the Series 200 COBOL compilers.) In many cases a test compilation on the Honeywell system will quickly identify those areas of the source program, if any, which must be rephrased to allow compilation. One subsequent recompilation after a COBOL programmer has rephrased the source program should complete the conversion process.

.36 FORTRAN Programs

The FORTRAN implementations for the IBM and Honeywell systems are not identical with respect to the facilities included. (See Section 510:163 for a description of the Series 200 FORTRAN compilers.) However, a special program, SCREEN, will be available to assist in the conversion of IBM FORTRAN source programs.

.37 Application Packages

Application packages developed for IBM systems have been successfully converted for use on Honeywell Series 200 systems. No list is available of the packages that have been converted to date, but since these application packages are simply collections of conventional computer programs, such conversions can be performed by the user himself with the aid of the Bridge or Easytran routine.

.4 CONVERSION OF PERSONNEL

The machine language of the Honeywell Series 200 computers is closely similar to that of the IBM 1400 Series. A few instructions have different assembly-language mnemonics, and the systems analyst must consider the effects of the increased simultaneity in the Series 200 systems, but the overall training and knowledge acquired by users of the IBM 1400 Series computers can be applied to the Honeywell Series 200 with a minimum of confusion and relatively little need for retraining.

A corollary of the close similarity between the IBM and Honeywell systems is that old documentation will continue to be useful even to novice programmers who have never actually written programs for the IBM computer itself.

.5 OPERATION OF CONVERTED PROGRAMS

.51 Operation of Individual Programs

A converted program requires the same general operating procedures on the Honeywell system as on the IBM system, but in some cases different display lights will occur upon program halts. Hand patching can be used in some cases to retain the original displays. Two sense switch settings are represented by internal memory locations, whose contents are set by control cards and read or changed by console operations and printouts.

.52 Utilization of Program Libraries

An installation requiring the use of a program library, either to hold programs prior to use or to assemble programs from program segments and routines held in the library, must prepare its own library facilities. Conversion of a previously-

(Contd.)

.52 Utilization of Program Libraries (Contd.)

operating library program may or may not prove practical, depending on the control methods used and on the amount of memory available for library purposes.

.53 Utilization of Operating Systems

Many IBM 1410 installations currently make use of a supervisory operating system. The Honeywell Operating System — Mod 2, described in Section 510:193, includes all of the facilities of the 1410 operating system and also permits use of the 1410's system control cards.

.54 Preparation of Operating Instructions and Program Documentation

Programs converted by Bridge continue to use the old IBM operating instructions and program documentation, with amendments to cover the different displays, the internal representation of sense switches, and the different printer control tape.

Programs converted by Easytran use the side-by-side Easytran listing of the two assembly decks as part of the program documentation. Remarks from the original IBM deck are carried forward on the Honeywell assembly deck. New operating instructions for the converted program must be prepared by hand.

.6 SPECIAL TECHNIQUES

.61 Stacker Select Instructions

The Honeywell Series 200 instruction set includes Stacker Select instructions; however, in order to obtain maximum overlapping of peripheral units and central processor operation, the peripheral operations (such as card reading) proceed asynchronously. As a result, it is not possible to use the Stacker Select instructions to sort out individual cards in cases where the selection criteria are established during the processing of data read from the card.

At present, there is no easy way around this limitation. In many cases, it is necessary to redesign the process to avoid the problem. One commonly-used method is to write card images of the cards which would have been selected out on a magnetic tape, read them back after the run, punch them out, and use the punched cards to control a collate run.

.62 Binary Addressing

The Honeywell Series 200 systems use binary addressing, while all IBM 1400 Series systems use decimal addressing. Any address usage which assumes that the address is in decimal form can therefore lead to problems. In most cases the equivalent binary form can be substituted, and this is done by the conversion programs. Where necessary, both decimal and binary forms of the address are maintained separately. In a few cases, such as dynamic address modification by a variable, special analysis of the programmer's intent must be made and special programming patches must be inserted as necessary.

.63 Machine Operation Codes

The binary representation of specific operation codes differs between the two systems. Where a machine operation code has been arithmetically modified, specialized patching is needed.

.7 OPERATIONAL EFFICIENCY

The Honeywell Series 200 processors feature powerful, flexible facilities for simultaneous operations. In addition, their internal speeds are higher than those of the older IBM 1400 Series systems. Table I shows the approximate internal speed ratios, in typical business applications, of the central processors in the Honeywell and IBM lines.

TABLE I: APPROXIMATE CENTRAL PROCESSOR SPEED RATIOS

New Computer \ Original Computer	IBM 1401	IBM 1410	IBM 1440	IBM 1460
Honeywell 120	4:1	2:1	4:1	2:1
Honeywell 200	5:1	2.5:1	5:1	2.5:1
Honeywell 1200	8:1	4:1	8:1	4:1
Honeywell 2200	10:1	5:1	10:1	5:1
Honeywell 4200	50:1	25:1	50:1	25:1

Effective operational efficiency of the converted programs can be measured both by contrasting the old performance with the new performance (in terms of throughput), and by comparing the new performance with the maximum potential performance of the new computer system. The results of both of these comparisons are valid and informative, and both are included in the tables that follow. These tables summarize the estimated average performance on the Series 200 systems of typical 1400 Series business data processing programs converted by means of both Easytran (Table II) and Bridge (Table III). The performance of individual programs may vary widely from the indicated average figures.

.8 LIMITATIONS

The Honeywell Series 200 processors cannot currently handle IBM 1400 Series computer programs that use:

- RPQ (non-standard) features or peripheral devices.
- Other IBM peripheral devices for which there are no Honeywell equivalents.
- Stacker Select instructions.

Programs that use any of these 1400 Series facilities will need to be redesigned to eliminate the resulting incompatibilities.

.9 CASE HISTORY OF A BRIDGE-CONVERTED 1401 PROGRAM

An estimate of the performance of a specific, Bridge-converted IBM 1401 program run on a

.9 CASE HISTORY OF A BRIDGE-CONVERTED 1401 PROGRAM (Contd.)

Honeywell 200 System is shown in Figure 1 and Table IV. The 1401 program used is our Generized File Processing Program (Problem A) for Standard Configuration III. See pages 4:200.110 (Users' Guide) and 401:201.001 (IBM 1401 report) for a detailed description of this program. The Bridge-converted program is assumed to be run on Standard Configuration III of a Honeywell 200 system (see page 512:031.300). Two cases were considered: (1) use of the basic Bridge routine, and (2) use of Bridge with the optional double-buffered tape subroutine. The estimated total processing times required for the original IBM 1401 program, as well as for the two Bridge-converted programs run on the Honeywell 200, are shown in Figure 1. Table IV summarizes the important timing elements for all three cases, in our standard System Performance Worksheet format.

The execution times for the converted programs were estimated by dividing the central processor times for the 1401 program by a factor of 2.5. This factor was derived by downgrading the five-fold central processor speed advantage of the Honeywell 200 (from Table I) by the estimated 50 per cent processor utilization efficiency of Bridge-converted 1401 programs run on the Honeywell 200. The time required to transfer data to Bridge input-output areas was added to these figures. At high and moderate activities, the Bridge-converted programs performed about 20 to 30% better than the 1401 programs because of the Honeywell 200's superior capabilities for input-output simultaneity. At lower activities (zero to 0.1), both the 1401 program and the Bridge-converted program with single buffering are processor-limited.

The Bridge-converted program with double buffering is tape-limited at these lower activities. Performance is about 50 to 55% better than the original 1401 program because of the read-write-compute overlap capabilities of the Honeywell 200. The core storage requirements for this version of the Bridge-converted program appear to be slightly greater than the 16K memory available in Standard Configuration III.

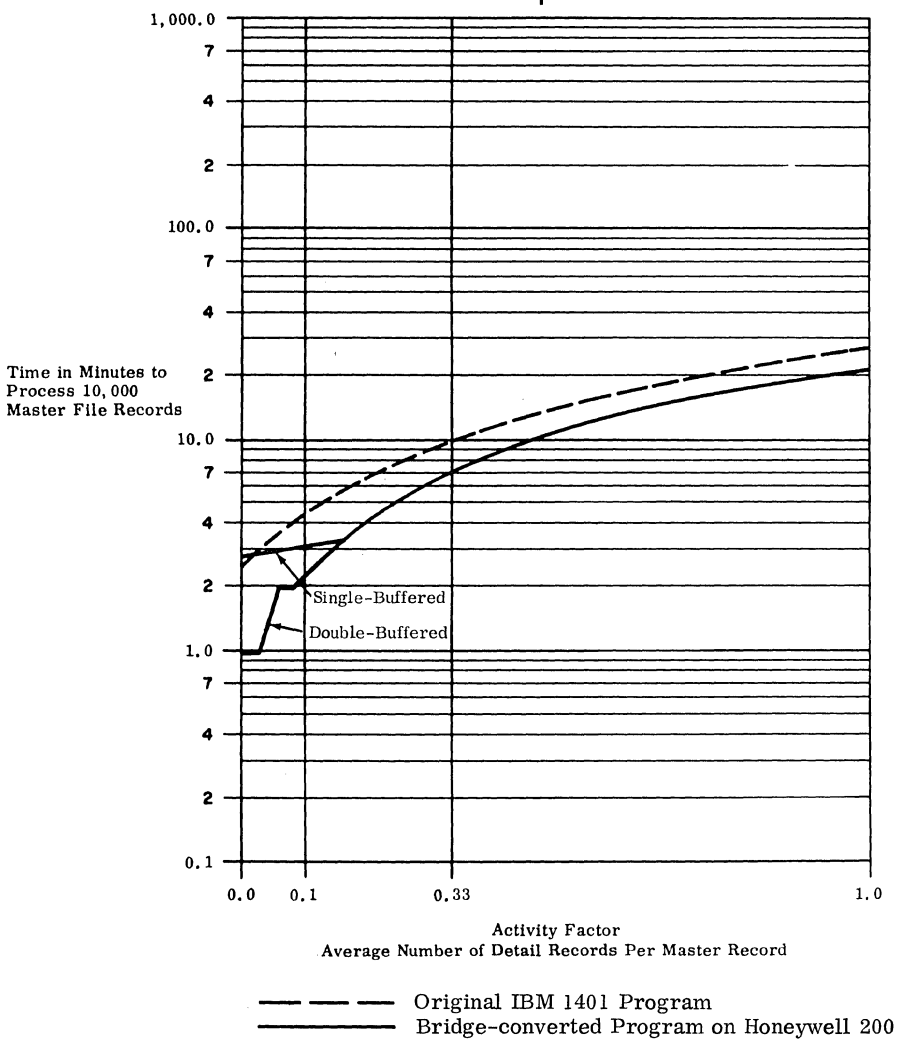


Figure 1: Estimated Performance on Standard File Problem A

(Contd.)

TABLE II: OPERATIONAL EFFICIENCY OF EASYTRAN-CONVERTED PROGRAMS

New Computer \ Original Computer		IBM 1401	IBM 1410	IBM 1460
Honeywell 120	When available:	Now	Not Possible	Now
	Performance compared with original system:	?		?
	Efficiency in using new system:	?		?
	Reserved hardware;	4K chars.		4K chars.
	Reserved hardware cost:	$250/mo.		$250/mo.
Honeywell 200	When available:	Now	Not Possible	Now
	Performance compared with original system:	60% average improvement		25% average improvement
	Efficiency in using new system:	About 80%	About 90%	About 80%
	Reserved hardware:	4K chars.		4K chars.
	Reserved hardware cost:	$250/mo.		$250/mo.
Honeywell 1200	When available:	Now	1966	Now
	Performance compared with original system:	60% average improvement	25% average improvement	25% average improvement
	Efficiency in using new system:	About 70%	About 90%	About 70%
	Reserved hardware:	4K chars.	2K chars.	4K chars.
	Reserved hardware cost:	$400/mo. **	None.	$400/mo. **
Honeywell 2200	When available:	Now	1966	Now
	Performance compared with original system:	60% average improvement	25% average improvement	25% average improvement
	Efficiency in using new system:	About 65%*	About 90%	About 65%*
	Reserved hardware:	4K chars.	2K chars.	4K chars.
	Reserved hardware cost:	$800/mo. ***	None.	$800/mo. ***
Honeywell 4200	When available:	1966	1966	1966
	Performance compared with original system:	60% average improvement	?	25% average improvement
	Efficiency in using new system:	About 55%*	?	About 55%*
	Reserved hardware:	4K chars.	4K chars.	4K chars.
	Reserved hardware cost:	$1000/mo****	None.	$1000/mo. ****
Basic Limitations		Stacker Select not usable in same way. Some I/O devices not handled. Must have assembly-level program.	Stacker Select not usable in same way. Some I/O devices not handled. Must have assembly-level program.	Stacker Select not usable in same way. Some I/O devices not handled. Must have assembly-level program.

* Could be greatly improved in an effective multiprogramming operation.
** Price quoted for an additional 8K module, the smallest additional size available.
*** Price quoted for an additional 16K module, the smallest additional size available.
**** Price quoted for an additional 32K module, the smallest additional size available.

TABLE III: OPERATIONAL EFFICIENCY OF BRIDGE-CONVERTED PROGRAMS

New Computer \ Original Computer		IBM 1401	IBM 1410	IBM 1460
Honeywell 120	When available: Performance compared with original system: Efficiency in using new system: Reserved hardware: Reserved hardware cost:	Now about equal about 80% 4K chars. $250/mo.	Not Available	Now ? ? 4K chars. $250/mo.
Honeywell 200	When available: Performance compared with original system: Efficiency in using new system: Reserved hardware: Reserved hardware cost:	Now 50% average improvement about 70% 4K chars. $250/mo.	Not Available	Now 20% average improvement about 70% 4K chars. $250/mo.
Honeywell 1200	When available: Performance compared with original system: Efficiency in using new system: Reserved hardware: Reserved hardware cost:	Now 50% average improvement about 65% 4K chars. $400/mo. *	Not Available	Now 20% average improvement about 65% 4K chars. $400/mo. *
Honeywell 2200	When available: Performance compared with original system: Efficiency in using new system: Reserved hardware: Reserved hardware cost:	BRIDGE IS NOT USED WITH MODEL 2200		
Honeywell 4200	When available: Performance compared with original system: Efficiency in using new system: Reserved hardware: Reserved hardware cost:	BRIDGE IS NOT USED WITH MODEL 4200		
Basic Limitations		Stacker Select not usable in same way. Some I/O devices not handled.	No Bridge routine is available for IBM 1410 programs.	Stacker Select not usable in same way. Some I/O devices not handled.

* Price quoted for an additional 8K module, the smallest size available.

(Contd.)

TABLE IV: TIMING PARAMETERS FOR STANDARD FILE PROBLEM A ‡

	ITEM		CONFIGURATION III						REFERENCE
			IBM 1401		Honeywell 200 (Single Buffered)		Honeywell 200 (Double Buffered)		
1 Input-Output Times	Char/block	(File 1)	1,080		1,080		1,080		4:200.112
	Records/block	K (File 1)	10		10		10		
	msec/block	File 1 = File 2	38.6		58.5		58.5		
		File 3	75		75		75		
		File 4	120		129		129		
	msec/switch	File 1 = File 2	0		0		0		
		File 3	0		0		0		
		File 4	0		0		0		
	msec penalty	File 1 = File 2	29.9/26.0		58.5		2.2		
		File 3	12		0.2		0.2		
		File 4	84		12.1		12.1		
2 Central Processor Times	msec/block	a_1	2.1		9.5		9.5		4:200.1132
	msec/record	a_2	8.3		3.3		3.3		
	msec/detail	b6							
	msec/work	b5 + b9	21.1		9.3		9.3		
	msec/report	b7 + b8							
3 Standard File Problem A F = 1.0	msec/block for C.P. and dominant column.		C.P.	I/O	C.P.	I/O	C.P.	I/O	4:200.114
		a_1	2.1		9.5		9.5		
		a_2 K	83.0		33.2		33.2		
		a_3 K	211.0		93.2		93.2		
		File 1: Master In	29.9	38.6	58.5		2.2		
		File 2: Master Out	26.0	38.6	58.5		2.2		
		File 3: Details	120.0		1.6		1.6		
		File 4: Reports	840.0	1,500.0*	121.0	1,290.0	121.0	1,290.0	
		Total	1,312.0	1,577.2	375.5	1,290.0	262.9	1,290.0	
4 Standard File Problem A Space	Unit of Measure	(characters)							4:200.1151
		Std. routines	3,150		1401 Prog.: 9,181		1401 Prog.: 9,181		
		Fixed	9		Bridge: 4,096		Bridge: 4,096		
		3 (Blocks 1 to 23)	654				Double		
		6 (Blocks 24 to 48)	2,676				buffering: 3,598		
		Files	2,584						
		Working	108						
		Total	9,181		13,277		16,875**		

‡ The Standard File Problem A programs timed in this table for the Honeywell Model 200 system are assumed to have been translated from an original IBM 1401 machine language deck via the Honeywell Bridge translator.

* Total time for Files 3 and 4, using combination "read and print" instruction.

** Exceeds amount of core storage available in Configuration III.

DATA CODE TABLE

Key Punch	Card Code	Central Processor Code	Octal	High Speed Printer	Key Punch	Card Code	Central Processor Code	Octal	High Speed Printer
0	0	000000	00	0	$\bar{0}$ or -	X, 0 or X(1)	100000	40	-
1	1	000001	01	1	J	X, 1	100001	41	J
2	2	000010	02	2	K	X, 2	100010	42	K
3	3	000011	03	3	L	X, 3	100011	43	L
4	4	000100	04	4	M	X, 4	100100	44	M
5	5	000101	05	5	N	X, 5	100101	45	N
6	6	000110	06	6	O	X, 6	100110	46	O
7	7	000111	07	7	P	X, 7	100111	47	P
8	8	001000	10	8	Q	X, 8	101000	50	Q
9	9	001001	11	9	R	X, 9	101001	51	R
	8, 2	001010	12	'		X, 8, 2	101010	52	#
#	8, 3	001011	13	=	$	X, 8, 3	101011	53	$
@	8, 4	001100	14	:	*	X, 8, 4	101100	54	*
Space	Blank	001101	15	Blank		X, 8, 5	101101	55	"
	8, 6	001110	16	> (2)		X, 8, 6	101110	56	≠ (2)
	8, 7	001111	17	&	- or $\bar{0}$	X or X, 0(1)	101111	57	1/2 or ! (2)
& over 0 or &	R, 0 or R(1)	010000	20	+		8, 5*	110000	60	< (2)
A	R, 1	010001	21	A	/	0, 1	110001	61	/
B	R, 2	010010	22	B	S	0, 2	110010	62	S
C	R, 3	010011	23	C	T	0, 3	110011	63	T
D	R, 4	010100	24	D	U	0, 4	110100	64	U
E	R, 5	010101	25	E	V	0, 5	110101	65	V
F	R, 6	010110	26	F	W	0, 6	110110	66	W
G	R, 7	010111	27	G	X	0, 7	110111	67	X
H	R, 8	011000	30	H	Y	0, 8	111000	70	Y
I	R, 9	011001	31	I	Z	0, 9	111001	71	Z
	R, 8, 2	011010	32	;		0, 8, 2	111010	72	@
.	R, 8, 3	011011	33	.	,	0, 8, 3	111011	73	,
□	R, 8, 4	011100	34	)	%	0, 8, 4	111100	74	(
	R, 8, 5	011101	35	%		0, 8, 5	111101	75	C_R
	R, 8, 6	011110	36	■		0, 8, 6	111110	76	□ (2)
& or & over 0	R or R, 0(1)	011111	37	? (2)		0, 8, 7	111111	77	¢ (2)

(1) Special Code. This card code-central processor code equivalency is effective when control character 26 is coded in a card read or punch PCB instruction.

(2) Indicates symbol which will be printed by a printer which has a 63-character drum (Types 122 and 222 printers).

Reproduced from Honeywell 120 Programmers' Reference Manual, 2nd Edition, page B-6.

PROBLEM ORIENTED FACILITIES: BASIC PROGRAMMING SYSTEM

Software support for the Honeywell Series 200 is grouped into several general categories based on the amount of core storage within which the programs will operate. The utilities covered in this section operate within the Honeywell Series 200 Basic Programming System's 4K-to 12K-character design level. The Advanced Programming feature and edit instructions are generally required for use of these utilities.

.1 UTILITY ROUTINES

The utility programs of the Basic Programming System fall into two sub-categories:

- A: Programs with an A designation are written in the two-character addressing mode for use in processors having 4,096 characters of core storage. The facilities included in the A design level are generally a subset of those found in the B design level.
- B: Programs with a B designation are written in the three-character addressing mode for use in processors having 8,192 to 12,288 characters of core storage. The facilities included in utility routines of the B design level are similar to those found in the larger Honeywell Operating Systems although more operator intervention is required with the Basic Programming System utilities. (See Section 510:152 for a description of the utility programs that function under control of the Operating System—Mod 1.

Minimum peripheral equipment requirements for use of the Honeywell Series 200 Basic Programming System include a card reader, a card punch, and a printer. Exceptions to this general minimum requirement are noted in the descriptions of the individual programs.

.11 Simulators of Other Computers

Bridge Object Program Translator B

This translator accepts IBM 1401 machine-language programs, and converts them into equivalent Honeywell Series 200 machine-language object programs. See Section 510:181 for a detailed description of Bridge 1401.

Easytran 1401 and Easytran Symbolic Translator B

These Easytran programs convert IBM 1401 and 1460 assembly language programs to Honeywell Series 200 Easycoder assembly language programs. This technique allows not only the conversion of programs, but also the integration of programs with Honeywell software. Standardized documentation is also provided. Easytran contrasts with the Bridge conversion technique in which conversion takes place at machine-code level. See Section 510:183 for a detailed description of the several Easytran translators.

.13 Data Sorting and Merging

Honeywell Series 200 SORT A, B, and C

The basic characteristics of each of these programs are shown in Table I. They differ in the amount of memory and the number and types of tape units they can utilize. SORT A uses the minimum 4K-character memory and either 3 or 4 tape units of any type. Both SORT C and SORT C-V can use anywhere from 8K to 64K characters of core storage and up to 8 tape units. Only one-half-inch (204B Series) tape units can be used by SORT C and SORT C-V. Variable-length records can be handled only by SORT C-V.

In all cases, own-code insertions are allowed in the pre-sort and last-pass phases, so that records can be added, deleted, or modified during the sort process.

SORT B can utilize from 8K to 32K characters of core storage and up to four magnetic tape units. All records must be of fixed length and have a minimum length of 80 characters. Own-code insertions are not permitted.

Drum SORT C is a key sort for use when the records are stored on a magnetic drum device. The keys are sorted into order and stored back on the drum with the addresses of the associated records. Only the keys and their addresses are involved in this operation, so the size of the actual records does not significantly influence timing requirements.

.14 Report Writing

Tabulating Simulator A and B (TABSIM)

Reference: . . . . Honeywell Software Manual 168.
Date available: . . . . . July 1964.
Description:

TABSIM is a "load and go" program designed to simulate the summarizing and report-writing functions of punched card tabulating equipment. The TABSIM coding specifications are designed to be compatible with FARGO, the roughly equivalent IBM 1401 report program generator.

TABSIM A accepts input from punched cards or magnetic tape. The output options include printing, punching, or a combination of both operations.

The reports produced by TABSIM A can be one of three types: listings, "group-printed" reports, or "group-indicated" reports. A group-printed report provides a group total rather than a listing of each entry within the group. A group-indicated report lists each entry but omits repetitive information within a group. Up to four levels of totals can be provided, in addition to a final total.

Standard arithmetic operations can be performed upon the data fields. Multiplication and division operations are performed by subroutines included in the TABSIM program. Own-coding entries can be made only at the machine-language level.

TABLE I: CHARACTERISTICS OF SORTING ROUTINES

SORT NAME	SORT A	SORT B	SORT C	SORT C-V	DRUM SORT C
Record Sizes (characters)	1 to 800	80 or 160	1 to 4,095	1 to 4,095	4,000 max.
Record Type (fixed or variable)	fixed size	fixed size	fixed size	variable	any
Key Size (characters)	1 to 693	1 to 80	1 to 990	1 to 990	1 to 990
Max. Number of Keys	7	8	10	10	10
Max. File Size	1 full reel	1 full reel	1 full reel	1 full reel	—
Equipment Requirements:					
Core Storage	4K	8 to 32K	8 to 32K	8 to 32K	8 to 32K
Magnetic Tape Units	3 or 4	3 or 4	3 to 8	3 to 8	none
Card Reader/Punch	Yes	Yes	No	No	No
Printer	No	No	No	No	No
Sorting Method	forward polyphase	backward polyphase	backward polyphase	backward polyphase	variable-way merge
Date Available	July 1964	January 1966	October 1964	January 1965	July 1965

.14 Report Writing (Contd.)

TABSIM B provides all of the TABSIM A functions and offers in addition:

- Signed arithmetic operations
- Sterling currency conversion routines
- Option to load the TABSIM B program from magnetic tape.

Report Generator A and B

Reference: . . . . . Honeywell Software Manual 080.
Date available: . . . July 1964.
Description:

The Honeywell Series 200 Report Generators are compatible with the IBM 1401 RPG. Report Generator A permits single-buffered card punch and printer operations. In Report Generator B, printer operations can be double-buffered for efficiency of printed report generation. Punched card operations which do not use the stacker-select feature are also double-buffered. The two versions of the Honeywell Report Generator vary only in these methods of output device operation.

There are four major steps in a Series 200 Report Generator operation:

- Describing the report and specifying the format the output will take.
- Generating the symbolic program.
- Assembling the symbolic program.
- Executing the assembled program to produce the desired report.

The facilities of these Report Generators include: detecting control breaks within control groups; arithmetic operations with optional rounding or truncation of results; exiting to user-supplied own-coding for table lookup operations; and optionally substituting magnetic tape units for both card reader and printer.

.15 Data Transcription

Simultaneous Media Conversion A (SCOPE)

Reference: . . . . . . Honeywell Software Manual 021.
Date available: . . . July 1964.
Description:

Simultaneous Media Conversion A consists of a group of independent subroutines to control the automatic transfer of data between magnetic tape and punched card or paper tape devices, and from magnetic tape units to printers. Up to three of these independent input-output conversion operations can be performed simultaneously within the minimum allowable environment of 4,096 characters of core storage. Records on magnetic tape can be handled only if they are unblocked and of fixed length. However, if at least 12K characters of core storage are available, specialized data editing and blocking and unblocking operations can be performed during the data transcription operation by means of own-coding routines.

Honeywell supplies a SCOPE program deck tailored to individual equipment configurations. The user then assembles this deck to integrate all desired peripheral device routines. The output of the assembly is called a custom-designed "version" of SCOPE.

The media conversion operations that can be performed in installations that use 3/4-inch (Type 204-A) magnetic tape units simulate operations typically performed by H-800/1800 off-line systems. This simulation includes the performing of data conversion operations necessary to produce 14-word (alphanumeric mode) or 24-word (transcription mode) card-image output records when transcribing data from 3/4-inch Honeywell magnetic tape.

(Contd.)

.15 Data Transcription (Contd.)

LINK (Peripheral Processor Control Package)

Reference: . . . . Honeywell Information Bulletin DSI-257.
Date available: . . . . July 1964.
Description:

This package is designed for users of large-scale Honeywell 800 or 1800 systems who wish to use a Honeywell 200 as an on-line satellite. The LINK package operates within 4,096 character positions of Series 200 core storage and can do both on-line and off-line jobs. Any three of the following functions can be performed simultaneously:

- On-line operations—
  Card reading;
  Card punching;
  Paper tape reading;
  Paper tape punching;
  Printing;
  Magnetic tape reading (maximum record size using minimum 4K-character system: 24 H-800 words);
  Magnetic tape writing (maximum record size using minimum 4K-character system: 24 H-800 words).
- Off-line operations, independent of the Honeywell 800 or 1800 —
  Punched cards or paper tape to magnetic tape; Magnetic tape to punched cards, paper tape, or printer.

The LINK package will accept standard H-800/1800 peripheral instructions through the Model 212 On-Line Adapter, so existing H-800/1800 programs will, in most cases, operate with the on-line H-200 as they would with standard H-800/1800 peripheral devices.

.16 File Maintenance

1/2-Inch Tape Handling Routine A (THOR)

Reference: . . . . Honeywell Software Bulletin DSI-367.
Date available: . . . . . May 1964.
Description:

The Series 200 1/2-Inch Tape Handling Routine A (formerly called THOR) is a set of generalized tape-handling and correction routines designed for use with Type 204-B 1/2-inch magnetic tape files on any Series 200 system that has at least 4,096 characters of core storage, a printer, one or two magnetic tape units, and a punched card or paper tape reader.

The principal file maintenance functions performed by these routines are the following:

- Edit — to dump to a printer specified records or portions of records.
- Copy — to duplicate all or specified records of one tape file on another file.
- Correct and Copy — to update designated records with specified changes.
- Compare and Print — to match, record for record, two tape files or portions of files, and to print those records that are not identical.
- Locate — to search tape files for specified records.
- Write Label — to prepare a new tape file for processing by creating a dummy label containing the physical tape reel serial number.

These operations and others are performed under the direction of parameters that are entered by the operator from either punched cards, paper tape, or the control panel of the central processor.

.17 Others

1/2-Inch Tape I/O A and B (TIPTOP-1 and 1A)

Reference: . . . . Honeywell Software Manuals 293 and 016.
Date available: . . . . March 1965.
Description:

These two levels of Tape Input-Output macro routine packages relieve the programmer of repetitive and complex coding of I/O routines. The packages are provided in source language form for incorporation into the user's program during a preassembly program pass. Descriptions of the two offerings follow.

- 1/2-Inch Tape I/O A: This version reads and writes 1/2-inch tape files, blocks and unblocks fixed-length items within records, opens and closes files, detects error conditions, and automatically corrects them when possible, using either IBM or Honeywell magnetic tape conventions. The A version uses approximately 1,640 characters of core storage.
- 1/2-Inch Tape I/O B: This version performs the same functions as Tape I/O A and provides additional capabilities for handling both fixed and variable-length records. Another extension, the "move mode" of the GET and PUT Macros, moves items between buffer and processing areas. The alternative "locate mode" (used in both A and B versions) provides the user's program with the starting address location of the record currently being processed. The B version of the TAPE I/O package uses approximately 2,250 characters of core storage.

EASYTAB

Reference: . . . . Honeywell Software Manual 206.
Date available: . . . . June 1966.
Description:

EASYTAB provides a means for users of conventional tabulating equipment to make the transition to computer equipment with minimal reorientation of personnel and modifications of existing operating procedures. In the description below, the name of each of seven routines is followed by the name and function of the punched card tabulating device that it replaces.

- Merge B (Collator) — combines two ordered files in either ascending or descending sequence into one ordered file. Four principal kinds of file merging can be specified: only matched items in the two files are merged into an output file; or all items in the two files are merged; or matched items are merged and non-matched items in the primary file are punched or printed; or

.17 Others (Contd.)

matched items are merged and non-matched items in the secondary file are punched or printed. Up to five merge keys per record can be specified. Either the primary or the secondary input file can be on cards; alternatively both files can be on magnetic tape.

- Sort B (Sorter) — sorts a full reel of 80-character records on a maximum of eight sort keys, using the backward merging polyphase technique. The input file can be on either cards or magnetic tape.
- Select B (Collator) — selects items from an input file either by item count (every Nth item), by location in the group (first or last item in each group), or by test. In selection by test, each of one, two, or three input-item fields is compared with a corresponding parameter card constant using high-low-equal tests. Logical tests (AND or OR) can also be specified.
- Reproduce B (Reproducer) — provides any or all of the following functions: reproduces each 80-character record with the option of dropping and/or offsetting specified fields; reproduces each 80-character record while transferring information from a parameter card to specified fields within the record; or numbers each card sequentially or by a specified increment.
- Total B (Tabulator) — produces printed reports, and offers the following capabilities: the Total B mechanism accumulates and prints a maximum of seven totaled amount fields under control of a minimum of four control-break keys. The list function of Total B produces a detail line for each item processed and a total line containing totals for all items within each specified control group. The tabulating function of Total B produces a total line containing an accumulation of all items within each specified control group.
- Alter B (Manual Operation) — deletes inserts or replaces items on an ordered primary file depending on the contents of a director deck.
- Peripheral I/O B (No Tabulating Device Equivalent) — performs media conversions separately or in limited combinations between the following media: card to tape, tape to card, tape to printer, or tape to printer with simultaneous card to tape or tape to card.

Card images on magnetic tape are generally blocked two records per block. Minimum equipment requirements for Easytab include three 204B magnetic tape units and 8,192 positions of core storage. Extensions to the listed functions can be added by the user in the COBOL B language (see Section 510:061 for a description of COBOL B).

H-200 Card Loader

The H-200 Single Instruction Card Loader contains routines to clear core storage to specific characters (including zeros and blanks within specified limits), to load core storage with instructions and constants, and to set "inherent" and specially-requested punctuation bits. Facilities are also included to branch to the user's coding and initiate execution of the object program upon partial or total completion of loading.

The routines to accomplish these functions are produced as part of the Easycoder assembly system output. A block of 80 consecutive core storage positions is specified by the programmer for the loader's use.

H-200 Memory Dump Routine

The H-200 Memory Dump Routine edits and prints the contents (both data and punctuation bits) of core storage between limits specified by the user. The output is in both alphameric and octal representation. There are two versions of this routine. One operates in the 2-character addressing mode and can dump the contents of up to 4,095 consecutive locations of core storage. The dump routine operating in 3-character mode can dump the contents of any area of core storage.

The dump routine is produced by the Easycoder assembly system as a separate card deck preceding the object program deck. The 2-character mode routine requires 392 core storage positions, card reader, and printer. The 3-character mode dump routine requires an additional 93 core storage positions.

Industry Applications (8K-character design level, using a minimum of three magnetic tape units)

General Distribution:

- SALE - a package developed to direct the even flow of merchandise from warehouse to retail store.
- CASH — an integrated system of accounting for the distribution industry that includes accounts receivable, accounts payable, and general ledger accounting.
- PROFIT — a system that provides inventory control through production of order strategies based on the concept of joint replenishment at minimum total cost.

Manufacturing:

Forecasting for Inventory Control System (FICS) makes demand forecast and inventory decisions. The components of the system provide forecasting information concerning economic order quantity, reorder point, safety stock, and exponential smoothing.

Education:

Pupil Registering and Operational Filing (PROF) incorporates grade recording, attendance accounting, testing, educational research, pupil assignment, and financial accounting. A valuable extension of PROF is the implementation of WORDCOM, an instructional programming language used in teaching students fundamental computing principles.

Banking:

Demand Deposit Accounting is offered as an integrated package. MICR entry check sorting, settlement accounting, clearing and collection, customer posting, exception procedures, and associated reports and statements are included. Equipment requirements include a Burroughs MICR Sorter-Reader.

(Contd.)

.17 Others (Contd.)

Industry Applications (12K-character design level, using a minimum of three magnetic tape units)

Finance:

Computerized portfolio analysis is provided. This package originated from a conversion of the IBM financial Analysis Package (FAP). (The use of a fourth magnetic tape unit greatly increases the capability of this system in terms of volume of data and overall performance.)

General:

MANAGE facilitates the planning and control of a new computer installation or new applications. Variables such as program length, program complexity, and programmer experience are entered to obtain an installation or application status report.

AUTOLOG

Reference: . . . . . Autolog Reference Manual, 209
Date available: . . now in use.
Description:

This package provides equipment usuage reports on a per-job and per-hardware-unit basis. The minimum equipment requirements for use of AUTOLOG include 4,096 characters of core storage, three 1/2-inch magnetic tape units, a card reader, and a printer.

PROBLEM ORIENTED FACILITIES: MOD 1/MOD 2 OPERATING SYSTEMS

.1 UTILITY ROUTINES

Software for the Honeywell Series 200 is grouped into categories based on minimum core storage requirements and the particular operating system under whose control the software elements function. The utilities covered in this section operate within either the 12K- to 65K-character design level of the Honeywell Series 200 Operating System — Mod 1, or the 49K-character design level of the Operating System — Mod 2. The Advanced Programming feature and the Edit instructions are generally required for both groups of programs.

Utility programs in Operating System — Mod 1 fall into two subcategories:

- C — Programs with a C designation have a minimum core storage requirement of 12,288 characters. The facilities included in utility routines of the C design level are similar to those found in the B design level of the Basic Programming System (see Section 510:151). Extensions and improvements of the C-level utilities in relation to B-level utilities are discussed in this report section. The basic features of each utility program are described in Section 510:151, as noted above. Table I lists the principal utility routines offered by Honeywell, with references to descriptive paragraphs within this and the previous report section.
- D — Programs with a D designation have a minimum core storage requirement of 16,384 characters and generally offer additional features beyond those provided in C-level programs.

The utilities that are available with the Operating System — Mod 2 provide few extensions to those offered for use with the Basic Programming System and the Operating System — Mod 1.

TABLE I: SERIES 200 UTILITY ROUTINES

CLASS OF SERVICE	UTILITY ROUTINE	REFERENCE
General Data Processing	Sort and Collate A	510:151. 13
	Sort and Collate B	510:151. 13
	Sort and Collate C	510:152. 13
	Sort and Collate C (V)	510:152. 13
	TABSIM A and B	510:151. 14
	Report Generator A and B	510:151. 14
	Simultaneous Media Conversion A and C	510:151. 15
	LINK	510:151. 15
	Tape I/O A, B, and C	510:151. 16
	TIPTOP II and III	510:152. 16
	Scientific and Mathematical Routines	510:152. 17
General Installation Maintenance	Autolog (equipment utilization reporting)	510:151. 17
	MANAGE (aid to control of new installations and applications)	510:151. 17
Library Maintenance	Program Library Processors	510:171. 100
IBM 1401 Simulation	BRIDGE	510:181
	Easytran	510:185
	Report Generator A and B	510:151. 14
	TIPTOP III	510:152. 16
Tabulating Equipment Simulation	TABSIM	510:151. 14
	EASYTAB	510:151. 17
Random Access Data Processing	Drum Sort C	510:152. 13
	DIAL (transcription routines between drum and cards or tape; includes additional utility functions)	510:152. 15
	DIPDOP (I/O package for Model 270 Drum Storage)	510:152. 16
Communications Systems	Message Switch, Input Interface, Real Time Input Analyzer, Output Stocking and Interface, Communications Line Status Director, and Standard Error Control Routines.	510:152. 17
Industry Applications	8K level	510:151. 17
	12K level	510:151. 17
	16K level or above	510:152. 17

.11 Simulators of Other Computers

Bridge 1401: . . . . Section 510:181.
Easytran for IBM 1401: Section 510:183.
Easytran for IBM 1410: Section 510:183.

.12 Simulation by Other Computers: . . . . none.

.13 Data Sorting and Merging

Tape Sort and Collate C, Tape Sort and Collate C (V), and Drum Sort C.

The basic characteristics of each of these programs are shown in Table II. Both Sort C and Sort C (V) can use from 8K to 64K characters of core storage and up to 6 magnetic tape units. Sort C and Sort C (V) programs can function only with Type 204B 1/2-inch magnetic tape units. Variable-length records can be handled only by the Sort C (V) program.

In all programs, own-coding insertions are allowed in the pre-sort and last-pass phases, so that records can be added, deleted, or modified during the sort process.

Drum Sort C is a key sort for use when records are stored on a random access device. The keys in a directory are sorted into order and stored back on the mass storage device with the addresses of the associated records. Only the keys and their addresses are involved in the sort operation, so the actual record size does not significantly influence timing considerations.

Simultaneous Sort and Print

Reference: . . . . Honeywell Software Manual 201.
Date available: . . . . . December 1965.
Description:

This modification to Tape Sort C allows concurrent sorting and printing operations, providing potential time savings of up to 30% over separate sort and print operations. The print program requires exclusive use of 942 memory positions, and also requires a 132-position printer and one 1/2-inch tape unit.

.14 Report Writing

The several Honeywell Series 200 Report Program Generators are described in Paragraph 510:151.14.

.15 Data Transcription

DIAL (Drum Interrogation, Alteration, and Loading System)

Reference: . . . . Honeywell Software Bulletin DSI-361.
Date available: . . . . . January 1965.
Description:

DIAL is a generalized drum handling and correction routine which can examine the contents of a drum and make corrections to a file. Utility routines to transfer data between drum and punched cards or magnetic tape (in either direction) are included. The routines in the DIAL package can be assembled individually with any Series 200 program. Easy-coder programs can make use of specified DIAL functions through macro instructions such as LOCATE, UNLOAD, RESTORE, EDIT, CORRECT, COMPARE, and CLEAR.

Other Honeywell Series 200 data transcription routines are described in Paragraph 510:151.15.

.16 File Maintenance

THOR (Tape Handling Option Routine)

Reference: . . . . Honeywell Software Bulletin DSI-367
Date available: . . . . . . July 1964.
Description:

THOR is a general tape handling and correction routine which can position tape, locate information on tape, copy one tape onto another, and make corrections to information on tape. It can also compare two tapes and edit information on a tape. The various actions are controlled by parameters introduced via the card reader or the operator control panel.

TABLE II: CHARACTERISTICS OF SORTING ROUTINES

SORT NAME	SORT C	SORT C (V)	DRUM SORT C
Record Sizes (characters)	1 to 4,095	1 to 4,095	4,000 max.
Record Type (fixed or variable)	fixed size	variable	any
Key Size (characters)	1 to 990	1 to 990	1 to 4,000
Max. Number of Keys	10	10	10
Max. File Size	1 full reel	1 full reel	—
Equipment Requirements:			
Core Storage	8 to 64K	8 to 64K	8 to 64K
Magnetic Tape Units	3 to 6	3 to 6	none
Card Reader/Punch	No	No	No
Printer	No	No	No
Sorting Method	backward polyphase	backward polyphase	variable-way merge
Date Available	October 1964	January 1965	July 1965

(Contd.)

.17 Others

Input-Output Routines

- TIPTOP II: This routine reads and writes 3/4-inch tape files, blocks and unblocks items within records, detects error conditions, and automatically corrects them when possible. Honeywell 400/1400 and 800/1800 tape files can be handled. The routine uses 1,800 characters, plus 500 characters for each input file and 600 characters for each output file. These are the space requirements at object time, i.e., when the program that uses the TIPTOP routines is being executed. MACRO, a control program, recognizes the TIPTOP II macro-instructions, selects the appropriate macro routines, specializes them, and inserts them into the Easycoder symbolic program for subsequent assembly. The MACRO program must be run before the assembly proceeds; it requires at least an 8K Honeywell 200 system with the Advanced Programming optional instructions.
- TIPTOP III: This version is a tape input-output control package which is functionally compatible with IBM 1401 IOCS. TIPTOP III consists of a series of routines that manage the input-output procedures for magnetic tape, punched card, and printer operations without requiring detailed coding. IBM tape conventions are maintained. TIPTOP III became available in October 1964. The ability to handle Honeywell tape conventions was added in June 1965.

Scientific Subroutines Package

A number of standard scientific subroutines are available for the Honeywell Series 200. Table III lists several of these routines together with their core storage requirements and typical execution times.

Linear Programming Package D

Reference: . . . . Honeywell Software Announcement 143.
Date available: . . . . . now in use.
Description:

This package is based on the simplex method of solving linear equations. The simplex algorithm is a constructive technique which, in addition to demonstrating the existence of feasible solutions to a linear programming problem, provides a practical means of obtaining an optimal solution on which the user can base required decisions.

Series 200 Linear Programming Package D is composed of a resident control program and a group of major programs called "agenda." The control program loads the agenda into memory as directed by agendum call cards. These call cards control the sequence of the agenda being executed.

Minimum equipment requirements for Linear Programming Package D include 16,384 characters of core storage, a card reader, card punch, printer, magnetic tape unit, and the Editing and Advanced Programming instructions.

Statistics Package D

Reference: . . . . Honeywell Software Bulletin 0.01.
Date available: . . . . . October 1965.
Description:

Statistics Package D is a set of five programs written in FORTRAN D that enable the user to perform various statistical analyses on numerical data. The number of variables permitted in most of these programs depends on the amount of memory available when running the object program. The user may change I/O, Dimensional, and Data statements to fit the particular requirements of his program. The five programs within the Statistics Package D are:

Chi-Square
Least Squares Curve Fitting
Mean Variance and Correlation
Step-Wise Multiple Regression Analysis
Random Number Generator.

Industry Applications

Insurance

- FACILE (Fire and Casualty Insurance Library Editions): This series of programs constitutes an integrated management information and control system for fire and casualty insurance companies. The major application areas covered by FACILE include: Premium determination for private passenger automobiles and pickup trucks; premium determination for homeowners' physical damage and liability insurance; claims processing to verify coverage and to produce claims face sheets; agents' production and experience records, including compilation of premium and loss information to produce incurred losses to earned premium ratios by agent; and internal and external statistical summaries.
- SOLO: organizes the required information for new policy issue; processes automatic internal changes including premium billing, loan interest, coupon/dividend funds and policy face amount changes, as well as external changes. External changes include the addition or deletion of benefits, inquiry into policy status, and loan payments or loan requests.

The minimum hardware configuration required for use of FACILE and SOLO includes 12,288 characters of core storage, four 204B magnetic tape units, one card reader, one card punch, and one printer. The Advanced Programming and Editing instructions are also required.

Printing and Publishing

- STET (Specialized Technique for Efficient Typesetting) is a package designed to justify and hyphenate hot metal type. The minimum hardware requirements include any Honeywell Series 200 processor, 16K characters of core storage, a paper tape reader, and a paper tape punch. Such a minimum system uses a strict orthographic logic method of hyphenation. The addition of a random access device to this equipment complement enhances hyphenation accuracy by combining the logic method with a dictionary lookup technique. Hyphenation accuracy of 99% is claimed with the combined technique, but no maximum frequency of hyphenation is stated.

TABLE III: TIME AND SPACE REQUIREMENTS OF REPRESENTATIVE SCIENTIFIC SUBROUTINES

FUNCTION	CORE STORAGE LOCATIONS USED	OPERAND LENGTH, characters	MODEL 200 (1) EXECUTION TIME, milliseconds
Fixed Point Multiply	540	5	2.6
		10	4.9
Fixed Point Multiply (2)	537	5	2.4
		10	4.5
Fixed Point Divide	639	5	2.7
		10	5.0
Fixed Point Divide (2)	681	5	2.1
		10	3.5
Floating Point			
Basic Package:	1144 + 6f (6)	—	—
Add/Subtract	(3)	10	1.44
Multiply	(3)	10	1.78
Divide	(3)	10	4.88
Compare (4)	364	10	0.34 to 1.16
Sine (4)	657	10	59.0
Cosine (4), (5)	140	10	61.0
Exponential (4)	482	10	93.0
Log (4)	751	10	74.0
Square Root (4)	521	10	99.0
Arctangent (4)	1,517	10	45.6
Conversion — Floating Decimal to Integer	456	10	1.14
Conversion — Integer to Floating Decimal	303	10	1.04
Matrix Inversion (4)	approx. 1,600	5 x 5 matrix	1,820
	approx. 3,400	10 x 10 matrix	16,200
	approx. 10,000	20 x 20 matrix	126,000

(1) Multiply indicated execution times by 1.50 for the Model 120, 0.75 for the Model 1200, and 0.50 for the Model 2200. When the Scientific Option is installed, the arithmetic subroutines will not be required, and execution times for any of the transcendental functions will be approximately 1.8 milliseconds on Model 1200 and 1.2 milliseconds on Model 2200.

(2) With Advanced Programming option.

(3) Included in storage requirement for Floating Point Basic Package.

(4) Floating Point Basic Package must be in core storage, and Advanced Programming option must be included in processor.

(5) Sine routine must also be in core storage.

(6) Where f = the length of the mantissa.

.17 Others (Contd.)

One of the more valuable extensions of STET in comparison to many competitive offerings is the inclusion of up to 99 preset tabular formats for ease in setting tabular material.

- PHOTO-SET is another package used for outputting justified and hyphenated material to photo-composition systems such as Harris-Intertype Fototronic, Mergenthaler Linofilm, and Photon 713. At least 24K characters of core storage are required to use PHOTO-SET.

General Distribution

- DISPATCH is a package of programs that provides the distribution manager with an assignment sheet advising him of order groupings for vehicle loads, total weight and/or volume of each group or orders, efficient distribution routes for the vehicles to follow, and departure and arrival times. The minimum hardware requirements for use of DISPATCH include 16K characters of core storage, four magnetic tape units, card reader, printer, and Advanced Programming and Editing instructions.

- CART is a program package that provides the trucking industry with an automatic system for computing freight rates. CART can utilize from 16K to 32K characters of core storage, plus magnetic tape units, card reader, card punch, random access storage, and a communications network.

Communication System General Routines

- Drum Storage and Retrieval Routine

  A generalized drum storage routine capable of allocating drum storage and storing and retrieving information from the drum on a real-time basis; will include both drum read/write and message queuing functions. At least 8K characters of core storage are required for use of this routine.

- Standard Error-Control Routines

  Required equipment: interrupt feature and Model 286 Communications Control Unit.

(Contd.)

.17 Others (Contd.)

A generalized standard error-control package designed to provide positive error-control action without causing the Central Processor or working real-time devices to be shut down. Provision will be made for the addition of user-coded specific error routines in conjunction with the standard package.

- Input Interface Routine

  Required equipment: Model 286 Communications Control Unit and interrupt feature.

  A modularized interrupt control routine to handle real-time input interrupts from several lines, capable of utilizing common memory as well as memory unique to a given input line.

- Real-Time Input Analyzer

  Required equipment: 12K characters of core storage.

  A routine capable of performing editing and "bookkeeping" functions, setting up data for drum buffering, and providing buffering requests.

- Output Stacking and Interface Routine

  Required equipment: Model 286 Communications Control Unit.

  A routine capable of retrieving data from drum storage, operating common-carrier equipment, and causing data to be transmitted from the H-200 to distant stations.

- Communications Line Status Director

  Required equipment: Model 286 Communications Control Unit.

  A polling routine capable of determining communication line availability and controlling the operation of these lines.

PROCESS ORIENTED LANGUAGE: COBOL B

.1 GENERAL

.11 Identity: . . . . COBOL B.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . Honeywell Software Bulletin 028.

.14 Description

Honeywell's COBOL B Compiler is designed to operate on a Series 200 system that has a minimum of 8,192 characters of core storage, two magnetic tape units, a card reader, a card punch, and a printer. COBOL B provides a restricted COBOL source language but offers a fast and efficient compiler. (Paragraph .142 lists the principal language restrictions of COBOL B in relation to Compact COBOL.) Therefore, COBOL B may prove somewhat constricting to the experienced programmer. However, it provides the new user with a language that is easy to learn and use. Two larger COBOL languages for use with the Honeywell Series 200 are described in the following report section (510:162).

This compiler is offered in three forms: as a stand-alone program, as a program integrated to run under Control of Operating System—Mod 1, or as an integral part of Easytab—the unit record equipment simulator described in Paragraph 510:151.17. Any desired additions to the routines provided by Easytab must be coded in the COBOL B language. Users of tabulating equipment who desire to move up to their first computer are thus offered use of a relatively easy-to-learn language and easy-to-use conversion package.

The Compact COBOL language standards used in the remainder of this section are those published in the American Standards Associations X3.4 COBOL Information Bulletin #5 in October 1964. However, Compact COBOL has not been officially adopted as an American standard to date.

.141 Availability

Language specifications: . . . . . October 1965.
Compiler: . . . . May 1966.

.142 Restrictions of Honeywell's COBOL B with Respect to ASA X3.4 CIB #5

(1) Any level number must be in the range 01 through 05, rather than 01 through 10 as specified by ASA.

(2) The MULTIPLE REEL clause of the FILE-CONTROL entry is not permitted, although multiple-reel files can be handled in less direct ways.

(3) The RECORDING MODE IS clause of the File Description entry is not included.

(4) The DATA RECORD IS clause is accepted by the compiler, but no compilation action takes place.

(5) The USAGE IS and SYNCHRONIZED clauses of the Record Description entry are not present.

(6) Only one level of OCCURS is allowed in the Record Description entry; the ASA standard requires two.

(7) The PICTURE IS clause of the Record Description entry is restricted to a string of characters without further options. BLANK WHEN ZERO is not implemented.

(8) The ADD and SUBTRACT verbs permit only two quantities to be added or subtracted.

(9) The DISPLAY verb does not provide an alternative output device to the on-line printer.

(10) The AFTER ADVANCING option is not provided with the WRITE verb.

.143 Extensions of Honeywell's COBOL B with Respect to ASA X3.4 CIB #5

(1) A SENSE-SWITCH ON or OFF STATUS clause is provided within the SPECIAL-NAME entry. Up to four sense switches can be specified.

(2) An APPLY DOUBLE-BUFFER ON clause is provided with the I-O CONTROL entry. This permits use of the simultaneous input-output operations capability of the Honeywell Series 200 systems.

(3) A Switch Status imperative statement is provided with the IF verb.

(4) A THRU Character option is provided with the MOVE verb.

PROCESS ORIENTED LANGUAGE: COBOL D AND H

.1 GENERAL

.11 Identity: . . . . COBOL D.
COBOL H.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . Honeywell Software Bulletin 065.

.14 Description

Two COBOL compilers are available for use with Honeywell's Tape Resident Operating System — Mod 1. The COBOL D and COBOL H languages differ in the number of language elements provided, in the addressing mode of the object code generated, and in the minimum core storage requirements for compilation.

COBOL D operates in a minimum environment of 16K characters of core storage and generates instructions in the three-character address mode at an average speed of 300 card images per minute. Because of the relatively small core storage design level, certain COBOL language deficiencies are present relative to the Department of Defense Required COBOL-61. These deficiencies are tabulated in Paragraph .142.

COBOL H operates in a minimum environment of 32K characters of core storage and generates instructions in the four-character address mode. Three-character addresses can also be generated if desired. COBOL H offers all of the features of Required COBOL-61 with the exception of three-level subscripting. COBOL H also provides certain features of COBOL-61 Extended, as well as several elective features. Paragraphs .142 through .145 compare the language facilities of Honeywell's COBOL D and H languages to the language facilities of COBOL-61.

The Extended facilities of COBOL-61 and new mass storage handling and table look-up facilities have been included within the latest official DOD COBOL language—COBOL-65. Honeywell is currently implementing the Sequential and Random Access with Sequential Processing statements of COBOL-65. However, the PROCESS statement used for Random Access with Random Processing, and the Hold statement used for Asynchronous Processing, are not included.

A number of COBOL-65 facilities are not provided in either version of Honeywell's current COBOL languages. These deficiencies, in addition to that mentioned in the paragraph above, include:

- No Report Writing Options.
- Only a basic implementation of the SORT feature.
- No multiple receiving field facilities in arithmetic statements.
- No Table Handling facilities with the indexing and search options.

In addition to the minimum core storage requirement already mentioned, both compilers require the use of four magnetic tape units, a card reader, a card punch, and an on-line printer. The compilers are designed to be expandable in modules and are self-adapting to core memories larger than their minimum requirements.

A Language Preprocessor is available to handle the entire range of COBOL language features that involve the use of duplicate user-created names. The Language Preprocessor will operate outside the main "compile loop" and will provide these additional facilities at the cost of an additional tape pass. The many users who require no duplicate names in their source programs can bypass this Preprocessor pass.

The following language features are handled by the Language Preprocessor:

Environment Division:

- All RENAMING clauses in the FILE-CONTROL paragraph.

Data Division:

- All non-library COPY statements.
- All duplicate data-names, whether caused by RENAMING, COPY, or normal use, which have been referred to in the PROCEDURE DIVISION.

Procedure Division:

- All duplicate paragraph-names, whether referred to or not.
- All use of qualification in references to data-names or procedure-names.
- All use of the CORRESPONDING options in MOVE, ADD, and SUBTRACT statements.

.141 Availability

Language: . . . . 1961.

Compiler—
COBOL D: . . . . basic compiler available now; compiler with option to use up to 6 tape units will be available in July 1966.
COBOL H: . . . . basic compiler available now; complete mass storage-oriented compiler in first quarter 1967.

.142 Deficiencies of Honeywell COBOL D with Respect to Required COBOL-61

Environment Division:

- The RENAMING option in the FILE-CONTROL paragraph, which is used if more than one file utilizes the same File Description, is omitted. (COBOL D will handle it if the Language Preprocessor is used.)

.142 Deficiencies of Honeywell COBOL D with Respect to Required COBOL-61 (Contd.)

Data Division:

- Level numbers may be in the range 01 to 49 and level 77. Up to ten levels may be used to describe a data item in a Record Description.
- Only 2 levels of subscripting are permitted.

Procedure Division:

- The DEPENDING ON clause of the GO verb is omitted.
- Subscript variation within the PERFORM verb (Option 5) is not allowed.
- The INTO clause of the READ verb is omitted.
- The FROM clause of the WRITE verb is omitted.

.143 Extensions of Honeywell COBOL D and H With Respect to COBOL-61

Extensions to COBOL-61 included in both COBOL D and COBOL H include the CORRESPONDING option of the ADD and SUBTRACT verbs. In addition, a special form of the PERFORM verb, Option 5, is available in both versions to provide optimization of subroutines and maintain compatibility with other COBOL compilers. COBOL H provides the basic implementation of the SORT verb, a restricted version of the table handling option, and a limited version of the Mass Storage language extension of COBOL-61.

.144 COBOL-61 Electives Implemented (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
1*	Formula characters	+, -, *, /, **, = may be used in formulas.
2*	Relationship characters	> and < are available.
3	Semicolon	Used for convenience of reader.
5	Figurative constants	HIGH BOUND(S), LOW BOUND(S).
6	Figurative constants	HIGH-VALUE(S); LOW-VALUE(S).
	File Description	
8	BLOCK size	Allows block size to be expressed as a range.
9	FILE CONTAINS	Approximate file size can be shown.
11	SEQUENCED ON	Specifies the keys on which records in a file are sequenced.
	Record Description	
13	Table length	Lengths of tables and arrays may vary.
16*	RANGE IS	Value ranges of items can be shown.
19*	SIZE clause option	Can be used to specify size of any record.
20	Conditional range	A conditional value can be a range.
	Verbs	
22*	COMPUTE	Algebraic formulas are permitted. (This feature is currently being implemented.)
25	INCLUDE	Library routines can be called.
26	USE	Enables own coding to be specified for I/O errors and file and tape labels.
	Verb Options	
27	LOCK	Locks rewound tapes.
28	MOVE CORRESPONDING	Moves and edits relevant records.
30	ADVANCING	Specifies paper advance for each line of print.
32*	Formulas	Algebraic formulas can be used.
33	Operand size	Up to 18 digits.
34	Relationships	IS UNEQUAL TO, EQUALS, and EXCEEDS are provided.
35	Tests	IF { } IS NOT ZERO form is provided.
36	Conditionals	Abbreviation 3 of IF verb.
36*	Conditionals	Implied objects with implied subjects.
37	Compound conditionals	ANDs and ORs can be intermixed.
38	Complex conditionals	Conditional statements are permitted within conditional statements.
39	Conditional statements	
	Environment Division	
40	SOURCE-COMPUTER	Enables a programmer to describe a subset of an automatic description.

* Implemented in COBOL H only.

(Contd.)

.144 COBOL-61 Electives Implemented (see 4:161.3) — Contd.

Key No.	Elective	Comments
41	OBJECT-COMPUTER	Enables a programmer to describe a subset of an automatic description.
42	SPECIAL-NAMES	Enables names to be given to parts of a console.
43	FILE-CONTROL	Enables a library description to be used to describe a file.
45	I-O-CONTROL	Enables a library description to be used.
	Identification Division	
47	DATE-COMPILED	Current date will be inserted automatically.
	Special Features	
48	Library	Library routines can be called.
49	Segmentation	Object programs can be segmented.

.145 COBOL-61 Electives Not Implemented (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
4	Long literals	Literals may not exceed 120 characters.
7	Computer-name	No alternative computer names
	File Description	
10	Label formats	Labels must be standard or omitted.
12	HASHED	Hash totals cannot be created.
	Record Description	
14	Item length	Variable item lengths cannot be specified in a PICTURE.
15	BITS option	Items cannot be specified in bits.
17	RENAMES	Alternative groupings of elementary items cannot be specified.
18	SIGN IS	No separate signs are allowed.
21	Label handling	Only standard labels (or none) may be used.
	Verbs	
23	DEFINE	New verbs cannot be defined.
24	ENTER	Other languages can be entered only through use of LOAD and CALL verbs.
	Verb Options	
29	OPEN REVERSED	Read reverse facility is not provided.
31	STOP	

PROCESS ORIENTED LANGUAGE: FORTRAN D, H, AND J

.1 GENERAL

.11 Identity: . . . . FORTRAN D, H, and J.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . FORTRAN Reference Manuals 027 and 028.

.14 Description

The Honeywell FORTRAN compilers D, H, and J can be used with the full spectrum of Series 200 processors — from a 16K-character Model 120 that has no multiply and divide hardware, through a Model 200 that uses either three or four-character addressing, up to the larger Models 1200, 2200, and 4200 that utilize the optional floating-point Scientific Instruction Package. Compatibility is stressed between the three levels of the FORTRAN source language in order to permit graceful growth from the smaller Series 200 processor models to the larger. Recompilation of FORTRAN source programs is all that is required to incorporate the additional hardware features of the larger processor models.

The compatibility goals of the Honeywell FORTRAN language extend also to the earlier FORTRAN languages of the IBM 1400 Series. All language features of the 1401 FORTRAN language are provided as a subset of the 16K design level FORTRAN D language. Likewise, the language features of IBM's 1410/7010 FORTRAN are provided as a subset of the 32K design level FORTRAN H and the 65K design level FORTRAN J.

Discrepancies between the FORTRAN II used with the IBM 1400 Series and the Honeywell FORTRAN D language can be resolved by a conversion program supplied by Honeywell. This program requires a separate pass prior to the FORTRAN D compilation. The conversion program, called SCREEN, either reproduces the FORTRAN II statements directly, or, in the case of I/O statements and library function names, converts the FORTRAN II name to its FORTRAN D equivalent. Table I provides a listing of the statement conversions provided by SCREEN.

Listed below are several extensions of the Honeywell FORTRAN H language as compared to the basic FORTRAN D language. FORTRAN H requires the use of at least 32K characters of core storage and floating point hardware.

- The FORTRAN H compiler can operate as a background program in a communications environment.
- Both complex and double-precision data types are permitted.
- Mixed-mode arithmetic expressions are permitted. The priority of the data types within arithmetic expressions follows, in descending order: complex, double-precision, real and integer.
- In both arithmetic and logical assignment statements, evaluation takes place during execution and the resultant value is assigned to a variable. FORTRAN H provides a BEGIN TRACE statement that will cause the name of the variable and its assigned value to be printed each time an assignment statement is executed.
- The programmer can optionally arrange data records in free-form data sentences. Each field in a sentence is associated by its position with a list variable of a READ or WRITE statement. When data is formatted in data records, no FORMAT statement is required for the data. Each variable-length data-field corresponds to a word of a sentence, and each data-field corresponds to the variable in the same position in the I/O statement.

TABLE I. SCREEN CONVERSION OUTPUT

Conversion of Library Function Names				Conversion of I/O Statements	
FORTRAN II	FORTRAN D	FORTRAN II	FORTRAN D	FORTRAN II	FORTRAN D
ABSF	ABS	MIN1F	AMIN1	READ INPUT TAPE i, n, List	READ (i, n) List
XABSF	IABS	XMIN1F	MIN1		
INTF	AINT	FLOATF	FLOAT	READ TAPE i, List	READ (i) List
XINTF	INT	XFIXF	IFIX		
MODF	AMOD	DIMF	DIM	READ n, List	READ (i, n) List
XMODF	MOD	XDIMF	IDIM		
SIGNF	SIGN	LOGF	ALOG	WRITE OUTPUT TAPE i, n, List	WRITE (i, n) List
XSIGNF	ISIGN	SINF	SIN		
MAX0F	AMAX0	COSF	COS	WRITE TAPE i, List	WRITE (i) List
XMAX0F	MAX0	EXPF	EXP		
MAX1F	AMAX1	SQRTF	SQRT	PRINT n, List	WRITE (i, n) List
XMAX1F	MAX1	ATANF	ATAN		
MIN0F	AMIN0	TANHF	TANH	PUNCH n, List	WRITE (i, n) List
XMIN0F	MIN0				

.14 Description (Contd.)

- Whenever a Hollerith constant is valid (such as in FORMAT statements, data initialization statements, and as an argument in CALL statements), the programmer has the option of substituting a self-defining character string delimited by colons. This eliminates the need for counting the number of characters in the string.
- In FORMAT statements, the T-specification indicates the next position in the record that will be read or written; the G-specification indicates a generalized format for integer, real, alphabetic, logical, and double-precision data.
- An IMPLICIT statement permits assignment of type-specification according to the first letter of variable names.

Additional FORTRAN H extensions in relation to FORTRAN D are presented in Table II.

The "Chaining" overlay technique used by Honeywell's FORTRAN compilers is a major extension to the method of overlay control used in the IBM 1400 Series FORTRAN and in the 7090 FORTRAN II languages. A job can consist of a group of independent segments (links) which can occupy memory at different times. Each link is overlaid in memory by the subsequent link. The CALL CHAIN statement causes transfer of control between links. This chaining feature permits execution of large FORTRAN programs in relatively small core storage environments.

Paragraphs .142 and .143 below compare Honeywell FORTRAN D to IBM 7090/7094 FORTRAN IV. The facilities of the FORTRAN D language are compared to those of FORTRAN H in the above description and in Table II. The FORTRAN J language is provided for use with Honeywell's large-scale Operating System — Mod 2 integrated software control system. It is expected that FORTRAN J will offer few, if any, language extensions over FORTRAN H.

All Honeywell FORTRAN compilers require the use of at least four magnetic tape units. Additional tape units can be utilized to improve the performance of the FORTRAN compilers and to provide flexible operational options during compilation.

The minimum core storage requirements are as follows: FORTRAN D — 16K characters; FORTRAN H — 32K characters; and FORTRAN J — 49K characters.

Honeywell states that compilation speeds for the three FORTRAN compilers are approximately as follows:

FORTRAN D: . . . . . . 250 statements per minute.
FORTRAN H: . . . . . . 800 statements per minute.
FORTRAN J: . . . . . . 800 statements per minute.

.141 Availability

Language specifications: . . . . 1964.
FORTRAN Compiler D: . . . . July 1965.
FORTRAN Compiler H: . . . . 3rd quarter 1966.
FORTRAN Compiler J: . . . . 1st quarter 1967.

.142 Restrictions of FORTRAN D Relative to IBM 7090/7094 FORTRAN IV

(1) Integer constants can range to 2^{23}-1 as compared to 2^{35}-1 in 7090/7094 FORTRAN.

.143 Extensions of FORTRAN D Relative to IBM 7090/7094 FORTRAN IV

(1) FORTRAN D floating-point constants can range from 2 to 20 digits. IBM 7090/7094 FORTRAN IV provides a range of from 1 to 9 digits in this type of constant.

(2) The subroutines MDUMP, DUMP, and PDUMP provide a variety of dynamic dumping facilities.

(3) The subroutines PARITY, EOF, and EOT permit tests for parity error, end of file, and end of tape I/O conditions.

TABLE II. COMPARISON OF FORTRAN H AND FORTRAN D

Feature	FORTRAN Compiler H	FORTRAN Compiler D
Maximum dimension of arrays	3 as in ASA	2
Extended ranges in DO nests	As in ASA	Not implemented
BLOCK DATA subprograms	As in ASA	Not implemented
Naming main program	Via control card	On TITLE statement
End-of-tape on object tapes	Console type-out, but program re-entry not permitted	EOT subroutine permits program re-entry
Conversion of FORTRAN II I/O statements	During compilation	Via SCREEN run mode
Parity and EOF checks	Via input statement	Via subroutine

MACHINE ORIENTED LANGUAGE: EASYCODER

.1 GENERAL

.11 Identity: . . . . Easycoder A, B, C, and D.

.12 Origin: . . . . Honeywell EDP.

.13 Reference: . . . . Honeywell 200 Programmers Reference Manual.

.14 Description

Easycoder is the standard assembly language for the Honeywell Series 200. It is patterned after the IBM 1401 Autocoder language, but there is no direct source language compatibility between the two systems.

There are four versions of the Easycoder language, designed for use with progressively larger configurations of the translating Series 200 computer system. A fifth Series 200 symbolic assembly language, Assembler J, is described in Section 510:193—Operating System—Mod 2.

The four versions of Easycoder are:

- Easycoder A: usable on minimum configurations with card input-output units and 4,096 positions of core storage; no literals; macros can be used only in systems with at least 8K storage positions.
- Easycoder B: requires 8,192 core storage positions, card or paper tape input-output units, and a printer; provides all the facilities of Easycoder A plus macro instructions and literals.
- Easycoder C: requires 12,288 core storage positions and at least 3 magnetic tape units; provides additional facilities to simplify program preparation and segmentation of object programs.
- Easycoder D: requires 16,384 core storage positions and at least 3 magnetic tape units; provides all the facilities of Easycoder C, plus the additional facility of assembling programs that use 4-character mode addressing.

The paragraphs that follow describe in considerable detail the facilities of the Easycoder C and D versions of the assembly language. The limitations of the Easycoder A and B languages and their relationships to the two larger versions are discussed in Section 510:182, Program Translators, where the differentiating characteristics of the four Easycoder translators are presented. It should be noted that the basic language facilities of Easycoder are the same for all versions.

The instruction format in Easycoder consists of a mnemonic operation code followed by a free-form number of operands separated by commas. Addresses can be specified in absolute, symbolic, or relative form. The operands may be core storage locations or control characters which further define the meaning of the instruction. See Figure 1 for an Easycoder coding form and some sample coding.

Easycoder provides for the use of all the Series 200 machine instructions, for object-time modification by indirect addressing and indexing of operands, and for relative addressing of operands in the source language. The operand TEMP + 26 will be interpreted by the assembly program as referring to the field which is addressed by the 26th location after TEMP.

Relative addressing is widely used in the Easycoder language, particularly where the size of the symbol table is restricted by core storage limitations (see Paragraph .311). Because of the various addressing modes, ambiguities can arise; for instance, the references INST + 2, INST + 3, and INST + 4 might all actually refer to the A-address field of the instruction INST, depending on the addressing mode currently in use. Such ambiguities are normally handled by defining a symbolic constant which is equated to the address length, and using this in place of the absolute value of the address length.

Honeywell
ELECTRONIC DATA PROCESSING

EASYCODER
CODING FORM

PROBLEM ______ PROGRAMMER ______ DATE ______ PAGE ___ OF ___

	CARD NUMBER (1-5)	TYPE (6)	MARK (7)	LOCATION (8-14)	OPERATION CODE (15-20)	OPERANDS (21-62)	(63-80)
1	Ø411			TWO	A	ADDEND, AUG+1Ø	
2	Ø412				S	AUG+1Ø, YEAR	
3	Ø413			COMPAR	BCE	GOTOIF, SAMEAS, 31	
4	Ø414				NA	AUG+1Ø, SAMEAS	
5	Ø415			IF	S	+31, ACCUM	
6	Ø416				BA	#2B5Ø, BEGIN	
7	Ø417			THREE	A	ADDEND, SEPT	
8	Ø418				S	SEPT, YEAR	
9	Ø419				BCE	FOUR, SEPT, 3Ø	
10	Ø42Ø				A	ADDEND, SEPT+1	
11							
12							
13							
14							
15							
16							

Figure 1. Easycoder Coding Form and Sample Coding

.14 Description (Contd.)

The programmer writing in Easycoder also has the flexibility of deciding whether to refer to constants, reserved fields, and instructions by the leftmost or rightmost character. Constants and reserved fields are normally addressed by the rightmost character, and instructions by the leftmost. This convention can be reversed by the programmer by indenting the symbol name one character. (This also reduces the maximum label length to five characters.) This indentation is carried forward onto the program listing, but it may not stand out in the absence of other contiguous symbolic names. However, when the symbol is subsequently used, no explicit reference is made on the listing to indicate that the conventions have been reversed, so it is advisable for the programmer to take a few precautions to prevent misinterpretations.

In addition to the executable imperative statements of the Easycoder language, a number of statements are provided for initiating the system, formatting constants and work areas, setting word marks, etc. Still other statements guide the assembly process. Included are statements that set the allocation counter to some specific absolute or relative value, or to the next value which is modulo any specified power of two (i.e., a multiple of 2, 4, 8, 16, 32, etc.).

Another group of statements in the Easycoder language guides execution of the object program. These include the CLEAR statement, which clears specified core storage areas; the END statement, which specifies the starting address of the program; and the EX (Execute) statement. The EX statement allows certain parts of the program to be executed before other parts are loaded. This facility allows initialization and ending routines to share the program area with the main program, and it can be used in various other ways for saving memory space. In form, it consists of a branch address to which control is transferred during the loading process.

Macro-instructions may be included in programs written in Easycoder. These are single-statement instructions, with parameters included as operands in the instruction. Specialization and inclusion of the desired macro-routines are accomplished during a separate pass preceding the assembly. Currently available macro-routines are designed to facilitate the manipulation of data files on magnetic tape, drum, or disc; to perform floating-point computations; and to evaluate mathematical functions.

The Easycoder C and D languages include a number of assembly control instructions not provided in the Easycoder A and B languages. These statements are aimed primarily at simplifying the use of segmented programs. The SFX (Suffix) statement directs the assembly program to add a single-character suffix to each symbolic tag in the subsequent coding, and the SEG (Segment) header defines the start of a segment.

Two other instructions, REP (Repeat) and GEN (Generate), act on a single adjacent instruction, repeating it a specific number of times, with or without modification. These facilities can be helpful where the contents of a table are to be accumulated, or where some other repetitive operation must be performed. The limitation of processing only a single instruction in this manner can be restricting in some cases.

.15 Publication Date: . . . . . February 1966 for Easycoder C and D.

November 1964 for Easycoder A and B.

.16 Availability: . . . . all four assemblers are currently in operation.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . see Figure 1.

.22 Legend

Card Number: . . . . . . first 2 digits for page number; next 2 for line number; last one for insertions.

Card Type: . . . . blank for all instructions, constants, and control instructions. An * indicates a Remarks card.

Mark: . . . . "L" indicates an item mark is to be placed over leftmost character of field or instruction; "R" indicates item mark over rightmost character. Note that when L is used and the leftmost character already contains a word mark, a record mark will result. Also, in Easycoder C, D, and J, the letters A through T can be used to indicate any punctuation (item, word, or record mark) over the leftmost and/or rightmost position in the statement.

Location: . . . . may be blank or may contain a symbolic tag or an absolute decimal address. (If the first column is left blank, the normal address assignment will be reversed.)

Operation Code: . . . . contains an octal or mnemonic instruction code, a data-defining code, a library call, or an assembly control instruction code.

Operands: . . . . contains the operands and variants (separated by commas) for the instruction, in free form. Remarks may follow the terminating space.

.23 Corrections

.231 Insertions: . . . . at bottom of page.

.232 Deletions: . . . . cross out offending line.

.233 Alterations: . . . . erase and correct. (Easycoder C and D provide facilities for program corrections during assembly.)

(Contd.)

.24 Special Conventions

.241 Compound addresses: . any number of symbols and decimal integers (up to the limit of card field length) combined by addition (+) and/or subtraction (-) signs.
.242 Multi-addresses: . . . . free-form, separated by commas.
.243 Literals—
Easycoder A and B: . none.
Easycoder C and D: . alphameric, decimal, binary, octal, or address literals may be used.
.244 Special coded addresses: . . . . *refers to leftmost character of the instruction in which the* symbol appears as an operand.
.245 Others—
Absolute addresses: . any decimal number from zero to the largest numbers which can be contained in an address field (4095 for 2-character addresses, 32, 767 for 3-character addresses, 65,535 for 4-character addresses). Leading zeros may be omitted.
Indirect addresses: . enclosed in parentheses.
Indexed addresses: . address followed by +X and the number of the index register.

Note: Indirect and indexed addresses can be used only in the 3-character or 4-character addressing modes.

.3 LABELS

.31 General

.311 Maximum number of labels—
Easycoder A (4K core): . . . . . . 400.
Easycoder B (8K core): . . . . . . 400.
Easycoder B (12K core): . . . . . . 850.
Easycoder C and D: . no practical limit.
.312 Common label formation rule: . . . . yes.
.313 Reserved labels: . . . . none.
.314 Other restrictions: . . . special characters are not allowed in programmer-defined symbols.
.316 Synonyms permitted: . yes; EQU pseudo.

.32 Universal Labels

.321 Labels for procedures—
Existence: . . . . mandatory if referenced by other instructions, unless address arithmetic is used.
Formation rule—
First character: . . alphabetic.
Last character: . . . numeric or alphabetic
Others: . . . . numeric or alphabetic.
Number of characters: . . . . 1 to 6.
.322 Labels for library routines: . . . . same as procedures.
.323 Labels for constants: . same as procedures.
.324 Labels for files: . . . . same as procedures.
.325 Labels for records: . . same as procedures.
.326 Labels for variables: . same as procedures.

.33 Local Labels: . . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constants:
Integer—
Decimal: . . . . 40 decimal digits.
Octal: . . . . 40 octal digits (20 character positions).
Binary: . . . . 6 decimal digits (20 character positions).
Alphabetic: . . . . . . 40 characters, preceded and followed by @.
Alphameric: . . . . . same as alphabetic.
.412 Maximum size literals: . . . . same as constants; all literals longer than 5 characters will be stored once for each occurrence.

.42 Working Areas

.421 Data layout—
Implied by use: . . . . alternative.
Specified in program: alternative (through use of DA control instruction).
.422 Data Type: . . . . not required.
.423 Redefinition: . . . . yes.

.43 Input-Output Areas

.431 Data layout: . . . . implicit or specified with DA control instruction.
.432 Data type: . . . . not required.
.433 Copy layout: . . . . yes.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic—
Existence: . . . . alternative.
Number: . . . . 43 (many variations through "V" variant characters).
Example: . . . . A = Decimal Add.
.512 Absolute—
Existence: . . . . alternative.
Number: . . . . 41.
Example: . . . . 36 = Decimal Add.
Comment: . . . . written as two octal digits right justified in command field.

.52 Macro-Codes

.521 Number available: . . . 13 to date for input-output control.
.523 New macros: . . . . inserted into library by assembly.

.53 Interludes: . . . . none.

.54 Translator Control

.541 Method of control—
Allocation counter: . . pseudo-operation.
Label adjustment: . . pseudo-operation.
Annotation: . . . . special cards.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . . multiply, divide; floating-point add, subtract, multiply, divide.
.612 Method of call: . . . . . macro.

.62 Special Functions

.621 Facilities: . . . . log, sine, cosine, exponential, square root, arctangent, hyperbolic tangent.
.622 Method of call: . . . . . macro.

.63 Overlay Control: . . . . controlled by programmer; no special facilities.

.64 Data Editing

.641 Radix conversion: . . . none.
.642 Code translation: . . . . hardware capability (optional).
.643 Format control: . . . . . by hardware editing capability (optional).

.65 Input-Output Control

.651 File labels: . . . . yes.
.652 Reel labels: . . . . yes.
.653 Blocking: . . . . yes.
.654 Error control: . . . . . . yes.
.655 Method of call: . . . . . macro.

.66 Sorting: . . . . see Paragraphs 510:151.13 and 510:152.13 for descriptions of the Series 200 Sort programs.

.67 Diagnostics

.671 Dumps: . . . . core memory and tape dumps may be called in by operator or connected by programmed linkage.
.672 Tracers: . . . . none.
.673 Snapshots: . . . . see Paragraph .671.

.7 LIBRARY FACILITIES

.71 Identity: . . . . Series 200 Easycoder Library.

.72 Kinds of Libraries

.721 Fixed master: . . . . . . no.
.722 Expandable master: . . yes.
.723 Private: . . . . may be added to.

.73 Storage Form: . . . . . . magnetic tape or mass storage devices.

.74 Varieties of Contents: . subroutines and macro routines.

.75 Mechanism

.751 Insertion of new item: . by Easycoder C and D assemblers.
.752 Language of new item: Easycoder.
.753 Method of call: . . . . . macro or insertion deck.

.76 Insertion in Program: . inserted in-line at point of call.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Code	Description
OPEN:	initializes a file and checks label.
CLOSE:	terminates and deactivates a file.
GET:	locates a record for processing.
PUT:	inserts a record in an output file.
FEOR:	initiates end of reel routine at other than the normal end.
FETCH:	reads items from disc or drum in the order of sorted keys.
LOCATE, UNLOAD, RESTORE, EDIT, CORRECT, COMPARE, CLEAR:	initiate utility functions.

.82 Pseudos

Code	Description
CONF:	describes configuration of translating and object systems.
DCA:	precedes a series of file descriptions.
PROG:	identifies the program.
RESV:	reserves an area of core memory.
**DA:	defines area(s) of memory which contain fields or subfields
ORG:	specifies the following coding is to be assigned to memory locations starting at the location written in the operand field.
MORG:	assigns locations to the following coding starting at the next location which is a multiple of the numbers written in the operand field (must be a power of 2).
EQU:	assigns the value written in the operand field to the tag in the location field. The operand may be an absolute, symbolic, or indexed address. If * is used, it refers to the next location available for allocation.
CEQU:	equates an octal constant with a tag which represents a variant character.
ADMODE:	directs assembler to assemble the following instructions with 2, 3, or 4 character addresses, as specified in the operand field. Stays in effect until the next ADMODE instruction.

** Not available in Easycoder A.

(Contd.)

.82 Pseudos (Contd.)

Code	Description
EX:	allows coding to be executed during the loading process.
END:	last card of the program; specifies starting address of program.
CLEAR:	specifies which area(s) of memory are to be cleared before loading the program (may be specified in absolute or symbolic).
DCW:	loads a constant and sets a word mark in the high-order position.
DC:	loads a constant without a word mark.
DSA:	stores a constant equivalent to the machine address assigned to a specific symbolic address.
*SFX:	assigns a suffix code to the sixth position of labels.
*SKIP:	controls vertical spacing of assembly listing.
**LITORG:	assigns storage locations to previously encountered literals and closed library routines.
*REP:	indicates that the following statement (DC or DCW) is to be repeated N times, where N is 0 to 63.
*GEN:	indicates that the following statement is to be repeated (with increments or decrements applied to operands) N times, where N is 0 to 63.

*Easycoder C and D only.
**Not available in Easycoder A.

PROGRAM TRANSLATOR: BRIDGE 1401

.1 GENERAL

.11 Identity: . . . . BRIDGE 1401.

.12 Description

BRIDGE 1401 is a translating program that will convert IBM 1401 machine-language programs to Series 200 machine-language programs automatically. Many 1401 programs will run immediately after conversion, with no further intervention; many others will require a few hours' desk checking by analysts familiar with the 1401 program and with BRIDGE 1401; and a few programs (see Paragraph .123 below) may require a complete overhaul.

The final Honeywell program will have the same logical structure as the original program, and Honeywell estimates that it will run (on a Honeywell Model 200) from 2 to 5 times as fast as the original, except in those cases where the 1401 program was limited by the speed of a single input or output device (see Paragraph .122 below).

The principal restrictions of BRIDGE are:

(1) The Honeywell system must have an additional 4,096 core storage positions as well as all the peripheral devices and features of the original 1401.

(2) The Honeywell system must have the Advanced Programming and Editing options (n.b., the rental price of these two features, plus the additional 4K core storage module, is $450 per month for Model 200).

(3) The 1401 program must be an operational, legal program (i.e., it must not use instructions other than the way they are described in the IBM programming manuals). In some cases an installation will be able to modify Bridge so that non-standard instructions can be simulated. (See Paragraph .122 below.)

BRIDGE 1401 has been operational since April, 1964. The results of its application to date, both for demonstrations and operational use, are stated by the manufacturer to be highly effective.

Translation time averages about one minute per 4,000 characters of IBM 1401 program volume. For typical 1401 programs, the instruction breakdown currently being found by Honeywell is as follows:

- 76% of the 1401 instructions are being directly translated.
- 23.4% of the 1401 instructions require object-time interpretation by subroutines.
- 0.6% of the 1401 instructions cannot be handled by BRIDGE 1401, and are flagged for programmers' scrutiny.

The average BRIDGE'd 1401 program runs about twice as fast on the H-200 as on the IBM 1401, with exceptional programs running up to five times as fast in some cases, and, in other cases, at approximately the same speed as on the 1401.

The translation methods adopted, the reasons why different programs will be improved by different proportions, and the IBM 1401 facilities which are not presently covered by BRIDGE 1401 are reviewed separately in the sections below.

.121 Methodology of BRIDGE 1401

BRIDGE 1401 runs on either a card or tape system. A condensed IBM 1401 Autocoder, condensed SPS, or SPS single load format program deck (together with a card describing certain options in conversion) is read in and stored in main memory, character by character, as it would be stored at the start of a regular 1401 operational run. During this operation all affected locations are identified in tabular form. The program is then analyzed, and an attempt is made to identify all instruction areas and list their locations in a table. At this point, a capability is provided for reproducing its contents so that other segments and overlays will correspond in the operand analysis areas.

Having isolated the instruction areas, BRIDGE 1401 then scans the 1401 program and produces a Series 200 program. Instruction operation codes, addresses, and variant characters are replaced with their equivalents where it is possible to do so on a character-by-character basis. Where this is impossible, but a simulation technique can be employed, an item mark is associated with the op code. The op code itself is replaced by a number which identifies the subroutine that exactly simulates the function of the instruction. (When the converted program runs on the Honeywell system, the computer is conditioned by instruction to operate in the "item mark trapping" mode. In this mode, an item-marked operation code will cause the other Sequence Counter to control subsequent instruction executions. The value of the operation code of this instruction is then used to transfer control to the appropriate simulating subroutine. The H-200, with its two Sequence Counters, uses one for directly translated instructions and the other for executing closed subroutines where simulation is required.) If the scrutinized instruction is not recognized as a legal 1401 instruction, or cannot at this point be simulated, a stop or pass order is inserted in its place and flagged for later use.

(Contd.)

.121 Methodology of BRIDGE 1401 (Contd.)

The converted program is printed out, in memory order, together with a corresponding listing of the original 1401 program. Each line lists both the 1401 and Series 200 constant or instruction, together with the location value, mnemonic operation code, and error flag type, where pertinent. A Series 200 program deck is punched or written on tape.

An optional final phase will accept the program deck containing one instruction per card and produce a condensed Series 200 program deck.

.122 The Resulting Honeywell Program

The final program, as run on the Series 200 system, bears a character-by-character, instruction-by instruction relationship to the original program except in the following details:

(1) Buffer input-output areas are provided for the tape units (optionally), the card reader, card punch, and printer, allowing these units to operate simultaneously with processing without disturbing the original 1401 program logic.

(2) All simulated functions are handled interpretively. The actual work done within the routine is usually short (simulation of an input or output instruction, for example); but if an instruction address is being arithmetically modified (i.e., if the original program added the contents of a data field to an address), a binary to decimal conversion and a decimal to binary reconversion will have to be performed.

There is a 300-microsecond overhead for each 1401 instruction that needs to be simulated. This allows for the necessary branching and control functions. In addition to this overhead, the simulation of the instructions concerned is handled by special library routines. Typical timings for these routines vary from 120 microseconds to simulate a Move Numeric instruction to 4,050 microseconds for a Clear Storage and Branch instruction.

These routines are easily replaceable, and in fact some installations have already written their own versions, either to cover instructions or RPQ features which are not present in the standard library or to gain improved performance through the use of additional storage. For example, the decimal-to-binary conversions could be speeded up, but this would require additional storage over and above the 4,000 additional locations normally required by BRIDGE 1401. If an installation is able to allow more storage space, then different conversion routines can be substituted.

A number of different possible limiting factors may control the performance of the object program. The resultant program will overlap card reading, card punching, and printing. Overlapping of magnetic tape reading and writing is optional. Central processor time, in the case of the Model 200 Processor, will be reduced to between 20% and 50% of the original 1401 time. The overall effect of these factors on any specific program can be estimated with reasonable accuracy if the timing factors that determine the performance of the original 1401 program are known.

Facilities added to the BRIDGE 1401 repertoire since its original announcement include the following:

- Magnetic tape reading and writing can be buffered at object time.
- Magnetic tape can be read or written with word marks.
- Compressed magnetic tapes, as used with the IBM 7070 and equivalent systems (see page 403:091.100 in the IBM 7070 Computer System Report), can be used.
- Column binary cards can be read, and all other column binary instructions can be translated.

.123 IBM 1401 Facilities Not Currently Handled by BRIDGE 1401

- Use of any RPQ (non-standard) features or peripheral devices.
- Use of 1311 Disk Storage Drives.
- Use of paper tape equipment.
- Use of 7340 Model 2 Hypertape Drives.
- Use of magnetic or optical character readers.
- Use of the Console Inquiry Station.
- Use of Teleprocessing devices, such as the 1009 and 7710.
- Programs which modify operation codes arithmetically (e.g., add "3" to a "Read a Card" instruction to make a "Punch a Card" instruction.
- Programs which modify parts of operand addresses arithmetically (e.g., add "5" to the tens position of the address "454" to make "504").

.13 Originator: . . . . Honeywell EDP.

.14 Maintainer: . . . . Honeywell EDP.

.15 Availability: . . . . April 1964.

.2 INPUT

.21 Language

.211 Name: . . . . IBM 1401 Autocoder condensed load program deck, SPS single, SPS condensed, and Autocoder tape programs.

.212 Exemptions: . . . . programs which, while running, modify operation codes or partial addresses. The replacement of a complete operation code,

.212 Exemptions (Contd.)

or the modification of an entire address field will, however, be handled correctly.

.22 Form

.221 Input media: . . . . IBM 1401 program deck or card images on tape (see .211 above).

.222 Obligatory ordering: . . none — patching cards may be included anywhere in the program deck.

.23 Size Limitations: . . . must be able to be run on an IBM 1401 computer with 4K fewer storage positions than the target system.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . Series 200 machine code.
.313 Output media: . . . . . . punched card deck.

.32 Conventions

.321 Standard inclusions: . . subroutines to simulate the 1401 instructions that have no direct Series 200 equivalent.

.33 Documentation

Subject	Provision
Source program: / Object program:	analysis listing of both source and object programs in storage order.
Storage map:	in three parts: original instructions, constants, and simulation package.
Restart point list: . .	none.
Language errors: . . .	any unrecognized 1401 instruction codes are noted on the analysis listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Phase 1 — Loading the Program to be Converted.

In this phase the 1401 assembly-language program deck is read by BRIDGE 1401. The data and instructions are stored in equivalent positions in the Honeywell system, and a memory table defining all loaded areas is constructed. At the completion of the phase, therefore, a virtual copy of the original running 1401 program is stored in the Series 200 processor.

Phase 2 — Analysis of the Program.

Working from the memory table, the loaded 1401 program is examined to identify which parts of it are instructions. (It is considered that all parts which are not instructions are data — no direct provision is made for any use of an instruction as data, except for address modifications.)

This analysis covers all cases of conditional and unconditional branches, subroutine exits, and other similar situations. A table is prepared showing which areas of the IBM 1401 memory contain instructions.

Phase 3 — Preparation of Item Tape or Card Deck.

The IBM 1401 machine instructions and data constants are then placed on an "item tape" or "item card deck." This output contains the 1401 form and location of each instruction and data constant.

Phase 4 — Conversion, Printout, and Punching of the Series 200 Program.

The item tape (or card deck) is read. Each instruction is checked for apparent validity, whether the instruction code concerned is or is not logically identical in the two systems, and whether the operand addresses are in the instruction area of the original program.

If the instruction appears to be valid, and the two systems have logically identical codes, and the operands are not in the instruction areas, then the necessary direct substitutions are made; the converted instruction and its corresponding word mark location are prepared for punching; and a printed record is made of the instruction in both the IBM 1401 and Honeywell format.

If, however, the instruction code is not valid (it may be some 1401 RPQ feature), an NOP instruction is inserted in the punched version of the converted program, and a note is made on the printed listing.

If the instruction code is one which has no direct equivalent, but can be completely simulated on the Honeywell system, a jump to a subroutine entry is made. The "item mark trapping technique" is used, which only takes one punctuation position and will, therefore, never interfere with the addresses of other instructions. This jump will lead to a routine which will, at object time, simulate the effect of the original instruction.

If an operand address refers to the instruction area, a jump is inserted to a binary to decimal conversion before the operation and to a decimal to binary conversion after the operation, thus allowing the address of the result to be the correct equivalent of the 1401 coding.

If a data constant appears as an item, it is moved, unchanged, to the output.

An object program deck is punched or written on tape.

Phase 5 — Condensation of the new Program Deck (optional). This also provides an Assembly listing.

.42 Optional Mode: . . . . . translation may be restarted at Phase 3 after manual insertions have been made to the list of instruction areas.

(Contd.)

.42 Optional Mode (Contd.)

The instruction table may be punched for overlay updating in Phase 2.

.43 Special Features

.431 Alter to check only: . . no, but a complete check can be made by running to produce the printed listing only, without a card deck. This mode operates about 25% faster than when a card deck is being produced.

.432 Fast unoptimized translate: . . . . no.

.433 Short translate on restricted program: . . . . no.

.44 Bulk Translating: . . . . BRIDGE 1401 is in five segments which must be reloaded individually for each program to be processed. Where these segments are held on magnetic tape, the reloading procedure is automatic.

.45 Program Diagnostics: . . . . none directly. The program listing records the original and final instructions, and the data constants.

.46 Translator Library

.461 Identity: . . . . subroutines simulating IBM 1401 operations and Series 200 optional facilities.

.462 User restriction: . . . . none.

.463 Form: . . . . magnetic tape or cards.

.464 Contents: . . . . closed routines only.

.465 Librarianship —
Insertion or amendment: . . . . possible.
Call procedure: . . . . automatic.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . . currently defined as 4,096 characters; the following portions are known to be included.

Name	Space
Subroutines: Input/Output Macros: Printer Control Table:	approx. 2,000 characters.

.512 Space required for each input-output file: . . . . the card and printer input-output areas are double-buffered. No change is made in the tape file areas.

.513 Approximate expansion of procedures: . . . . . 1 to 1 (exclusive of overhead in .511 above).

.52 Translation Time: . . . 4 minutes for a maximum-size (16K) original program.

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . see Paragraph .122, "The Resulting Honeywell Program."

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . Series 200 processor with 4,096 core storage positions more than the IBM 1401 programs utilize, plus the Advanced Programming Option.
printer.
card reader/punch.

.612 Larger configuration advantages: . . . . up to 4 magnetic tapes can be used to provide faster translations.

.62 Target Computer: . . . any Series 200 system with sufficient input-output equipment and programming options to make it logically equivalent to the original 1401 system. The Advanced Programming and Editing options, and 4,096 more core storage positions than the original IBM 1401 programs utilized, are required.

.8 ALTERNATIVE TRANSLATORS: . . . where a 1401 program exists in SPS or Autocoder form, the conversion into Easycoder assembly language can be handled by Easytran. See Sections 510:131 and 510:183 of this report.

PROGRAM TRANSLATOR: EASYCODER ASSEMBLERS

.1 GENERAL

.11 Identity: . . . . Easycoder Assemblers A, B, C and D.

.12 Description

Easycoder Assembler programs translate Easycoder source-language programs into Honeywell Series 200 machine-language programs and produce object programs on magnetic tape, punched paper tape, punched cards, or mass storage units. The programs produced by the C and D versions are executed under control of the Series 200 Operating System—Mod 1 (described in Section 510:192) The A and B versions of Easycoder produce programs in a self-loading format to be run independently in the Basic Programming System environment. (See Section 510:191 for a description of this environment.)

(A fifth Assembler program is provided for use with Honeywell Series 200 systems: Assembler J. This assembler is used exclusively under control of the Operating System—Mod 2 and is described in Section 510:193.)

The need for two versions of the Easycoder translator (Easycoder A and B, and Easycoder C and D) within the same operating system is caused by the variable-length addressing scheme in the Series 200. The addressing mode choice within the Basic Programming System is 2- or 3-character addressing. The Operating System—Mod 1 offers the option of 3- or 4-character addressing.

Many of the facilities of the Easycoder versions that operate under control of the larger operating systems are offered in the two basic versions through the use of separate program passes. Four major facilities are not offered with Easycoder A and B in any manner:

- Bulk translating is not provided. The Easycoder assembler program must be reloaded prior to each program assembled.
- The use of literals is not permitted.
- The symbol table must be wholly contained in the available core storage. Symbols defined after the table has reached its limit are rejected.
- Segmentation control statements are not provided.

The larger Easycoder assemblers (C and D) maintain a master file (library) of symbolic programs. Programs can be added to this file during the assembly run; also, programs existing in this file can be updated with symbolic corrections, insertions, and deletions, again as part of a normal assembly run. Programs can be batched when this combined updating/assembling function is performed. (Easycoder assemblers A and B allow the user to simulate the symbolic correction facility through separate program passes).

The assembler operates from card image input (on punched card, paper tape, magnetic tape, or mass storage devices), and produces, in addition to the updated library file and the executable machine-language programs, a printed listing. The listing contains the symbolic input language and absolute object program instructions, comments, and error indications. The assembler does not create storage maps, but cross-reference listings can be obtained in a post-assembly run. A directory of the programs in the symbolic file is printed. Any program in the symbolic file can be listed and/or placed in the machine-language output without being reassembled.

The assembler with correction facility is a three-phase program. The first phase edits the input cards and performs the updating function, using an input master symbolic file if one is present for the run. The next two phases perform the normal allocation and resolution of references. On the larger versions of Easytran, these two phases are repeated as many times as necessary to handle all of the symbolic tags in the program. Thus, there is no limit on the number of such tags.

The assembly system may also include a macro processor to handle the macro-instruction facilities of the Easycoder language. Macro-routines are stored in a symbolic file, in exactly the same format as symbolic object programs. They can therefore be maintained using the standard assembler. Incorporation of macro-routines in a program requires a special pre-assembly run against this file.

Memory requirements for use of the various versions of Easycoder are shown in Table I.

The operational speed of the assemblers varies between 125 and 1,000 statements per minute, depending upon the size of the object program, the configuration of the assembling machine, and the output options selected.

.13 Originator: . . . . Honeywell EDP Division.

.14 Maintainer: . . . . Honeywell EDP Division.

.15 Availability: . . . . See Table I.

.2 INPUT

.21 Language

.211 Name: . . . . Easycoder (see Section 510:171).
.212 Exemptions: . . . . none.
.221 Input media: . . . . punched cards, magnetic tape, or paper tape.
.222 Obligatory ordering: . . according to program logic.

(Contd.)

TABLE I: CHARACTERISTICS OF THE VARIOUS EASYCODER ASSEMBLERS

Assembler Version	Easycoder A	Easycoder B	Easycoder C	Easycoder D
Availability	July 1964	April 1965	October 1964	October 1964
Operational Requirements — Minimum	4K positions of core storage. card or paper tape reader. card or paper tape punch. Advanced Programming feature.	8K positions of core storage. magnetic tape, punched card or paper tape reader. magnetic tape, card punch or paper tape punch. Advanced Programming feature.	12K positions of core storage. card reader, printer, and 3 magnetic tape units. Advanced Programming feature.	16K positions of core storage. card reader, printer, and 3 magnetic tape units. Advanced Programming feature.
Operational Requirements — Expanded	printer: to obtain listings. 3 magnetic tape units: to simulate macro library and correction procedures of expanded assemblers. additional core storage for expanded label capacity.	printer: to obtain listings. 3 magnetic tape units: to simulate macro library and correction procedures of expanded assemblers. additional core storage for expanded label capacity.	additional magnetic tape units can be used in place of card reader and printer to increase assembly speed. additional core storage for larger label table capacity increases assembly speed.	additional magnetic tape units can be used in place of card reader and printer to increase assembly speed. additional core storage for larger label table capacity increases assembly speed.
Maximum Number of Data Items	4K: 400 labeled items. 8K: 900 labeled items.	8K: 300 labeled items. additional 4K increments: 500 labeled items per increment.	12K: 300 labeled items. additional 4K increments: 500 labeled items per increment. No limit to table size on magnetic tape.	No limit to table size.

.223 Obligatory grouping: . . (1) PROGram card.
(2) CLEAR cards (if any).
(3) Program; including EXecute cards where part of the program is to be executed before loading is completed.
(4) END card.

.23 <u>Size Limitations</u>

.231 Maximum number of source statements: . . no limit other than the capacity of one full reel of tape.

.232 Maximum size of source statements: . . 80 characters.

.233 Maximum number of data items: . . . . See Table I.

.3 <u>OUTPUT</u>

.31 <u>Object Program</u>

.311 Language name: . . . . . Series 200 machine language.

.312 Language style: . . . . . machine.

.313 Output media: . . . . . . punched cards, punched paper tape, magnetic tape, or mass storage.

.32 <u>Conventions</u>

.321 Standard inclusions: . . bootstrap and loader.

.33 <u>Documentation</u>

Source program: . . . . listing.
Object program: . . . . listing.
Storage map: . . . . none.
Restart point list: . . . . operating instructions.
Language errors: . . . . indicated on listing.

.4 <u>TRANSLATING PROCEDURE</u>

.41 <u>Phases and Passes</u>

<u>Phase I</u>

- The symbolic card (or card image) input is scanned, checked for legality, and edited into a form acceptable by Phase II.
- The mnemonic operation codes of the source program statements are translated into single-character machine-language operation codes.
- All literal operands (if available in the version of the assembler) are scanned, legality is checked and partially resolved.
- Corrections are merged with programs on the input symbolic program file.
- Programs not being assembled are copied to the output symbolic program tape. Optionally, Phase I produces listings for these programs and/or produces machine-language output for them.

.41 Phases and Passes (Contd.)

Phase II

Allocates memory, builds a symbol table in memory, and writes the partially assembled coding onto intermediate storage.

Phase III

Uses the symbol table to resolve the operands and writes the fully or partially assembled coding back on the output symbolic program tape.

.42 Optional Mode

.421 Translate: . . . . yes.
.422 Translate and run: . . . yes.
.423 Check only: . . . . no.
.424 Patching: . . . . no.
.425 Updating: . . . . yes.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . no.
.433 Short translate on restricted program: . no.

.44 Bulk Translating: . . . . yes, but only with Easycoder C and D.

.45 Program Diagnostics

.451 Tracers: . . . . no.
.452 Snapshots: . . . . no.
.453 Dumps: . . . . yes.

.46 Translator Library: . . yes; programs on a symbolic program file can be incorporated into object programs and specialized according to a parameter list; in the case of Easycoder A and B, library routines can be added by means of a separate pass.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space: same as for hand machine-language coding.

.52 Translation Speed:

Card systems: . . . . . . approximately 125 statements/minute.

Magnetic tape systems: . . . . up to 550 statements/minute (with listing) or 1,000 statements/minute (without listing).

Mass storage systems: ?

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . same as for hand machine-language coding.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: see Table I.
.612 Larger configuration advantages: . . . . see Table I.

.62 Target Computer: . . . . any Series 200 system with a card reader or magnetic tape unit.

.7 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	flagged on listing.
Unsequenced entries:	check (interlock optional)	flagged on listing.
Duplicate names:	check	flagged on listing.
Improper format:	check	flagged on listing.
Incomplete entries:	check	flagged on listing.
Target computer overflow:	no check.	

PROGRAM TRANSLATOR: EASYTRAN

.1 GENERAL

.11 Identity: . . . . Easytran Symbolic Program Translator.

.12 Description

Easytran is a punched card or magnetic tape oriented translation system that accepts as input symbolic programs in IBM 1400 Series assembly codes and produces as output equivalent Honeywell Series 200 programs in the Easycoder assembly language. A number of Easytran translator programs are provided, each with specialized characteristics and capabilities, as described below.

.121 Easytran 1401

This version of Easytran translates IBM 1401/1460 SPS or Autocoder source language to Series 200 Easycoder language, using an IBM 1401 system as the translating computer. The minimum 1401 configuration required for Easytran 1401 operation is:

- IBM 1401 processor with the Advanced Programming feature.
- 4000 character positions of core storage.
- 4 magnetic tape units.
- 1402 Card Read-Punch.
- 1403-2 Printer with 132 print positions.

There are three phases to the Easytran 1401 translation process. Phase I performs an input edit and reference analysis, and also replaces the 1401 input-output coding with subroutines that permit use of the input-output simultaneity of the Series 200 systems. Phase II performs the translation of instructions. Phase III performs the output edit and produces an Easycoder A source-language deck, a symbol cross-reference listing, a diagnostic listing, a program listing, and a header page with control card print-out.

Once a program has been converted, any hand editing required to ensure that the intentions of the original 1401 programmer have been carried out can be performed in the Easycoder source language. No return to the original SPS or Autocoder language is required.

.122 Easytran B

Easytran B uses a Series 200 system as the translating computer rather than an IBM 1401. The minimum Series 200 configuration is:

- Any Honeywell Series 200 processor with 8,192 characters of core storage and the Advanced Programming and editing instructions
- Four 1/2-inch tape units with IBM Format and Code Compatibility features.
- Card reader and punch with hole-count checking feature.
- Printer with 132 print positions.

An extension of Easytran B over Easytran 1401 permits mixing of IBM 1400 Series SPS and Autocoder source programs in the input stream. This is accomplished by a special prepass that converts all source language input to the Autocoder source language. Easytran 1401 uses different versions of the program when converting SPS or Autocoder programs.

The Easycoder program produced by Easytran includes the coding for input-output routines, but any input-output macro statements must be entered manually by the programmer. If input-output macros are entered, the modified symbolic program is processed with Honeywell's 1/2-inch Tape Input-Output B(M) package in a pre-assembly phase (known as Library Processor B) to link the automatically generated input-output coding with the manually inserted macro statements. The output of this phase is then assembled by the Easycoder A or B program.

.123 Easytran C

Easytran C is an extended version of Easytran B. The following principal difference can be noted:

- Easytran C produces Easycoder symbolic programs as output which are assembled under the Easycoder Assembler C system and executed in the Series 200 Operating System — Mod 1 environment. By contrast, programs translated by Easytran 1401 and Easytran B are assembled by Easycoder A or B and are executed in the environment of the Basic Programming System.
- Easytran C automatically translates IBM IOCS and user macro calls into macro calls compatible with Honeywell's 1/2-inch Tape and Terminal I/O C packages. A separate pass is still required to integrate the macro routines into the object program.
- Easytran C permits translations to be batched for consecutive processing.
- Easytran C requires a minimum of 12,288 characters of core storage for its operation, as compared to the 8,192-character requirement of Easytran B.

.124 Easytran D

The newly-released Easytran D translator embodies a number of features which make it noticeably superior to previous versions of Easytran. It is a comprehensive system that includes facilities to translate, update, and assemble programs in one continuous operation. The final output of the Easytran D system is an executable program which is compatible with the control facilities of the Series 200 Operating System — Mod 1.

The most significant advantage of Easytran D over earlier Easytrans is the addition of the file update features. After initial translation, this update program accepts "change director cards" that will modify an individual symbolic line, a group of lines,

.124 Easytran D (Contd.)

an overlay, or an entire program. Thus, the symbolic output code of the translator can be automatically altered, virtually eliminating the clerical hand-tailoring formerly necessary to resolve any residual problems which the translator could not handle.

Another feature of Easytran D permits either individual translation or bulk translation of IBM Autocoder programs.

Finally, Easytran D handles 1401 absolute addresses in a convenient way. All 1401 actual addresses are related to a series of symbolic tags. If it becomes necessary to modify certain actual addresses in the course of preparing the symbolic program for final assembly, the modifications can easily be made by simply reassigning the corresponding tags. In previous versions of Easytran, 1401 absolute addresses were replaced with fixed values which could be modified only by manual adjustments throughout the program.

The following minimum equipment configuration is required for use of Easytran Symbolic Translator D:

- Any Series 200 processor with Advanced Programming and editing instructions.
- 16,384 characters of memory.
- Four 1/2-inch magnetic tape units.
- Printer with 132 print positions.
- Card reader.

.125 Easytran J

Easytran J translates IBM 1410/7010 Autocoder assembly language into Assembler J language, the symbolic assembly language used with the Series 200 Operating System — Mod 2. (See Section 510:193 for a description of the Operating System — Mod 2 and its associated components.) Easytran J automatically resolves Series 200 and 1410 differences in addressing, indexing, and internal character codes.

Easytran J has the same extended processing facilities as the Easytran D translator that functions under control of the Operating System — Mod 1. The File Update feature, called a "default translator" in Easytran J, reduces the need for hand tailoring of translator symbolic output to an average of 1 per cent of the translated instructions. (The versions of Easytran that lack the File Update feature require hand tailoring of an average of 5 per cent of the translated instructions.)

The first version of Easytran J will be released for field test in the third quarter of 1966 together with the initial offering of Series 200 Operating System — Mod 2.

The minimum hardware requirements for use of Easytran J include:

- Any Series 200 processor with 32,768 characters of core storage and the Optional Instruction package.
- Six 1/2-inch magnetic tape units equipped with the IBM Format and Code Compatibility Features.
- Card reader.
- Printer with 132 print positions.
- Console typewriter.

.13 Originator: . . . . Honeywell EDP.

.14 Maintainer: . . . . Honeywell EDP.

.15 Availability: . . . . . . now in operation except for Easytran J, which is due for release in the third quarter of 1966.

.2 INPUT

.21 Language

.211 Name: . . . . IBM 1401/1460 SPS or Autocoder and IBM 1410 SPS or Autocoder.

.212 Exemptions: . . . . . . most 1400 Series input-output instructions are handled by specialized Series 200 subroutines.

.22 Form

.221 Input media: . . . . . . punched cards or magnetic tape.

.222 Obligatory ordering: . as in original assembly.

.223 Obligatory grouping: . special Easytran control cards must precede main program.

.23 Size Limitations

.231 Maximum number of source statements: . 10,000 SPS or Autocoder lines.

.232 Maximum size of source statements: . one SPS or Autocoder line.

.234 Others —
Maximum number of ORG statements: . . 99.
Maximum number of Execute cards: . . . 39.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . Easycoder or Assembler J.

.312 Language style: . . . . Series 200 symbolic assembly code. (Note that the Easytran output program must be assembled in normal fashion by one of the Honeywell assemblers before it can be executed.)

.313 Output media: . . . . . punched cards or magnetic tape.

.32 Conventions

.321 Standard inclusions: . input-output routines.

.322 Compatible with: . . . . IBM 1410 Operating System IOCS.

.33 Documentation

Subject	Provision
Source program:	listed on right-hand side of List 1.
Object program:	listed on left-hand side of List 1.
Storage map:	none.
Restart point list: . . .	not applicable.
Language errors: . . .	flagged on List 1.
Diagnostics:	indexed and arranged by category on List 2.
Cross-reference table:	List 3.

(Contd.)

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

There are at least four phases in an Easytran conversion process, as described below. A halt occurs at the end of the optional phase 0 for possible operator action; transitions between the other phases are automatic.

Phase 0 (SPS-to-Autocoder Prepass)

Phase 0 converts any SPS statements into symbolic 1401 Autocoder statements, so that the input to Phase I is always Autocoder.

Phase I (Input Edit and Reference Analysis)

The input symbolic program, in Autocoder language, is analyzed and converted to a fixed form. During this processing, symbolic references to actual locations established by EQU statements are replaced by absolute references, and symbolic addresses are substituted for absolute addresses which reference the fixed input-output areas.

A number of passes are made over the program in order to analyze the operands of each instruction. The result of this analysis is detailed information on the form of each referenced entry, which is then used to determine the specific function of each instruction and operand in the program.

Phase II (Translation)

Utilizing the information produced by the reference analysis, one of the following actions is taken for each instruction of the input program:

(1) Its operation code is converted to a one-character pseudo op code that represents a Series 200 instruction;

(2) In-line macro-coding is substituted for the instruction;

(3) The instruction is replaced by a direct call to a subroutine; or

(4) The instruction is deleted. (If the instruction is referenced elsewhere in the program, it is changed to an NOP instruction.)

Phase III (Output Edit)

In Phase III, the proper Easycoder mnemonic operation code is substituted for each one-character pseudo op code provided during the second phase. Phase III performs any adjustment of address modifiers that may be required as a result of insertions, deletions, and substitutions performed during Phase II. In addition, the outputs of the previous phases are combined to produce the following:

(1) An Easycoder or Assembler J symbolic program.

(2) A parallel listing of the Autocoder and Series 200 symbolic programs with diagnostic messages.

(3) An English-language diagnostic listing pointing out any areas where "hand-tailoring" may need to be done by the programmer.

(4) A cross-reference listing of all tags used in the input program.

(5) A control card warning listing (Easytran control card and carriage control card).

Easytran D provides the following additional program phases following the actual translation process.

File Update

The File Update phase allows the programmer to initiate whole series of changes to the program being converted by means of individual change director cards. Input to File Update is the Easycoder or Assembler J symbolic program output from Phase III, plus an input change deck with director cards, and, if necessary, change director cards. Changes can be made applicable to a program, to a segment, or to a line or several lines of a program or segment. The primary output of File Update is a card-image tape in a suitable format for input to Library Processor C.

Library Processor C

Library Processor C inserts macro routines which exist on a library symbolic program tape (SPT) into source programs in response to macro instructions within the source program generated by the Easytran D translator process. The output of Library Processor C can then be merged with previously processed programs to allow bulk translating by the Easycoder C assembler.

Comparable File Update and Library Processor program phases will also be provided within the Easytran J system.

.42 Optional Modes

		Basic	Easytran D and J
.421	Translate:	yes	yes.
.422	Translate and run: . .	no	yes.
.423	Check only:	yes	yes.
.424	Patching:	no	yes.
.425	Updating:	no	yes.

.43 Special Features

.431 Alter to check only: . . yes.

.432 Fast unoptimized translate: . . . . no.

.433 Short translate on unrestricted program: . . . . no.

.44 Bulk Translating: . . . multiple programs can be translated in a single batch.

.45 Program Diagnostics: none (i.e., no facility is included for running automatic traces or providing automatic snapshots during execution of the translated program).

.46 Translator Library

.461 Identity: . . . . Easytran library.

.462 User restriction: . . . none.

.463 Form —
Storage medium: . . . magnetic tape.
Organization: . . . . . sequential.

.464 Contents —
Routines: . . . . input-output routines.
Functions: . . . . macros which replace certain 1401 and 1410 instructions.
Data descriptions: . . none.

.465 Librarianship —

Insertion: . . . . normally by manufacturer; can be performed by installation.

Call procedure: . . . . set bit in selector table.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . see Table I.

.512 Space required for each input-output file: . . . . card and printer file areas are included in Table I; magnetic tape files require one buffer area per input file, and a single output buffer.

.513 Approximate expansion of procedures: . typically 1.1 to 1 in body of translation, plus fixed overhead as listed in Table I.

.52 Translation Time: . . . approximately 5 minutes overhead, plus 1 minute per 1,000 characters of input program size (e.g., 13 minutes for an 8K 1401 program).

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . internal processing runs at about 80 per cent of maximum potential of the Series 200 processor; overlapping is available for punched card and printer operations, and optionally for magnetic tape.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . 4-tape, 4K IBM 1401 or 8K Honeywell Series 200 system.
132-position printer.
Advanced Programming feature.

.612 Larger configuration advantages: . . . . . . additional tape units speed translation; larger memories reduce the probability of passes being repeated due to table overflows.

Easytran D environment permits smoother, less time-consuming translations with its minimal hand editing requirement and bulk translation procedures.

Easytran J environment permits conversion of IBM 1410/7010 programs.

TABLE I. FIXED STORAGE REQUIREMENTS FOR EASYTRAN OBJECT PROGRAMS

Name of Subroutine	Core Storage Requirement in Characters		
	Basic (A and B)	Easytran C	Easytran D
Commonly used constants and routines (including dynamic op code table, read/write channel select, branch on indicator, halt, and seven-character store B-address Register)	351	391	630
Subroutine common entry	74	164	548
Decimal to binary conversion	153	148	346
Binary to decimal conversion	-	-	481
Clear storage	93	90	110
Read, print, punch buffers	375	375	375
I/O subroutine entry	37	101	100
Card Read	185	189	304
Card Punch	102	92	275
Print	253	253	883
Carriage Control	346	348	348
Buffered tape I/O routines	1724	1330	1776
Move and suppress zeros	27	18	140
Move and insert zeros	-	-	160
Multiply and divide	371	282	375

Note: The subroutine core storage requirements for Easytran J have not been released to date.

(Contd.)

.62 Target Computer

.621 Minimum configuration: . . . . execution of converted 1401/1460 programs requires any Series 200 system with Advanced Programming feature, Editing instructions, card reader and punch with hole-count checking.

execution of converted 1410 programs requires any Series 200 processor with the Table Lookup instructions and a minimum of 32,768 characters of core storage.

.622 Usable extra facilities: . . . . printer.
magnetic tape units (must have IBM compatibility features).
mass storage units (with Easytran J).

.7 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	entry on diagnostic list.
Unsequenced entries:	no check.	
Duplicate names:	check	entry on diagnostic list.
Improper format:	check	entry on diagnostic list.
Incomplete entries:	check	entry on diagnostic list.
Target computer overflow:	no check.	
Inconsistent program:	no check.	

.8 ALTERNATIVE TRANSLATORS: . . . Bridge 1401 (see Section 510:181).

OPERATING ENVIRONMENT: BASIC PROGRAMMING SYSTEM

.1 GENERAL

.11 Identity: . . . . Honeywell Series 200 Basic Programming System.

.12 Description

The Basic Programming System is a loosely integrated software system offered by Honeywell for users of Series 200 computers with from 4K to 12K characters of core storage. The numerous components of the package are oriented for use with punched card, paper tape, and magnetic tape equipment. The operating environment contains minimal supervisory control. Operator intervention between independent programs is generally required unless run-to-run linkage is supplied by users' routines.

Table I lists the principal independent program elements supplied with the Basic Programming System. Also listed are comparable integrated control routines that are provided in the larger Honeywell Mod 1 and Mod 2 Operating Systems as described in Sections 510:192 and 510:193, respectively. All program elements listed in Table I can function within 4K characters of core storage except the Macro Program, which requires at least 8K characters.

The language translators of the Basic Programming System are listed below. These translators, excluding the machine-oriented assembler, are oriented toward users converting to Honeywell Series 200 systems from either unit record (tab) equipment or from IBM 1400 Series computer systems.

- TABSIM: This "load and go" program is designed to simulate the report-writing functions of punched card tabulating equipment. The input format is compatible with FARGO, the IBM 1400 Series equivalent report generator. See Paragraph 510:151.14 for additional information on TABSIM.
- Report Generator: This program produces its output in a form acceptable to the machine-oriented assembler. Its function is to simulate the report writing functions of tabulating equipment in a form equivalent to the IBM 1401 offering. See Section 510:151 for additional information.
- COBOL B: This compact COBOL compiler provides the user of unit record equipment with a means of transition that is more flexible than the basic offerings of TABSIM. See Section 510:161 for a detailed description of COBOL B.
- Bridge: This routine facilitates conversion of IBM 1401 machine-language programs to Honeywell Series 200 machine-language programs. See Section 510:181 for a detailed description of Bridge.
- Easytran: This routine facilitates conversion of IBM 1401 assembly-language programs to equivalent Honeywell Series 200 assembly-language programs. This technique permits standardized program conversions that include the incorporation of Honeywell's simultaneous input-output capabilities, along with standardized assembly-language program documentation. See Section 510:183 for a detailed description of Easytran.

TABLE I: BASIC PROGRAMMING SYSTEM ELEMENTS AND COMPARABLE OPERATING SYSTEM CONTROL ROUTINES

Basic Programming System Elements	Function	Comparable Control Routines in Larger Operating Systems
Easycoder Phase II	Translates intermediate language to fixed object code	Linkage Editor
Card Image Loading Routine	Loads a program and initiates execution	Job Control
Macro Program	Provides common input-output operations requested by users' programs	Input-Output Control
Update Routines	Library maintenance	Librarian
Search Routine	Finds a program for loading	Job Control
The Basic Programming System user	Maintains overall system control	Supervisor

(Contd.)

.12 Description (Contd.)

Easycoder: This is a machine-oriented assembler program that includes the capability to process macro routines supplied both by the manufacturer and the user. See Sections 510:171 and 510:182 for detailed descriptions of the Easycoder language and translator, respectively.

.13 Availability

Entire Basic Programming System: . . . . 1965.

.14 Originator: . . . . Honeywell EDP.

.15 Maintainer: . . . . . . Honeywell EDP.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . none; the user can elect to store program elements as separate card decks or reels of paper tape or as card images on magnetic tape.

.212 Independent programs: entered via punched cards, paper tape, or magnetic tape.

.213 Data: . . . . from any device under control of I/O routines (either Honeywell or user-supplied) located within individual programs.

.214 Master routines: . . . Search and Loader routines are loaded as independent programs.

.22 Library Subroutines: . can be incorporated with macro program processing prior to assembly.

.23 Loading Sequence: . . sequence is determined by the order in which programs are loaded; alternatively, the operator can manually enter the 6-character program name and initiate a magnetic tape search for the program to be loaded.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . loading of program segments can occur by calling the Loader.

.312 Occupation of working storage: . . . . storage allocation is fixed at program generation time.

.32 Input-Output Units

.321 Initial assignment: . . specified in individual programs.

.322 Alternation: . . . . . . handled by I/O routines located in individual programs.

.323 Reassignment: . . . . provided by programmer or operator.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: . . . . through Honeywell-supplied input-output routines.

.42 Multiprogramming: . . "SCOPE" provides concurrent execution of up to 3 data transcription operations. See Paragraph 510:151.15.

.43 Multi-sequencing: . . . none.

.44 Errors, Checks, and Action*

Error	Check or Interlock	Action
Loading input error	check	error halt.
Allocation impossible:	none.	
In-out error-single:	check	error routine retry.
In-out error-persistent:	check	error halt.
Storage overflow:	none.	
Invalid instructions:	check	printed message.
Program conflicts:	none.	
Arithmetic overflow	check	error halt.
Underflow:	check	error halt.
Invalid operation:	check	printed message.
Improper format:	check	printed message.
Invalid address:	check	printed message.
Reference to forbidden area:	none.	

*No single operating system component is responsible for overall system error checking. Most errors must be caught either at assembly or load time.

.45 Restarts: . . . . provided by programmer.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . none.

.512 Snapshots: . . . . dynamic memory dumps are available by calling the dump utility program.

.52 Post Mortem: . . . . . initiated by operator.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . indicated by contents of address register at halt point.

.612 Action required by operator: . . . . indicated by contents of address register at halt point.

.613 Reporting progress of run: .... programmer's responsibility; practical if console typewriter is available.

.62 Operator's Decisions: .... manual actions by operator.

.63 Operator's Signals

.631 Inquiry: .... none.
.632 Change of normal progress: ..... manual actions by operator.

.7 LOGGING: ..... provided by programmer.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: .. at least 4,096 characters of core storage, card reader, card punch, printer, and Advanced Programming feature.

.812 Usable extra facilities: .... up to 4 magnetic tape units and paper tape equipment.

.813 Reserved equipment: 80 characters of core storage for card loader; 1 magnetic tape unit and 177 characters of core storage for the resident search and load function.

.82 System Overhead

.821 Loading time: .... limited by speed of input device.

.822 Reloading frequency: ..... program search and load routines can remain in storage and can be called by users' programs.

.83 Program Space Available: ..... C-177, where C is the core storage capacity in characters.

.84 Program Loading Time: .... limited by speed of input device.

.85 Program Performance: .. the load function is not required during object program execution, except when calls for further programs are made. No running overhead is therefore associated with the system.

OPERATING ENVIRONMENT: OPERATING SYSTEM—MOD 1

.1 GENERAL

.11 Identity: . . . . Honeywell Series 200 Operating System—Mod 1.

.12 Description

Operating System—Mod 1 is supplied by Honeywell for use with Series 200 computer systems that have between 12K and 262K characters of core storage. Systems that have less than 12K characters of core storage will use those facilities provided with the Basic Programming System (Section 510:191). Systems that have more than 65K characters of core storage and include the Optional Instruction Package (available only with Models 1200, 2200, and 4200) can use Operating System—Mod 2 (Section 510:193).

Two versions of the Operating System—Mod 1 are provided: Tape Resident and Mass Storage Resident. The Tape Resident Operating System—Mod 1 has been in use since the release of the original Honeywell 200 system in 1964. This version was formerly called PLUS. The Mass Storage Resident Operating System—Mod 1 was announced in May 1966 for delivery in the fourth quarter of 1966.

.121 Operating System—Mod 1 (Tape Resident)

The Tape Resident Operating System requires use of from three to six magnetic tape units. The nucleus of the system is a resident loader/monitor which contains provisions for automatic job sequencing, program library searching, program loading, and overlay handling. No centralized input-output routines are provided.

Operator-to-monitor communication is accomplished directly through the control panel or by means of parameter cards which can be entered by the operator directly into a standard communication area. The operator can thus call for the execution of any program or any group of programs (job). Parameter cards can also be placed into the standard input file to provide for automatic job sequencing.

A major feature in the program library search functions of the Tape Resident Operating System is the assignment of key characters to programs and program segments as a means of grouping programs for execution. These keys are known as "visibilities"; each program or segment can be assigned one or several of the 37 visibilities recognized by Mod 1; each visibility is denoted by a single character code: A-Z, 0-9, and *.

When operating in the visibility mode, the loader is conditioned to recognize only programs which it "sees"; i.e., programs which include a particular visibility as part of their own set. There are many useful applications of this feature. For example, in testing a system of interrelated programs, it is possible to maintain, on the same tape, several alternative program blocks. Each alternative is associated with a particular visibility key. Programs which are common to several versions are made "visible" to several visibilities and therefore need not be duplicated. On the other hand, programs which are specific to a given version, although bearing exactly the same identification, can be placed on the same tape and yet be recognized by the loader on the basis of their unique visibility. Likewise, the visibility scheme can be used to link any set of programs into a given job.

An interrupt control program provides an extension to the resident loader/monitor. Interrupt control provides a limited concurrent processing facility. The monitor/interrupt control combination requires a minimum of 3.6K characters of core storage.

The interrupt control system of Tape Resident Operating System—Mod 1 permits switching of processor control between one program with extensive processing requirements and one with high peripheral device dependency. Through use of the interrupt system, a background program can be run in normal mode while a foreground program is executed in interrupt mode. When a peripheral data transfer is initiated in the foreground program, control is transferred to the background program until the foreground program's data transfer ends. Upon data transfer termination, an interrupt signal is issued to the peripheral control unit involved and control is returned to the foreground program.

Standardization of translator and compiler machine-language output is provided by the Tape Resident Operating System. Thus, the outputs from the various language processors can be readily combined into a single executable job.

The following language processors are provided to function under control of the Tape Resident Operating System—Mod 1.

- Easycoder Assemblers C and D (Sections 510:171 and 510:182).
- FORTRAN Compilers D and H (Section 510:163).
- COBOL Compilers D and H (Sections 510:161 and 510:162).
- Easytran D (Section 510:183).

Input-output routines are entered into each object program at generation time by the various language processors.

Tape Resident Operating System—Mod 1 also includes a comprehensive library of utility routines to facilitate program maintenance and debugging, and to assist in general production tasks. Utility functions available include: dynamic and postmortem dump routines; a program correction routine; a standard peripheral conversion package (which can perform up to three data transcription operations concurrently); general-

.121 Operating System—Mod 1 (Tape Resident) (Contd.)

ized tape, drum, and disc I/O handling routines; a data file generator; and facilities for communication with the operator.

.122 Operating System—Mod 1 (Mass Storage Resident)

The Mass Storage Resident (MSR) Operating System—Mod 1 consists of integrated software modules designed to assist the user in efficient usage of his mass storage equipment. These modules provide four major control functions:

- Supervision: All functions of the Mass Storage Resident (MSR) Operating System—Mod 1 are performed under the control of a supervisor program. Portions of this program are permanently resident in main memory, and the resident portions are relocatable (except for the fixed-location communications area). Other portions of the supervisor are loaded from mass storage as required. The supervisor performs the same tasks as the resident loader, monitor, and interrupt control routines of the Tape Resident Operating System.

- Data Management: All mass storage files are controlled and accessed by a common set of Data Management routines. The primary functions provided by the routines include file support and input-output control.

  File support includes allocator, load, and unload routines. These routines create, organize, and reorganize data files, and also convert these files from one storage medium to another.

  The allocation routine reserves storage areas described by the user, modifies a volume directory as necessary, and formats and initializes the area as required. The load routine loads data into a previously allocated file, establishes the sequence of items, and sets up indexes as required by the file organization. The unload routine unloads data from a mass storage file, reorganizing the data so that storage utilization and access time are improved when the file is reloaded.

  The input-output functions furnish the programmer with macro routines to access files that are arranged in one of the three supported file organizations: sequential, direct, or indexed sequential.

- Program Development: Program development support includes routines for language translation, program file maintenance, and program analysis. A specialized monitor routine controls the automatic sequencing of the various steps in a program development job.

  The Easycoder and FORTRAN language translators are comparable to the D-level versions of the Tape Resident Operating System. The COBOL compiler provided is comparable to COBOL B in the Series 200 Basic Programming System (described in Section 510:161).

- Service: The utilities provided with the MSR Operating System—Mod 1 are generally equivalent in function to those provided with the Tape Resident Operating System (see Section 510:152, Problem Oriented Facilities). The volume preparation routine is of special interest to users of mass storage equipment. This routine prepares a mass storage volume for use in the Mass Storage Resident Operating System by checking for bad surface areas, formatting tracks, and establishing a volume label and directory. Sort routines and data edit routines are also provided for use with mass storage devices.

.13 Availability: . . . . 1964 (Tape Resident). 1966 (Mass Storage Resident).

.14 Originator: . . . . Honeywell EDP Division.

.15 Maintainer: . . . . Honeywell EDP Division.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . yes.

.212 Independent programs: may either be placed on a run tape, in a standard input file, or, in the case of MSR, in a mass storage device.

.213 Data: . . . . may be input from any device under control of I/O routines located in each individual program or supplied by the MSR Data Management routines, or input from standard input file and distributed on programs' private files.

.214 Master routines: . . . . the loader/monitor program searches the program file for a program, clears and punctuates memory, and loads and starts the program.

.22 Library Subroutines: . . can be incorporated as part of the loading process, or called by the program during a run.

.23 Loading Sequence: . . . sequence can be determined externally, through the sequence of control cards, or internally, through the sequence of programmed calls.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Segmenting of program: Operating System—Mod 1 accepts multi-segment programs; segment loading occurs upon calls to the loader.

.312 Occupation of working storage: . . . . storage allocation is performed at generation or subprogram collection time.

.32 Input-Output Units

.321 Initial assignments: . . specified by operator through control cards.

(Contd.)

.322 Alternate assignments: handled by I/O routines located in each individual program (in the Tape Resident version), or by the Data Management function (in the Mass Storage Resident version).

.323 Reassignment: . . . . . . own coding is required.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: own coding is required.

.42 Multiprogramming: . . . limited to two main programs: one with high processing requirements and one with high peripheral device requirements.

.43 Multi-Sequencing: . . . . none.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	programmed check	error halt.
Allocation impossible:	none.	
In-out error (single):	programmed check	reread or rewrite.
In-out error (persistent):	programmed check	error halt.
Storage overflow:	none.	
Program conflicts:	none.	
Arithmetic overflow:	none.	
Invalid operation:	programmed check	program is rejected.
Improper format:	programmed check	program is rejected.
Invalid address:	none.	
Reference to forbidden area:	none.	

.45 Restarts

.451 Establishing restart points: . . . . own coding.

.452 Restarting process: . . own coding.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic: . . . . dynamic memory and tape dumps are available through calls to utility programs.

.52 Postmortem: . . . . dumps can be initiated by calls written into the programmer's own coding or originated by the operator from system-provided utility programs.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . indicated by address register contents at halt point.

.612 Action required by operator: . . . . indicated by address register contents at halt point.

.613 Reporting progress run: . . . . comments cards in input file are listed.

.62 Operator's Decisions: . . . . manual actions by operator.

.63 Operator's Signals

.631 Inquiry: . . . . none.

.632 Change of normal progress: . . . . manual actions by operator.

.7 LOGGING

.71 Operator Signals: . . . . not recorded.

.72 Operator Decisions: . . not recorded unless console typewriter is available.

.73 Run Progress: . . . . . . comments cards in input file.

.74 Errors: . . . . not recorded unless console typewriter is available.

.75 Running Times: . . . . . not recorded.

.8 PERFORMANCE

.81 System Requirements

		Tape Resident	Mass Storage Resident
.811	Minimum configuration:	12,288 core storage positions. card reader. printer. Advanced Programming feature. 3 magnetic tape units.	12,288 core storage positions. card reader. printer. Advanced Programming feature. 1 mass storage device.
.812	Usable extra facilities:	4 magnetic tape units. paper tape equipment. card punch.	additional mass storage devices. additional magnetic tape units paper tape equipment. card punch.

	Tape Resident	Mass Storage Resident
.813 Reserved equipment:	1 tape unit and 1,400 characters of core storage (for a resident loader/monitor operating in 3-character addressing mode, and using a control panel as message medium). Memory requirements increase to 2,600 characters for a resident monitor in 4-character addressing mode using a console typewriter as message medium. The Interrupt Control program requires an additional 1,000 characters of core storage.	1,500 characters of core storage and 2.9 million characters of a mass storage device for system residence.

.82 System Overhead

.821 Loading time: . . . . . . negligible.

.822 Reloading frequency: . loader/monitor program is always in core storage.

.83 Program Space Available

Tape Resident: . . . . . . C-1,400 to C-3,600, where C is the core storage capacity in characters.

Mass Storage Resident: C-1,500.

.84 Program Loading Time: . . . . input device speed.

.85 Program Performance: neither the Tape Resident nor Mass Storage Resident Operating System is operational during object program execution except when calls for additional routines are made or when interrupt service is required. Therefore, no running overhead is associated with the system. Any transfer of control to interrupt routines and then to the other main program in a two-program multiprogramming mix requires 500 microseconds.

OPERATING ENVIRONMENT: OPERATING SYSTEM—MOD 2

.1 GENERAL

.11 Identity: . . . . Honeywell Series 200 Operating System — Mod 2.

.12 Description

The Series 200 Mod 2 Operating System consists of an integrated set of programs that provide facilities for supervision of overall system operation, development of user programs, maintenance of both user and Honeywell-supplied programs, job and data control, and utility operations. Series 200 processors that can use Mod 2 include Models 1200, 2200, and 4200 that have Table Lookup instructions and at least 49K characters of core storage.

All of the Mod 2 language processors generate common-language relocatable program modules that can be easily combined by the control routines of the system. Unlike the Mod 1 (Tape Resident) Operating System, Mod 2 assumes responsibility for all input-output operations, both at the physical and logical levels. Flexibility is provided for data transfers to and from card, tape, mass storage, and communications equipment.

The minimum hardware configuration required for use of the Mod 2 Operating System — in addition to the processor and core storage requirements already mentioned — includes five 1/2-inch magnetic tape units (Type 204B) and a tape control equipped with the IBM Format and Code Compatibility features. A mass storage unit can be used as an alternate device for two of the five required magnetic tape units. Other required peripherals include a card reader, a printer with 132 print positions, and a console typewriter.

Release dates of the Operating System — Mod 2 components extend from the third quarter of 1966 (for the initial system) to the fourth quarter of 1967 (for the fully expanded system). Table I lists the principal components of Mod 2 together with their scheduled availability dates.

.121 Processing Programs

The processing programs controlled by the Mod 2 Operating System include source language translators, programs for conversion of IBM 1410/7010 Autocoder programs, service programs, and the user's problem programs. The initial versions of the language translators supplied with Mod 2 include the facilities provided by the highest level of the Operating System — Mod 1 translators, differing only in the fact that Mod 2 programs produce relocatable program-module output, rather than fixed object-code output. Language facility extensions, primarily in the area of mass storage handling capabilities, will be provided approximately one year after initial Mod 2 deliveries. The language translators available with Mod 2 include the following:

- Assembler J: This is a new Series 200 symbolic assembly system designed for use exclusively with the Operating System — Mod 2. The Assembler J language is a high-level machine-oriented language that includes statements to control program generation and execution in a monitored, multiprogramming environment. Five types of statements are provided: (1) Imperative statements that are directly translated into machine-language instructions; (2) Declarative statements that define symbols and establish common and peculiar data areas, data constants, and address constants; (3) Linkage Loader statements that direct the independent Linkage Loader program to convert the relocatable Assembler J output into absolute machine code; (4) Control statements to direct the contents and form of the card and print output of Assembler J and to direct the address generation in all subprograms; and (5) Macro statements that enable the programmer to use the library of macro routines and to insert new macro routines into the library. In all, more than 200 assembly-language statements are provided.
- FORTRAN J: The FORTRAN J language is a full implementation of ASA FORTRAN IV. Features include TRACE debugging statements, mixed-mode arithmetic statements, and the acceptance of FORTRAN II I/O statements. Section 510:163 describes the currently available Series 200 FORTRAN languages.
- COBOL J: COBOL J has the same basic language facilities as COBOL H (described in Section 510:162). The library copy facility included with COBOL H becomes a function of the centralized system maintenance control program of Mod 2.
- Easytran J: As described in Section 510:183, Easytran J is a conversion program that is designed to translate IBM 1410/7010 Autocoder assembly language programs into Honeywell Series 200 Assembler J assembly-language programs. Easytran J will resolve, at the assembly-language level, basic machine dissimilarities, such as in the areas of addressing, indexing, and internal character codes. It is estimated by Honeywell that only one percent of the original IBM 1410/7010 Autocoder instructions will require hand editing following the Easytran J conversion process. Converted programs then become components of the Mod 2 Operating System. These programs are translated by Assembler J, processed by the Linkage Loader, and executed under control of the Resident Monitor.

In addition to the language translators, a number of service routines are included among the processing programs available with Mod 2. These include Linkage Loader J, System Maintenance J, Tape Sort J, Mass Storage Sort J, and program testing and media preparation services.

TABLE I: RELEASE DATES FOR OPERATING SYSTEM — MOD 2 COMPONENTS

PROGRAM	AVAILABILITY DATE
Tape Resident Components	
Language Processing	
Assembler J	3rd qtr 66
COBOL J	3rd qtr 66
FORTRAN J	1st qtr 67
1410/7010 Easytran J	3rd qtr 66
Program Editing and Maintenance	
System Maintenance J	3rd qtr 66
I/O Control System J	3rd qtr 66
Input-Output Control	
Input-Output Editor A	3rd qtr 66
Operation Control	
System Monitor J	3rd qtr 66
Data Transcription and Editing	
Linkage Loader J	3rd qtr 66
Tape Sort J	3rd qtr 66
Utility J	3rd qtr 66
Language Processing (extended)	
COBOL J	4th qtr 67
FORTRAN J	4th qtr 67
Easytran J	1st qtr 67
Input-Output and Operation Control (extended)	
I/O Control System J	1st, 2nd, 3rd, and 4th qtr 67
System Monitor J	1st and 3rd qtr 67
SCREEN J	2nd qtr 67
Data Transcription and Editing (extended)	
Tape Sort J	4th qtr 67
Linkage Loader J	4th qtr 67
Mass Storage Resident Components	
Basic Mass Storage Capability	
Assembler J COBOL J System Maintenance J System Monitor J I/O Control System J Linkage Loader J Utility J	1st qtr 67
Extended Mass Storage Capability	
COBOL J FORTRAN J I/O Control System J	3rd qtr 67

(Contd.)

.121 Processing Programs (Contd.)

Linkage Loader J prepares absolute machine-language programs for execution by selecting and combining relocatable program modules generated by the source-language translators. Complete programs may be built from any combination of program modules.

System Maintenance J creates, edits, and maintains the Honeywell-supplied tape file containing all elements of the Mod 2 Operating System required for a specific user's installation. These elements are in the form of symbolic source-language modules. System Maintenance J also maintains the System Operating File containing all user and Honeywell-supplied programs in absolute format. This tape or mass storage resident file can also contain libraries of modules in relocatable machine language and symbolic source language. The file containing the output of the language processors is also handled by System Maintenance J.

Based on control card specifications supplied by the user, System Maintenance J can create a new System Operating File by adding program units in a specified order. System Maintenance J can also select a source module from a system file, produce a printed listing, and place it on another file for later system input. The ability to selectively update the various system files is also provided.

Tape Sort J is a program package that consists of one routine in absolute format (called Sort Definition J) and several other program modules in relocatable format. Sort Definition J, as its name implies, selects the relocatable sort/merge modules required to create the user's particular sorting program. The user can specify fixed or variable-length records, the number and size of key fields, and the presence or absence of user-written modifications.

Mass Storage Sort J operates on fixed-length data records residing on a mass storage device. Up to ten sorting keys can be accommodated. Honeywell has released no estimates on the performance of Sort J to date.

.122 Control Programs

The control programs of the Mod 2 Operating System handle all interrupt servicing, input-output operations, and communications with the operator and other programs. The principal control programs are the Resident Monitor J, Transitional Monitor J, and Input-Output File Controller J.

Resident Monitor J, the central control portion of Mod 2, is permanently resident in approximately 9,400 characters of core storage. It is responsible for complete control of the computer's internal environment and associated peripheral devices. The Resident Monitor will control the concurrent execution of two main programs. The monitor functions performed during such multiprogrammed operation include detecting the beginning and end of input-output operations, alternating the assignment of processor cycles, and maintaining the integrity of one program while the other program is active.

The Resident Monitor also maintains a communication area and input-output tables in core storage. The communication area contains an information interface between user-written programs and components of the Mod 2 Operating System. Using the input-output tables, the Resident Monitor and the Transitional Monitor work as a team to select and assign peripheral equipment for each program.

The Transitional Monitor J is loaded when necessary by the Resident Monitor to handle automatically the transfer of control between programs within a job. This program interprets the user-supplied system control cards and indicates to the Resident Monitor the functions specified. It then locates the program segment to be loaded and returns control to the appropriate portion of the Resident Monitor.

The Input-Output File Controller J performs all data file access and file control functions. Part of the I/O File Controller remains in core storage with the Resident Monitor at all times and uses approximately 10,500 characters of core storage. In the initial version, the resident portion of the I/O Controller will execute all input-output operations for card equipment, printers, console typewriter and magnetic tape units. Later versions will include extensive facilities for the control of mass storage devices and data communication equipment.

The I/O File Controller J routines direct the dynamic allocation of input-output channels and control the simultaneity of internal computing and I/O operations. They also allocate data buffers, block and unblock tape records, check tape labels, and detect input-output errors. When errors cannot be automatically corrected, the I/O File Controller furnishes the operator with a description of the error and directions for its correction. Exit points are provided in the resident portion of the I/O Controller to permit insertion of own-coding routines.

File access functions are requested by statements in the user's symbolic source programs. In assembly-language programs, file-description statements and macro instructions are directed to the attention of the I/O File Controller. When processed by Assembler J, the macro instructions are translated into machine-language links to the appropriate resident I/O routines. In COBOL and Fortran programs, directions for the I/O File Controller are implemented within the syntax of the compiler language itself.

The I/O File Controller will provide the following automatic data access methods:

- Sequential access: Physical or logical records are stored or retrieved serially, either on demand or on a queued basis.
- Direct access: The programmer specifies an actual physical address, the relative position of the record in the file, or the address at which a search for a key match is to begin.
- Partitioned access: In this method, sequential information is interspersed with special records containing keys and other data. It is suited for efficient storage and retrieval of relatively short strings of sequential records.
- Controlled sequential access: This access method uses a multi-level indexing scheme which retrieves physical or logical records stored either in a logical sequence defined by a key field or randomly by individual keys.

.122 Control Programs (Contd.)

Communications access: The Mod 2 Operating System automatically queues input and output messages sent to and received from remote terminals. Dependent programs treat the queues like data on sequential peripheral devices.

.13 Availability

See Table I for scheduled release dates. The contents of the initial release of Operating System — Mod 2 are roughly equivalent to the facilities of the IBM 1410/7010 Operating System. Later versions of Mod 2 will include multiprogramming control, extensive capabilities for the control of mass storage and data communications devices, improved facilities for converting from the Mod 1 to the Mod 2 Operating System, and improved conversion aids for IBM 1410/7010 users who are moving to a Honeywell Series 200 system.

.14 Originator: . . . . Honeywell EDP Division.

.15 Maintainer: . . . . Honeywell EDP Division.

.2 PROGRAM LOADING

.21 Source Programs

.211 Programs for on-line libraries: . . . . System Operating File (SOF) contains modules in absolute format, including all programs of the Mod 2 Operating System. This file can reside on magnetic tape or on a mass storage device.

.212 Independent programs: loaded at execution time by system control cards from the Standard Input Unit (SIU) which can be a card reader or a magnetic tape unit.

.213 Data: . . . . as required by users' programs.

.214 Master routines: . . . System Operating File and Master History File (MHF). The latter is a backup of the SOF in source-language module form.

.22 Library Subroutines: . macro-routines can be called from the SOF by macro-instructions at assembly time.

.23 Loading Sequence: . . . determined by sequence of system control cards.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . provided through use of the Transitional Monitor if directed by system control cards.

.312 Occupation of working storage: . . . . storage is allocated in a fixed fashion by the Resident Monitor prior to program load; overlay areas are also set aside at that time.

.32 Input-Output Units

.321 Initial assignment: . . . programmer names symbolic device; system control cards assign devices to the symbolic names at execution time.

.322 Alternation: . . . . prepared by system control statements; made operational by direct request of user's program.

.323 Reassignment: . . . . . . effected by system control cards if job is aborted prematurely.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: controlled by the resident portion of the I/O File Controller.

.42 Multiprogramming: . . up to two main programs, controlled by the Resident Monitor.

.43 Multi-Sequencing: . . . no provisions.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	check	coded message on printer.
Allocation impossible:	check	Transitional Monitor message.
In-out error — single:	check	interrupt.
In-out error — persistent:	check	interrupt.
Storage overflow:	check	interrupt.
Invalid instructions:	check	interrupt.
Arithmetic overflow:	check	interrupt.
Invalid operation:	check	interrupt.
Improper format:	check	interrupt.
Invalid address:	check	interrupt.
Reference to forbidden area of core memory:	check	interrupt.

.45 Restarts: . . . . Resident Monitor's checkpoint routine writes checkpoint program status records when directed; a system control statement directs the restart routine to begin at a specific checkpoint.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . none.

.512 Snapshots: . . . . provided through Storage Print J Routine.

.52 Post Mortem: . . . . . . Storage Print J is executed in response to users' control cards.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . . Transitional Monitor J and I/O File Controller J.

(Contd.)

.612 Action required by operator: . . . . . . Transitional Monitor J and I/O File Controller.

.613 Reporting progress of run: . . . . Resident Monitor J.

.62 Operator's Decisions:. through typewriter console.

.63 Operator's Signals

.631 Inquiry: . . . . through typewriter console.

.632 Change of normal progress: . . . . indicated by coded messages on typewriter.

.7 LOGGING: . . . . as incorporated in user's program.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: . . . . 49,192 characters of core storage. Optional Instruction Package.
5 1/2-inch Tape 204B magnetic tape units* with IBM Format and Code Compatibility features.
1 card reader.
1 printer with 132 print positions.
1 console typewriter.

.812 Usable extra facilities: . . . . all (as incorporated in program).

.813 Reserved equipment: . approximately the first 19,900 characters of core storage (reserved for Resident Monitor and File Controller).

.82 System Overhead

.821 Loading time: . . . . . . dependent upon speed of input unit used.

.822 Reloading frequency: . Resident Monitor need be loaded only once; Transitional Monitor is loaded upon completion of each dependent program.

.83 Program Space Available: . . . . the core storage that remains in excess of the 9,400 characters of storage reserved for the Resident Monitor control routines and the 10,500 characters reserved for the resident portion of the File Controller.

.84 Program Loading Time: . . . . depends upon the speed of the input device used.

.85 Program Performance: . . . . no performance times have been made available by Honeywell to date.

SYSTEM PERFORMANCE

The overall performance of Honeywell Series 200 systems naturally varies widely, depending upon the user's choice of central processor model and peripheral equipment. Therefore, the performance of the Series 200 line on the AUERBACH Standard EDP Reports benchmark measures of system performance has been analyzed separately for representative configurations using each of the processor models. For performance curves, summary worksheets, and analyses of the results, please turn to the System Performance sections of the subreports on the models of interest:

Model 120 . . . . Section 511:201
Model 200 . . . . Section 512:201
Model 1200 . . . . Section 513:201
Model 2200 . . . . Section 514:201
Model 4200 . . . . Section 516:201
Model 8200 . . . . Section 518:201

PHYSICAL CHARACTERISTICS

Model	Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
—	Logic Cabinet (houses six drawers)	57	30	42	620	—	—
	Logic Cabinet (houses four drawers)	39	30	42	450	—	—
H-120							
120-P	Power Unit	36	30	42	980	7.2	8,883
121	Central Processor (2K-16K)	57	30	42	395	*	4,072
121	Central Processor (20K-32K)	57	30	42	470	*	5,568
122	Printer (H-120 only)	76	30	42	790	2.0	5,320
123	Card Reader (H-120 only)	42	30	42	480	1.2	3,400
214-1,2	Card Reader/Punch	44	30	42	550	2.2	6,390
U4	Control for Models 122,123,214-1 and -2 (one drawer)	—	—	—	75	*	852
H-200							
201-P	Power Unit	36	30	42	1,000	9.0	10,990
201	Central Processor (4K-16K)	42	30	42	450	*	5,444
201	Central Processor (20K-32K)	84	30	42	675	*	6,715
201	Central Processor (40K-49K)	84	30	42	750	*	8,361
201	Central Processor (52K-64K)	84	30	42	825	*	10,007
H-1200							
1201-P	Power Unit	36	30	42	1,000	8.4	10,240
1201	Central Processor (16K-32K)	84	30	42	675	*	5,965
1201	Central Processor (49K-65K)	84	30	42	750	*	6,891
1201	Central Processor (81K-98K)	84	30	42	825	*	7,847
1201	Central Processor (114K-131K)	84	30	42	900	*	8,803
H-2200							
2201-P	Power Unit	72	30	42	1,300	9.2	10,787
2201	Central Processor (16K-32K)	72	40	68	1,125	*	7,356
2201	Central Processor (49K-65K)	72	40	68	1,200	*	8,282
2201	Central Processor (81K-98K)	72	40	68	1,275	*	9,238
2201	Central Processor (114K-131K)	72	40	68	1,350	*	10,194

* Power is obtained from Power Unit in processor cabinet.

(Contd.)

Model	Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
H-2200 (Contd.)							
2201	Central Processor (165K)	114	40	68	1,425	*	11,150
2201	Central Processor (196K)	114	40	68	1,500	*	12,106
2201	Central Processor (229K)	114	40	68	1,575	*	13,062
2201	Central Processor (262K)	114	40	68	1,650	*	14,118
1100	Scientific Unit	30	40	68	600	*	3,642
204A-1,2,3	Magnetic Tape Unit (3/4-inch tape)	27	28	69	1,100	2.8	7,300
203A-1	Control Unit for 204A-1,2,3 (one drawer)	—	—	—	75	*	962
204B-1,3	Magnetic Tape Unit (1/2-inch tape)	27	28	61	900	2.1	5,100
204B-2,4	Magnetic Tape Unit (1/2-inch tape)	27	28	61	900	1.7	4,100
203B-1	Control Unit for 204B-1,2,3,4 (two drawers)	—	—	—	75	*	1,460
204B-5	Magnetic Tape Unit (1/2-inch tape)	27	28	69	1,100	2.8	7,300
203B-2	Control Unit for 204B-5 (two drawers)	—	—	—	75	*	1,460
204B-6	Magnetic Tape Unit (1/2-inch tape)	27	28	69	1,100	2.8	7,300
203B-3	Control Unit for 204B-6 (two drawers)	—	—	—	75	*	1,044
204B-7	Magnetic Tape Unit (1/2-inch tape)	27	28	69	900	2.1	5,100
203B-4	Control Unit for 204B-7 (two drawers)	—	—	—	75	*	1,769
204B-8	Magnetic Tape Unit (1/2-inch tape)	27	28	69	1,100	2.8	7,300
204B-4	Control Unit for 204B-8 (two drawers)	—	—	—	75	*	1,769
204B-9	Magnetic Tape Unit (1/2-inch tape)	27	28	69	1,100	2.8	7,300
203B-3	Control Unit for 204B-9 (two drawers)	—	—	—	75	*	1,044
204B-10	Magnetic Tape Unit (1/2-inch tape)	27	28	69	1,100	2.8	7,300
203B-3	Control Unit for 204B-10 (two drawers)	—	—	—	75	*	1,044
204B-12	Magnetic Tape Unit (1/2-inch tape)	27	28	61	900	1.08	2,800
204B-5	Control Unit for 204B-12 (one drawer)	—	—	—	75	*	960
204B-11	Electronic Unit for 204B-12	20	28	61	700	1.68	4,580

* Power is obtained from Power Unit in processor cabinet.

Model	Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
205	Magnetic Tape Switching Unit (1-4 switches)	27	28	61	450	0.2	700
209	Paper Tape Reader	24	22	61	385	0.65	2,080
209	Control Unit (one drawer)	—	—	—	75	*	282
210	Paper Tape Punch	24	22	61	380	0.55	1,785
210	Control Unit (one drawer)	—	—	—	75	*	293
214-1,2	Punched Card Units	44	30	42	550	2.2	6,390
208-1,2	Control Unit for 214-1,2 (one drawer)	—	—	—	75	*	480
220-1,2,3	Console	39	30	42	350	0.75	950
222-1,2,3,4	Printer	85	30	42	900	2.7	6,830
222	Control Unit for 222-1,2,3,4 (one drawer)	—	—	—	75	*	520
222-5	Printer	76	30	42	790	2.0	5,320
222-5	Control Unit (one drawer)	—	—	—	75	*	520
223	Card Reader	42	30	42	520	1.2	3,415
223	Control Unit (one drawer)	—	—	—	75	*	480
224-1,2	Card Reader/Punch	43	24	49	525	0.7	1,700
208-1,2	Control Unit for 224-1,2 (one drawer)	—	—	—	75	*	485
227	Card Reader/Punch	58	30	45	1,300	1.2	3,500
207	Control for 227 Reader (one drawer)	—	—	—	75	*	562
208	Control for 227 Punch (one drawer)	—	—	—	75	*	562
233-2	Control Unit for MICR Sorter/Reader (one drawer)	—	—	—	75	*	496
251	Mass Memory File	30	24	42	300	1.2	5,460
252	Mass Memory File	30	24	42	450	2.5	8,500
253	Mass Memory File	30	50	42	1,000	10.0	13,590
250	Mass Storage Control Unit (one drawer)	—	—	—	75	*	680
270	Random Access Drum	68	30	42	1,250	1.1	2,732
270	Control Unit (one drawer)	—	—	—	60	*	910
281	Single-Channel Communication Control, all models (one drawer)	—	—	—	75	*	1,400
285	Communication Adapter, all models (one drawer)	—	—	—	75	*	1,400
280	Multi-Channel Communication Control, all models (one drawer)	—	—	—	75	*	1,400
303	Display Station	14	14	16	?	?	?
311	Display Station	11	22	11	?	?	?
312	Display Station	11	22	11	?	?	?

* Power is obtained from Power Unit in processor cabinet.
NOTE: Additional information on H-200 cabinetry is presented in Section 510:061, Console.

General Requirements
Temperature: . . . . . . 68°F to 78°F (20°C to 26°C) Dry Bulb.
Relative humidity: . . . 40% to 60%.
Power: . . . . 120/208-volt, 60-cycle, 3-phase.

PRICE DATA

In November 1965, Honeywell announced a major revision in its pricing policy for the Series 200 equipment in a move designed to encourage either immediate purchase or long-term lease contracts. The essential elements of the new policy are summarized in Paragraph .7 of the Honeywell Series 200 Introduction, Section 510:011.

The several columns of price data presented below include the short-term monthly rental prices and the corresponding five-year lease plan prices, illustrating the savings to be gained by renting on the five-year plan. Two columns of purchase price figures are also shown, illustrating the savings to be gained by purchasing the equipment immediately rather than at some time after the first year of installation.

CLASS	IDENTITY OF UNIT		PRICES				
	No.	Name	Monthly Rental (1-Year Term) $	Monthly Rental (5-Year Term) $	Monthly Maintenance $	Purchase (Immediate) $	Purchase (After 1 Year) $
CENTRAL PROCESSORS		Honeywell 120 Central Processor					
	121-1	2,048 characters of memory	880	795	86	32,900	38,700
	121-2	4,096 characters of memory	1,000	910	93	37,700	44,325
	121-3	8,192 characters of memory	1,270	1,140	105	47,800	55,575
	121-4	12,288 characters of memory	1,520	1,375	118	58,200	66,825
	121-5	16,384 characters of memory	1,780	1,605	130	68,750	78,075
	121-6	20,480 characters of memory	1,980	1,790	140	78,370	87,075
	121-7	24,576 characters of memory	2,190	1,975	150	86,470	96,075
	121-8	28,672 characters of memory	2,390	2,160	160	94,570	105,075
	121-9	32,768 characters of memory	2,600	2,345	170	102,670	114,075
		Optional Features					
	1011	Advanced Programming	75	75	6	2,880	3,375
	1013	Edit Instruction	50	50	4	1,900	2,250
	1014	8-Bit Code Handling Instruction	25	25	2	960	1,125
	1015	I/O Adapter (non-simultaneous)	155	140	15	5,740	6,750
	1016	I/O Adapter (simultaneous)	310	280	30	11,500	13,500
		Honeywell 200 Central Processor (includes Multiply-Divide and Program Interrupt)					
	201-2-1	4,096 characters of memory	1,360	1,225	106	50,700	59,625
	201-2-2	8,192 characters of memory	1,615	1,460	119	60,250	70,875
	201-2-3	12,288 characters of memory	1,870	1,690	131	70,000	82,125
	201-2-4	16,384 characters of memory	2,130	1,920	144	81,500	93,375
	201-2-5	20,480 characters of memory	2,380	2,150	156	91,000	104,625
	201-2-6	24,576 characters of memory	2,640	2,380	169	102,000	115,875
	201-2-7	28,672 characters of memory	2,895	2,615	181	112,000	127,125
	201-2-8	32,768 characters of memory	3,150	2,845	194	122,000	138,375
	201-2-9	40,960 characters of memory	3,460	3,120	209	134,000	151,875
	201-2-10	49,152 characters of memory	3,765	3,400	224	149,000	165,375
	201-2-11	57,344 characters of memory	4,075	3,680	239	161,500	166,350
	201-2-12	65,536 characters of memory	4,380	3,955	254	174,000	178,910
		Optional Features					
	01x	Advanced Programming	100	100	8	3,800	4,500
	013	Editing Instructions	90	90	7	3,400	4,050
	015	Eight Additional I/O Trunks	155	140	12	5,750	6,750
	016	Auxiliary Read/Write Channel	50	50	4	1,900	2,250
	017	Stacker Select	25	25	2	950	1,125

CLASS	No.	Name	Monthly Rental (1-Year Term) $	Monthly Rental (5-Year Term) $	Monthly Maintenance $	Purchase (Immediate) $	Purchase (After 1 Year) $
CENTRAL PROCESSORS (Cont'd.)		Honeywell 1200 Central Processor (includes Multiply-Divide, Program Interrupt, and all optional features for H-200)					
	1201-1	16,384 characters of memory	2,665	2,405	196	100,000	117,000
	1201-2	32,768 characters of memory	3,485	3,145	236	131,600	153,000
	1201-3	49,152 characters of memory	4,205	3,795	271	162,400	184,500
	1201-4	65,536 characters of memory	4,870	4,395	304	192,400	213,750
	1201-5	81,920 characters of memory	5,330	4,810	326	210,600	234,000
	1201-6	98,304 characters of memory	5,740	5,180	346	226,800	252,000
	1201-7	114,688 characters of memory	6,100	5,505	369	241,000	267,750
	1201-8	131,072 characters of memory	6,460	5,830	386	255,150	283,500
		Optional Features					
	1114	Storage Protection	50	50	4	1,900	2,250
	1100	Scientific Unit	310	280	24	11,500	13,500
	0191	Optional Instruction Package	50	50	4	1,900	2,250
		Honeywell 2200 Central Processor (includes Multiply-Divide)					
	2201-1	16,384 characters of memory	3,640	3,285	284	135,800	159,750
	2201-2	32,768 characters of memory	4,665	4,210	334	174,050	204,750
	2201-3	49,152 characters of memory	5,590	5,040	379	210,950	245,250
	2201-4	65,536 characters of memory	6,460	5,830	422	243,800	283,500
	2201-5	81,920 characters of memory	7,280	6,570	462	281,200	319,500
	2201-6	98,304 characters of memory	7,995	7,215	497	308,900	351,000
	2201-7	114,688 characters of memory	8,510	7,680	527	336,150	373,500
	2201-8	131,072 characters of memory	9,020	8,140	552	356,400	396,000
	2201-9	163,840 characters of memory	9,995	9,020	599	395,000	438,750
	2201-10	196,608 characters of memory	10,765	9,715	637	425,300	472,500
	2201-11	229,376 characters of memory	11,275	10,175	662	445,500	495,000
	2201-12	262,144 characters of memory	11,785	10,640	687	465,750	517,500
		Optional Features					
	1115	Additional 4 Read/Write Channels and 16 I/O Trunks	100	100	8	3,850	4,500
	1117	Storage Protect	50	50	4	1,900	2,250
	1100	Scientific Unit	310	280	24	11,500	13,500
	0191	Optional Instruction Package	50	50	4	1,900	2,250
		Honeywell 4200 Central Processor					
	4201-1	65,536 characters of memory	10,660	10,080	490	472,500	496,130
	4201-2	98,304 characters of memory	11,670	11,040	540	517,500	543,380
	4201-3	131,072 characters of memory	12,690	12,000	590	562,500	590,630
	4201-4	196,608 characters of memory	14,720	13,920	680	652,500	685,130
	4201-5	262,144 characters of memory	16,750	15,840	770	742,500	779,630
	4201-6	327,680 characters of memory	18,780	17,760	860	832,500	874,130
	4201-7	393,216 characters of memory	20,810	19,680	950	922,500	968,630
	4201-8	458,752 characters of memory	22,840	21,600	1,040	1,012,500	1,063,130
	4201-9	524,288 characters of memory	24,870	23,520	1,130	1,102,500	1,157,630
		Optional Features					
	1101	Scientific Unit	510	480	40	22,500	23,630
	1116	Additional 8 Read/Write Channels and 32 I/O Trunks	510	480	40	22,500	23,630
	1118	Storage Protect	155	140	12	6,750	7,090
		Honeywell 8200 Central Processor (see Model 8200 subreport, page 518:221.101)					

(Contd.)

CLASS	IDENTITY OF UNIT		PRICES				
	No.	Name	Monthly Rental (1-Year Term) $	Monthly Rental (5-Year Term) $	Monthly Maintenance $	Purchase (Immediate) $	Purchase (After 1 Year) $
INTERNAL STORAGE		Mass Memory System					
	250	Mass Memory Control	335	300	33	14,625	14,725
	251	Mass Memory File (15 million chars)	670	600	163	29,250	29,400
	252	Mass Memory File (60 million chars)	1,155	1,045	281	50,625	50,775
	253	Mass Memory File (300 million chars)	2,280	2,058	556	100,125	100,400
		Random Access Drum Storage (all include control unit)					
	270-1	2.6 million characters	950	855	138	41,625	41,725
	270-2	5.2 million characters	1,605	1,450	233	70,425	70,525
	270-3	7.5 million characters	2,260	2,040	328	99,225	99,500
	075	Track Protection	25	25	4	1,125	1,135
INPUT-OUTPUT		Punched Card and Printer					
	227	Card Reader-Card Punch (includes Early Card Read)	560	560	120	30,215	30,215
	207	Card Reader Control (for 227)	245	220	24	10,800	10,900
	208	Card Punch Control (for 227)	215	195	21	9,450	9,500
	060	Direct Transcription (optional)	50	50	5	2,250	2,280
	061	Hole Count Checking (optional)	100	100	10	4,500	4,550
	062	Punch Feed Read (optional)	80	80	8	3,600	3,650
	223	Card Reader and Control	310	280	74	13,500	13,575
	043	51-Column Read (optional)	40	40	4	1,800	1,830
	044	Direct Transcription (optional)	25	25	3	1,125	1,140
	214-1	Card Punch; 100-400 CPM	310	280	74	13,500	13,575
	214-2	Card Reader/Punch; 100-400 CPM	360	325	87	15,750	15,850
	224-1	Card Punch; 262 CPM	310	310	34	19,900	19,900
	224-2	Card Punch; 354 CPM	425	425	41	21,050	21,050
	208-1	Punch Control for 224 and 214-1	155	140	15	6,750	6,875
	208-2	Punch Control and Punch Feed Read feature for 224 and 214-2	230	210	22	10,175	10,225
	065	Reject Stacker (optional)	20	20	1	1,100	1,100
	123	Card Reader; 400 CPM (Honeywell 120 only)	205	185	50	9,000	9,100
	209	Paper Tape Reader (includes control unit)	280	255	34	12,375	12,450
	210	Paper Tape Punch (includes control unit)	230	210	28	10,125	10,225
	222-1	Printer (650 LPM; 96 positions)	820	740	198	36,000	36,100
	222-2	Printer (650 LPM; 108 positions)	870	785	211	38,250	38,350
	222-3	Printer (650 LPM; 120 positions)	925	835	223	40,500	40,750
	222-4	Printer (950 LPM; 120 positions)	1,305	1,180	316	57,375	57,600
	222-5	Printer (450 LPM; 120 positions) (All above printers include control units.)	665	600	161	29,250	29,350
	122	Printer (450 LPM; 120 positions)-Honeywell 120 only	510	465	124	22,500	22,700
	032	Extension of print positions from 120 to 132 for 222-3 and 222-4 Printers (optional)	65	65	16	2,925	2,975
	034	Numeric Print for 222-1, 222-2, and 222-3 Printers (optional)	130	115	12	5,625	5,685
	035	Numeric Print for 222-4 (optional)	25	25	3	1,125	1,140
	1034	Extension of print positions from 120 to 132 for 222-5 and 122 Printers (optional)	50	50	12	2,250	2,280
	206A	Control for 822-3 Printer	155	140	15	6,750	6,800

CLASS	IDENTITY OF UNIT		PRICES				
	No.	Name	Monthly Rental (1-Year Term) $	Monthly Rental (5-Year Term) $	Monthly Maintenance $	Purchase (Immediate) $	Purchase (After 1 Year) $
INPUT-OUTPUT (Cont'd)		Magnetic Tape Units (3/4-inch)					
	204A-1	31,760 characters per second	450	450	100	20,250	20,250
	204A-2	63,520 characters per second	900	900	155	43,200	43,200
	204A-3	88,800 characters per second	900	900	155	43,200	43,200
	203A-1	Tape control for up to four 204A-1 units	280	255	28	12,375	12,450
	203A-2	Tape control for up to four 204A-2 units	280	255	28	12,375	12,450
	203A-3	Tape control for up to four 204A-3 units	410	370	40	18,000	18,100
		Magnetic Tape Units (1/2-inch)					
	204B-1	19,980 char/sec - primary unit	360	325	74	14,800	15,750
	204B-2	19,980 char/sec - secondary unit	310	280	63	12,700	13,500
	204B-3	44,400 char/sec - primary unit	515	460	105	21,150	22,500
	204B-4	44,400 char/sec - secondary unit	460	415	95	19,035	20,250
	204B-5	66,600 char/sec	720	650	147	28,350	31,500
	204B-7	28,800 char/sec	410	370	84	16,920	18,000
	204B-8	64,000 char/sec	615	555	126	24,300	27,000
	204B-9	96,000 char/sec	820	740	168	32,400	36,000
	204B-11	13,300 char/sec - primary unit	280	255	58	12,375	12,475
	204B-12	13,300 char/sec - secondary unit	230	210	48	10,125	10,225
	203B-1	Tape Control for up to eight 204B-1 and 204B-2, or 204B-3 and 204B-4 units	435	395	42	17,220	19,125
	203B-2	Tape Control for up to eight 204B-5 units	435	395	42	17,220	19,125
	203B-4	Tape Control for up to eight 204B-6 or 204B-8 units	435	395	42	17,220	19,125
	203B-5	Tape Control for up to four 204B-11 and 204B-12 units	310	280	30	12,150	13,500
	203B-6	Tape Control for up to eight 204B-9 units	435	395	42	17,220	19,125
	103	Tape Control for up to four 204B-11 and 204B-12 units (includes one 204B-11 unit) - Honeywell 120 only)	460	415	63	19,050	20,250
	050	IBM 729/7330 format (gap length and EOF recognition) for 203B-1, -2, -3, and -4 Tape Controls (optional)	50	50	5	2,250	2,280
	051	IBM code compatibility (BCD) for 203B-1, -2, -3, and -4 Tape Control (optional)	50	50	5	2,250	2,280
	057	IBM (7-track) compatibility for 203B-5 Tape Control (optional)	50	50	5	2,250	2,280
	1055	IBM (7-track) compatibility for 103 Tape Control (optional)	50	50	5	1,900	2,250
		On-Line Adapters					
	212	On-Line Adapter (for direct connection of Series 200 and H-800 or H-1800 Central Processors)	515	460	50	22,500	22,600
	212-1	On-Line Adapter (for direct connection of any two Series 200 Central Processors)	410	370	40	18,000	18,100
		Clocks					
	213-3	Interval Timer (1 second)	80	80	8	3,600	3,650
	213-4	Time of Day Clock	205	185	20	9,000	9,050
	071	Interval Selector for 213-3 (optional)	50	50	5	2,250	2,280

(Contd.)

CLASS	IDENTITY OF UNIT		PRICES				
	No.	Name	Monthly Rental (1-Year Term) $	Monthly Rental (5-Year Term) $	Monthly Maintenance $	Purchase (Immediate) $	Purchase (After 1 Year) $
INPUT-OUTPUT (Cont'd)		Communication Controls					
	281	Single-Channel Communication Control (including adapter)	155 to 230	140 to 210	22 to 34	6,750 to 10,125	6,800 to 10,225
	286-1	Multi-Channel Control (2-3 lines)	215	195	32	9,450	9,550
	286-2	Multi-Channel Control (4-15 lines)	330	295	48	14,400	14,500
	286-3	Multi-Channel Control (16-63 lines)	410	370	60	18,000	18,100
	084-1	Reverse Channel Option	25	25	4	1,125	1,140
	086	Parity Check	50	50	7	2,250	2,280
	087	Long Check	50	50	7	2,250	2,280
	285	Communication Control Adapters (one per line)	30 to 100	30 to 100	5 to 15	1,350 to 4,500	1,375 to 4,600
		MICR Control Unit					
	233-2	Control Unit (for Burroughs Sorter/Reader)	400	360	39	17,550	17,700
		Switching Units					
	205-1	Magnetic Tape Switching Unit	155	140	15	6,750	6,800
	205-2	Magnetic Tape Switching Unit	245	220	24	10,800	10,900
	205-3	Magnetic Tape Switching Unit	340	305	33	14,850	14,950
	205-4	Magnetic Tape Switching Unit	430	390	42	18,900	19,000
	215-1	Communication Switching Unit (used with 285-1, 2 adapters)	75	75	8	3,375	3,425
		Consoles					
	220-1	Program Control	205	185	20	9,000	9,050
	220-2	Hardware Control	310	280	30	13,500	13,575
		Data Station					
	288-1	Central Control Unit	155	140	32	6,750	6,800
	289-2	Page Printer (10 CPS) and Keyboard	65	65	15	2,925	2,975
	289-3	Page Printer (40 CPS) and Keyboard	180	165	37	7,875	7,925
	289-4	Paper Tape Reader (120 CPS)	60	60	14	2,700	2,725
	289-5	Paper Tape Punch (120 CPS)	85	85	19	3,825	3,950
	289-7	Card Reader (120 CPS) - requires option 088-1	70	70	15	3,150	3,180
	289-8	Optical Bar Code Reader (50 CPS) - requires option 088-1	260	230	53	11,250	11,350
	088-1	Buffer Option for 288-1 or 288-2 Control Unit	70	70	15	3,150	3,180
	088-2	Extended Operations Option	30	30	7	1,350	1,375
		Display Stations					
	303	Display Station	77	72	20	2,500	2,650
	311	Display Station	57	53	16	2,900	3,075
	312	Display Station	62	58	18	1,900	2,015
	322	Universal Control Unit	231	216	60	8,600	9,120
	323	Universal Control Unit	267	250	60	10,400	11,025
	331	Communication Module	88	82	10	3,720	3,945
	332	Communication Module	116	106	12	5,150	5,335
	341	Expansion Module	72	68	10	2,700	2,865
	342	Expansion Module	113	106	15	4,300	4,500
	343	Expansion Module	26	24	5	900	955
	351	Message-Editing Module	6	5	-	250	265
	352	Multi-Message Transactions Module (no extra cost)					
	353	Printer Control Module	57	53	8	1,950	2,070
	353A	Printer Control Module	26	24	3	950	1,010
	355	Polling Control Module	16	15	2	530	555
	357	KSR Control Module	57	53	9	2,020	2,145

HONEYWELL 120

Honeywell EDP Division

STANDARD EDP REPORTS

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INTRODUCTION

The Honeywell 120 Processor is a small-scale business-oriented processor that can be connected to any of the Honeywell Series 200 peripheral units, can use any of the Honeywell Series 200 programming languages, and can execute most programs originally written for an IBM 1401. The 120 Processor is restricted by having an unusual set of input-output channels which include built-in controllers for certain specific peripheral units. Therefore, it is likely that these specific units will be used in most Honeywell 120 systems in order to minimize equipment costs. The preferred set consists of the 400-card-per-minute card reader and the 100-card-per-minute card punch, which are housed in a single cabinet and called the Honeywell 214 Card Reader/Punch; the 450-line-per-minute Honeywell 122 Printer; and the 13,333-character-per-second 204B-11 and 204B-12 Magnetic Tape Units.

The Honeywell 120 Processor can contain between 2,048 and 32,768 characters of core storage, with a cycle time of 3 microseconds per character.

Standard features of the Honeywell 120 Processor include: Program Interrupt, two read-write channels, three input-output trunks, and integrated controls.

Optional features are: Advanced Programming, Edit Instruction, 8-Bit Code Handling Instruction, Control Unit Adapter, and Control Unit Adapter with Read/Write Channel.

Nonavailable features are: multiply-divide, floating-point, table look-up facilities, and the Storage Protect feature.

The rental for typical Honeywell 120 systems ranges between approximately $2,000 and $6,000 per month. Deliveries began in March 1966.

This report concentrates upon the characteristics and the performance of the Honeywell 120 in particular. All the general characteristics of the Honeywell Series 200 hardware and software are described in Computer System Report 510: Honeywell Series 200 — General.

The System Configuration section which follows shows the Honeywell 120 in the following standard System Configurations:

I: Typical Card System
II: 4-Tape Business System
III: 6-Tape Business System

These configurations were prepared according to the rules in the Users' Guide, page 4:030.120, and any significant deviations from the standard specifications are listed.

Section 511:051 provides detailed central processor timings for the Honeywell 120.

The input-output channel capabilities of the Honeywell 120, and the demands upon the processor during input-output operations, are described in Section 511:111.

The software that can be used with any Series 200 computer depends upon its core storage capacity and the number and type of peripheral devices. Several versions of the Easycoder Assembler and COBOL Compiler will be made available. These languages, and numerous other support routines for the Honeywell 120, are described in Sections 510:151 through 510:193.

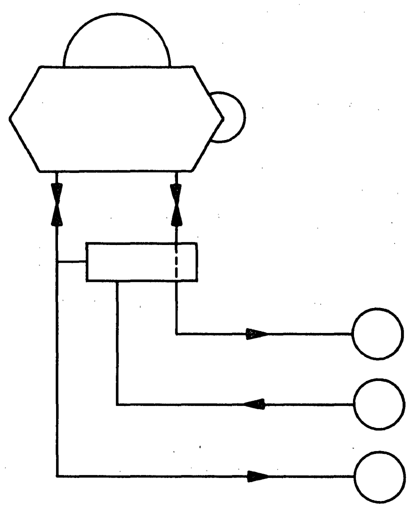
The overall performance of any Honeywell Series 200 system is heavily dependent upon the processor model used. A full System Performance analysis of standardized configurations utilizing the Honeywell 120 Processor is provided in Section 511:201.

SYSTEM CONFIGURATION

The Honeywell 120 Processor differs from all the other Series 200 Processors in that it includes special input-output controllers for certain specific peripheral units: one Model 122 Printer, one Model 214 Card Reader/Punch, and up to four Model 204B-11/12 Magnetic Tape Units. If the optional Simultaneous or Non-Simultaneous I/O Adapter is added, any of the available Series 200 peripheral units can be used in a Honeywell 120 system. These peripheral units are described in detail in the main Series 200 Computer System Report, and their trunk requirements are summarized in the main System Configuration section, page 510:031.100.

.1 TYPICAL CARD SYSTEM; CONFIGURATION I

Deviations from Standard Configuration: . . . . card reader is 20% slower.
card punch is slower.
Multiply-Divide not available.
6 index registers instead of 1.



Equipment	Rental*
121-3 Processor and Console with 8,192 characters of Core Storage.	$1,270
I/O Adapter (Simultaneous) †	310
222-4 Printer and Control: 950 lines/min (120 print positions)**	1,305
223 Card Reader: 800 cards/min**	310
214-1 Card Punch: 100-400 cards/min	310
Optional Features Included: Advanced Programming	75
Edit Instruction	50
TOTAL RENTAL:	$3,630

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $3,285 per month.

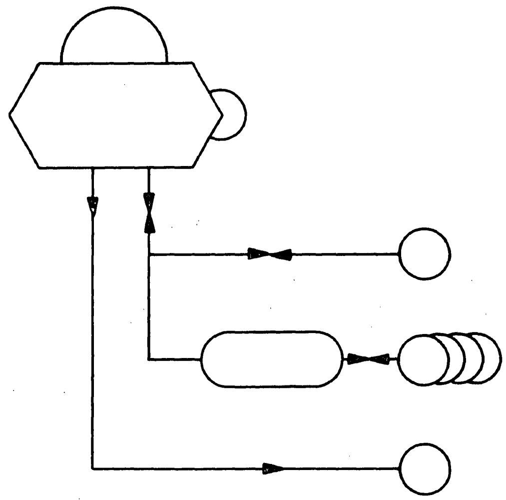
** The basic Honeywell 120 system provides slower card reading and printing speeds. The basic 120 system, with the 450-lpm Model 122 Printer and the 400-cpm reading speed of the Model 214-2 Card Reader/Punch, rents for $2,265 per month in Standard Configuration I.

† This feature provides an additional read-write channel for appreciably better performance on the Standard File Processing Problems.

(Contd.)

.2 4-TAPE BUSINESS SYSTEM; CONFIGURATION II

Deviations from Standard Configuration: . . . . card reader is 20% slower.
ability to overlap printing and one input-output operation with internal processing is standard.



Equipment	Rental*
121-3 Processor and Console with 8,192 characters of Core Storage	$1,270
214-2 Card Reader/Punch: Reads: 400 cards/min Punches: 100-400 cards/min	360
103 Non-Simultaneous Tape Control (includes a 204B-11 Tape Unit)	460
204B-12 Magnetic Tape Units (3): 13,300 char/sec**	690
122 Printer: 450 lines/min (120 print positions)	510

Optional Features Included: . . . .

Edit Instruction	50
Advanced Programming †	75
TOTAL RENTAL:	$3,415

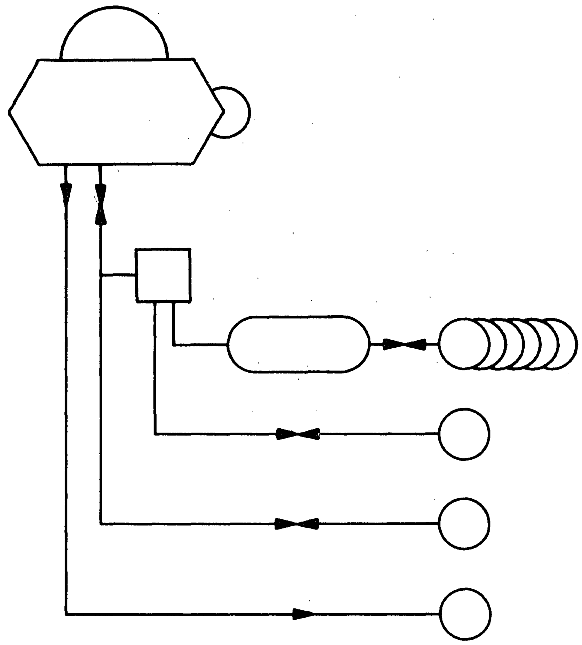
* The rental prices quoted are for a one-year monthly rental base term agreement. The same equipment with a five-year rental agreement leases for $3,100 per month.

** IBM 729 and 7330 Magnetic Tape (7-track) compatibility can be added at an extra cost of $50 per month.

† This optional feature, which permits indexing, indirect addressing, etc., is considered well worth its price in all Honeywell 120 configurations.

.3 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 20% slower.
console typewriter input is included.
Multiply-Divide is not available.



Equipment	Rental*
121-5 Processor and Console with 16,384 characters of Core Storage	$1,780
I/O Adapter (Non-Simultaneous)	155
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Unit (6): 28,800 char/sec (800 CPI)	2,460
220-1 Console (includes Teleprinter)	205
214-2 Card Reader/Punch: Reads: 400 cards/min Punches: 100-400 cards/min	360
122 Printer: 450 lines/min (120 print positions)	510
Optional Features Included: Edit Instruction	50
Advanced Programming	75
TOTAL RENTAL:	$6,030

* The rental prices quoted are for a one-year monthly rental base term agreement. The same equipment with a five-year rental agreement leases for $5,460 per month.

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . Central Processor Models 121-1 through 121-9

.12 Description

The Model 121 Central Processor performs logical, addition, and subtraction operations in either decimal or binary modes. (Honeywell provides subroutines to perform decimal multiplication and division operations.) The Central Processor contains the following six basic functional units:

- Main memory.
- Control memory.
- Control unit.
- Arithmetic unit.
- Input-output traffic control.
- Integrated peripheral control.

Main memory is a magnetic core storage unit that is modularly expandable from 2,048 to 32,768 alphanumeric characters. Cycle time is three microseconds per one-character access, as described in Section 510:041. In Honeywell 120 systems that are equipped with the Advanced Programming optional feature, the first 24 locations locations in main memory are used as six 4-character index registers, and therefore cannot be used as working storage.

Each character position consists of six data bits, one parity bit, and two punctuation bits. The punctuation bits can be used to indicate a word mark, an item mark, or a record mark, which define the length of a data field or instruction, an item, or a record, respectively. An "item" consists of a group of consecutive data fields. (The IBM 1400 series computers utilize only one punctuation bit — the "word mark" bit — and each record mark occupies an entire character position. The two punctuation bits used in Series 200 will decrease data storage requirements and provide increased flexibility in data movement operations. The optional Extended Move instruction, for example, can be terminated by a word mark, an item mark, or a record mark, as specified by the programmer.)

The control memory is a magnetic core storage unit that provides thirteen additional control registers for general usage by the central processor. A 14th register is used with the Advanced Programming optional feature. The number of bit positions in each register varies from 11 to 15, depending on the number of bits required to accommodate the maximum address size of the main core memory unit. For example, eleven-bit registers are sufficient to address 2,048 memory locations, and fifteen-bit registers are required to address 32,768 memory locations.

The functional names of the control memory's registers are:

(1) A-Address Register
(2) B-Address Register
(3) Sequence Register
(4) Read/Write Channel 1 — Current Location Counter
(5) Read/Write Channel 2 — Current Location Counter
(6) Read/Write Channel 3 — Current Location Counter
(7) Read/Write Channel 1 — Starting Location Counter
(8) Read/Write Channel 2 — Starting Location Counter
(9) Read/Write Channel 3 — Starting Location Counter
(10) Work Register 1
(11) Work Register 2
(13) External Interrupt Register
(14) Change Sequence Register (optional).

The control unit controls the sequential selection, interpretation, and execution of all stored program instructions and checks for correct (odd) parity whenever a character is moved from one location to another. It also provides for communication with the operator's Control Panel described in Section 510:061.

The arithmetic unit executes all arithmetic and logical operations. It consists of an adder that can perform both decimal and binary arithmetic and two one-character operand storage registers. The Honeywell 120 is basically a two-address, add-to-storage system. All operations are performed serially by character and terminated when specific punctuation bit configurations are sensed. This means that operand sizes are fully variable and are limited only by the amount of core storage available to hold them.

The input-output traffic control directs the time-sharing of accesses to the main memory by the various peripheral devices and the Central Processor. Up to three input-output operations can occur simultaneously with internal processing.

The basic Model 120 is equipped with integrated peripheral controls for a 450-line-per-minute printer, a 400-card-per-minute card reader, and a card punch that processes from 100 to 400 cards per minute. Also available is the Type 103 Magnetic Tape Control Unit which can be connected directly to the Model 120 peripheral interface and which accepts four 13,300-character-per-second magnetic tape units. The basic 120 processor can accept up to two standard Series 200 peripheral controls instead of the Type 103 control. Either of two optional features (Feature 1015 or 1016) allows the connection of up to five standard Series 200 peripheral controls in addition to those

.12 Description (Contd.)

already mentioned. The exact number of standard controls which can be added to the Model 120 varies according to the I/O trunk and address requirements of the controls.

The degree of peripheral simultaneity achieved by any Series 200 processor depends upon the number of read/write channels with which it is equipped. The Model 120 processor provides as standard equipment three read/write channels, any two of which can be active at one time. Simultaneous use of the third channel is available by means of Feature 1016.

All peripheral devices can use any non-reserved core storage areas of appropriate size as input-output areas.

The processor is well suited to general data manipulation, but editing, indexing, indirect addressing, and full-record data movement capabilities are all extra-cost options, as described below. (The Advanced Programming option provides so much more computing power and programming convenience that it would seem well worth its price of $75 per month in virtually every Honeywell 120 installation.) Binary addition and subtraction, logical AND, exclusive OR, and masking instructions are standard. The optional Move and Translate instruction uses a 64-character translation table to translate any number of consecutive characters from one 6-bit code to another. Handling of 8-bit codes is another optional feature. Multiply-divide hardware is not available in the Honeywell 120.

Instruction length is variable from one to nine characters. Arithmetic and data movement instructions are most commonly seven characters long. Through careful placement of data, instructions can sometimes be "chained" so that a one-character instruction does the work of a seven-character one, resulting in savings in both storage space and execution time. Chaining is possible only when a series of operations is to be performed upon items of data stored in consecutive locations, so that the A- and B-Address Registers do not need to be reloaded before each instruction is executed.

The Honeywell 120 uses a pure binary addressing system. In the 3-character mode, each address portion within an instruction normally consists of three characters, or 18 data bits. Fifteen bits are used to specify an address between 0 and 32,767, and the remaining three bits can specify address modification — either indirect addressing or indexing by one of the six index registers. Both indexing and indirect addressing are part of the optional Advanced Programming feature. A special instruction enables the Central Processor to switch between the three-character addressing mode and a special two-character mode. Use of two-character addresses reduces both storage space and execution time but has two significant disadvantages: only the 4,096 character positions within a single core module can be addressed, and neither indexing nor indirect addressing can be used.

Program interrupt capabilities are provided by the Interrupt Register and a single character instruction called Resume Normal Mode (RNM). The Interrupt Register (IR) is under programmer control; i.e., any particular memory address is loaded into the IR. When the Central Processor receives a demand from an external device, pertinent arithmetic and control indicators are automatically stored and the contents of the sequence register and the IR are exchanged. This action results in a transfer of control to the instructions indicated by the previous contents of the IR. When the RNM instruction is executed, all the pertinent address registers, indicators, etc., are automatically restored to their normal condition (i.e., their status prior to the interrupt), and control reverts to the address within the sequence register.

Typical instruction execution times (using the three-character addressing mode) are 54 microseconds for a 5-character move, 69 microseconds for a 5-digit decimal add, and 57 microseconds for a 5-character compare. These instruction times are reduced by 6 microseconds when two-character addresses are used. Indexing or indirect addressing requires an additional 9 microseconds per modified address.

Optional Features

Advanced Programming: Makes six 3-character registers in core storage available as index registers which can index any 3-character instruction address; allows indirect addressing; permits the loading of data into the control registers; permits the transfer of complete records of data within core storage by a single instruction; allows bi-sequence operations through the use of a consequence register; provides instructions for translating 6-bit codes (MAT), zero and adding or subtracting (ZA and ZS), branching on character equal (BCE), an extended form of the branch on character condition (BCC), a Read Reverse instruction for 204B Magnetic Tapes, and the Change Address Mode instruction (for systems of 4,096 characters or less).

Editing Instructions: All editing capabilities are optional in the Honeywell 120. The capabilities available are those of the basic and Expanded Print Edit of the IBM 1401.

Type 103 Magnetic Tape Control Unit: Allows the use of one Model 204B-11 master tape unit and up to three 204B-12 slave tape units.

Magnetic Tape Compatibility feature: Allows the Honeywell Model 120 Central Processor to read and write tape using industry-compatible BCD code. This feature can be installed on the Type 103 Magnetic Tape Control Unit.

Series 200 Control Unit Adapter: Allows the connection of up to five standard Series 200 peripheral controls in addition to those available with the basic Model 120.

Series 200 Control Unit Adapter with Read/Write Channel: Provides unrestricted and simultaneous use of a third read/write channel.

Eight-Bit Code Handling Instruction: Permits automatic translation of 8-bit codes to and from 6-bit codes through the use of translation tables in core storage. Where an 8-bit code (or any code of up to 12 bits) is involved, two storage positions are used to hold each character; the punctuation bits are not used for code representations.

Instruction Compatibility with the IBM 1401

Please see the detailed comparison of instruction lists in the Instruction List section, page 510:121.100.

(Contd.)

.14 First Delivery: . . . . . March 1966.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add-subtract:	automatic	decimal or binary	1 to N char.
	Multiply:	subroutine	decimal	1 to N char.
	Divide:	subroutine	decimal	1 to N char.

		Provision	Radix	Size
.212	Floating point —			
	Add-subtract:	subroutine.		
	Multiply:	subroutine.		
	Divide:	subroutine.		
.213	Boolean —			
	AND:	automatic	binary	1 to N char.
	Inclusive OR:	none.		
	Exclusive OR:	automatic	binary	1 to N char.

		Provision	Size
.214	Comparison —	(branch on high, low, equal, unequal, or zero balance.)	
	Numbers:	automatic	1 to N char.
	Absolute:	none.	
	Letters:	automatic	1 to N char.
	Mixed:	automatic	1 to N char.
	Collating sequence:	0 through 9, then A through Z, with special symbols interspersed.	

.215 Code translation —
- Provision: . . . . . . automatic with optional features (using code table constructed by programmer).
- From: . . . . any 6-bit or 8-bit code.
- To: . . . . any 6-bit or 8-bit code.
- Size: . . . . 1 to N characters.

.216 Radix conversion: . . none.

		Provision	Comment	Size
.217	Edit format —			
	Alter size:	optional feature	expand but not contract.	1 to N char.
	Suppress zero:	optional		1 to N char.
	Round off:	none		1 to N char.
	Insert point:	optional		1 to N char.
	Insert spaces:	optional		1 to N char.
	Insert $, CR-*:	optional		1 to N char.
	Float $:	optional		1 to N char.
	Protection:	optional		1 to N char.
.218	Table look-up:	none.		
.219	Others —			
	Substitute:	automatic	performs binary masking	1 char.
	Change Addressing Mode:	automatic	shift between 2- and 3-character addresses.	
	Branch on Sense Switches:	automatic	16 possible settings.	

.22 Special Cases of Operands

.221 Negative numbers: . . absolute value, with B zone bit in units position.
.222 Zero: . . . . positive, negative, and unsigned zeros and blanks give same results in decimal arithmetic but are unequal in comparisons.
.223 Operand size determination: . . . . . word mark, item mark, or record mark bits in high or low order digit position. (Some instructions imply one-character operands).

.23 Instruction Formats

.231 Instruction structure: . variable; 1 to 10 characters.
.232 Instruction layout:

Part:	OP	A or I	B	V_1 or C_1	V_2 or C_2	C_3
Size (char):	1	2 or 3	2 or 3	1	1	1

An instruction may consist of:

(1) OP only
(2) OP, V_1
(3) OP, A or I
(4) OP, A or I, V_1
(5) OP, A or I, B
(6) OP, A or I, B, V_1
(7) OP, A, B, V_1, V_2
(8) OP, A or I, C_1
(9) OP, A or I, C_1, C_2
(10) OP, A or I, C_1, C_2, C_3.

.233 Instruction parts —
Name . . . . Purpose
OP: . . . . operation code.
A: . . . . address of an operand or field in core storage.
I: . . . . location of next instruction if a branch occurs.
B: . . . . address of an operand or field in core storage.
V_1 or C_1: . . . . modifier for an operation code, control field for an I/O instruction, or partial address in a translate instruction.
V_2 or C_2: . . . . partial address in a translate instruction or control field for an I/O instruction.
C_3: . . . . control field for an I/O instruction.
.234 Basic address structure: . . . . 2 + 0.
.235 Literals —
Arithmetic: . . . . none.
Comparisons and tests: . . . . yes; single character.
Incrementing modifiers: . . . . . . none.
Masking: . . . . yes; single character mask.
.236 Directly addressed operands —
Internal storage type: . . . . core.
Minimum size: . . . . 1 character.
Maximum size: . . . . total capacity.
Volume accessible: . total capacity.
.237 Address indexing —
.2371 Number of methods: . 1.
.2372 Names: . . . . indexing (with optional Advanced Programming feature).
.2373 Indexing rule: . . . . . addition (modulo core storage capacity).
.2374 Index specification: . . Address Type Indicator — first 3 bits of 18-bit operand address.
.2375 Number of potential indexers: . . . . 6.
.2376 Addresses which can be indexed: . . . . . . all 3-character addresses.
.2377 Cumulative indexing: . . . . none.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . . with optional Advanced Programming feature.
.2381 Recursive: . . . . yes.
.2382 Designation: . . . . . . Address Type Indicator — first 3 bits of operand address.
.2383 Control: . . . . direct address has no indicator bit.
.2384 Indexing with indirect addressing: . . yes.
.239 Stepping: . . . . none.

.24 Special Processor Storage: . . . . 13 registers (14 optionally) in magnetic core control memory, as described on page 511:051.100.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . 1.
.312 Arrangement: . . . . . . programmer can exchange the contents of the sequence register and the change sequence register by use of Change Sequence Mode instruction.
.313 Precedence rule: . . . . programmer indicates register to be used.
.314 Special sub-sequence counters: . . . . none.
.315 Sequence control step size: . . . . 1 character.
.316 Accessibility to routines: . . . . yes; can be loaded and stored by instructions.
.317 Permanent or optional modifier: . . . . no.

.32 Look-Ahead: . . . . none.

.33 Interruption

.331 Possible causes —
In-out units: . . . . . . ready to transfer one unit of data (character or record).
Storage access: . . . . cannot initiate interrupts.
Processor errors: . . cannot initiate interrupts.
.332 Control by routine: . . . yes.
.333 Operator control: . . . . operator can initiate I/O interrupt from console.
.334 Interruption conditions: . . . . execution of current instruction is completed.

(Contd.)

.335 Interruption process —
Registers saved: . . . contents of sequence register and interrupt register are automatically interchanged; address register and indicator settings are automatically saved and restored.
Destination: . . . . . . fixed location (contents of Interrupt Register).

.34 Multiprogramming: . . none.

.35 Multisequencing: . . . . none.

.4 PROCESSOR SPEEDS

All execution times listed here are based on use of the 3-character addressing modes; most instructions are 6 microseconds shorter in the 2-character addressing mode.

D = operand length in decimal digits.
C = operand length in characters.

.41 Instruction Times in Microseconds

.411 Fixed point:
Add-subtract —
Decimal: . . . . 24 + 9D.
Binary: . . . . 24 + 9C.
Multiply: . . . . 3,100 (using subroutine, for 5-digit operands).
Divide:. . . . . 3,700 (using subroutine, for 5-digit operands).

.412 Floating point (performed by subroutines) —
Add-subtract: . . . . . 1,950.
Multiply: . . . . 4,478.
Divide:. . . . . 7,710.

.413 Additional allowance for —
Indexing: . . . . 9 per modified address.
Indirect addressing: . 9 per stage.
Re-complementing: . 6D.

.414 Control —
Compare:. . . . . 27 + 6D.
Branch: . . . . 18.

.415 Counter control: . . . . none.
.416 Edit: . . . . 24 + 21D.
.417 Convert:. . . . . none.
.418 Shift: . . . . none.

.42 Processor Performance in Microseconds

.421 For random addresses (fixed point):
c = a + b —
Decimal: . . . . 48 + 15D.
Binary: . . . . 48 + 15C.
b = a + b —
Decimal: . . . . 24 + 9D.
Binary: . . . . 24 + 9C.
Sum N items —
Decimal: . . . . (24 + 9D)N.
Binary: . . . . (24 + 9C)N.
c = ab: . . . . 3,100 (using subroutine, for 5-digit operands).
c = a/b: . . . . 3,700 (using subroutine, for 5-digit operands).

.422 For arrays of data:
$c_i = a_i + b_j$ —
With indexing: . . . . 225 + 15D.
Without indexing: . . 273 + 15D.
$b_j = a_i + b_j$ —
With indexing: . . . . 183 + 9D.
Without indexing: . . 180 + 9D.
Sum N items: . . . . . (138 + 9D)N.
$c = c + a_i b_j$: . . . . . . 3,180 (using subroutines, for 5-digit operands).

.423 Branch based on comparison —
Numeric data: . . . . . 252 + 6D.
Alphabetic data:. . . . 252 + 6C.

.424 Switching —
Unchecked:. . . . . . . 234; 144 with optional feature.
Checked: . . . . 342; 144 with optional feature.
List search: . . . . . . 189 + (165 + 6D)N.

.425 Format control, per character —
Unpack: 8.9
Compose:. . . . . 12.9 (with optional Editing Instructions).

.426 Table look-up, per comparison
For a match:. . . . . . 159 + 6C.
For least or greatest: . . . . 169.2 + 7C.
For interpolation point:. . . . . 159 + 6C.

.427 Bit indicators —
Set bit in separate location:. . . . . 30.
Set bit in pattern:. . . 33.
Test bit in separate location:. . . . . 58.
Test bit in pattern:. . 87.

.428 Moving: . . . . 24 + 6C.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator.
Zero divisor:	overflow check	set indicator.
Invalid data:	validity check	set indicator.
Invalid operation:	check	stop with error indication.
Arithmetic error:	none.	
Invalid address:	limit check	stop with error indication.
Receipt of data:	parity check	set indicator.
Dispatch of data:	send parity bit.	

SIMULTANEOUS OPERATIONS

The Honeywell 120 can control up to three input-output operations concurrently with internal processing, as described below.

(1) Computation within the central processor continues at all times, except during the individual 3-microsecond cycles required for each unit of data transferred between core storage and any peripheral unit.

(2) In every Honeywell 120 system, operation of any two of the system's basic peripheral devices (450-lpm printer, Model 214 card unit, and 13KC magnetic tape unit) can proceed at one time in addition to the continuing central processor operation.

(3) If the optional Series 200 Control Unit Adapter (Feature 1015) is added to the system, up to five standard Series 200 peripheral control units can be connected -- in addition to the basic Honeywell 120 peripheral units. However, the maximum number of input-output operations that can proceed concurrently with computing is still two.

(4) If the optional Series 200 Control Unit Adapter and Read/Write Channel (Feature 1016) is added to the system instead of Feature 1015, the capability is provided to connect the same maximum complement of peripheral control units as described in Paragraph (3), and to control one additional concurrent input-output operation.

Table I (over) lists the peripheral data transfer operations. Lengths of the start time, data transmission time, and stop time are shown for each operation, along with its demands upon the central processor (CP) and the selected channel.

OPERATION	Cycle Time, msec.	Start Time			Data Transmission			Stop Time		
		Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use
214 and 123 Card Readers*	150	20.0	0	Yes	55.0	0.2%	Yes	75.0	0	No
214 Card Punch*	150-600	7.5	0	Yes	6.25n	<0.1%	Yes	92.5	0	No
223 Card Reader	75	13.0	0	Yes	46	0.3%	Yes	16	0	No
224-1 Card Punch	335-1210	6.2	0	Yes	12.5n	<0.1%	Yes	210	0	No
224-2 Card Punch	223-660	3.0	0	Yes	6.25n	0.1%	Yes	160	0	No
227 Card Reader	75	21 to 46	0	Yes	44	13.5%	Yes	10	0	No
227 Card Punch	240	42 to 120	0	Yes	176	1.5%	Yes	22	0	No
222-1, 2, 3 Printer (51-character set)	92 + 5LS	0	—	—	75	25.5%	Yes	17 + 5LS	0	No
222-4 Printer (46-character set)	63 + 5LS	0	—	—	46	36.0%	Yes	17 + 5LS	0	No
222-5 Printer* (64-character set)	133 + 5LS	0	—	—	116	19.5%	Yes	17 + 5LS	0	No
209 Paper Tape Reader	2.0	?	0	Yes	Var.	0.3%	Yes	?	0	No
210 Paper Tape Punch	8.3	?	0	Yes	Var.	<0.1%	Yes	?	0	No
204A-1 Magnetic Tape, 32KC	—	11.0[a]	0	Yes	Var.	9.4%	Yes	0[a]	—	—
204A-2 Magnetic Tape, 64KC	—	5.5[a]	0	Yes	Var.	19.2%	Yes	0[a]	—	—
204A-3 Magnetic Tape, 89KC	—	5.5[a]	0	Yes	Var.	26.7%	Yes	0[a]	—	—
204B-1, -2 Magnetic Tape, 20KC	—	12.5[a]	0	Yes	Var.	6.0%	Yes	0[a]	—	—
204B-3, -4 Magnetic Tape, 44KC	—	7.5[a]	0	Yes	Var.	13.2%	Yes	0[a]	—	—
204B-5 Magnetic Tape, 67KC	—	5.8[a]	0	Yes	Var.	20.1%	Yes	0[a]	—	—
204B-7 Magnetic Tape, 29KC	—	20.8[a]	0	Yes	Var.	8.4%	Yes	0[a]	—	—
204B-8 Magnetic Tape, 64KC	—	7.5[a]	0	Yes	Var.	19.2%	Yes	0[a]	—	—
204B-11, -12 Magnetic Tape, 13KC*	—	18.7[a]	0	Yes	Var.	4.0%	Yes	0[a]	—	—
270 Random Access Drum	—	25.0	0	Yes	Var.	30.6%	Yes	0	—	—
251 Mass Memory	16.7	95 av.	0	Yes	Var.	30%	Yes	—	0	No
252 Mass Memory	16.7	150 av.	0	Yes	Var.	30%	Yes	—	0	No
253 Mass Memory	16.7	225 av.	0	Yes	Var.	30%	Yes	—	0	No

a Cross-gap time for short gap (replaces start and stop times).
b For the character mode; time for the record mode is variable.
LS Number of lines skipped between successive printed lines.
n Number of characters punched.
Var. Data transmission time varies with record length.
* Basic Honeywell 120 peripheral units.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (511:201.100)

These problems involve updating a master file from information in a detail file and producing a printed record of each transaction. This application is one of the most common commercial data processing jobs and is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of three different record sizes in the master file. Standard Problem D increases the amount of computation performed upon each transaction. Each problem is estimated for activity factors (ratios of number of detail records to number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

The basic Honeywell 120 system allows simultaneous computing, printing (by the basic printer), and one other input-output operation. As an optional feature, one additional input-output operation can take place on any Series 200 peripheral unit connected to the I/O Adapters. This special feature is included in Standard Configuration I.

In Configuration I, the master and detail input files are assigned to the card reader. The output files are assigned to the basic card punch (updated master file) and printer (report file). The card reader and printer used in Configuration I are faster than the basic Honeywell 120 equipment. The printer is assigned to the optional read-write channel and the card reader to the basic read-write channel. For Problems A, B, C, and D, the combined time of the card punch and the card reader is always the controlling factor on overall processing time.

In Configurations II and III, the master files are on magnetic tape. The detail file is assigned to the card reader and the report file to the printer. Configuration II uses only the basic Honeywell 120 peripheral devices. In Problems A, B, C, and D, for all activities, the card reader and two master-file tapes are the controlling factors for both Configurations II and III.

SORTING (511:201.200)

The standard estimate for sorting 80-character records by straightforward merging on magnetic tape was developed by the method explained in Paragraph 4:200.213 of the Users' Guide. A two-way merge was used in System Configuration II (which has only four magnetic tape units) and a three-way merge in Configuration III. The results are shown in Graph 511:201.200.

MATRIX INVERSION AND GENERALIZED MATHEMATICAL PROCESSING

It is not possible to install automatic floating-point operations in the Honeywell 120 Processor; therefore, these two mathematically-oriented standard problems have not been coded for the 120.

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)

	ITEM		CONFIGURATION I		CONFIGURATION II		CONFIGURATION III		REFERENCE
1 Input-Output Times	Char/block	(File 1)	80		540		1,080		
	Records/block	K (File 1)	0.5		5		10		
	msec/block	File 1 = File 2	75/437.5		59.2		58.5		
		File 3	75		150		150		
		File 4	94		157		157		
	msec/switch	File 1 = File 2	0		0		0		4:200.112
		File 3	0		0		0		
		File 4	0		0		0		
	msec penalty	File 1 = File 2	0.2		1.6		3.2		
		File 3	0.2		0.2		0.2		
		File 4	16.5		16.5		16.5		
2 Central Processor Times	msec/block	a_1	0.5		0.5		0.5		
	msec/record	a_2	1.7		1.7		1.7		
	msec/detail	b_6	0.3		0.3		0.3		4:200.1132
	msec/work	$b_5 + b_9$	8.7		8.7		8.7		
	msec/report	$b_7 + b_8$	2.0		2.0		2.0		
3 Standard File Problem A F = 1.0	msec/block for C.P. and dominant column.		C.P.	I/O	C.P.	I/O	C.P.	I/O	
		a_1	0.5		0.5		0.5		
		a_2 K	0.8		7.8		15.8		
		a_3 K	5.4		54.0		108.0		
		File 1: Master In	0.2	75.0	1.6	59.2	3.2	58.5	4:200.114
		File 2: Master Out	0.2	437.5	1.6	59.2	3.2	58.5	
		File 3: Details	0.1	37.5	1.0	750.0	2.0	1,500.0	
		File 4: Reports	8.3		82.5		165.0		
		Total	15.5	550.5	149.0	868.4	297.7	1,617.0	
4 Standard File Problem A Space	Unit of measure	(characters)							
		Std. routines	774		2,924		2,924		
		Fixed	120		120		120		
		3 (Blocks 1 to 23)	350		612		612		
		6 (Blocks 24 to 48)	2,334		2,334		2,334		4:200.1151
		Files	440		1,400		2,560		
		Working	0		108		108		
		Total	4,018		7,498		8,658		

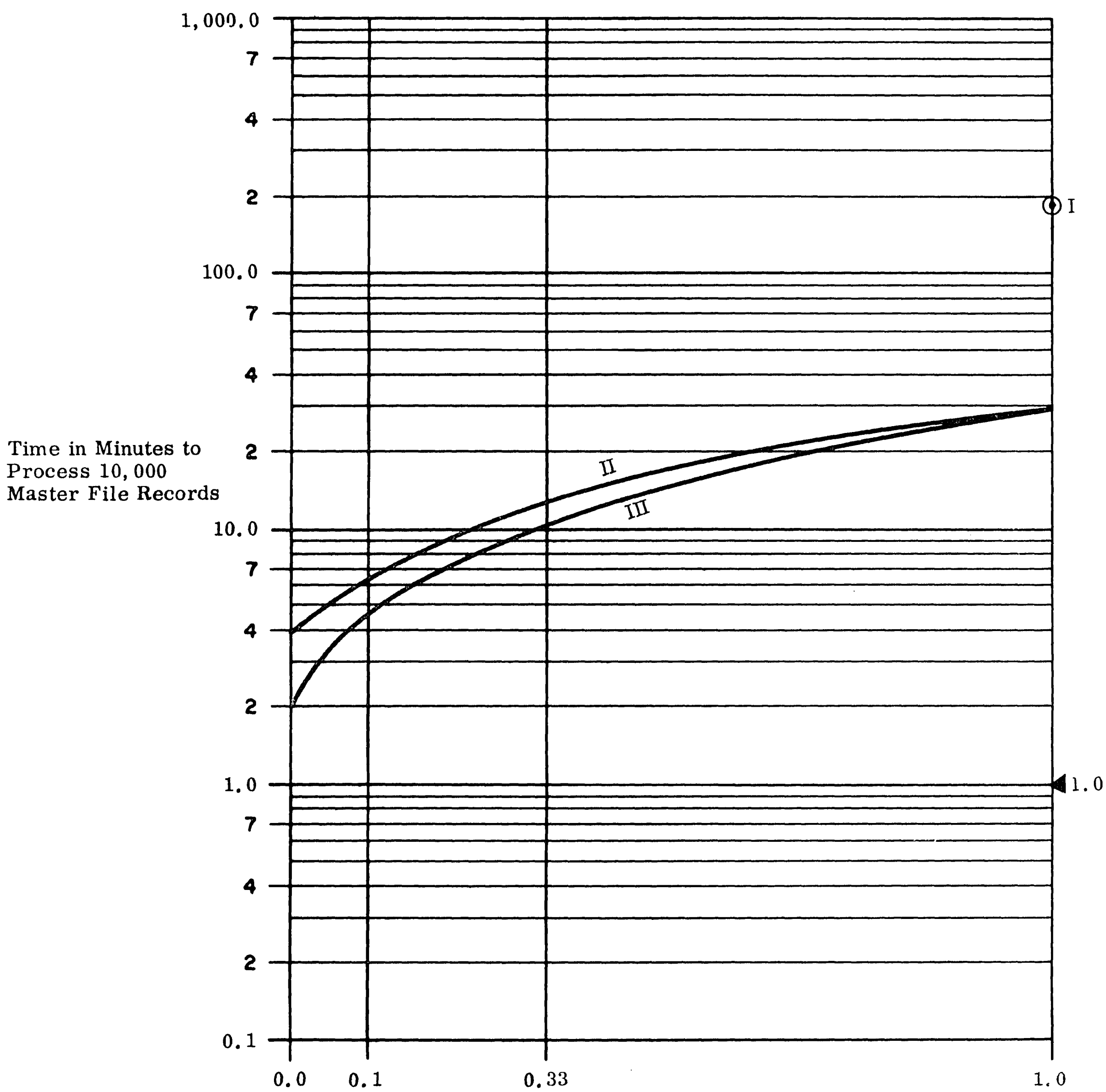
(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

.111 Record sizes —
Master file: . . . . . . 108 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.112 Computation:. . . . . . . standard.
.113 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.
.114 Graph:. . . . . see graph below.
.115 Storage space required —
Configuration I: . . . . 4,018 characters.
Configuration II: . . . 7,498 characters.
Configuration III: . . . 3,658 characters.



(Roman numerals denote standard System Configurations.)

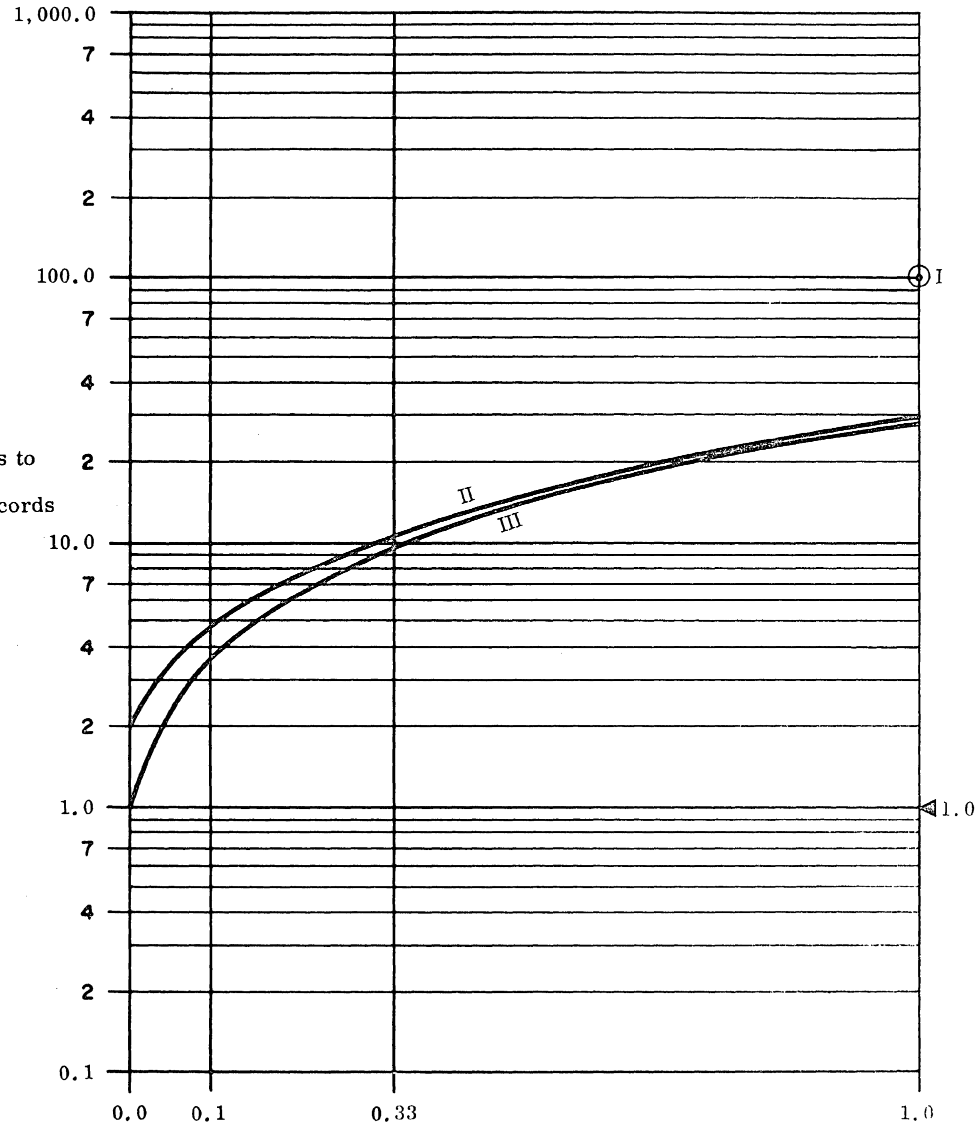
.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . . 54 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.122 Computation:. . . . . . . standard.

.123 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.

.124 Graph:. . . . . see graph below.



(Roman numerals denote standard System Configurations.)

(Contd.)

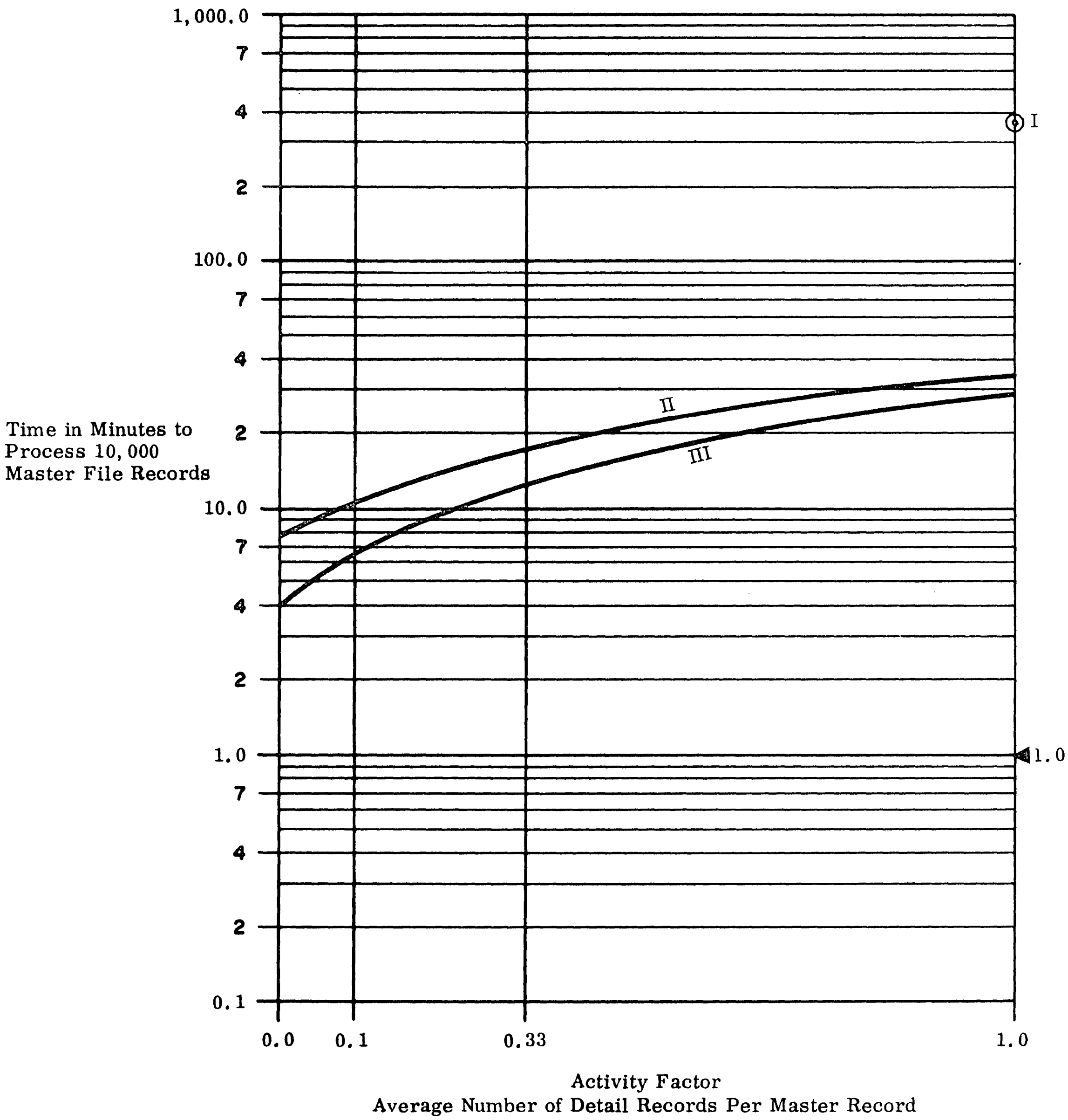
.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . . 216 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.132 Computation:. . . . . . . standard.

.133 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

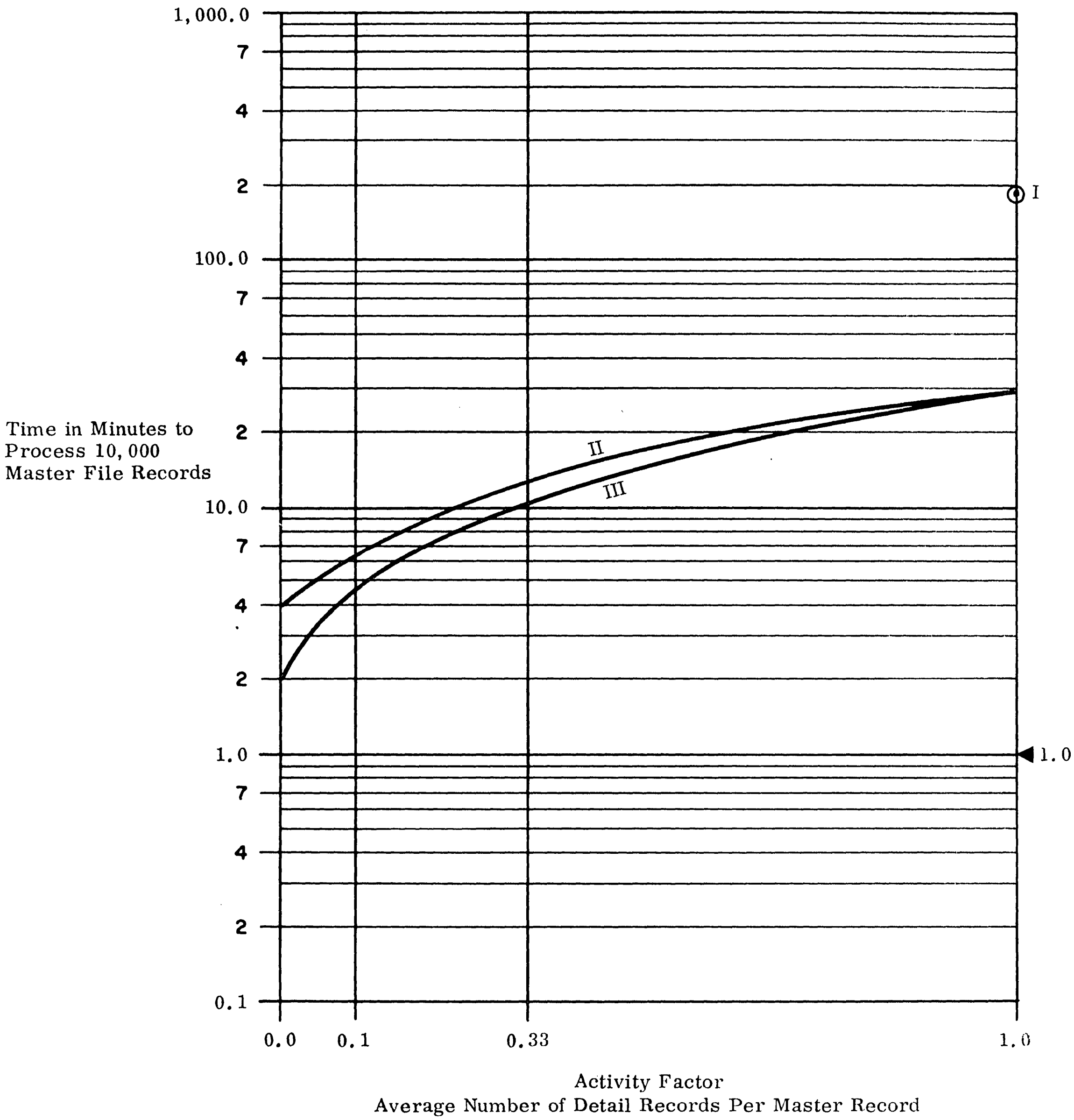
.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . . . 108 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.142 Computation:. . . . . . . trebled.

.143 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.

.144 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

(Contd.)

.2 SORTING

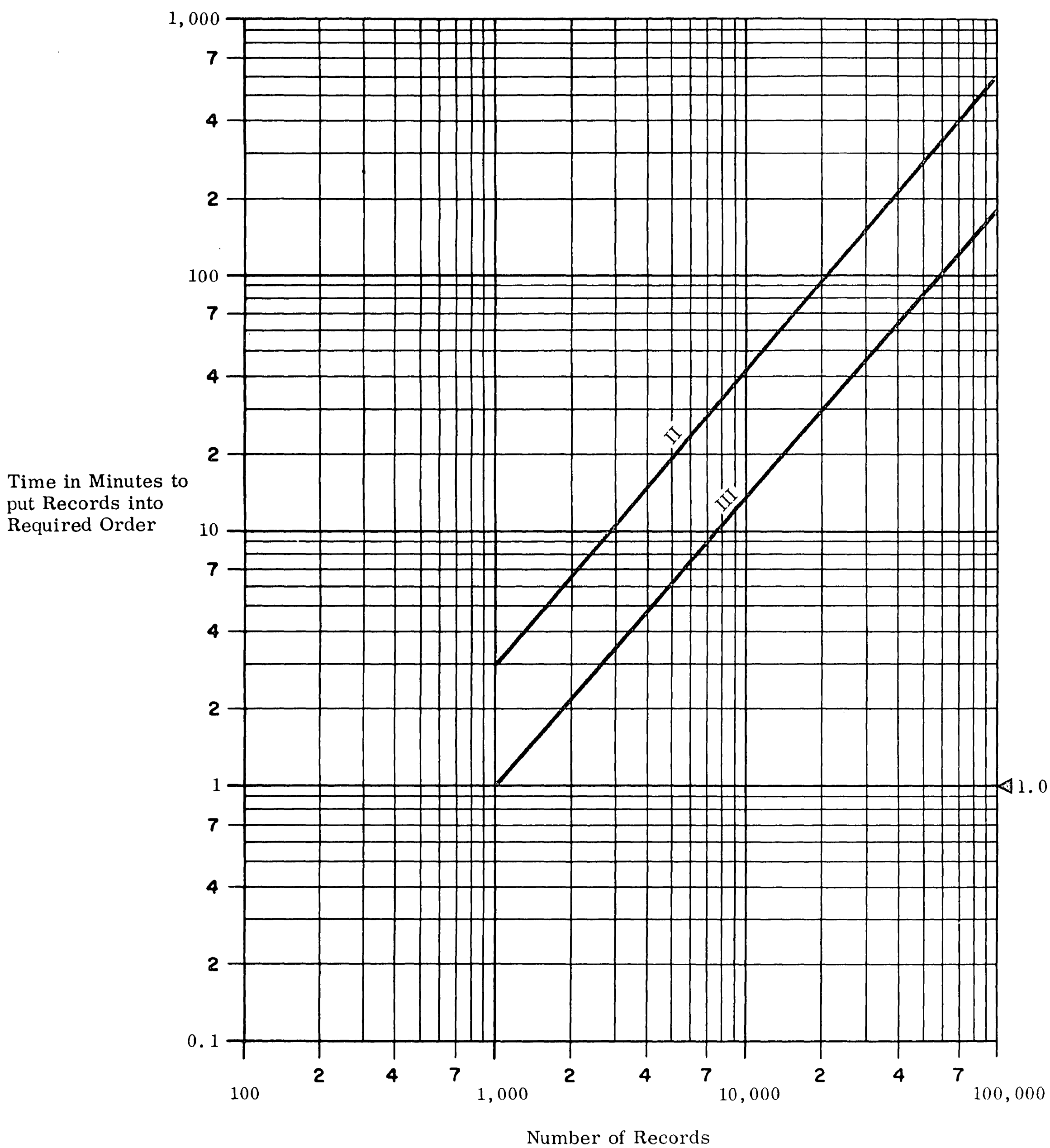
.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.

.212 Key size: . . . . 8 characters.

.213 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

HONEYWELL 200

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INTRODUCTION

The Honeywell 200 Processor can be connected to any of the Honeywell Series 200 peripheral units, can use any of the Series 200 programming languages, and can run most programs originally written for an IBM 1401. It can contain between 4,096 and 65,536 characters of core storage, with a cycle time of 2 microseconds per character.

Standard features of the Honeywell 200 Processor include: Multiply-Divide, 8-Bit Code Handling Instruction, three read-write channels, eight I/O trunks, and Program Interrupt.

Optional features are: Advanced Programming, Edit Instruction, Eight Additional I/O Trunks, and Auxiliary Read-Write Channel.

Nonavailable features are: floating-point arithmetic instructions, table look-up facilities, and the Storage Protect feature.

The rental for typical Honeywell 200 systems ranges between $4,000 and $9,000 per month. Deliveries of the latest-model Honeywell 200 began in November 1965; deliveries of the original Honeywell 200 began in July 1964.

This report concentrates upon the characteristics and the performance of the Honeywell 200 in particular. All the general characteristics of the Honeywell Series 200 hardware and software are described in Computer System Report 510: Honeywell Series 200 — General.

The System Configuration section which follows shows the Honeywell 200 in the following standard System Configurations:

- I: Typical Card System
- II: 4-Tape Business System
- III: 6-Tape Business System
- IV: 12-Tape Business System
- V: 6-Tape Auxiliary Storage System

These configurations were prepared according to the rules in the Users' Guide, page 4:030.120, and any significant deviations from the standard specifications are listed. In addition, the System Configuration section also shows a typical configuration for data communications applications.

Section 512:051 provides detailed central processor timings for the Honeywell 200.

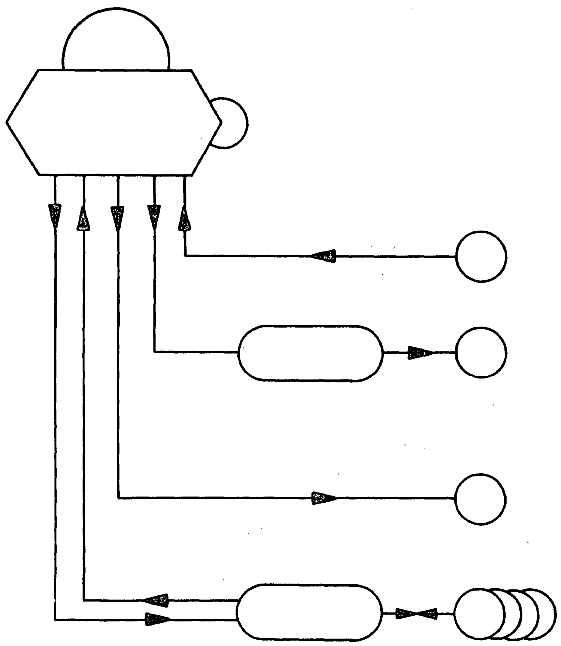
The input-output channel capabilities of the Honeywell 200, and the demands upon the processor during input-output operations, are described in Section 512:111.

The software that can be used with any Series 200 computer depends upon its core storage capacity and the number and type of peripheral devices. Several versions of the Easycoder Assembler and COBOL Compiler will be made available. A FORTRAN compiler will be able to operate on the Honeywell 200, without the floating-point arithmetic option, provided that the other configuration requirements are met. These languages, and numerous other support routines for the Honeywell 200, are described in Sections 510:151 through 510:193.

The overall performance of any Honeywell Series 200 system is heavily dependent upon the processor model used. A full System Performance analysis of standardized configurations utilizing the Honeywell 200 Processor is provided in Section 512:201.

.2 4-TAPE BUSINESS SYSTEM: CONFIGURATION II

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.
ability to overlap input-output operations with internal processing is standard.
Multiply-Divide is standard.



Equipment	Rental**
201-2-2 Processor and Console with 8,192 characters of Core Storage	$1,615
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-5 Tape Control Unit	310
204B-11 and -12 Magnetic Tape Units (4): 13,300 char/sec	970

Optional Features Included: . . . .

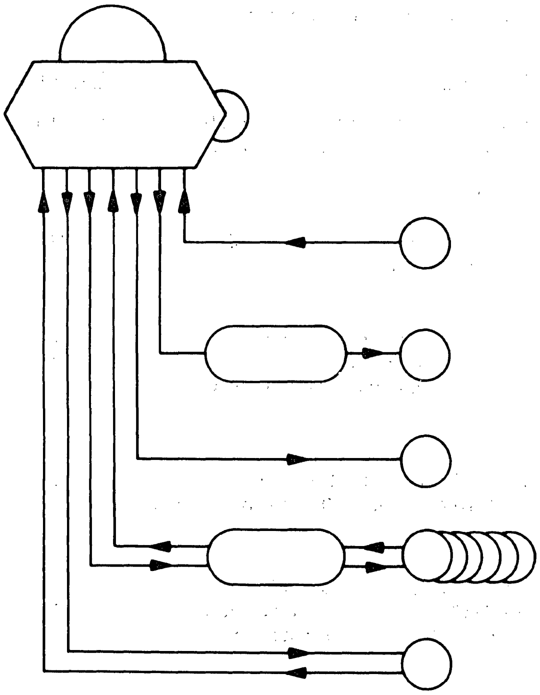
Editing Instructions	90
Advanced Programming*	100
TOTAL RENTAL:	$4,785

* This optional feature, which permits indexing, indirect addressing, loading of control registers, etc., is considered well worth its price in all Honeywell 200 configurations.

** The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement rents for $4,350 per month.

.3 6-TAPE BUSINESS SYSTEM: CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.
console typewriter input is included.
ability to read and write magnetic tape simultaneously is standard.



Equipment	Rental*
201-2-4 Processor and Console with 16,384 characters of Core Storage	$2,130
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-4 Tape Control Unit	460
204B-7 Magnetic Tape Units (6): 28,800 char/sec (800 CPI)	2,460
220-1 Console (includes Teleprinter)	205

Optional Features Included: . . . .

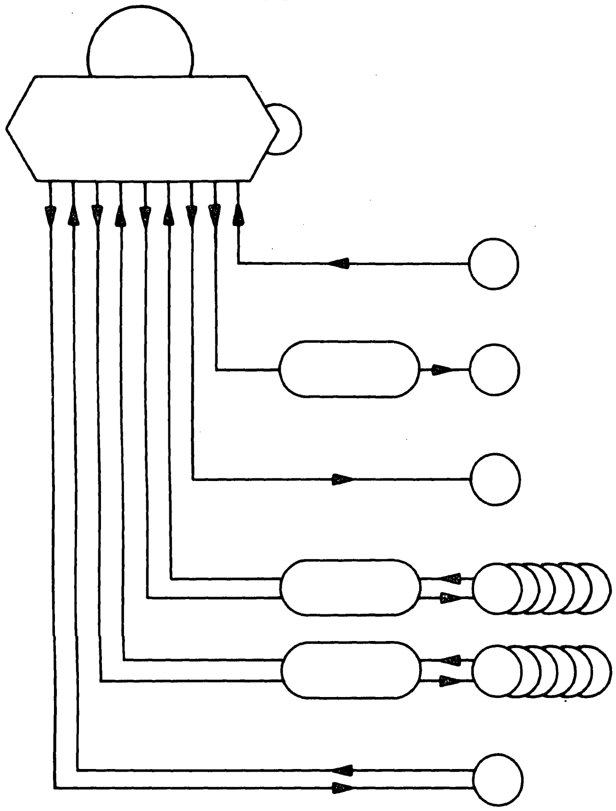
Advanced Programming with BBE	100
Editing Instructions	90
TOTAL RENTAL:	$7,145

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement rents for $6,465 per month.

(Contd.)

.4 12-TAPE BUSINESS SYSTEM: CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 20% slower.
card punch is slower.



Equipment	Rental*
201-2-8 Processor and Console with 32,768 characters of Core Storage	$ 3,150
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-4 Printer and Control: 950 lines/min (120 print positions)	1,305
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (6): 64,000 char/sec	3,690
203B-4 Tape Control	435
204B-8 Magnetic Tape Units (6): 64,000 char/sec	3,690
220-1 Console (includes Teleprinter)	205

Optional Features Included: . . . .

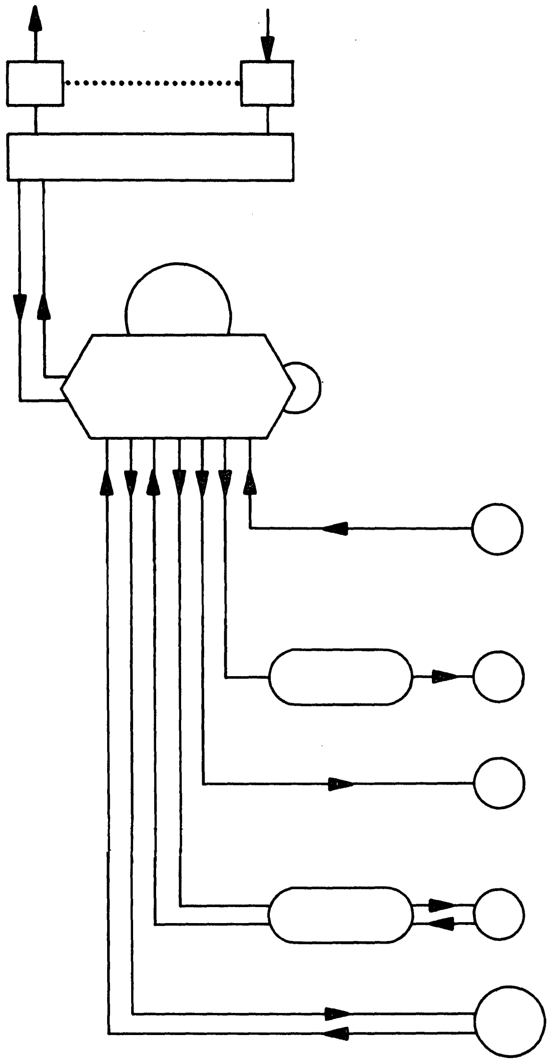
Advanced Programming with BBE	100
Editing Instructions	90
Auxiliary Read/Write Channel	50
TOTAL RENTAL:	$13,925

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement rents for $12,600 per month.

.5 6-TAPE AUXILIARY STORAGE SYSTEM: CONFIGURATION V

This Configuration is identical to Configuration III for the Honeywell 200 (preceding page) except for the addition of one 250 Mass Memory Control and one 251 Mass Memory File Transport, which provide 15 million characters of storage and bring the total system rental to $8,150 per month for a one-year contractual agreement. The same configuration with a five-year rental agreement rents for $7,365 per month.

.6 TYPICAL COMMUNICATIONS SYSTEM



Equipment	Rental**
285 Communication Control Adapter Units (up to 63: one per line used)	*
286-3 Multiple Communication Control Unit and 085-61 Expansion Feature (total 63 lines)	$ 410
201-2-8 Processor and Console with 32,768 characters of Core Storage	3,150
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully punched cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-4 Tape Control Unit	460
204B-7 Magnetic Tape Units (6): 28,800 char/sec (800 CPI)	2,460
250 Mass Storage Control Unit	335
251 Mass Memory File (15 million character capacity, 95 millisecond average access time)	670
Optional Features Included: Advanced Programming with BBE	100
Second Set of I-O Trunks	150
Editing Instructions	90
TOTAL RENTAL:	$9,525*

* Cost of the necessary communication interface units is not included.

** The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement rents for $8,210 per month.

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . Central Processor. Models 201-2-1 through 201-2-12.

.12 Description

The Model 201-2 Central Processor performs all arithmetic and logical functions in a Honeywell 200 system under control of the internally stored program. The Central Processor consists of five basic functional units: the main memory, the control memory, the control unit, the arithmetic unit, and the input-output traffic control.

The main memory consists of from 4,096 to 65,536 alphameric character positions of core storage and is fully described in Section 510:041. Cycle time is two microseconds per one-character access.

Each character position consists of six data bits, one parity bit, and two punctuation bits. The punctuation bits can be used to indicate a word mark, an item mark, or a record mark, which define the length of a data field or instruction, an item, or a record, respectively. An "item" consists of a group of consecutive data fields. (The IBM 1400 series computers utilize only one punctuation bit — the "word mark" bit — and each record mark occupies an entire character position. The two punctuation bits used in the H-200 will decrease data storage requirements and provide increased flexibility in data movement operations. The optional Extended Move instruction, for example, can be terminated by a word mark, an item mark, or a record mark, as specified by the programmer.)

The control memory is a small magnetic core storage unit with an access time of 0.25 microsecond and a cycle time of 0.50 microsecond. It holds 16 control registers, each capable of storing the address of one character position in the main memory. Instructions are provided to load and store the contents of each of these registers. The 16 control registers have the following functions:

(1) A-Address Register.

(2) B-Address Register.

(3) Sequence Register.

(4) Change Sequence Register.

(5) Read-Write Channel 1 — Present Location Counter.

(6) Read-Write Channel 1 — Starting Location Counter.

(7) Read-Write Channel 2 — Present Location Counter.

(8) Read-Write Channel 2 — Starting Location Counter.

(9) Read-Write Channel 3 — Present Location Counter.

(10) Read-Write Channel 3 — Starting Location Counter.

(11) Auxiliary R/W Channel - Present Location Counter.*

(12) Auxiliary R/W Channel — Starting Location Counter.*

(13) Interrupt Register.

(14) Work Register 1.

(15) Work Register 2.

(16) Unassigned.

* denotes optional registers.

The arithmetic unit executes all arithmetic and logical operations. It consists of an adder that can perform both decimal and binary arithmetic and two one-character operand storage registers. The H-200 is basically a two-address, add-to-storage system. All operations are performed serially by character and terminated when specific punctuation bit configurations are sensed. This means that operand sizes are fully variable and are limited only by the amount of core storage available to hold them.

The control unit controls the sequential selection, interpretation, and execution of all stored program instructions and checks for correct (odd) parity whenever a character is moved from one location to another. It also provides for communication with the operator's Control Panel described in Section 510:061.

The input-output traffic control directs the time-sharing of accesses to the main memory by the various peripheral devices and the Central Processor. Up to four input-output operations can occur simultaneously with internal processing. Three read-write channels are included in the basic H-200 system, and a fourth channel is available as an option. The fourth channel is an auxiliary channel that alternates with read/write channel 1. The auxiliary channel is interlocked when either a Model 227

.12 Description (Contd.)

Card Reader, any printer, a drum unit, mass storage unit, or a magnetic tape unit (with a speed of over 45KC) is operating on channel 1.

Highly significant is the fact that the programmer can maximize the utilization of the read-write channels by selecting any one of the channels to serve any input-output device; there is no need for permanent assignment of each peripheral device to a specific channel as in most competitive systems. All peripheral devices can use any core storage areas of appropriate size as input-output areas. Demand on the Central Processor for most peripheral operations is two microseconds per character transferred to or from core storage.

The processor is well suited to general data manipulation, but editing, indexing, indirect addressing, and full-record data movement capabilities are all extra-cost options, as described below. (The Advanced Programming option provides so much more computing power and programming convenience that it would seem well worth its price of $100 per month in virtually every H-200 installation.) Binary addition and subtraction, logical AND, exclusive OR, and masking instructions are standard. The optional Move and Translate instruction uses a 64-character translation table to translate any number of consecutive characters from one 6-bit code to another. Translation of 8-bit codes is a standard feature, as is direct decimal multiplication and division.

Instruction length is variable from one to eleven characters. Arithmetic and data movement instructions are most commonly seven characters long. Through careful placement of data, instructions can sometimes be "chained" so that a one-character instruction does the work of a seven-character one, resulting in savings in both storage space and execution time. Chaining is possible only when a series of operations is to be performed upon items of data stored in consecutive locations, so that the A- and B-Address Registers do not need to be reloaded before each instruction is executed.

The H-200 uses a pure binary addressing system. In the 3-character mode, each address portion within an instruction normally consists of three characters, or 18 data bits. Fifteen bits are used to specify an address between 0 and 32,767, and the remaining three bits can specify address modification: either indirect addressing or indexing by one of the six index registers. Both indexing and indirect addressing are part of the optional Advanced Programming feature. A special instruction enables the Central Processor to switch between the three-character addressing mode and a special two-character mode. Use of two-character addresses reduces both storage space and execution time but has two significant disadvantages: only the 4,096 character positions within a single core module can be addressed and neither indexing nor indirect addressing can be used. A four-character addressing mode is used for addresses 32,768 to 65,536. This mode permits the use of 15 index registers.

Program interrupt facilities are provided by a control memory register called the Interrupt Register and a single-character instruction called Resume Normal Mode (RNM). The Interrupt Register (IR) is under programmer control; i.e., any particular memory address is loaded into the IR. Upon the Central Processor receipt of a demand from an external device, pertinent arithmetic and control indicators are automatically stored, and the contents of the sequence register and the IR are exchanged. The latter action results in a transfer of control to the instruction indicated by the previous contents of the IR.

When the RNM instruction is executed, all the pertinent address registers, indicators, etc., are automatically restored to their normal condition (i.e., their status prior to the interrupt), and control reverts to the sequence or the cosequence register (the one in control when the interrupt occurred).

Typical instruction execution times (using the three-character addressing mode) are 36 microseconds for a 5-character move, 48 microseconds for a 5-digit decimal add, and 38 microseconds for a 5-character compare. Each of these instructions is 4 microseconds shorter when two-character addresses are used and 4 microseconds longer when four-character addresses are used. Indexing or indirect addressing requires an additional 6 microseconds per modified address.

Optional Features

Advanced Programming: Makes six 3-character registers in core storage available as index registers which can index any 3-character or 4-character instruction address; allows indirect addressing; permits the loading of data into the control registers; permits the transfer of complete records of data within core storage by a single instruction; allows bisequence operations through the use of a consequence register; provides instructions for translating 6-bit codes (MAT), zero and adding or subtracting (ZA and ZS), branching on character equal (BCE), an extended form of the branch on character condition (BCC), a Read Reverse instruction for 204B Magnetic Tapes, the Change Address Mode instruction (for systems of 4,096 characters or less), and branching on bit equal (BBE).

Editing Instructions: All editing capabilities are optional in the H-200. The capabilities available with the option are those of the basic and Expanded Print Edit of the IBM 1401.

Second Set of Eight Input-Output Trunks: permits additional peripheral units to be connected.

Auxiliary Read-Write Channel: Permits a total of four simultaneous peripheral operations to occur during processing.

Compatibility with the IBM 1401

Please see the detailed comparison of available instructions in the Instruction List section, page 510:121.100. A general review of the compatibility between the Honeywell 200 Series and the IBM 1400 Series is presented in Section 510:131.

.14 First Delivery: . . . . . July 1964; deliveries of the improved Model 201-2 Processors began in November 1965.

(Contd.)

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add-subtract:	automatic	decimal or binary	1 to N char.
	Multiply:	automatic	decimal	1 to N char.
	Divide:	automatic	decimal	1 to N char.
.212	Floating point —			
	Add-subtract:	subroutine.		
	Multiply:	subroutine.		
	Divide:	subroutine.		
.213	Boolean —			
	AND	automatic	binary	1 to N char.
	Inclusive OR:	none.		
	Exclusive OR:	automatic	binary	1 to N char.
.214	Comparison:	branch on high, low, equal, unequal, or zero balance.		
	Numbers:	automatic		1 to N char.
	Absolute:	none.		
	Letters:	automatic		1 to N char.
	Mixed:	automatic		1 to N char.
	Collating sequence:	0 through 9, then A through Z, with special symbols interspersed.		

.215 Code translation —
Provision: . . . . automatic (using code table constructed by programmer).
From: . . . . any 6-bit or 8-bit code.
To: . . . . any 6-bit or 8-bit code.
Size: . . . . 1 to N characters.

.216 Radix conversion: . . . none.

		Provision	Comment	Size
.217	Edit format —			
	Alter size:	optional feature	expand but not contract.	1 to N char.
	Suppress zero:	optional		1 to N char.
	Round off:	none		1 to N char.
	Insert point:	optional		1 to N char.
	Insert spaces:	optional		1 to N char.
	Insert $, CR-*:	optional		1 to N char.
	Float $:	optional		1 to N char.
	Protection:	optional		1 to N char.
.218	Table look-up:	none.		
.219	Others —			
	Substitute:	automatic	performs binary masking	1 char.
	Change Addressing Mode:	automatic	shifts between 2, 3, and 4 char addresses.	
	Branch on Sense Switches:	automatic	16 possible settings.	

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value, with B zone bit in units position.

.222 Zero:. . . . . positive, negative, and unsigned zeros and blanks give same result in decimal arithmetic but are unequal in comparisons.

.223 Operand size determination:. . . . . word mark, item mark, or record mark bits in high or low order digit position. (Some instructions imply one-character operands).

.23 Instruction Formats

.231 Instruction structure: . variable; 1 to 12 characters.
.232 Instruction layout:

Part:	OP	A or I	B	V_1 or C_1	V_2 or C_2	C_3
Size (char):	1	2, 3, or 4	2, 3, or 4	1	1	1

An instruction may consist of:

(1) OP only
(2) OP, V_1
(3) OP, A or I
(4) OP, A or I, V_1
(5) OP, A or I, B
(6) OP, A or I, B, V_1
(7) OP, A, B, V_1, V_2
(8) OP, A or I, C_1
(9) OP, A or I, C_1, C_2
(10) OP, A or I, C_1, C_2, C_3.

.233 Instruction parts

Name	Purpose
OP:	operation code.
A:	address of an operand or field in core storage.
I:	location of next instruction if a branch occurs.
B:	address of an operand or field in core storage.
V_1 or C_1:	modifier for an operation code, control field for an I/O instruction, or partial address in a translate instruction.
V_2 or C_2:	partial address in a translate instruction or control field for an I/O instruction.
C_3:	control field for an I/O instruction.

.234 Basic address structure: . . . . 2 + 0.
.235 Literals —
Arithmetic: . . . . none.
Comparisons and tests: . . . . yes; single character.
Incrementing modifiers: . . . . . . none.
Masking: . . . . yes; single character mask.
.236 Directly addressed operands —
Internal storage type: . . . . core.
Minimum size: . . . . 1 character.
Maximum size: . . . . total capacity.
Volume accessible: . total capacity.
.237 Address indexing —
.2371 Number of methods: 1.
.2373 Names: . . . . indexing (with optional Advanced Programming feature).
.2373 Indexing rule: . . . . . addition (modulo core storage capacity).
.2374 Index specification: . . Address Type Indicator — first 3 bits of 18-bit operand address or first 5 bits of 24-bit operand address.
.2375 Number of potential indexers: . . . . 6 or 15.
.2376 Addresses which can be indexed: . . . . . . all 3- and 4-character addresses.
.2377 Cumulative indexing: . . . . none.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . . with optional Advanced Programming feature.
.2381 Recursive: . . . . yes.
.2382 Designation: . . . . . . Address Type Indicator — first 3 or 5 bits of operand address.
.2383 Control: . . . . direct address has no indicator bit.
.2384 Indexing with indirect addressing: . yes.
.239 Stepping: . . . . none.

.24 Special Processor Storage: . . . . 16 registers in magnetic core control memory (described on page 512:051.100), plus 2 silicon-diode operand storage registers.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . 1.
.312 Arrangement: . . . . . . programmer can exchange the contents of the Sequence Register and the Change Sequence Register by use of Change Sequence Mode instruction.
.313 Precedence rule: . . . . programmer indicates register to be used.
.314 Special sub-sequence counter: . . . . none.
.315 Sequence control step size: . . . . 1 character.
.316 Accessibility to routines: . . . . yes; can be loaded and stored by instructions.
.317 Permanent or optional modifier: . . . . no.

.32 Look-Ahead: . . . . none.

.33 Interrupt

.331 Possible causes —
In-out units: . . . . . . ready to transfer one unit of data (character or record).
In-out controllers: . . yes.
Storage access: . . . . cannot initiate interrupts.
Processor errors: . . cannot initiate interrupts.

(Contd.)

.332 Control by routine: . . . yes.
.333 Operator control: . . . . operator can initiate I/O interrupt from console.
.334 Interruption conditions: execution of current instruction is completed.
.335 Interruption process —
Registers saved: . . . contents of sequence register and interrupt register are automatically interchanged; address register and indicator settings are automatically saved and restored.
Destination: . . . . . . fixed location (contents of Interrupt Register).

.34 Multiprogramming: . . . Change Sequence Mode instruction facilitates switching control between two programs.

.35 Multisequencing: . . . none.

.4 PROCESSOR SPEEDS

All execution times listed here are based on use of the 3-character addressing modes; most instructions are 4 microseconds shorter in the 2-character addressing mode, and 4 microseconds longer in the 4-character addressing mode.

D = operand length in decimal digits.
C = operand length in characters.

.41 Instruction Times in Microseconds

.411 Fixed point —
Add-subtract:
Decimal: . . . . 18 + 6D.
Binary: . . . . 16 + 6C.
Multiply: . . . . $24 + 14D^2$; where the multiplier and multiplicand are both D digits in length.
Divide: . . . . $49 + 59D + 30D^2$; where the dividend is twice as long as the divisor (D = no. of digits in divisor).
.412 Floating point (performed by subroutines)
Add-subtract: . . . . . 1,440.
Multiply: . . . . 5,460.
Divide: . . . . 9,820.
.413 Additional allowance for —
Indexing: . . . . 6 per modified address.
Indirect addressing: 6 per stage.
Re-complementing: 4D.
.414 Control —
Compare: . . . . 18 + 4D.
Branch: . . . . 14.
.415 Counter control: . . . . none.
.416 Edit: . . . . 16 + 14C.
.416 Convert: . . . . none.
.418 Shift: . . . . none.

.42 Processor Performance in Microseconds

.421 For random addresses (fixed point) —
c = a + b:
Decimal: . . . . 34 + 10D.
Binary: . . . . 32 + 10C.
b = a + b:
Decimal: . . . . 18 + 6D.
Binary: . . . . 16 + 6C.
Sum N items:
Decimal: . . . . (18 + 6D)N.
Binary: . . . . (16 + 6C)N.
c = ab: . . . . $40 + 18D + 14D^2$.
c = a/b: . . . . $83 + 71 + 30D^2$.
.422 For arrays of data —
$c_i = a_i + b_j$:
With indexing: . . . . 150 + 10D.
Without indexing: . . 182 + 10D.
$b_j = a_i + b_j$:
With indexing: . . . . 122 + 6D.
Without indexing: . . 120 + 6D.
Sum N items: . . . . . (92 + 6D)N.
$c = c + a_i b_j$: . . . . . . $168 + 30D + 14D^2$.
.423 Branch based on comparison —
Numeric data: . . . . . 168 + 4D.
Alphabetic data: . . . . 168 + 4C.
.424 Switching —
Unchecked: . . . . 156; 96 with optional feature.
Checked: . . . . 228; 96 with optional feature.
List search: . . . . . . 126 + (110 + 4D)N.
.425 Format control per character —
Unpack: 5.8
Compose: . . . . 8.6 (with optional Editing Instruction).
.426 Table look-up per comparison —
For a match: . . . . . . 106 + 4C.
For least or greatest: 112.8 + 4.4C.
For interpolation point: . . . . 106 + 4C.
.427 Bit indicators —
Set bit in separate location: . . . . 20.
Set bit in pattern: . . . 22.
Test bit in separate location: . . . . 36.
Test bit in pattern: . . 58.
.428 Moving: . . . . 16 + 4C.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator.
Zero divisor:	overflow check	
Invalid data:	validity check	set indicator.
Invalid operation:	check	stop with error indication.
Arithmetic error:	none.	
Invalid address:	limit check	stop with error indication.
Receipt of data:	parity check	set indicator.
Dispatch of data:	send parity bit.	

SIMULTANEOUS OPERATIONS

The Honeywell 200 can control three or four input-output operations concurrently with internal processing, as described below.

(1) Computation within the central processor continues at all times, except during the individual 2-microsecond cycles required for each unit of data transferred between core storage and any peripheral unit.

(2) In addition, in every Honeywell 200 system, any three of the peripheral data transfer operations listed in Table I (over) can proceed at one time (one on each read-write channel) in addition to the continuing central processor operation. Lengths of the start time, data transmission time, and stop time are shown for each operation, along with its demands upon the central processor (CP) and the selected channel.

(3) If the optional Auxiliary Read-Write Channel is added, one additional simultaneous data transfer operation can occur, provided that the data transfer rates on both Channel 1 and the Auxiliary Read-Write Channel are "comparatively undemanding." Input-output units which do allow both Channel 1 and the Auxiliary Channel to operate in parallel include the Model 227 Card Punch, Model 223 Card Reader, Model 224 Card Punch, Model 214 Card Units, any magnetic tape units operating at under 45,000 characters per second, and the paper tape equipment.

(4) The capability to read from one tape unit and write simultaneously on another tape unit connected to the same Tape Control Unit is provided in all 204B Series (one-half inch) Magnetic Tape Units except the 204B-11 and -12, but not in the 204A Series (three-quarter inch) tapes.

TABLE I - SIMULTANEOUS OPERATIONS

OPERATION	Cycle Time, msec.	Start Time			Data Transmission			Stop Time		
		Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use
214 Card Reader	150	20.0	0	Yes	55.0	0.1%	Yes	75.0	0	No
214 Card Punch	150-600	7.5	0	Yes	6.25n	<0.1%	Yes	92.5	0	No
223 Card Reader	75	13.0	0	Yes	46	0.2%	Yes	16	0	No
224-1 Card Punch	335-1210	6.2	0	Yes	12.5n	<0.1%	Yes	210	0	No
224-2 Card Punch	223-660	3.0	0	Yes	6.25n	0.1%	Yes	160	0	No
227 Card Reader	75	21 to 46	0	Yes	44	9.0%	Yes	10	0	No
227 Card Punch	240	42 to 102	0	Yes	176	1.0%	Yes	22	0	No
222-1, -2, -3 Printer (51-character set)	92+5LS	0	-	-	75	17.0%	Yes	17+5LS	0	No
222-4 Printer (46-character set)	63+5LS	0	-	-	46	24.0%	Yes	17+5LS	0	No
222-5 Printer (63-character set)	133+5LS	0	-	-	116	13.0%	Yes	17+5LS	0	No
209 Paper Tape Reader	2.0	?	0	Yes	Var.	0.1%	Yes	?	0	No
210 Paper Tape Punch	8.3	?	0	Yes	Var.	<0.1%	Yes	?	0	No
204A-1 Magnetic Tape, 32KC	-	11.0[a]	0	Yes	Var.	6.4%	Yes	0[a]	-	-
204A-2 Magnetic Tape, 64KC	-	5.5[a]	0	Yes	Var.	12.8%	Yes	0[a]	-	-
204A-3 Magnetic Tape, 89KC	-	5.5[a]	0	Yes	Var.	17.8%	Yes	0[a]	-	-
204B-1, -2 Magnetic Tape, 20KC	-	12.5[a]	0	Yes	Var.	4.0%	Yes	0[a]	-	-
204B-3, -4 Magnetic Tape, 44KC	-	7.5[a]	0	Yes	Var.	8.8%	Yes	0[a]	-	-
204B-5 Magnetic Tape, 67KC	-	5.8[a]	0	Yes	Var.	13.4%	Yes	0[a]	-	-
204B-7 Magnetic Tape, 29KC	-	20.0[a]	0	Yes	Var.	5.6%	Yes	0[a]	-	-
204B-8 Magnetic Tape, 64KC	-	7.5[a]	0	Yes	Var.	12.8%	Yes	0[a]	-	-
204B-11, -12 Magnetic Tape, 13KC	-	18.7[a]	0	Yes	Var.	2.7%	Yes	0[a]	-	-
270 Random Access Drum	-	25.0	0	Yes	Var.	20.4%	Yes	0	-	-
251 Mass Memory	16.7	95 av.	0	Yes	Var.	20%	Yes	-	0	No
252 Mass Memory	16.7	150 av.	0	Yes	Var.	20%	Yes	-	0	No
253 Mass Memory	16.7	225 av.	0	Yes	Var.	20%	Yes	-	0	No

a Cross-gap time for short gap (replaces start and stop times).
b For the character mode; time for the record mode is variable.
LS Number of lines skipped between successive printed lines.
n Number of characters punched.
Var. Data transmission time varies with record length.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (512:201.100)

These problems involve updating a master file from information in a detail file and producing a printed record of each transaction. This application is one of the most common commercial data processing jobs and is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C vary the record sizes in the master file. Standard Problem D increases the amount of computation performed upon each transaction. Each problem is estimated for activity factors (ratios of number of detail records to number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

The graphs for the Honeywell 200 are unusual in that there are three general purpose read-write channels, permitting any three peripheral operations to occur simultaneously with central processor functions. (A fourth read-write channel is optional, and is used in standard System Configuration IV.) Since there are four peripheral units in use in System Configurations II, III, and IV, the units were assigned to the read-write channels in such a manner as to minimize overall processing time.

In Configuration I, the master and detail input files are on the card reader. The output files are on the card punch (updated master file) and printer (report file). For Problems A, B, C, and D, the card punch is always the controlling factor on overall processing time.

In Configurations II, III, and IV, the master files are on magnetic tape. The detail file is assigned to the card reader and the report file to the printer. The curves for Configuration II for all problems show that the printer is the controlling factor at high and moderate activities, while the two master-file tapes (which are connected to a single-channel 203B-5 Tape Control) control at lower activities.

In Problem A, the times at high and moderate activities for Configuration III are controlled by the printer. At lower activities, the two magnetic tape units assigned to one read-write channel become the controlling factor (the higher horizontal line on Graph 512:201.100). When the activity becomes low enough so that the combined times for the printer and card reader become less than the combined time for the tapes, the printer and card reader are assigned to one channel and the two tapes are assigned to two separate channels (the sloping straight line). Near zero activity, the combined times for the printer and card reader become less than the time for each tape, so a single tape unit becomes the controlling factor (the lower horizontal line). The curves for Problems B and D (Graph 512:201.130) can be explained in the same way.

The curves for Configuration IV in Problems A through C have the same general slope as those for Configuration III, even though Configuration IV has the auxiliary read-write channel. Because of the higher speed of the tape units used in this configuration, it cannot use the auxiliary channel to advantage in the Standard File Processing Problem. Due to the Honeywell 200's relatively high internal speed and simultaneity, the graph for Problem D (with trebled computation) is identical to the graph for Problem A.

SORTING (512:201.200)

The standard estimate for sorting 80-character records by straightforward merging on magnetic tape was developed from the time for Standard File Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide. A two-way merge was used in System Configuration II (which has only four magnetic tape units) and a three-way merge in Configurations III and IV. The results are shown in Graph 512:201.200. Because of the Honeywell 200's ability to overlap magnetic tape reading, writing, and computation in Configurations III and IV, its performance on the Sorting program (as on the Standard File Problems at low activities) is significantly better than that of several other computers in its price class which do not possess such an overlap feature.

MATRIX INVERSION AND GENERALIZED MATHEMATICAL PROCESSING

It is not possible to install automatic floating-point arithmetic operations in the Honeywell 200 Processor; therefore, these two mathematically-oriented standard problems have not been coded for the Honeywell 200.

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)

	ITEM		CONFIGURATION I		II		III		IV		REFERENCE
1 Input-Output Times	Char/block	(File 1)	80		1,080		1,080		1,080		4:200.112
	Records/block	K (File 1)	0.5		10		10		10		
	msec/block	File 1 File 2	75/138		99.7		58.5		23.5		
		File 3	75		75		75		75		
		File 4	94		129		129		94		
	msec/switch	File 1 File 2	0		0		0		0		
		File 3	0		0		0		0		
		File 4	0		0		0		0		
	msec penalty	File 1 File 2	0.1		2.2		2.2		2.2		
		File 3	0.2		0.2		0.2		0.2		
		File 4	11.0		11.0		11.0		11.0		
2 Central Processor Times	msec/block	a_1	0.3		0.3		0.3		0.3		4:200.1132
	msec/record	a_2	1.1		1.1		1.1		1.1		
	msec/detail	b_6	0.2		0.2		0.2		0.2		
	msec/work	$b_5 + b_9$	5.8		5.8		5.8		5.8		
	msec/report	$b_7 + b_8$	1.3		1.3		1.3		1.3		
3 System Performance at F = 1.0	msec/block for C.P. and dominant column.		C.P.	Punch	C.P.	Printer	C.P.	Printer	C.P.	Printer	4:200.114
		a_1	0.3		0.3		0.3		0.3		
		a_2K	0.5		10.5		10.5		10.5		
		a_3K	3.6		72.0		72.0		72.0		
		File 1 Master In	0.1		2.2		2.2		2.2		
		File 2 Master Out	0.1	437	2.2		2.2		2.2		
		File 3 Details	0.1		1.6		1.6		1.6		
		File 4 Reports	5.5		110.0	1,290	110.0	1,290	110.0	940	
		Total	10.2	437.5	198.8	1,290	198.8	1,290	198.8	940	
4 Storage Space Required	Unit of Measure	(character)									4:200.1151
		Std. routines	100		2,250		2,250		2,250		
		Fixed	18		18		18		18		
		3 (Blocks 1 to 23)	350		612		612		612		
		6 (Blocks 24 to 48)	2,334		2,334		2,334		2,334		
		Files	720		2,560		4,720		4,720		
		Working	0		108		108		108		
		Total	3,522		7,882		10,042		10,042		

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

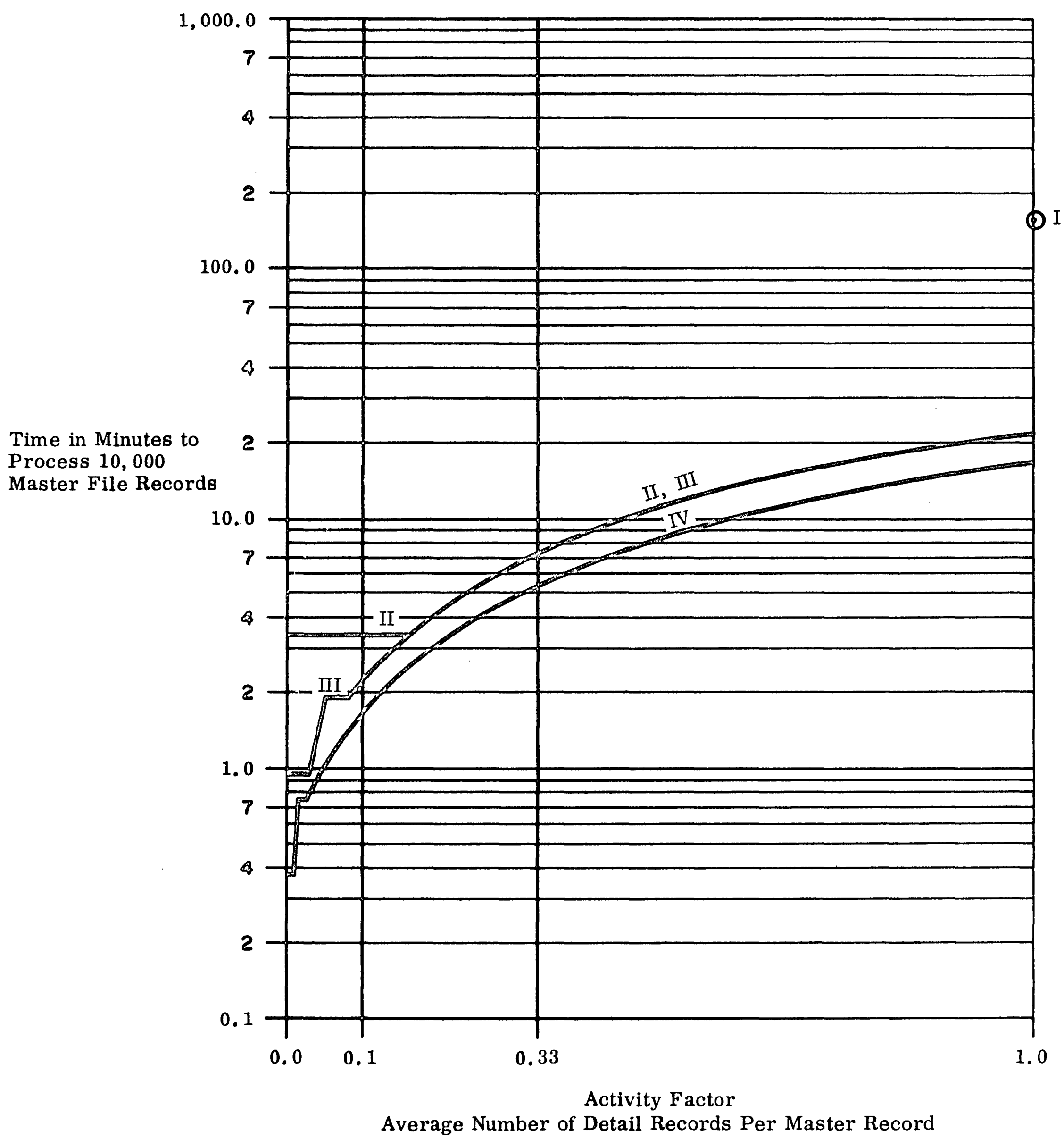
.111 Record sizes —
Master file: . . . . . . 108 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.112 Computation:. . . . . . . standard.

.113 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage space required
Configuration I: . . . . 3,522 characters.
Configuration II: . . . 7,882 characters.
Configuration III: . . . 10,042 characters.
Configuration IV: . . . 10,042 characters.

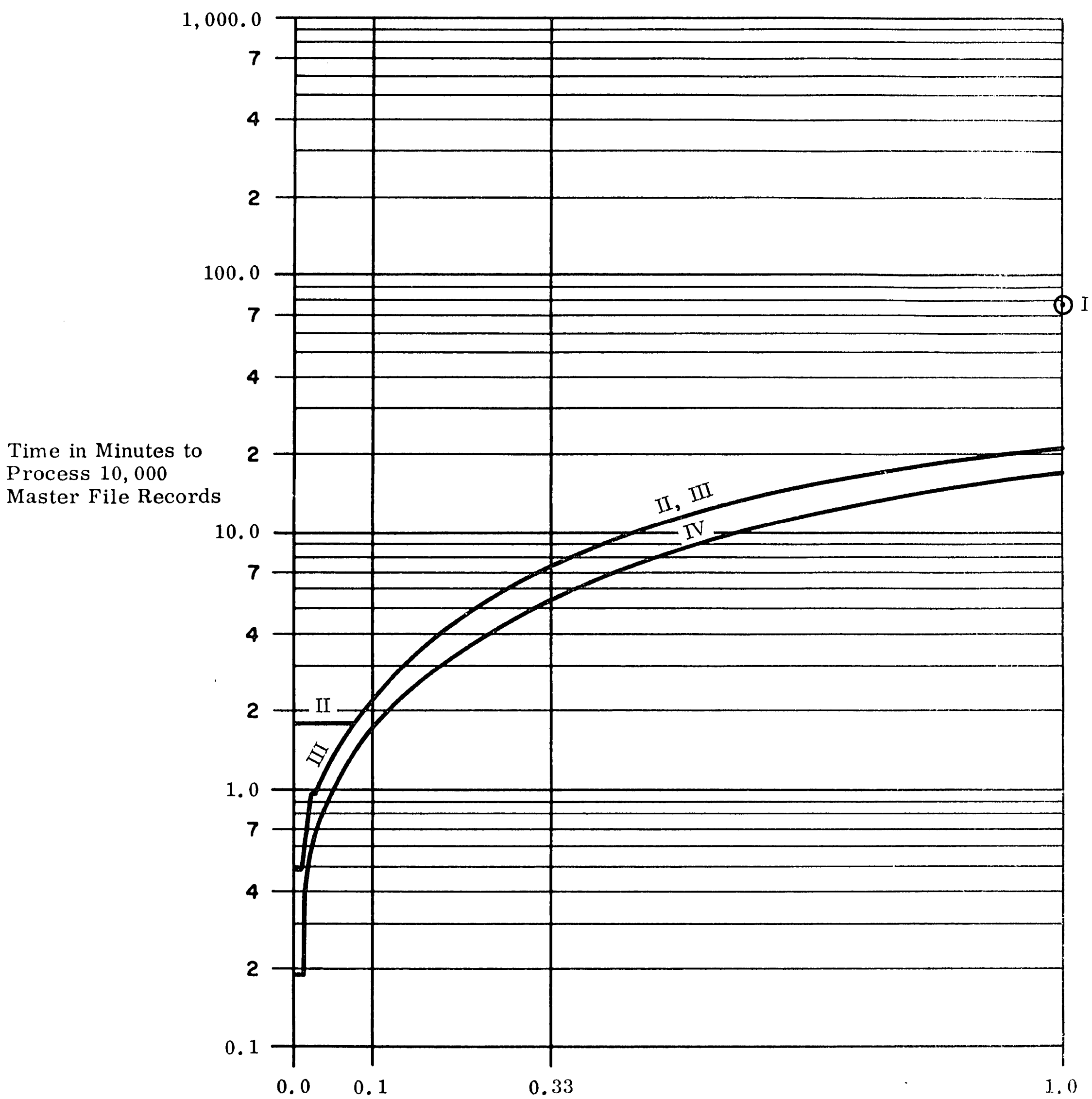


(Roman numerals denote standard System Configurations.)

.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . . 54 characters.
Detail file: . . . . 1 card.
Report file: . . . . . . 1 line.

.122 Computation:. . . . . . . standard.
.123 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . see graph below.



Activity Factor
Average Number of Detail Records Per Master Record

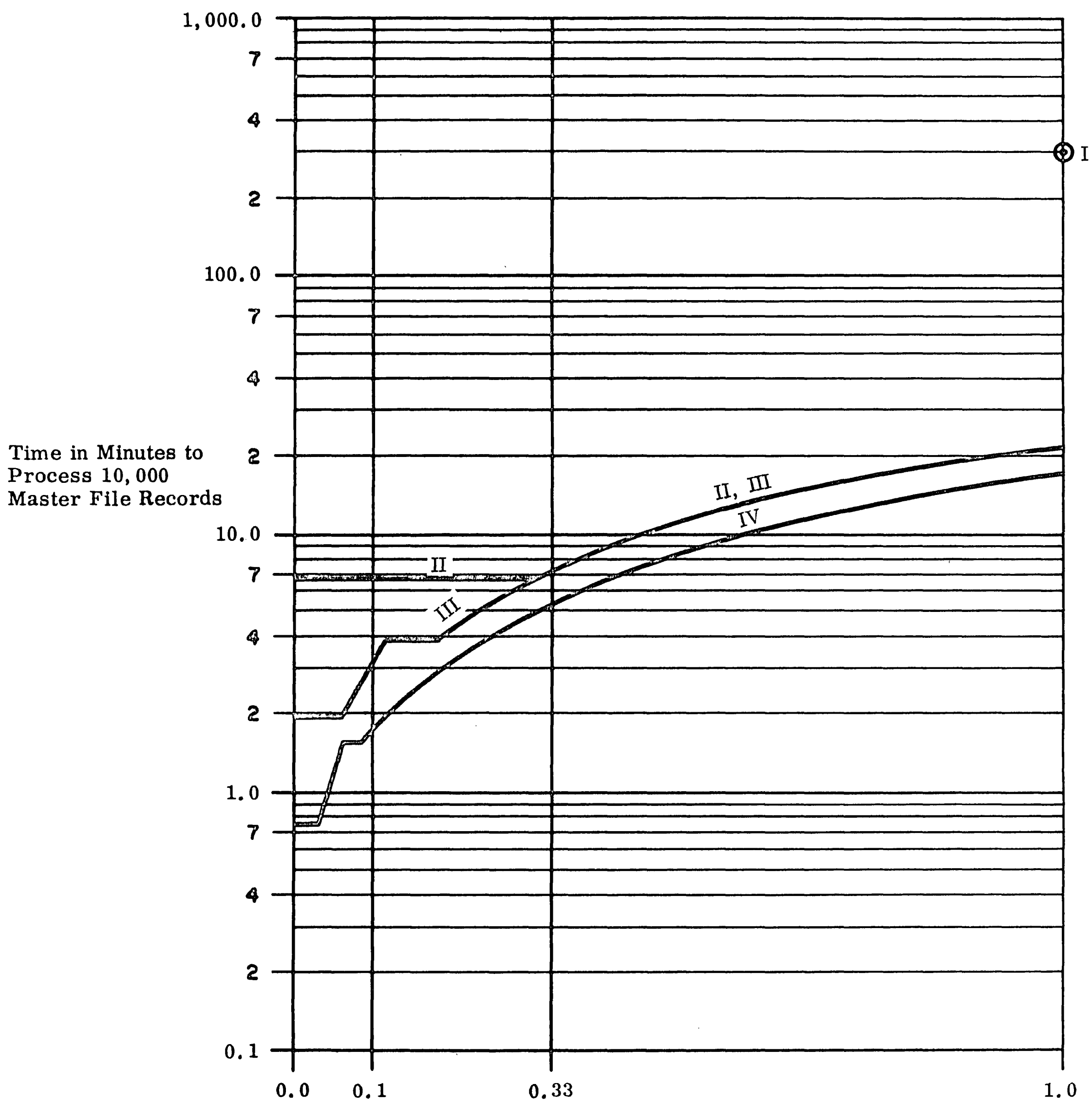
(Roman numerals denote standard System Configurations.)

(Contd.)

.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . . 216 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.132 Computation:. . . . . . . standard.
.133 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . see graph below.



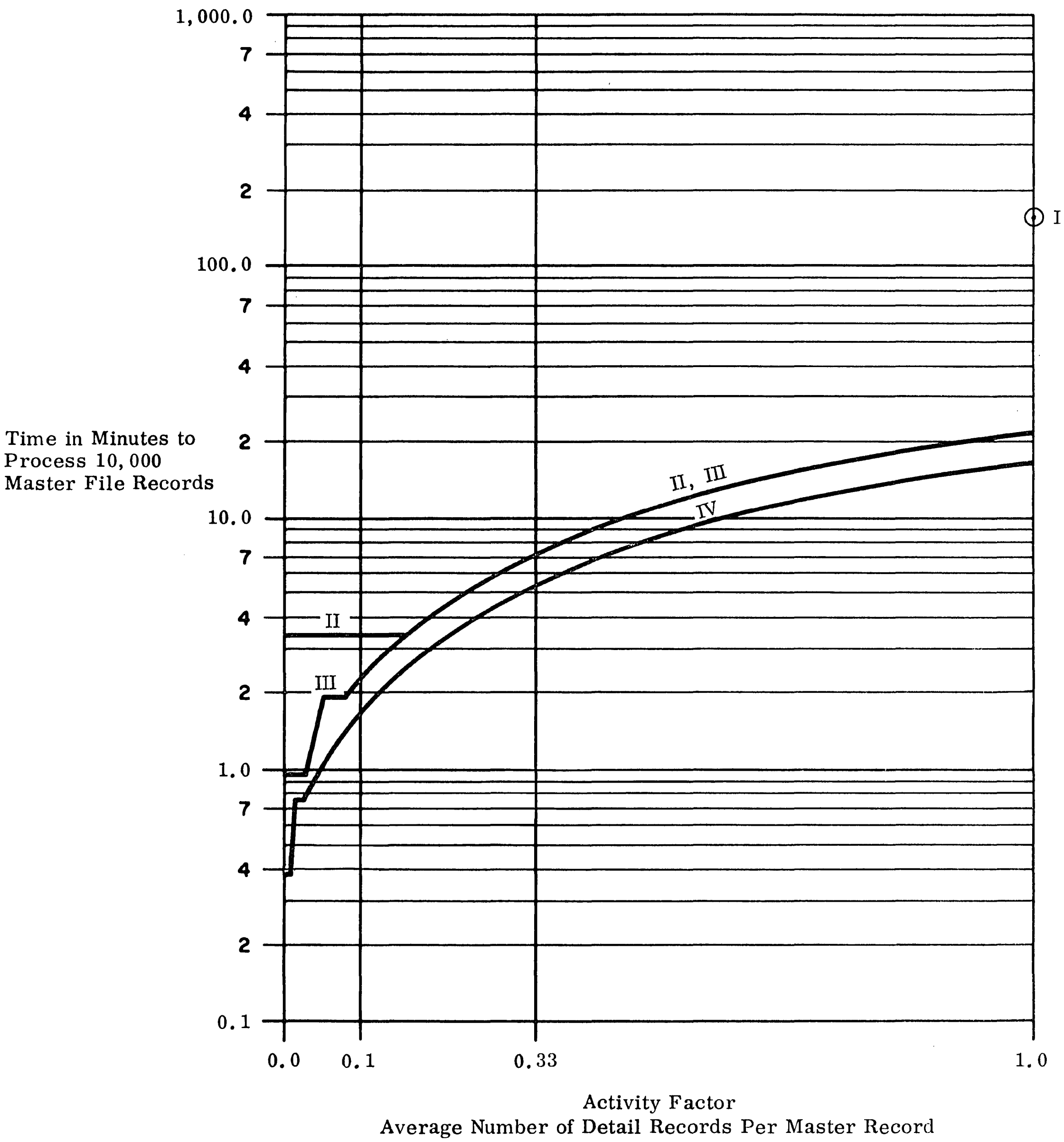
Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . . . 108 characters.
Detail file: . . . . 1 card.
Report file: . . . . . . 1 line.

.142 Computation:. . . . . . . trebled.
.143 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . see graph below.



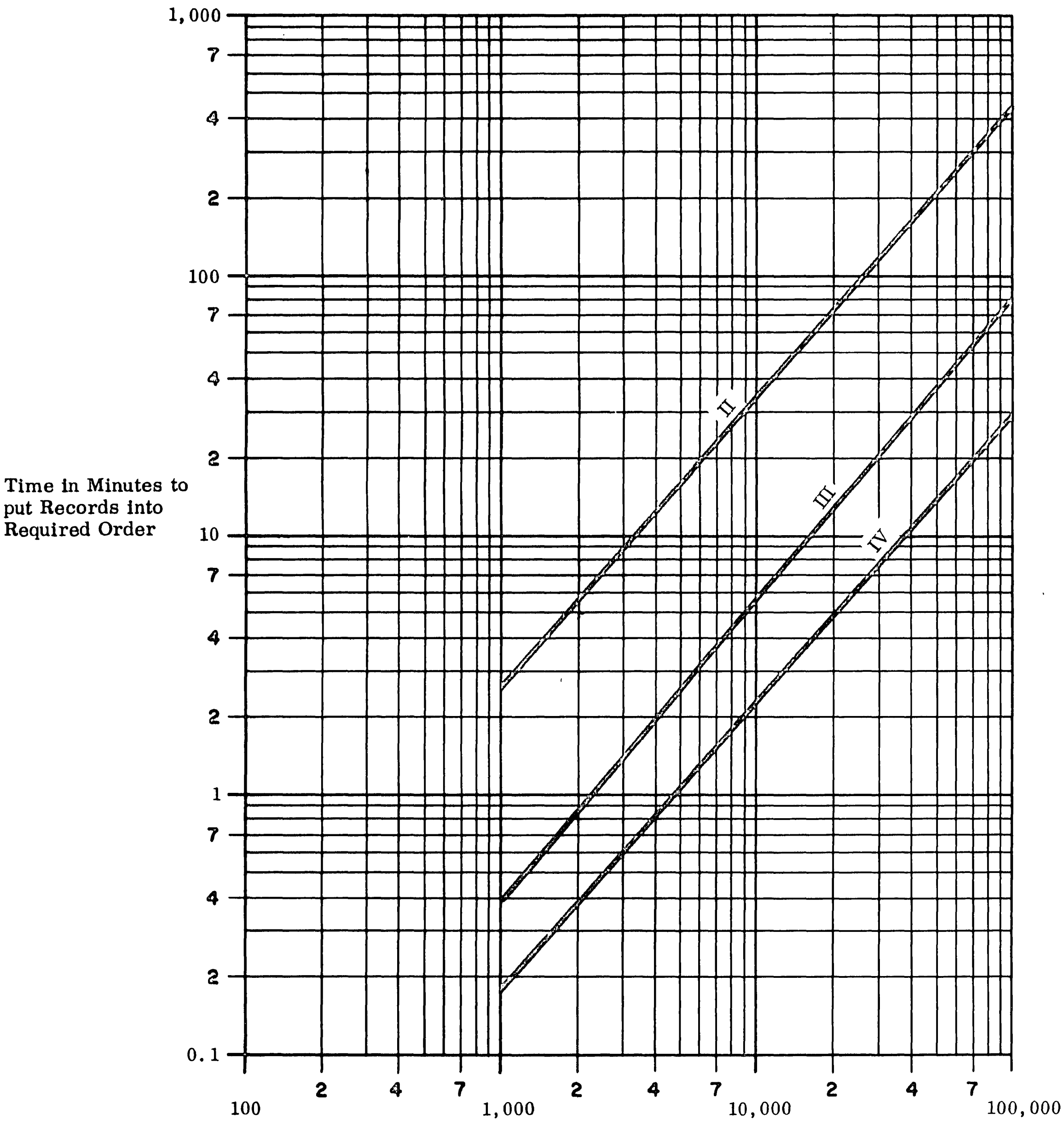
(Roman numerals denote standard System Configurations.)

(Contd.)

.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.
.212 Key size: . . . . 8 characters.
.213 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.213, with 2-way merge in Configuration II and 3-way merge in Configurations III and IV.
.214 Graph: . . . . see graph below.



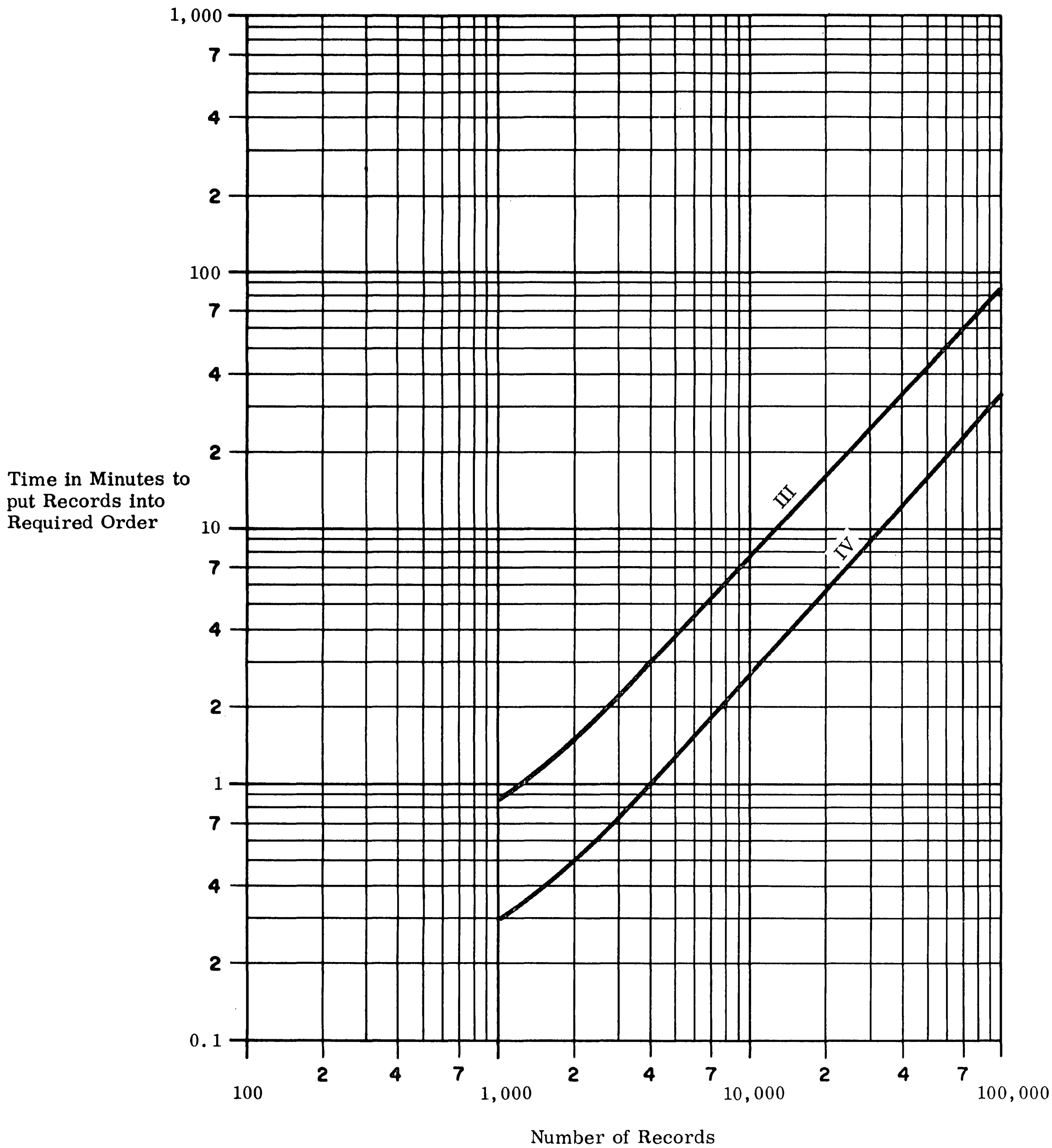
(Roman numerals denote standard System Configurations.)

.22 H-200 Sort II Times

.221 Record size: . . . . 80 characters.
.222 Key size: . . . . 8 characters.

.223 Timing basis: . . . . . . timing formulas supplied by Honeywell.

.224 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

HONEYWELL 1200

Honeywell EDP Division

AUERBACH

STANDARD EDP REPORTS

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INTRODUCTION

The Honeywell 1200 Processor can be connected to any of the Honeywell Series 200 peripheral units, can use any of the Series 200 programming languages, and can run most programs originally written for an IBM 1401. It can contain between 16,384 and 131,072 characters of core storage, with a cycle time of 1.5 microseconds per character.

Standard features of the Honeywell 1200 Processor include: Multiply-Divide, Program Interrupt, Advanced Programming, Edit Instruction, four read-write channels, 16 I/O trunks, and 8-Bit Code Handling.

Optional features are: the floating-point arithmetic facilities provided by the Scientific Unit, Storage Protect, and the Optional Instruction Package (table look-up facilities).

The rental for typical Honeywell 1200 systems is expected to fall between $5,000 and $14,000 per month. Deliveries began in February 1966.

This report concentrates upon the characteristics and the performance of the Honeywell 1200 in particular. All the general characteristics of the Honeywell Series 200 hardware and software are described in Computer System Report 510: Honeywell Series 200 — General.

The System Configuration section which follows shows the Honeywell 1200 in the following standard System Configurations:

I: Typical Card System
II: 4-Tape Business System
III: 6-Tape Business System
IV: 12-Tape Business System
V: 6-Tape Auxiliary Storage System
VI: 6-Tape Business/Scientific System
VIIA: 10-Tape General System (Integrated)
VIIB: 10-Tape General System (Paired with the Honeywell 120)

These configurations were prepared according to the rules in the Users' Guide, page 4:030.120, and any significant deviations from the standard specifications are listed.

Section 513:051 provides detailed central processor timings for the Honeywell 1200.

The input-output channel capabilities of the Honeywell 1200, and the demands upon the processor during input-output operations, are described in Section 513:111.

The software that can be used with any Series 200 computer depends upon its core storage capacity and the number and type of peripheral devices. Several versions of the Easycoder Assembler and the COBOL Compiler will be made available. A FORTRAN compiler will be able to operate on the Honeywell 1200, whether or not the floating-point arithmetic option is installed, provided that the other configuration requirements are met. These languages, and numerous other support routines for the Honeywell 1200, are described in Sections 510:151 through 510:193

The overall performance of any Honeywell Series 200 system is heavily dependent upon the processor model used. A full System Performance analysis of standardized configurations utilizing the Honeywell 1200 is provided in Section 513:201.

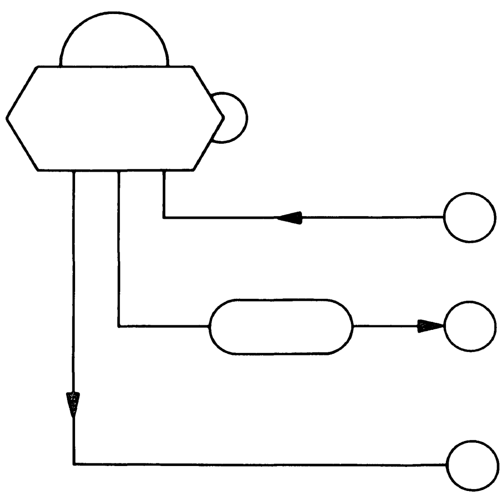
SYSTEM CONFIGURATION

The Honeywell 1200 Processor contains 4 input-output channels and 16 input-output trunks. This means that up to 16 peripheral devices or controllers can be connected, and a maximum of 4 data transfer operations can occur simultaneously with internal processing. The connections between devices and channels are established under program control.

Any of the available Series 200 peripheral units can be connected to a Honeywell 1200 Processor. These peripheral units are described in detail in the main Series 200 Computer System Report, and their trunk requirements are summarized in the main System Configuration section, page 510:031.101.

.1 TYPICAL CARD SYSTEM; CONFIGURATION I

Deviations from Standard Configuration: . . . . card reader is 20% slower.
card punch is up to 50% slower.
6 index registers instead of 1.



Equipment	Rental**
1201-1 Processor and Console with 16,384 characters of Core Storage	$2,665
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-4 Printer and Control: 950 lines/min (120 print positions)*	1,305

Optional Features Included: . . . . none.

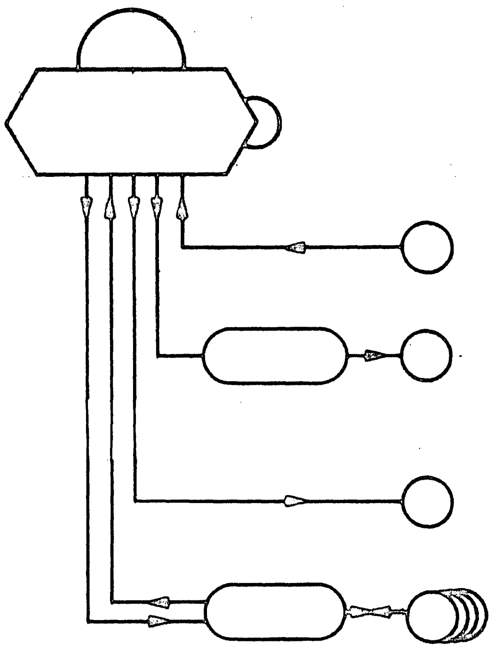
TOTAL RENTAL: $4,745

* For compatibility with the IBM 1401, number of printing positions can be expanded to 132 at an extra cost of $65 on all configurations.

** The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $4,285 per month.

.2 4-TAPE BUSINESS SYSTEM; CONFIGURATION II

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.
ability to overlap input-output operations with internal processing is standard.
Multiply-Divide is standard.



Equipment	Rental*
1201-1 Processor and Console with 16,384 characters of Core Storage	$2,665
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-5 Tape Control Unit	310
204B-11 and -12 Magnetic Tape Units (4): 13,300 char/sec	970

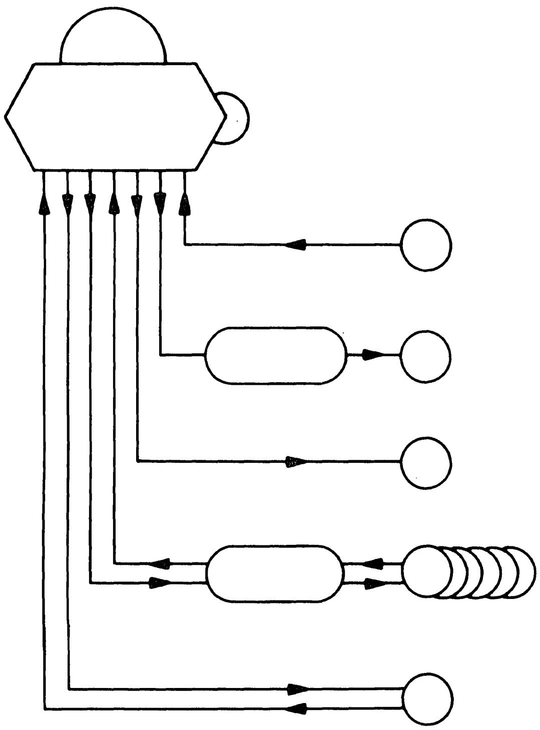
Optional Features Included: . . . . none.

TOTAL RENTAL: $5,645

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $5,105 per month.

.3 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.
console typewriter input is included.
ability to read and write magnetic tape simultaneously is standard.



Equipment	Rental*
1201-1 Processor with 16,384 characters of Core Storage	$2,665
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Units (6): 28,800 char/sec (800 bpi)	2,460
220-3 Console (includes Teleprinter)	310

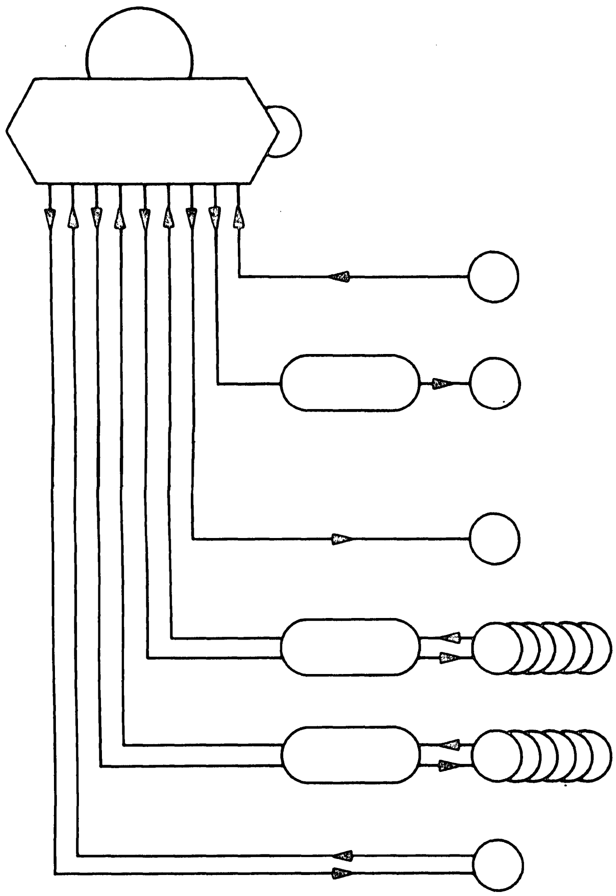
Optional Features Included: . . . . none.

TOTAL RENTAL:	$7,570

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $6,835 per month.

.4 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 20% slower.
card punch is up to 50% slower.



Equipment	Rental*
1201-2 Processor with 32,768 characters of Core Storage	$ 3,485
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-4 Printer and Control: 950 lines/min (120 print positions)	1,305
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (6): 64,000 char/sec	3,690
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (6): 64,000 char/sec	3,690
220-3 Console (includes Teleprinter)	310

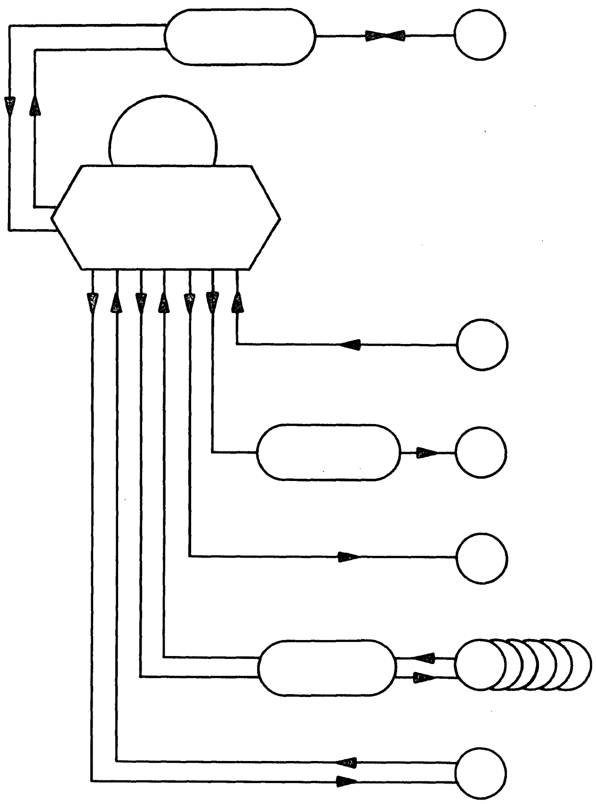
Optional Features Included: . . . . none.

TOTAL RENTAL:	$14,125

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $12,755 per month.

.5 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.
console typewriter input is included.
ability to read and write magnetic tape simultaneously is standard.



Equipment	Rental*
250 Card Mass Memory Control	$ 335
251 Card Mass Memory File: 15,000,000 char; access time 95 msec (av)	670
1201-1 Processor with 16,384 characters of Core Storage	2,665
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Units (6): 28,800 char/sec (800 cpi)	2,460
220-3 Console (includes Teleprinter)	310

Optional Features Included: . . . . none.

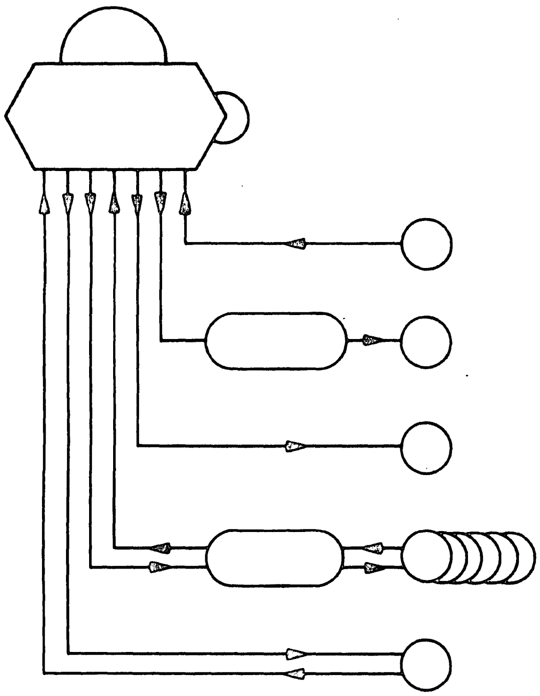
TOTAL RENTAL:	$8,575

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $7,735 per month.

(Contd.)

.6 6-TAPE BUSINESS/SCIENTIFIC SYSTEM; CONFIGURATION VI

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.
console typewriter input is included.
ability to read and write magnetic tape simultaneously is standard.

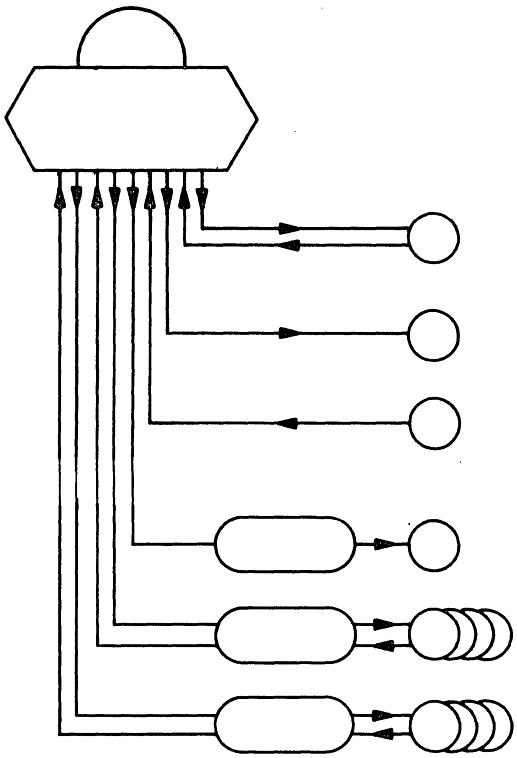


Equipment	Rental*
1201-4 Processor with 65,536 characters of Core Storage	$4,870
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-4 Tape Control Unit	425
204B-7 Magnetic Tape Units (6): 28,800 char/sec (800 cpi)	2,460
220-3 Console (includes Teleprinter)	310
Optional Features Included: Scientific Unit	310
TOTAL RENTAL:	$10,085

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $9,105 per month.

.7 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIA

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.

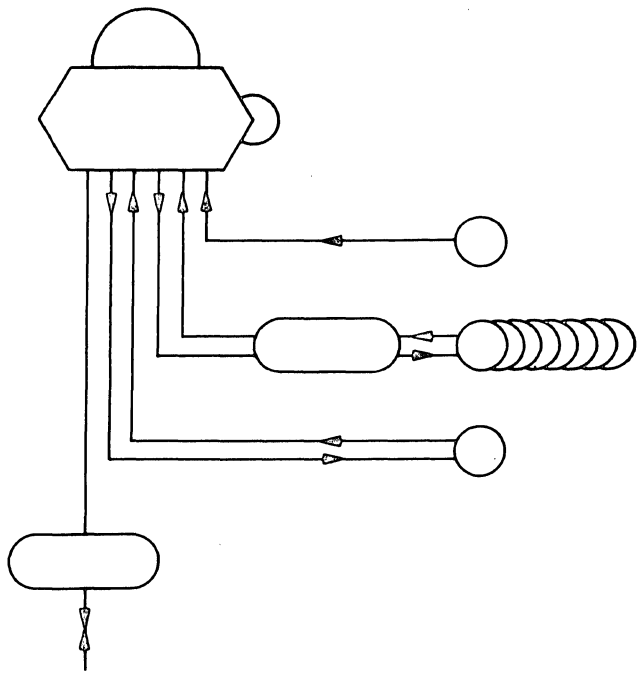


Equipment	Rental*
1201-6 Processor with 98,304 characters of Core Storage	$ 5,740
220-3 Console (includes typewriter and direct control)	310
222-3 Printer and Control (120 print positions); 650 lines/min	925
223 Card Reader and Control: 800 lines/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 fully-punched cards/min	310
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 64,000 char/sec	3,075
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 64,000 char/sec	3,075
Optional Features Included: . . . . Scientific Unit	310
TOTAL RENTAL	$15,080

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $13,615 per month.

.8 10-TAPE GENERAL SYSTEM (PAIRED): CONFIGURATION VIIB

Deviations from Standard Configuration: . . . . card reader is 700% faster.
direct connection to satellite system.



Equipment	Rental*
1201-4 Processor and Console with 65,536 characters of Core Storage	$4,870
223 Card Reader and Control: 800 cards/min	310
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (8): 64,000 char/sec	4,920
220-3 Console (includes Teleprinter and direct control)	310
212-1 On-Line Adapter Unit (for connection to H-120)	410

Optional Features Included: . . . . Scientific Unit 310

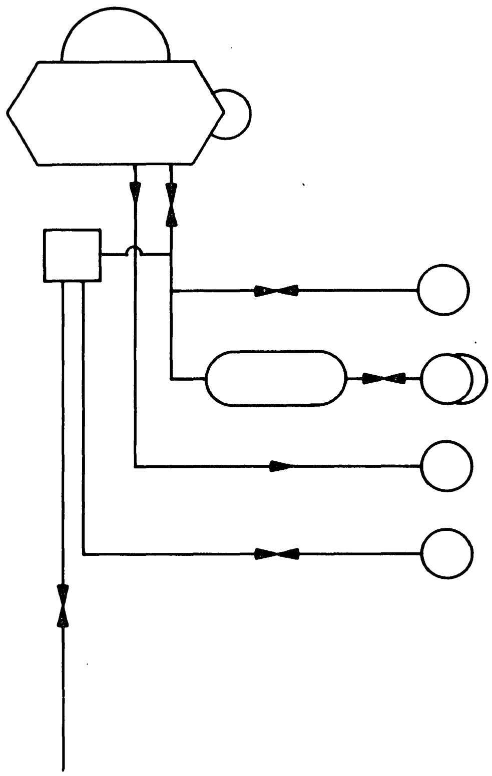
TOTAL ON-LINE EQUIPMENT:	11,565
TOTAL SATELLITE EQUIPMENT:	3,560
TOTAL RENTAL:	$15,125

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year rental agreement leases for $13,675 per month.

.8 CONFIGURATION VIIB (Contd.)

SATELLITE EQUIPMENT (Honeywell 120)

Deviations from Standard Configuration: . . . . card reader is 20% slower.
ability to overlap printing and one input-output operation with computing is standard.
console typewriter input is included.
6 index registers.



Equipment	Rental
121-2 Central Processor and Console with 4,096 character positions of Core Storage	$1,000
I/O Adapter (Non-Simultaneous)	155
214-2 Card Reader/Punch: Reads: 400 cards/min Punches: 100-400 cards/min	360
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Units (2)	820
122 Printer: 450 lines/min (120 print positions)	510
220-1 Console (includes Teleprinter)	205

Optional Features Included: . . . .

Advanced Programming	75
Edit Instruction	50
TOTAL SATELLITE EQUIPMENT	$3,560

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . Central Processor. Models 1201-1 through 1201-12.

.12 Description

The Model 1201 Central Processor performs all arithmetic and logical functions in a Honeywell 1200 system under control of the internally stored program. The Central Processor consists of five basic functional units: the main memory, the control memory, the control unit, the arithmetic unit, and the input-output traffic control.

The main memory consists of from 16,384 to 131,072 alphameric character positions of core storage and is fully described in Section 510:041. Cycle time is 1.5 microseconds per one-character access.

Each character position consists of six data bits, one parity bit, and two punctuation bits. The punctuation bits can be used to indicate a word mark, an item mark, or a record mark, which define the length of a data field or instruction, an item, or a record, respectively. An "item" consists of a group of consecutive data fields. (The IBM 1400 series computers utilize only one punctuation bit — the "word mark" bit – and each record mark occupies an entire character position. The two punctuation bits used in the Series 200 will decrease data storage requirements and provide increased flexibility in data movement operations. The optional Extended Move instruction, for example, can be terminated by a word mark, an item mark, or a record mark, as specified by the programmer.)

The control memory is a small magnetic core storage unit with an access time of 0.25 microsecond and a cycle time of 0.50 microsecond. It holds up to 29 basic control registers. Each register either stores the address of one character position in the main memory or functions as part of the Scientific Unit (see "Optional Features" on the following page).

Instructions are provided to load and store the contents of each of these registers. The 29 basic control registers have the following functions:

(1) A-Address Register.

(2) B-Address Register.

(3) Sequence Register.

(4) Change Sequence Register.

(5) Read-Write Channel 1 — Present Location Counter.

(6) Read-Write Channel 1 — Starting Location Counter.

(7) Read-Write Channel 2 — Present Location Counter.

(8) Read-Write Channel 2 — Starting Location Counter.

(9) Read-Write Channel 3 — Present Location Counter.

(10) Read-Write Channel 3 — Starting Location Counter.

(11) Auxiliary R/W Channel — Present Location Counter.

(12) Auxiliary R/W Channel — Starting Location Counter.

(13) Interrupt Register.

(14) Internal Interrupt Register (used with the Storage Protect Feature).

(15) Work Register 1.

(16) Work Register 2.

(17) Work Register 3.

(18-29) Scientific Unit (Feature 1100).

The control unit controls the sequential selection, interpretation, and execution of all stored program instructions and checks for correct (odd) parity whenever a character is moved from one location to another. It also provides for communication with the operator's Control Panel described in Section 510:061.

The arithmetic unit executes all arithmetic and logical operations. It consists of an adder that can perform both decimal and binary arithmetic and two one-character operand storage registers. The Honeywell 1200 is basically a two-address, add-to-storage system. All operations are performed serially by character and terminated when specific punctuation bit configurations are sensed. This means that operand sizes are fully variable and are limited only by the amount of core storage available to hold them.

The input-output traffic control directs the time-sharing of accesses to the main memory by the various peripheral devices and the Central Processor. Up to four input-output operations can occur simultaneously with internal processing. Three read-write channels and an auxiliary channel are included in the basic Honeywell 1200 system. The auxiliary channel alternates with read/write channel 1, and is interlocked when the Model 227 Card Reader, any printer, the drum, a mass storage unit, or a magnetic tape unit with a speed of over 45KC is operating on channel 1.

Highly significant is the fact that the programmer can maximize the utilization of the read-write channels by selecting any one of the channels to serve any input-output device; there is no need for permanent assignment of each peripheral device to a specific channel, as in many competitive systems. All peripheral devices can use any core storage areas of appropriate size as input-output areas.

.12 Description (Contd.)

Demand on the Central Processor for most peripheral operations is only 1.5 microseconds per character transferred to or from core storage.

The processor is well suited to general data manipulation. Editing, multiplication, division, indexing, indirect addressing, and full-record data movement capabilities are all standard in the Honeywell 1200. Binary addition and subtraction, logical AND, exclusive OR, and masking instructions are also standard. The Move and Translate instruction uses a 64-character translation table to translate any number of consecutive characters from one 6-bit code to another. Handling of 8-bit codes is also provided.

Instruction length is variable from one to eleven characters. Arithmetic and data movement instructions are most commonly seven characters long. Through careful placement of data, instructions can sometimes be "chained" so that a one-character instruction does the work of a seven-character one, resulting in savings in both storage space and execution time. Chaining is possible only when a series of operations is to be performed upon items of data stored in consecutive locations, so that the A- and B-Address Registers do not need to be reloaded before each instruction is executed.

The Honeywell 1200 uses a pure binary addressing system. In the 3-character mode, each address portion within an instruction normally consists of three characters, or 18 data bits. Fifteen bits are used to specify an address between 0 and 32,767, and the remaining three bits can specify address modification: either indirect addressing or indexing by one of the six index registers. A special instruction enables the Central Processor to switch between the three-character addressing mode and a special two-character mode. Use of two-character addresses reduces both storage space and execution time but has two significant disadvantages: only the 4,096 character positions within a single core module can be addressed, and neither indexing nor indirect addressing can be used. A four-character addressing mode is used for addresses 32,768 to 131,072. Fifteen index registers can be used in the 4-character mode.

Program Interrupt capabilities are provided by two control memory Interrupt Registers and a single-character instruction called Resume Normal Mode (RNM). The Interrupt Registers (IR) are under programmer control; i.e., any particular memory address can be loaded into an IR. When the Central Processor receives a demand from an external device or a notification of a memory barricade violation, pertinent arithmetic and control indicators are automatically stored, and the contents of the sequence register and an IR are exchanged. This action results in a transfer of control to the instruction indicated by the previous contents of the IR.

When the RNM instruction is executed, all the pertinent address registers, indicators, etc., are automatically restored to their normal condition (i.e., their status prior to the interrupt), and control reverts to the sequence register.

Typical instruction execution times (using the three-character addressing mode) are 27 microseconds for a 5-character move, 35 microseconds for a 5-digit decimal add, and 29 microseconds for a 5-character compare. Each of these instructions is 3 microseconds shorter when two-character addresses are used and 3 microseconds longer when four-character addresses are used. Indexing or indirect addressing requires an additional 4.5 microseconds per modified address.

Optional Features

Storage Protect: Protects the contents of one designated memory area against accidental reference or alteration by unrelated programs; provides 15 additional index registers for use by programs inside the protected area.

Scientific Unit: Provides instructions for floating-point operations and decimal-binary radix conversions.

Optional Instruction Package: Provides table look-up control facilities.

Instruction Compatibility with the IBM 1401 and 1410

Please see the detailed comparison of instruction codes in the Instruction List section, page 510:121.100. A general discussion of the compatibility between the Honeywell Series 200 and the IBM 1401/1410 is presented in Section 510:131.

.14 First Delivery: . . . . . February 1966.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add-subtract:	automatic	decimal or binary	1 to N char.
	Multiply:	automatic	decimal	1 to N char.
	Divide:	automatic	decimal	1 to N char.
.212	Floating point —			
	Add-subtract:	automatic*	binary	36 & 12 bits.
	Multiply:	automatic*	binary	36 & 12 bits.
	Divide:	automatic*	binary	36 & 12 bits.

* with optional Scientific Unit.

(Contd.)

	Operation and Variation	Provision	Radix	Size
.213	Boolean —			
	AND	automatic	binary	1 to N char.
	Inclusive OR:	none.		
	Exclusive OR:	automatic	binary	1 to N char.
.214	Comparison:	branch on high, low, equal, unequal, or zero balance.		
	Numbers:	automatic		1 to N char.
	Absolute:	none.		
	Letters:	automatic		1 to N char.
	Mixed:	automatic		1 to N char.
	Collating sequence:	0 through 9, then A through Z, with special symbols interspersed.		

.215 Code translation —
- Provision: . . . . . . automatic (using code table constructed by programmer).
- From: . . . . any 6-bit or 8-bit code.
- To: . . . . any 6-bit or 8-bit code.
- Size: . . . . 1 to N characters.

.216 Radix conversion —
- Provision: . . . . . . automatic (with optional Scientific Unit).
- From: . . . . binary or decimal.
- To: . . . . decimal or binary.

		Provision	Comment	Size
.217	Edit format —			
	Alter size:	automatic	expand but not contract.	1 to N char.
	Suppress zero:	automatic		1 to N char.
	Round off:	none.		1 to N char.
	Insert point:	automatic		1 to N char.
	Insert spaces:	automatic		1 to N char.
	Insert $, CR-*:	automatic		1 to N char.
	Float $:	automatic		1 to N char.
	Protection:	automatic		1 to N char.
.218	Table look-up:	automatic (with Optional Instruction Package).		
.219	Others —			
	Substitute:	automatic	performs binary masking	1 char.
	Change Addressing Mode:	automatic	shifts between 2, 3, and 4 char addresses.	
	Branch on Sense Switches:	automatic	16 possible settings.	

.22 <u>Special Cases of Operands</u>

.221 Negative numbers: . . . absolute value, with B zone bit in units position.

.222 Zero: . . . . positive, negative, and unsigned zeros and blanks give same result in decimal arithmetic but are unequal in comparisons.

.223 Operand size determination: . . . . . word mark, item mark, or record mark bits in high or low order digit position. (Some instructions imply one-character operands).

.23 <u>Instruction Formats</u>

.231 Instruction structure: . variable; 1 to 12 characters.

.232 Instruction layout:

Part	OP	A or I	B	V_1 or C_1	V_2 or C_2	C_3
Size (char):	1	2, 3, or 4	2, 3, or 4	1	1	1

.232 Instruction layout (Contd.)

An instruction may consist of:

(1) OP only	(6) OP, A or I, B, V_1
(2) OP, V_1	(7) OP, A, B, V_1, V_2
(3) OP, A or I	(8) OP, A or I, C_1
(4) OP, A or I, V_1	(9) OP, A or I, C_1, C_2
(5) OP, A or I, B	(10) OP, A or I, C_1, C_2, C_3.

.233 Instruction parts

Name	Purpose
OP:	operation code.
A:	address of an operand or field in core storage.
I:	location of next instruction if a branch occurs.
B:	address of an operand or field in core storage.
V_1 or C_1:	modifier for an operation code, control field for an I/O instruction, or partial address in a translate instruction.
V_2 or C_2:	partial address in a translate instruction or control field for an I/O instruction.
C_3:	control field for an I/O instruction.

.234 Basic address structure: . . . . 2 + 0.
.235 Literals —
Arithmetic: . . . . . . none.
Comparisons and tests: . . . . yes; single character.
Incrementing modifiers: . . . . . . none.
Masking: . . . . yes, single character mask.
.236 Directly addressed operands —
Internal storage type: . . . . core.
Minimum size: . . . . 1 character.
Maximum size: . . . . total capacity.
Volume accessible: . total capacity.
.237 Address indexing —
.2371 Number of methods: . 1.
.2372 Name: . . . . indexing.
.2373 Indexing rule: . . . . . addition (modulo core storage capacity).
.2374 Index specification: . . Address Type Indicator — first 3 bits of 18-bit operand address or first 5 bits of 24-bit operand address.
.2375 Number of potential indexers: . . . . 15.
.2376 Addresses which can be indexed: . . . . . . all 3- and 4-character addresses.
.2377 Cumulative indexing: . . . . none.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . . yes.
.2381 Recursive: . . . . yes.
.2382 Designation: . . . . . . Address Type Indicator — first 3 bits or 5 bits of operand address.
.2383 Control: . . . . direct address has no indicator bit.
.2384 Indexing with indirect addressing: . yes.
.239 Stepping: . . . . none.

.24 Special Processor Storage

(see tables below.)

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . 1
.312 Arrangement: . . . . . . programmer can exchange the the contents of the sequence and change sequence registers by use of Change Sequence Mode instruction.
.313 Precedence rule: . . . . programmer indicates register to be used.
.314 Special sub-sequence counters: . . . . none.
.315 Sequence control step size: . . . . 1 character.
.316 Accessibility to routines: . . . . yes; can be loaded and stored by instructions.
.317 Permanent or optional modifier: . . . . no.

.32 Look-Ahead: . . . . none.

.241

Category of storage	Number of locations	Size in characters	Program usage
Control memory:	16	48	address registers, read/write counters, interrupt register.
Arithmetic unit:	2	1	operand storage registers (not accessible to programmer).
Scientific Unit:	12	32	floating-point registers.

.242

Category of storage	Total number of locations	Physical form	Access time, μsec	Cycle time, μsec
Control memory:	16	magnetic core	0.25	0.50
Arithmetic unit:	2	silicon diodes	0.50	1.00

(Contd.)

.33 Interruption

.331 Possible causes —

In-out units:	ready to transfer one unit of data (character or record).
Storage access:	Storage Protection interrupt.
Processor errors:	Storage Protection interrupt.

.332 Control by routine: . . . yes.

.333 Operator control: . . . . operator can initiate I/O interrupt from console.

.334 Interruption conditions: execution of current instruction is completed.

.335 Interruption process —

Registers saved:	contents of sequence register and an interrupt register are automatically interchanged; address register and indicator settings are automatically saved and restored.
Destination:	fixed location (contents of Interrupt Register).

.34 Multiprogramming: . . concurrent execution of two programs is controlled by the Operating System — Mod 2, described in Section 510:193.

.35 Multisequencing: . . . . none.

.4 PROCESSOR SPEEDS

All execution times listed here are based on use of the 3-character addressing modes; most instructions are 3 microseconds shorter in the 2-character addressing mode, and 3 microseconds longer in the 4-character addressing mode.

D = operand length in decimal digits.
C = operand length in characters.

.41 Instruction Times in Microseconds

.411 Fixed point —

Add-subtract:	
Decimal:	$13.5 + 4.5D$
Binary:	$12.0 + 4.5C$
Multiply:	$18 + 10.5D + 10.5D^2$; where multiplier and multiplicand are both D digits in length.
Divide:	$36.75 + 44.25D + 22.5D^2$; where the dividend is twice the length of the divisor (D = no. of digits in divisor).

.412 Floating point —

Add-subtract:	30.
Multiply:	66.
Divide:	95.

.413 Additional allowance for —

Indexing:	4.5 per modified address.
Indirect addressing:	4.5 per stage.
Re-complementing:	3D.

.414 Control —

Compare:	13.5 + 3D.
Branch:	10.5

.415 Counter control: . . . . none.

.416 Edit: . . . . 12 + 10.5C

.417 Convert —

Decimal to binary:	47.5*
Binary to decimal:	45.*

.418 Shift: . . . . 10.5 + 0.375N (optional binary mantissa shift); where N = number of bits shifted.

.42 Processor Performance in Microseconds

	Fixed point	Floating point
.421 For random addresses —		
$c = a + b$:		
Decimal:	$25.5 + 7.5D$	—
Binary:	$24.0 + 7.5C$	84.
$b = a + b$:		
Decimal:	$13.5 + 4.5D$	—
Binary:	$12.0 + 4.5C$	84.
Sum N items:		
Decimal:	$(13.5 + 4.5D)N$	—
Binary:	$(12.0 + 4.5D)N$	30N.
$c = ab$:	$30.0 + 13.5D + 10.5D^2$	120.
$c = a/b$:	$62.3 + 53.3D + 22.5D^2$	149.
.422 For arrays of data —		
$c_i = a_i + b_j$:	$117.5 + 7.5D$	166.5
$b_j = a_i + b_j$:	$91.5 + 4.5D$	166.5
Sum N items:	$(73.5 + 4.5D)N$	90N.
$c = c + a_ib_j$:	$126 + 22.5D + 10.5D^2$	192.

.423 Branch based on comparison —

Numeric data:	127.5 + 3D.
Alphabetic data:	127.5 + 3C.

.424 Switching —

Unchecked:	72.
Checked:	72.
List search:	34.5 + (84.0 + 3D)N.

.425 Format control per character —

Unpack:	4.4
Compose:	6.4

.426 Table look-up per comparison —

Unpack:	1.5C*
For least or greatest:	1.5C*
For interpolation point:	1.5C*

.427 Bit indicators —

Set bit in separate location:	15.
Set bit in pattern:	16.5
Test bit in separate location:	18.
Test bit in pattern:	18.

.428 Moving: . . . . 12.0 + 3C.

* With optional features.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator.
Zero divisor:	overflow check	set indicator.
Invalid data:	validity check	set indicator.
Invalid operation:	check	stop with error indication.
Arithmetic error:	none.	
Invalid address:	limit check	stop with error indication.
Receipt of data:	parity check	set indicator.
Dispatch of data:	send parity bit.	

SIMULTANEOUS OPERATIONS

The Honeywell 1200 can control three or four input-output operations concurrently with internal processing, as described below.

(1) Computation within the central processor continues at all times, except during the individual 1.5-microsecond cycles required for each unit of data transferred between core storage and any peripheral unit.

(2) In addition, in every Honeywell 1200 system any three of the peripheral data transfer operations listed in Table I (over) can proceed at one time (one on each read-write channel) in addition to the continuing central processor operation. Lengths of the start time, data transmission time, and stop time are shown for each operation, along with its demands upon the central processor (CP) and the selected channel.

(3) One additional simultaneous data transfer operation can occur (a total of four), provided that the data transfer rates on both Channel 1 and the Auxiliary Read-Write Channel are "comparatively undemanding." Input-output units which do allow both Channel 1 and the Auxiliary Channel to operate in parallel include the Model 227 Card Punch, Model 223 Card Reader, Model 224 Card Punch, Model 214 Card Units, any magnetic tape units operating at under 45,000 characters per second, and the paper tape equipment.

(4) The capability to read from one tape unit and write simultaneously on another tape unit connected to the same Tape Control Unit is provided in most of the 204B Series (one-half inch) Magnetic Tape Units, but not in the 204A Series (three-quarter inch) tapes.

TABLE I - SIMULTANEOUS OPERATIONS

OPERATION	Cycle Time, msec.	Start Time			Data Transmission			Stop Time		
		Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use
214 Card Reader	150	20.0	0	Yes	55.0	<0.1%	Yes	75.0	0	No
214 Card Punch	150-600	7.5	0	Yes	6.25n	<0.1%	Yes	92.5	0	No
223 Card Reader	75	13.0	0	Yes	46	0.2%	Yes	16	0	No
224-1 Card Punch	335-1210	6.2	0	Yes	12.5n	<0.1%	Yes	210	0	No
224-2 Card Punch	223-660	3.0	0	Yes	6.25n	0.1%	Yes	160	0	No
227 Card Reader	75	21 to 46	0	Yes	44	6.8%	Yes	10	0	No
227 Card Punch	240	42 to 102	0	Yes	176	0.8%	Yes	22	0	No
222-1, -2, -3 Printer (51-character set)	92 + 5LS	0	—	—	75	12.8%	Yes	17 + 5LS	0	No
222-4 Printer (46-character set)	63 + 5LS	0	—	—	46	18.0%	Yes	17 + 5LS	0	No
222-5 Printer (63-character set)	133 + 5LS	0	—	—	116	9.8%	Yes	17 + 5LS	0	No
209 Paper Tape Reader	2.0	?	0	Yes	Var.	01.%	Yes	?	0	No
210 Paper Tape Punch	8.3	?	0	Yes	Var.	<0.1%	Yes	?	0	No
204A-1 Magnetic Tape, 32KC	—	11.0[a]	0	Yes	Var.	4.8%	Yes	0[a]	—	—
204A-2 Magnetic Tape, 64KC	—	5.5[a]	0	Yes	Var.	9.6%	Yes	0[a]	—	—
204A-3 Magnetic Tape, 89KC	—	5.5[a]	0	Yes	Var.	13.4%	Yes	0[a]	—	—
204B-1, -2 Magnetic Tape, 20KC	—	12.5[a]	0	Yes	Var.	3.0%	Yes	0[a]	—	—
204B-3, -4 Magnetic Tape, 44KC	—	7.5[a]	0	Yes	Var.	6.6%	Yes	0[a]	—	—
204B-5 Magnetic Tape, 67KC	—	5.8[a]	0	Yes	Var.	10.1%	Yes	0[a]	—	—
204B-7 Magnetic Tape, 29KC	—	20.8[a]	0	Yes	Var.	4.2%	Yes	0[a]	—	—
204B-8 Magnetic Tape, 64KC	—	7.5[a]	0	Yes	Var.	9.6%	Yes	0[a]	—	—
204B-11, -12 Magnetic Tape, 13KC	—	18.7[a]	0	Yes	Var.	2.0%	Yes	0[a]	—	—
270 Random Access Drum	—	25.0	0	Yes	Var.	15.3%	Yes	0	—	—
251 Mass Memory	16.7	95 av.	0	Yes	Var.	15%	Yes	—	0	No
252 Mass Memory	16.7	150 av.	0	Yes	Var.	15%	Yes	—	0	No
253 Mass Memory	16.7	225 av.	0	Yes	Var.	15%	Yes	—	0	No

a Cross-gap time for short gap (replaces start and stop times).
b For the character mode; time for the record mode is variable.
LS Number of lines skipped between successive printed lines.
n Number of characters punched.
Var. Data transmission time varies with record length.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (513:201.100)

These problems involve updating a master file from information in a detail file and producing a printed record of each transaction. This application is one of the most common commercial data processing jobs and is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of three different record sizes in the master file. Standard Problem D increases the amount of computation performed upon each transaction. Each problem is estimated for activity factors (ratios of number of detail records to number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

Conventional Processing (Configurations I, II, III, IV, VI, and VIIA)

In Configuration I, the master and detail input files are assigned to the card reader. The output files are assigned to the card punch (updated master file) and printer (report file). For Problems A, B, C, and D, the card punch is always the controlling factor on overall processing time.

In Configurations II, III, IV, VI, and VIIA, the master files are on magnetic tape. The detail file is assigned to the card reader and the report file to the printer. For Configuration II, in all four Standard File Problems, the printer is the controlling factor at high and moderate activities, while the two master-file tape units (which cannot read and write simultaneously) are the controlling factor at lower activities. For Configurations III, IV, VI, and VIIA, in all four of the Standard File Problems, the printer is the controlling factor at high, moderate, and low activities. One master-file tape controls at activities near zero.

In Configurations IV and VIIA, for problems A, B, and C, the auxiliary read/write channel is interlocked because of the high speed of the tapes used, and only three read/write channels are available. At low activity, the two magnetic tape units assigned to one read/write channel become the controlling factor for Configurations IV and VIIA (the higher horizontal line segment on graph 513:201:100). When the activity becomes low enough so that the combined times for the printer and card reader become less than the combined time for the tapes, the printer and card reader are assigned to one channel and the two tapes are assigned to two separate channels (the sloping straight line). Near zero activity, the combined times for the printer and card reader become lower than the time for each tape, so a single tape unit becomes the controlling factor (the lower horizontal line segment).

Tape-to-Tape Processing (Configuration VIIB)

In tape-oriented Configuration VIIB, all four files are on magnetic tape. Data transcriptions between tape and card or printer are performed off-line on a satellite system in this configuration, and timings for the data transcription operations are therefore not shown. In Problems A, B, and D, for Configuration VIIB with all four files blocked, the central processor is the controlling factor at high to moderate activities, and one master-file tape and the report-file tape control at low activity. In Problem C, one master-file tape and the report-file tape control at all activities. For Configuration VIIB with unblocked detail and report files, one master-file tape and the report-file tape are the controlling factors at all activities in all four problems.

SORTING (513:201.200)

The standard estimate for sorting 80-character records by straightforward merging on magnetic tape was developed from the time for Standard File Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide. A two-way merge was used in System Configuration II (which has only four magnetic tape units) and a three-way merge in Configurations III, IV, VI, VIIA, and VIIB. The results are shown in Graph 513:201.200.

MATRIX INVERSION (513:201.300)

In matrix inversion, the object is to measure central processor speed on the straightforward inversion of a non-symmetric, non-singular matrix. No input-output operations are involved. The standard estimate is based on the time required to perform cumulative multiplication ($c = c + a_i b_j$) in 8-digit-precision floating-point, as explained in Paragraph 4:200.3 of the Users' Guide. The precision of floating-point operations is equivalent to approximately 11 digits in the Honeywell Series 200.

GENERALIZED MATHEMATICAL PROCESSING (513:201.400)

This problem measures overall system performance on a simple mathematical application that involves widely varying ratios of input-to-computation-to-output volumes, as described in Section 4:200.4 of the Users' Guide.

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)

	ITEM		CONFIGURATION I		II		III & VI		IV		VIIA		VIIB (Blocked Files 3 & 4)		VIIB (Unblocked Files 3 & 4)		REFERENCE
1 Input-Output Times	Char/block	(File 1)	80		1,080		1,080		1,080		1,080		1,080		1,080		4:200.112
	Records/block	K (File 1)	0.5		10		10		10		10		10		10		
	msec/block	File 1 = File 2	75/437.5		99.7		58.5		23.5		23.5		23.5		23.5		
		File 3	75		75		75		75		75		20		8.8		
		File 4	94		129		129		94		129		* 25		9.3		
	msec/switch	File 1 = File 2	0		0		0		0		0		0		0		
		File 3	0		0		0		0		0		0		0		
		File 4	0		0		0		0		0		0		0		
	msec penalty	File 1 = File 2	0.1		1.7		1.7		1.7		1.7		1.7		1.7		
		File 3	0.1		0.1		0.1		0.1		0.1		1.2		0.1		
		File 4	8.3		8.3		8.3		8.3		8.3		1.8		0.2		
2 Central Processor Times	msec/block	a_1	0.27		0.27		0.27		0.27		0.27		0.27		0.27		4:200.1132
	msec/record	a_2	0.85		0.85		0.85		0.85		0.85		0.85		0.85		
	msec/detail	b_6	0.12		0.12		0.12		0.12		0.12		0.12		0.12		
	msec/work	$b_5 + b_9$	2.18		2.18		2.18		2.18		2.18		2.18		2.18		
	msec/report	$b_7 + b_8$	0.94		0.94		0.94		0.94		0.94		0.94		0.94		
3 Standard File Problem A, F = 1.0	msec/block for C.P. and dominant column		C.P.	Punch	C.P.	Printer	C.P.	Printer	C.P.	Printer	C.P.	Printer	C.P.	I/O	C.P.	I/O	4:200.114
		a_1	0.3		0.3		0.3		0.3		0.3		0.3		0.3		
		a_2 K	0.4		8.5		8.5		8.5		8.5		8.5		8.5		
		a_3 K	1.6		32.3		32.3		32.3		32.3		32.3		32.3		
		File 1: Master In	0.1		1.7		1.7		1.7		1.7		1.7		1.7		
		File 2: Master Out	0.1	437.5	1.7		1.7		1.7		1.7		1.7	23.5	1.7	23.5	
		File 3: Details	0.0		1.0		1.0		1.0		1.0		1.2		1.2		
		File 4: Reports	4.2		83.0	1,290	83.0	1,290	83.0	940	83.0	1,290	1.8	25.0	1.8	93.0	
		Total	6.7	437.5	128.5	1,290	128.5	1,290	128.5	940	128.5	1,290	47.5	48.5	47.5	116.5	
4 Standard File Problem A Space	Unit of measure	(characters)															4:200.1151
		Std. routines	100		2,250		2,250		2,250		2,250		2,250		2,250		
		Fixed	18		18		18		18		45		45		45		
		3 (Blocks 1 to 23)	350		612		612		612		612		612		612		
		6 (Blocks 24 to 48)	2,334		2,334		2,334		2,334		2,334		2,334		2,334		
		Files	720		2,560		4,720		4,702		4,720		8,320		4,720		
		Working	0		108		108		108		108		108		108		
		Total	3,522		7,882		10,042		10,042		10,069		13,669		10,069		

* Records blocked 10 records/block.

WORKSHEET DATA TABLE 2 (STANDARD MATHEMATICAL PROBLEM A)

	ITEM		CONFIGURATION VI, VIIA	VIIB	REFERENCE
Standard Mathematical Problem A	Fixed/Floating Point		Floating point	Floating point	4:200.413
	Unit name	input	223 Card Reader	204B-8 Magnetic Tape	
		output	222-3 Printer	204B-8 Magnetic Tape	
	Size of record	input	80	80	
		output	120	80	
	msec/block	input T_1	75	8.8	
		output T_2	92	8.8	
	msec penalty	input T_3	0.1	0.1	
		output T_4	8.3	0.1	
	msec/record	T_5	10.71	10.71	
	msec/5 loops	T_6	7.14	7.14	
	msec/report	T_7	2.06	2.06	

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

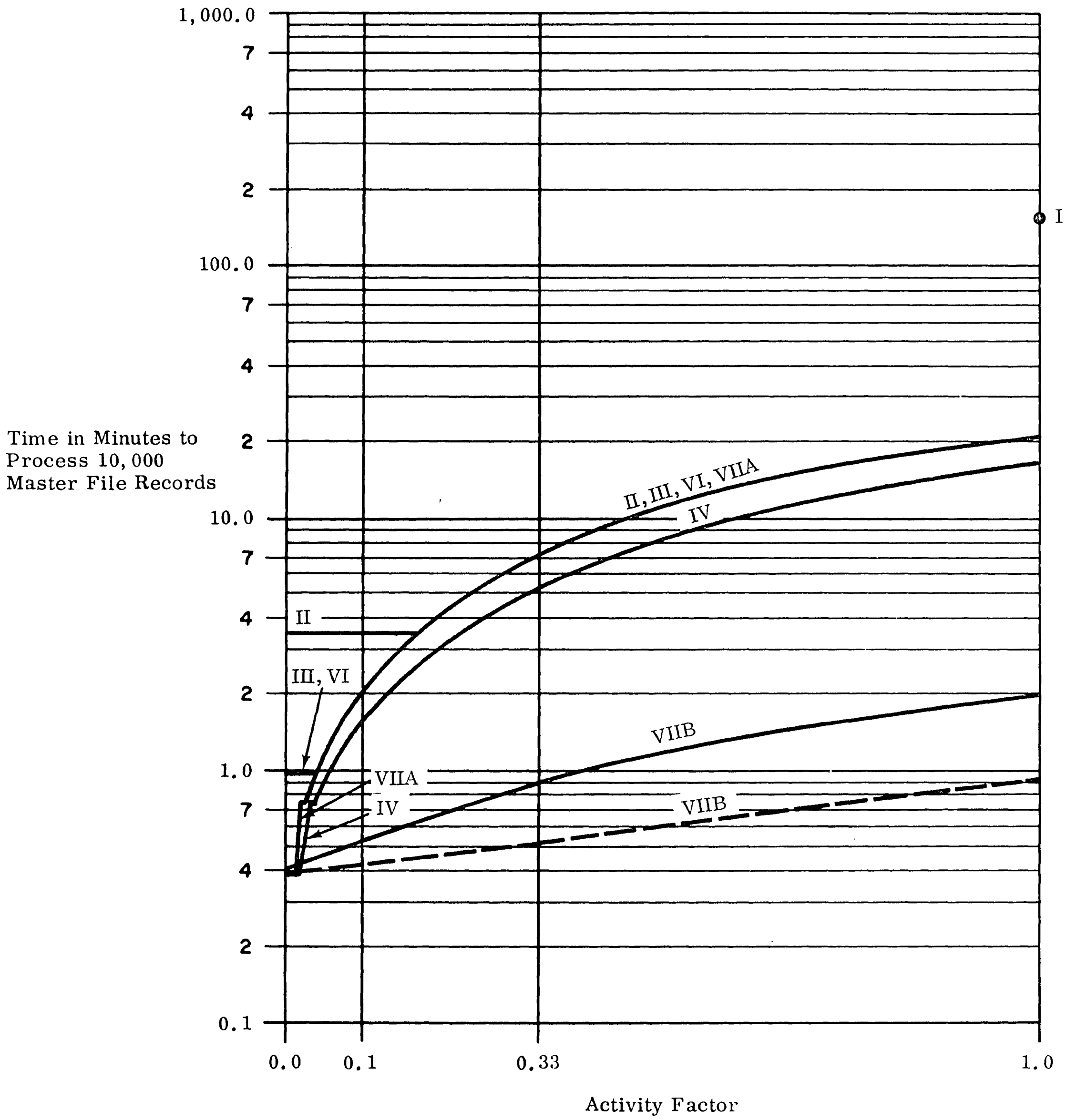
.111 Record sizes —
- Master file: . . . . 108 characters.
- Detail file: . . . . 1 card.
- Report file: . . . . 1 line.

.112 Computation: . . . . standard.

.113 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage space required —
- Configuration I: . . . 3,522 characters.
- Configuration II: . . 7,882 characters.
- Configurations III, IV, & VI: . . . . . 10,042 characters.
- Configuration VIIA: . 10,069 characters.
- Configuration VIIB (blocked Files 3&4):. 13,669 characters.
- Configuration VIIB (unblocked Files 3&4): . . . . 10,069 characters.



(Roman numerals denote standard System Configurations.)

——— unblocked Files 3 and 4.
— — — blocked Files 3 and 4.

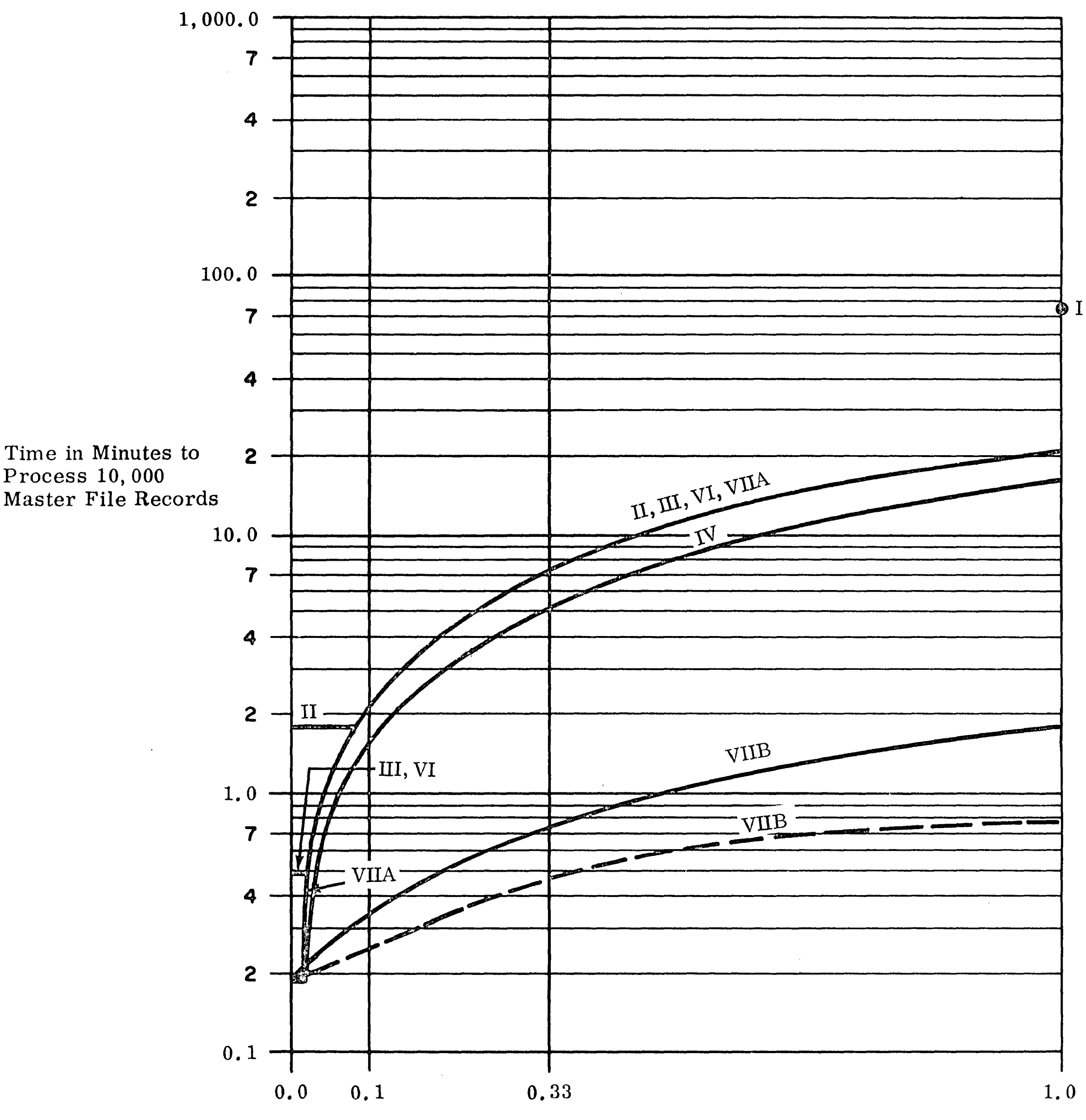
.12 Standard File Problem B

.121 Record sizes —
- Master file: . . . . 54 characters.
- Detail file: . . . . 1 card.
- Report file: . . . . 1 line.

.122 Computation: . . . . standard.

.123 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.12.

.124 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

——— unblocked Files 3 and 4.
– – – blocked Files 3 and 4.

(Contd.)

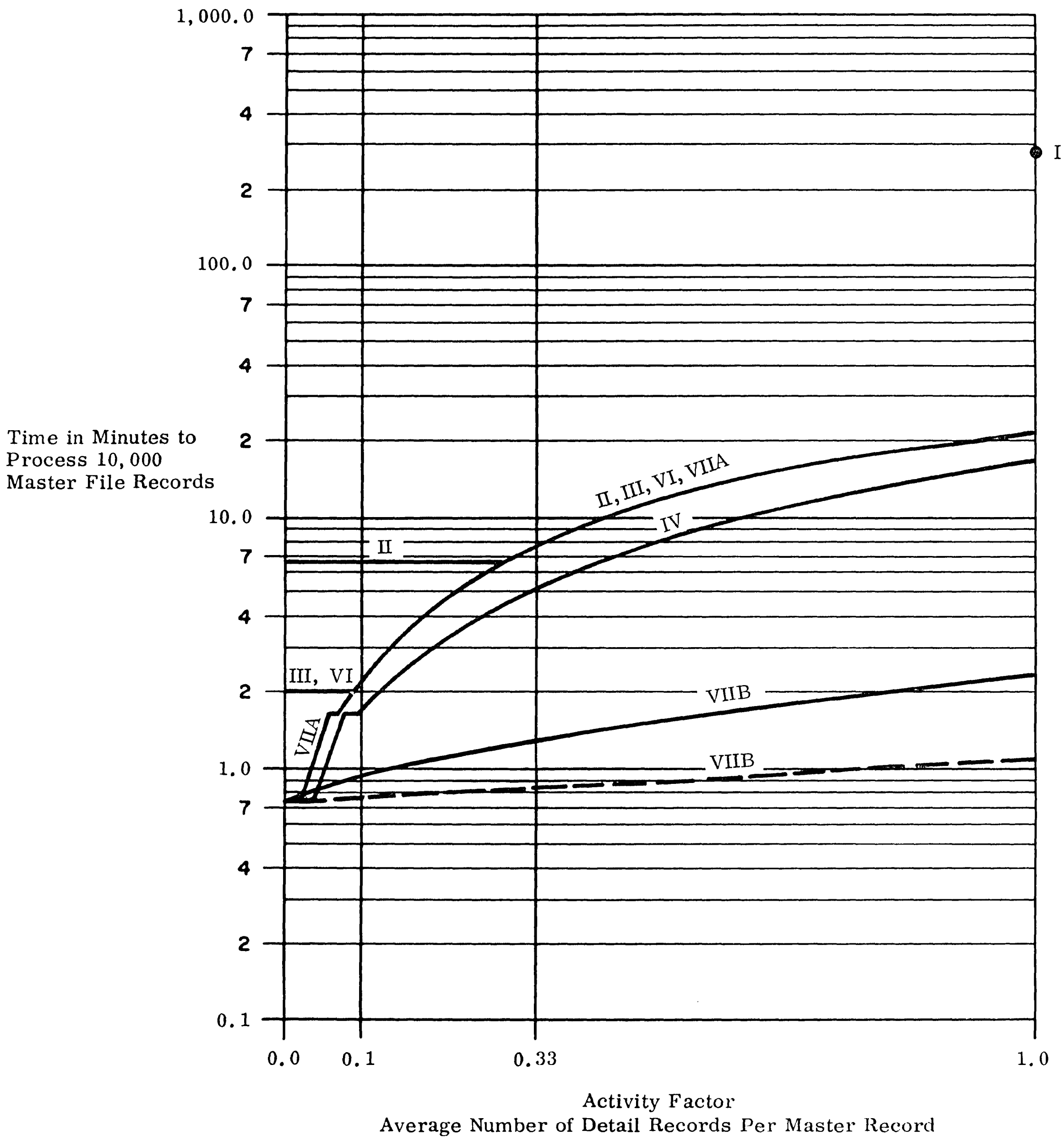
.13 Standard File Problem C

.131 Record sizes —
- Master file: . . . . 216 characters.
- Detail file: . . . . 1 card.
- Report file: . . . . 1 line.

.132 Computation: . . . . standard.

.133 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

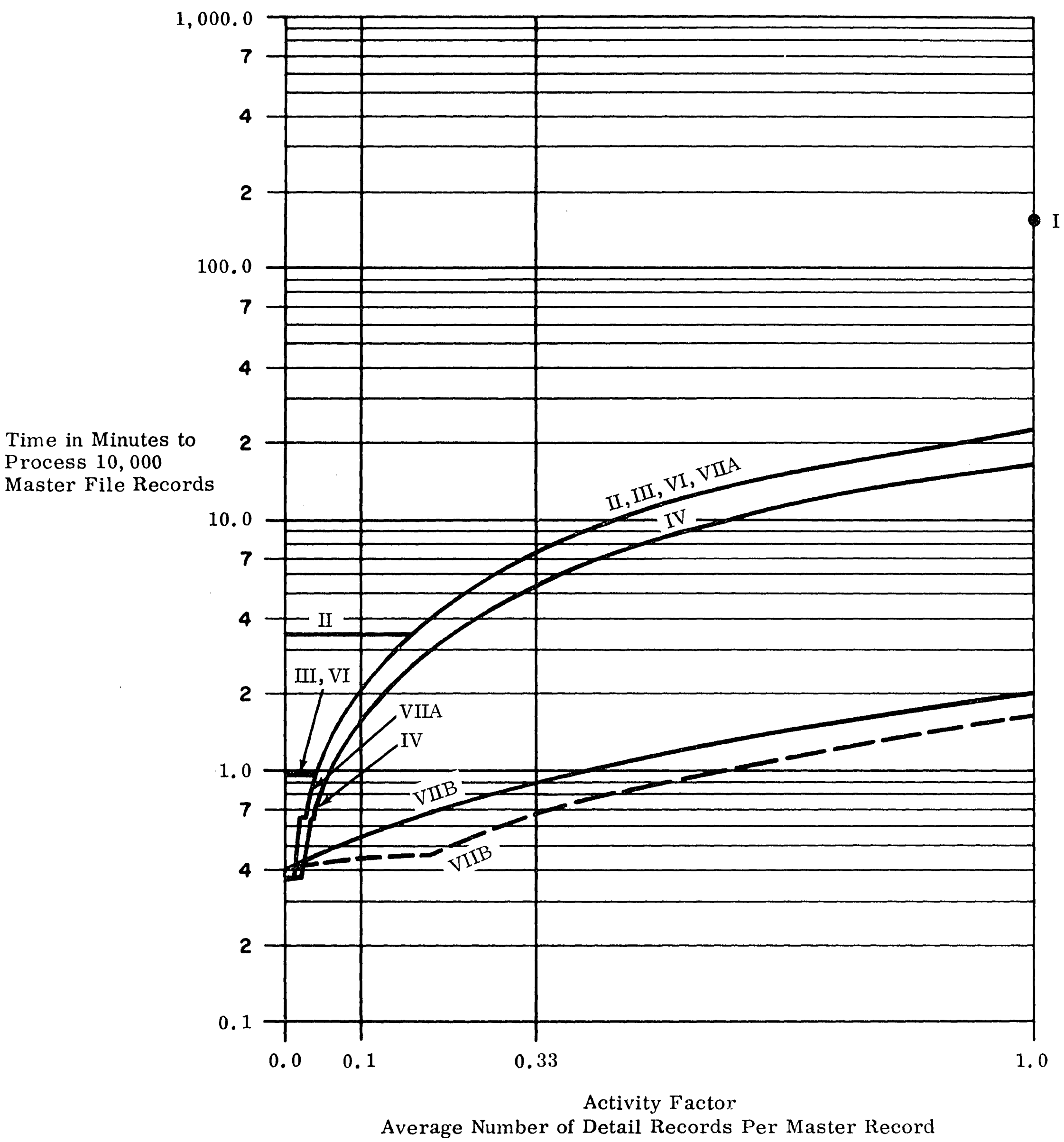
——— unblocked Files 3 and 4.
— — — blocked Files 3 and 4.

.14 Standard File Problem D

.141 Record sizes —

Master file: . . .	108 characters.
Detail file:	1 card.
Report file:	1 line.

.142 Computation:	trebled.
.143 Timing basis:	using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph:	see graph below.



(Roman numerals denote standard System Configurations.)

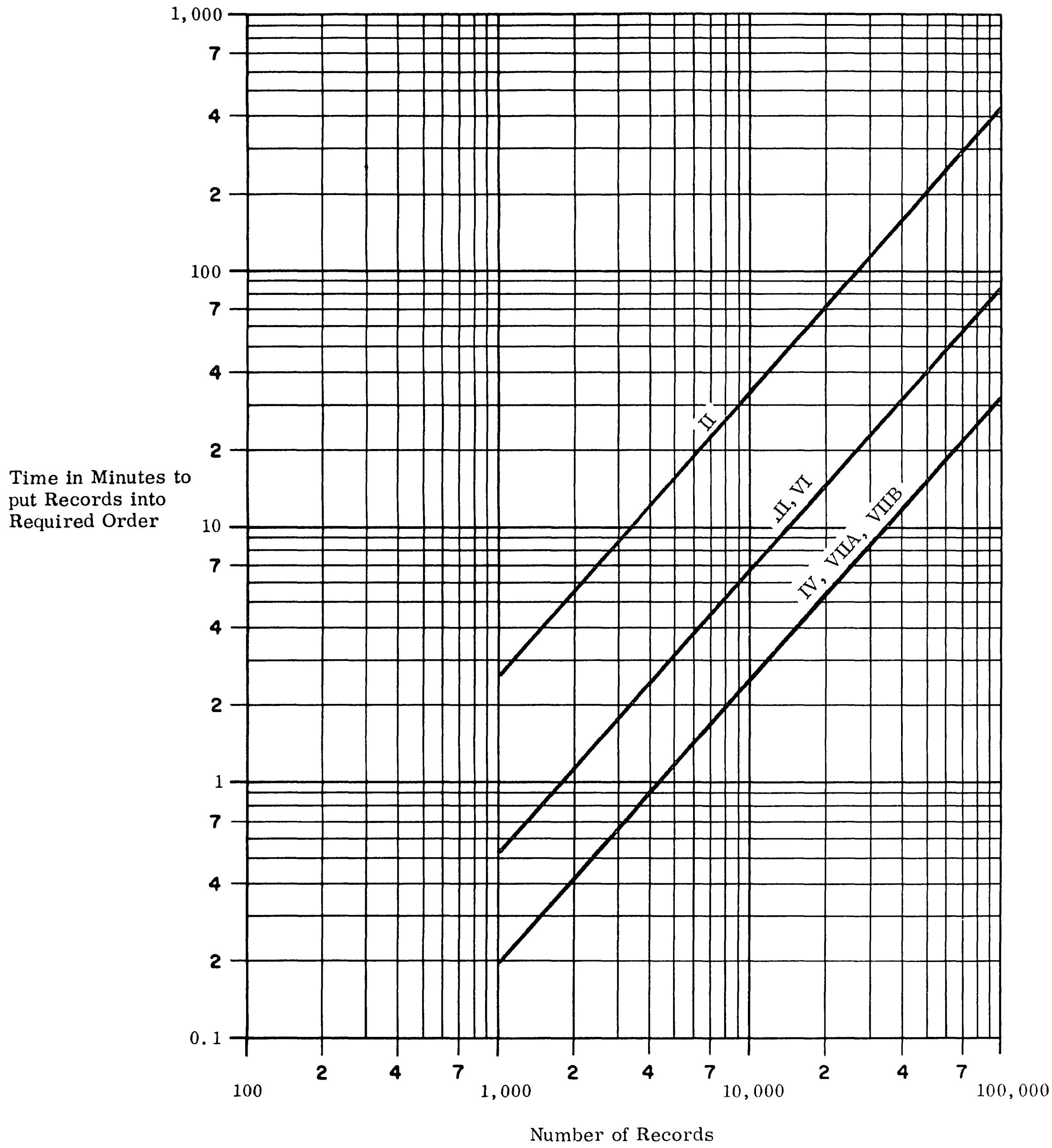
——— unblocked Files 3 and 4.
– – – blocked Files 3 and 4.

(Contd.)

.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.
.212 Key size: . . . . . . 8 characters.
.213 Timing basis: . . . using estimating procedure outlined in Users' Guide, 4:200.213.
.214 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

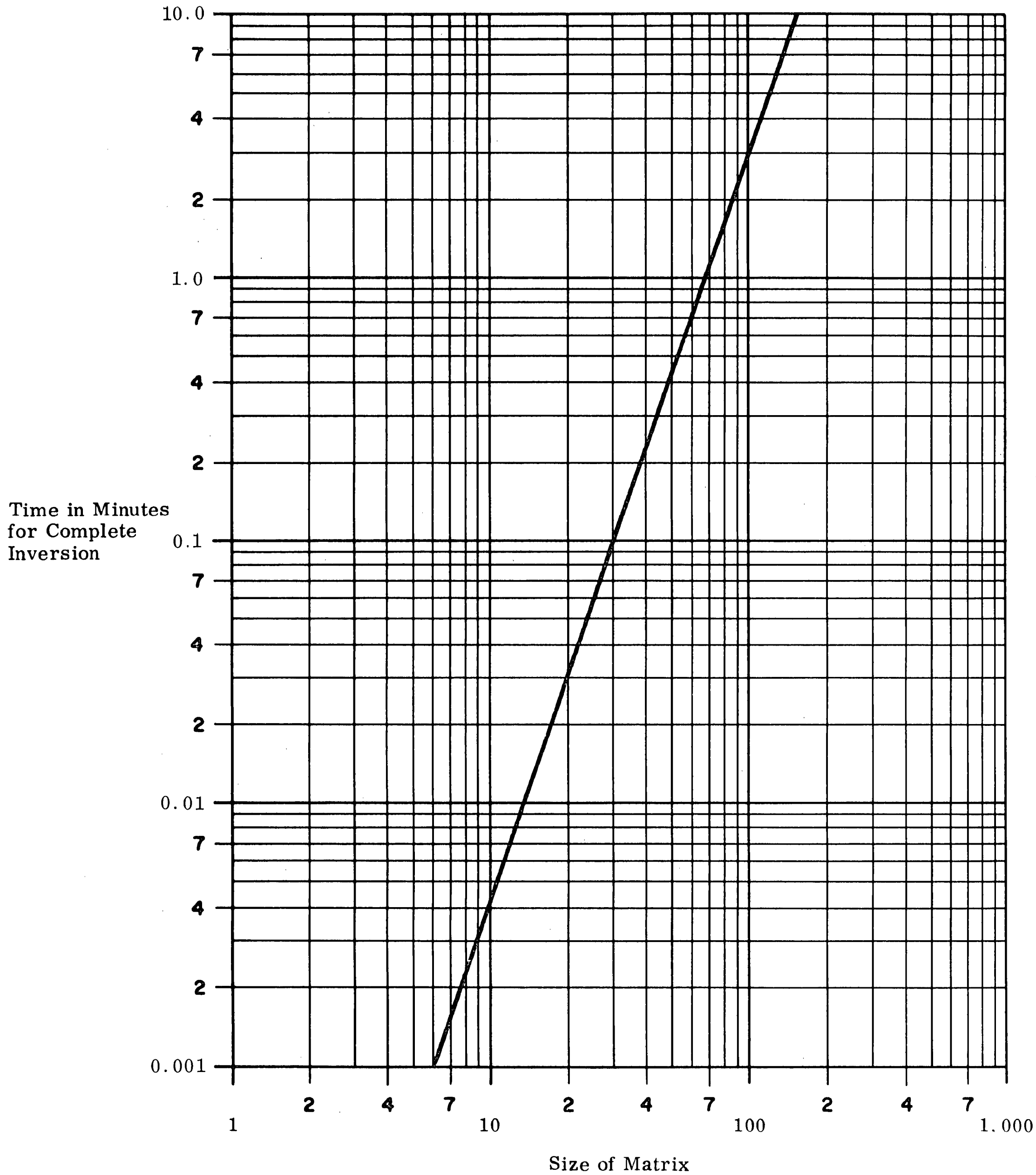
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . see graph below.



(For all configurations equipped with the Scientific Option)

(Contd.)

.4 GENERALIZED MATHEMATICAL PROCESSING

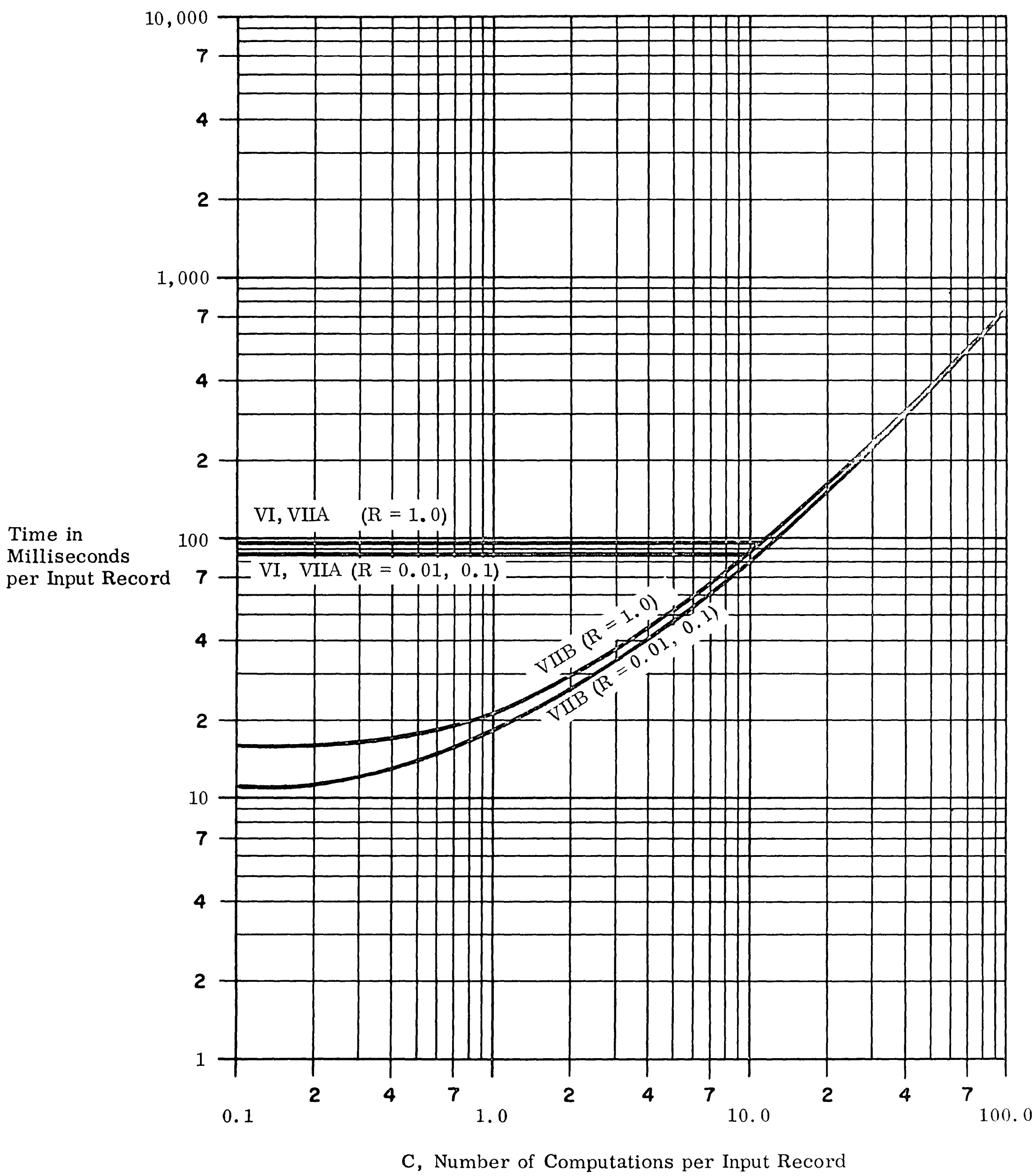
.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . 5 fifth-order polynomials, 5 divisions, 1 square root; 11-digit-precision floating-point mode.

.413 Timing basis: . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



HONEYWELL 2200

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INTRODUCTION

The Honeywell 2200 Processor can be connected to any of the Honeywell Series 200 peripheral units, can use any of the Series 200 programming languages, can run most programs originally written for an IBM 1401 or 1410, and can operate in a multiprogrammed mode, using the Storage Protect feature to help insure safe handling of the concurrently-operating programs. The 2200 Processor can contain between 16,384 and 262,144 characters of core storage, with a cycle time of one microsecond per character.

Standard features of the Honeywell 2200 Processor include: Program Interrupt, Multiply-Divide, Advanced Programming, Edit Instruction, 8-Bit Code Handling, four read-write channels, and 16 I/O trunks.

Optional features are: Scientific Unit (floating-point arithmetic), Storage Protect, Additional Four Read-Write Channels and 16 I/O Trunks, and Optional Instruction Package (table look-up facilities).

The rental for typical Honeywell 2200 systems ranges from about $8,000 to $17,000 per month. Deliveries began in December 1965.

This report concentrates upon the characteristics and the performance of the Honeywell 2200 in particular. All the general characteristics of the Honeywell Series 200 computers, peripheral equipment, and software are described in Computer System Report 510: Honeywell Series 200 — General.

The System Configuration section which follows shows the Honeywell 2200 in the following standard System Configurations:

III: 6-Tape Business System
IV: 12-Tape Business System
V: 6-Tape Auxiliary Storage System
VIIA: 10-Tape General System (Integrated)
VIIB: 10-Tape General System (Paired with the Honeywell 120).

These configurations were prepared according to the rules in the Users' Guide, page 4:030.120, and any significant deviations from the standard specifications are listed.

Section 514:051 provides detailed central processor timings for the Honeywell 2200.

The input-output channel capabilities of the Honeywell 2200, and the demands upon the processor during input-output operations, are described in Section 514:111.

Several levels of software support can be used with Honeywell 2200 systems. The two versions of Operating System — Mod 1 can be used, providing software packages that are resident on either magnetic tape or mass storage devices. Several levels of COBOL and FORTRAN language processors and Easycoder assemblers are offered with Operating System — Mod 1. Automatic stacked job processing facilities and several data management routines are also provided. Honeywell 2200 systems that have at least 49K characters of core storage can also use the advanced software of the Operating System — Mod 2, featuring automatic program scheduling and improved language processors. These software systems and the Series 200 Basic Programming System are described in Sections 510:151 through 510:193.

The overall performance of any Honeywell Series 200 system is heavily dependent upon the processor model used. A full System Performance analysis of standardized configurations utilizing the Honeywell 2200 is provided in Section 514:201.

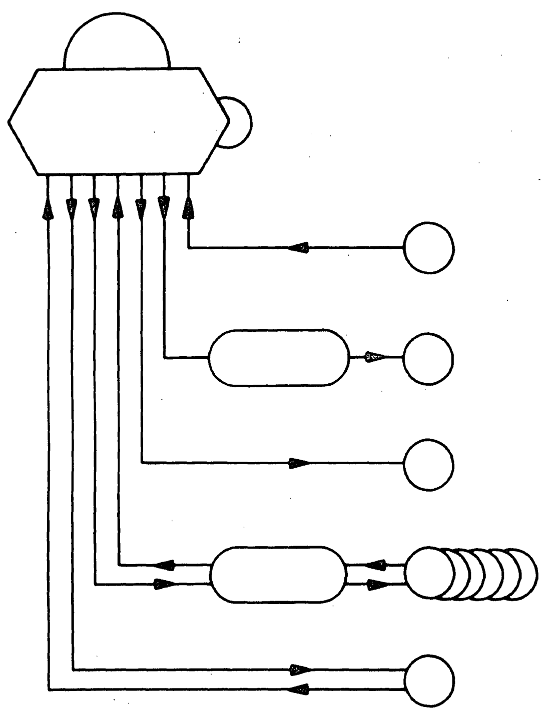
SYSTEM CONFIGURATION

The Honeywell 2200 Processor contains either 4 or 8 input-output channels and 16 or 32 input-output trunks. This means that up to 32 peripheral devices or controllers can be connected, and a maximum of 8 data transfer operations can occur simultaneously with internal processing. The connections between devices and channels are established under program control.

Any of the available Series 200 peripheral units can be connected to a Honeywell 2200 Processor. These peripheral units are described in detail in the main Series 200 Computer System Report, and their trunk requirements are summarized in the main System Configuration section, page 510:031.100.

.1 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: card reader is 60% faster.
printer is 30% faster.
console typewriter input is included.
ability to read and write magnetic tape simultaneously is standard.

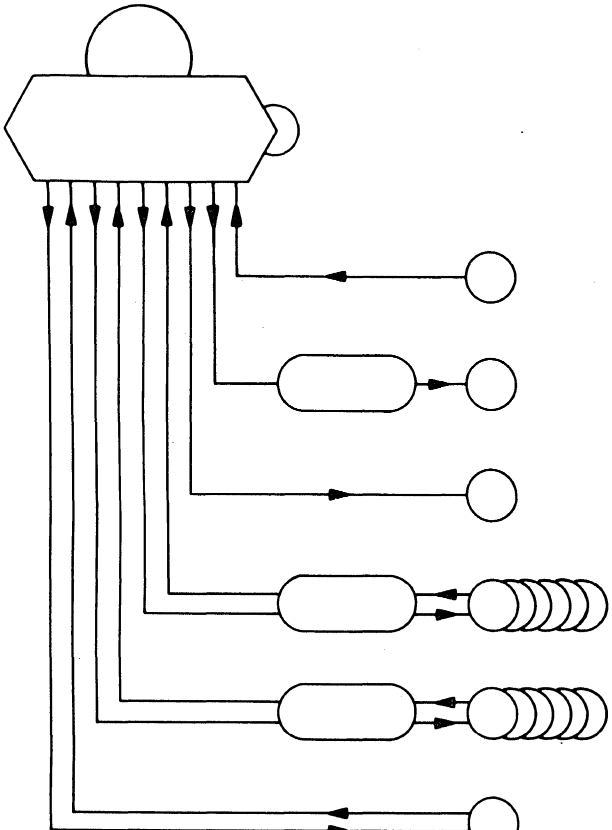


Equipment	Rental*
2201-1 Processor with 16,384 characters of core storage	$3,640
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Units (6): 28,800 char/sec (800 cpi)	2,460
220-3 Console (includes Teleprinter)	310
Optional Features Included: Optional Instruction Package (Table Look-up Facilities)	50
TOTAL RENTAL:	$8,545

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement rents for $7,715 per month.

.2 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 20% slower.
card punch is up to 50% slower.



Equipment	Rental*
2201-2 Processor with 32,768 characters of core storage	$ 4,665
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/min	310
222-4 Printer and Control: 950 lines/min (120 print positions)	1,305
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (6): 64,000 char/sec	3,690
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (6): 64,000 char/sec	3,690
220-3 Console (includes Teleprinter)	310

Optional Features Included: . . . . Optional Instruction Package (Table Look-up Facilities) 50

TOTAL RENTAL: $15,305

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement rents for $13,820 per month.

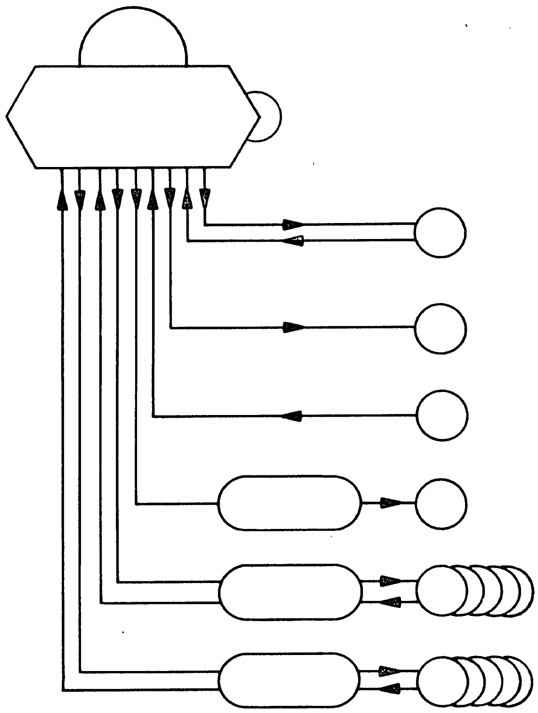
.3 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

This Configuration is identical to Configuration III for the Honeywell 2200 (preceding page) except for the addition of one 250 Mass Memory File Control and one 251 Mass Memory File, which provide 15 million characters of storage and bring the total system rental to $9,550 per month ($8,615 with a 5-year contract).

(Contd.)

.4 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIA

Deviations for Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.



Equipment	Rental*
2201-6 Processor with 98,304 characters of core storage	$ 7,995
220-3 Console (includes typewriter and direct control)	310
222-3 Printer and Control (120 print positions): 650 lines/min	925
223 Card Reader and Control: 800 lines/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/min	310
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 64,000 char/sec	3,075
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 64,000 char/sec	3,075

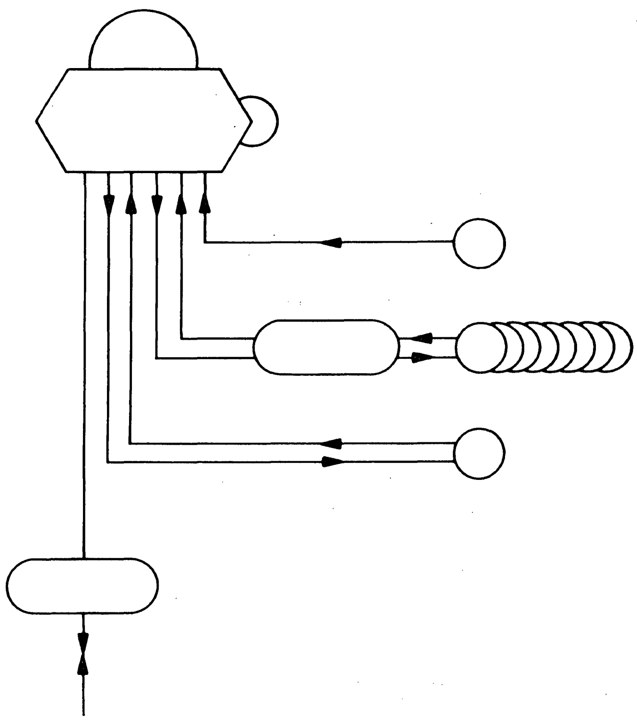
Optional Features Included: . . . . Scientific Unit 440
Optional Instruction Package (Table Look-up Facilities) 50

TOTAL RENTAL: $17,515

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement rents for $15,700 per month.

.5 10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIIB

Deviations from Standard Configuration: . . . . card reader is 700% faster.
direct connection to satellite system.



Equipment	Rental *
2201-4 Processor and Console with 65,536 characters of core storage	$ 6,460
223 Card Reader and Control: 800 cards/min	310
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (8): 64,000 char/sec	4,920
220-3 Console (includes Teleprinter and direct control)	310
212-1 On-Line Adapter Unit (for connection to H-120 Processor)	410

To Satellite System
(next page)

Optional Features Included:		
	Scientific Unit	440
	Optional Instruction Package	50
	TOTAL ON-LINE EQUIPMENT:	$13,335
	TOTAL SATELLITE EQUIPMENT:	3,590
	TOTAL RENTAL:	$16,925

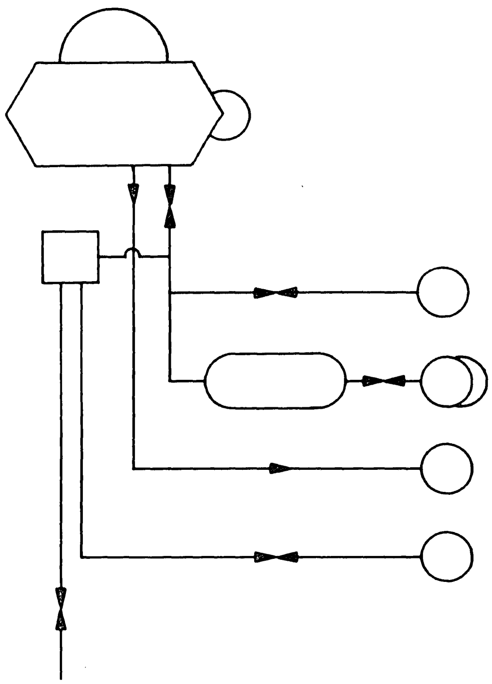
* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement rents for $15,305 per month.

(Contd.)

.5 CONFIGURATION VIIB (Contd.)

SATELLITE EQUIPMENT (Honeywell 120)

Deviations from Standard Configuration: . . . . card reader is 20% slower.
ability to overlap printing and one input-output operation with computing is standard.
console typewriter input is included.
6 index registers.



To H-2200
System (previous page)

Equipment	Rental
121-2 Central Processor Console with 4,096 character positions of core storage	$ 1,000
Control Unit Adapter (Non-Simultaneous)	155
214-2 Card Reader/Punch — Reads: 400 cards/min Punches: 100-400 cards/min	340
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Units (2): 28,800 char/sec	820
122 Printer: 450 lines/min (120 print positions)	510
220-1 Console (includes Teleprinter)	205

Optional Features Included: . . . .

Advanced Programming	75
Edit Instruction	50
TOTAL SATELLITE EQUIPMENT:	$ 3,590

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . Central Processor. Models 2201-1 through 2201-12

.12 Description

The Model 2201 Processor performs all the arithmetic and logical functions in a Honeywell 2200 system under control of one or more internally stored programs. The processor works in conjunction with a control memory that contains program sequencing, program interrupt, and other associated registers. Only one control memory can be utilized in a Honeywell 2200 system. (The original specifications, now withdrawn, called for two control memories.)

The 2201 instruction code is basically a two-address, add-to-storage type. This code includes all the Honeywell 200 instructions (which are almost identical with those of the IBM 1401), plus alphanumeric comparison and table look-up operations. Fifteen index registers are also included in the basic unit. The instruction repertoire, from a programmer's view, is very similar to that of the IBM 1410 and 7010 systems.

Binary addressing is used to minimize instruction sizes; address lengths can vary from two characters to four characters. Four-character addressing permits direct addressing of any position within the maximum 262K core memory. The type of addressing in use at any time is controlled by special instructions and can be varied by the programmer as needed. Even with this facility, the multiple addressing modes may lead to complications in the interpretation of diagnostics and in the use of operating systems.

The Model 2201 Processor consists of five basic functional units: the main memory, the control memory, the control unit, the arithmetic unit, and the input-output traffic control.

The main memory consists of from 16,384 to 262,144 alphanumeric character positions of core storage with a cycle time of one microsecond per character; see Section 510:041 for a complete description. Each character position consists of six data bits, one parity bit, and two punctuation bits. The punctuation bits can be used to indicate a word mark, an item mark, or a record mark, which defines the length of a data field or instruction, an item, or a record, respectively. An "item" consists of a group of consecutive data fields. (The IBM 1400 series computers utilize only one punctuation bit — the "word mark" bit — and each record mark occupies an entire character position. The two punctuation bits used in the Honeywell 2200 will decrease data storage requirements and provide increased flexibility in data movement operations. The Extended Move instruction, for example, can be terminated by a word mark, an item mark, or a record mark, as specified by the programmer.)

The control memory is a small magnetic core storage unit with an access time of 0.25 microsecond and a cycle time of 0.50 microsecond. It holds up to 64 control registers, each capable of storing the address of one character position in the main memory. Instructions are provided to load and store the contents of each of these registers. Only 37 of the control registers can currently be used by the Model 2201 Processor:

(1) A-Address Register.

(2) B-Address Register.

(3) Sequence Register.

(4) Change Sequence Register.

(5) Read-Write Channel 1 — Present Location Counter.

(6) Read-Write Channel 1 — Starting Location Counter.

(7) Read-Write Channel 2 — Present Location Counter.

(8) Read-Write Channel 2 — Starting Location Counter.

(9) Read-Write Channel 3 — Present Location Counter.

(10) Read-Write Channel 3 — Starting Location Counter.

(11) Auxiliary R/W Channel — Present Location Counter.

(12) Auxiliary R/W Channel — Starting Location Counter.

(13) Interrupt Register.

(14) Internal Interrupt Register (Storage Protect).

(15-17) Work Registers.

(18-29) Scientific Unit (Feature 1100).

(30-37) Optional I/O Sector — 4 additional Read-Write Channels.

The control unit controls the sequential selection, interpretation, and execution of all stored program instructions and checks for correct (odd) parity whenever a character is moved from one location to another. It also provides for communication with the operator's control panel.

The input-output traffic control directs the time-sharing of accesses to the main memory by the various peripheral devices and the central processor. This control operation is associated with the control memories, which contain the control information used by each of the data transfers. Up to eight input-output operations can proceed simultaneously under the supervision of the control memory. The basic processor contains four read-write channels; one of them is termed an "auxiliary" channel and can transfer data at a

.12 Description (Contd.)

maximum rate of 33,333 characters per second. Four additional read-write channels are available as an option.

The allocation of data transmission channels to input-output trunks is flexible. The actual allocation of a specific peripheral device to a specific channel is initiated by an instruction, rather than by the operator.

The arithmetic unit executes all arithmetic and logical operations. It consists of an adder that can perform both decimal and binary arithmetic and two one-character operand storage registers. The 2200 is basically a two-address, add-to-storage system. All operations are performed serially by character and terminated when specific punctuation bit configurations are sensed. This means that operand sizes are fully variable and are limited only by the amount of core storage available to hold them.

The processor is well suited to general data manipulation, including, as standard features, excellent editing capabilities, indexing, indirect addressing, an Item Move instruction, a Move and Translate instruction, multiplication, and division.

The indexing facilities are comparatively numerous. Each of the 15 or 30 registers is held in the main core memory, so indexing takes one microsecond per character or three microseconds per address modified.

The Move and Translate instructions can effect translations between any two 6-bit codes. A table must be provided for every code into which conversions are to be made, arranged in the order of the bit patterns of the code from which conversion is planned. Handling of 8-bit codes is also provided.

Instruction length is variable from one to twelve characters. Arithmetic and data movement instructions are most commonly nine characters long when using the four-character addressing mode. Through careful placement of data, instructions can sometimes be "chained" so that a one-character instruction does the work of a nine-character one, resulting in savings in both storage space and execution time. Chaining is possible only when a series of operations is to be performed upon items of data stored in consecutive locations, so that the A- and B-Address Registers do not need to be reloaded before each instruction is executed.

Typical instruction execution times, using the four-character addressing mode, are 28 microseconds for a five-digit decimal addition and 224 microseconds for a five-digit multiplication.

Optional Features

Additional 4 Read-Write Channels and 16 Input-Output Trunks: Permits 16 additional peripheral units or controllers to be connected to a Honeywell 2200, and provides up to 4 additional simultaneous data transfers.

Storage Protect: Protects the contents of one specified block of memory against accidental reference or alteration by unrelated programs; provides 15 additional index registers for use by programs inside and outside the protected area.

Scientific Unit: Provides automatic floating-point arithmetic and decimal-binary radix conversion operations.

Optional Instruction Package: Provides table look-up instructions.

.14 First Delivery: . . . . . December 1965.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add-subtract:	automatic	decimal or binary	1 to N char.
	Multiply:	automatic	decimal	1 to N char.
	Divide:	automatic	decimal	1 to N char.
.212	Floating point —			
	Add-subtract:	automatic*	binary	36 & 12 bits.
	Multiply:	automatic*	binary	36 & 12 bits.
	Divide:	automatic*	binary	36 & 12 bits.

*with optional Scientific Unit.

	Operation and Variation	Provision	Radix	Size
.213	Boolean —			
	AND	automatic	binary	1 to N char.
	Inclusive OR:	none.		
	Exclusive OR:	automatic	binary	1 to N char.
.214	Comparison —	branch on high, low, equal, unequal, or zero balance.		
	Numbers:	automatic		1 to N char.
	Absolute:	none.		
	Letters:	automatic		1 to N char.
	Mixed:	automatic		1 to N char.
	Collating sequence:	0 through 9, then A through Z, with special symbols interspersed.		

(Contd.)

.215 Code translation —

Provision: . . . . automatic (using code table constructed by programmer).

From: . . . . any 6-bit through 12-bit code.

To: . . . . any 6-bit through 12-bit code.

Size: . . . . 1 to N characters.

.216 Radix conversion —

Provision: . . . . automatic (with Scientific Unit).

From: . . . . decimal or binary.

To: . . . . binary or decimal.

.217 Edit format —

	Provision	Comment	Size
Alter size:	automatic	expand but not contract	1 to N char.
Suppress zero:	automatic		
Round off:	none.		
Insert point:	automatic		
Insert spaces:	automatic		
Insert $, CR-*:	automatic		
Float $:	automatic		
Protection:	automatic		

.218 Table look-up —

Condition	Provision	Comment
Equality:	automatic*	1 to N entries, delimited by word marks. Fixed size table arguments are required.
Not equal:	automatic*	
Greater than (or equal):	automatic*	
Less than (or equal):	automatic*	
Greatest:	none.	
Least:	none.	

*with Optional Instruction Package.

.219 Others —

Substitute	automatic	performs binary masking on a single 6-bit character.
Change Addressing Mode:	automatic	shifts between 2, 3, or 4 character addressing.
Branch on Sense Switches:	automatic	branches according to each of 30 possible settings.
Branch on Data Control Indicators:	automatic	branches on any specific combination of the Data Control Indicators.

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value, with B zone bit in units position.

.222 Zero: . . . . positive, negative, and unsigned zeros and blanks give same result in most decimal arithmetic operations but are unequal in comparisons.

.223 Operand size determination: . . . . . word mark, item mark, or record mark bits in high or low-order digit position. (Some instructions imply one-character operands.)

.23 Instruction Formats

.231 Instruction structure: . variable; 1 to 12 characters.

.232 Instruction layout:

Part:	OP	A or I	B	V_1 or C_1	V_2 or C_2	C_3
Size (char):	1	2 to 4	2 to 4	1	1	1

An instruction may consist of:

(1) OP only
(2) OP, V_1
(3) OP, A or I
(4) OP, A or I, V_1
(5) OP, A or I, B
(6) OP, A or I, B, V_1
(7) OP, A, B, V_1, V_2
(8) OP, A or I, C_1
(9) OP, A or I, C_1, C_2
(10) OP, A or I, C_1, C_2, C_3
(11) OP, A, C_1, C_2, C_3, Cn

.233 Instruction parts —

Name	Purpose
OP:	operation code.
A:	address of an operand or field in core storage.
I:	location of next instruction if a branch occurs.
B:	address of an operand or field in core storage.
V_1 or C_1:	modifier for an operation code, control field for an I/O instruction, or partial address in a translate instruction.

.233 Instruction parts — (Contd.)

Name	Purpose
V_2 or C_2:	partial address in a translate instruction or control field for an I/O instruction.
C_3:	control field for an I/O instruction.

.234 Basic address structure: . . . . 2 + 0.

.235 Literals —
- Arithmetic: . . . . none.
- Comparisons and tests: . . . . yes; single character.
- Incrementing modifiers: . . . . none.
- Masking: . . . . yes; single character mask.

.236 Directly addressed operands —
- Internal storage type: . . . . core.
- Minimum size: . . . . . 1 character.
- Maximum size: . . . . total capacity.
- Volume accessible: . . total capacity.

.237 Address indexing —

.2371 Number of methods: . 1.

.2372 Name: . . . . indexing.

.2373 Indexing rule: . . . . . . addition (modulo core size).

.2374 Index specification: . . Address Modifier — first 3 bits of an 18-bit operand or first 5 bits of a 24-bit operand.

.2375 Number of potential indexers: . . . . 15 or 30.

.2376 Addresses which can be indexed: . . . . . . all 3- and 4-character addresses.

.2377 Cumulative indexing: . none.

.2378 Combined index and step: . . . . none.

.238 Indirect addressing: . . yes.

.2381 Recursive: . . . . yes.

.2382 Designation: . . . . Address Modifier — first 3 or 5 bits of an operand.

.2383 Control: . . . . direct address has no indicator bit.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence facilities: . . . . 2; sequence and co-sequence registers. Programmer may switch at will from one to the other by use of Change Sequence Mode instruction.

.312 Arrangement: . . . . . one set per processor.

.313 Precedence rule: . . . only one register in use at any one time. (Programmer indicates the register to be used.)

.314 Special sub-sequence counters: . . . . none.

.315 Sequence control step size: . . . . 1 character.

.316 Accessibility to routines: . . . . yes; can be loaded and stored by instruction.

.317 Permanent or optional modifier: . . . . no.

.32 Look-Ahead: . . . . . . none.

.33 Interruption

.331 Possible causes —
- In-out units: . . . . . end of operation, including availability of all error indications.
- Storage access: . . . violation of Storage Protection, either by alteration of contents or by reference to contents.
- Processor errors: . cannot initiate interrupts.
- Others: . . . . via two programmed instructions and console control panel.

.332 Control by routine: . . each peripheral interrupt can be set or reset individually by the program. External interrupts are recognized during the operation of an internal interrupt routine.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in bits	Program usage
Control memory:	23	18	address registers, read/write counters, interrupt register.
Arithmetic unit:	2	16	operand storage registers (not accessible to programmer).
Scientific unit:	12	18	floating-point registers.

.242

Category of storage	Total number of locations	Physical form	Access time, µsec	Cycle time, µsec
Control memory:	23	magnetic core	0.25	0.50
Arithmetic unit:	2	silicon diodes	0.50	1.00
Scientific unit:	12	magnetic core	0.25	0.50

(Contd.)

.333 Operator control: . . . interrupt can be caused via console.

.334 Interruption conditions: . . . . . . Interrupt requested. Interrupt not inhibited. Interrupt routine not in operation.

.335 Interruption process —

Registers saved: . . The active sequencing register is stored. The next instruction is taken from the address given in the interrupt register. The interrupt routine operates and, when completed, causes the original sequence register to be restored.

Destination: . . . . . . 2 different locations, depending on whether interrupt is external or internal.

.336 Control methods —

Determine cause: . . test indicators for explicit cause.

Enable interruption: by instruction.

.34 Multiprogramming

.341 Method of control: . . . executive program; see Sections 510:192 and 510:193.

.342 Maximum number of programs: . . . . one main program and one or more peripheral-limited programs.

.343 Precedence rules: . . . determined by executive program.

.344 Program protection —

Storage: . . . . storage area on one side of movable, logical boundary must not be read, written or tested by a program stored on the other side of the boundary.

In-out units: . . . . . . protected via disallowance of the two peripheral device control instructions.

.35 Multisequencing: . . . . none.

.4 PROCESSOR SPEEDS

All execution times listed here are based on use of the 4-character addressing mode; most instructions are 4 microseconds shorter in the 2-character addressing mode, and 2 microseconds shorter in the 3-character addressing mode.

D = operand length in decimal digits.

C = operand length in characters.

.41 Instruction Times in Microseconds

.411 Fixed point:

Add-subtract —

Decimal: . . . . 13 + 3D.

Binary: . . . . 12 + 3C.

Multiply: . . . . $14 + 7D + 7D^2$; where the multiplier is the same length as the multiplicand.

Divide: . . . . $26.5 + 29.5D + 15D^2$; where the dividend is twice the length of the divisor (D = no. of digits in divisor).

.412 Floating point (with Scientific Unit) —

Add-subtract: . . . . . 20 (min).

Multiply: . . . . 45 (avg).

Divide: . . . . 63 (max).

.413 Additional allowance for —

Indexing: . . . . 3 per modified address.

Indirect addressing: . 3 per stage.

Re-complementing: . . 2D.

.414 Control —

Compare: . . . . 13 + 2C.

Branch: . . . . 10.

.415 Counter Control: . . . . none.

.416 Edit: . . . . 12 + 4C + 2(No. of characters scanned during zero-suppression plus no. scanned for floating dollar sign insertion).

.417 Convert (5-char. fields) —

To binary: . . . . 33.

To decimal: . . . . 32.

.418 Shift: . . . . 9 + 0.25N (binary mantissa shift with Scientific Unit, where N = no. of bits shifted).

.42 Processor Performance in Microseconds

		Fixed point	Floating point*
.421	For random addresses:		
	c = a + b —		
	Decimal:	25 + 5D	—
	Binary:	24 + 5C	56.
	b = a + b —		
	Decimal:	13 + 3D	—
	Binary:	12 + 3D	56.
	Sum N items —		
	Decimal:	(13 + 3D)N	—
	Binary:	(12 + 3C)N	20.
	c = ab:	$24 + 9D + 7D^2$	81.
	c = a/b:	$47.5 + 35.5D + 15D^2$	99.
.422	For arrays of data —		
	$c_i = a_i + b_j$:	100 + 5D	128.
	$b_j = a_i + b_j$:	82 + 3D	128.
	Sum N items:	66 + 3D	73.
	$c = c + a_i b_j$:	$108 + 12D + 7D^2$	146.

.423 Branch based on comparison —

Numeric data: 103 + 2D.

Alphabetic data: 103 + 2C.

.424 Switching —

Unchecked: . . . . . . 64.

Checked: . . . . 64.

* with optional Scientific Unit.

.425 Format control, per character —
  Unpack: . . . . 3.0.
  Compose: . . . . 5.3.
.426 Table look-up, per comparison —
  For a match: . . . . . 1C.*
  For least or greatest: . . . . 1C.*
  For interpolation point: . . . . 1C.*
.427 Bit indicators —
  Set bit in separate location: . . . . 14.
  Set bit in pattern: . . 16.
  Test bit in separate location: . . . . 16.
  Test bit in pattern: . 16.
.428 Moving: . . . . 12 + 2C.

*with optional Scientific Unit.

5. ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator.
Zero divisor	overflow check	set indicator.
Invalid data:	validity check	set indicator.
Invalid operation:	check	interrupt.**
Arithmetic error:	none.	
Invalid address:	limit check	interrupt.**
Receipt of data:	parity check	set indicator.
Dispatch of data:	send parity bit.	
Reference to protected area:	check	interrupt.**

**with optional Storage Protect Feature.

SIMULTANEOUS OPERATIONS

Input-output operations in the Honeywell 2200 Computer System are initiated by the program and subsequently supervised by the input-output traffic control unit in conjunction with the control memory unit of the central processor.

The control memory can control either four or eight input-output operations concurrently with internal processing, as described below.

(1) Computation within the central processor continues at all times, except during the individual 1-microsecond cycles required for each unit of data transferred between core storage and any peripheral unit.

(2) In addition, either three or six (depending upon the configuration chosen) of the peripheral data transfer operations listed in Table I (over) can proceed at one time (one on each read-write channel) in addition to the continuing central processor operation. Lengths of the start time, data transmission time, and stop time are shown for each operation, along with its demands upon the central processor (CP) and the selected channel.

(3) One or two additional simultaneous data transfer operations can occur, provided that the data transfers occurring on both Channel 1 and Channel 1' (the auxiliary read/write channel) are "comparatively undemanding." In general, these "split" channels can service any two units operating at less than 33,000 characters per second each.

The capability to read from one tape unit and write simultaneously on another tape unit connected to the same Tape Control Unit is provided in most of the 204B Series (one-half inch) Magnetic Tape Units, but not in the 204A Series (three-quarter inch) tapes.

Up to 16 peripheral devices or peripheral control units can be connected to a basic Model 2200 system. By adding Feature 1115, the optional Input-Output Sector, 16 additional peripheral device control units can be added. This feature also provides four additional Read-Write channels, doubling the basic system's capacity to perform input-output operations simultaneously with computing.

TABLE I: SIMULTANEOUS OPERATIONS

OPERATION	Cycle Time, msec.	Start Time			Data Transmission			Stop Time		
		Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use	Time, msec.	CP Use	Channel Use
214 Card Reader	150	20.0	0	Yes	55.0	<0.1%	Yes	75.0	0	No
214 Card Punch	150-600	7.5	0	Yes	6.25n	<0.1%	Yes	92.5	0	No
223 Card Reader	75	13.0	0	Yes	46	0.1%	Yes	16	0	No
224-1 Card Punch	222-1200	6.2	0	Yes	12.5n	<0.1%	Yes	210	0	No
224-2 Card Punch	166-645	3.1	0	Yes	6.25n	<0.1%	Yes	160	0	No
227 Card Reader	75	21 to 46	0	Yes	44	4.5%	Yes	10	0	No
227 Card Punch	240	42 to 102	0	Yes	176	0.5%	Yes	22	0	No
222-1, -2, -3 Printer (51-character set)	92 + 5LS	0	—	—	75	8.5%	Yes	17 + 5LS	0	No
222-4 Printer (46-character set)	63 + 5LS	0	—	—	46	12.0%	Yes	17 + 5LS	0	No
222-5 Printer (55-character set)	133 + 5LS	0	—	—	116	6.5%	Yes	17 + 5LS	0	No
209 Paper Tape Reader	2.0	?	0	Yes	Var.	0.1%	Yes	?	0	No
210 Paper Tape Punch	8.3	?	0	Yes	Var.	<0.1%	Yes	?	0	No
204A-1 Magnetic Tape, 32KC	—	11.0[a]	0	Yes	Var.	3.2%	Yes	0[a]	—	—
204A-2 Magnetic Tape, 64KC	—	5.5[a]	0	Yes	Var.	6.4%	Yes	0[a]	—	—
204A-3 Magnetic Tape, 89KC	—	5.5[a]	0	Yes	Var.	8.9%	Yes	0[a]	—	—
204B-1, -2 Magnetic Tape, 20KC	—	12.5[a]	0	Yes	Var.	2.0%	Yes	0[a]	—	—
204B-3, -4 Magnetic Tape, 44KC	—	7.5[a]	0	Yes	Var.	4.4%	Yes	0[a]	—	—
204B-5 Magnetic Tape, 67KC	—	5.8[a]	0	Yes	Var.	6.7%	Yes	0[a]	—	—
204B-7 Magnetic Tape, 29KC	—	12.5[a]	0	Yes	Var.	2.8%	Yes	0[a]	—	—
204B-8 Magnetic Tape, 64KC	—	7.5[a]	0	Yes	Var.	6.4%	Yes	0[a]	—	—
204B-11, -12 Magnetic Tape, 13KC	—	18.7[a]	0	Yes	Var.	1.3%	Yes	0[a]	—	—
270 Random Access Drum	—	25.0	0	Yes	Var.	10.2%	Yes	0	—	—
251 Mass Memory	16.7	94 av.	0	Yes	Var.	10%	Yes	—	0	No
252 Mass Memory	16.7	150 av.	0	Yes	Var.	10%	Yes	—	0	No
253 Mass Memory	16.7	225 av.	0	Yes	Var.	10%	Yes	—	0	No

a Cross-gap time for short gap (replaces start and stop times).
LS Number of lines skipped between successive printed lines.
n Number of characters punched.
Var. Data transmission time varies with record length.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (514:201.100)

These problems involve updating a master file from information in a detail file and producing a printed record of each transaction. This application is one of the most common commercial data processing jobs and is fully described in Section 4:200.1 of the Users' Guide.

Because the Honeywell 2200 is capable of multiprogrammed operation, the central processor time requirements are shown on all of the graphs in addition to the usual curves of elapsed time (i.e., total processing time). The difference between the curves of elapsed time and central processor time represents the amount of central processor time that is potentially available for concurrent processing of other programs.

In order to show its true potential for business data processing in a varity of equipment configurations and operational modes, the Honeywell 2200's performance on the Standard File Problems has been analyzed for two different cases, as described in the following paragraphs:

(1) Conventional processing with on-line card reading and printing.

(2) Tape-to-tape processing with off-line card-to-tape and tape-to-printer transcriptions.

Conventional Processing (Configurations III, IV, and VIIA)

In Configurations III, IV, and VIIA, the master files are on magnetic tape. The detail file is assigned to the on-line card reader and the report file to the on-line printer. For Problems A, B, C, and D, the printer is the controlling factor at high, moderate, and low activities. One master-file tape controls at activities near zero.

In Configuration IV, for Problems A, B, C, and D, the auxiliary read/write channel is interlocked because of the high speed of the tapes used, and only three read/write channels are available. At low activity, the two magnetic tape units assigned to one read/write channel become the controlling factor for Configurations IV and VIIA (the higher horizontal line segment on graph 514:201.100). When the activity becomes low enough so that the combined times for the printer and card reader become less than the combined time for the tapes, the printer and card reader are assigned to one channel and the two tapes are assigned to two separate channels (the sloping straight line). Near zero activity, the combined times for the printer and card reader become lower than the time for each tape, so a single tape unit becomes the controlling factor (the lower horizontal line segment).

Tape-to-Tape Processing (Configuration VIIB)

In tape-oriented Configuration VIIB, all four files are on magnetic tape. Data transcriptions between tape and card or printer are performed off-line on a satellite system in this configuration, and timings for the transcription operations are therefore not shown. For Configuration VIIB, with blocked or unblocked detail and report files, one master-file tape and the report-file tape are the controlling factors at all activities in Problems A, B, and C. In Problem D, for Configuration VIIB with blocked files, the central processor is the controlling factor at high activity. The report-file tape and one master-file tape are controlling at activities near zero. The Problem D curve for the case of unblocked files is the same as that for Problem A.

SORTING (514:201.200)

The standard estimate for sorting 80-character records on magnetic tape (graph 514:201.200) was developed from the time calculated for Standard File Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide. The times for Honeywell's SORT C routine (graph 514:201.220) were calculated from timing formulas supplied by Honeywell.

MATRIX INVERSION (514:201.300)

In matrix inversion, the object is to measure central processor speed on the straightforward inversion of a non-symmetric, non-singular matrix. No input-output operations are involved. The standard estimate is based on the time required to perform cumulative multiplication ($c = c + a_i b_j$) in 8-digit-precision floating point, as explained in Paragraph 4:200.3 of the Users' Guide. The precision of floating-point operations is equivalent to approximately 11 digits in the Honeywell Series 200.

GENERALIZED MATHEMATICAL PROCESSING (514:201.400)

This problem measures overall system performance on a simple mathematical application that involves widely varying ratios of input-to-computation-to-output volumes, as described in Section 4:200.4 of the Users' Guide.

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)

	ITEM		CONFIGURATION										REFERENCE
			III		IV		VIIA		VIIB (blocked Files 3 and 4)		VIIB (unblocked Files 3 and 4)		
1 Standard File Problem A Input-Output Times	Char/block	(File 1)	1,080		1,080		1,080		1,080		1,080		4:220.112
	Records/block	K (File 2)	10		10		10		10		10		
	msec/block	File 1 File 2	58.5		23.5		23.5		23.5		23.5		
		File 3	75		75		75		20.0*		8.8		
		File 4	128		94		128		25.0*		9.3		
	msec/switch	File 1 File 2	0		0		0		0		0		
		File 3	0		0		0		0		0		
		File 4	0		0		0		0		0		
	msec penalty	File 1 File 2	1.1		1.1		1.1		1.1		1.1		
		File 3	0.1		0.1		0.1		0.8*		0.1		
		File 4	5.5		5.5		5.5		1.2*		0.12		
2 Central Processor Times	msec/block	a1	0.22		0.22		0.22		0.22		0.22		4:200.1132
	msec/record	a2	0.57		0.57		0.57		0.57		0.57		
	msec/detail	b6	0.09		0.09		0.09		0.09		0.09		
	msec/work	b5 + b9	1.18		1.18		1.18		1.18		1.18		
	msec/report	b7 + b8	0.63		0.63		0.63		0.63		0.63		
3 System Performance at F = 1.0	msec/block for C.P. and dominant I/O column.	a_1	0.2		0.2		0.2		0.2		0.2		4:200.114
		a_2K	5.7		5.7		5.7		5.7		5.7		
		a_3K	19.0		19.0		19.0		19.0		19.0		
		File 1: Master In	1.1		1.1		1.1		1.1		1.1		
		File 2: Master Out	1.1		1.1		1.1		1.1	23.5	1.1	23.5	
		File 3: Details	1.0		1.0		1.0		0.8		0.8		
		File 4: Reports	55.0	1,280	55.0	940	55.0	1,280	1.2	25.0	1.2	93.0	
		Total	83.1	1,280	83.1	940	83.1	1,280	29.1	48.5	29.1	116.5	
4 Storage Space Required	Unit of measure	characters											4:200.1151
		Std. routines	4,300**		4,300**		4,300**		4,300**		4,300*		
		Fixed	18		18		75		75		75		
		3 (Blocks 1 to 23)	612		612		612		612		612		
		6 (Blocks 24 to 48)	2,334		2,334		2,334		2,334		2,334		
		Files	4,720		4,720		4,720		8,320		4,720		
		Working	108		108		108		108		108		
		Total	12,092		12,092		12,149		15,749		12,149		

* Blocked 10 records per block.
** Includes estimated storage requirements for Tape I/O Package.

WORKSHEET DATA TABLE 2 (STANDARD MATHEMATICAL PROBLEM A)

	ITEM		CONFIGURATION		REFERENCE
			VIIA	VIIB	
5 Standard Mathematical Problem A	Fixed/Floating point		Floating point	Floating point	4:200.413
	Unit name	input	223 Card Reader	204B-8 Magnetic Tape	
		output	222-3 Printer	204B-8 Magnetic Tape	
	Size of record	input	80	80	
		output	120	80	
	msec/block	input T_1	75	8.8	
		output T_2	128	8.8	
	msec penalty	input T_3	0.1	0.1	
		output T_4	5.5	0.1	
	msec/record	T_5	8.44	8.44	
	msec/5 loops	T_6	4.84	4.84	
	msec/report	T_7	1.46	1.46	

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

.111 Record sizes —
Master file: . . . . . . 108 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

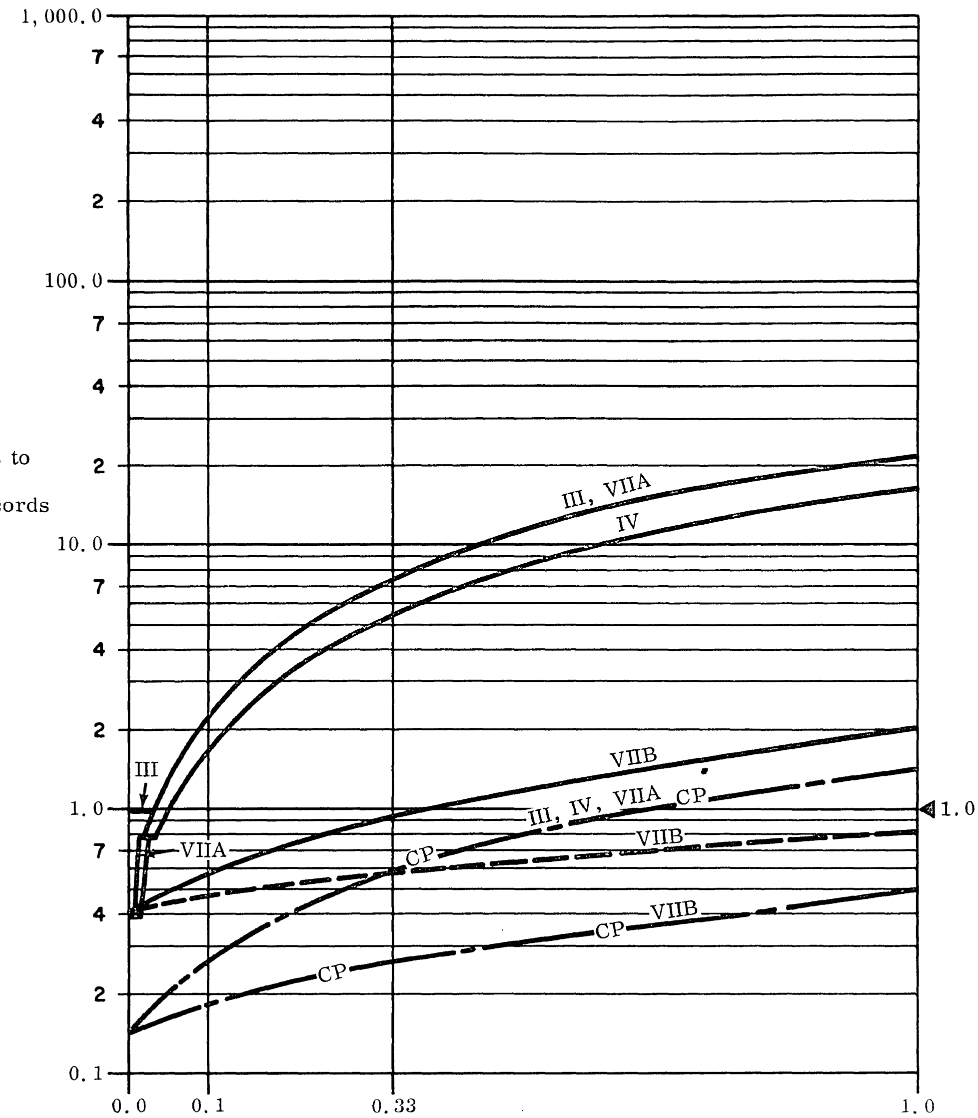
.112 Computation:. . . . . . . standard.

.113 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage space required —
Configuration III: . . . 12,092 characters.
Configuration IV: . . . 12,092 characters.
Configuration VIIB (blocked files 3 & 4): 15,749 characters.
Configuration VIIB (unblocked files 3 & 4): . . . . 12,149 characters.
Configuration VIIA: . 12,149 characters.

Time in Minutes to Process 10,000 Master File Records



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

LEGEND

Elapsed time; unblocked Files 3 & 4
Elapsed time; blocked Files 3 & 4
CP Central processor time

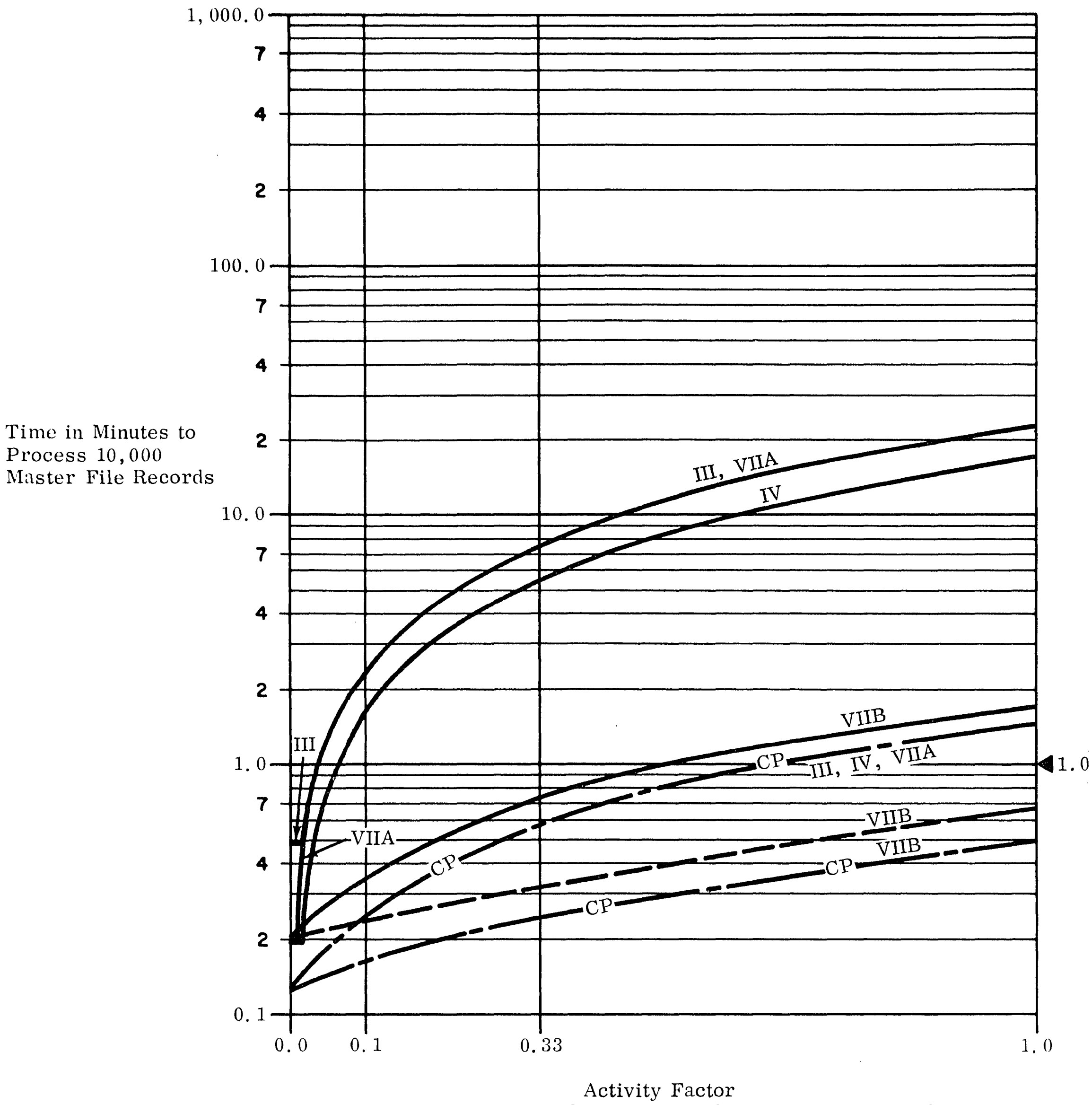
.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . . 54 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.122 Computation:. . . . . . . standard.

.123 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.

.124 Graph:. . . . . see graph below.



(Roman numerals denote standard System Configurations.)

LEGEND

————————	Elapsed time; unblocked Files 3 & 4
— — — — — — —	Elapsed time; blocked Files 3 & 4
——— - ———CP———	Central processor time

(Contd.)

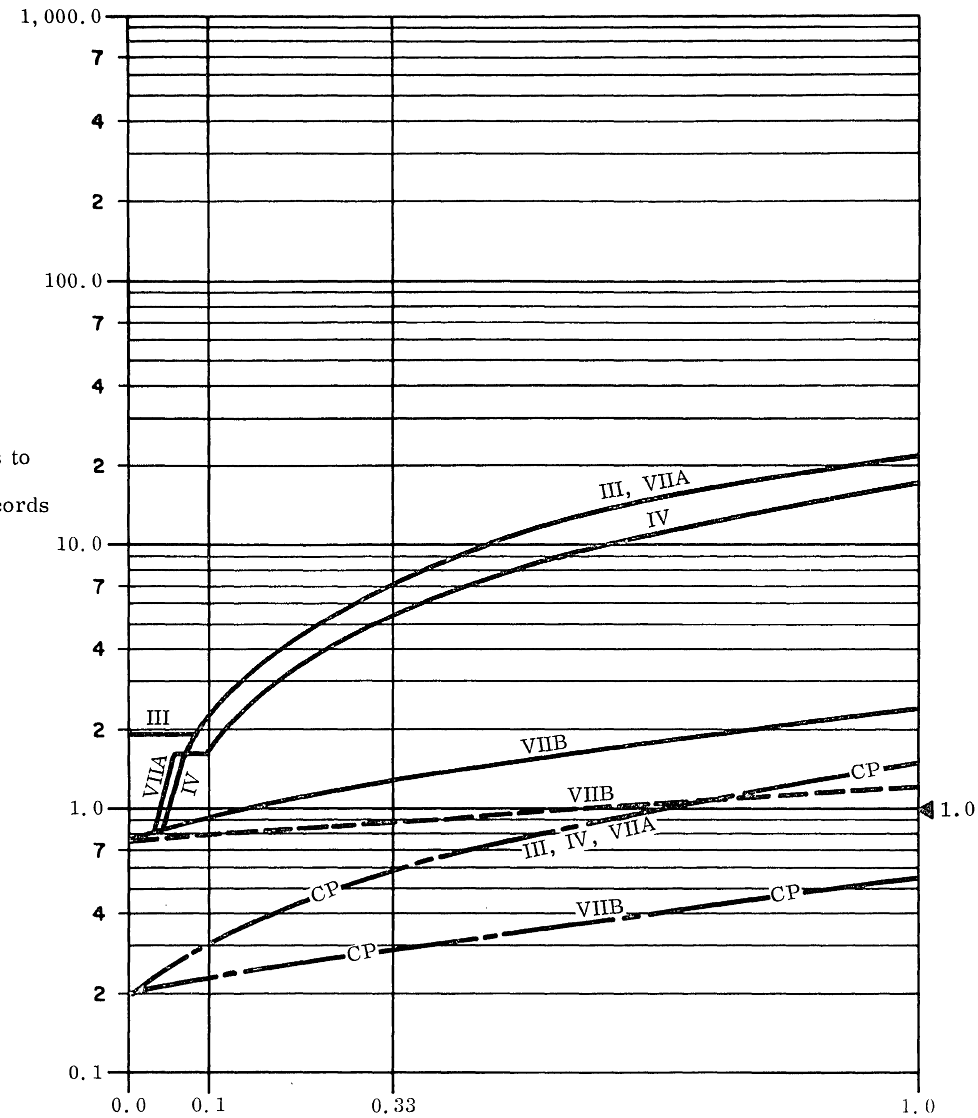
.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . . 216 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.132 Computation:. . . . . . . standard.

.133 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

LEGEND

Elapsed time; unblocked Files 3 & 4
Elapsed time; blocked Files 3 & 4
CP Central processor time

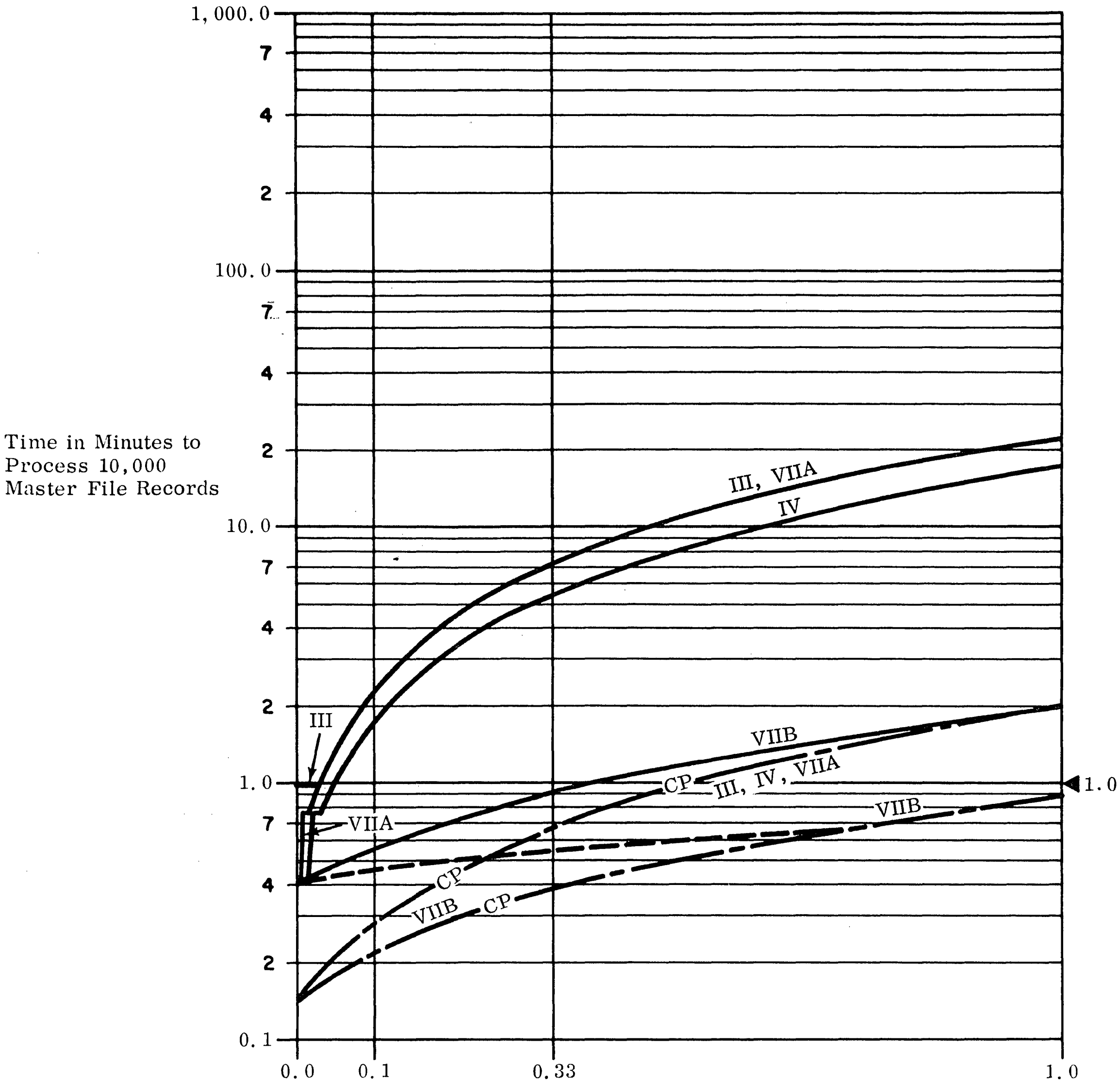
.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . . . 108 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.142 Computation:. . . . . . . trebled.

.143 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.

.144 Graph: . . . . see graph below.



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

LEGEND

Elapsed time; unblocked Files 3 & 4
Elapsed time; blocked Files 3 & 4
Central processor time

(Contd.)

AUERBACH ®

.2 SORTING

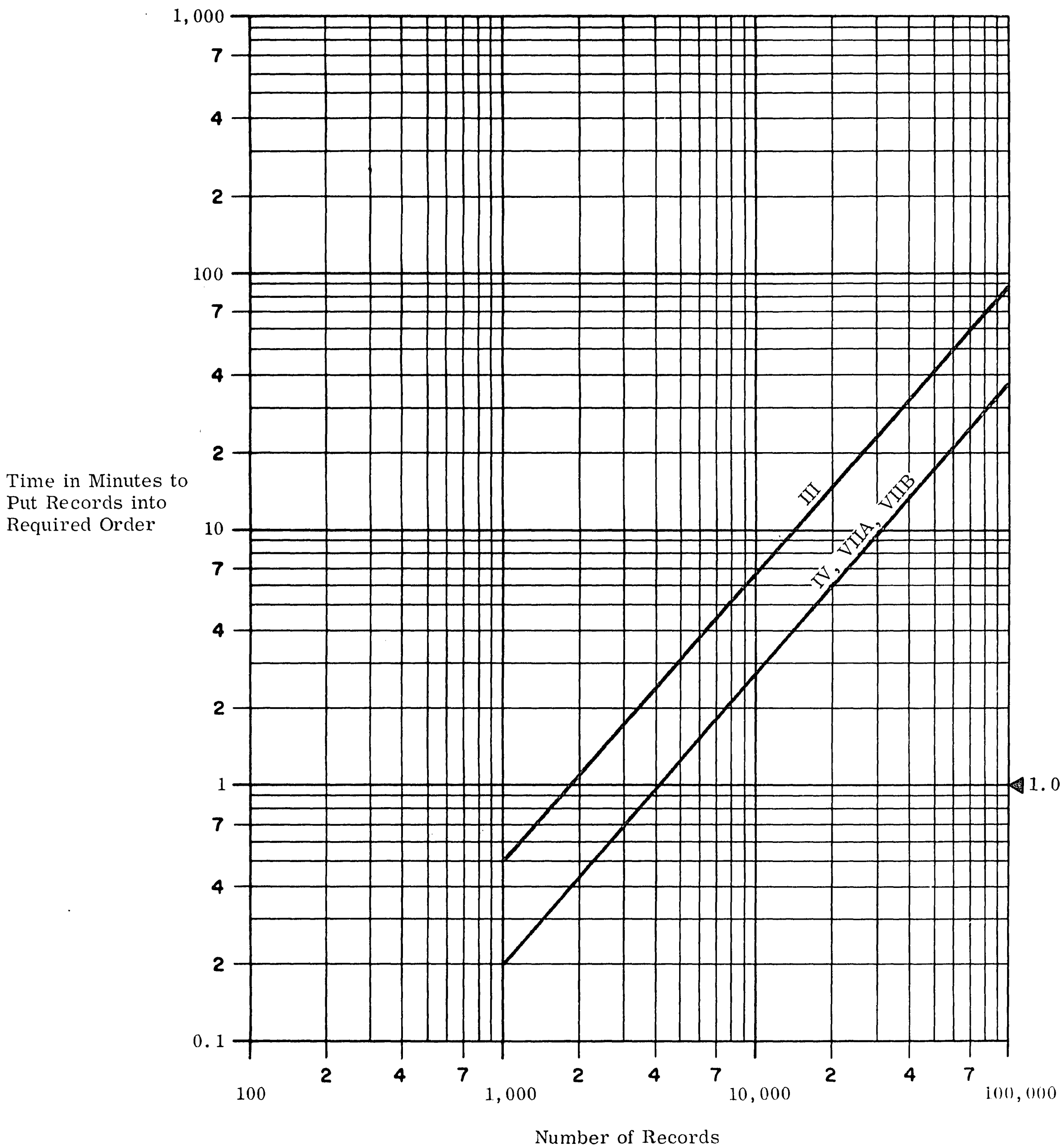
.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.

.212 Key size: . . . . 8 characters.

.213 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

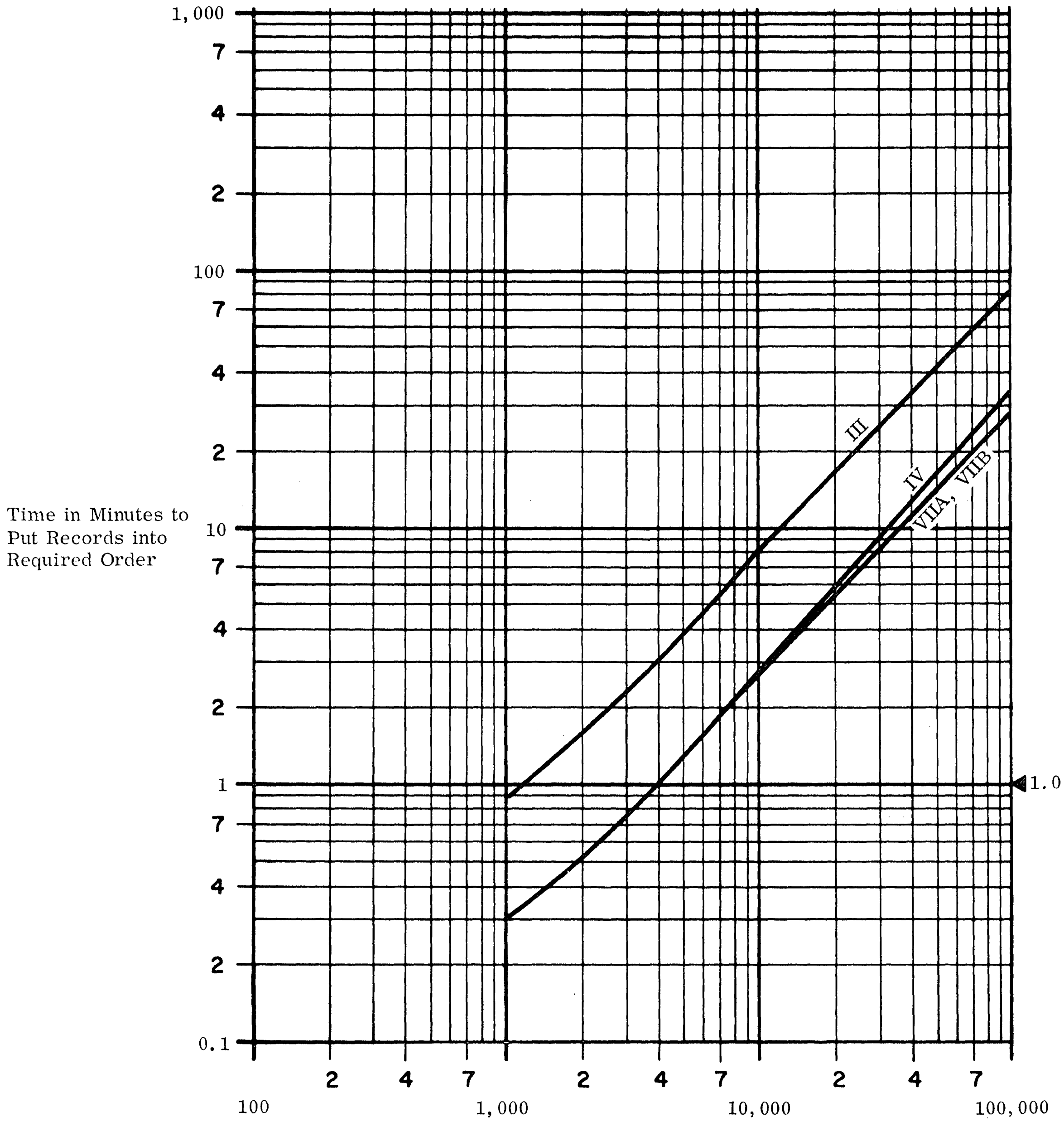
.214 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

.22 SORT C Times

.221 Record size: . . . . 80 characters.
.222 Key size: . . . . 8 characters.
.223 Timing basis: . . . . . . timing formulas supplied by Honeywell.
.224 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations)

(Contd.)

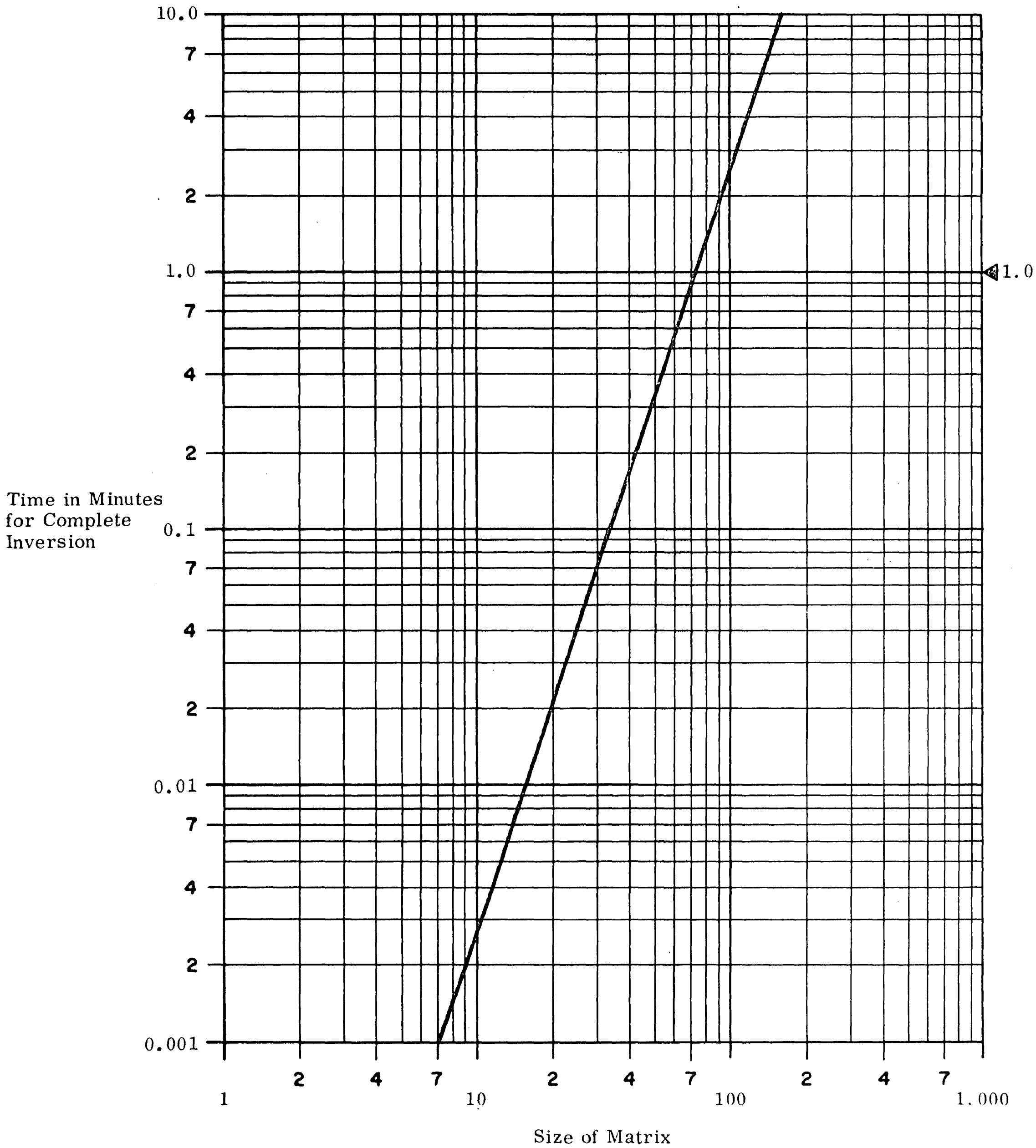
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . see graph below.



(For all configurations equipped with the Scientific Option)

.4 GENERALIZED MATHEMATICAL PROCESSING

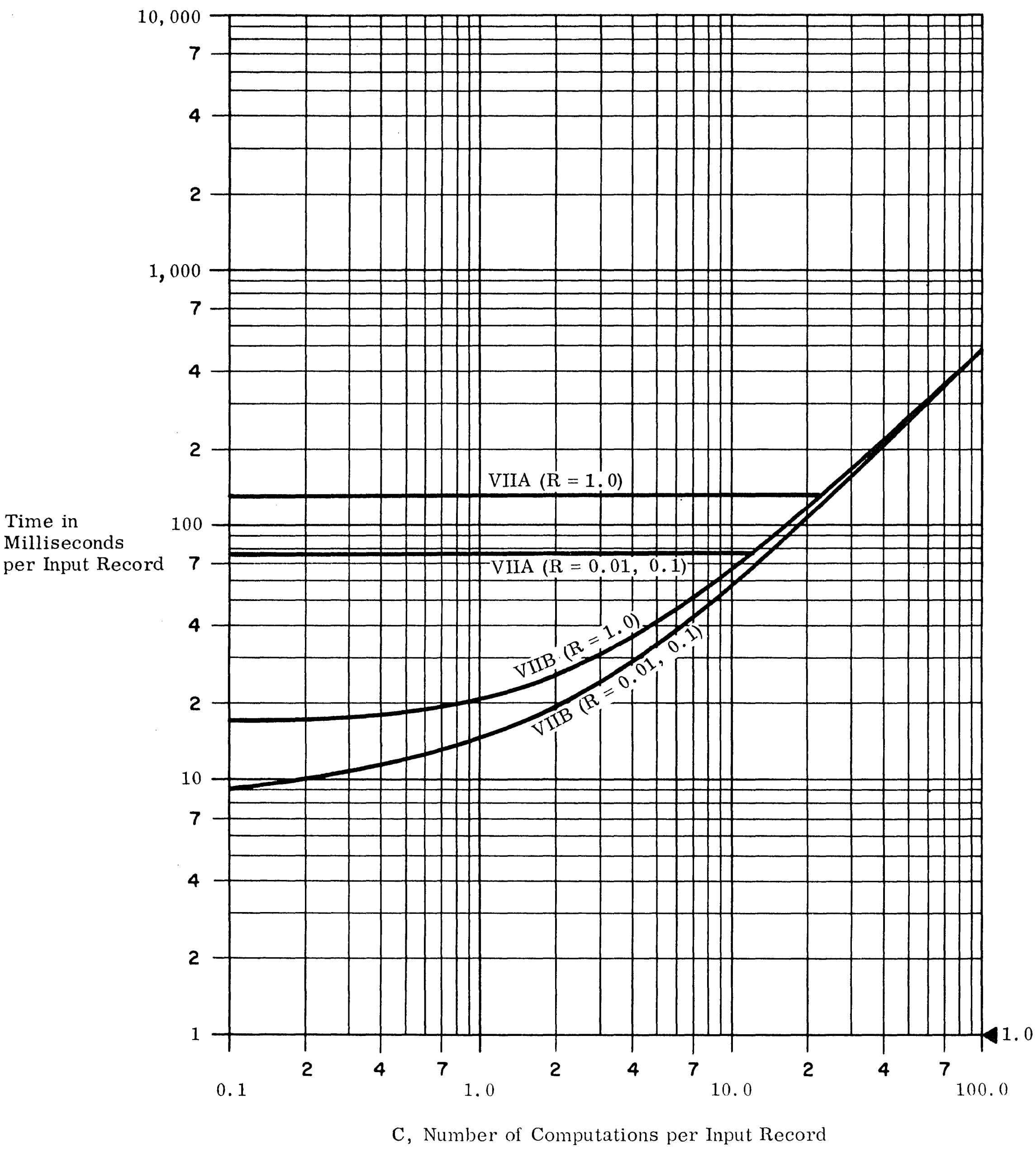
.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . 5 fifth-order polynomials, 5 divisions, 1 square root; 11-digit precision floating-point mode.

.413 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



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HONEYWELL 4200

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INTRODUCTION

The Honeywell 4200 Processor can be connected to any of the Honeywell Series 200 peripheral units, can use any of the Series 200 programming languages, can run most programs originally written for an IBM 1401, 1410, or 7010, and can operate in a multiprogrammed mode, using the Storage Protect feature to help insure safe handling of the two concurrently-operating programs. The 4200 Processor can contain from 65,556 to 524,288 characters of core storage, with a cycle time of 0.75 microsecond per four characters.

Standard features of the Honeywell 4200 include: Program Interrupt, Multiply-Divide, Advanced Programming, Edit Instruction, 8-Bit Code Handling, eight read/write channels, 32 peripheral address assignments, and table lookup instructions.

Optional features are: Scientific Unit (floating-point arithmetic), Storage Protect, and eight additional read/write channels and 16 peripheral address assignments.

The rental for typical Honeywell 4200 systems is expected to range from $16,400 to $25,500 per month. Deliveries will begin in October 1967.

This report concentrates upon the characteristics and the performance of the Honeywell 4200 in particular. All the general characteristics of the Honeywell Series 200 computers, peripheral equipment, and software are described in Computer System Report 510: Honeywell Series 200 — General.

The System Configuration section which follows shows the Honeywell 4200 in the following System Configurations:

III:	6-Tape Business System
IV:	12-Tape Business System
V:	6-Tape Auxiliary Storage System
VI:	6-Tape Business/Scientific System
VIIA:	10-Tape General System (Integrated)
VIIB:	10-Tape General System (Paired with the Model 120)
VIIIB:	20-Tape General System (Paired with the Model 120)

These configurations were prepared according to the rules in the Users' Guide, page 4:030.120, and any significant deviations from the standard specifications are listed.

Section 516:051 provides detailed central processor timings for the Honeywell 4200.

The input-output channel capabilities of the Honeywell 4200, and the demands upon the processor during input-output operations, are described in Section 516:111.

Several levels of software support can be used with Honeywell 4200 systems. The two versions of Operating System — Mod 1 can be used, providing software packages that are resident on either magnetic tape or mass storage devices. Several levels of COBOL and FORTRAN language processors and Easycoder assemblers are offered with Operating System — Mod 1. Automatic stacked-job processing facilities and several data management routines are also provided. Honeywell 4200 systems that have at least 49K characters of core storage can also use the advanced software of the Operating System — Mod 2, featuring automatic program scheduling and improved language processors. These software systems and the Series 200 Basic Programming System are described in Sections 510:151 through 510:193.

The overall performance of any Honeywell Series 200 system is heavily dependent upon the processor model used. A full System Performance analysis of standardized configurations utilizing the Honeywell 4200 processor is provided in Section 516:201.

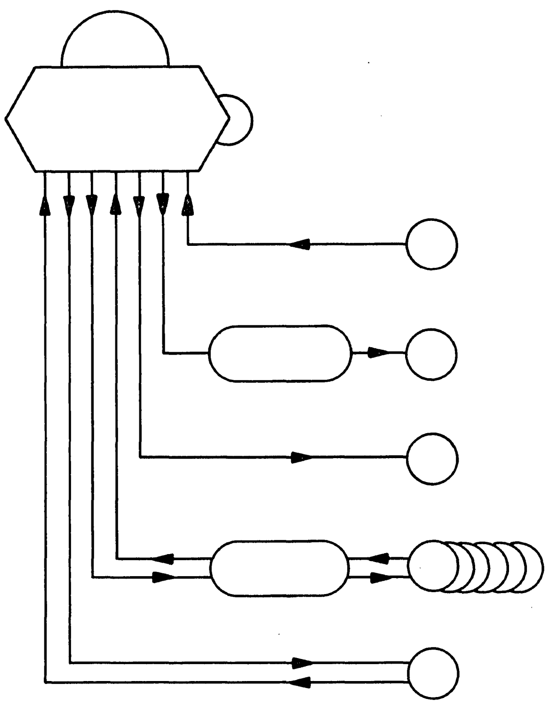
SYSTEM CONFIGURATION

The Honeywell 4200 Processor contains either 8 or 16 input-output channels and either 32 or 48 peripheral address assignments. This means that up to 48 peripheral devices or controllers can be connected, and a maximum of 16 data transfer operations can occur simultaneously with internal processing. The connections between devices and channels are established under program control.

Any of the available Series 200 peripheral units can be connected to a Honeywell 4200 Processor. These peripheral units are described in detail in the main Series 200 Computer System Report, and their trunk requirements are summarized in the main System Configuration section, page 510:031.100.

.1 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.
console typewriter input is included.
ability to read and write magnetic tape simultaneously is standard.
core storage is 200% larger.



Equipment	Rental*
4201-1 Processor with 65,536 characters of core storage	$10,660
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/min	310
222-3 Printer and Control: 650 lines/min (120 print positions)	925
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Units (6): 28,800 char/sec (800 cpi)	2,460
220-3 Console (includes Teleprinter)	310

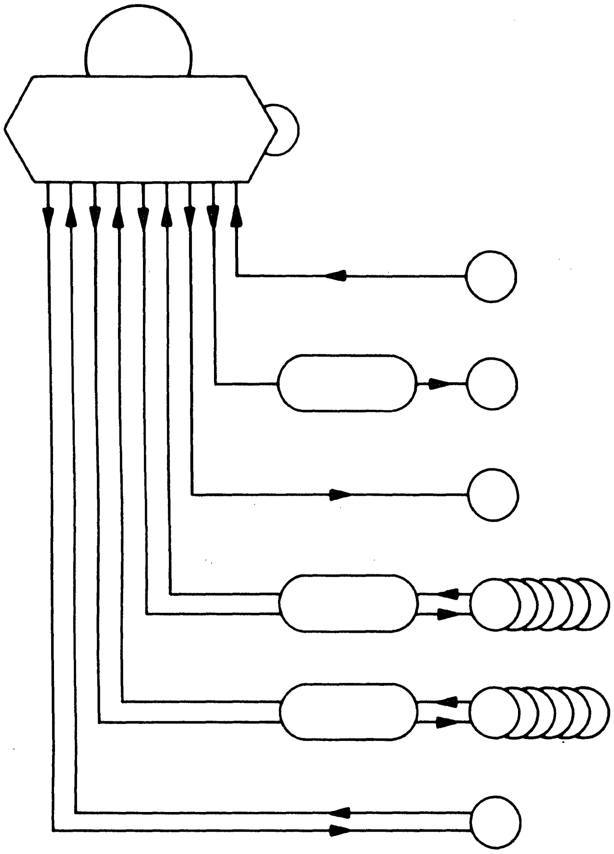
Optional Features Included: . . . . none.

TOTAL RENTAL:	$15,565

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement leases for $14,460 per month.

.2 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 20% slower.
card punch is up to 50% slower.
core storage is 100% larger.



Equipment	Rental*
4201-1 Processor with 65,536 characters of core storage	$10,660
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/min	310
222-4 Printer and Control: 950 lines/min (120 print positions)	1,305
203B-2 Tape Control Unit	435
204B-5 Magnetic Tape Units (6): 64,000 char/sec	3,690
203B-4 Tape Control Unit	435
204B-5 Magnetic Tape Units (6): 64,000 char/sec	3,690
220-3 Console (includes Teleprinter)	310

Optional Features Included: . . . . none.

TOTAL RENTAL: $21,250

.3 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

This configuration is identical to Configuration III (preceding page) except for the addition of one 250 Mass Memory Control and one 251 Mass Memory File, which provide 15 million characters of storage and bring the total system rental to $16,570 per month for a one-year term agreement. Rental under the five-year agreement is $15,360 per month.

.4 6-TAPE BUSINESS/SCIENTIFIC SYSTEM; CONFIGURATION VI

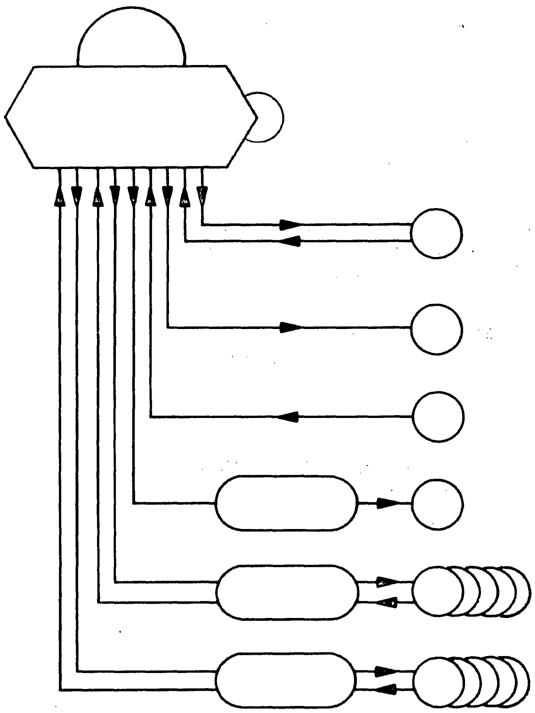
This configuration is also identical to Configuration III, except for the addition of the Scientific Unit. The cost of this unit is $510 per month on a one-year term agreement and $490 per month for the five-year agreement. Core storage requirements for Configuration VI are satisfied by the minimum-sized 65K-character Model 4201-1 Processor.

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement leases for $19,760 per month.

(Contd.)

.5 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIA

Deviations from Standard Configuration: . . . . card reader is 60% faster.
printer is 30% faster.

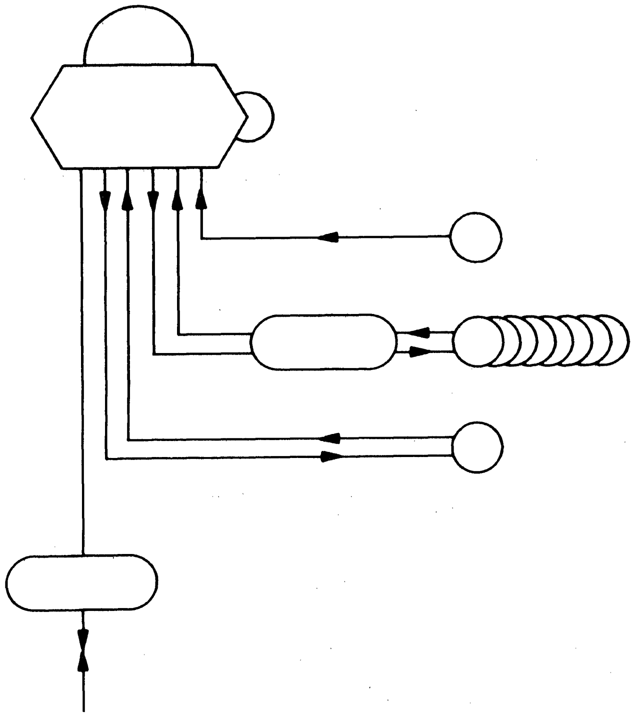


Equipment	Rental*
4201-2 Processor with 98,304 characters of core storage	$11,650
220-3 Console (includes typewriter and direct control)	310
222-3 Printer and Control (120 print positions): 650 lines/min	925
223 Card Reader and Control: 800 lines/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/min	310
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 64,000 char/sec	3,075
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 64,000 char/sec	3,075
Optional Features Included: Scientific Unit	510
TOTAL RENTAL:	$21,590

* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement leases for $19,680 per month.

.6 10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIIB

Deviations from Standard Configuration: . . . . card reader is 700% faster.
direct connection to satellite system.



To Satellite System
(next page)

Equipment	Rental*
4201-1 Processor and Console with 65,536 characters of core storage	$10,660
223 Card Reader and Control: 800 cards/min	310
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (8): 64,000 char/sec	4,920
220-3 Console (includes Teleprinter and direct control)	310
212-1 On-Line Adapter Unit (for connection to H-120 Processor)	410

Optional Features Included: . . . . Scientific Unit 510

TOTAL ON-LINE EQUIPMENT:	$17,555
TOTAL SATELLITE EQUIPMENT:	$ 3,610
TOTAL RENTAL:	$21,165

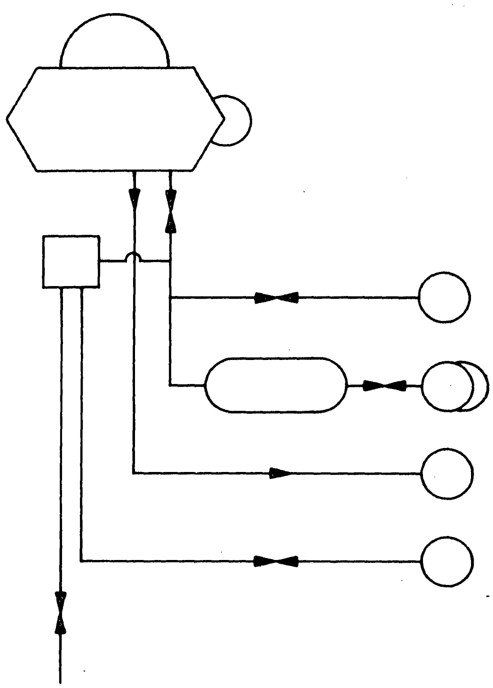
* The rental prices quoted are for a one-year monthly rental base term agreement. The same configuration with a five-year agreement leases for $19,605 per month.

(Contd.)

.6 CONFIGURATION VIIB (Contd.)

SATELLITE EQUIPMENT (Honeywell 120)

Deviations from Standard Configuration: . . . . card reader is 20% slower.
ability to overlap printing and one input-output operation with computing is standard.
console typewriter input is included.
6 index registers.



To Model 4200 System
(previous page)

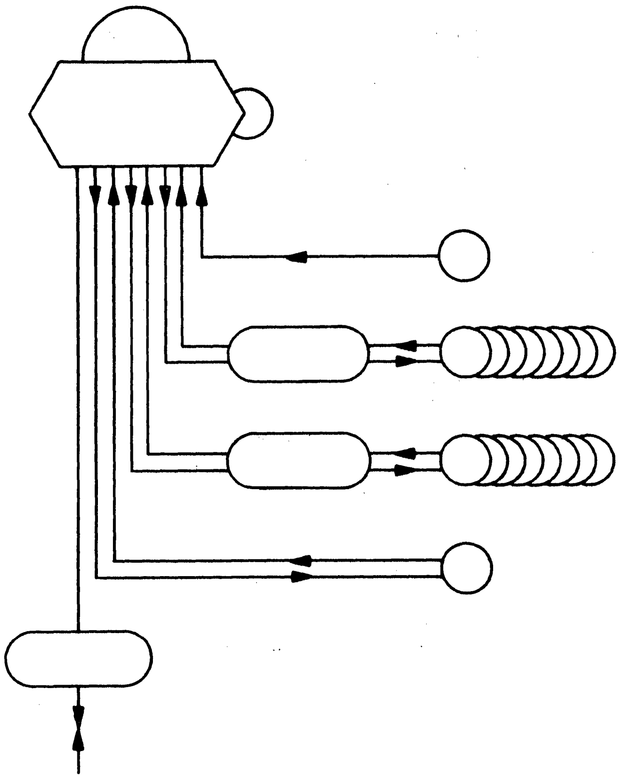
Equipment	Rental
121-2 Central Processor Console with 4,096 character positions of core storage	$1,000
I/O Adapter (Non-Simultaneous)	155
214-2 Card Reader/Punch: Reads: 400 cards/min Punches: 100-400 cards/min	360
203B-4 Tape Control Unit	435
204B-7 Magnetic Tape Units (2): 28,800 char/sec	820
122 Printer: 450 lines/min (120 print positions)	510
220-1 Console (includes Teleprinter)	205

Optional Features Included: . . . .

Advanced Programming	75
Edit Instruction	50
TOTAL SATELLITE EQUIPMENT:	$3,610

.7 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIIIB

Deviations from Standard Configuration: . . . . direct connection to satellite system.
card reader is 700% faster.
magnetic tape is 20% slower.



To Satellite System
(next page)

Equipment	Rental*
4201-3 Processor with 131,072 characters of core storage	$12,690
223 Card Reader and Control: 800 cards/min	310
203B-4 Tape Control Unit	435
204B-9 Magnetic Tape Units (8): 96,000 char/sec	6,560
203B-4 Tape Control Unit	435
204B-9 Magnetic Tape Units (8): 96,000 char/sec	6,560
220-3 Console (includes Teleprinter and direct control)	310
212-1 On-Line Adapter Unit (for connection to Honeywell 200 Processor)	410

Optional Features Included: . . . . Scientific Unit 510

TOTAL ON-LINE EQUIPMENT:	$28,220
TOTAL SATELLITE EQUIPMENT:	$ 6,675
TOTAL RENTAL:	$34,895

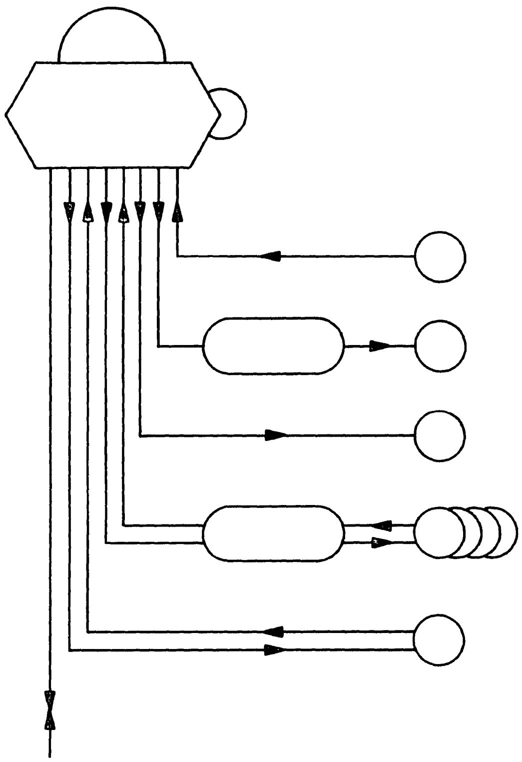
* The rental prices quoted are for a one-year monthly rental base term agreement.
The same configuration with a five-year monthly agreement leases for $32,080 per month.

(Contd.)

.7 CONFIGURATION VIIIB (Contd.)

SATELLITE EQUIPMENT (Honeywell 120)

Deviations from Standard Configuration: . . . . card reader is 20% slower.
card punch is slower.
console-typewriter input is included.
ability to read and write magnetic tape simultaneously is standard.



Equipment	Rental
120-3 Processor and Console with 8,192 characters of core storage	$1,270
223 Card Reader and Control: 800 cards/min	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/min	310
222-4 Printer and Control: 950 lines/min (120 print positions)	1,305
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (4): 64,000 char/sec	2,460
220-3 Console (includes Teleprinter)	310

To Honeywell 4200 System (previous page)

Optional Features Included: . . . .

Advanced Programming	75
Editing Instructions	50
TOTAL SATELLITE EQUIPMENT:	$6,675

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . Central Processor. Models 4201-1 through 4201-5.

.12 Description

The Model 4201 Processor performs all the arithmetic and logical functions in a Honeywell 4200 system under control of one or more internally stored programs. The processor works in conjunction with a control memory that contains program sequencing, program interrupt, and other associated registers. Only one control memory can be utilized in a Honeywell 4200 system.

The 4201 instruction code is basically a two-address, add-to-storage type. This code includes all the Honeywell 200 instructions (which are almost identical with those of the IBM 1401), plus alphanumeric comparison and table look-up operations. Fifteen index registers are also included in the basic unit; the instruction repertoire, from a programmer's view, is very similar to that of the IBM 1410 and 7010 systems.

Binary addressing is used to minimize instruction sizes; address lengths can vary from two characters to four characters. Four-character addressing is the mode normally used in programs written for the Honeywell 4200; it permits direct addressing of any position within the maximum 524K core memory. The type of addressing in use at any time is controlled by special instructions and can be varied by the programmer as needed. Even with this facility, the multiple addressing modes may lead to complications in the interpretation of diagnostics and in the use of operating systems.

The Model 4201 Processor consists of five basic functional units: the main memory, the control memory, the control unit, the arithmetic unit, and the input-output traffic control.

The main memory consists of from 65,536 to 524,288 alphanumeric character positions of core storage with a cycle time of 0.75 microsecond per 4-character word; see Section 510:041 for a complete description. Each character position consists of six data bits, one parity bit, and two punctuation bits. The punctuation bits can be used to indicate a word mark, an item mark, or a record mark, which defines the length of a data field or instruction, an item, or a record, respectively. An "item" consists of a group of consecutive data fields. (The IBM 1400 series computers utilize only one punctuation bit — the "word mark" bit — and each record mark occupies an entire character position. The two punctuation bits used in the Honeywell 4200 will decrease data storage requirements and provide increased flexibility in data movement operations. The Extended Move instruction, for example, can be terminated by a word mark, an item mark, or a record mark, as specified by the programmer.)

The control memory is a small magnetic core storage unit with an access time of 0.125 microsecond and a cycle time of 0.25 microsecond. Control memory provides 64 processor control registers, each containing as many bits as required to address all of the installed main memory locations. Instructions are provided to load and store the contents of most of these registers.

Of the available 64 processor control registers, only 56 have functions currently assigned to them. The basic Model 4200 Processor includes 24 program registers — 16 for input-output channel control, two sequence control registers, an external interrupt register, A-address and B-address registers, and three processor work registers. Fifteen additional registers are provided if the Scientific Unit (floating-point) feature is installed, and each of these registers contains 18 bits. The optional Storage Protect feature makes use of another control register, and installation of the second set of eight Read/Write Channels provides 16 more control registers.

The control unit controls the sequential selection, interpretation, and execution of all stored program instructions and checks for correct (odd) parity whenever a character is moved from one location to another. It also provides for communication with the operator's control panel.

The input-output traffic control directs the time-sharing of accesses to the main memory by the various peripheral devices and the central processor. This control operation is associated with the control memories, which contain the control information used by each of the data transfers. Up to sixteen input-output operations can proceed simultaneously under the supervision of the control memory. The basic processor contains eight normal Read/Write Channels; two of them can be split into two subchannels, provided that neither operation proceeds at a higher rate than 45,000 characters per second, which takes into account worst-case conditions. Eight additional Read/Write Channels are available as an option.

The allocation of data transmission channels to input-output trunks is flexible. The actual allocation of a specific peripheral device to a specific channel is initiated by an instruction, rather than by the operator.

The arithmetic unit executes all arithmetic and logical operations. It consists of an adder that can perform both decimal and binary arithmetic and two one-character operand storage registers. The 4200 is basically a two-address, add-to-storage system. All operations are performed serially by character and terminated when specific punctuation bit configurations are sensed. This means that operand sizes are fully variable and are limited only by the amount of core storage available to hold them.

.12 Description (Contd.)

The processor is well suited to general data manipulation, including, as standard features, excellent editing capabilities, indexing, indirect addressing, an Item Move instruction, a Move and Translate instruction, multiplication and division, and table lookup instructions.

The indexing facilities are comparatively numerous. Fifteen index registers are supplied as standard equipment, and fifteen more are available when the optional Storage Protect feature is installed.

The Move and Translate instructions can effect translations between any two 6-bit codes. A table must be provided for every code into which conversions are to be made, arranged in the order of the bit patterns of the code from which conversion is planned. Handling of 8-bit codes is also provided.

Instruction length is variable from one to eleven characters. Arithmetic and data movement instructions are most commonly nine characters long. Through careful placement of data, instructions can sometines be "chained" so that a one-character instruction does the work of a nine-character one, resulting in savings in both storage space and execution time. Chaining is possible only when a series of operations is to be performed upon items of data stored in consecutive locations, so that the A- and B-Address Registers do not need to be reloaded before each instruction is executed.

Typical instruction execution times, using the four-character addressing mode, are 10.7 microseconds for a five-digit decimal addition and 81.7 microseconds for a five-digit multiplication.

Optional Features

Additional 8 Read/Write Channels and 16 Input-Output Trunks: Permits 16 additional peripheral units or controllers to be connected to a Honeywell 4200, and provides up to 8 additional simultaneous data transfers.

Storage Protect: Protects the contents of one designated memory area against accidental reference or alteration by unrelated programs; provides 15 additional index registers for use by programs inside the protected area.

Scientific Unit: Provides automatic floating-point arithmetic and decimal-binary radix conversion operations.

.14 First Delivery: . . . . . October 1967.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add-subtract:	automatic	decimal or binary	1 to N char.
	Multiply:	automatic	decimal	1 to N char.
	Divide:	automatic	decimal	1 to N char.
.212	Floating point —			
	Add-subtract:	automatic*	binary	36 & 12 bits.
	Multiply:	automatic*	binary	36 & 12 bits.
	Divide:	automatic*	binary	36 & 12 bits.

*with optional Scientific Unit.

	Operation and Variation	Provision	Radix	Size
.213	Boolean —			
	AND	automatic	binary	1 to N char.
	Inclusive OR:	none.		
	Exclusive OR:	automatic	binary	1 to N char.

	Operation and Variation	Provision	Size
.214	Comparison —	branch on high, low, equal, unequal, or zero balance.	
	Numbers:	automatic	1 to N char.
	Absolute:	none.	
	Letters:	automatic	1 to N char.
	Mixed:	automatic	1 to N char.
	Collating sequence:	0 through 9, then A through Z, with special symbols interspersed.	

.215 Code translation —
Provision: . . . . automatic (using code table constructed by programmer).
From: . . . . any 6-bit or 8-bit code.
To: . . . . any 6-bit or 8-bit code.
Size: . . . . 1 to N characters.

(Contd.)

.216 Radix conversion —
Provision: . . . . automatic (with Scientific Unit.).
From: . . . . decimal or binary.
To: . . . . binary or decimal.

	Provision	Comment	Size
.217 Edit format —			
Alter size:	automatic	expand but not contract	1 to N char.
Suppress zero:	automatic		
Round off:	none.		
Insert point:	automatic		
Insert spaces:	automatic		
Insert $, CR-*:	automatic		
Float $:	automatic		
Protection:	optional		

.218 Table look-up —

Condition	Provision	Comment
Equality:	automatic	1 to N entries, separated by word marks. Fixed size table arguments are required.
Not equal:	automatic	
Greater than (or equal):	automatic	
Less than (or equal):	automatic	
Greatest:	none.	
Least:	none.	

.219 Others —

Substitute:	automatic	performs binary masking on a single 6-bit character.
Change Addressing Mode:	automatic	shifts between 2, 3, or 4 character addressing.
Branch on Sense Switches:	automatic	branches according to each of the 16 possible settings.
Branch on Data Control Indicators:	automatic	branches on any specific combination of the Data Control Indicators.

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value, with B zone bit in units position.

.222 Zero: . . . . positive, negative, and unsigned zeros and blanks give same result in decimal arithmetic but are unequal in comparisons.

.223 Operand size determination: . . . . . word mark, item mark, or record mark bits in high or low-order digit position. (Some instructions imply one-character operands.)

.23 Instruction Formats

.231 Instruction structure: . variable; 1 to 11 characters.

.232 Instruction layout:

Part:	OP	A or I	B	V_1 or C_1	V_2 or C_2	C_3
Size (char):	1	2 to 4	2 to 4	1	1	1

An instruction may consist of:

(1) OP only
(2) OP, V_1
(3) OP, A or I
(4) OP, A or I, V_1
(5) OP, A or I, B
(6) OP, A or I, B, V_1
(7) OP, A, B, V_1, V_2
(8) OP, A or I, C_1
(9) OP, A or I, C_1, C_2
(10) OP, A or I, C_1, C_2, C_3

.233 Instruction parts —

Name	Purpose
OP:	operation code.
A:	address of an operand or field in core storage.
I:	location of next instruction if a branch occurs.
B:	address of an operand or field in core storage.
V_1 or C_1:	modifier for an operation code, control field for an I/O instruction, or partial address in a translate instruction.
V_2 or C_2:	partial address in a translate instruction or control field for an I/O instruction.
C_3:	control field for an I/O instruction.

.234 Basic address structure: . . . . 2 + 0.

.235 Literals —
Arithmetic: . . . . none.
Comparisons and tests: . . . . yes; single character.
Incrementing modifiers: . . . . none.
Masking: . . . . yes; single character mask.

.236 Directly addressed operands —
Internal storage type: . . . . core.
Minimum size: . . . . . 1 character.
Maximum size: . . . . total capacity.
Volume accessible: . . total capacity.

.237 Address indexing —
.2371 Number of methods: . 1.
.2372 Name:. . . . . indexing.
.2373 Indexing rule:. . . . . . addition (modulo core size).
.2374 Index specification: . . Address Modifier — first 3 bits of an 18-bit operand or first 5 bits of a 24-bit operand.
.2375 Number of potential indexers:. . . . . 15 or 30.
.2376 Addresses which can be indexed: . . . . all 3- and 4-character addresses.
.2377 Cumulative indexing: . none.
.2378 Combined index and step:. . . . . none.
.238 Indirect addressing: . . yes.
.2381 Recursive:. . . . . yes.
.2382 Designation:. . . . . . . Address Modifier — first 3 or 5 bits of an operand.
.2382 Control: . . . . direct address has no indicator bit.

.24 Special Processor Storage: . . . . see Paragraph .21, Control Memory.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence facilities: . . . . 2; sequence and co-sequence registers. Programmer may switch at will from one to the other by use of Change Sequence Mode instruction.
.312 Arrangement: . . . . one set per processor.
.313 Precedence rule: . . . . only one register in use at any one time. (Programmer indicates the register to be used.)
.314 Special sub-sequence counters: . . . . none.
.315 Sequence control step size: . . . . 1 character.
.316 Accessibility to routines:. . . . . yes; can be loaded and stored by instruction.
.317 Permanent or optional modifier: . . . . no.

.32 Look-Ahead: . . . . none.

.33 Interruption

.331 Possible causes —
In-out units: . . . . . . end of operation, including availability of all error indications.
Storage access: . . . . violation of Storage Protection, either by alteration of contents or by reference to contents.
Processor errors: . . cannot initiate interrupts.
Others:. . . . . none.

.332 Control by routine: . . . each peripheral interrupt can be set or reset individually by the program. All interrupts are inhibited during the operation of an interrupt routine.
.333 Operator control: . . . . none.
.334 Interruption conditions: Interrupt requested. Interrupt not inhibited. Interrupt routine not in operation.
.335 Interruption process —
Registers saved: . . . The active sequencing register is stored. The next instruction is taken from the address given in the interrupt register. The interrupt routine operates and, when completed, causes the original sequence register to be restored.
Destination:. . . . . . . 2 different locations, depending on whether interrupt is external or internal.
.336 Control methods —
Determine cause: . . . test indicators for explicit cause.
Enable interruption: . by instruction.

.34 Multiprogramming

.341 Method of control: . . . executive program; see Section 510:192.
.342 Maximum number of programs:. . . . . one main program and one or more peripheral-limited programs.
.343 Precedence rules: . . . determined by executive program.
.344 Program protection —
Storage: . . . . storage area on one side of movable, logical boundary must not be read, written or tested by a program stored on the other side of the boundary.
In-out units: . . . . . . no protection.

.35 Multisequencing: . . . . none.

.4 PROCESSOR SPEEDS

All execution times listed here are based on use of the 4-character addressing mode; most instructions require 1.0 microsecond less time in the 2-character and 3-character processing modes.

D = operand length in decimal digits.

C = operand length in alphanumeric characters.

(Contd.)

.41 Instruction Times in Microseconds

.411 Fixed point:
- Add-subtract —
  - Decimal: 5.6 to 0.96D
  - Binary: 5.6 to 0.96C
- Multiply: $7.9 + 2.5D + 2.5D^2$; where multiplier and multiplicand are both D digits in length.
- Divide: $14.9 + 11.8D + 6D^2$; where the dividend is twice the length of the divisor. (D = no. of digits in divisor.)

.412 Floating point —
- Add-subtract: 16.0
- Multiply: 23.0
- Divide: 26.0

.413 Additional allowance for —
- Indexing: 0.75 per modified address.
- Indirect addressing: 0.75 per stage.
- Re-complementing: 0.75D

.414 Control —
- Compare: 5.6 + 0.47D
- Branch: 5.6

.415 Counter control: none.

.416 Edit: 6.4 + 1.7C + 1.1(N + Nn). N = no. of characters scanned during zero suppression; Nn = no. scanned for floating dollar sign insertion.

.417 Convert (with Scientific Unit) —
- Decimal to Binary: 15.75
- Binary to Decimal: 14.75

.418 Shift: 5.6 + 0.13N (binary mantissa shift using Scientific Unit, where N = no. of bits shifted).

.423 Branch based on comparison —
- Numeric data: 52.5 + .47D
- Alphabetic data: 52.5 + .47C

.424 Switching —
- Unchecked: 30.0
- Checked: 30.0

.425 Format control, per character —
- Unpack: 1.2
- Compose: 2.1

.426 Table Look-up, per comparison —
- For a match: 0.8C
- For least or greatest: 0.8C
- For interpolation point: 0.8C

.427 Bit indicators —
- Set bit in separate location: 5.6
- Set bit in pattern: 6.4
- Test bit in separate location: 6.4
- Test bit in pattern: 6.4

.428 Moving: 5.6 + 0.38C

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator.
Zero divisor:	overflow check	set indicator.
Invalid data:	validity check	interrupt or stop.*
Invalid operation:	check	interrupt or stop.*
Arithmetic error:	none.	
Invalid address:	limit check	interrupt or stop.*
Receipt of data:	parity check	interrupt or stop.*
Dispatch of data:	send parity bit.	
Reference to protected area:	check	interrupt.

*Specific action is determined by status of program protect bits.

.42 Processor Performance in Microseconds

	Fixed point	Floating point
.421 For random addresses:		
c = a + b —		
Decimal:	11.3 + 0.96D	—
Binary:	11.3 + 0.96C	31.0
b = a + b —		
Decimal:	5.6 + 0.96D	—
Binary:	5.6 + 0.96C	31.0
Sum N items —		
Decimal:	(5.6 + 0.96D)N	—
Binary:	(5.6 + 0.96C)N	16.0
c = ab:	$13.5 + 3.25D + 2.5D^2$	43.5
c = a/b:	$20.5 + 12.55D + 6D^2$	45.8
.422 For arrays of data —		
$c_i = a_i + b_j$:	46.9 + 1.97D	67.6
$b_j = a_i + b_j$:	39.7 + 1.59D	67.6
Sum N items:	23.9 + 1.59D	35.3
$c = a + a_ib_j$:	$51.7 + 4.66D + 2.5D^2$	83.5

SIMULTANEOUS OPERATIONS

Input-output operations in the Honeywell 4200 computer system are initiated by the executive program and subsequently supervised by the Control Memory. A fully-expanded Honeywell 4200 system can handle between 8 and 16 input-output operations simultaneously with computing, and can be connected to between 32 and 48 different peripheral units or peripheral controllers. Table I shows the start time, data transmission time, and stop time for most of the Series 200 peripheral operations, along with their demands upon the central processor (CP) and the selected channel.

TABLE I: SIMULTANEOUS OPERATIONS

OPERATION	Cycle Time, msec.	Start Time: Time, msec.	Start Time: CP Use	Start Time: Channel Use	Data Transmission: Time, msec.	Data Transmission: CP Use	Data Transmission: Channel Use	Stop Time: Time, msec.	Stop Time: CP Use	Stop Time: Channel Use
214 Card Reader	150	20.0	0	Yes	55.0	<0.1%	Yes	75.0	0	No
214 Card Punch	150-600	7.5	0	Yes	6.25n	<0.1%	Yes	92.5	0	No
223 Card Reader	75	13.0	0	Yes	46	<0.1%	Yes	16	0	No
224-1 Card Punch	335-1210	6.2	0	Yes	12.5n	<0.1%	Yes	210	0	No
224-2 Card Punch	223-660	3.0	0	Yes	6.25n	<0.1%	Yes	160	0	No
227 Card Reader	75	21 to 46	0	Yes	44	0.9%	Yes	10	0	No
227 Card Punch	240	42 to 102	0	Yes	176	<0.1%	Yes	22	0	No
222-1, 2, 3 Printer (51-character set)	92 + 5LS	0	-	-	75	1.7%	Yes	17 + 5LS	0	No
222-4 Printer (46-character set)	63 + 5LS	0	-	-	46	2.4%	Yes	17 + 5LS	0	No
222-5 Printer (63-character set)	133 + 5LS	0	-	-	116	1.3%	Yes	17 + 5LS	0	No
209 Paper Tape Reader	2.0	?	0	Yes	Var.	<0.1%	Yes	?	0	No
210 Paper Tape Punch	8.3	?	0	Yes	Var.	<0.1%	Yes	?	0	No
204A-1 Magnetic Tape, 32KC	-	11.0[a]	0	Yes	Var.	0.7%	Yes	0[a]	-	-
204A-2 Magnetic Tape, 64KC	-	5.5[a]	0	Yes	Var.	1.3%	Yes	0[a]	-	-
204A-3 Magnetic Tape, 89KC	-	5.5[a]	0	Yes	Var.	1.8%	Yes	0[a]	-	-
204B-1, -2 Magnetic Tape, 20KC	-	12.5[a]	0	Yes	Var.	0.4%	Yes	0[a]	-	-
204B-3, -4 Magnetic Tape, 44KC	-	7.5[a]	0	Yes	Var.	0.9%	Yes	0[a]	-	-
204B-5 Magnetic Tape, 67KC	-	5.8[a]	0	Yes	Var.	1.6%	Yes	0[a]	-	-
204B-9 Magnetic Tape, 96KC	-	5.8	0	Yes	Var.	1.9%	Yes	0[a]	-	-
204B-7 Magnetic Tape, 29KC	-	20.8	0	Yes	Var.	0.6%	Yes	0[a]	-	-
204B-8 Magnetic Tape, 64KC	-	7.5[a]	0	Yes	Var.	1.5%	Yes	0[a]	-	-
204B-11, -12 Magnetic Tape, 13KC	-	18.7[a]	0	Yes	Var.	0.3%	Yes	0[a]	-	-
270 Random Access Drum	-	25.0	0	Yes	Var.	2.1%	Yes	0	-	-
251 Mass Memory	16.7	95 av.	0	Yes	Var.	2.0%	Yes	-	0	No
252 Mass Memory	16.7	150 av.	0	Yes	Var.	2.0%	Yes	-	0	No
253 Mass Memory	16.7	225 av.	0	Yes	Var.	2.0%	Yes	-	0	No

a — Cross-gap time for short gap (replaces start and stop times).
LS — Number of lines skipped between successive printed lines.
n — Number of characters punched.
Var. — Data transmission time varies with record length.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (516:201.100)

These problems involve updating a master file from information in a detail file and producing a printed record of each transaction. This application is one of the most common commercial data processing jobs and is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of three different record sizes in the master file. Standard Problem D increases the amount of computation performed upon each transaction. Each problem is estimated for activity factors (ratios of number of detail records to number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

Because multiprogramming is a featured capability of the Honeywell 4200, the central processor time requirements are shown on all of the graphs in addition to the usual curves of elapsed time (i.e., total processing time). The difference between the curves of elapsed time and central processor time represents the amount of central processor time that is potentially available for concurrent processing of other programs.

An analysis of the resulting graphs shows that in Standard Configurations III, VI, and VIIA, the central processor is available to process other programs during more than 95% of the total time required to handle the Standard File Problems. In Configuration IV, central processor availability averages about 95% of the total processing time. In Configuration VIIB, central processor availability averages about 75% or 85%, depending upon whether the detail and report files are blocked or unblocked, respectively. In Configuration VIIIB, central processor availability is about 60% or 80%, depending upon whether the detail and report files are blocked or unblocked.

In order to show its true potential for business data processing in a variety of equipment configurations and operational modes, the Honeywell 4200's performance on the Standard File Problems has been analyzed for two different cases, as described in the following paragraphs:

(1) Conventional processing with on-line card reading and printing.

(2) Tape-to-tape processing with off-line card-to-tape and tape-to-printer data transcriptions.

Another way of processing that may become standard in Honeywell 4200 systems is to combine these two approaches and run the data transcription operations as separate entities, independent of the main processing run but on the same computer. Times required in this mode of operation, using on-line data transcription routines which are run concurrently with some other main program, can be estimated by using the times shown for Configurations III, IV, VI, and VIIA as the elapsed times required for the data transcription runs, and the times shown for the tape-to-tape operations, Configurations VIIB and VIIIB, as the times used by the central processor and by the tape drives during the main processing run.

Conventional Processing (Configurations III, IV, VI, and VIIA)

In Configurations III, IV, VI and VIIA, the master files are on magnetic tape. The detail file is assigned to the on-line card reader and the report file to the on-line printer. For Standard File Problems A, B, C, and D, the printer is the controlling factor at high, moderate, and low activities. One master-file tape controls at activities near zero.

Tape-to-Tape Processing (Configurations VIIB and VIIIB)

In tape-oriented Configurations VIIB and VIIIB, all four files are on magnetic tape. Data transcriptions from cards to tape and from tape to printer are performed off-line on a satellite system in these configurations, and timings for the data transcription operations are therefore not shown.

For Configuration VIIB with blocked or unblocked detail and report files, one master-file tape and the report-file tape are the controlling factors at all activities in Problems A, B, C, and D. For Configuration VIIIB, with all four files blocked, the report-file tape controls at high activities and one master-file tape controls at moderate and low activities in Problems A and B. In Problem C, one master-file tape controls at all activities. In Problem D, where computation is trebled, the central processor controls at high activities, and one master-file tape controls at moderate and low activities.

In Problems A, B, and D, for Configuration VIIIB with unblocked detail and report files, the report-file tape controls at high and moderate activities. In Problem C, one master-file tape controls at moderate activities. At lower activities, one master-file tape is the controlling factor.

SORTING (516:201.200)

The standard estimate for sorting 80-character records on magnetic tape (graph 516:201.200) was developed from the time calculated for Standard File Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide.

MATRIX INVERSION (516:201.300)

In matrix inversion, the object is to measure central processor speed on the straightforward inversion of a non-symmetric, non-singular matrix. No input-output operations are involved. The standard estimate is based on the time required to perform cumulative multiplication ($c=c + a_i b_j$) in 8-digit-precision floating point, as explained in Paragraph 4:200.3 of the Users' Guide. The precision of floating-point operations is equivalent to approximately 11 digits in the Honeywell Series 200.

GENERALIZED MATHEMATICAL PROCESSING (516:201.400)

This problem measures overall system performance on a simple mathematical application that involves widely varying ratios of input-to-computation-to-output volumes, as described in Section 4:200.4 of the Users' Guide.

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)

	ITEM		CONFIGURATION														REFERENCE
			III & VI		IV		VIIA		VIIB (Blocked Files 3 & 4)		VIIB (Unblocked Files 3 & 4)		VIIIB (Blocked Files 3 & 4)		VIIIB (Unblocked Files 3 & 4)		
1 Input-Output Times	Char/block	(File 1)	1,080		1,080		1,080		1,080		1,080		1,080		1,080		4:200.112
	Records/block	K (File 1)	10		10		10		10		10		10		10		
	msec/block	File 1 = File 2	58.5		22.0		22.0		23.5		23.5		17.0		17.0		
		File 3	75		75		75		20.0		8.8		16.0*		6.2		
		File 4	129		94		129		25.0		9.3		22.9*		6.8		
	msec/switch	File 1 = File 2	0		0		0		0		0		0		0		
		File 3	0		0		0		0		0		0		0		
		File 4	0		0		0		0		0		0		0		
	msec penalty	File 1 = File 2	0.20		0.20		0.20		0.20		0.20		0.20		0.20		
		File 3	0.15		0.15		0.15		0.15*		0.02		0.15*		0.02		
		File 4	1.05		1.05		1.05		0.23*		0.02		0.23*		0.02		
2 Central Processor Times	msec/block	a_1	0.09		0.09		0.09		0.09		0.09		0.09		0.09		4:200.1132
	msec/record	a_2	0.23		0.23		0.23		0.23		0.23		0.23		0.23		
	msec/detail	b_6	0.04		0.04		0.04		0.04		0.04		0.04		0.04		
	msec/work	$b_5 + b_9$	0.47		0.47		0.47		0.47		0.47		0.47		0.47		
	msec/report	$b_7 + b_8$	0.25		0.25		0.25		0.25		0.25		0.25		0.25		
3 Standard File Problem A F = 1.0	msec/block for C.P. and dominant I/O column.		C.P.	I/O	C.P.	I/O	C.P.	I/O	C.P.	I/O	C.P.	I/O	C.P.	I/O	C.P.	I/O	4:200.114
		a_1	0.09		0.09		0.09		0.09		0.09		0.09		0.09		
		a_2 K	2.28		2.28		2.28		2.28		2.28		2.28		2.28		
		a_3 K	7.66		7.66		7.66		7.66		7.66		7.66		7.66		
		File 1: Master In	0.20		0.20		0.20		0.20		0.20		0.20		0.20		
		File 2: Master Out	0.20		0.20		0.20		0.20	23.5	0.20	23.5	0.20		0.20		
		File 3: Details	0.15		0.15		0.15		0.15		0.15		0.15		0.15		
		File 4: Reports	10.49	1,290	10.49	940	10.49	1,290	0.23	25.0	0.23	93.0	0.23	19.4	0.23	64	
		Total	28.54	1,290	28.54	940	28.54	1,290	11.01	48.5	11.01	116.5	11.01	19.4	11.01	64	
4 Standard File Problem A Space	Unit of measure	(characters)															4:200.1151
		Std. routines	4,300		4,300		4,300		4,300		4,300		4,300		4,300		
		Fixed	0		0		0		0		0		0		0		
		3 (Blocks 1 to 23)	612		612		612		612		612		612		612		
		6 (Blocks 24 to 48)	2,334		2,334		2,334		2,334		2,334		2,334		2,334		
		Files	4,720		4,720		4,720		8,320		4,720		8,320		4,720		
		Working	108		108		108		108		108		108		108		
		Total	12,149		12,149		12,149		15,749		12,149		15,749		12,149		

* Records blocked 10 records/block.

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

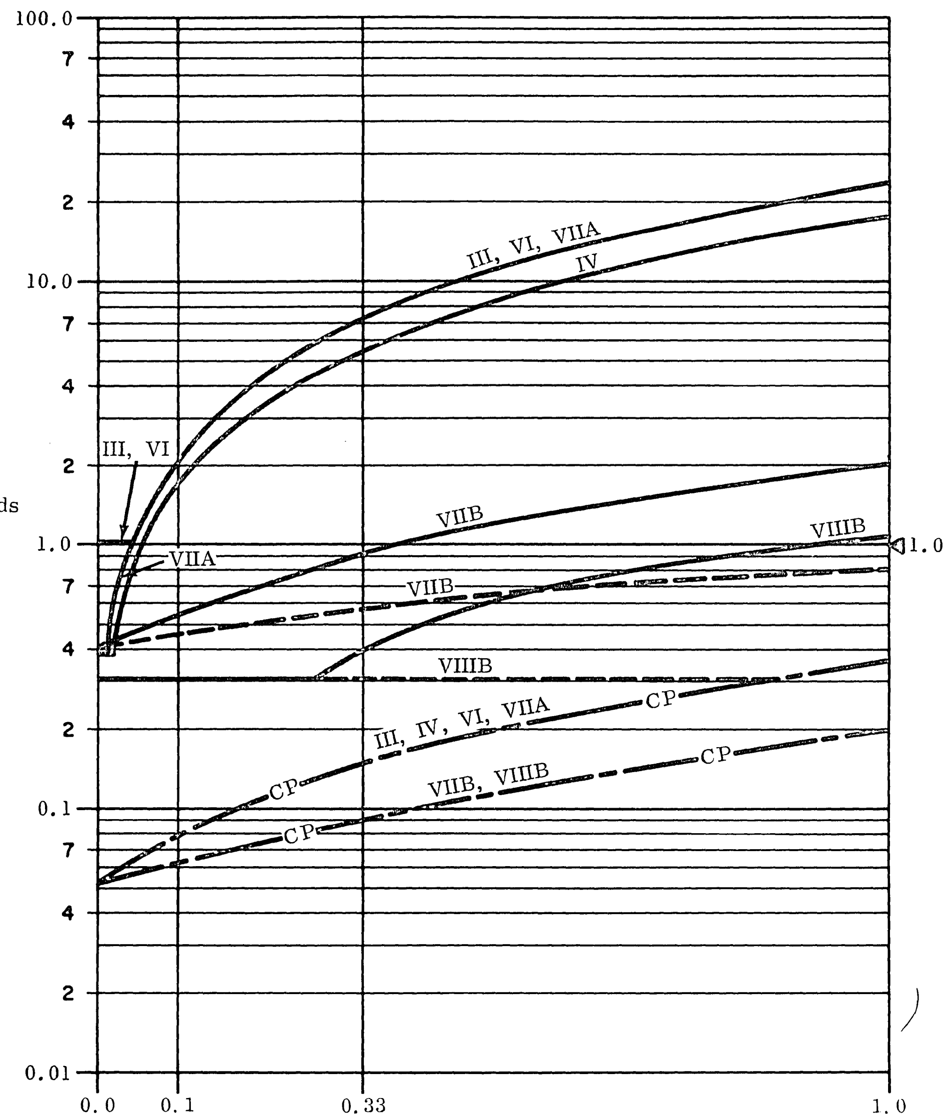
.111 Record sizes —
- Master file: . . . . . . 108 characters.
- Detail file: . . . . . . 1 card.
- Report file: . . . . . . 1 line.

.112 Computation: . . . . . . standard.

.113 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage space required —
- Configurations III, IV, VI, VIIA: . . . . 12,149 characters.
- Configurations VIIB & VIIIB (blocked files 3 & 4): . . . . . 15,749 characters.
- Configurations VIIB & VIIIB (unblocked files 3 & 4): . . . . . 12,149 characters.



(Roman numerals denote standard System Configurations.)

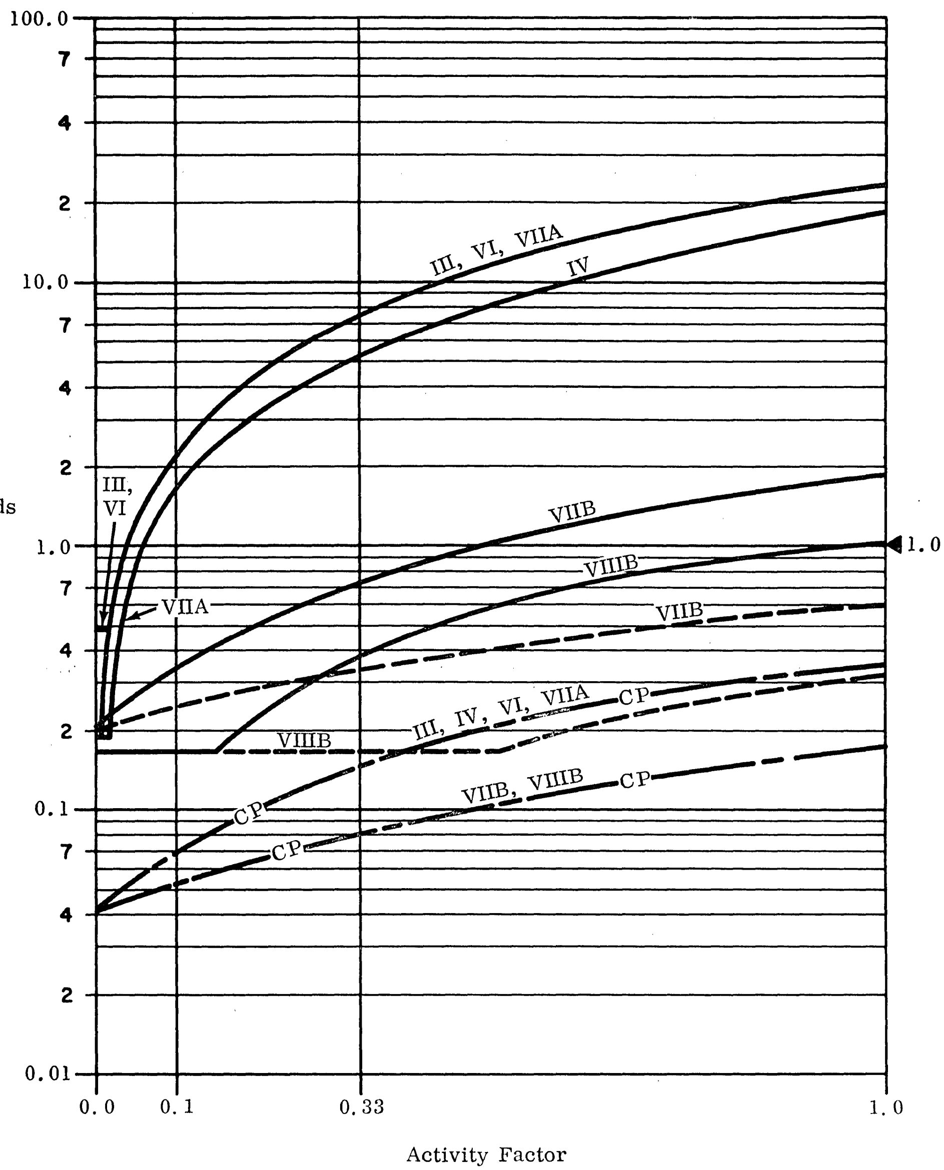
LEGEND

- Elapsed Time, Unblocked Files 3 & 4.
- Elapsed Time, Blocked Files 3 & 4.
- CP Central Processor Time.

.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . . 54 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.122 Computation: . . . . . . standard.
.123 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

LEGEND

solid line	Elapsed Time, Unblocked Files 3 & 4.
dashed line	Elapsed Time, Blocked Files 3 & 4.
—— CP ——	Central Processor Time.

(Contd.)

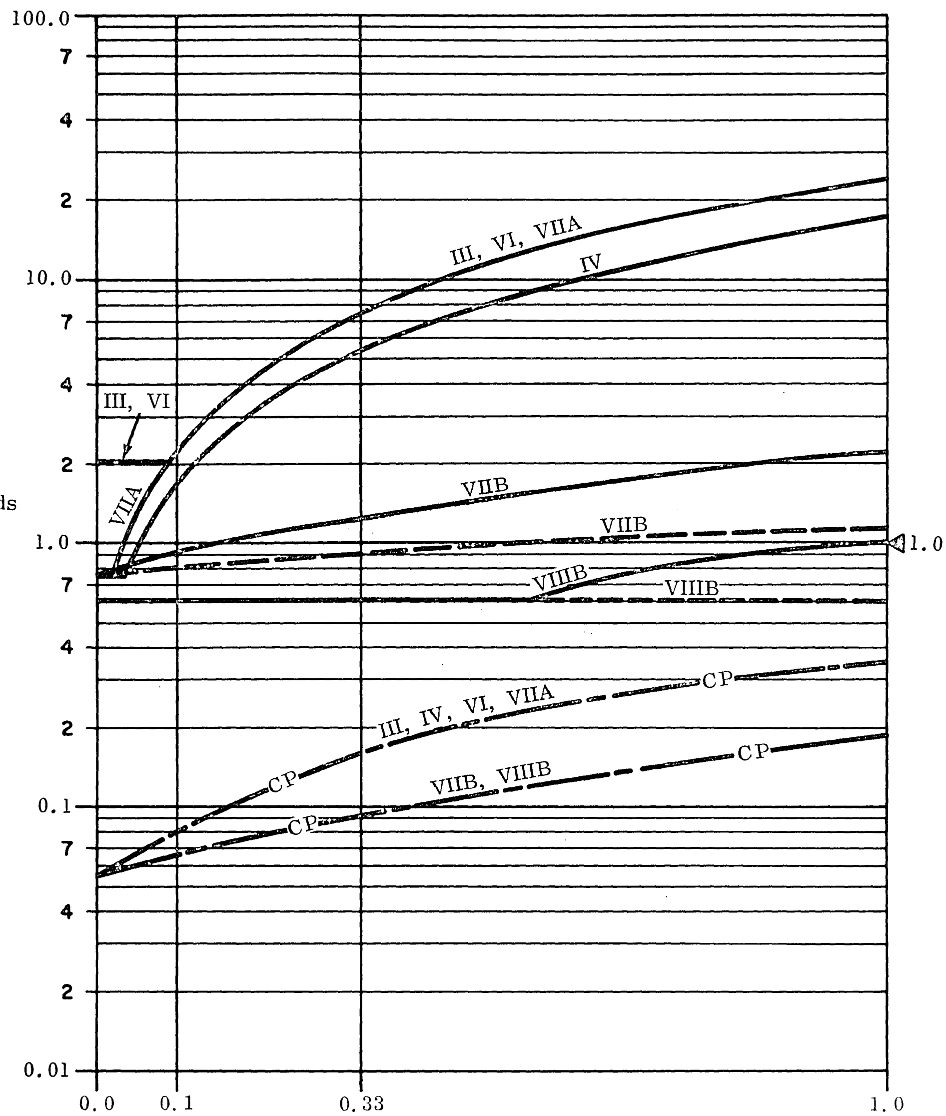
.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . . 216 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.132 Computation: . . . . . . standard.

.133 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

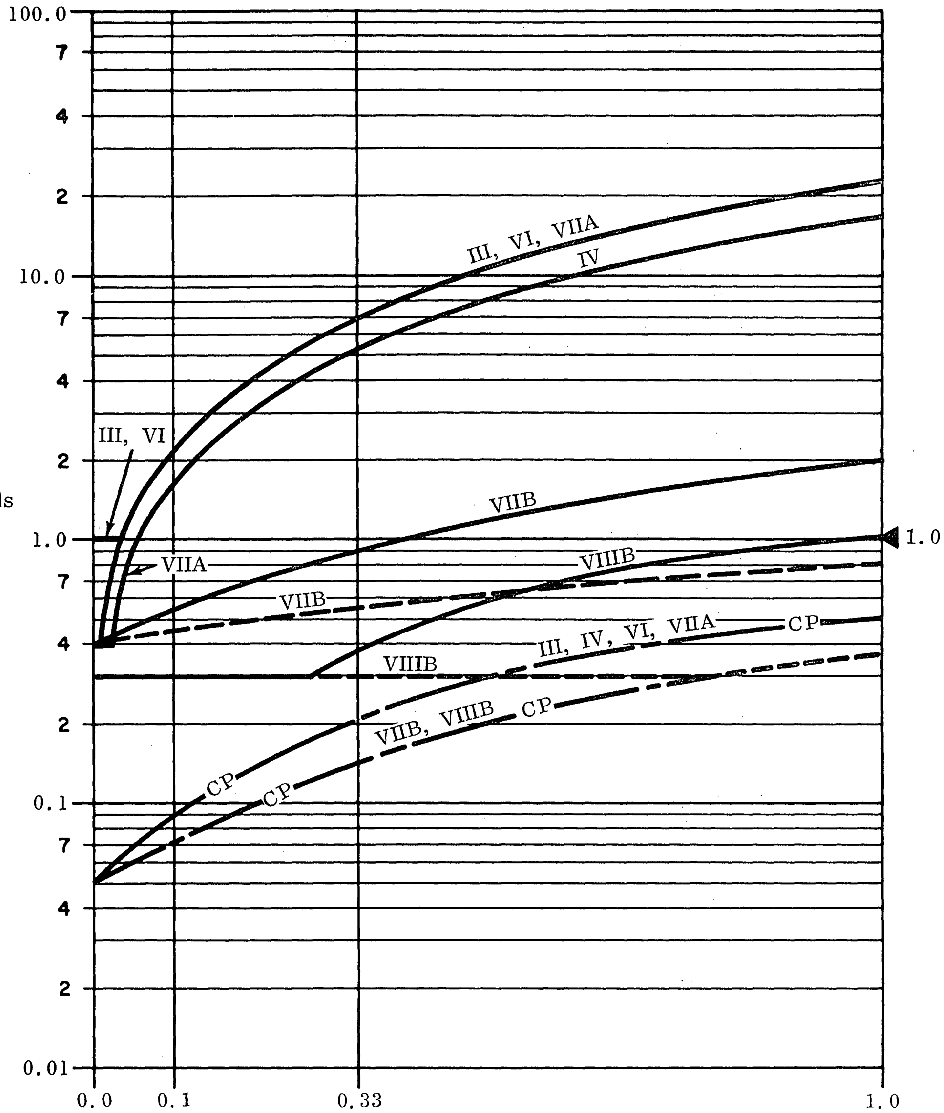
LEGEND

Elapsed Time, Unblocked Files 3 & 4.
Elapsed Time, Blocked Files 3 & 4.
CP Central Processor Time.

.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . . . 108 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.142 Computation: . . . . . . trebled.
.143 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . see graph below.



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

LEGEND

Elapsed Time, Unblocked Files 3 & 4.
Elapsed Time, Blocked Files 3 & 4.
CP Central Processor Time.

(Contd.)

.2 SORTING

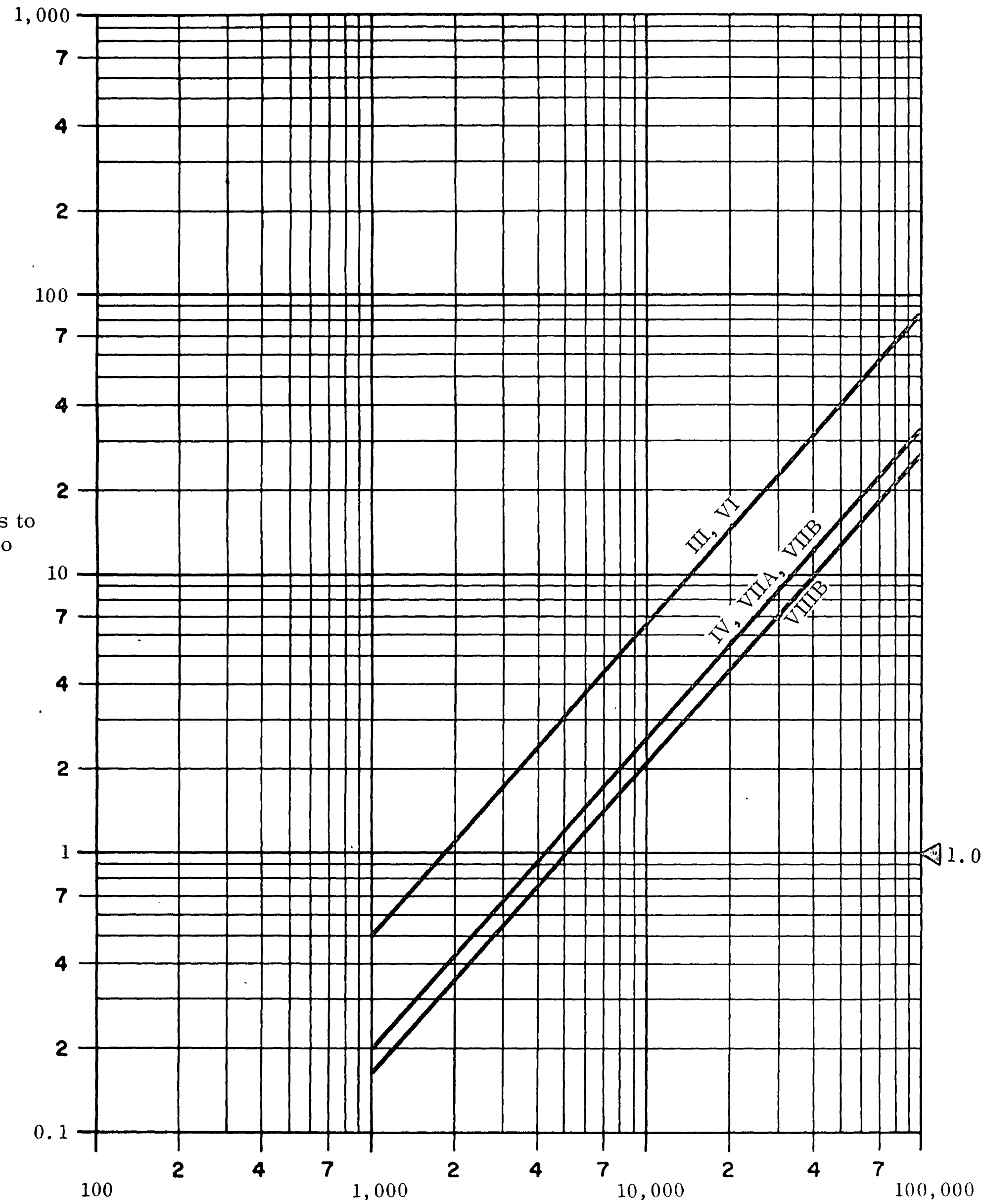
.21 Standard Problem Estimates

.211 Record size: . . . . . . .80 characters.

.212 Key size: . . . . 8 characters.

.213 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . see graph below.



Number of Records

(Roman numerals denote standard System Configurations.)

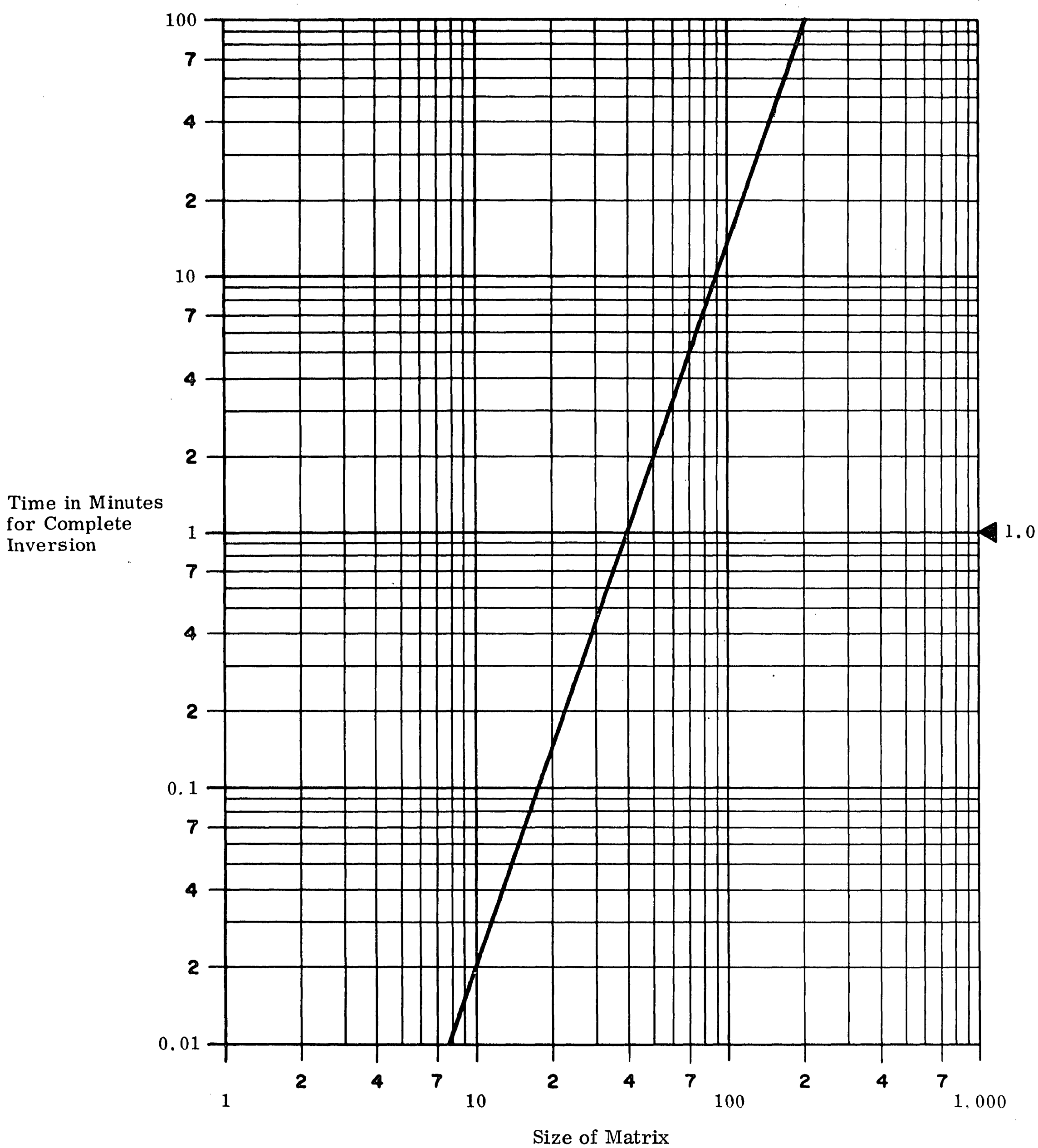
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . see graph below.



(For all configurations equipped with the Scientific Option)

(Contd.)

.4 GENERALIZED MATHEMATICAL PROCESSING

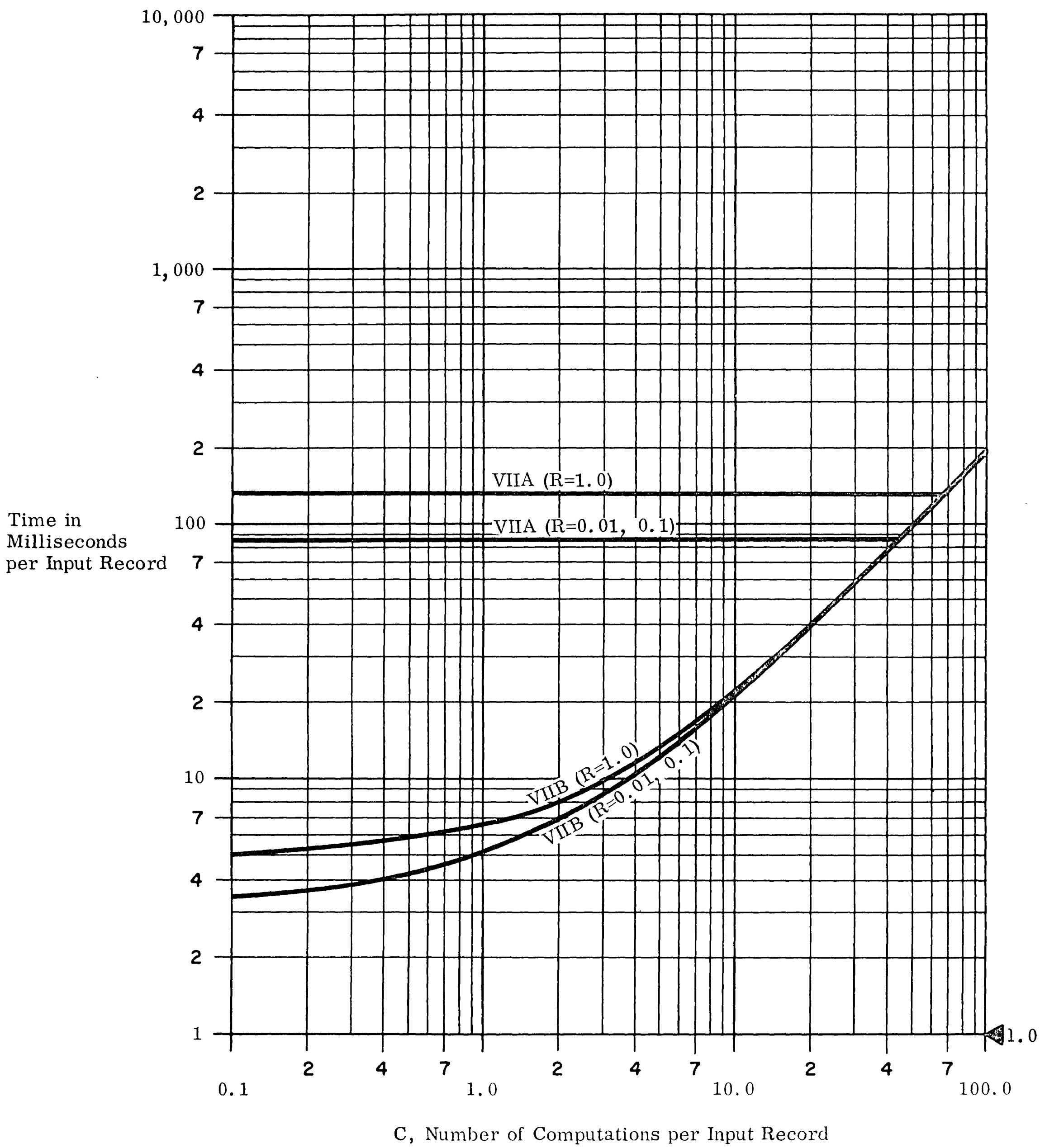
.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . 10 signed numbers. avg. size 5 digits; max. size 8 digits.

.412 Computation: . . . . 5 fifth-order polynomials, 5 divisions, 1 square root; 11-digit precision floating-point mode.

.413 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



HONEYWELL 8200

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STANDARD

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INTRODUCTION

The Honeywell Model 8200 system, announced in June 1965, is in the unique position of forming the top of the product line for two current Honeywell computer families: the character-oriented Series 200 system and the 48-bit word-oriented Honeywell 800 and 1800 systems. This unusual situation results from the hybrid design of the Model 8200 processing unit which contains a character-oriented processor (closely resembling a Series 200 Model 4200 processor in speed and performance) and a word-oriented processor (based on the logical design of the Honeywell 800/1800 systems but with significant improvements in speed and performance).

The Honeywell Model 8200 offers users of the earlier H 800/1800 systems a more powerful, fully compatible processing system at virtually the same cost as their present systems. Typical Model 8200 systems will rent at prices between \$30,000 and \$50,000 per month. The 8200 word processor can perform up to 400,000 three-address instructions per second — almost four times the instruction speed of an H 1800 processor. Also, the main core memory cycle time of the 8200 is 750-nanoseconds per 8-character word, as compared to the core storage cycle time of 2 microseconds per word in the 1800. (The H 800 system is approximately three times slower than the H 1800.) In addition, the Model 8200 provides twice the main memory storage capacity of the H 1800: 1,048,576 characters versus 524,288 characters, respectively; and up to four 8200 memory modules can be accessed simultaneously, as compared to the lack of simultaneous memory access capability in the H 1800.

Multiprogramming, or the ability to execute more than one main program concurrently in a single processor, has been for some time an outstanding feature of the Honeywell 1800 systems: up to eight programs can be executed concurrently with no overhead delays incurred by program switching. The Model 8200 processing unit provides the same multiprogramming capabilities as the H 1800, plus many more. The 8200 includes a ninth group of processor control registers that is completely dedicated to usage by an overall system control program, permitting the remaining eight independent groups of processor control registers to be used exclusively by concurrently running user programs.

The standard method of multiprogrammed processing in the 8200 word processor consists of hardware assignment of single instruction execution opportunities to each active program in a consecutive, cyclic manner. When the execution of an instruction is initiated by a program, control remains with that program until the instruction is completed. An instruction overlap feature enables the word processor to fetch the next instruction in the multiprogramming sequence while the current instruction is being executed.

The Model 8200 processing unit also provides true multiprocessing capability with the inclusion of the character-oriented, variable-length-field (VLF) processor — in addition to the word-oriented processor. Program execution in the character processor can proceed independently of the multiprogrammed operations occurring simultaneously in the word processor. In fact, the character processor can itself function in a multiprogramming mode, permitting the concurrent execution of up to two main programs. Both processors share a common main memory and common Honeywell Series 200 peripheral devices.

Multiprogramming and multiprocessing operations in a Model 8200 system can take advantage of an extensive interrupt control system and a comprehensive memory protection scheme that features hardware-controlled protection of individual 512-word blocks of main core storage. Inter-processor communication is facilitated through use of specialized instructions in the word processor and a set of privileged instructions reserved for the system's master control facility.

Effective usage of the potential multiprogramming power of a Model 8200 system is made feasible by provision of a high-capacity, expandable input-output system. An independently operating Input-Output Controller permits up to 34 I/O data transfer operations to be performed concurrently with computing in the word and character processors. The I/O Controller also permits connection of up to 96 peripheral device control units, serviced by up to 48 "floating" input-output channels. The maximum aggregate data transfer rate that can be accommodated by the input-output system is 2,833,333 characters per second.

Current users of Honeywell Series 200 Model 4200 equipment will probably find that replacement of their 4200 system with a Model 8200 system, for the purpose of expanding their current processing capabilities, is an undesirable step. A typical Model 8200 system is substantially more expensive (approximately \$10,000 more per month for processing unit and required mass storage device) than a typical Model 4200 system. Much of the additional expense is due to the fact that the Model 8200 contains two processors — a word-oriented processor and a Series 200 character-oriented processor that provides virtually the same performance as the standard Model 4200 processor. In addition, an upward move to a Model 8200 system from a Model 4200 system could require a complete re-orientation and re-education of personnel in order to take advantage of what would be a new world of word-oriented processing. This extensive re-orientation probably would not be necessary if the installation writes the great majority of its programs in high-level programming languages.

Thus the Honeywell Model 8200 system represents an attractive upward move for users of Honeywell 800 and 1800 systems, but a somewhat questionable move for users of Series 200 systems who desire to upgrade their systems quantitatively, rather than qualitatively.

The competitive position of the Honeywell 8200 system with respect to the offerings from the other major computer manufacturers can be indicated by determining the relationship between the 8200 and the IBM System/360. The pricing of the Model 8200 is similar to that of the IBM System/360 Model 65: monthly rental prices typically range between $30,000 and $50,000. In addition, the core storage cycle times of these two systems are roughly equivalent, and the binary arithmetic instruction execution times of the 8200 word processor and the System/360 Model 65 are also very similar. However, the word processor of the Model 8200 can perform typical decimal arithmetic tasks, such as $c = a+b$, $c = a/b$, from three to five times faster than the Model 65 processing unit, aided largely by the 8200's three-address instructions and add-to-storage logic. As a result, when executing programs that contain an instruction mix that is oriented to processing commercial, decimal information, a Model 8200 processing unit will probably outperform an IBM System/360 Model 65 processing unit.

This competitive position of the Honeywell Model 8200 system is also made possible by the availability of the wide range of Honeywell Series 200 peripheral devices — a range that, in general, offers devices that are directly comparable to those offered with the IBM System/360 Model 65.

Software support for the Honeywell Model 8200 will consist of a variety of language processors and service programs designed to function under control of a system of integrated supervisory programs. The complete mass memory-resident software system is called the Operating System — Mod 8, and requires permanent use of about 65,536 characters of core storage and an additional 15 million characters of random-access storage. The Operating System — Mod 8 provides virtually uninterrupted operation of the Model 8200 system; little operator intervention will be required. Automatic and dynamic program scheduling is also provided, designed to utilize as much as possible of the available hardware configuration at all times. The concurrent execution of multiple user programs is also controlled automatically.

All software programs provided with the earlier Honeywell 800 and 1800 systems can function without modification in the Model 8200 word processor, and all Series 200 Model 4200 programs can function without modification in the Model 8200 character processor. Because of this high degree of compatibility with current Honeywell computer systems, the Model 8200 will have a large body of time-proven software available for use with its initial systems.

Operating System — Mod 8 will include an ASA FORTRAN IV compiler, an ASA COBOL compiler, and a large-scale assembler. All Model 8200 programs, including compilers, will initially operate in a batched job processing mode, although these jobs can be batched from remote locations. Conversational, time-sharing software will be provided some time after initial deliveries of the hardware.

The Honeywell Model 8200 system — complete with software — is scheduled for delivery in January 1968.

SYSTEM CONFIGURATION

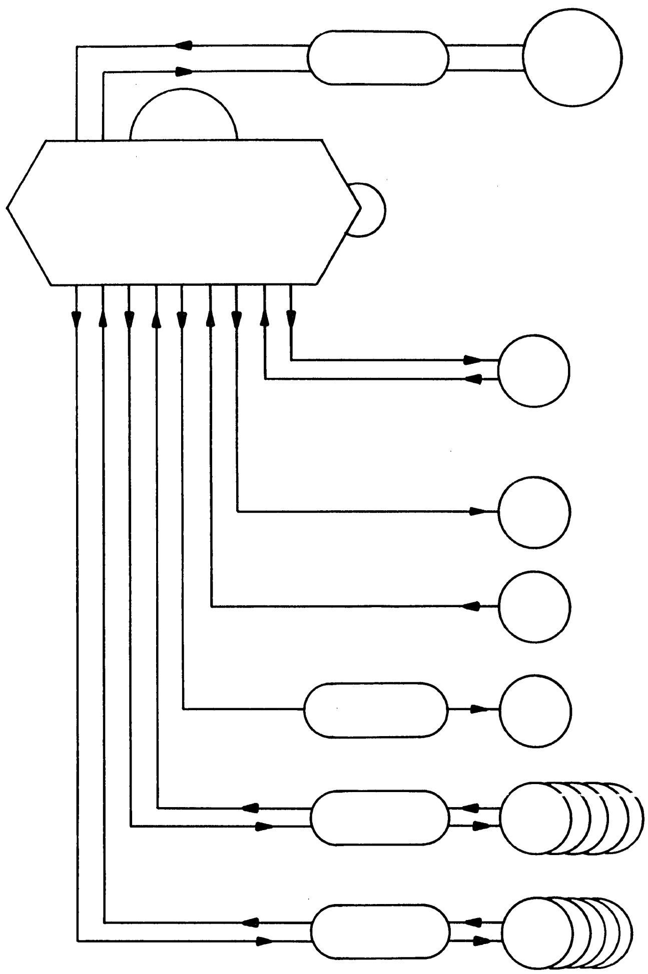
The Input-Output Controller of the Honeywell 8200 processing unit contains either 16 or 32 input-output channels. Read/write channels associated with the controller are capable of variable assignments under program control.

All peripheral devices associated with the Series 200, and selected devices used with the Honeywell 800/1800 systems, can be connected to an 8200 system. In the following system configurations, Honeywell's newer 1/2-inch magnetic tape units are used rather than the 3/4-inch units that are standard on the 800/1800 systems. Selection of the 1/2-inch units was made because the specialized software being developed for use with the Model 8200 system requires the use of 1/2-inch magnetic tape units.

Since the Model 8200 consists of a word and character processor within a single system, the use of a satellite computer system in conjunction with the 8200 can frequently be unnecessary. As a result, the two Standard Configurations shown in this section are both integrated systems. However, Honeywell notes that a Series 200 Model 120 system can effectively serve the 8200 as a remote terminal processor or as a local data communications controller or data adapter.

.1 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIA

Deviations from Standard Configuration: . . . . two processors are included in basic Processing Unit.
mass storage with a capacity of 15 million characters is required for the 8200's Mod 8 operating system.
card reader is 60% faster.
printer is 30% faster.
core storage is 170% larger.
84 additional index registers.



Equipment	Rental*
250 Mass Storage Control Unit	$ 335
251 Mass Memory File, 15 million characters	670
8201-1 Processor with 262, 144 characters of core storage; Input-Output Console (includes typewriter and direct control)	25, 580
222-3 Printer and Control (120 print positions): 650 lines/minute	925
223 Card Reader and Control: 800 lines/minute	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/minute	310
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 64, 000 char/second	3, 075
203B-4 Tape Control Unit	435
204B-8 Magnetic Tape Units (5): 63, 520 char/second	3, 075

Optional Features Included: . . . . Feature 8214 (permits buffered transfer of 4-character data blocks; also provides 16 additional read/write channels) 1, 525

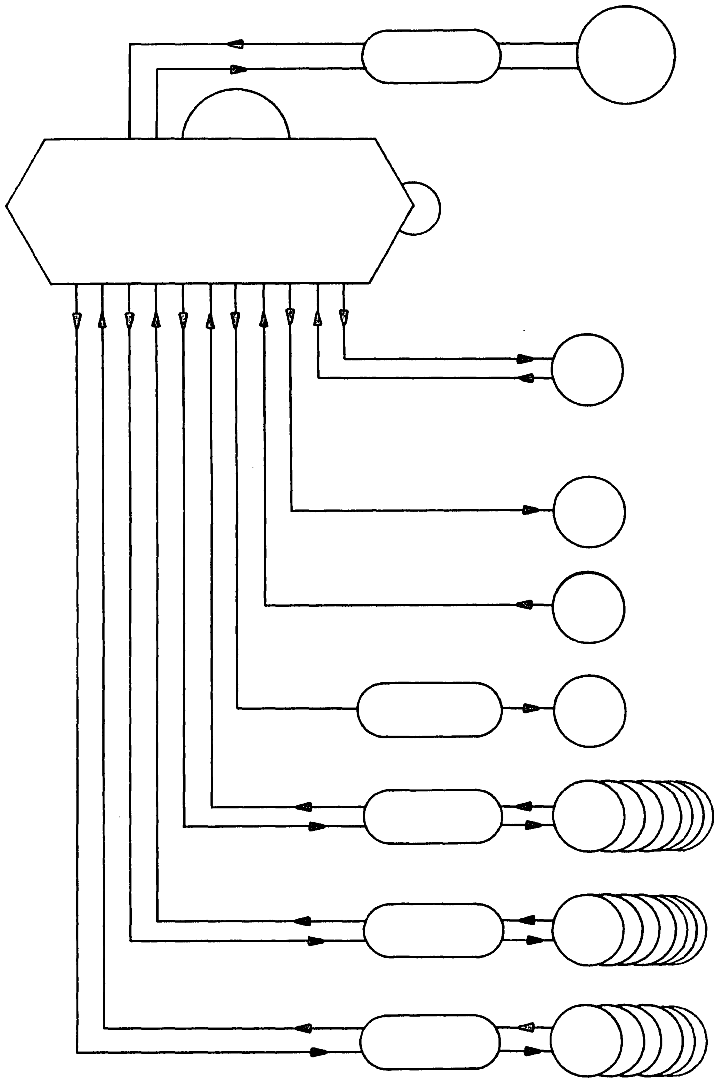
TOTAL $36, 830

* The rental prices quoted above represent monthly rental prices under a one-year monthly term agreement. The same configuration under a five-year agreement rents for $34, 405 per month.

(Contd.)

.2 20-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIIA

Deviations from Standard Configuration: . . . .
two processors are included in basic Processing Unit.
mass storage with a capacity of 15 million characters is required for the 8200's Mod 8 operating system.
core storage is 36% larger.
84 additional index registers.
magnetic tape is 20% slower.
card reader is 20% slower.



Equipment	Rental*
250 Mass Storage Control Unit	$ 335
251 Mass Memory File, 15 million character capacity	670
8201-1 Processor with 262,144 characters of core storage; Input-Output Console (includes typewriter and direct control)	25,580
222-4 Printer and Control (120 print positions): 950 lines/minute	1,305
223 Card Reader and Control: 800 lines/minute	310
208-1 Card Punch Control	155
214-1 Card Punch: 100 to 400 cards/minute	310
203B-6 Tape Control	435
204B-9 Magnetic Tape Units (7): 96,000 char/sec	5,740
203B-6 Tape Control Unit	435
204B-9 Magnetic Tape Units (7): 96,000 char/sec	5,740
203B-6 Tape Control Unit	435
204B-9 Magnetic Tape Units (6): 96,000 char/sec	4,920

Optional Features Included: . . . .

Scientific Unit (floating-point arithmetic)	760
Feature 8214 (permits buffered transfer of 4-character data blocks; also provides 16 additional read/write channels)	1,525
TOTAL	$48,655

* The rental prices quoted above represent monthly rental prices under a one-year monthly term agreement. The same configuration under a five-year agreement rents for $45,115 per month.

INTERNAL STORAGE: CORE STORAGE

.1 GENERAL

.11 Identity: . . . . Honeywell 8201 Core Storage.

.12 Basic Use: . . . . . . working storage.

.13 Description

The main memory of the Model 8200 is a core storage unit that consists of either two, four, or eight independent memory modules with a cycle time of 750 nanoseconds. Each memory module stores either 16,384 or 32,768 36-bit (4-character) "half-words." Combinations of these two module sizes make up the four models of 8200 core storage, ranging in size from 32,768 8-character words to 131,072 8-character words (262,144 to 1,048,576 characters). Up to four memory accesses to four different, independent memory modules can occur simultaneously.

A central memory controller unit routes memory access requests from four potential sources: the Input-Output Controller, the 8200 character-oriented processor, and the "left and right sides" of the 8200 word-oriented processor. The 8200 word processor simultaneously accesses two adjacent memory modules to obtain the left and right side of each addressed 72-bit word. If two or three sources request the same module simultaneously, the memory controller always grants access first to the I/O controller, and then, alternately, to either the character-or-word-oriented processor. This alternating scheme serves to avoid the possibility of one processor dominating the use of a single memory module. Note that the word-oriented processor never has a memory access conflict with itself, since each memory module will contain either all right-halves or all left-halves of stored words.

Consecutive memory addresses are interleaved accross all installed memory modules in the 8200 core storage unit. The central processor can thereby automatically access several memory modules concurrently to speed execution of most instructions. As an example, Figure 1 shows the amount of memory overlap possible with the 8200's word-oriented processor as contrasted with the non-overlapped memory operation of the earlier Honeywell 800 and 1800 processors.

Each word of stored data can consist of either one 48-bit word plus 8 check bits or eight characters with six data bits, two punctuation bits, and one parity bit per character.

A parity bit is provided for each 6-bit character during its recording in core storage. When the stored data is read out of memory, the parity of each character is checked and an error is signalled if improper parity is discovered.

Memory protection in the 8200 is provided for each block of 512 words of storage. Each block has an associated four-bit "Lock" register, and each active program element, whether in the character

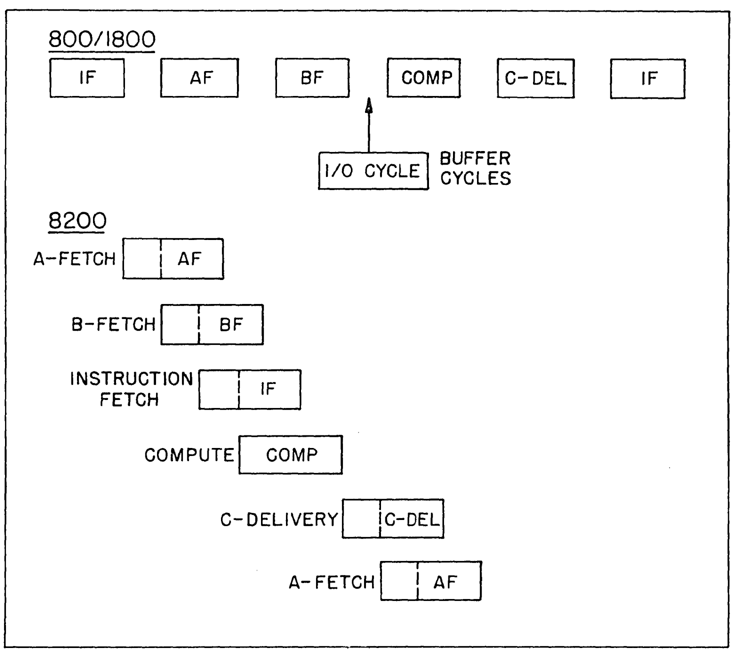


Figure 1. Honeywell 8200 Memory Overlap Compared to Non-Overlapped Operations of Honeywell 800 and 1800.

.13 Description (Contd.)

processor or in one of the eight control portions of the word processor, has a four-bit "Key" register. Every memory access, whether to extract an instruction, fetch an operand, deliver a result, or transfer input-output data, requires the use of a memory key. The memory controller compares the key to the lock of the addressed memory block. If a match occurs, the memory access is allowed; if a mismatch is detected, control is transferred to the master control program.

Memory locks can be set so that only active program elements that have matching keys can both read and write in the protected parts of memory. Locks can also be set to permit reading of core storage blocks by all active program elements—reserving the privilege of writing in core storage to active program elements with matching keys. Finally, locks can be set to allow both reading and writing in a common portion of memory by all active program elements.

.14 Availability: . . . . January 1968.

.16 Reserved Storage

Purpose	Address Range
Communication with—	
The word-oriented processor:	100 - 107
The master group:	110 - 113
The character-oriented processor:	114 - 117
The I/O Controller:	120 - 123

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.23 Storage Phenomenon: . . . . . . direction of magnetization.

.29 Potential Transfer Rates

.292 Peak data rates —
Cycling rates: . . . up to 1,333,000 cps. per module.
Unit of data: . . . . one-half-word of four 9-bit characters.
Gain factor: . . . . . 2 to 4 modules can be a accessed simultaneously.
Data rate: . . . . . 1,333,000 half-words per second per module.
Compound data rate: . . . . . 2,667,000 to 5,334,000 half-words per second.

.3 DATA CAPACITY

.31 Module and System Sizes: . . . see Table I.

.4 CONTROLLER: . . . . no separate controller; all required control facilities are included in processor and storage modules.

.5 ACCESS TIMING

.52 Simultaneous Operations: . . . . access to any four modules can take place independently of other modules.

.53 Access Time Parameters and Variations

.531 For uniform access (each module) —
Access time: . . . . 0.38 μsec.
Cycle time: . . . . 0.75 μsec.
For data unit of: . . . . one half-word (containing four characters).

.7 PERFORMANCE

.72 Transfer Load Size

With self: . . . . one 6-bit character to N 48-bit words; N is limited only by storage capacity.

.73 Effective Transfer Rate (With Self)

871,000 words/sec (average); 1,332,565 words/sec (max).
6,968,000 char/sec (average); 10,660,520 char/sec (max).

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	transfer to Master Group.
Receipt of data:	check	controlled by program.
Recording of data:	check	controlled by program.
Timing conflict:	check	resolved automatically by priority control.
Machine malfunction:	check	transfer to Master Group.
Barricade violations:	check	transfer to Master Group.

TABLE I: MODULE AND SYSTEM SIZES

	8201-1	8201-2	8201-3	8201-4
16 x 2^{10} half-word modules:	0/4	0	0	0
32 x 2^{10} half-word modules:	2/0	4	0	8
48 x 2^{10} half-word modules*:	0	0	4	0
Words:	32,768	65,536	98,304	131,072
Characters:	262,144	524,288	786,432	1,048,576
Packed digits:	393,216	786,432	1,179,648	1,572,864

*The 48 x 2^{10} half-word module is a combination of the two smaller module sizes.

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . Honeywell 8201 Central Processor.

.12 Description

The processing portion of the Honeywell 8200 computer system features both multiprogramming and multiprocessing operations. The 8200 is a multiprocessing system in that it features both a word-oriented and a character-oriented processor, each capable of independent and simultaneous operation. It is a multiprogramming system in that both the word and character processors can concurrently execute more than one program. The word processor is an improved but direct descendant of the earlier Honeywell 800 and 1800 processors, and, as such, features hardware facilities to permit execution of up to eight user programs concurrently. The character processor (or Variable Length Field processor) is compatible with the other processors of the Honeywell Series 200 and most closely resembles the Model 4200 processor. The character processor can concurrently execute up to two main programs. Both processors share a common core storage unit which can be accessed in either 48-bit words or 8-bit characters.

Coordinating the activities of the word processor, the character processor, and a shared Input-Output Controller is the function of a master control facility that uses the specialized "Master Group" of control registers. Program data and control information are passed between the several principal components of the Honeywell 8200 through the use of common buffer areas and interconnecting channels.

.121 Word Processor

The word processor is made up of eight groups of program control registers, plus a Master Group of control registers and a single Arithmetic Unit. Each program control group consists of 32 program control registers in a control memory unit that has a read/write cycle time of 125 nanoseconds. Figure 2 identifies each of the registers within a group. Each register in a group is 24 bits in length, 6 bits longer than the control registers provided in the earlier Honeywell 800 and 1800 processors. The additional register bits are used only by certain special instructions that have been added to the basic 8200 instruction set.

Multiprogramming control in the Model 8200 word processor is performed largely by hardware alone. A Sequence Register Traffic Controller passes control cyclically — one instruction execution per program — to the nine programs (including the master control program) that potentially can be processed concurrently. Since each program has its own complete set of 32 control registers, including two sequence counters, no program control information need be stored when control passes between programs. Control remains with each program until its entire instruction is executed. This situation occurs because there is only one arithmetic unit in the word processor; partial results of arithmetic instructions could be lost if control were allowed to pass to instructions of another program.

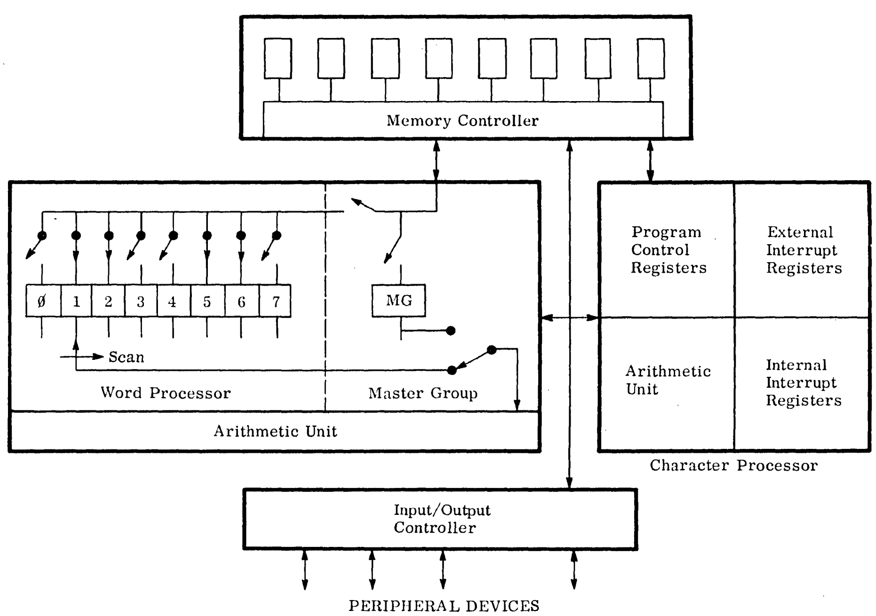


Figure 1. Logical Diagram of the Principal Components of the Honeywell Model 8200.

.121 Word Processor (Contd.)

The automatic sharing of processor cycles among programs can be inhibited by the master control facility in order to obtain exclusive use of all available memory cycles. Individual user programs can also obtain from the Monitor program dedicated, non-shared use of the word processor. By contrast, whenever active programs do not require immediate use of processor cycles — for example, during input-output operations performed by the independent I/O Controller — the Traffic Controller passes processor control to those programs that can utilize processor cycles and loses no cycles while skipping those nondemanding programs.

Thus, the Model 8200 word processor is a single processor with effective hardware facilities for executing up to eight core-resident user programs concurrently. Switching of control from program to program is accomplished by hardware without any overhead switching time.

The principal advantage of the multiprogramming hardware of the Model 8200 word processor is the fact that each active program has its own set of processor control registers. Program switching by the method of sharing processor cycles between resident programs has the same general problem as all other forms of multiprogramming control: its effectiveness is totally dependent upon the nature of the program mix. For example, the execution of eight compute-bound programs running concurrently in the Model 8200 word processor will consume essentially the same amount of time as running these same programs in the conventional sequential batch processing manner. However, when the Model 8200 word processor is executing a balanced mix of I/O and compute-bound programs, definite increases in throughput can be gained by processing in a multiprogramming mode rather than in a sequential mode.

Instruction Format

The basic instruction format of the 8200 word processor consists of four 12-bit fields: the operation code, A address, B address, and C address. The high-order bit of each address field contains an addressing mode indicator. The remaining 11 address bits can designate one of the 2,048 word locations in a bank of memory. (There are eight banks per memory module and a maximum of eight memory modules per system.) These 11 bits are appended to the specific bank selector bits contained in the sequence counter register that accessed the instruction. The resultant 23-bit address field represents a direct memory address to potentially 8,388,608 words of core storage. The current maximum size of Model 8200 core storage is 131,072 words (see Section 518:041). Thus, the method of direct addressing will facilitate later expansion of the 8200 main core storage unit, and it also provides the potential capability to address directly a massive auxiliary core storage unit — although Honeywell has given no indication that such a unit is being developed.

Depending on the values of the high-order bit of each address and the Memory Designator bit contained in the operation code field of the instruction, several other basic forms of main memory addressing can be specified: indirect addressing, with an addressed program control register (one of 32 within each group) providing the actual 23-bit address; indexed addressing, using one of the eight index registers within each register group; and indexed indirect addressing, in which the indexed value points to any of the 256 program control registers for accessing the contents of the indicated register or for specifying an operand location in main memory. In addition, all 32 program registers within each of the 8 program control groups can be addressed in the direct and indirect modes.

The Model 8200 word processor also utilizes an extended instruction format that can occupy two

AU1 AU2	Arithmetic Control Registers
SC	Sequence Counter
CSC	Cosequence Counter
SH	Sequence History Register
CSH	Cosequence History Register
UTR	Unprogrammed Transfer Register
MXR	Mask Index Register
X0 - X7	Index Registers 0 - 7
R0 - R7	General Purpose Registers 0 - 7
S0 - S7	General Purpose Registers 0 - 7

| X | X | X | X | Key Register |

Base Relocation Register

Stopper Relocation Register

Figure 2. Program Control Registers within a Control Group; eight Control Groups are provided within the Model 8200 Word Processor.

(Contd.)

.121 Word Processor (Contd.)

consecutive 48-bit words: a 24-bit operation code and three 24-bit addresses. The double-length, extended addresses can directly designate any word in Model 8200 core storage. Extended indirect addressing of main memory is also provided, as is extended indexed main memory addressing. Extended indexed addressing permits the use of any of the 32 processor registers within a control group as index registers. The extended addressing mode also permits the direct addressing of any processor register within the 8200 word processor.

It is worth noting that the extended instruction format need not occupy two words of core storage: if two of the three 24-bit addresses within an instruction are not required by the nature of the instruction, then the extended instruction is compressed into one 48-bit word, consisting of a 24-bit operation code and one 24-bit address.

Processing Facilities

Arithmetic operations are performed on whole 48-bit words, in either binary or decimal mode. The basic word processor has facilities for performing fixed-point binary and decimal arithmetic. Binary operands have a length of 44 bits plus a 4-bit sign. (A special binary word add instruction uses a 48-bit unsigned binary operand.) The fixed-point decimal operands have eleven 4-bit numeric digits plus a 4-bit sign. Data conversion instructions are provided to convert between binary and decimal formats.

A floating-point arithmetic option uses single-word operands consisting of a 40-bit mantissa and a 7-bit exponent plus 1-bit sign. The mantissa can represent a 40-bit binary or 10-digit decimal number.

The central processor instruction execution times of the Model 8200 word processor are significantly better than those of the earlier Honeywell 800 and 1800 processors. As an example, fixed-point multiply takes 5 microseconds in the Model 8200, 66 microseconds in the 1800, and 200 microseconds in the 800.

Supervisory Control Registers

Besides the program control registers that are used directly in program execution, the Model 8200 word processor also provides three additional registers per register group for supervisory control purposes.

A Key register carries a Master Group-assigned key to any of the 512-word blocks of memory assigned for the use of the particular program group. The method and types of memory protection provided through use of the Key register are described in Section 518:041, Core Storage.

The Key register is also used in conjunction with specialized input-output device control logic to provide peripheral device protection. When an I/O instruction is initiated, the addressed device is checked by an independently-functioning hardware checking mechanism against a Monitor-constructed table of legitimate devices for that program. If the program attempts to address a device not assigned for its use, the I/O operation is not performed and the Monitor is called. If the addressed device is legitimate, the I/O device control unit selects the physical device address from a table in core storage and passes the I/O order to the Input-Output Controller to initiate the peripheral data transfer operation.

A Base Relocation Register stores an assigned base address corresponding to the initial location of a group's program code in main memory. All addressing is done relative to the contents of this register, which is set by the monitor program that works in conjunction with the Master Group.

The third new register is called a Stopper Relocation Register. It stores the upper address limit of a program group's assigned memory allocation.

In summary, the word processor as a separate element of the 8200 Central Processor offers a significant performance improvement over the earlier 800 and 1800 multiprogramming systems. Many apparent limitations in those systems have been removed in the Model 8200 by the provision of such features as extended direct memory addressing, storage protection, and dynamic program relocation. The lack of good editing facilities would still remain a significant drawback of the 8200 in business applications, except for the fact that the 8200 also contains a Variable Length Field (VLF) character processor especially suited to character-manipulation operations.

.122 Character-Oriented Processor

The 8200's character-oriented processor has virtually the same characteristics and capabilities as the Honeywell Model 4200 processor described in Section 516:051. However, the following differences should be noted:

- The Scientific Unit, which provides floating-point arithmetic capability in the 4200, is not offered with the 8200 character processor.
- The storage protection optional feature of the 4200 processor is standard with the 8200 character processor. The character processor can also use the common 8200 memory protection scheme, described in Paragraph .121 above.
- Control of the character processor by Master Group requires the use of one new instruction: Master Group Call.
- The Model 8200 operating system that works through the Master Group replaces the operating system used with the 4200. However, the character processor uses a small group of customized control routines to handle the following program faults:
    - (a) Storage protection violation initiated by a program within the character processor.
    - (b) Illegal or undefined operation codes.
    - (c) Attempt to execute privileged operations by non-privileged programs.
    - (d) Reference to non-existent memory.

The character-oriented processor, using the 4-character address mode, can directly address a maximum of 524,288 characters.

.123 Master Group

The Master Group is the ninth group of Model 8200 program control registers. Master Group works in conjunction with a master control routine to

.123 Master Group (Contd.)

coordinate the operations and interactions of the various subsystems within the central processor of the Model 8200 system. Master Group is the principal hardware component of the master control hardware-software facility. However, by association, the whole control system is often referred to as Master Group.

Master Group performs the following functions:

- Sets Protection Identification Tag (PIT) Registers.
- Sets program Base Relocation registers and Stopper Relocation registers.
- Controls the storage protection, program protection, and peripheral protection features of the processing unit.
- Controls program running states for the word-oriented and character-oriented processors.
- Uses the character processor to perform several services for the word processor, such as to format print lines, to buffer data communication messages, and to handle slow-speed input-output operations.

Master Group has three modes of operation: Ready, Hunt, and No Hunt. In the Ready Mode, Master Group is actually inactive. It can be activated (i.e., called) by any active program or by the Input-Output Controller. In the Hunt mode, Master Group is effectively the ninth active program control group of the word-oriented processor, cyclically sharing processor cycles. While in the Hunt mode, Master Group can be called in the same manner as in the Ready mode. When operating in the No Hunt mode, Master Group fully monopolizes use of the word-oriented processor. In this mode, Master Group cannot be called by any other functional components of the 8200 central hardware. If the I/O Controller or any active program calls Master Group when it is in the Hunt or Ready mode, Master Group will change to the No Hunt mode to service the call.

All interrupt conditions in the Model 8200 processor are recognized and serviced by the Master Group hardware/software control facility. Table I lists in service priority order the five general categories of interrupt conditions, including the principal interrupts within each category.

.124 Interprocessor Communication

All communications between the word and character processors and between both processors and the I/O Controller take place in the following manner: the calling component of the 8200 system places coded information in a buffer area of core storage; the called component then fetches the information from the buffer, analyzes the code words, and performs the requested function. The communication buffers are located in 20 fixed locations of core storage starting at octal location 100.

There are five sets of interface cable connections, establishing the following paths of component intercommunication:

- Master Group to and from character processor.
- Master Group to and from I/O controller.
- Master Group to and from word processor.
- I/O controller to and from character processor.
- I/O controller to and from word processor.

The interprocessor communication buffers store information such as a six-bit "reason code." In some cases the reason code serves to identify the calls that have to be analyzed by program. In the cases in which the calls can be processed automatically by hardware, the reason code is the operation code of the function to be performed.

The communications buffer area also stores the following information: a six-bit sub-reason code that contains descriptive information concerning the reason for the call; a four-bit group number that identifies either the word processor and a particular program group number, or the character processor and its operating mode; and the program identification code of the calling program.

.14 First Delivery . . . . . . January 1968.

TABLE I: INTERRUPTS TO MASTER GROUP

	External	Master Group	I/O	Character Processor	Word Processor
Priority	1	2	3	4	5
Cause of Interrupt	Receipt of data from a communications device	Memory parity error Master Group fault Service request Add/subtract overflow* Divide over-capacity* Exponent underflow* Exponent overflow*	I/O operation fault Peripheral interruption	Machine fault Program fault Master Group call	Trapped orders (some peripheral orders, console instructions) Illegal operation codes Storage Protection violation Parity failures Instruction time-out** Program No Hunt Loop**

* Interrupt occurs only if specified by programmer.

** Interrupt is initiated by an interval timer that can be set to one of 16 stages ranging from 125 nanoseconds to 8.2 milliseconds.

(Contd.)

.2 PROCESSING FACILITIES

Note: Unless otherwise indicated, the entries below refer to the capabilities of the 8200 word processor only. The capabilities of the character processor are, in general, identical with those of the Honeywell Model 4200 processor, described in Section 516:051.

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add/subtract:	automatic	binary	44 bits + sign.
			decimal	11 digits + sign.
	Multiply:	automatic	binary	44 bits + sign.
			decimal	11 digits + sign.
	Divide:	automatic	binary	44 bits + sign.
			decimal	11 digits + sign.
.212	Floating point* (available both with and without normalization) —			
	Add/subtract:	*automatic	binary or decimal	40 & 7.
	Multiply:	*automatic	binary or decimal	40 & 7.
	Divide:	*automatic	binary or decimal	40 & 7.

* Provided only when Scientific Unit is included in word processor.

.213	Boolean —		
	AND:	automatic	binary.
	Inclusive OR:	automatic	binary.
	Exclusive OR:	automatic	binary.
.214	Comparison —		
	Numbers:	automatic	
	Absolute:	automatic.	
	Letters:	automatic.	
	Mixed:	character processor only.	

.215 Code translation: . . . . character processor only.
.216 Radix conversion . . . . character and word processors.
.217 Edit format: . . . . character processor only.
.218 Table lookup:. . . . . character processor only
.219 Others —
Accumulate: . . . . automatic.

.22 Special Cases of Operands

.221 Negative numbers: . . . . in fixed-point representation, the sign is stored as 4 bits, but used as 1 bit; in floating point, 1-bit sign representation is used.

.222 Zero: . . . . positive or negative zero possible. These behave differently in alphabetic comparisons but identically in numeric comparisons.

.23 Instruction Formats

.231 Instruction structure: . . . . . 1-word, 3-address instructions. Two-word instructions with extended addressing can also be used (see Paragraph .121).

.232 Instruction layout: . . . . see diagram on the following page.

<table>
<tr><th>BITS</th><th>1</th><th>2 3</th><th>4</th><th>5</th><th>6</th><th>7 8 9</th><th>10 11 12</th><th>13-24</th><th>25-36</th><th>37-48</th></tr>
<tr><td rowspan="2">General Instructions Unmasked</td><td rowspan="2">S / C</td><td rowspan="2">1st Part of Op Code</td><td colspan="3">Memory Designator</td><td colspan="2" rowspan="2">2nd Part of Operation Code</td><td rowspan="2">A</td><td rowspan="2">B</td><td rowspan="2">C</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>General Instructions Masked</td><td>S / C</td><td colspan="4">Partial Mask Address</td><td colspan="2">Operation Code</td><td>A</td><td>B</td><td>C</td></tr>
<tr><td rowspan="2">Peripheral Instructions</td><td colspan="5">Peripheral Address</td><td colspan="2" rowspan="2">Operation Code</td><td rowspan="2">A</td><td rowspan="2">B</td><td rowspan="2">C</td></tr>
<tr><td colspan="2">I/O Channel</td><td colspan="3">Device</td></tr>
<tr><td>Simulator Instructions</td><td>D / I</td><td colspan="5">Remainder of Address</td><td>1 1 1</td><td>A</td><td>B</td><td>C</td></tr>
</table>

.233 Instruction parts —

Name	Purpose
S/C:	to designate either the Sequence Counter or the Cosequence counter as providing the next instruction.
Op Code:	operation code of 6, or 6 and 2 bits.
Memory Designator:	part of addressing structure of the operands
D/I:	part of addressing structure
A, B, C:	part of addresses of operands.

.234 Basic address structure: . . . . 3-address.

.235 Literals —
- Arithmetic: . . . . . . none.
- Comparisons and tests: . . . . character processor only.
- Incrementing modifiers: . . . . . . yes, by use of indirect addressing.

.236 Directly addressed operands

Internal storage type	Minimum size	Maximum size	Volume accessible
Core Storage:	1 bit	48 bits	2,048 words
Special Register:	1 bit	24 bits	256 words

.237 Address indexing —

.2371 Number of methods: . . . . one. (However, see "Indirect addressing," whose increment feature allows index-type operation.)

.2372 Names: . . . . indexing.

.2373 Indexing rule: . . . . . up to 256 is added to (or subtracted from) the storage address given in the specified index register. Extended addressing permits indexing by values up to 131,072. The IR is not modified. The storage address can be either in Main Memory or in the Control Memory (where the 288 24-bit processor control registers are implemented) and the augmented address obtained can be used directly or indirectly.

.2374 Index specification: . . . . within the instruction.

.2375 Number of potential indexers: . . . . 288.

.2376 Address which can be indexed: . . . . . . 211.

.2377 Cumulative indexing: . . . . none.

.2378 Combined index and step: . . . . not using index registers, but available using an index register simply as a special register. See "Indirect addressing."

.238 Indirect addressing —

.2381 Recursive: . . . . no.

.2382 Designation: . . . . . . special bit in instruction, which then interprets the 11 address bits of the appropriate A, B, or C address as an increment and the address of any one of the control registers in any group.

.2383 Control: . . . . absolute address must be contained in an addressed special register.

.2384 Indexing with indirect addressing: . . . . . . modification occurs before the indirect address is determined.

.239 Stepping —
- Index registers: . . . . own coding or a special register.
- Indirect addressing: . as specified above.

.2391 Specification of increment: . . . . . . in instruction.

.2392 Increment sign: . . . . special register sign.

.2393 Size of increment: . . 0 through 17 bits.

.2394 End value: . . . . own coding.

.2395 Combined step and test: . . . . yes.

.24 Special Processor Storage: . . . . the nine groups of program control registers are implemented in a special control memory. See Figure 2 for a listing of the registers within each group.

(Contd.)

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . 18.
.312 Arrangement: . . . . . . 2 per program, 9 programs per word processor.
.313 Precedence rule (within program): . . . continues with one control until instructed to transfer control to other.
Precedence rule (within processor): . . cyclically in turn to all active programs unless inhibited.
.314 Special sub-sequence counters: . . . . nine (the Unprogrammed Transfer Registers).
.315 Sequence control step size: . . . . instruction words.
.316 Accessibility to routines: . . . . yes.

.32 Look-ahead: . . . . yes; see Paragraph 518:041.13.

.33 Interruption

.331 Possible causes: . . . . see Table I.
.332 Control by routine —
Individual control: . . all interrupts within one program; positions relative to a standard control register.
Method: . . . . either the sign of the increment or the base of the increment can be adjusted.
.333 Operator control: . . . none.
.334 Interruption conditions: interruption condition arises in program channel.
.335 Interruption process —
Disabling interruption: . . . . automatic
Registers saved: . . . all.
Designation: . . . . . . standard distance away from variable base address stored in special register of program group. Base address varies depending on interruption cause.
.336 Control methods —
Determine cause: . . . given by entry place.
Enable interruption: . enabled whenever Master Group enters the Hunt or Ready operating mode.

.34 Multiprogramming

.341 Method of control: . . . multisequence counters.
.342 Maximum number of programs: . . . . 11 — 8 user programs in word processor, 1 control program in word processor, and 2 user programs in character processor.
.343 Precedence rules: . . . cyclic; first-off, first-on, with cycling inhibition in own coding.
.344 Program protection —
Storage: . . . . by hardware, under control of Master Group.
I/O areas: . . . . by hardware, under control of Master Group.
I/O units: . . . . by hardware, under control of Master Group, or by software.

.35 Multi-Sequencing: . . . . a single program within the word processor can use as many program control groups as desired to perform subprograms concurrently with the main program. In addition, the word and character processors execute programs simultaneously.

.4 PROCESSOR SPEEDS*

NOTE: The entries below refer to the speeds of the 8200 word processor only. The internal speeds of the 8200 character processor are identical with those of the Model 4200 processor, described in Section 516:051.

.41 Instruction Times in Microseconds

		Minimum	Maximum
.411	Fixed point (binary and decimal) —		
	Add/subtract:	1.75	3.0
	Multiply:	5.0	5.0
	Divide:	14.0	14.0
.412	Floating point** —		
	Add/subtract:	2.25	5.0
	Multiply:	5.0	5.0
	Divide:	13.0	13.0
.413	Additional allowance for —		
	Indexing:	can be completely overlapped with access of another operand	0.75
	Indirect addressing:		
	Recomplementing:		

* Minimum times assume maximum overlap of instruction and operand accesses using 4-way interleaving of memory addresses; all addresses are considered active and in direct main memory. Maximum times assume that all addresses are indirect and indexed.

** With optional equipment.

		Minimum	Maximum
.414	Control —		
	Compare:	3.0	3.5
	Branch:	1.75	2.25
	Compare and Branch:	3.0	3.5
.415	Counter control —		
	Step:	not available for index registers; included in use of indirect address.	
	Step and Test:	not available.	
	Test:	3.0	3.5
.416	Edit:	6.4 + 1.7C + 1.1X (performed in character processor). C = number of characters scanned during zero suppression; X = number scanned for floating dollar sign insertion.	
.417	Convert —		
	Fixed decimal to floating binary Conversion:	17.75	17.75
	Floating binary to fixed decimal Conversion:	9.5	9.5
.418	Shift:	1.75	4.5

.42 Processor Performance in Microseconds

		Fixed Point Min.	Fixed Point Max.	Floating Point Min.	Floating Point Max.
.421	For random addresses —				
	$c = a + b$:	1.75	3.0	2.25	5.5
	$b = a + b$:	1.75	3.0	2.25	5.5
	Sum N items:	1.25+.25N	1.5+.75N	2.25N	5.5N
	$c = ab$:	5.0	5.0	5.0	5.0
	$c = a/b$:	14.0	14.0	13.0	13.0
.422	For arrays of data —				
	$c_i = a_i b_j$:	3.5	5.25	4.0	7.75
	$b_j = a_i + b_j$	3.5	5.25	4.0	7.75
	Sum N items (uniform signs):	3.0+0.25N	3.25+0.75N	4.0	7.75
	Sum N items (different signs:	3.0+0.25N	3.25+0.25N	7.0	11.25
	$c = c + a_i b_j$:	8.5	10.25	9.0	12.75
.423	Branch based on comparison —				
	Numeric data:	10.75		12.75	
	Alphabetic data:	10.75		12.75	
.424	Switching —				
	Unchecked:	3.75		4.25	
	Checked:	9.75		11.25	
	List search:	3.0+3.75N		3.5+4.25N	
.425	Format control, per character —				
	Unpack:	1.2 (character processor).			
	Compose:	2.1 (character processor).			
.426	Table lookup, per comparison —				
	For a match:	3.75		4.25	
	For least or greatest:	5.5		6.5	
	For interpolation point:	3.75		4.25	
.427	Bit indicators —				
	Set bit in separate location:	1.75		3.0	
	Set bit in pattern:	2.5		3.75	
	Test bit in separate location:	1.75		3.0	
	Test bit in pattern:	2.5		3.75	
	Test AND for B bits:	2.5		2.5	
	Test OR for B bits:	2.5		2.5	
.428	Moving (per N 72-bit words):	1.25+0.75N		1.25+1.5N	

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	Program Group interrupt.
Underflow:	check	Program Group interrupt.
Zero divisor:	check	Program Group interrupt.
Invalid data:	check	Program Group interrupt.
Invalid operation:	check	Master Group interrupt.
Arithmetic error:	check	Master Group interrupt.
Invalid address:	check	Master Group interrupt.
Receipt of data:	check	Program Group interrupt.
Dispatch of data:	check	Program Group interrupt.

SIMULTANEOUS OPERATIONS

A Honeywell Model 8200 Processing Unit consists of three principal processing components: the word processor, character processor, and Input-Output Controller. These components can simultaneously and independently access four different core storage memory modules. The word processor always accesses two modules in parallel for every 72-bit word access — one 36-bit half-word from each module. The character processor and I/O Controller can access only one module at a time. Thus, four modules of memory are required to achieve the highest degree of simultaneous accessing of core storage. The minimum 8200 system configuration includes two memory modules, permitting simultaneous memory access by the character processor and the I/O Controller, or a single memory access (to both modules) by the word processor.

The overall capacity of a Honeywell 8200 system with four memory modules permits the simultaneous execution of:

- Two independent instructions, one in each processor; and
- Three memory accesses, one from each processor and one from the I/O Controller; and
- From 16 to 34 data transfer operations between the I/O Controller and the 96 potential peripheral devices or peripheral device control units; and
- As many buffered peripheral I/O operations as have been initiated by the peripheral device control units and not yet terminated.

The Input-Output Controller in the basic Model 8200 system provides two sets of 16 input-output channels, up to 16 of which can be used simultaneously. One set performs the functions of the Read-Write Channels of the Series 200 processors, and the other set performs the functions of the Read-Write Channels of the Honeywell 800/1800 processors. Normally, only the character processor uses the Series 200-type channels, and only the word processor uses the 800/1800-type channels. Up to 16 channels in any combination can transfer data simultaneously.

An expanded Model 8200 system with Feature 8214 provides 16 character processor channels and 32 word processor channels, and up to 34 of these channels in any combination can transfer data simultaneously.

The basic Honeywell 8200 I/O Controller has three input-output sectors, each of which permits the permanent connection of up to 16 peripheral device control units. Feature 8214 increases the number of sectors to six and provides connection for up to 96 permanently installed peripheral control units — again, 16 per sector. The 32 basic I/O channels (48 with Feature 8214) are not permanently associated with any sector or any peripheral device connected to a sector. Instead, each channel floats to any sector and device currently addressed, thereby increasing the likelihood of achieving a high degree of simultaneous input-output data transfers.

The maximum input-output data transfer capacity of the basic Honeywell 8200 I/O Controller (i.e., without Feature 8214) is 1,333,333 characters per second. One character of data is transferred between main memory and the I/O Controller during each memory cycle. Sectors 1 and 2 of the basic I/O Controller have a maximum transfer capacity of 500,000 characters per second, and Sector 3 has a maximum capacity of 333,333 characters per second. Up to six peripheral devices within Sector 1 can concurrently share its sector's 500KC data capacity, resulting in a maximum I/O data capacity of 83,333 characters per second for each device if all six peripheral devices in Sector 1 were operating concurrently. Similarly, Sector 2 permits up to six peripheral devices to operate concurrently, provided its 500KC data transfer rate is not exceeded. Sector 3 of the basic I/O Controller permits up to four peripheral devices to function simultaneously, also at a maximum rate of 83,333 characters per second for each device when all four devices are concurrently operating. Therefore, the basic Model 8200 I/O Controller permits the concurrent operation of up to 16 peripheral devices or peripheral control units within its three sectors, provided none of the 16 data transfer operations exceeds 83,333 characters per second.

Peripheral devices with higher data transfer rates are accommodated by the I/O Controller's interlocking of the six memory cycles available to each sector (four cycles available to Sector 3) and assigning the six cycles to either one, three, four, or five devices, thereby providing sector data transfer capacities of either 500KC, 333KC, 250KC, or 166KC, respectively. Sector 3 can be interlocked to provide transfer rates of either 166KC or its maximum 333KC.

Feature 8214 provides four "buffered" sectors instead of the basic Sector 2. Each of these four sectors effectively has the same characteristics as the single Sector 2 which they replace. For example, each buffered sector has a maximum data rate capacity of 500,000 characters per second, can handle a maximum of 6 concurrent I/O operations, and can connect up to 16 peripheral control devices. The explanation for the apparently quadrupled data transfer capacity in relation to that of Sector 2 lies in the fact that each of these four 8214 sectors contains 4-character buffers in which four data characters are accumulated before requiring an access to main memory.

Table I shows the start time, stop time, and data transmission time (including demand on main memory) for each of the principal Honeywell Series 200 peripheral devices that will be used with the Model 8200 system. Certain devices cannot be used in the buffered I/O mode (with Feature 8214), and such devices are so indicated.

TABLE I: SIMULTANEOUS OPERATIONS

OPERATION	Cycle Time, msec	Start Time			Data Transmission				Stop Time		
		Time, msec	CP Use	Channel Use	Time, msec	Core Use	Core Use W/Feature 8214	Channel Use	Time, msec	CP Use	Channel Use
214 Card Reader	150	20.0	0	Yes	55.0	<0.1%	NA	Yes	75.0	0	No
214 Card Punch	150-600	7.5	0	Yes	6.25n	<0.1%	NA	Yes	92.5	0	No
223 Card Reader	75	13.0	0	Yes	46	0.1%	NA	Yes	16	0	No
224-1 Card Punch	335-1210	6.2	0	Yes	12.5n	<0.1%	<0.1%	Yes	210	0	No
224-2 Card Punch	223-660	3.0	0	Yes	6.25n	<0.1%	<0.1%	Yes	160	0	No
227 Card Reader	75	21 to 46	0	Yes	44	3.4%	NA	Yes	10	0	No
227 Card Punch	240	42 to 102	0	Yes	176	0.4%	NA	Yes	22	0	No
206 High-Speed Printer	67 + 8LS	0	—	—	47	10.7%	NA	Yes	20 + 8LS	0	No
222-1, 2, 3 Printer (51-character set)	92 + 5LS	0	—	—	75	6.4%	NA	Yes	17 + 5LS	0	No
222-4 Printer (46-character set)	63 + 5LS	0	—	—	46	9.0%	NA	Yes	17 + 5LS	0	No
222-5 Printer (63-character set)	133 + 5LS	0	—	—	116	4.8%	NA	Yes	17 + 5LS	0	No
209 Paper Tape Reader	2.0	?	0	Yes	Var.	0.1%	<0.1%	Yes	?	0	No
210 Paper Tape Punch	8.3	?	0	Yes	Var.	<0.1%	<0.1%	Yes	?	0	No
204A-1 Magnetic Tape, 32KC	—	11.0[a]	0	Yes	Var.	2.4%	0.8%	Yes	0[a]	—	—
204A-2 Magnetic Tape, 64KC	—	5.5[a]	0	Yes	Var.	4.8%	1.2%	Yes	0[a]	—	—
204A-3 Magnetic Tape, 89KC	—	5.5[a]	0	Yes	Var.	6.8%	1.7%	Yes	0[a]	—	—
204B-1, -2 Magnetic Tape, 20KC	—	12.5[a]	0	Yes	Var.	1.5%	0.4%	Yes	0[a]	—	—
204B-3, -4 Magnetic Tape, 44KC	—	7.5[a]	0	Yes	Var.	3.3%	0.8%	Yes	0[a]	—	—
204B-5 Magnetic Tape, 67KC	—	5.8[a]	0	Yes	Var.	5.0%	1.2%	Yes	0[a]	—	—
204B-7 Magnetic Tape, 29KC	—	20.8	0	Yes	Var.	2.2%	0.6%	Yes	0[a]	—	—
204B-8 Magnetic Tape, 64KC	—	7.5[a]	0	Yes	Var.	4.8%	1.2%	Yes	0[a]	—	—
204B-9 Magnetic Tape, 96KC	—	5.8[a]	0	Yes	Var.	7.2%	1.8%	Yes	0[a]	—	—
204B-11, -12 Magnetic Tape, 13KC	—	18.7[a]	0	Yes	Var.	1.0%	0.3%	Yes	0[a]	—	—
270 Random Access Drum	—	25.0	0	Yes	Var.	7.9%	2.0%	Yes	0	—	—
251 Mass Memory	16.7	95 av.	0	Yes	Var.	7.5%	1.9%	Yes	—	0	No
252 Mass Memory	16.7	150 av.	0	Yes	Var.	7.5%	1.9%	Yes	—	0	No
253 Mass Memory	16.7	225 av.	0	Yes	Var.	7.5%	1.9%	Yes	—	0	No

a Cross-gap time for short gap (replaces start and stop times).
LS Number of lines skipped between successive printed lines.
n Number of characters punched.
Var. Data transmission time varies with record length.
NA Device cannot be used in the buffered I/O mode.

INSTRUCTION LIST

The instruction complement of the dual-processor Honeywell 8200 processing unit includes all instructions found in the earlier Honeywell 800/1800 processors, and all instructions found in the Honeywell Series 200 Model 4200 processor, except for the optional Scientific Unit instruction set. Certain additional instructions are supplied to control the interaction of the 8200's word processor, character processor, Master Group, and I/O Controller.

This section lists the privileged instructions supplied for Master Group processor control operations. Also listed are the several "Communication Buffer Calls" which enable the major 8200 processing components to communicate with each other. Finally, a complete listing of the 8200 word processor instructions is provided, together with the minimum and maximum instruction execution times. (The timing variations result from the degree of overlapping of memory accesses and the use of indirect and indexed addresses.) The instruction set of the 8200 character processor is identical to that of the Honeywell Model 4200 processor except for the nonavailability of the Scientific Unit instructions. Please refer to Section 510:121 for a complete list of Model 4200 instructions.

MASTER GROUP CONTROL INSTRUCTIONS

Instruction Name	Operation Code	Function
Acknowledge	ACK	Restart the specified processor or processor group after performing a specified action.
Barricade Load	BLD	Load a memory protection barricade address for the processor.
Barricade Read	BRD	Read the contents of a group's barricade register.
Execute	EXC	Transfer the contents of N words of main memory to the Master Group Communication Buffer and raise the Service Request Line to the processor specified by the B field. Branch if the called processor is busy.
Group Set Up	GSU	Load the Base Relocation, Stopper and Protection Identification Tag from main memory to a group register.
Group Read	GRD	Read the contents of Base Relocation, Stopper and Protection Identification Tag registers.
Read Punctuation	RPU	Take Series 200 punctuation bits associated with a full word and store them in specified bit positions of another word.
Set Punctuation	SPU	Move a data word, adding the Series 200 punctuation bits specified by the B address.
Master Group Call	MGC	Initiate a call from the character processor to Master Group.

COMMUNICATION BUFFER CALLS

Calls From	Calls To	Call Code	Reason for Call
Word Processor	Master Group	Ba1	Trapping of I/O Order.
		Ba2	Trapping of I/O Order.
		Ba3	Multiprogram Control Order.
		Ba4	Barricade Violation.
		Ba5	Machine Malfunction.
		Ba6	Program Malfunction.
Character Processor	Master Group	Ca1	Master Call (in user program).
		Ca2	I/O Order.
		Ca3	Barricade Violation.
		Ca4	Machine Malfunction.
		Ca5	Program Malfunction.
I/O Controller	Master Group	Da1	I/O Interrupts.
		Da2	Special Timer Interrupts.
		Da3	Barricade Violation.
		Da4	I/O Faults.
Master Group	Character Processor	Ac1	Execute Character Instruction.
Master Group	I/O Controller	Ad1	I/O Orders.
		Ad2	Group Set Up.
		Ad3	Group Read.
		Ad4	Barricade Load.
		Ad5	Barricade Read.
		Ad6	Program Control Register Contents.
		Ad7	Read/Write I/O Counters.
		Ad8	Read/Write Steering Register Counters.
		Ad9	Read Time Assignment Table.
Word Processor	I/O Controller	Bd1	Program Control Register Contents.
		Bd2	Read/Write I/O Counters.
Character Processor	I/O Controller	Cd1	I/O Order.
		Cd2	Read/Write I/O Counters.

Note: In addition to these communication calls, several other calls are provided that ask each processor for the contents of additional control registers.

(Contd.)

WORD PROCESSOR INSTRUCTION SET

Name of Operation	Execution Time in Microseconds*	
	Minimum	Maximum
Fixed-Point Arithmetic		
Binary Add, Subtract	1.75	3.0
Binary Accumulate	1.25 + 0.25N	1.5 + 0.75N
Binary Multiply	5.0	5.0
Binary Divide	14.0	14.0
Decimal Add, Subtract	1.75	3.0
Decimal Accumulate	1.25 + 0.25N	1.5 + 0.75N
Decimal Multiply	5.0	5.0
Decimal Divide	14.0	14.0
Word Add, Difference	1.75	3.0
Scientific Processing Instructions †		
Floating Binary Add, Subtract	2.25	5.5
Floating Binary Multiply	5.0	5.0
Floating Binary Divide	13.0	13.0
Floating Decimal, Add, Subtract	2.25	5.5
Floating Decimal Multiply	5.0	5.0
Floating Decimal Divide	13.0	13.0
Normalized Less Than Comparison	3.0	3.5
Normalized Inequality Comparison	3.0	3.5
Multiple Unload	1.75	3.0
Fixed Decimal to Floating-Binary Conversion	17.75	17.75
Floating Binary to Fixed-Decimal Conversion	9.95	9.95
Fixed-to-Floating Normalize	1.75	3.0
Logical Functions		
Halt Add	1.75	3.0
Superimpose	1.75	3.0
Substitute	2.5	3.75
Extract	1.75	3.0
Inequality Comparison, Alphanumeric	3.0	3.5
Inequality Comparison, Numeric	3.0	3.5
Less Than Or Equal to Comparison, Alphanumeric	3.0	3.5
Less Than Or Equal to Comparison, Numeric	3.0	3.5

N = number of 72-bit words.

* Minimum times are for maximum overlap with 4-way interleaving, all addresses active and direct main memory. Maximum times are for all addresses indexed-indirect with no memory overlap. All times are exclusive of masking, which can take a maximum of two additional memory cycles, depending on amount of overlap.

† Single-precision, floating-point operands consist of a 1-bit sign, followed by a 7-bit exponent and a 40-bit mantissa.

WORD PROCESSOR INSTRUCTION SET (Contd.)

Name of Operation	Execution Time in Microseconds*	
	Minimum	Maximum
Shift Instructions †		
Shift Word and Substitute	1.75	4.5
Shift Preserving Sign and Substitute	1.75	4.5
Shift Word and Extract	1.75	4.5
Shift Preserving Sign and Extract	1.75	4.5
Shift Word and Select	3.0	6.0
Data Move Instructions		
Transfer A to C	1.75	2.25
Transfer A to B and Go to C	1.75	2.25
Multiple Transfer	1.25 + 0.75N	1.25 + 1.5N
N Word Transfer	1.25 + 0.75N	1.25 + 1.5N
Item Transfer	1.25 + 0.75N	1.25 + 1.5N
Record Transfer	1.25 + 0.75N	1.25 + 1.5N
General Control Functions		
Compute Orthocount	3.75 + 0.50N	6 + 1.5N
Check Memory Parity	2.5	3.0
Multiprogram Control	3.5	3.75
Proceed	1.75	1.75
Input/Output and Other Peripheral Functions #		
Read Forward	-	-
Read Backward	-	-
Write Forward	-	-
Peripheral Data Transfer	-	-
Print Alpha, Decimal, or Octal	-	-
Rewind Tape	-	-
Peripheral Control and Branch	-	-

N = number of 72-bit words.

* Minimum times are for maximum overlap with 4-way interleaving, all addresses active and direct main memory. Maximum times are for all addresses indexed-indirect with no memory overlap. All times are exclusive of masking, which can take a maximum of two additional memory cycles, depending on overlap.

† Execution times for shift instructions are based on an average shift distribution over 1-48 bits.

These instructions are performed in an independent logic module of the processing unit. In most cases their instruction execution times will be completely masked.

OPERATING ENVIRONMENT: OPERATING SYSTEM—MOD 8

.1 GENERAL

.11 Identity: . . . . Operating System—Mod 8.

.12 Description

The Honeywell Operating System—Mod 8 is a complete software package designed exclusively for use with the hybrid Model 8200 computer system. Control facilities are included within the Mod 8 software to supervise and coordinate the operations of the principal functional components of a Model 8200 system: word processor, with nine groups of program control registers; character processor; Input-Output Controller, with up to 48 floating input-output channels; and peripheral device control units, up to 96 of which can be attached.

The principal control programs provided with Operating System—Mod 8 are the following:

- A Monitor program that regulates the concurrent execution of up to eight user programs in the word processor and up to two main user programs in the character processor—all sharing a common main memory and common peripheral devices. Processor interrupt conditions are also handled by the Monitor. The Monitor performs its functions through use of the Master Group of processor control registers, and is itself often referred to, by association, as "Master Group."
- A Scheduler program that builds a job queue according to program priority and availability of system resources. As programs are executed, the Scheduler re-evaluates the job mix and schedules additional programs, automatically allocating core storage, processor register groups, and peripheral equipment.
- A Loader program that loads program segments into whatever portions of core storage are currently available. The Loader program can be called by the Master Group at any time to relocate dynamically any active program segment. The Loader also handles calls by active programs for other program segments or subroutines from the on-line object-code library.
- A Central I/O control system that supplies all input-output routines, including logical file handling routines and standard device error recovery routines.

The Operating System—Mod 8 is designed to function exclusively as a mass storage-oriented software system. Mod 8 requires use of at least 15 million characters of random-access storage in any of the family of such devices offered by Honeywell with its Series 200 systems. Another 65,536 characters of Model 8200 core storage is required for permanent residence of the control portions of the Mod 8 system.

Although a Model 8200 system can be obtained with a core storage size of 131,072 characters (by special request only), Honeywell will generally sell a minimum core storage size of 262,144 characters to ensure that the customer will be able to utilize effectively the multiprogramming and multiprocessing capabilities of the 8200 system.

Because the Model 8200 processing unit contains two processors—one that closely resembles the earlier Honeywell 800/1800 processors and one that closely resembles the Series 200 Model 4200 processor—all current 800/1800 software programs can be executed in the 8200 word processor, and all current Model 4200 software support can be used in the 8200 character processor.

Thus the user of a Model 8200 system will have time-proven software available when the system is first delivered in January 1968. Only the control program portions of the Operating System—Mod 8 software will have been redesigned to take advantage of the unconventional design of the Model 8200 Processing Unit. However, the new Mod 8 Monitor program need not be used during the early days of equipment installation. Alternatively, the word processor can function under control of any of the current Honeywell 800/1800 monitor programs, permitting direct usage of all 800/1800 production programs. Also, current users of Series 200 Model 2200 or 4200 systems who are moving to a Model 8200 system can load their Series 200 monitor program into the 8200 character processor and then execute all of their existing Series 200 programs without modification.

Since the new Mod 8 Monitor program functions through use of its own specialized "Master Group" of control registers, this program can control the execution of new or recompiled Model 8200 programs without interfering with other programs running in parallel under their original monitor programs in the so-called "compatibility mode."

Among the more significant language processors that will function under control of Operating System—Mod 8 are a FORTRAN IV compiler that incorporates all features of the FORTRAN IV language as approved by the American Standards Association, and an A.S.A. COBOL compiler that includes a complete implementation of the SORT verb plus mass storage and table handling language features. The FORTRAN IV language also includes provisions to permit usage of mass storage devices through explicit language statements.

A large-scale assembler will provide macro processing capabilities and the ability to call routines from an on-line library of programs originally written in COBOL, FORTRAN, or the

.12 Description (Contd.)

assembly language. In fact, all language processors can call program segments originally written in any 8200 language, since the output of all compilers and generators is produced in a common data file format and in relocatable program segments. Macro routines are provided to give the programmer control of the multiprogramming capabilities of the 8200 processing unit. Subprograms can be specified to run in parallel with the main task of a problem program, and the generation of re-entrant code can be specified when entering a routine into the on-line library.

Linear programming, PERT TIME, and PERT COST programs, virtually identical to those used with the Honeywell 800/1800 systems, will also be provided with Operating System—Mod 8.

According to Honeywell, all Model 8200 language processors will generate object code at high speeds and in highly efficient form due to the addition of several instructions in the 8200 word processor to assist in standard compiler functions. Honeywell expects that the COBOL compiler will process from 2,500 to 3,000 card images per minute; that the FORTRAN IV compiler will process between 2,000 and 2,500 card images per minute; and that the assembler will assemble between 2,500 and 3,000 card images per minute.

The initial design of Operating System—Mod 8 software features batched-job processing in a multiprogramming mode. Jobs can be batched from remote sites or at the central computer complex. Remote, conversational time-sharing software will eventually be provided, appearing in gradual phases. An early Time-Sharing phase will contain a control system that will permit users at remote locations to call for specified on-line library routines and to enter input data or accept output data remotely. This multiple remote access to the central computer can occur while processing up to eight background programs in the word processor.

The Operating System—Mod 8 is scheduled for delivery in January 1968, concurrently with the first deliveries of the Model 8200 hardware.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (518:201.100)

These problems involve updating a master file from information in a detail file and producing a printed record of each transaction. This application is one of the most common commercial data processing jobs and is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of three different record sizes in the master file. Standard File Problem D increases the amount of computation performed upon each transaction. Each problem is estimated for activity factors (ratios of number of detail records to number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

Because multiprogramming is an essential characteristic of Honeywell 8200 operation, the central processor time requirements are shown on all of the graphs in addition to the usual curves of elapsed time (i.e., total processing time). These central processor times have been calculated by using both available processors to handle the computational load. The file handling and editing capabilities of the character processor have been matched with the processing capabilities of the word processor.

The magnetic tape master file is formatted to allow fixed-field-length operations by the word processor. The word processor performs the entire standard problem up to and including updating each new master record. Prior to generating the report file, control is relinquished by the word processor and transferred to the character processor. There the print line is formatted and either printed immediately or written on magnetic tape for later printing. In the latter case, the tape-to-printer transcription may be performed either on-line in conjunction with other programs or as a separate off line operation.

The difference between the plotted curves of elapsed time and central processor time represents the amount of central processor time that is potentially available for concurrent processing of other programs. Configuration VIIIA, with its three tape control units and the capability to perform six simultaneous tape operations, could perform two Standard File Processing Problems (A version) within the 15.45 minutes required to perform the single Problem A with printing performed on-line.

If eight file update programs were being performed concurrently in the word processor, the character processor would not have the speed and capacity to process concurrently the report files from each of these eight programs. In such program mixes, Honeywell suggests that the word processor store its unedited report files directly on mass storage devices. The character processor can then process these files consecutively as time permits. Processing in this manner helps to assure that both the character and word processors will operate at steady efficiency throughout a given work period.

SORTING (518:201.200)

The standard estimate for sorting 80-character records on magnetic tape (graph 518:201.200) was developed from the time calculated for Standard File Problem A according to the technique described in Paragraph 4:200.213 of the Users' Guide.

MATRIX INVERSION

In matrix inversion, the object is to measure the central processor speed on the straightforward inversion of a non-symmetric, non-singular matrix. No input-output operations are involved. The standard estimate is based on the time required to perform cumulative multiplication ($c = c + a_i b_j$) in 8-digit-precision floating point, as explained in Paragraph 4:200.3 of the Users' Guide. For the Model 8200, the word processor was used throughout, and floating-point binary format was selected. This format provides approximately 12-digit precision.

STANDARD MATHEMATICAL PROBLEM A (518:201.400)

The standard estimating procedure outlined in the Users' Guide, Paragraph 4:200.413, was used. Computation includes 5 fifth-order polynomials, 5 divisions, and 1 square root. The computation was performed exclusively by the word processor because its arithmetic capabilities far outstrip those of the character processor. The penalty incurred by printing on-line is clearly shown by the R = 1.0 curve (one output line for each card entered).

WORKSHEET DATA TABLE

	ITEM		CONFIGURATION												REFERENCE
			VIIA (on-line card/print)			VIIA (off-line card/print)			VIIIA (on-line card/print)			VIIIA (off-line card/print)			
1 Standard File Problem A Input-Output Times	Char/block	(File 1)	940			940			940			940			4:200.112
	Records/block	K (File 1)	10			10			10			10			
	msec/block	File 1 = File 2	21.2			21.2			14.8			14.8			
		File 3	75			19.5*			75			13.7*			
		File 4	137			25.6*			92.7			17.5*			
	msec/switch	File 1 = File 2	0			0			0			0			
		File 3	0			0			0			0			
		File 4	0			0			0			0			
	msec penalty	File 1 = File 2	0.18			0.18			0.18			0.18			
		File 3	0.01			0.08*			0.01			0.01*			
		File 4	1.05			0.23*			1.05			0.10*			
2 Central Processor Times			Word CP	Char. CP	I/O Ctl.	Word CP	Char. CP	I/O Ctl.	Word CP	Char. CP	I/O Ctl.	Word CP	Char. CP	I/O Ctl.	4:200.1132
	msec/block	a_1	0.05			0.05			0.05			0.05			
	msec/record	a_2	0.08			0.08			0.08			0.08			
	msec/detail	b_6	0.04			0.04			0.04			0.04			
	msec/work	$b_5 + b_9$	0.12			0.12			0.12			0.12			
	msec/report	$b_7 + b_8$		0.25			0.25			0.25			0.25		
3 Standard File Problem A F = 1.0	msec/block for C.P. and dominant column.	a_1	0.05			0.05			0.05			0.05			4:200.114
		a_2K	0.80			0.80			0.80			0.80			
		a_3K	1.60	2.50		1.60	2.50		1.60	2.50		1.60	2.50		
		File 1: Master In	0.09			0.09			0.09			0.09			
		File 2: Master Out	0.09			0.09			0.09			0.09			
		File 3: Details	0.08			0.08			0.08			0.08			
		File 4: Reports	0.01	10.50	137.0	0.01	0.23	25.6	0.01	10.50	92.7	0.01	0.23	17.5	
		Total	2.72	13.00	137.0	2.72	2.73	25.6	2.72	13.00	92.7	2.72	2.73	17.5	
4 Standard File Problem A Space	Unit of measure	(characters)													4:200.1151
		Std. routines	6,000			6,000			6,000			6,000			
		Fixed	1,600			1,600			1,600			1,600			
		3(Blocks 1 to 23)	612			612			612			612			
		6(Blocks 24 to 48)	3,640			3,640			3,640			3,640			
		Files	2,280			5,880			2,280			5,880			
		Working	1,160			1,160			1,160			1,160			
		Total	15,292			18,892			15,292			18,892			

	ITEM		CONFIGURATION				REFERENCE
			VIIA (on-line card/print)	VIIA (off-line card/print)	VIIIA (on-line card/print)	VIIIA (off-line card/print)	
5 Standard Mathematical Problem A	Fixed/Floating point		Floating point	Floating point	Floating point	Floating point	4:200.413
	Unit name	input	223 Card Reader	204B-8 Tape Unit	223 Card Reader	204B-9	
		output	222-3 Printer	204B-8 Tape Unit	222-4 Printer	204B-9	
	Size of record	input	80 characters	80 characters	80 characters	80 characters	
		output	120 characters	120 characters	120 characters	120 characters	
	msec/block	input T_1	75	6.7	75	5.9	
		output T_2	137	7.7	92.7	6.7	
	msec penalty	input T_3	0.01	0.01	0.01	0.01	
		output T_4	1.05	0.01	1.05	0.01	
	msec/record	T_5	0.43	0.43	0.43	0.43	
	msec/5 loops	T_6	0.42	0.42	0.42	0.42	
	msec/report	T_7	0.20	0.20	0.20	0.20	

* Files 3 and 4 are on magnetic tape, blocked 10 records per block.

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

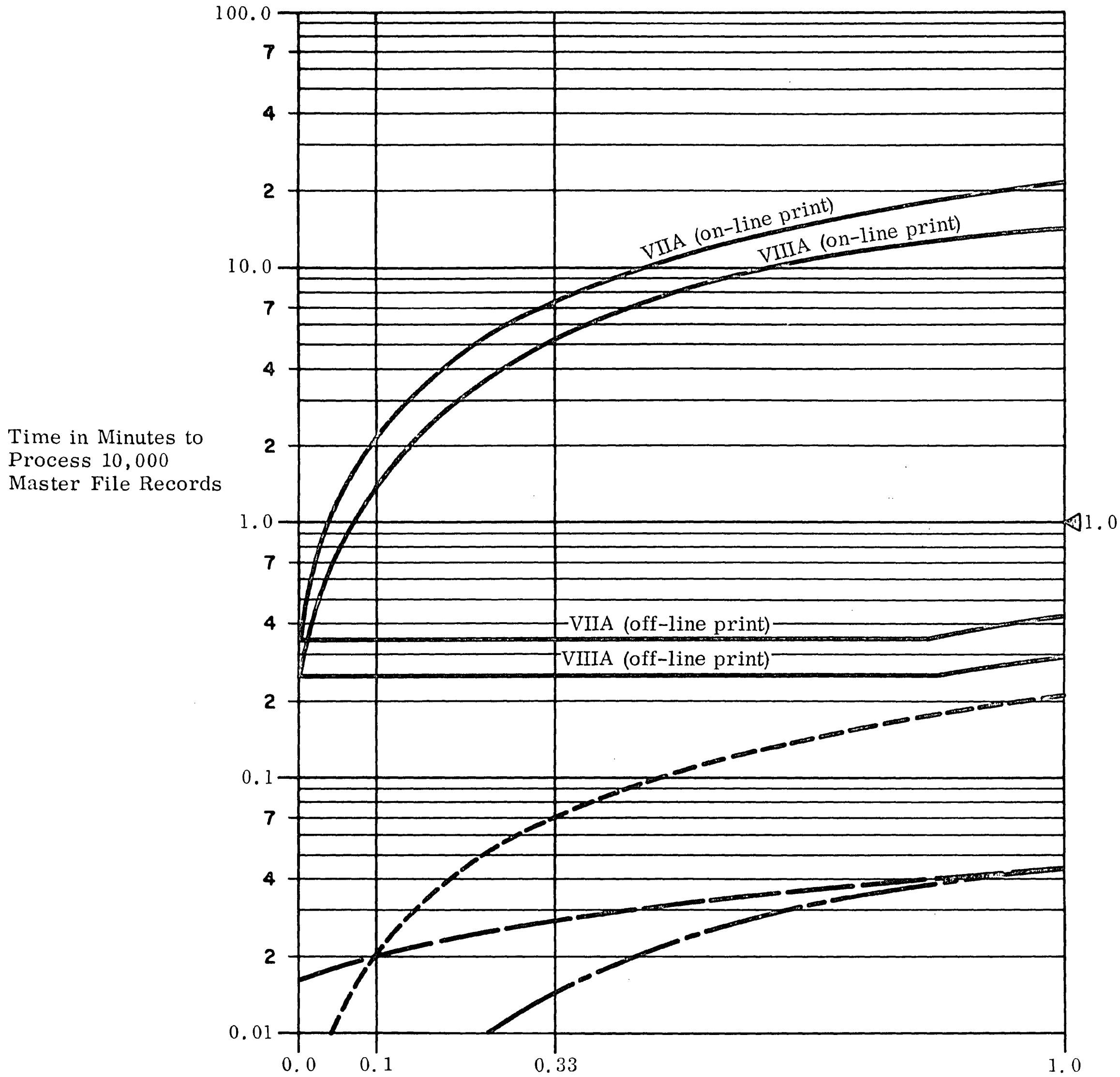
.111 Record sizes —
Master file: . . . . . . 94 characters.
Detail file: . . . . 1 card.
Report file: . . . . 1 line.

.112 Computation: . . . . shared between word and character processors.

.113 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage space required —
Configuration VIIA (on-line card and print): . . . . 15,292 characters.
Configuration VIIA (off-line card and print): . . . . 18,892 characters.
Configuration VIIIA (on-line card and print): . . . . 15,292 characters.
Configuration VIIIA (off-line card and print): . . . . 18,892 characters.



Activity Factor
Average Number of Detail Records Per Master Record
(Roman numerals denote standard System Configurations.)

LEGEND

Elapsed time
Word processor time
Character processor time (off-line print)
Character processor time (on-line print)

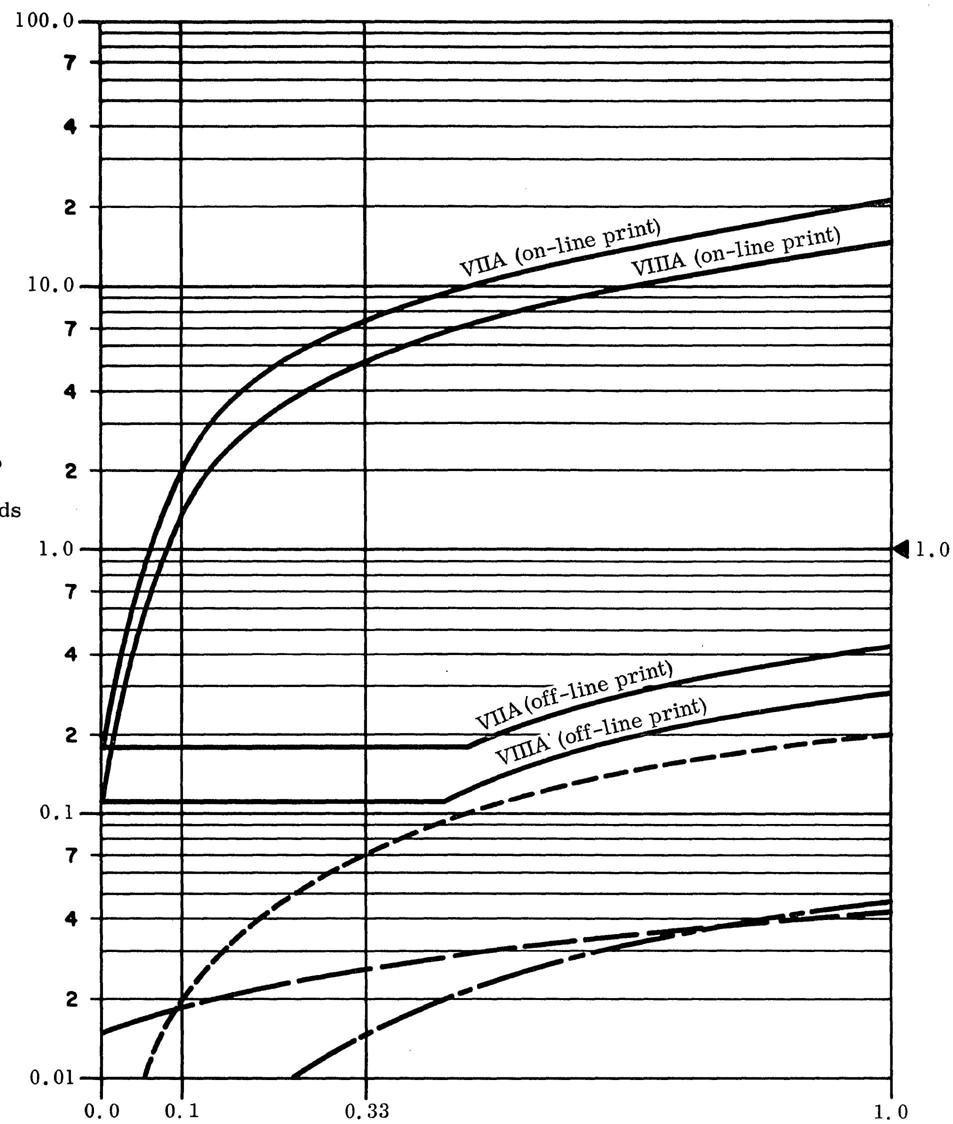
.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . . 47 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.122 Computation:. . . . . . . shared between word and character processors.

.123 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.

.124 Graph: . . . . see graph below.



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

LEGEND
Elapsed time
Word processor time
Character processor time (off-line print)
Character processor time (on-line print)

(Contd.)

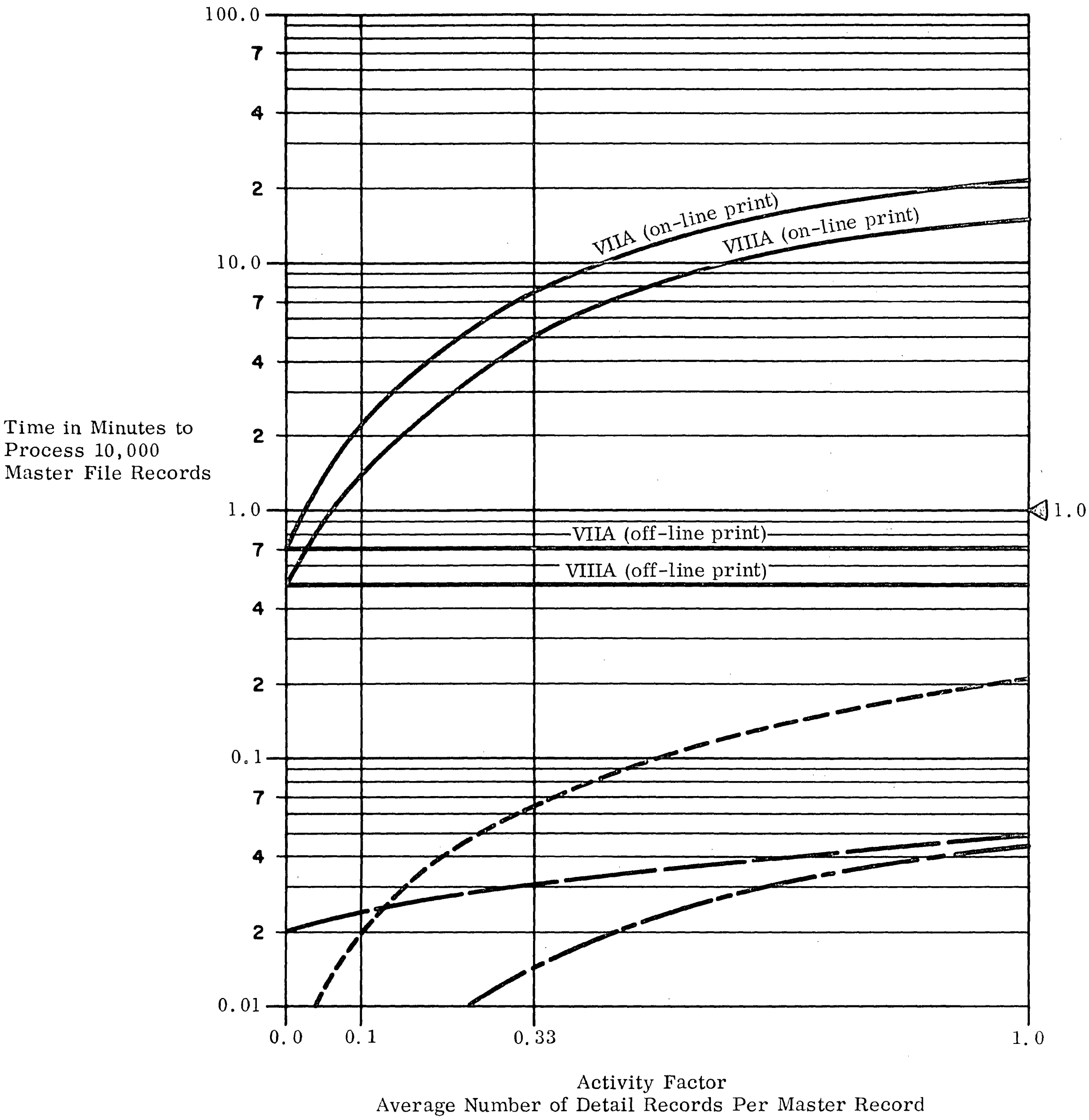
.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . . 188 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.132 Computation:. . . . . . . shared between word and character processors.

.133 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.13

.134 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

LEGEND

Elapsed time
Word processor time
Character processor time (off-line print)
Character processor time (on-line print)

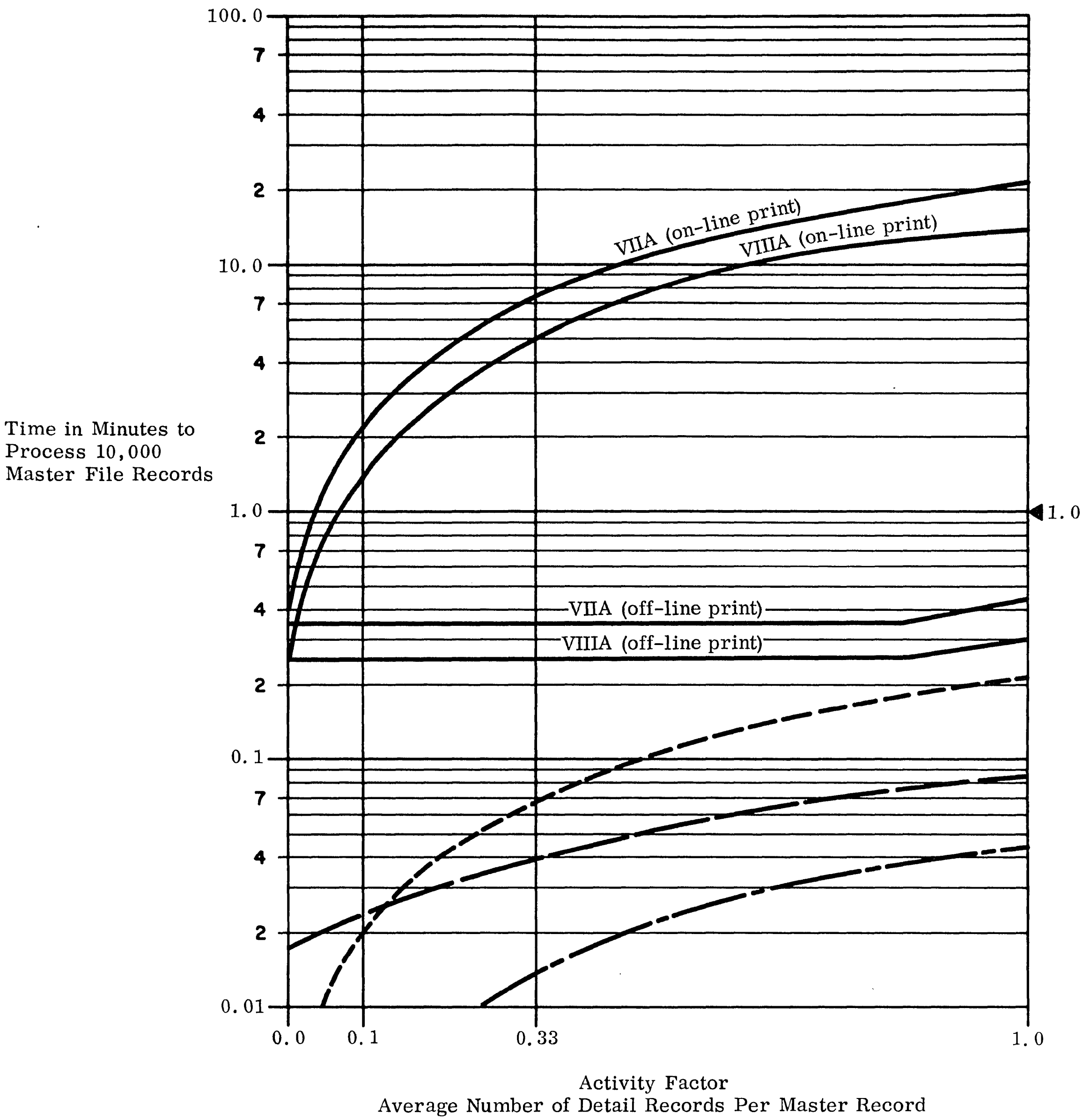
.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . . . 94 characters.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.142 Computation:. . . . . . . trebled in the main processing portion of the Standard File Processing Problem.

.143 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.

.144 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

LEGEND

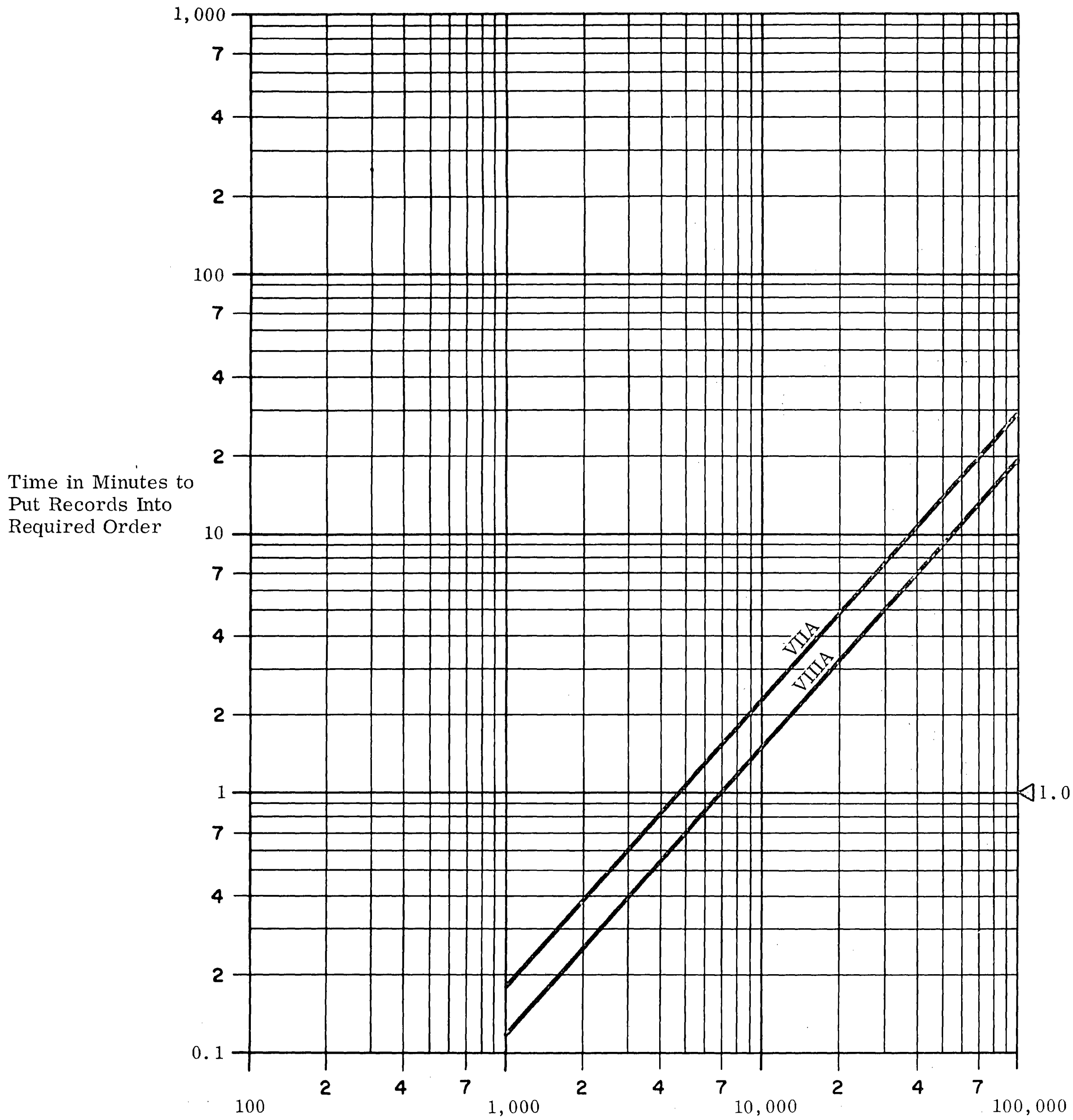
Elapsed time
Word processor time
Character processor time (off-line print)
Character processor time (on-line print)

(Contd.)

.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.
.212 Key size: . . . . 8 characters.
.213 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.213; 3-way tape merge.
.214 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

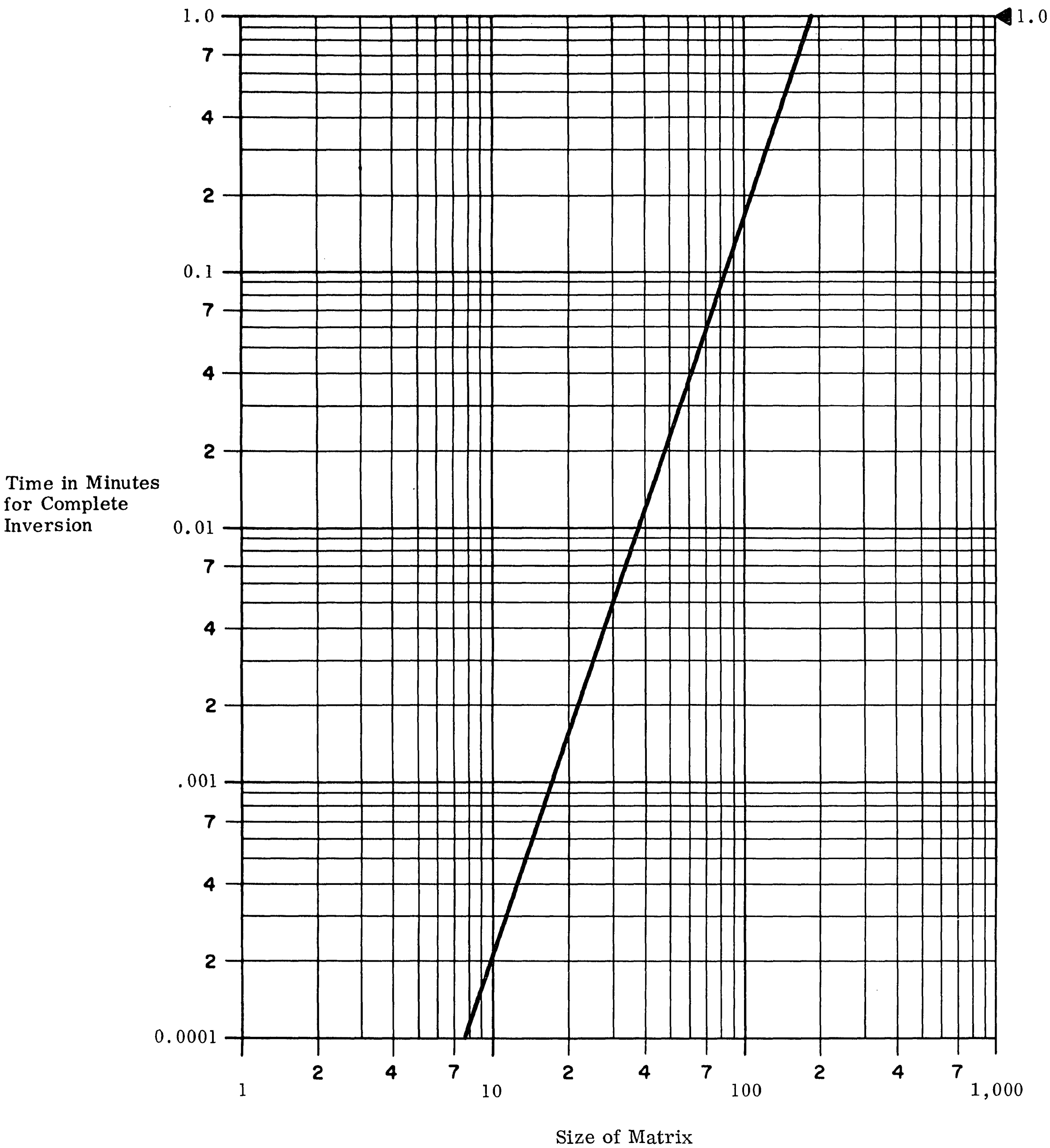
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits precision.

.312 Timing basis: . . . . . . estimating procedure outlined in Users' Guide, 4:200.312, using word processor with optional floating-point arithmetic feature.

.313 Graph: . . . . see graph below.



(Contd.)

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

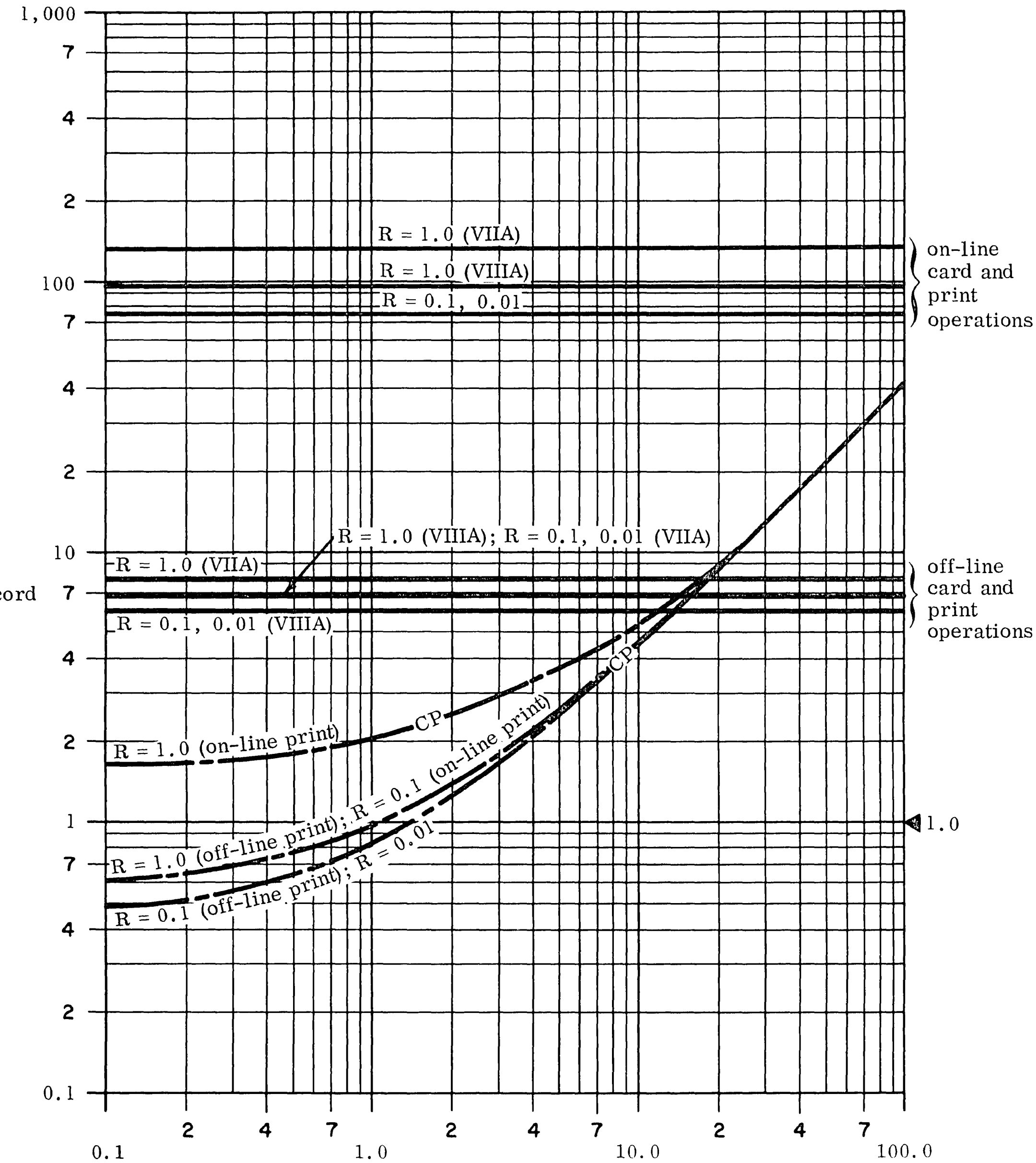
.411 Record sizes: . . . . . . 10 signed numbers; average size 5 digits, maximum size 8 digits.

.412 Computation: . . . . 5 fifth-order polynomials; 5 divisions and 1 square root; computation is performed in floating-point decimal mode, using word processor with optional floating-point arithmetic feature.

.413 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.

CONFIGURATIONS VIIA AND VIIIA



C, Number of Computations Per Input Record

(R = number of Output Records per Input Record.)

LEGEND

——————— Elapsed time

——CP——— — ——— Word processor time

PRICE DATA: HONEYWELL 8200

CLASS	IDENTITY OF UNIT		PRICES				
	No.	Name	Monthly Rental $ (1-year term)	Monthly Rental $ (5-year term)	Monthly Maintenance $	Purchase (immediate) $	Purchase (after 1 year) $
PROCESSING UNIT		Honeywell 8200 Central Processor					
	8201-1	262,144 characters of memory	25,580	24,190	1,920	1,149,120	1,209,600
	8201-2	524,288 characters of memory	34,210	32,350	2,560	1,536,720	1,617,600
	8201-3	786,432 characters of memory	43,140	40,800	3,230	1,938,000	2,040,000
	8201-4	1,048,576 characters of memory	51,770	48,960	3,880	2,325,600	2,048,000
		Optional Features					
	8201-B	Scientific Unit (Floating-Point Arithmetic)	760	720	60	34,200	36,000
	8214	Additional 8 Read/Write Channels and 8 Auxiliary Read/Write Channels	1,525	1,440	120	68,400	72,000

For prices of the Honeywell Series 200 peripheral devices, please refer to the general Honeywell Series 200 Price Data section, beginning on page 510:221.101.

MONROBOT XI

Monroe Calculating Machine Co., Inc.

Division of Litton Industries

AUERBACH

STANDARD EDP REPORTS

AUERBACH INFO, INC.

PRINTED IN U. S. A.

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CONTENTS

CONTENTS–Contd.

INTRODUCTION

§ 011.

The Monrobot XI is a compact, solid-state data processing system that is suitable for a variety of fairly complex but low-volume business and scientific applications. It is also being used in small instrumentation and process control systems. The basic system, consisting of computer, input-output typewriter, and paper tape reader and punch, can be purchased for $24,500 or leased for $700 per month. This makes it one of the lowest priced internally programmed data processing systems currently available.

The central processor is housed in a desk-size cabinet and weighs only 375 pounds. Most of the peripheral devices are housed in matching cabinet modules of desk height that can be arranged in a number of ways for maximum operating efficiency. There are no special power or air conditioning requirements.

A magnetic drum provides 1,024 word locations of working storage; a 2,048-word drum is a recently-announced option. Each 32-bit location can hold two single-address instructions, one binary data word, or from four to six alphameric characters. Seven of the addressable storage locations are Fast Access Registers with a constant access time of 0.73 milliseconds. Average access time for all other storage locations is 5.85 milliseconds.

The small but convenient instruction repertoire includes addition, subtraction, and multiplication of single word-length, fixed point binary data. Division can only be accomplished by subroutines. Binary and decimal shifts and a repetitive subtraction ("detract") instruction facilitate the programmed radix conversions that usually must be performed upon input and output data. Neither index registers nor indirect addressing are provided, so a large proportion of the instructions in many programs will be devoted to "housekeeping" operations. Program execution speed will usually average 60 to 80 instructions per second. Somewhat higher speeds can be achieved if operand addresses are optimized where possible, but the increase in speed will seldom justify the extra coding time.

Up to three separate input devices and three output devices can be connected to the Monrobot XI and selected under program control. Each input or output instruction initiates the transfer of a single character between the processor and the addressed peripheral device. Overlapping of input-output operations and internal processing is possible.

Paper tape or verge-punched cards with 5- or 8-level codes can be punched and read mechanically at a peak speed of 20 characters per second. A photoelectric reader provides maximum input speeds of 40 to 50 characters per second. IBM 024 or 026 Card Punches can be connected through special couplers and used for on-line punched card input, output, or both. Standard 80-column cards are read and punched at 16 columns per second.

Printed output can be produced at up to 10 characters per second by either a modified IBM electric typewriter or a Teletype printer; either unit can also be used for manual entry of data. A 16-key keyboard is useful for rapid entry of all-numeric data.

The Monroe-Card Processor reads and records information on magnetizable cards. Up to 1,566 decimal digits or 1,044 alphameric characters can be stored on each card. Monroe-Cards will be useful for master file storage in a variety of data processing applications.

The Monrobot XI software situation, when viewed by potential users with a strong desire to minimize programming time and effort, leaves much to be desired. Routines currently available from the manufacturer are limited to general utility routines, a user-developed symbolic assembly system, and a group of scientific routines (floating point

INTRODUCTION–Contd.

§ 011.

arithmetic, functions, matrix inversion, etc.). No compiler systems, interpretive systems, or report generators are available or under development.

Most coding is done in machine language; the coder writes four hexadecimal digits per instruction, or eight per word. The hexadecimal addressing scheme is easy to master, but the operation codes have no mnemonic relationship to their effects. Generalized subroutines are available to handle division, loop control, address modification, and input-output with radix conversions, but the manufacturer encourages the use of individually-tailored, user-coded routines for greater efficiency.

A Monrobot XI users' group is now being formed, under Monroe's auspices, to encourage and control the publication, standardization, and distribution of routines developed by users and by the manufacterer.

DATA STRUCTURE

§021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Word:	32 bits	basic addressable location.
Tetrad:	4 bits	non-addressable sub group of a word.
Row:	8 or 5 bits	punched tape.
Column:	12 positions	punched cards.

.2 INFORMATION FORMATS

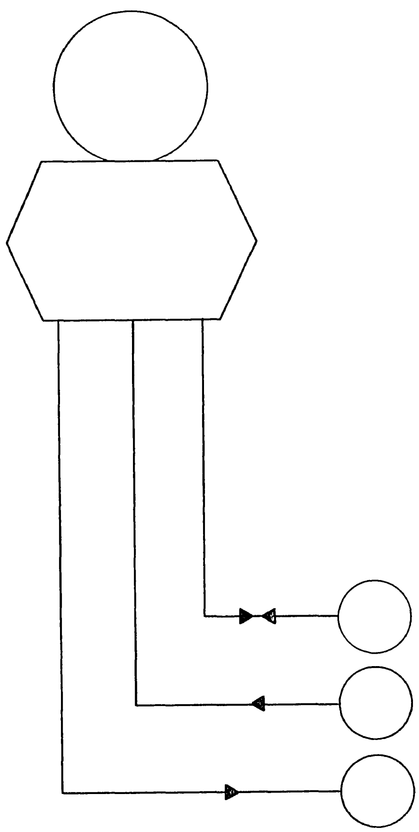
Type of Information	Representation
Character:	6 or 5 bits (internal). 1 row (punched tape). 1 column (punched cards).
Hexadecimal digit:	1 tetrad (4 bits).
Number:	1 word (sign bit, overflow bit, and 30 data bits).
Instruction:	16 bits (2 instructions per word).

SYSTEM CONFIGURATION

§ 031.

.1 DESK SIZE SYSTEM (CONFIGURATION IX)

Deviations from Standard Configuration: . . . . . . storage is smaller by about 700 words; automatic division is not available; tape reader and punch are faster by 10 char/sec.



Equipment	Rental
Drum Storage: 2,048 words.	$ 185
Central Processor Input-Output Typewriter: 10 char/sec. Paper Tape Reader: 20 char/sec. Paper Tape Punch: 20 char/sec.	$ 700
Total Rental:	$ 885

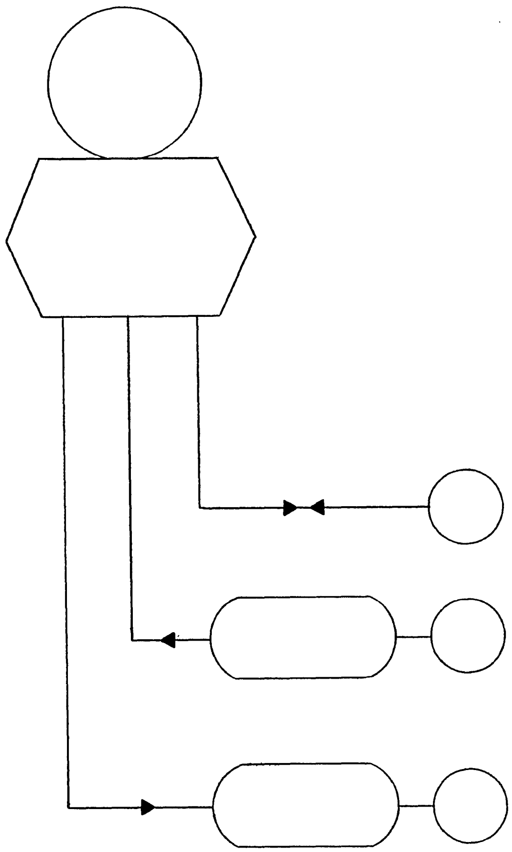
Optional Features Included: . . . . 2,048-Word Drum.

Notes: Use of standard 1,024-Word Drum decreases monthly rental to $700. Addition of a second Paper Tape Reader, required for the Generalized File Processing problem (Section :201.1), increases monthly rental to $945.

§ 031.

.2 PUNCHED CARD SYSTEM (CONFIGURATION I)

Deviations from Standard Configuration: . . . . input-output devices are slower by factors of 20 to 200; automatic division and indexing are not available.



Equipment	Rental
Drum Storage: 1,024 words.	
Central Processor	$ 700
Input-Output Typewriter: 10 char/sec.	
IBM 024 Card Punch and Coupler: reads 16 columns/sec.	$ 40
IBM 026 Printing Card Punch and Coupler: punches 16 columns/sec.	$ 60
Total Rental:	$ 800

Optional Features Included: . . . . none.

INTERNAL STORAGE: DRUM

§ 041.

.1 GENERAL

.11 Identity: . . . . Drum Storage (part of Monrobot XI Computer).

.12 Basic Use: . . . . . . working storage.

.13 Description:

The magnetic drum is an integral part of the Monrobot XI Computer. It provides a total of 1,024 addressable locations of working storage. Each word location contains 32 bit positions and can hold two instructions, one numeric data word, five 6-bit alphameric characters, or six 5-bit characters.

There are 18 addressable bands: 16 for "general" storage and two for "fast access" storage. Each band of general storage is divided into 16 "sectors", and each sector is further divided into four "phases", each capable of holding one word. Each band of fast access storage contains four recirculating registers, and each register is available for access every sector time, or 16 times per drum revolution.

One of the eight fast access registers is the Instruction Register, which holds the next two instructions to be executed and is addressed automatically by the control circuitry. The addresses 000 through 006 are assigned to the other fast access registers. Fast Access Register 6 serves as the accumulator, and Registers 2, 4, and 5 are also involved in certain machine operations (see Instruction List). Fast Access Registers 0, 1, and 3 have no special functions and can always be used as working storage. Addresses 007 through 3XX (in hexadecimal) refer to general storage, representing 1,017 addressable locations.

Drum speed is 5,124 revolutions per minute. Access time for general storage ranges from 0.73 to 11.7 milliseconds (one sector time to one revolution time). For the fast access registers, access time is a constant 0.73 millisecond. One fixed head serves each track, and reading and recording are serial by bit. Bits for the four words within each sector are interleaved in both general and fast access storage, so that only every fourth bit on the drum surface is read or recorded at a time. Internal transfer rates are low because of the lack of block transfer facilities and indexing. No error checks are provided.

Optional Feature

2,048-Word Drum: Announced in September, 1962, this unit can be installed in place of the standard 1,024-word drum at a rental increase of $185 per month. It provides 16 additional bands of general storage. One of the six "command" bits in the Monrobot XI instruction format is never used in operation codes that reference storage; this bit is used in addressing the 1,024 additional locations, and the resulting hexadecimal addresses are 800 through TXX. Except for its increased capacity, all operational characteristics of the 2,048-word drum are the same as those of the standard model.

.14 Availability: . . . . . . 3 to 6 months.

.15 First Delivery: . . . December, 1960.

.16 Reserved Storage

Purpose	Number of locations	Locks
Index registers:	none.	
Fast access registers:	8 (7 addressable)	none.
I/O control:	none.	
	none.	

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic drum.

.22 Physical Dimensions

.222 Drum
Diameter: . . . . 8 inches.
Length: . . . . 1.75 inches across recording surface.
Number on shaft: . . . . 1.

.23 Storage Phenomenon: . . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . fast access bands only.
.243 Data volatile: . . . . . . no.
.244 Data permanent: . . . no.
.245 Storage changeable: . . no.

§ 041.

.25 Data volume per band of 1 track

	General	Fast Access
Words:	64.	4.
Characters (6-bit code):	320.	20.
Digits (decimal equivalent):	576	36.
Instructions:	128.	8.

.26 Bands per physical unit: . . . . 16 general.
2 fast access.

.27 Interleaving Levels: . four.

.28 Access Techniques

.281 Recording method: . . . fixed heads.

.283 Type of access

Description of stage	Possible starting stage
Wait for selected sector:	always.
Read or write one word:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 5,124 rpm.
Track/head speed: . . 2,150 inches/sec.
Bits/inch/track: . . . 81.
Bit rate per track: . . 175,000 bits/sec/track.

.292 Peak data rates
Unit of data: . . . . word.
Conversion factor: . 32 bits/word.
Gain factor:. . . . . 1 track/band.
Loss factor: . . . . 4 interleaved words/sector.
Data rate: . . . . . . 1,370 words/second (but see paragraph .73).

.3 DATA CAPACITY

.31 Module and System Sizes

Identity: . . . . standard.
Drums: . . . . 1.
Words: . . . . 1,024.
Characters: . . . . . 5,120.
Instructions: . . . . . 2,048.
Modules:. . . . . 1.

.32 Rules for Combining Modules: 1 drum per system, as above (2,048-word drum is optional; see .13).

.4 CONTROLLER:. . . . Monrobot XI Computer.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks
Stacks per system: . . 18.
Stacks per module: . . 18.

.512 Stack movement: . . . none.

.513 Stacks that can access any particular location: . . . . 1 per band.

.514 Accessible locations
By single stack: . . . 64 or 4.
By all stacks
With no movement:. . . . . . . 1,024 per module.
1,024 per system.

.515 Relationship between stacks and locations: . . . . track address (4 bits) designates stack to be used.

.52 Simultaneous Operations: . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access (fast access storage)
Access time: . . . 730 μ sec.
Cycle time: . . . . 730 μ sec.
For data unit of: . . . 1 word.

.532 Variation in access time (general storage)

Stage	Variation, μsec.	Example, μ sec.
Wait for selected sector:	0 to 11,000	5,110.
Read or write one word:	730	730.
	730 to 11,730	5,840.

.6 CHANGEABLE STORAGE: . . . . none.

.7 STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage unit possibilities: . . . . with self only.

.72 Transfer Load Size

With self: . . . . 1 word.

.73 Effective Transfer Rate

With self, using loop: . . . . 14 words/sec.
With self, using straight-line coding: . . . . . . 85 words/sec. max.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock
Invalid address:	all addresses valid.
Invalid code:	none.
Receipt of data:	none.
Recording of data:	none.
Recovery of data:	none.
Dispatch of data:	none.
Timing conflicts:	none.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . Monrobot XI Computer.

.12 Description:

The Monrobot XI Computer is a desk-size, solid-state unit that also houses the magnetic drum store. The Console Control Unit is swivel-mounted on top of the Computer cabinet.

Two single-address instructions are stored in each 32-bit word location. The basic instruction format is a 6-bit operation code and a 10-bit operand address. Coding is usually done in machine language, with four hexadecimal characters per instruction.

There are 26 instructions available, including addition, subtraction, and multiplication of single word-length binary data. Automatic division is not provided, but the "detract" command causes repetitive subtraction with counting; it is useful in division subroutines and in binary-to-decimal radix conversions. The "extract" command is a logical AND. Binary or decimal shifts of up to 8 positions may be performed; the decimal shifts are automatic multiplications or divisions by powers of ten. Input and output instructions initiate the transfer of a single character of up to eight bits from or to the addressed input-output device, with automatic processor interlock if the device is not ready.

The Monrobot XI differs from most one-address processors by having no sequence counter. A three-instruction "control loop" consists of the 16-bit control register, which decodes the instruction being executed, and the 32-bit instruction register, which provides fast access storage for two instructions that are about to be or have just been executed. One of the three instructions in the control loop is always an "automatic jump" that contains the address of the next instruction word to be brought into the loop for execution. During normal sequential operation, every third instruction executed is the automatic jump; it loads the next pair of instructions into the instruction register and is itself incremented by one and recirculated through the loop. As far as the user is concerned, the instructions in his program are executed sequentially except when a programmed branch causes a different address to be placed into the automatic jump instruction. Therefore, the unusual sequence control facility can be ignored in programming except for its effect upon execution times.

All of the Monrobot XI instructions except multiply, detract, and shifts require four sector times (2.92 milliseconds, or one-fourth of a drum revolution) for execution. Each automatic jump instruction also requires four sector times. A pair of program instructions and the automatic jump instruction that loads them can be executed in a single drum revolution (11.7 milliseconds) if the operands of both program instructions are carefully located to minimize access times. Optimization of the operand addresses is time-consuming and often impossible, so two or three drum revolutions are more commonly required for each pair of instructions. Both minimum and typical execution times are shown in the Processor Performance section (paragraph .4).

Use of one or more of the seven fast access registers for temporary storage of data or instructions can significantly decrease execution times in many applications. These registers have a constant access time of 0.73 milliseconds, so they are always "optimum."

.13 Availability: . . . . . . 3 to 6 months.

.14 First Delivery: . . . . December, 1960.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-subtract:	automatic	binary	1 word.
Multiply			
Short:	none.		
Long:	automatic	binary	1 word.
Divide			
No remainder:	none.		
Remainder:	subroutine	binary	1 word.
.212 Floating point			
Add-Subtract:	subroutine	binary	24 & 8 bits.
Multiply:	subroutine	binary	24 & 8 bits.
Divide:	subroutine	binary	24 & 8 bits.
.213 Boolean			
AND:	automatic	binary	1 word.
Inclusive OR:	none.		
.214 Comparison			
Numbers:	subtract & test		1 word.
Absolute:	none.		
Letters:	subtract & test		1 word.
Mixed	subtract & test		1 word.
Collating sequence:	irregular (see Data Code Tables 1 & 2).		
.215 Code translation:	none.		

.216 Radix conversion

Provision	From	To	Size
subroutines	decimal	binary	1 to 9 digits.
subroutines	binary	decimal	1 word.

§ 051.

.217 Edit format:

	Provision	Comment	Size
Alter size:	none.		
Suppress zero:	subroutine		1 word.
Round off:	none.		
Insert point:	subroutine		1 word.
Insert spaces:	none.		
Protection:	none.		

.218 Table look-up: . . . . . none.

.219 Others

Decimal shift:	automatic	left or right	1 word
Binary shift:	automatic	left, right, end around	1 word; 2 words for end around shift.
Detract:	automatic	see Instruction List	1 word.

.22 Special Cases of Operands

.221 Negative numbers: . . . two's complement.

.222 Zero: . . . . 1 form, interpreted as plus zero in tests.

.223 Operand size determination: . . . . fixed; 1 word.

.23 Instruction Formats

.231 Instruction structure: . 2 instructions per word.

.232 Instruction layout:

Part	Command	Operand
Size (bits)	6	10

.233 Instruction parts

Name	Purpose
Command:	specifies operation
Operand:	1) specifies track (4 bits), sector (4 bits) and phase (2 bits) address of operand; 2) specifies length of a shift operation; or 3) contains the 8-bit code for an output character.

.234 Basic address structure: 1 + 0.

.235 Literals

Arithmetic: . . . . . . none.

Comparisons and tests: . . . . none.

Incrementing modifiers: . . . . . . none.

Shifting: . . . . 1 to 8 binary or decimal digit positions.

.236 Directly addressed operands

.2361 Internal storage type: drum.

Minimum size: . . 1 word.

Maximum size: . . 1 word.

Volume accessible: 1, 024 locations.

.2362 Increased address capacity: . . . . none.

.237 Address indexing: . . none.

.238 Indirect addressing: . none.

.239 Stepping: . . . . own coding required

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in bits	Program usage
Drum:*	7	32 each	fast access storage.
Drum:	1	32	instruction register.
Processor:	1	16	control register.

.242

Category of storage	Total number locations	Physical form	Access time, μ sec	Cycle time, μ sec
Drum:	8	recirculating tracks	730	730.
Processor:	1	flip-flops	?	730.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1 ("automatic jump" instruction in control loop).

.314 Special sub-sequence counters: . . . . none.

.315 Sequence control step size: . . . . 1 word (2 instructions).

.316 Accessibility to routines: . . . . by means of "jump mark" instruction (see Instruction List).

.317 Permanent or optional modifier: . . . . no.

.32 Look-Ahead: . . . . . . none.

.33 Interruption: . . . . . . none.

.34 Multi-running: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

Conditions

I: . . . . operands in optimum locations wherever possible.

II: . . . . operands randomly placed, as in typical user coding.

III: . . . . floating point mode, using standard subroutines.

§ 051.

.41 Instruction Times in μ secs

Condition:	I	II	III
.411 Fixed point			
Add-subtract:	5, 800	11, 700	-
Multiply:	29, 200	35, 000	-
Divide (estimated)			
Using generalized subroutine:	700, 000	700, 000	-
Using special routines:	300, 000	300, 000	-
.412 Floating point			
Add:	-	-	420, 000.
Subtract:	-	-	480, 000.
Multiply:	-	-	500, 000.
Divide:	-	-	600, 000.
.413 Additional allowance for			
Indexing:	none.		
Indirect addressing:	none.		
Re-complementing:	none.		
.414 Control			
Branch:	5, 850	11, 700	-
Compare and branch:	11, 700	23, 400	-
.415 Counter control			
Step and test: (5 instructions)	29, 200	58, 500	-
.416 Edit:	see Note below.		
.417 Convert:	see Note below.		
.418 Shift N positions: (decimal or binary)	3, 650 + 730N	9, 500 + 730N	-

Note: Radix conversion and straightforward editing of numeric data can usually be accomplished during the 47 milliseconds available between characters at the maximum input-output speed of 20 char/sec. when specially-coded, optimized routines are used.

.42 Processor Performance in μ secs

Condition:	I	II	III
.421 For random addresses			
c = a + b:	17, 600	35, 100	443, 000.
b = a + b:	17, 600	35, 100	443, 000.
Sum N items:	5, 850N	11, 700N	420, 000N.
c = ab:	41, 000	58, 500	523, 000.
c = a/b (estimated)			
Using generalized subroutine:	712, 000	723, 000	623, 000.
Using special routines:	312, 000	323, 000	-
.422 For arrays of data			
$c_i = a_i + b_j$:	105, 000	129, 000	537, 000.
$b_j = a_i + b_j$:	105, 000	129, 000	537, 000.
Sum N items:	58, 500	94, 000	502, 000.
$c = c + a_i b_j$:	105, 000	140, 000	1, 040, 000.

Condition:	I	II
.423 Branch based on comparison		
Numeric data:	117, 000	152, 000.
Alphabetic data:	117, 000	152, 000.
.424 Switching		
Unchecked:	46, 800	58, 500.
Checked:	82, 000	117, 000.
List search:	58, 500+ 82, 000N	58, 000+ 105, 000N.
.425 Format control per character (including radix conversions)		
Unpack:	47, 000(**).	
Compose:	47, 000(**).	
.426 Table look up per comparison		
For a match:	70, 000	94, 000.
For least or greatest:	72, 000	96, 000.
For interpolation point:	70, 000	94, 000.
.427 Bit indicators		
Set bit in separate location:	11, 700	23, 400.
Set bit in pattern:	35, 100	46, 800.
Test bit in separate location:	17, 600	35, 100.
Test bit in pattern:	23, 400	46, 800.
Test AND for B bits:	29, 200	58, 500.
Test OR for B bits:	58, 500	82, 000.
.428 Moving N words		
Using loop:	70, 000N	82, 000N.
Using straight-line coding:	11, 700N	23, 400N.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	programmed test	see note below.
Underflow:	none.	
Zero divisor:	checked by Divide subroutine	transfer to fixed location.
Invalid data:	none.	
Invalid operation:	none.	varies.
Arithmetic error:	none.	
Invalid address:	all addresses valid.	
Receipt of data:	none.	
Dispatch of data:	none.	

Note: The two high-order bit positions (sign and "overflow" bits) of an arithmetic result will always have the same values except when overflow has occurred; a programmed test is required.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . Console Control Unit.

.12 Associated Units: . . Input-Output Typewriter stands on console desk and provides keyboard input and typed output. Optional 16-Key Keyboard can be used for manual input of numeric data.

.13 Description:

The basic Monrobot XI system consists of the desk-size Computer cabinet and a knee-hole desk that holds the input-output equipment. The two cabinets are commonly arranged in an "L" shape with the input-output desk on the right. Additional matching cabinet modules can be used to house expanded equipment configurations.

The Console Control Unit is a small box that is swivel-mounted on the top of the Computer cabinet, at desk-top level. It contains five back-lighted control buttons, eight intervention (sense) switches, seven input-output alarm lights, and a 16-light binary display of the next instruction to be executed.

The controls are simple and convenient, but the lack of a display of the contents of the accumulator seriously hampers console debugging. This deficiency can be remedied by the addition of the optional Oscilloscope View Box, which can be manually switched to provide a binary display of the accumulator, control loop, or Fast Access Register 4 or 5.

In the RESET mode, automatic operation is suspended and data can be entered into the accumulator from the typewriter or 16-key keyboard. Only the hexadecimal characters 0 through 9 and S through X may be typed. If more than eight characters are typed the first ones will be shifted beyond the high order end of the accumulator and lost. The reset mode is necessary for loading initial "boot-strap" programs, for transferring control to the beginning of a specific program, and for manual alteration of data in storage.

.2 CONTROLS

.21 Power

Name: . . . . ON switch.
Form: . . . . off-on button.
Comment: . . . . . . controls system power.

.22 Connections: . . . . . none.

.23 Stops and Restarts

Name	Form	Comment
HALT switch:	off-on button	halts automatic operation after execution of instruction in control register.
START switch:	button	initiates automatic operation.

.24 Stepping: . . . . with HALT switch on, one instruction is executed each time START is depressed.

.25 Resets

Name: . . . . RESET switch.
Form: . . . . off-on button.
Comment: . . . . . . halts and prevents automatic operation and sets control loop to zero.

.26 Loading

Name: . . . . LOAD switch.
Form: . . . . button.
Comment: . . . . . . transfers contents of accumulator to instruction register when in RESET mode.

.27 Sense Switches

Name: . . . . Intervention Switches.
Form: . . . . 8 off-on buttons.
Comment: . . . . . . status can be tested by the stored program.

.28 Special: . . . . none.

.3 DISPLAY

.31 Alarms

Name	Form	Comment
Input:	3 lights	lit when no character is available from an addressed input device.
Output:	3 lights	lit when output cannot be made to an addressed device (busy, not connected, etc.)
Parity:	light	indicates even parity in last character entered.

§ 061.

.32 Conditions

Name	Form	Comment
ON: RESET: LOAD: HALT: START:	lighted buttons	lit when corresponding switch is "on".

.33 Control Registers: . . . . 16 Control Register Lights provide binary display of next instruction to be executed.
Optional Oscilloscope View Box provides binary display of any one of the following, selected by manual switch: accumulator, Fast Access Register 4 or 5, or control loop.

.34 Storage: . . . . no direct display available.

.4 ENTRY OF DATA

.41 Into Control Registers: . . . . in RESET mode, can be typed into accumulator (in hexadecimal form) and transferred into instruction register by depressing LOAD switch.

.42 Into Storage

1. Depress RESET switch.
2. Type "TADR", where ADR is hexadecimal address of the location to be filled.
3. Depress LOAD button.
4. Type desired data value, in hexadecimal form.
5. Depress START button.

.5 CONVENIENCES

.51 Communications: . . . none.

.52 Clock: . . . . none.

.53 Desk Space: . . . . . tops of Computer cabinet and knee-hole desk provide ample free work space.

.54 View: . . . . most equipment configurations can be arranged so that seated operator has clear view of entire system.

INPUT-OUTPUT: PAPER TAPE READER

§071.

.1 GENERAL

.11 Identity: . . . . Paper Tape Reader. (8-Track and 5-Track Models.)

.12 Description

The Paper Tape Reader is manufactured by Commercial Controls Corporation. It reads standard paper tape codes at a peak speed of 20 characters per second. The two models differ only in tape code level: 8-track or 5-track. The feed pan permits tape to be fed from the inside of a roll, so no rewinding is necessary. In the basic Monrobot XI system, the reader mechanism is mounted on the front of the upper drawer of the input-output desk, just below desktop level.

Each input instruction reads a single character into the low-order bit positions of the accumulator and then advances the tape to the next row. Execution of the input instruction takes less than three milliseconds, and other internal operations can be carried out during the remaining 47 milliseconds (4 drum revolutions) of each reader cycle. If consecutive input instructions occur too close together, the processor waits until the next character is available from the reader.

Optional Feature

5-8 Channel Switch: Permits reading either 5-track of 8-track punched tape, depending upon the position of a manual switch. Since all code conversions are programmed, the switch simply deactivates three of the eight sensing pins.

.13 Availability: . . . . . 3 to 6 months.

.14 First Delivery: . . . . December, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive, pull only.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . sensing pins.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . reading punched tape.
Stacks: . . . . 1.
Heads/stack: . . . . . 8 or 5.
Method of use: . . . . reads 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper or plastic tape.
.312 Phenomenon: . . . . . round holes, fully punched or chadless.

.32 Positional Arrangement

.321 Serial by: . . . . . . 1 to N rows at 10 per inch; N is controlled by program.
.322 Parallel by: . . . . . 8 or 5 tracks at standard spacing.
.324 Track use

Model:	8-Track	5-Track
Data:	6	5.
Redundancy check:	1	0.
Timing (sprocket track):	(1)	(1).
Control signals (end line):	1	0.
Unused:	0	0.
Total (exclusive of sprocket track):	8	5.

.325 Row use

Data: . . . . 1 to N.
Redundancy check: . . 0.
Timing: . . . . 0.
Control signals: . . . 1 (optional delimiter).
Unused: . . . . 0.
Gap: . . . . none required.

.33 Coding: . . . . 1 character per row, as in Data Code Table 1 or 2. (Since code translation is programmed, other codes can be read.)

.34 Format Compatibility: . . . . with all devices using standard 8- or 5-track punched tape.

.35 Physical Dimensions

.351 Overall width
8-track tape: . . . . 1.0 inch.
5-track tape: . . . . 0.6875 inch.
.352 Length: . . . . up to about 400 feet per roll.

§ 071.

.4 CONTROLLER

.41 Identity: . . . . Input-Output Buffer (housed in Computer cabinet).

.42 Connection to System

.421 On-line: . . . . 3 buffers (2 standard, 1 optional).
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . maximum of 1 input and 1 output device (or 1 input-output device) per buffer.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 character of 8 or 5 bits.
.442 Input area: . . . . . accumulator (low order bits).
.443 Input area access: . . fully accessible to program.
.444 Input area lockout: . . processor waits on lockout until the character has been read.
.445 Table control: . . . . none.
.446 Synchronization: . . . by program for successive characters.
.447 Synchronizing aids: . . see .444.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . variable.
.512 Block demarcation
Input: . . . . as programmed; any character can be used as a delimiter, or a fixed number of characters can be read.

.52 Input-Output Operations

.521 Input: . . . . read 1 character into low order bit positions of accumulator and advance tape to next row; set all other accumulator bit positions to 0, except set sign bit to 1 if input character has even parity.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . . . none.

.53 Code Translation: . . by program; Data Code Tables 1 and 2 show the standard 8-track and 5-track codes.

.54 Format Control: . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . no.
Select format: . . . . no.
Select code: . . . . . no.
Rewind: . . . . no.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . no; lockout.
Nearly exhausted: . . no.
Busy controller: . . . no.
End of medium marks: . . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . 20 char/sec.
.623 Overhead: . . . . . . asynchronous; reading rate is controlled by program.
.624 Effective speed: . . . 20 char/sec if less than 50 m.sec elapse between successive input instructions.

.63 Demands on System

Component: . . . . . processor.
m.sec. per char: . . 2.9
Percentage: 5.8

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Manual Gear Wheel:	knob	advances or backs up tape manually.
5-8 Channel Switch:	2-way switch	optional; selects code level.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Feed pan:	6-inch dia. roll (about 400 feet).
Take-up reel: . . .	6-inch dia. roll (about 400 feet).

.732 Replenishment time: . 0.5 to 1.0 minute; reader needs to be stopped.
.734 Optimum reloading period: . . . . about 40 minutes.

§ 071.

.72 Other Controls

Function	Form	Comment
Manual Gear Wheel:	knob	advances or backs up tape manually.
5-8 Channel Switch:	2-way switch	optional; selects code level.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity check (8-track only)	set bit indicator in accumulator.
Input area overflow:	not possible.	
Invalid code:	reads all codes into accumulator.	
Exhausted medium:	"no tape" switch	stop reader.
Imperfect medium:	"tight tape" switch	stop reader.
Timing conflicts	lockout	processor waits until character is available.

INPUT–OUTPUT: EDGE-PUNCHED CARD READER

§ 072.

.1 GENERAL

.11 Identity: . . . . Edge-Punched Card Reader.

.12 Description

The Edge-Punched Card Reader has all the facilities, features, and specifications of the Paper Tape Reader, described in section :071. In addition, it is equipped to feed rectangular cards of widely varying size and to read information punched along their margins in standard paper tape code formats at a peak speed of 20 characters per second. Eight-track and five-track models are available; both levels of coding can be read if the optional 5-8 Channel Switch is added.

No facilities are provided for feeding or stacking consecutive cards, so each card or short fanfold set must be loaded into the reader and removed by the operator. This can be done in a few seconds, and the more rapid loading and unloading represents a major advantage of cards over punched tape for applications where the external storage must be of the random access type. Change-overs between punched tape and cards require no special adjustments. The punched tape feed reel and take-up pan are identical to those in the Paper Tape Reader.

INPUT-OUTPUT: PAPER TAPE PUNCH

§ 073.

.1 GENERAL

.11 Identity: . . . . Paper Tape Punch. (8-Track and 5-Track Models).

.12 Description:

The Paper Tape Punch described here is built by Monroe. Other punches have been supplied with the Monrobot XI, but all have the same functional specifications. The punch is usually housed in the lower drawer of a cabinet module, where it can be rolled forward for convenient loading, unloading, and maintenance.

Punched tape codes of eight or five tracks can be produced at a peak speed of 20 characters per second. Since all code conversions are programmed, ed, any code that uses standard hole spacings can be accommodated. Each output instruction initiates the punching of a single character code, after which the tape is advanced one row. The processor is delayed for less than three milliseconds, and the remaining 47 milliseconds of the punch cycle are usually used to prepare the next character for punching. If consecutive output instructions occur too close together, the processor waits until the punch is ready. There are no checks on recording, but a parity bit can be computed and punched automatically on 8-track tape.

Optional Feature

5-8 Channel Switch: Permits punching either 5-track or 8-track codes, depending upon the position of a manual switch.

.13 Availability: . . . . . 3 to 6 months.

.14 First Delivery: . . . . December, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive, pull only.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punches.
.222 Sensing system: . . . . none.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . punching tape.
Stacks: . . . . 1.
Heads/stack: . . . . . 8 or 5 (plus sprocket punch).
Method of use: . . . . punches 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper or plastic tape.
.312 Phenomenon: . . . . . fully punched round holes.

.32 Positional Arrangement

.321 Serial by: . . . . . . 1 to N rows at 10 per inch; N is controlled by program.

.322 Parallel by: . . . . . 8 or 5 tracks at standard spacing.

.324 Track use

Model	8-Track	5-Track
Data:	6	5.
Redundancy check:	1	0.
Timing (sprocket track):	(1)	(1).
Control signals (end line):	1	0.
Unused:	0	0.
Total (exclusive of sprocket track):	8	5.

.325 Row use
Data: . . . . 1 to N.
Redundancy check: . 0.
Timing: . . . . . . 0.
Control signals: . . . 1 (optional delimiter).
Unused: . . . . . . 0.
Gap: . . . . none required.

.33 Coding: . . . . 1 character per row, as in Data Code Table 1 or 2. (Since code translation is programmed, other codes can be punched.)

.34 Format Compatibility: . . . . with all devices using standard 8- or 5-track punched tape.

.35 Physical Dimensions

.351 Overall width
8-track tape: . . . . 1.0 inch.
5-track tape: . . . . 0.6875 inch.
.352 Length: . . . . up to 1,000 feet per roll.

§ 073.

.4 CONTROLLER

.41 Identity: . . . . Input-Output Buffer (housed in Computer cabinet).

.42 Connection to System

.421 On-line: . . . . 3 buffers (2 standard, 1 optional).
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . 1.
.432 Restrictions: . . . . . maximum of 1 input and 1 output device (or 1 input-output device) per buffer.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 character of 8 or 5 bits.
.442 Output areas: . . . . low order bits of Fast Access Register 5 or of the output instruction itself.
.443 Output area access: . . fully accessible to program.
.444 Output area lockout: . . none required.
.445 Table control: . . . . . none.
.446 Synchronization: . . . by program for successive characters.
.447 Synchronizing aids: . . processor waits on lockout until previous character has been punched.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . variable.
.512 Block demarcation Output: . . . . as programmed.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . punch 1 character as defined by low-order bits of Fast Access Register 5 or of the output instruction itself; parity bit is computed and punched automatically on 8-track tape.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . by program; Data Code Tables 1 and 2 show the standard 8-track and 5-track codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . no.
Select format: . . . . no.
Select code: . . . . . no.
Rewind: . . . . no.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . . no; lockout.
Nearly exhausted: . . . no.
Busy controller: . . . no.
End of medium marks . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . 20 char/sec.
.623 Overhead: . . . . asynchronous; punching rate is controlled by program.
.624 Effective speeds: . . . . 20 char/sec. if less than 50 m.sec. elapse between successive output instructions.

.63 Demands on System

Component: . . . . . processor.
m.sec per char.: . . 2.9.
Percentage: . . . . . 5.8.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Tape Feed:	button	prepares leaders.
5-8 Channel Switch:	2-way switch	optional; selects code level.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Feed reel:	1,000 feet.
Take-up reel:	1,000 feet.

.732 Replenishment time: . . . . 2 to 3 minutes; punch needs to be stopped.
.734 Optimum reloading period: . . . . 100 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Output block size:	single char. only.	
Invalid code:	all codes valid.	
Exhausted medium:	"no tape" switch	stop punch.
Imperfect medium:	"tight tape" switch	stop punch.
Timing conflicts:	lockout	wait until operation can proceed.
Receipt of data:	none.	

INPUT-OUTPUT: EDGE-PUNCHED CARD PUNCH

§ 074.

.1 GENERAL

.11 Identity: . . . . Edge-Punched Card Punch.

.12 Description

The Edge-Punched Card Punch has all the facilities, features, and specifications of the Paper Tape Punch, described in section :073. In addition, it is equipped to feed rectangular cards of widely varying size and to punch information along their margins in standard paper tape code formats. No facilities are provided for feeding or stacking the cards, so each individual card or short fanfold set must be inserted and removed by the operator; the process takes only a few seconds. Feed and take-up facilities are provided for punched tape, and change-overs between cards and tape require no special adjustments. Eight-track and five-track models are available.

INPUT-OUTPUT: CARD READER

§ 075.

.1 GENERAL

.11 Identity: . . . . Card Reader.
(IBM 024 Card Punch or 026 Printing Card Punch with Model 24 Coupler).

.12 Description

The Card Reader used in the Monrobot XI system is the IBM 024 Card Punch or 026 Printing Card Punch (the familiar IBM "keypunches"). Each model includes a feeding, transport, and stacking mechanism for standard 80-column punched cards; a punch station; a read station; and a manual keyboard. Model 026 includes a printing mechanism that prints each character at the top of the card column in which it is punched. The printing feature is not useful unless the unit will also be used for on-line or manual punching.

Cards are read column by column at the rate of 16 columns per second. Skipping occurs at 80 columns per second. The standard Hollerith card code is used, and a translation matrix in the required Model 24 Coupler translates each column code into the corresponding 8-track paper tape code, which enters the low-order eight bit positions of the accumulator. Each input instruction causes a single column to be read, after which the card is advanced to the next column. Sixty-four milliseconds are available for internal processing between columns at the peak speed of 16 columns per second. Parity checks are made on the translated codes.

A single Card Punch can be used for both input and output. In this case both the Model 24 and Model 26 Couplers must be used. The couplers can be substituted for the paper tape reader and punch in the basic Monrobot XI system on a one-for-one basis; the Card Punches themselves must be rented or purchased from IBM. Before the Card Punch can be used for off-line keypunching, the cable connecting it to the Model 24 and/or Model 26 Coupler must be disconnected.

.13 Availability: . . . . . . 3 to 6 months.

.14 First Delivery: . . . . 1961 (with Monrobot XI).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punches.
.222 Sensing system: . . . . brushes.
.223 Common system: . . . no.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . . 12.
Method of use: . . . . . punches 1 column at a time.

Use of station: . . . . . printing (026 only).
Distance: . . . . at punch station.
Stacks: . . . . 1.
Heads/stack: . . . . . . 1.
Method of use: . . . . . prints each punched character at top of column; not used when reading.

Use of station: . . . . . reading.
Distance: . . . . 1 card length to left of punch station.
Stacks: . . . . 1.
Heads/stack: . . . . . . 12.
Method of use: . . . . . reads 1 column at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . standard 80-column cards.
.312 Phenomenon: . . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . 80 columns at standard spacing.
.322 Parallel by: . . . . . . 12 tracks at standard spacing.
.324 Track use: . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding: . . . . column code as in Data Code Table No. 3.

.34 Format Compatibility: . with other devices using standard 80-column cards.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . Model 24 Coupler.
Input-Output Buffer.
(Both are required).

§ 075.

.42 Connection to System

.421 On-line:	1 Model 24 Coupler. 3 Input-Output Buffers (2 standard, 1 optional).
.422 Off-line	
Use	Associated equipment
All normal keypunch functions:	none (must be disconnected from Coupler).

.43 Connection to Device

.431 Devices per controller:	1.
.432 Restrictions:	maximum of 1 input and 1 output device (or 1 input-output device) per buffer; if both Card Reader and Card Punch are used, they must be connected to the same buffer.

.44 Data Transfer Control

.441 Size of load:	1 column, translated to one 8-bit character.
.442 Input area:	accumulator (low order bits).
.443 Input area access:	fully accessible to program.
.444 Input area lockout:	processor waits on lockout until the character has been read.
.445 Table control:	none.
.446 Synchronization:	by program for successive characters.
.447 Synchronizing aids:	see .444.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:	1 card.
.512 Block demarcation:	fixed.

.52 Input-Output Operations

.521 Input:	read 1 column, translate, and store in low order 8 bit positions of accumulator; set all other bit positions to 0, except set sign bit to 1 if input character has even parity.
.522 Output:	see section :076.
.523 Stepping:	none.
.524 Skipping:	skip 2 to 80 columns, according to format of program card on Card Punch drum; skipping can be initiated by the program card or by a special instruction.
.525 Marking:	none.
.526 Searching:	none.

.53 Code Translation:	automatic translation from card code to 8-track tape code as in Data Code Table No. 1 (but translation from tape code to internal codes must be programmed).
.54 Format Control:	program card controls skipping.

.55 Control Operations

Disable:	no.
Request interrupt:	no.
Offset card:	no.
Select stacker:	no.
Select format:	no.
Select code:	no.
Skip:	yes.

.56 Testable Conditions

Disabled:	no.
Busy device:	no; lockout.
Nearly exhausted:	no.
Busy controller:	no.
Hopper empty:	no.
Stacker full:	no.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed	
Reading:	16 columns/sec.
Skipping:	80 columns/sec.
.623 Overhead:	0.25 second for card release-feed cycle.
.624 Effective speeds:	15 char/sec (or 11 cards/min.) for fully punched cards if less than 67 m. sec elapse between successive input instructions.

.63 Demands on System

Component:	processor.
m. sec per char.:	2.9.
Percentage:	4.6.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

§ 075.

.72 Other Controls

Function	Form	Comment
Feed:	button	initiates card feed-release cycle.
Program Control:	lever	selects program card format control.
Pressure Roll Release:	lever	permits manual removal of cards.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	500 cards.
Stacker:	500 cards.

.732 Replenishment time: . . 0.5 to 1.0 minute; reader needs to be stopped.

.734 Optimum reloading period: . . . . 44 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity check on translated code	set bit indicator in accumulator.
Invalid code:	translation matrix assigns even parity	set bit indicator in accumulator.
Imperfect medium:	none.	
Timing conflicts:	lockout	processor waits until character is available.
Hopper empty:	check	stop reader.
Stacker full:	check	stop reader.

INPUT-OUTPUT: CARD PUNCH

§ 076.

.1 GENERAL

.11 Identity: . . . . Card Punch. (IBM 024 Card Punch or 026 Printing Card Punch with Model 26 Coupler).

.12 Description

The Card Punch used in the Monrobot XI system is the IBM 024 Card Punch or 026 Printing Card Punch (the familiar IBM "keypunches"). Each model includes a feeding, transport, and stacking mechanism for standard 80-column punched cards; a punch station; a read station; and a manual keyboard. Model 026 includes a printing mechanism that can print each character at the top of the column in which it is punched.

Each output instruction causes one character to be transmitted from the processor in 8-track paper tape code, converted to a standard Hollerith card code by a translation matrix in the Model 26 Coupler, and punched into one card column. At the peak speed of 16 columns per second, 64 milliseconds are available for internal processing between columns.

Skipping occurs at 80 columns per second; it can be initiated by a special output instruction or by the program card on the Card Punch drum. The program card and/or computer program can also initiate the card release-feed cycle and control the duplication of information from one card into corresponding fields of the next card. No checks are performed on punching or on character validity, but certain illegal code patterns will cause the punch to "hang up."

A single Card Punch can be used for both input and output, in which case both the Model 24 and Model 26 Couplers must be used. Before the punch can be used for off-line keypunching, the cable connecting it to the Coupler(s) must be disconnected.

.13 Availability: . . . . . 3 to 6 months.

.14 First Delivery: . . . . 1961 (with Monrobot XI).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punches.
.222 Sensing system: . . . brushes.
.223 Common system: . . . no.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . 12.
Method of use: . . . . punches 1 column at a time.

Use of station: . . . . printing (026 only).
Distance: . . . . . . at punch station.
Stacks: . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . prints each character at top of column, simultaneous with punching.

Use of station: . . . . reading.
Distance: . . . . . . 1 card length to left of punch station.
Stacks: . . . . 1.
Heads/stack: . . . . . 12.
Method of use: . . . . reads 1 column at a time.

.25 Range of Symbols (printed by 026 only)

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	11	# @ ?, % $. * & □ -
Total:	47 and blank	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . . 80 columns at standard spacing.
.322 Parallel by: . . . . . 12 tracks at standard spacing.
.324 Track use: . . . . . . all for data.
.325 Row use: . . . . . . all for data.

.33 Coding: . . . . column code as in Data Code Table No. 3.

.34 Format Compatibility: . . . . with other devices using standard 80-column cards.

.35 Physical Dimensions: . . . . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . Model 26 Coupler.
Input-Output Buffer.
(Both are required).

§ 076.

.42 Connection to System

.421 On-line: . . . . 1 Model 26 Coupler.
3 Input-Output Buffers (2 standard, 1 optional).

.422 Off-line

Use	Associated equipment
All normal keypunch functions:	none (must be disconnected from Coupler).

.43 Connection to Device

.431 Devices per controller: . . . . 1.

.432 Restrictions: . . . . . maximum of 1 input and 1 output device (or 1 input-output device) per buffer; if both Card Reader and Card Punch are used, they must be connected to the same buffer.

.44 Data Transfer Control

.441 Size of load: . . . . . one 8-bit character, translated to 1 card column.

.442 Output areas: . . . . low order bits of Fast Access Register 5 or of the output instruction itself.

.443 Output area access: . . fully accessible to program.

.444 Output area lockout: . . . . none required.

.445 Table control: . . . . none.

.446 Synchronization: . . . by program for successive characters.

.447 Synchronizing aids: . . processor waits on lockout until previous character has been punched.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.

.512 Block demarcation: . . fixed.

.52 Input-Output Operations

.521 Input: . . . . see section :075.

.522 Output: . . . . translate to card code and punch 1 column, as defined by low order 8 bits of Fast Access Register 5 or of the output instruction itself.

.523 Stepping: . . . . . . none.

.524 Skipping: . . . . . . skip 2 to 80 columns, according to format of program card on Card Punch drum; skipping can be initiated by the program card or by a special instruction.

.525 Marking: . . . . . . none.

.526 Searching: . . . . . . none.

.53 Code Translation: . . . automatic translation from 8-track tape code to card code (but translation from internal codes to tape code must be programmed).

.54 Format Control

Control: . . . . program card.
Format alternatives: . . . . 2 with Alternate Program feature on 024 or 026.
Rearrangement: . . . no.
Suppress zeros: . . . 026 only.
Insert point: . . . . . no.
Insert spaces: . . . . yes.
Recording density: . . no.
Section sizes: . . . . yes.
Alphabetic shift: . . . yes.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . no.
Offset card: . . . . . no.
Select stacker: . . . . no.
Select format: . . . . 1 of 2 with Alternate Program feature only.
Select code: . . . . . no.
Skip: . . . . yes.
Duplicate: . . . . . . yes.
Release and feed next card: . . . . yes.
Multiple punch: . . . . yes.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . . no; lockout.
Nearly exhausted: . . . no.
Busy controller: . . . no.
Hopper empty: . . . . no.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed
Punching: . . . . . . 16 columns/sec.
Skipping: . . . . . . 80 columns/sec.

.623 Overhead: . . . . . . 0.25 second for card release-feed cycle.

.624 Effective speeds: 15 char/sec (or 11 cards/min.) for fully punched cards if less than 67 m.sec. elapse between successive output instructions.

.63 Demands on System

Component: . . . . . processor.
m.sec per char.: . . 2.9.
Percentage: . . . . . 4.6.

§076.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.72 Other Controls

Function	Form	Comment
Feed:	button	initiates card release-feed cycle.
Program Control:	lever	selects program card format control.
Pressure Roll Release:	lever	permits manual removal of cards.

Note: Duplication, skipping, shifting, multiple punching, release, and registration can all be controlled manually by keyboard buttons.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	500 cards.
Stacker:	500 cards.

.732 Replenishment time: . . . . 0.5 to 1.0 minute; punch needs to be stopped.

.734 Optimum reloading period: . . . . 44 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Output block size:	single char. only.	
Invalid code:	none	punch illegal card code or hang up.
Imperfect medium:	none.	
Timing conflicts:	lockout	wait until operation can proceed.
Hopper empty:	check	stop punch.
Stacker full:	check	stop punch.

INPUT-OUTPUT: PHOTOELECTRIC READER

§077.

.1 GENERAL

.11 Identity: . . . . Photoelectric Reader.

.12 Description

The Photoelectric Reader is a Monroe development, announced in September, 1962. It reads 8-track or 5-track punched tape, and all programming considerations are the same as for the mechanical reader described in Section :071. Peak speed is 300 characters per second, but the maximum rate at which the Monrobot XI can accept data from the reader is 40 to 50 characters per second.

The reader can be mounted in a drawer of the standard Monrobot cabinet modules. Tape threading is semi-automatic and rapid. Eight lights on the front panel provide a display of the next code pattern that will be read. Detailed technical specifications are not yet available.

INPUT-OUTPUT: TYPEWRITER

§081.

.1 GENERAL

.11 Identity: . . . . Input-Output Typewriter.
Output Typewriter.

.12 Description

These are single-case IBM Model B electric typewriters with modifications and control circuitry by Soroban Engineering, Inc. The two models are mechanically the same, but the Output Typewriter is usable only for printed output at a maximum speed of ten characters per second; the Input-Output Typewriter can be used for keyboard input as well. One Input-Output Typewriter is included in the basic Monrobot XI system; it is usually connected to input-output channel 1 and placed on the knee-hole input-output desk. An additional typewriter will be useful in many commercial applications where two different types of printed records must be produced; e.g., payroll checks and ledgers.

In the normal mode of operation, each input or output instruction causes one 8-bit character to be transferred from or to the typewriter. When the console RESET switch is depressed, automatic operation is halted and only four bits enter the accumulator each time a key is depressed. Only the hexadecimal characters 0 through 9 and S through X may be entered in the reset mode; it is used primarily for loading "bootstrap" routines and in console debugging.

Optional Features

20-inch Carriage: Replaces the standard 16-inch carriage and permits typing on forms up to 19 inches wide.

Pinfeed Platen: Provides positive feeding and alignment of forms; available for 16- or 20-inch carriage.

Form Aligner: Tractor feed mechanism for continuous forms.

Form Stand: Holds feed and take-up form stacks, each up to seven inches high.

.13 Availability: . . . . . 3 to 6 months.

.14 First Delivery: . . . December, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . platen friction (Pinfeed Platen is optional).

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . engraved hammers.
.222 Sensing system: . . . typewriter keyboard.
.223 Common system: . . . no.

.23 Multiple Copies

.231 Maximum number: . . depends on stationery; approximately 6.

.233 Types of master
Multilith: . . . . . . yes.
Xerox: . . . . yes.
Spirit: . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . 1.
Heads/Stack: . . . . 1 print station.
Method of use: . . . . 1 character at a time.

Use of station: . . . . keyboard input.
Stacks: . . . . 1.
Heads/stack: . . . . . 48 keys.
Method of use: . . . . 1 character at a time.

.25 Range of Symbols

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	8	, . / ; - ' * $
Alternatives:	none.	
FORTRAN set:	no.	
Basic COBOL set: . . .	no.	
Total:	44 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . . continuous fanfold stationery or individual sheets.

.312 Phenomenon
Input: . . . . key depression.
Output: . . . . printing.

§ 081.

.32 Positional Arrangement

.321 Serial by: . . . . . . character at 10 per inch.

.324 Track use: . . . . . . 140 print positions for data (180 with optional 20-inch carriage).

.325 Row use: . . . . . . all for data; 6 rows per inch

.33 Coding: . . . . engraved character font (internal coding as in Data Code Table No. 1).

.34 Format Compatibility: none.

.35 Physical Dimensions

.351 Overall width: . . . . continuously variable to maximum of 15 inches (19 inches with optional carriage).

.352 Length: . . . . no limit.

.4 CONTROLLER

.41 Identity: . . . . Input-Output Buffer (housed in Computer cabinet).

.42 Connection to System

.421 On-line: . . . . 3 buffers (2 standard, 1 optional).

.422 Off-line

Use — Associated equipment

Manual typing: . . . none.

.43 Connection to Device

.431 Devices per controller: 1.

.432 Restrictions: . . . . . maximum of 1 input and 1 output device (or 1 input-output device) per buffer.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 character of 8 bits (4 bits for input in reset mode).

.442 Input-output areas

Input: . . . . accumulator.

Output: . . . . Fast Access Register 5, or low-order 8 bits of output instruction.

.443 Input-output area access: . . . . . . fully accessible to program.

.444 Input-output area lockout: . . . . . . processor waits on lockout until the input or output operation can be initiated.

.445 Table control: . . . . none.

.446 Synchronization: . . . by program for successive characters.

.447 Synchronizing aids: . . see .444.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . variable.

.512 Block demarcation

Input: . . . . as programmed; any character can be used as a delimiter, or a fixed number of characters can be typed.

Output: . . . . as programmed.

.52 Input-Output Operations

.521 Input: . . . . accept 1 manually typed character and load it into low order 8 bit positions of accumulator; set all other positions to 0, except set sign bit to 1 if input character has even parity.

.522 Output: . . . . type 1 character as defined by low order 8 bits of Fast Access Register 5 or of the output instruction itself.

.523 Stepping: . . . . . . return carriage and step 1, 2, or 3 lines.

.524 Skipping: . . . . . . "tab" to next preset tab position.

.525 Marking: . . . . . . none.

.526 Searching: . . . . . . none.

.53 Code Translation: . . by program; Data Code Table No. 1 shows the internal code corresponding to each typewriter character.

.54 Format Control

Input: . . . . manual.

Output: . . . . by program.

.55 Control Operations

Disable: . . . . no.

Request interrupt: . . no.

Select format: . . . . no.

Select code: . . . . . . no.

.56 Testable Conditions

Disabled: . . . . . . no.

Busy device: . . . . . no; lockout.

Nearly exhausted: . . no.

Busy controller: . . . no.

End of medium marks: no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed

Input: . . . . manual typing speed.

Output: . . . . 10 char/sec.

§ 081.

.623 Overhead: maximum of 0.75 second for carriage return.

.624 Effective speeds
Input: . . . . manual typing speed.
Output: . . . . depends upon number of carriage returns and efficiency of output routines.

.63 <u>Demands on System</u>

Component: . . . . . processor.
m.sec. per char.: . . . 2.9*
Percentage: 2.9*

*These are minimum demands, assuming device is not busy on output and has a character available on input; i.e., no processor lockouts.

.7 <u>EXTERNAL FACILITIES</u>

.71 <u>Adjustments</u>: . . . . . standard typewriter facilities.

.72 <u>Other Controls</u>: . . . none.

.73 <u>Loading and Unloading</u>

.731 Volumes handled (using optional Form Stand)

Storage	Capacity
Feed:	7-inch stack.
Take-up:	7-inch stack.

.732 Replenishment time: . 2 to 3 minutes; typewriter needs to be stopped.

.733 Adjustment time: . . . 3 to 4 minutes.

.8 <u>ERRORS, CHECKS AND ACTION</u>

Error	Check or Interlock	Action
Recording:	none.	
Reading:	parity check	set bit indicator in accumulator
Input area overflow:	not possible.	
Output block size:	single char. only.	
Invalid code:	none	no character is printed.
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	lockout.	wait.

INPUT-OUTPUT: TELETYPE PRINTER

§082.

.1 GENERAL

.11 Identity: . . . . Teletype Send-Receive Printer. Model 28.

.12 Description

The Teletype Model 28 Send-Receive Printer can be used in place of or in addition to the Input-Output Typewriter for keyboard input and printer output at a peak speed of ten characters per second. The 5-bit Teletype code is used for both input and output; no parity checking can be done. Keyboard input in the non-automatic reset mode is impossible with the Teletype Printer, so either a typewriter or a 16-Key Keyboard must be available for "bootstrap" operations and console debugging.

Fanfold or roll stationery can be used, but the form width is limited to 8.5 inches. There is no horizontal movement of the platen. A typebox containing 64 type pallets is moved to bring the selected character into printing position, and a single print hammer drives the type pallet against the ribbon and paper. The primary advantages of the Teletype Printer over the standard Input-Output Typewriter are its higher reliability record and its code and keyboard compatibility with other communications equipment. These must be weighed against the Teletype unit's lower flexibility of operation and lack of parity checking.

Because the Teletype Printer's control circuitry is modified for on-line use with the Monrobot XI, direct connection to a communications line is not recommended.

.13 Availability: . . . . . 3 to 6 months.

.14 First Delivery: . . . . 1961 (with Monrobot XI).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . platen friction.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . 64 engraved type pallets, actuated by a single printing hammer.
.222 Sensing system: . . . keyboard.
.223 Common system: . . . no.

.23 Multiple Copies: . . . maximum not specified.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . 1.
Heads/stack: . . . . . 1 print station.
Method of use: . . . . prints 1 character at a time.

Use of station: . . . . keyboard input.
Stacks: . . . . 1.
Heads/stack: . . . . . 37 keys; 32 characters and 5 controls.
Method of use: . . . . 1 character at a time.

.25 Range of Symbols

Numerals: 10 0-9
Letters: . . . . 26 A-Z
Special: 14 . , ; : ( ) ? $ & " ' # / -
Alternatives: . . . . . other special chars available.
FORTRAN set: . . . . no.
Basic COBOL set: . . . no.
Total: . . . . 50 and blank.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . continuous roll or fan-fold stationery.
.312 Phenomenon
Input: . . . . key depression.
Output: . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . . character.
.324 Track use: . . . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding: . . . . engraved character font (internal coding as in Data Code Table No. 2).

.34 Format Compatibility: . . . . none.

.35 Physical Dimensions

.351 Overall width: . . . . 8.5 inches.
.352 Length: . . . . ?

.4 CONTROLLER

.41 Identity: . . . . Input-Output Buffer (housed in Computer cabinet).

§082.

.42 Connection to System

.421 On-line: . . . . 3 buffers (2 standard, 1 optional).

.422 Off-line
Use: . . . . manual typing.
Associated equipment: . . . . none.

Note: Because of circuit modifications, the use of this device for normal Teletype transmission via cables is not recommended.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 character of 5 bits.
.442 Input-output areas
Input: . . . . accumulator.
Output: . . . . Fast Access Register 5, or low order bits of output instruction.
.443 Input-output area access: . . . . fully accessible to program.
.444 Input-output area lockout: . . . . . . processor waits on lockout until the input or output operation is initiated.
.445 Table control: . . . . none.
.446 Synchronization: . . . by program for successive characters.
.447 Synchronizing aids: . . see .444

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . variable.
.512 Block demarcation
Input: . . . . as programmed; any character can be used as a delimiter, or a fixed number of characters can be entered.
Output: . . . . as programmed.

.52 Input-Output Operations

.521 Input: . . . . accept 1 manually typed character and load it into low order 5 bit positions of accumulator.
.522 Output: . . . . type 1 character as defined by low order bits of Fast Access Register 5 or of the output instruction itself.
.523 Stepping: . . . . feed 1 to 7 lines, depending upon position of manually inserted stops.
.524 Skipping: . . . . "tab" to next manually inserted tab stop.
.525 Marking: . . . . . . none.
.526 Searching: . . . . . . none.

.53 Code Translation: . . . by program; Data Code Table No. 2 shows the 5-bit code for each character.

.54 Format Control

Input: . . . . manual.
Output: . . . . by program.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . no.
Select format: . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . . no; lockout.
Nearly exhausted: . . no.
Busy controller: . . . no.
End of medium marks: . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed
Input: . . . . manual typing speed.
Output: . . . . 10 char/sec.
.623 Overhead: . . . . 0.20 second for carriage return.
.624 Effective speeds
Input: . . . . manual typing speed.
Output: . . . . depends upon number of carriage returns and efficiency of output routines.

.63 Demands on System

Component: . . . . . processor.
M.sec per char.: . . 2.9.*
Percentage: . . . . . 2.9.

* These are minimum demands, assuming device is not busy on output and has a character available on input; i.e., no processor lockouts.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	none.	
Input area overflow:	not possible.	
Output block size:	single char. only.	
Invalid code:	all codes valid.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts	lockout	wait.

INPUT-OUTPUT: 16-KEY KEYBOARD

§ 101.

.1 GENERAL

.11 Identity: . . . . 16-Key Keyboard.

.12 Description

The 16-Key Keyboard is a compact unit that stands on top of the computer cabinet or input-output desk and permits manual entry of decimal or hexadecimal information. Each key depression sends one 4-bit code into the low order end of the accumulator.

.12 Description (Contd.)

Input may be in either the automatic mode (one character per input instruction) or the reset mode (automatic shift left of four bit positions before each character is entered). Eight hexadecimal characters fill a 32-bit word, and no code conversion is required. When the input is in the form of decimal numeric data, the usual decimal-to-binary radix conversion is required. Input of alphameric information via the 16-Key Keyboard is not practical.

INPUT-OUTPUT: MONROE-CARD PROCESSOR

§ 102.

.1 GENERAL

.11 Identity: . . . . Monroe-Card Processor.

.12 Description

Monroe-Cards, announced in September, 1962, are the same size as standard 80-column punch cards. One side has a magnetizable coating upon which 96 or 174 32-bit words can be recorded in Monrobot XI internal format. The 96-word card has 16 tracks and can be used in any reasonable environment; the 174-word card has 29 tracks and requires a humidity-controlled environment to insure dimensional stability. Each track is divided into 6 sectors, and each sector can hold one 32-bit word, recorded serially by bit. The cards can be handled manually without affecting the recorded information. Up to ten columns at each end of the Monroe-Card can be punched on standard 80-column punched-card equipment, but magnetically recorded information may be affected when the cards are passed through some punched-card machines.

The Monroe-Card Processor is a compact, desk-top unit that connects to the Monrobot XI and reads and records upon Monroe-Cards. While a given card is in the Processor, it can be considered a random access store of 96 or 174 words' capacity. The input hopper can hold up to 250 cards, or they can be inserted singly. One card at a time is loaded into the Processor by a special instruction. Then reading and/or recording can be done in any or all of the 96 or 174 locations on the card, and the card can be ejected into either of two stackers under program control. Ejection of one card and loading of the next card takes 1.5 seconds.

.12 Description (Cont'd)

When a card enters the processor, it is aligned at the "home" position. When a read or record instruction is received, the card moves forward to the appropriate sector; this takes from 56 to 336 milliseconds, during which time internal processing is inhibited. After a single word has been read or recorded, execution of the stored program can continue while the card moves back to the home position; this takes from 37 to 222 milliseconds.

For error-detection purposes, 34 check bits are recorded along with each 32-bit information word, and an automatic comparison of the two patterns is made when the word is read. There is no automatic check on recording, so each recorded word should be read back and compared with the original word. Total recording time, therefore, is twice as great as reading time and will range from about 200 to 1100 milliseconds per word.

One Monroe-Card Processor can be connected to a Monrobot XI system in addition to the full complement of three other input and three other output devices.

No off-line equipment is available for transcribing data to or from Monroe-Cards, and the information recorded on them cannot be sensed by human operators. Therefore, their major function will be the storage of master file data that is updated from input data on punched tape, punched cards, or a keyboard. Monroe-Cards should be useful in semi-automated "random access" systems where the operator manually selects the appropriate master record card for each transaction. Up to 1, 566 decimal digits or 1, 044 alphameric characters can be stored on each card.

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . Input-Output Buffer.

.12 Description

Two Input-Output Buffers are supplied as part of the basic Monrobot XI system, and a third buffer is optional. One input device and one output device, or one combination input-output device, can be connected to each buffer. The Input-Output Buffers provide no actual buffer storage, but only the control circuitry for input-output operations.

Each input or output instruction initiates the transfer of a single character code of up to eight bits from or to the addressed input or output device. Internal processing is delayed until a character is available from the addressed input device, or until the addressed output device is ready to accept the character to be punched or printed. Execution of an input or output instruction takes only 2.92 milliseconds (four sector times), after which the processor is available for other computation while the input or output device completes its character cycle. Theoretically, up to three input and three output devices could be operating simultaneously. In practice, however, most or all of the inter-character time is required to process the last character read or the next character to be written, and it is unusual for more than one input or output operation to occur at a time.

Each output instruction can specify one, two, or all three output devices, so output information can be duplicated on devices that accept the same codes (e.g., the typewriter and paper tape punch). When an input instruction specifies two or three devices, a character will be accepted from the first input device that makes one available; if two devices are ready at the same time, their codes will be ORed together. The multiple input facility is useful when data may be entered from one of two or three different input devices (e.g., paper tape for routine transactions and keyboard for exceptions).

.2 CONFIGURATION CONDITIONS: . . . none.

.3 CLASSES OF OPERATIONS

Class	Members
A :	input from Paper Tape Reader. input from Edge-Punched Card Reader. input from Typewriter. input from Teletype Printer. input from 16-Key Keyboard.
B :	input from Card Reader.
C :	output on Paper Tape Punch. output on Edge-Punched Card Punch. output on Typewriter. output on Teletype Printer.
D:	output on Card Punch.
P :	internal processing.

.4 RULES

a + b = at most 3.
c + d = at most 3.
b = at most 1.
d = at most 1.
p = at most 1.

Note: The above rules represent the maximum theoretical simultaneity. In most applications, only one input-output operation at a time is practical.

§ 121.

INSTRUCTION LIST

INSTRUCTION			OPERATION
Mnemonic Command	Address	Hexadecimal Code	
			Arithmetic
A	Y	Xyyy	(A) + (Y)⟶A
S	Y	Wyyy	(A) - (Y)⟶A
M	Y	5yyy	(A) x (Y)⟶A & FA5; low-order 32 bits are in FA5 and high-order 32 bits in A.
D	Y	lyyy	DETRACT: Subtract (Y) from (A) until (Y) is less than (A); add 1 to (FA5) each time a subtraction is made.
			Logic
J	Y	3yyy	Jump unconditionally to Y.
JZ	Y	6yyy	Jump to Y if (A) = 0.
JN	Y	7yyy	Jump to Y if high order bit of (A) = 1.
JM	Y	3(4+y)yy	JUMP MARK: (IR)⟶FA2; (Y)⟶IR.
XT	Y	X(4+y)yy	AND: Place a 1 bit in A wherever there is a 1 bit in the corresponding positions of both A and Y; otherwise place a 0 bit in A.
K	S	U4ss	Set A to all 1 bits if Intervention Switch S is set; otherwise set A to 0.
LD	N	80nn	Multiply (A) by 10^N (N = 1 to 8).
RD	N	88nn	Divide (A) by 10^N.
L	N	90nn	Shift (A) left N binary positions.
R	N	98nn	Shift (A) right N binary positions.
LC	N	8Unn	Shift (A & FA5) left N binary positions in circular fashion.
RP	N	9Unn	Shift (A) right N binary positions, inserting 1 bits in vacated high order positions if original sign bit was a 1.
N	-	S100	No operation.
H	-	0000	Stop.
			Data Transfers
CA	Y	Vyyy	(Y)⟶A
T	Y	Tyyy	(A)⟶Y
XC	Y	Uyyy	(A)⟶Y and (Y)⟶A; Y must be 000, 001, 002, 003, 004, 005, or 006.
C	006	U500	0⟶A
C	005	S000	0⟶FA5
-	-	U400	all ones⟶A
			Input-Output: General
I	D	2D00	Read one character of up to 8 bits into low order positions of A from input device D. Set all other positions of A to 0, except set sign bit to 1 if input character has even parity.
OR	D	SD7X	Send low order 8 bits of (FA5) to output device(s) D, then set FA5 to 0.
0S	DCC	S(D+1)CC	Send low order 8 bits of this instruction (CC) to output device(s) D.
			Note: The input-output instructions cause automatic rearrangement between the external bit format 876P4321 and the internal format 8P764321, where P is the parity bit and 8 is the "end line" bit.
			Input-Output: Monroe-Cards
-	-	40MM	Read contents of magnetic card register MM into FA5. Set A to 0 unless a parity error occurs.
-	-	48MM	Transfer (FA5) to magnetic card register MM.
-	-	080B	Eject card into stacker B and feed next card (B = 0 or 1).

§ 121. **INSTRUCTION LIST NOMENCLATURE**

A: . . . . accumulator (Fast Access Register 6).

D: . . . . address specifying any one input device or any one, two, or three output devices.

FAn: . . . . Fast Access Register n (storage location 00n, where n = 0 through 6).

IR: . . . . Instruction Register.

N: . . . . length of a shift operation in binary or decimal positions (N = 1 to 8).

S: . . . . address of one of 8 Intervention Switches.

Y: . . . . address of a drum storage location.

yyy: . . . . address of a drum storage location in hexadecimal form ($000 \leq yyy \leq 3XX$).

( ): . . . . contents of a register or storage location; e.g., (A) means contents of accumulator.

CODING SPECIMEN: MACHINE CODE

§ 131.

.1 CODING SHEET

MONROBOT MARK XI PROGRAM SHEET		PAGE
PROGRAM: DECIMAL TO BINARY CONVERSION	PROGRAMMER	DATE

REGISTER			STEP		CONTENTS				NOTES
1	0	0		A	V	2	0	1	Load 1010 (decimal 10) in FA 6
				B	T	0	0	4	Store 1010 in FA 4
1	0	1		A	V	2	0	0	Load 1 (decimal 1) in FA 6
				B	T	0	0	1	Store 1 in FA 1
1	0	2		A	T	0	0	0	Write 1 in FA 1 as positive sign
				B	U	5	0	0	Clear FA 6 to zero
1	0	3		A	T	0	0	3	Store zeros in FA 3 (store for conversion)
				B	3	1	0	6	Jump to input routine
1	0	4		A	V	0	0	3	Load conversion into FA 6
				B	8	0	0	1	Multiply conversion by 10
1	0	5		A	X	0	0	5	Add input digit from FA 5
				B	T	0	0	3	Store conversion plus input digit
1	0	6		A	2	2	0	0	Read input digit from Device No. 1
				B	7	3	X	X	Test for parity error; if parity error, jump to 3XX
1	0	7		A	T	0	0	5	Store input digit in FA 5 as temporary storage
				B	W	0	0	4	Subtract 1010 from input digit
1	0	8		A	7	1	0	4	Test FA 6 negative; if negative, jump to conversion
				B	6	1	0	U	Test FA 6 for zero; if zero, input ceases
1	0	9		A	W	0	0	1	Subtract 1 from input digit
				B	6	1	0	T	Test FA 6 for zero; if zero, minus sign entered
1	0	S		A	3	1	0	1	Jump to reset input routine, error code entered
				B	0	0	0	0	Fill instruction
1	0	T		A	T	0	0	0	Store 0 in FA 0 as minus sign
				B	3	1	0	6	Jump to input routine for next digit
1	0	U		A	V	0	0	0	Load FA 6 with sign register
				B	6	1	0	W	Test FA 6 for zero; if zero, number negative
1	0	V		A	V	0	0	3	Load FA 6 with converted number
				B	3	0	0	2	Jump to exit to next program step
1	0	W		A	W	0	0	3	Complement converted number as negative
				B	3	0	0	2	Jump to exit to next program step
		X		A					
				B					

Reprinted from Monrobot XI Programming Manual, p. 89.

§ 131.

.2 COMMENTS

This routine accepts and binarizes input from a 16-Key Keyboard. Keys 0 (code 0000) through 9 (code 1001) are the allowable digit values. Key S (code 1010) causes input to cease. Key T (code 1011) is a minus sign. The other four keys (U, V, W, X) give error indications which erase all previously entered digits.

CODING SPECIMEN: MACHINE CODE

§ 131.

.1 CODING SHEET

MONROBOT MARK XI PROGRAM SHEET		PAGE
PROGRAM: DECIMAL TO BINARY CONVERSION	PROGRAMMER	DATE

REGISTER			STEP		CONTENTS				NOTES
1	0	0		A	V	2	0	1	Load 1010 (decimal 10) in FA 6
				B	T	0	0	4	Store 1010 in FA 4
1	0	1		A	V	2	0	0	Load 1 (decimal 1) in FA 6
				B	T	0	0	1	Store 1 in FA 1
1	0	2		A	T	0	0	0	Write 1 in FA 1 as positive sign
				B	U	5	0	0	Clear FA 6 to zero
1	0	3		A	T	0	0	3	Store zeros in FA 3 (store for conversion)
				B	3	1	0	6	Jump to input routine
1	0	4		A	V	0	0	3	Load conversion into FA 6
				B	8	0	0	1	Multiply conversion by 10
1	0	5		A	X	0	0	5	Add input digit from FA 5
				B	T	0	0	3	Store conversion plus input digit
1	0	6		A	2	2	0	0	Read input digit from Device No. 1
				B	7	3	X	X	Test for parity error; if parity error, jump to 3XX
1	0	7		A	T	0	0	5	Store input digit in FA 5 as temporary storage
				B	W	0	0	4	Subtract 1010 from input digit
1	0	8		A	7	1	0	4	Test FA 6 negative; if negative, jump to conversion
				B	6	1	0	U	Test FA 6 for zero; if zero, input ceases
1	0	9		A	W	0	0	1	Subtract 1 from input digit
				B	6	1	0	T	Test FA 6 for zero; if zero, minus sign entered
1	0	S		A	3	1	0	1	Jump to reset input routine, error code entered
				B	0	0	0	0	Fill instruction
1	0	T		A	T	0	0	0	Store 0 in FA 0 as minus sign
				B	3	1	0	6	Jump to input routine for next digit
1	0	U		A	V	0	0	0	Load FA 6 with sign register
				B	6	1	0	W	Test FA 6 for zero; if zero, number negative
1	0	V		A	V	0	0	3	Load FA 6 with converted number
				B	3	0	0	2	Jump to exit to next program step
1	0	W		A	W	0	0	3	Complement converted number as negative
				B	3	0	0	2	Jump to exit to next program step
		X		A					
				B					

Reprinted from Monrobot XI Programming Manual, p. 89.

§ 131.

.2 COMMENTS

This routine accepts and binarizes input from a 16-Key Keyboard. Keys 0 (code 0000) through 9 (code 1001) are the allowable digit values. Key S (code 1010) causes input to cease. Key T (code 1011) is a minus sign. The other four keys (U, V, W, X) give error indications which erase all previously entered digits.

CODING SPECIMEN: SYMBOLIC ASSEMBLY PROGRAM

§ 132.

.1 CODING SHEET

MONROE XI SYMBOLIC ASSEMBLER PROGRAM SHEET

PAGE 26

PROGRAM Example 4

CORRECTIONS ONLY						
CT	NAME	INCR	NAME	OPER	OPERAND	COMMENTS
			PRT	CA	/FTOTAL	Place 8 channel
				T	010	Codes for total in Reg. 010
				G	3760	Use alpha/num output
				G	0210	Routine
				CA	/D10000000	Place 10^7 in FA 0
				T	000	For output
				G	3762	Use numeric output
				G	0208	Routine

CT-CORRECTION TYPE (I,E,R)
INCR-INCREMENT
OPER-OPERATION CODE

Reprinted from The Symbolic Assembly Program, p. 26.

§ 132.

.2 COMMENTS

This example illustrates the use of alphameric and decimal literals and the Easy subroutines Read/Write/Store Alphameric and Write Numeric (cued by machine-code instructions) to print or punch "TOTAL" and "10000000"

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . 8-track punched tape, typewriter, and 6-bit internal code.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 8 bits; 6 data, 1 odd parity, 1 end line (only the 6 data bits need be used internally).

.22 Character Structure

.221 More significant pattern: . . . . 2 zone bits; 32, 16.

.222 Less significant pattern: . . . . 4 numeric bits; 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	space		-	* or &
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	;		$	l.c.
11		,	' or %	.
12				u.c.
13	•	b.s.		
14		tab		
15				

b.s.: . . . . backspace.
l.c.: . . . . lower case.
u.c.: . . . . upper case.

DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . 5-track punched tape, Teletype printer, and 5-bit internal code.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 5 bits.

.22 Character Structure

.221 More significant pattern: . . . . 2 bits; 16, 8.

.222 Less significant pattern: . . . . 3 bits; 4, 2, 1.

.23 Character Codes

	LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
		0	8	16	24
LETTERS	0	blank	l.f.	E	A
	1	T	L	Z	W
	2	c.r.	R	D	J
	3	0	G	B	figs.
	4	space	I	S	U
	5	H	P	Y	Q
	6	N	C	F	K
	7	M	V	X	ltrs.
FIGURES	0	blank	l.f.	3	-
	1	5	)	"	2
	2	c.r.	4	$	'
	3	9	&	?	figs.
	4	space	8	bell	7
	5	#	0	6	1
	6	,	:	!	(
	7	.	;	/	ltrs.

c.r.: . . . . carriage return.
figs.: . . . . figures shift.
ltrs.: . . . . letters shift.
l.f. : . . . . line feed.

DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . . punched cards.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	blank	&	-	
12				
11				
0	0			
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2				
8-3	#	.	$	,
8-4	@	□	*	%
8-5				
8-6				
8-7				

PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers: . . . . . none.

.12 Simulation by Other Computers: . . . . . none.

.13 Data Sorting and Merging: . . . . . . none.

.14 Report Writing: . . . . none.

.15 Data Transcription: . . . . none.

.16 File Maintenance: . . . none.

.17 Scientific and Engineering

Floating Point Arithmetic: Full facilities are provided for floating point arithmetic on single word-length operands. Eight bits are used for the exponent and 24 for the fixed point part. One of the operands is always in the accumulator; the address of the other operand is specified in the one-word subroutine linkage. Storage required is 132 locations. Execution times are as follows.

Addition:	420 m.sec.
Subtraction:	480 m.sec.
Multiplication: . .	500 m.sec.
Division:	600 m.sec.

Floating Point Square Root: Single precision, requires 35 storage locations and 3,800 milliseconds.

Floating Point Input-Output: Handles input, output, and radix conversions of floating point data items on specified input-output device(s); requires 109 storage locations.

Float and Unfloat: Handles conversions between fixed and floating point internal formats; requires 74 storage locations.

Mathematical Routines: All of the following routines operate on single word-length, fixed point operands.

Name	Time, m.sec.	Storage locations
Sine-Cosine:	1,300	64
Tangent-Cotangent:	3,000	18
Arcsine-Arccosine:	6,000	59
Arctangent-Arccotangent:	2,300	49
Log-Antilog:	2,900	111
Square Root:	4,200	48
Cube Root:	4,500	30

Matrix Inversion: Inverts matrices of orders 2 through 16 in single precision floating point form. The Floating Point Arithmetic and Input-Output subroutines are used.

Least Squares Polynomial Approximation: Computes the coefficients of a power series which best represents a set of X, Y co-ordinates, using the Matrix Inversion routine. Time required to fit a second order polynomial to five pairs of data values was 109 seconds.

Chi-Square Test of Independence: Given a contingency table, this routine computes the expected frequencies from the observed frequencies, chi-square for each frequency, total chi-square, and the number of degrees of freedom. Time required for three classes and three variables was 37 seconds.

Open Traverse Survey Program: Computes and prints azimuth error of closure, total distance, closure errors of X and Y co-ordinates, closure precision, and a table of station names, adjusted azimuths, distances, and co-ordinates. Up to 61 stations can be handled; total running time for 9 stations was 4 minutes (1.7 minutes for calculations).

.2 PROBLEM ORIENTED LANGUAGES: . . . . none.

MACHINE-ORIENTED LANGUAGE: EASY

§171.

.1 GENERAL

.11 Identity: . . . . Easy Programming System.

.12 Origin: . . . . Monroe Calculating Machine Company, Inc.

.13 Reference: . . . . . . Monroe publications MO-97, MO-147.

.14 Description

The Easy Programming System is a group of generalized subroutines that facilitate the coding of input-output, radix conversion, multiplication, division, and loop control operations. Because of the Monrobot XI's half-word instruction structure, coding with the Easy system resembles coding in an interpretive language. Cueing of each Easy subroutine requires a single word; the first half contains a "jump mark" instruction that transfers control to the subroutine, and the second half contains the parameters for the subroutine, in the form of up to four hexadecimal digits. The Easy subroutine cues are called "compound instructions," and are written as if the operands were in decimal form. The Monrobot XI machine operations are called "simple instructions." Routines using the Easy system consist of intermixed simple and compound instructions.

The Easy system was designed to enable inexperienced programmers to use the Monrobot XI without having to learn binary arithmetic and write complex input-output routines. For this purpose, the system is quite useful, but it does not permit maximum utilization of the Monrobot XI's capabilities. The generalized nature of the subroutines makes them less efficient than routines tailored for the job at hand, and the binary system must be understood to utilize the Monrobot's logical and binary shifting facilities. Because Easy coding is basically machine language, the coder must learn and use the hexadecimal instruction address system and the non-mnemonic hexadecimal operation codes.

The Easy subroutines are described in Paragraph .6. They are normally stored in hexadecimal addresses 290 through 3VX - a total of 376 storage locations. Each of the subroutines is also available individually in relocatable format. Execution times for the Easy subroutines have not been made available. Wherever maximum operating speeds are important, the manufacturer recommends the use of hand-coded routines in place of the generalized subroutines.

.15 Publication Date: . . . July, 1960.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . . see coding sheet, Section :131.

.22 Legend

Register: . . . . . . drum storage address of the instruction or constant, in hexadecimal form.
Step: . . . . A or B, designating first or second simple instruction in a location, or first or second half of a compound instruction.
Contents: . . . . . . instruction or constant.
Notes: . . . . comments for coding sheet documentation.

.23 Corrections: . . . . . no special facilities; generally handled by substitution or "patching."

.24 Special Conventions

.241 Compound addresses: . none.
.242 Multi-addresses: . . . none.
.243 Literals: . . . . . . used only in shifting and input-output instructions.
.244 Special coded addresses: . . . . . . none.

.3 LABELS: . . . . . . none; all operands are specified by their addresses in 3-digit hexadecimal form.

.4 DATA

.41 Constants

.411 Maximum size constants

Machine Form	Coding Sheet Form
Integer	
Binary:	8 hexadecimal digits.
Fixed numeric: . .	none.
Floating numeric: .	none.
Alphameric: . . .	8 hexadecimal digits per word (2 per character).

.412 Maximum size literals

Machine Form	Coding Sheet Form
Integer	
Binary:	1 hexadecimal digit; used only to specify length of a shift or size of an input-output item.
Fixed numeric: . .	none.
Floating numeric:	none.
Alphameric:	2 hexadecimal digits per character (input-output only).

§ 171.

.42 Working Areas

.421 Data layout: . . . . . implied by use.
.422 Data type: . . . . . . implied by use.

.43 Input-Output Areas

.431 Data layout: . . . . . specified register and format for each input-output instruction.
.432 Data type: . . . . . implied by use.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic: . . . . . . none.
.512 Absolute
Existence: . . . . . . mandatory for simple instructions.
Number: . . . . . . 27.
Example: . . . . . . X = "add".
.513 Compound
Existence: . . . . . . mandatory for compound instructions.
Number: . . . . . . 14.
Example: . . . . . . 3768 = divide.
Comment: . . . . . . causes jump to the subroutine that implements each compound instruction.

.52 Macro-Codes: . . . . none.

.6 SPECIAL ROUTINES AVAILABLE

Note: The following subroutines comprise the Easy Programming System and are cued by the "compound instructions"; each is also available as an individual subroutine in relocatable format.

.61 Special Arithmetic

Divide: . . . . divides contents of FA 1 (Fast Access Register 1) by contents of accumulator; stores rounded or unrounded quotient in FA 1 and accumulator, and remainder in FA 3.

Multiply, Shift, and Round: . . . . . multiplies contents of accumulator by contents of FA 1, shifts product right a specified number of places, and (optionally) rounds off least significant digit; product is in accumulator and FA 1, and may not exceed 9 decimal digits in length.

Shift and Round After Multiply: . . . handles rounding and shifting of positive products not greater than 9 decimal digits.

.62 Special Functions: . . none.

.63 Overlay Control: . . . none.

.64 Data Editing

Read/Write/Store Alphameric: . . passes alphameric information between a specified input unit, output unit(s), and/or drum storage; halts when a prespecified character is reached. Up to 5 characters can be stored in each register.

Read/Write Numeric: . . . reads from 1 to 9 decimal digits from a specified input unit, converts the number to binary form, and stores it in FA 1. The digits read may be simultaneously transmitted to any specified output unit(s). Reading may be terminated by a slash or tab code or when a specified count has been reached.

Write Numeric: . . . . converts contents of FA 1 from binary to decimal form and transmits from 1 to 9 digits, preceded by a space or minus sign, to the specified output device(s). Location of the decimal point is specified.

.65 Input-Output Control: . . see .64, above.

.66 Sorting: . . . . none.

.67 Diagnostics: . . . . . none.

.68 Program Control: . . . three different "compound instructions" are provided for cueing each of the following subroutines; this permits control of up to 3 levels of looping.

Start Loop: . . . . . specifies number of times loop is to be performed and the increment or decrement.

Modify: . . . . causes the simple (machine) instruction contained in the second half of each Modify instruction to be incremented or decremented each time the loop is executed.

Close Loop: . . . . . controls loop test and exit.

.7 LIBRARY FACILITIES: . . . . none.

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . none.
.82 Pseudos: . . . . none.

MACHINE-ORIENTED LANGUAGE: SYMBOLIC

§ 172.

.1 GENERAL

.11 Identity: . . . . Symbolic Assembly Program.

.12 Origin: . . . . G. Whitney and D. Dunlop, Western Electric Co., Inc., Princeton, N. J. Revised by Monroe Calculating Machine Co., Inc.

.13 Reference: . . . . Monroe publication MO-140.

.14 Description

The Symbolic Assembly Program for the Monrobot XI was designed and developed at Western Electric's Engineering Research Center (where it is called SYMBO). After certain revisions and additions by Monroe, the system was made available for general distribution.

The system permits straightforward use of the computer's facilities, but offers few refinements. There are no provisions for macro-codes, relative addressing, allocation counter control, or program listings. An unusual feature is the provision of three special fields on the coding sheet that facilitate corrections to the source program. A correction tape can be prepared and merged automatically with the master source program tape at translation time, or the corrections can be manually typed.

Literals can be written in the operand field as groups of hexadecimal, decimal, Teletype, or 8-channel characters. Each literal is converted to binary form and stored as a constant. When a specific literal appears in more than one source program instruction, it will be stored only once.

Since all transfers of control are to the first instruction in a pair, each named instruction is placed in the first half of a word. A "no operation" instruction is placed in the second half of the previous word when necessary. Machine language instructions, in the form of four hexadecimal digits, can be interspersed with the symbolic instructions. Machine addresses may also be used with the mnemonic operation codes, which consist of one or two letters. Since the programmer cannot control the allocation counter nor reserve areas of storage, indiscriminate use of machine addresses can lead to conflicts in storage assignments.

.15 Publication Date: . . . . August, 1961.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . see coding sheet, Section :132.

.22 Legend

CT* : . . . . Correction Type: insert, eliminate, or replace a source statement.
NAME* : . . . . last named entry preceding point at which a correction is to be made.
INCR* : . . . . Increment: number of statements between last named entry and entry to be corrected.
NAME : . . . . symbolic name for a location.
OPERATION: . . . . . . mnemonic operation code.
OPERAND: . . . . 1) an actual storage address in hexadecimal -form;
2) a symbolic operand address; or
3) a literal in decimal, hexadecimal, Teletype, or 8-channel code.

Note: * denotes columns used for corrections only.

.23 Corrections: . . . . . . special columns on coding sheet specify correction type (insert, eliminate, or replace) and name of and increment from last named entry preceding the statement to be corrected.

.24 Special Conventions

.241 Compound addresses: . not permitted; i.e., relative addressing is not possible.
.242 Multi-addresses: . . . none.
.243 Literals: . . . . / in operand column, followed by D for decimal, H for hexadecimal, T for Teletype, or F for 8-channel code.
.244 Special coded addresses: . . . . . . none.

§ 172.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . 232 names (limited by translator).
.312 Common label formation rule: . . . . yes.
.313 Reserved labels: . . . . none.
.314 Other restrictions: . . none.
.315 Designators: . . . . . . none.
.316 Synonyms permitted: . no.

.32 Universal Labels

.321 Labels for procedures
Existence: . . . . . . mandatory if referenced by another statement.
Formation rule
First character: . . alphameric; may not be 0, 1, 2, or 3; must be numeric if name is 4 characters long.
Others: . . . . alphameric.
Number of characters: . . . . 1 to 4.
.322 Labels for library routines: . . . . none.
.323 Labels for constants: . same as procedures.
.324 Labels for files: . . . . none.
.325 Labels for records: . . none.
.326 Labels for variables: . same as procedures.

.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constants
Machine Form — Coding Sheet Form
Integer
Binary: . . . . . . 9 decimal or 8 hexadecimal digits.
Fixed numeric: . . . none.
Floating numeric: . none.
Alphameric: . . . . 5 8-channel code or six Teletype code characters.
.412 Maximum size literals: same as constants.

.42 Working Areas

.421 Data layout: . . . . . . implied by use.
.422 Data type: . . . . implied.
.423 Redefinition: . . . . . . none.

.43 Input-Output Areas

Input: . . . . accumulator.
Output: . . . . Fast Access Register 5 or the output instruction itself.

Note: As in machine coding, each input or output instruction initiates the transfer of a single character.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . . optional; required when address is symbolic.
Number: . . . . 25.
Example: . . . . A = "add".

.512 Absolute
Existence: . . . . . . optional.
Number: . . . . 27.
Example: . . . . X = "add".
Comment: . . . . . . "generate" pseudo permits specification of absolute operation code and address as 4 hexadecimal digits.

.52 Macro-Codes: . . . . . none.

.53 Interludes: . . . . none.

.54 Translator Control

Allocation counter: . . none.
Label adjustment: . . . none.
Annotation: . . . . none.

.6 SPECIAL ROUTINES AVAILABLE: . . . . . none in symbolic form; standard subroutines are in machine code format and are usually loaded separately at run time.

.7 LIBRARY FACILITIES: none.

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . none.

.82 Pseudos

Code	Description
G (Generate):	permits use of machine language instructions in a symbolic program.
I (Insert):	permits insertion of new instruction(s) between two old ones.
E (Eliminate):	permits deletion of instruction(s) from source program.
R (Replace):	permits substitution of new instructions for old ones.

PROGRAM TRANSLATOR: SYMBOLIC

§ 181.

.1 GENERAL

.11 Identity: . . . . Symbolic Assembly Program.

.12 Description

This program translates routines written in the Monrobot XI Symbolic Assembly language (described in Section :172) into machine language form. The translation can be performed on the basic Monrobot XI system (computer, typewriter, paper tape reader and punch). All facilities of the target system can be utilized. Source program input and object program output are on 8-track punched tape. The only typed documentation is a table of labels and constants and the machine addresses assigned to them.

Two tape passes are required in the translation process. Phase I forms the label table and generates the required constants. Phase II assigns machine operation codes and addresses to all symbolic instructions and punches the object program tape. No attempt is made to reduce rotational delays by optimizing operand locations. The maximum number of labels that can be processed is 232, and up to 83 different constants can be generated. Error checking is limited to parity checking of the input and notation of duplicate names in the typed label table.

.13 Originator: . . . . G. Whitney and D. Dunlop, Western Electric Co., Inc., Princeton, N. J. Revised by Monroe Calculating Machine Co., Inc.

.14 Maintainer: . . . . . . Monroe Calculating Machine Co., Inc.

.15 Availability: . . . . . . August, 1961.

.2 INPUT

.21 Language

.211 Name: . . . . Symbolic Assembly language; see :172.

.212 Exemptions: . . . . . . none.

.22 Form

.221 Input media: . . . . . . punched tape (or punched cards with special I/O routines).

.222 Obligatory ordering: . . in coding sheet line sequence.

.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage.

.232 Maximum size of source statements: . . 1 coding sheet line of up to 24 characters.

.233 Maximum number of data items: . . . . . . see next entry.

.234 Others
Maximum number of labels: . . . . 232.
Maximum number of different constants: . 83.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . Monrobot XI machine code.

.312 Language style: . . . . "normal parameterized binary format": tape is headed by initial and final loading addresses; each word (2 instructions or a constant) is represented by 8 hexadecimal digits and followed by a carriage return code.

.313 Output media: . . . . . punched tape (or punched cards with special I/O routines).

.32 Conventions

.321 Standard inclusions: . . none.

.322 Compatible with: . . . . program loading routines and Program Relocation System.

.33 Documentation

Subject	Provision
Source program: . . .	none.
Object program: . . .	none.
Label table:	typewriter listing.
Restart point list: . .	none.
Language errors: . .	none.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Phase I (first tape pass): . . . . forms symbol table and generates constants.

Phase II (second tape pass): . . . . assigns machine addresses and punches object program tape.

§ 181.

.42 Optional Modes

.421 Translate: . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . . no.
.424 Patching: . . . . yes.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . no.
.433 Short translate on restricted program: . no.

.44 Bulk Translating: . . . yes; not necessary to reload translator.

.45 Program Diagnostics: . none associated with translator.

.46 Translator Library: . . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . 25 locations for program loading routine.
.512 Space required for each input-output file: . . . as coded.
.513 Approximate expansion of procedures: . . . . unity.

.52 Translation Time

.521 Normal translating: . . 0.15S minutes, where S is number of source instructions (***).

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . unaffected; i.e., same as unoptimized hand coding.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: basic Monrobot XI system, with typewriter, paper tape reader and punch.
.612 Larger configuration advantages: . . . . . . 2 paper tape readers permit automatic merging of source and correction tapes.

.62 Target Computer

.621 Minimum configuration: basic Monrobot XI system.
.622 Usable extra facilities: all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	none.	
Duplicate names:	check	noted in label table typeout.
Improper format:	none.	
Incomplete entries:	none.	
Target computer overflow:	none.	
Inconsistent program:	none.	
Input error:	parity check	halt processor.

.8 ALTERNATIVE TRANSLATORS: . . . none.

OPERATING ENVIRONMENT: GENERAL

§ 191.

.1 GENERAL

.11 Identity: . . . . Loading Routine for Program Tapes.
Parameter Tape Output Program.
Parameter Type Output Program.
Parameter Tape/Type Output Program
Program Relocation System.

.12 Description

No integrated operating system is available for the Monrobot XI. The facilities covered in this section must be provided by individual utility routines such as those listed above, by the user's own coding, or by the operator at run time.

Programs are normally coded in hexadecimal form. They may be converted to punched tape off-line (e.g., by a Flexowriter) and loaded by the Loading Routine for Program Tapes; or they may be typed directly into storage, tested, and punched out by the Parameter Tape Output Program. In either case, the program tapes will be in "normal parameterized binary format": the tape is headed by the initial and final loading addresses for the program, and each word is represented by 8 hexadecimal digits and followed by a carriage return code. Object program tapes produced by the Symbolic Assembly Program translator have the same format.

The binary program tapes are non-relocatable. To permit loading of programs into core storage locations other than the ones for which they were written, the Program Relocation System is provided. This routine requires two tape passes. The first phase converts the original binary tape into a special format that designates those instructions whose addresses are relocatable. The second phase converts the "relocatable" tape back into a standard binary object tape that can be loaded into any one specified storage area. The "relocatable" tape can be used to produce any number of relocated object tapes for loading into different areas.

No standard program input or output routines using punched cards have been made available to date.

.13 Availability: . . . . . . all routines described here are currently available.

.14 Originator: . . . . Monroe Calculating Machine Co., Inc.

.15 Maintainer: . . . . . . as above.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . none.
.212 Independent programs: punched tape, punched cards, typewriter, or 16-key keyboard.
.213 Data: . . . . same as .212.
.214 Master routines: . . . . 5-location "bootstrap" routine is keyed in from typewriter or 16-key keyboard; it loads the appropriate program loading routine from punched tape.

.22 Library Subroutines: . same as .212.

.23 Loading Sequence: . . . manually controlled.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . as coded.
.312 Occupation of working storage: . . . . Program Relocation System converts 8-track binary program tapes to a relocatable format (Phase I), and then to a relocated binary format (Phase II); see .12.

.32 Input-Output Units

.321 Initial assignment: . . . fixed by coder.
.322 Alternation: . . . . . . as coded.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: . as coded; see Section :111.

.42 Multi-programming: . . not possible.

.43 Multi-sequencing: . . . not possible.

§ 191.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	parity check	processor halt.
Allocation impossible:	none.	
In-out error:	parity check	set bit indicator.
Storage overflow:	none.	
Arithmetic overflow:	hardware check	set bit indicator.
Invalid operation:	none.	
Improper format:	none.	
Invalid address:	all addresses valid.	

.45 Restarts: . . . . as incorporated in user's program.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . no routine available; manual sequence checking is possible, using Halt switch and control register display.

.512 Snapshots: . . . . none.

.52 Post Mortem: . . . . . Parameter Output Programs print and/or punch (on tape) the contents of a specified series of storage locations in "normal parameterized binary format" (see .12).

.6 OPERATOR CONTROL: as incorporated in user's program.

.7 LOGGING: . . . . as incorporated in user's program.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: all routines described here are usable on the basic Monrobot XI system.

.812 Usable extra facilities: as incorporated in user's program.

.813 Reserved storage locations

Loading Routine for Program Tapes: . . 25 locations.
Manual Typewriter Input Program: . . . 26 locations.
Parameter Tape Output Program: . . 31 locations.
Parameter Type Output Program: . . 35 locations.
Parameter Tape/Type Output Program: . . 51 locations.

.82 System Overhead

.821 Loading time: . . . . . approx. 2 minutes for program loading routine.

.822 Reloading frequency: . can be maintained in working storage.

.83 Program Space Available: . . . . . . $0.5I + D \leq 992$, where I is number of instructions and D is number of data items, when standard program loading routine is used.

.84 Program Loading Time: $0.5\,(0.5I + D)$ seconds, using punched tape; i.e., 2 words/second (**).

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

Among stored-program data processing systems, the Monrobot XI is near the bottom of the scale in both price and performance. To illustrate its performance on the Standard File Problems, the time scale on performance graphs .114, .124, .134, and .144 was shifted by a factor of 100. This should be kept in mind when making performance comparisons.

In Standard Configuration IX, punched tape is the obvious choice as the input medium for both the master and detail files. Therefore, it was necessary to add a second Paper Tape Reader to the system shown in :031.1, raising the monthly rental for Configuration IX to $945.

In Standard Configuration I, which uses punched card input, it is assumed that the master and detail cards will be collated off-line, so only one Card Reader is required.

.2 SORTING

Magnetic tape cannot be used with the Monrobot XI system, and no sorting routines are available.

.3 MATRIX INVERSION

The standard problem estimate and the manufacturer's standard routine use the Floating Point Arithmetic subroutines described in :151.17. No timing data has been made available for the standard Matrix Inversion routine.

.4 GENERALIZED MATHEMATICAL PROCESSING

The problem is coded in machine language, with operand addresses optimized and fast access registers used wherever practical. Specially-tailored subroutines are used for the radix conversions and input-output. All input is from punched tape and all results are printed on the Typewriter.

.5 GENERALIZED STATISTICAL PROCESSING

Fixed point machine coding is used, optimized where practical. Input is via the Paper Tape Reader.

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A Estimates

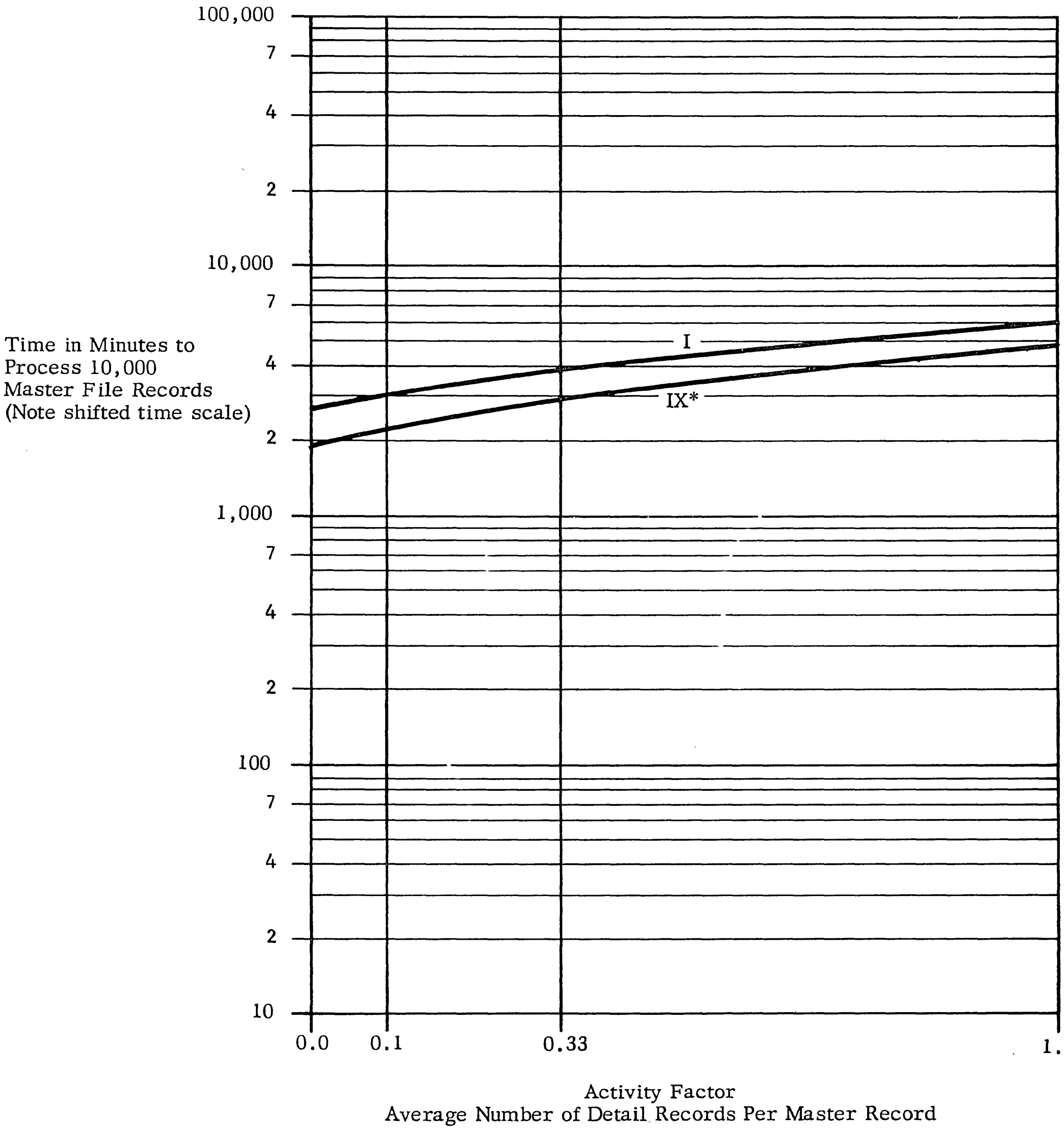
.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.112 Computation: . . . . . . standard.

.113 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . see graph below.

.115 Storage space required
Configuration I: . . . 750 locations.
Configuration IX: . . . 750 locations.



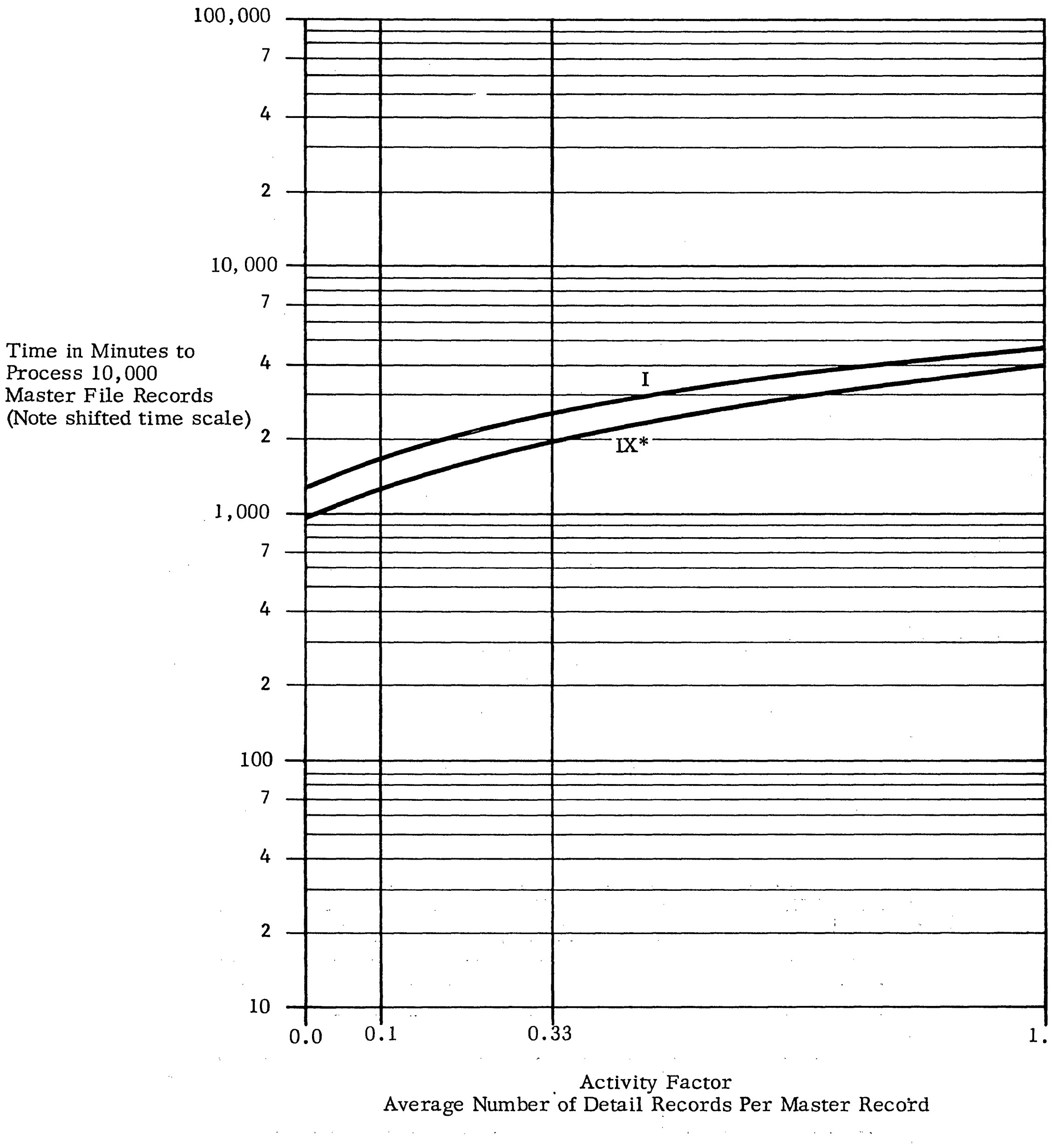
* Extra Paper Tape Reader added to Standard Configuration IX, at a rental increase of $60 per month.

§ 201.

.12 Standard File Problem B Estimates

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.122 Computation: . . . . . . standard.
.123 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . see graph below.



* Extra Paper Tape Reader added to Standard Configuration IX, at a rental increase of $60 per month.

§ 201.

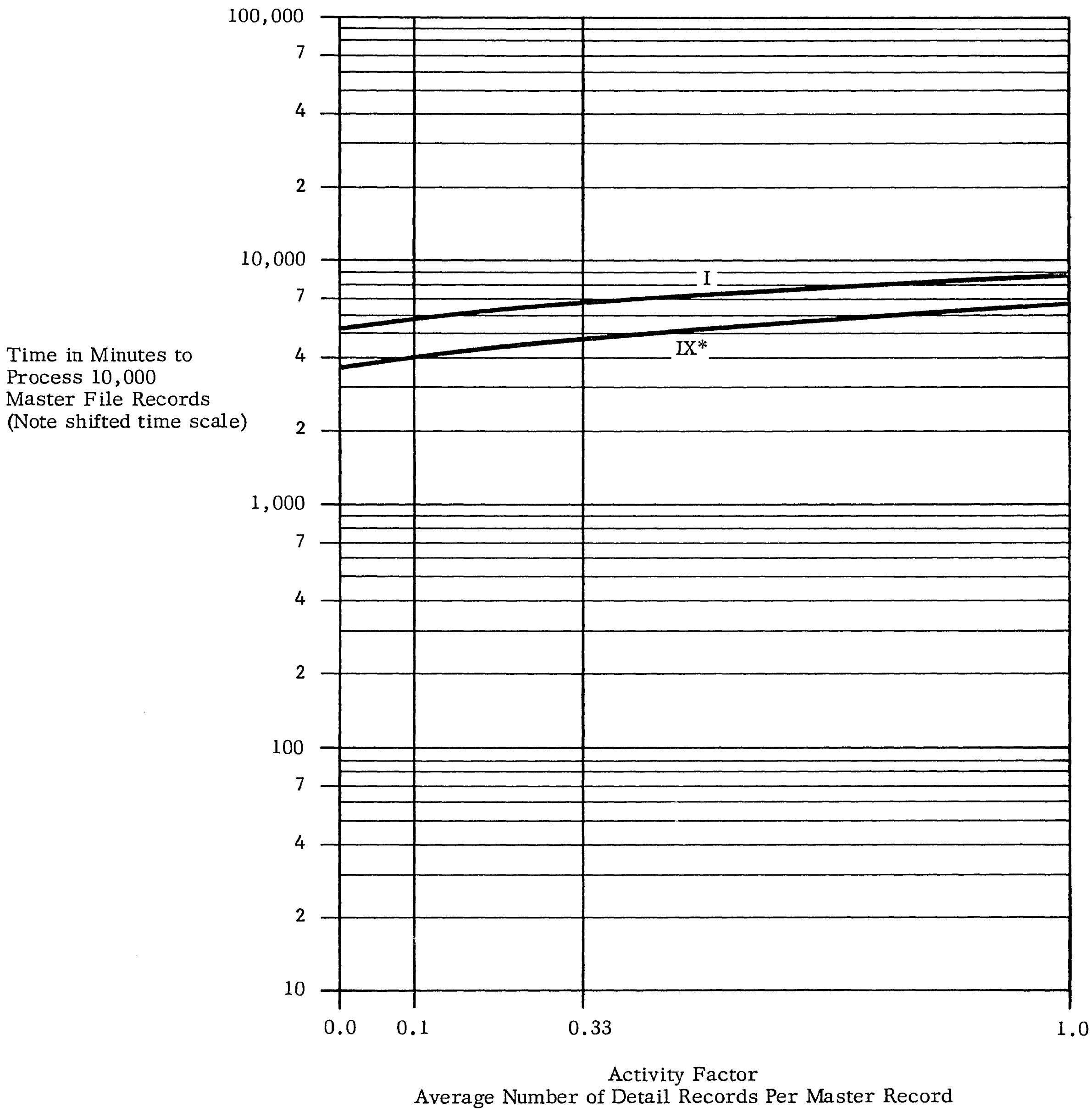
.13 Standard File Problem C Estimates

.131 Record sizes
Master file: . . . . . 216 characters.
Detail file: . . . . . . 1 card.
Report file: . . . . . . 1 line.

.132 Computation: . . . . . . standard.

.133 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.

.134 Graph: . . . . see graph below.



* Extra Paper Tape Reader added to Standard Configuration IX, at a rental increase of $60 per month.

§ 201.

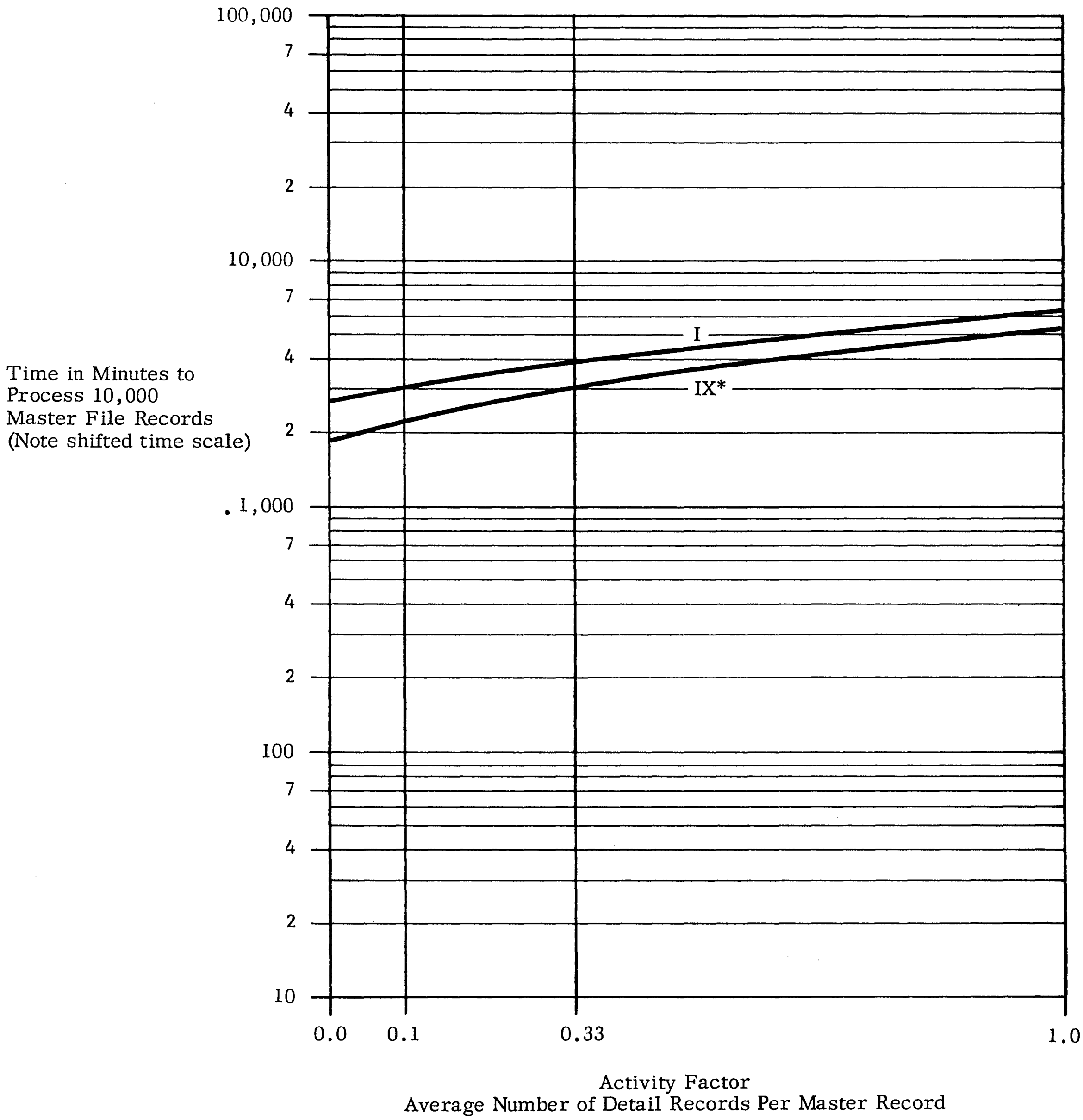
.14 Standard File Problem D Estimates

.141 Record sizes
- Master file: . . . . . 108 characters.
- Detail file: . . . . . . 1 card.
- Report file: . . . . . . 1 line.

.142 Computation: . . . . . . trebled.

.143 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.

.144 Graph: . . . . see graph below.



* Extra Paper Tape Reader added to Standard Configuration IX, at a rental increase of $60 per month.

§ 201.

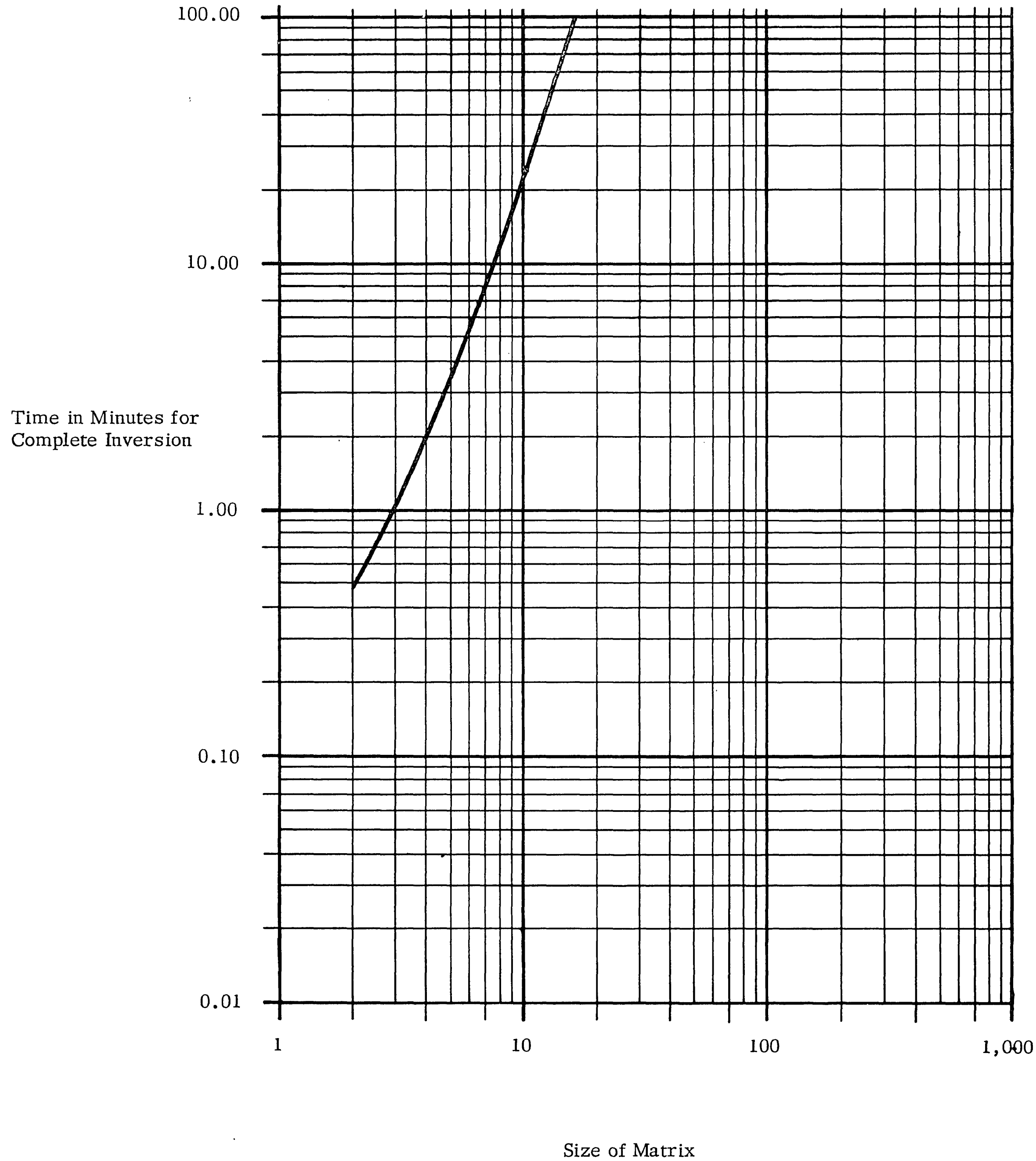
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices,* using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . see graph below.



§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

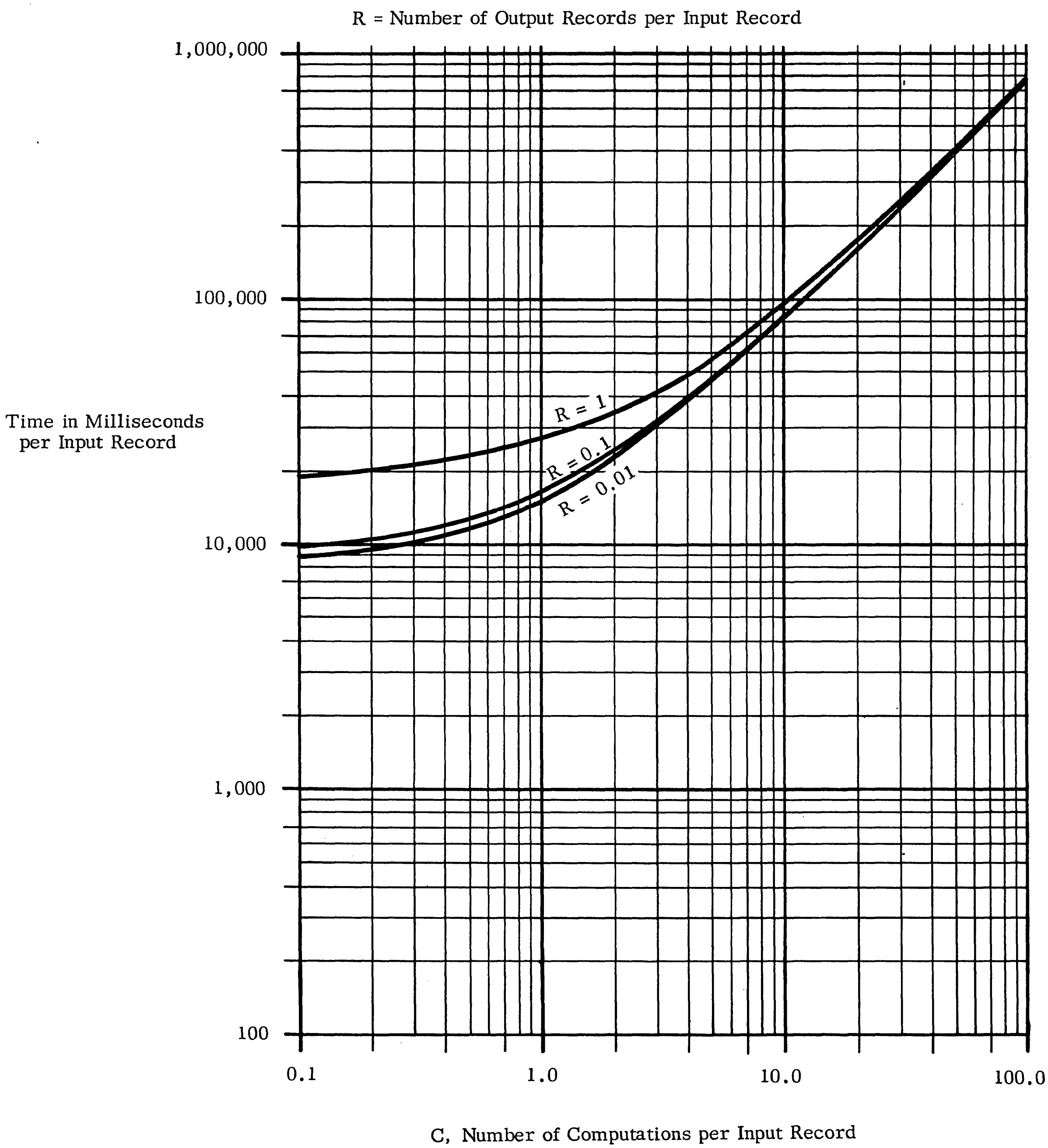
.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation:. . . . . . 5 fifth-order polynomials.
5 divisions.
1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . Configuration IX; paper tape input, typewriter output, fixed point machine coding.

Configuration IX; Single Length (9 digit precision); Fixed Point.



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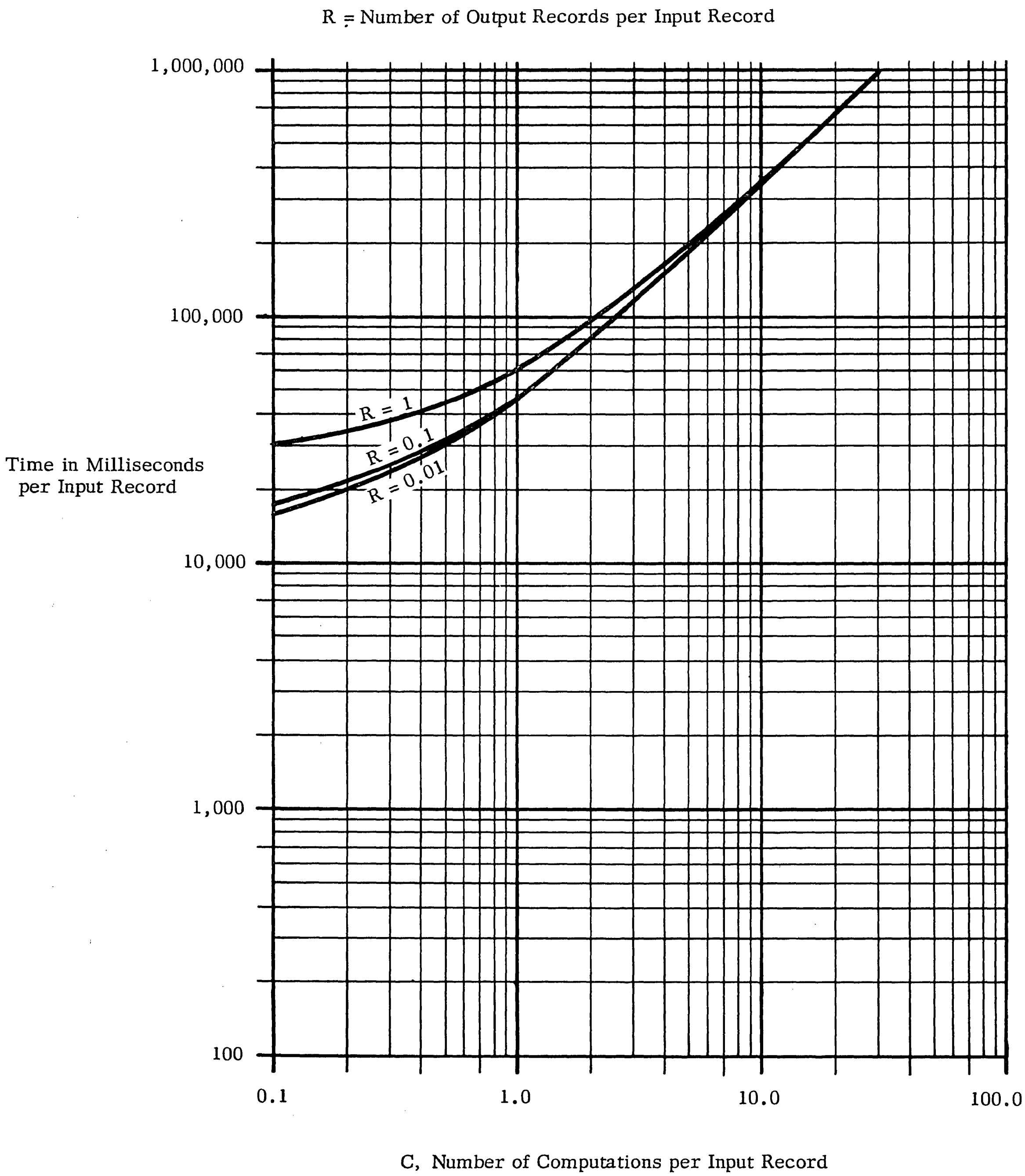
.415 Graph: . . . . Configuration IX; paper tape input, typewriter output, floating point arithmetic using subroutines described in :151.17.

Configuration IX; Single Length (7 digit precision); Floating Point.



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.5 GENERALIZED STATISTICAL PROCESSING

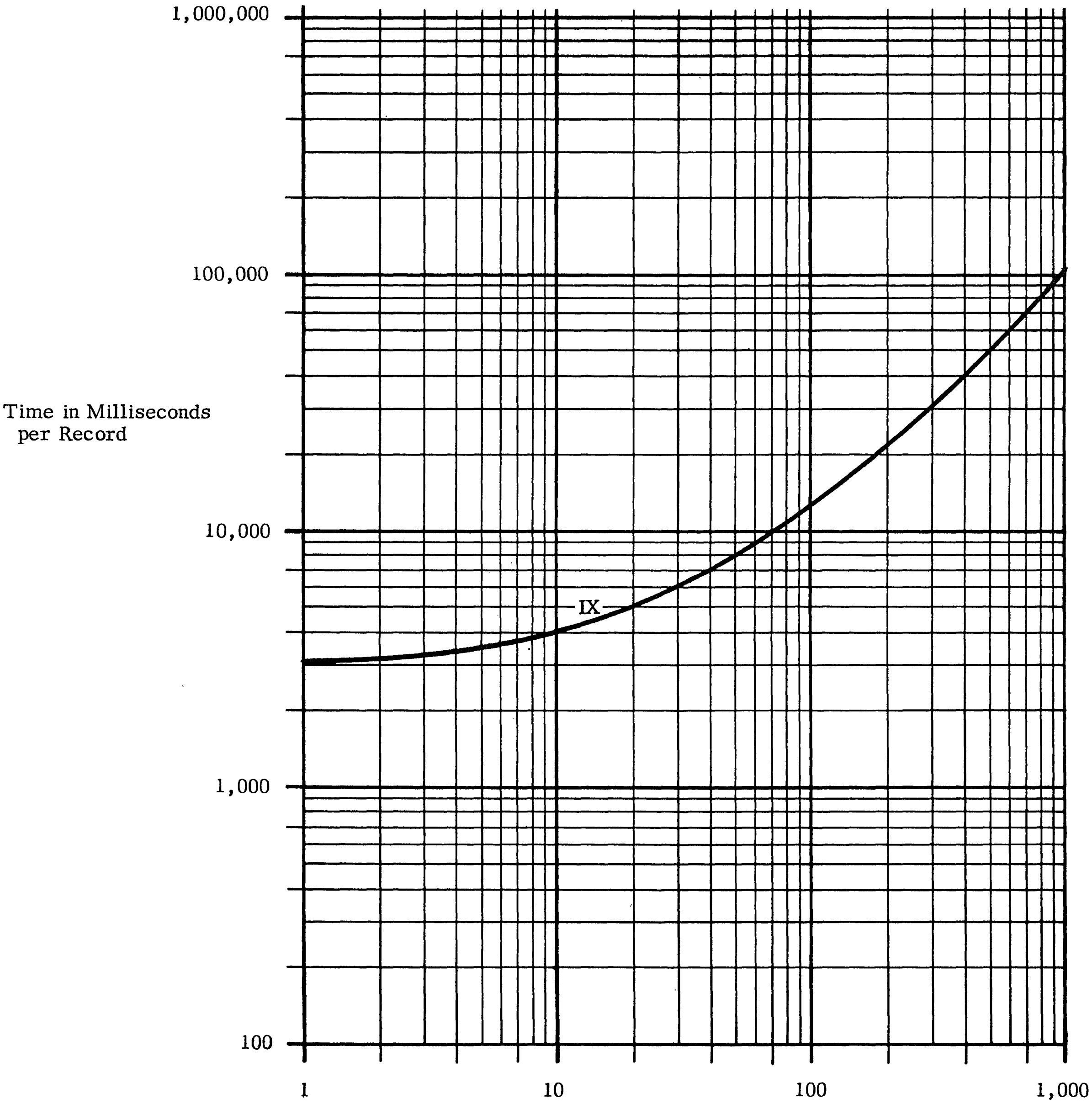
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . see below.



T, Number of Augmented Elements
Roman Numerals denote Standard Configurations

MONROBOT XI
PHYSICAL CHARACTERISTICS

MONROBOT XI PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Monrobot XI Computer	Paper Tape Reader	Paper Tape Punch	Typewriter	Teletype Printer
	Model Number						
PHYSICAL	Height × Width × Depth, in.		28 × 48 × 22	6 × 11 × 13	8 × 11 × 10	11 × 20 × 17	39 × 23 × 37
	Weight, lbs.		375	?	?	?	120
	Maximum Cable Lengths to indicated units, feet		Not specified				
ATMOSPHERE	Storage Ranges	Temperature, °F.					
		Humidity, %					
	Working Ranges	Temperature, °F.					
		Humidity, %	Not specified				
	Heat Dissipated, BTU/hr.						
	Air Flow, cfm.						
	Internal Filters						
ELECTRICAL	Voltage	Nominal	115				115
		Tolerance	±10				
	Cycles	Nominal	60				60
		Tolerance	Not specified				
	Phases and Lines		1ϕ, 3-wire				
	Load Power		850 watts				65 watts
NOTES			Control Unit, 7 × 12 × 12 inches, stands on top.	Housed in upper drawer of desk or cabinet.	Housed in lower drawer of desk or cabinet.		

MONROBOT XI PHYSICAL CHARACTERISTICS–Contd.

IDENTITY	Unit Name		IBM Card Punch	Punched Card Coupler	Cabinet (2 legs)	Table (2 legs)	Knee-hole Desk (2 legs)
	Model Number		024 and 026	24 and 26			
PHYSICAL	Height × Width × Depth, in.		39 × 32 × 29	7 × 15 × 10	28 × 26 × 22	28 × 26 × 22	28 × 51 × 22
	Weight, lbs.		225 max.	?	?	?	?
	Maximum Cable Lengths to indicated units, feet						
ATMOS-PHERE	Storage Ranges	Temperature, °F.					
		Humidity, %					
	Working Ranges	Temperature, °F.					
		Humidity, %					
	Heat Dissipated, BTU/hr.						
	Air Flow, cfm.						
	Internal Filters						
ELEC-TRICAL	Voltage	Nominal	115, 208, or 230				
		Tolerance					
	Cycles	Nominal	60				
		Tolerance					
	Phases and Lines		1ϕ, 3-wire				
	Load Power		320 watts				
NOTES				Usually housed in desk or cabinet.	Houses paper tape reader and punch or card couplers.	Provides work surface only.	Houses I/O units in basic system.

PRICE DATA

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CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Annual Maintenance $	Purchase $
Central Processor		Monrobot XI - Basic System	700.00	1, 200.00	24, 500.00
		Includes the following units:			
		Computer and control unit			
		Input-Output Typewriter			
		Paper Tape Reader			
		Paper Tape Punch			
		Knee-hole Desk			
		2 Input-Output Buffers			
		Optional Features			
		Oscilloscope View Box	NA	5.25	105.00
		Input-Output Buffer	20.00	30.00	600.00
		Cabinet (2 legs)	12.50	0	400.00
		Table (2 legs)	NA	0	60.00
		2, 048-word Drum	185.00	?	5, 250.00
		Note: For punched card input-output, 24 and 26 Couplers can be substituted for Paper Tape Reader and Punch on a one-for-one basis; 024 or 026 Card Punches must be ordered from IBM.			
Input-Output		Paper Tape Reader (includes Cabinet)	60.00	82.50	1, 650.00
		Paper Tape Punch (includes Cabinet)	33.00	55.00	1, 100.00
		Paper Tape Reader and Punch, in single Cabinet	81.00	125.00	2, 500.00
		Edge-Punched Card Reader	70.00	97.50	1, 950.00
		Edge-Punched Card Punch	43.00	70.00	1, 400.00
		Optional Features			
		5-8 Channel Switch	5.00	4.50	90.00
		Paper Tape Unwind Reel	NA	0	20.00
	24	Coupler (for punched card input)	25.00	40.00	800.00
	26	Coupler (for punched card output)	25.00	40.00	800.00
		Input-Output Typewriter	120.00	165.00	3, 300.00
		Output Typewriter	80.00	123.75	2, 475.00
		Optional Features			
		20-inch Carriage	NA	0	100.00
		20-inch Pinfeed Platen	NA	0	100.00
		16-inch Pinfeed Platen	NA	0	100.00
		Form Aligner (tracter feed)	NA	0	100.00
		Form Stand (paper tray)	NA	0	65.00
		Special keys (each)	NA	0	75.00
		Teletype Printer:			
		In lieu of basic Typewriter	50.00	50.00	1, 000.00
		As additional output unit	120.00	165.00	3, 300.00
		Monroe-Card Processor:			
		96 words/card	230.00	?	6, 500.00
		174 words/card	290.00	?	8, 500.00

PRICE DATA—Contd.

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Annual Maintenance $	Purchase $
Input-Output		16-Key Keyboard	12.50	20.00	400.00
Data Origination		Synchro-Monroe Punch Tape Adding Machine:			
		One-register model	88.00	110.00	1,950.00
		Two-register model	98.00	120.00	2,175.00

Notes: NA in rental column means unit or feature is available for purchase only.
Maintenance charges apply only to purchased equipment.
Prices do not include Manufacturers' Excise Tax of 6 percent on purchase or 10 percent on rental.