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STANDARD EDP REPORTS

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NCR 315

National Cash Register Company

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CONTENTS

INTRODUCTION

The NCR 315 is a small to medium scale, solid-state computer system oriented toward business data processing applications. A library of floating point subroutines equips the 315 to handle modest scientific computational loads as well. System rentals range from $2,850 to over $25,000 per month, with most installations falling within the $5,000 to $15,000 range. First customer deliveries of the NCR 315 were made in February, 1962, and more than 220 systems have been installed to date.

Compatibility

The NCR computer line was expanded in July 1963 by the announcement of the 315-100 series (Computer System Report 602:), and again in July 1964 by the announcement of the 315 RMC (Computer System Report 603:). The 315-100 is essentially an economy version of the 315 which uses the same processor, except that many of the features (such as multiply/divide and the capability to connect magnetic tape units) are optional. A line of low-performance, low-cost peripherals originally announced solely for the 315-100 is now available for the 315. This greatly reduces the effective differences between the two systems.

The NCR 315 RMC (Rod Memory Computer), on the other hand, uses a completely new central processor and internal storage. The 315 RMC uses the first commercially-available complete thin-film memory and performs internal operations about 7.5 times as fast as the original NCR 315. The instruction repertoire includes all the instructions of the 315 and features several extensions — primarily floating-point arithmetic hardware. Except for minor differences (and the added commands of the 315 RMC), all three computer systems in the 315 series are program-compatible and utilize the same software.

There is no program compatibility between the 315 line and NCR's other computers — the NCR 304 (a medium-scale system which is no longer in production, the NCR 310 (an adaptation of the Control Data 160 oriented toward MICR sorter-reader operations), and the NCR 390 and 500 Series (small-scale data processing systems built around the concept of magnetic ledger cards).

The NCR 315 is tape-compatible with the IBM 729 series and other "IBM-compatible" magnetic tape handlers. Because code translation for most NCR 315 peripheral devices is performed by the stored program, a wide variety of data codes can be accommodated on punched tape and cards.

Hardware

The basic addressable unit of internal storage in NCR 315 systems is the "slab," which consists of 12 data bits and 1 parity bit. Each slab can hold two 6-bit alphameric characters or three 4-bit decimal digits. Instructions are provided to convert information from the alphameric to the decimal mode, and vice versa. All arithmetic operations are performed upon data stored in the 4-bit decimal mode. Arithmetic operands can be from 1 to 8 slabs (or 3 to 24 digits) in length, as specified in the instruction. A minus sign requires one digit position, whereas a plus sign does not. The results of most arithmetic operations are developed in a variable-length accumulator.

Instructions occupy either two or four slabs each; most are of the one-address type, but others function as two-address instructions. The repertoire of approximately 150 instructions includes fixed point multiplication and division, add-to-storage, binary addition, three-way comparison, shifting, and block transfer facilities. Literal operands up to three digits in length can be specified in many instructions. Edit, Suppress, and Scan instructions facilitate format control and character manipulation. Internal instructions are executed at the rate of about 16,000 per second in typical NCR 315 routines.

Interrupt facilities aid in achieving efficient utilization of the NCR 315's input-output capabilities by informing the central processor when a peripheral device is ready to deliver or receive information. When the master Demand Permit Flag is on, any peripheral unit whose individual Unit Demand Flag is also on will generate an interrupt signal whenever it is ready to accept another input or output instruction. When the central processor receives the interrupt signal, it completes execution of the current instruction and then jumps to a special routine. This routine tests all active peripheral units to determine which one caused the interrupt, and then initiates the appropriate action.

Core storage is available in module sizes of 5,000, 10,000, or 15,000 slabs. Up to four of the 10,000-slab modules can be used in a system, providing a maximum core storage capacity of 40,000 slabs, 80,000 characters, or 120,000 decimal digits. Cycle time is 6 microseconds for each access to one 12-bit slab. A parity check is performed upon all internal data transfers.

An auxiliary core storage bank, which functions independently of the main core store, holds 32 index registers, 32 jump registers, the accumulator, and a number of program-testable "flags" which indicate the result of a comparison, an arithmetic overflow, or an interrupt condition. Because only 1,000 storage locations can be directly addressed by the 3-digit instruction address, nearly every NCR 315 instruction utilizes index register modification. (Indexing requires no additional execution time.) The 32 jump registers are used primarily to store "jump tables," which transfer control to specified locations when specific conditions (errors, end-of-tape marks, etc.) arise in the execution of certain instructions.

CRAM (Card Random Access Memory) is a key feature of the NCR 315 system that combines many of the advantages of magnetic tape and disc storage units. The CRAM storage medium is a deck of flexible magnetic cards. A cartridge containing up to 256 cards can be quickly removed from the CRAM Unit, replaced by another cartridge, stored off-line, and reinserted when necessary, in the same manner as a reel of magnetic tape. Three models of CRAM are available, differing in storage capacity and recording density. From 5.5 million (Model 353-1) to 16 million (Model 353-3) characters can be stored in a single CRAM cartridge.

One selected CRAM card at a time is dropped from the on-line cartridge and wrapped around a revolving drum; this takes about 235 milliseconds. Then any or all of the data bands (7 or 56, depending on the model) can be read and/or written sequentially. Average rotational delay is less than 25 milliseconds, and data is transferred at a peak rate of 100,000 characters per second (Model 353-1) or 38,000 characters per second (Models 353-2 and 353-3).

Up to 16 CRAM units can be connected to an NCR 315 system, and different models can be intermixed if desired. Card dropping time can be overlapped, but only one CRAM read or write operation can be performed at a time. Both lateral and longitudinal read-after-write parity checks are performed when writing a CRAM record in the Model 353-1. Since the recording mode of the other two models is bit-serial, only a longitudinal check is made.

NCR offers a large array of peripheral equipment for 315 systems, but complex configuration rules limit the selection of components for a particular installation.

Magnetic tape units are available with peak transfer rates ranging from 12,000 to 120,000 characters per second (tape speeds of 60 or 150 inches per second). NCR has discontinued the 333-bits-per-inch recording density and now uses the IBM 729-compatible densities of 200, 556, and 800 bits per inch. In all models, block length is variable from 1 to 7,999 slabs, and a read-after-write parity check is performed upon recording.

Up to eight magnetic tape handlers can be connected directly to an NCR 315 central processor, in which case no overlapping of magnetic tape reading or writing with computation is possible. Alternatively, Magnetic Tape Simultaneity Controllers can be used to provide either read-compute and write-compute overlapping (with one controller) or full read-write-compute simultaneity (with two controllers), through time-sharing of accesses to core memory. Up to eight tape handlers can be connected to each controller. Tape handlers of different tape speeds cannot be intermixed in a 315 system.

Two card readers (400 or 2,000 cards per minute), two card punches (both with completely buffered operation at 100 or 250 cards per minute), and two card read-punch units (which read at 300 or 400 cards per minute) provide punched card input-output. The 100-cpm punch and the card read-punches are the IBM 523, 1442 Model 1, and 1442 Model 2 units, respectively. The 250-cpm card punch is an adaptation of a Control Data unit. All these devices handle standard 80-column cards, and the slower card reader is also available in a 90-column version. A maximum of one card reader or two card read-punch units can be connected on-line to an NCR 315 system A total of four card punches and printers, in any combination, can be connected.

Two paper tape readers (600 and 1,000 characters per second) and two paper tape punches (120 and 110 characters per second) provide paper tape input-output. All models are unbuffered. Only one paper tape reader and one punch can be connected on-line at a time.

Three printers are available for the NCR 315. Two are fully buffered, have 120 print positions, and offer maximum printing rates of 1,000 or 690 lines per minute for alphanumeric information and 1,000 or 940 lines per minute for numeric information. The third model can function as either a buffered 24-position numeric lister at a peak rate of 1,850 lines per minute, or as an unbuffered 120-position line printer at a peak rate of 650 alphanumeric or 805 numeric lines per minute. A lower-cost version of the printer-lister is available without the lister feature, and with a different arrangement of the characters on the drum. This arrangement, common in recent line printers, permits single-spaced alphanumeric printing at speeds of up to 800 lines per minute. A total of four printers and card punches, in any combination, can be connected to an NCR 315.

(Contd.)

Documents encoded in magnetic ink can be read and sorted at the rate of 750 or 1,200 documents per minute. An optical character reader can read journal tapes produced by cash registers, adding machines, and accounting machines at up to 832 characters per second. Up to four buffered MICR and optical readers, in any combination, can be connected to an NCR 315.

A line of communications equipment makes the NCR 315 suitable for certain real-time applications. The Teletype Inquiry System permits two-way communication between a 315 and Teletypewriters, Automatic Send/Receive units, or Teleprinters (Kleinschmidt) located at the computer site or any distance away from it. The On-Line Savings System provides bank tellers with direct access to customer account information stored in CRAM memory. The Airline Reservations System enables an NCR 315 to process and answer inquiries from reservation agents at remote terminals and maintain an up-to-date inventory of available seats on all flights.

Software

The NEAT Compiler is an advanced symbolic assembly system designed for use in NCR 315 systems with at least 10,000 slabs of core storage, a punched tape or card reader, a printer, and either 1 CRAM unit or 4 magnetic tape handlers. (A special NEAT Compiler is available for systems with 5,000 slabs of core storage and 4 magnetic tape units.) References to an extensive library of macro instructions cause the insertion of in-line and/or closed subroutines in the object program. User-defined macros can be added to the library. The data to be processed by the object program is defined in terms of its hierarchical structure of files, records, groups, and fields, using COBOL-like level indicators. Standard forms are provided for tape or CRAM file specifications and compiler control. All object programs produced by the NEAT Compiler are compatible with the STEP and PACE operating systems described below.

The NEAT Assembler is a basic symbolic assembly system designed for small NCR 315 installations. It requires only 5,000 slabs of core storage, punched tape or card input-output, a printer, and 1 magnetic tape or CRAM unit. The coding format is fixed, and none of the macro instructions or data definition facilities of the NEAT Compiler are available. All the facilities of the target computer can be utilized.

BEST (Business EDP Systems Technique) is a technique developed by NCR to speed the programming and debugging of programs to perform routine business data processing functions. A job is defined in terms of BEST functions (38 are currently provided), and a series of parameter sheets is filled out. Cards, key-punched from the parameter sheets, are input to the BEST program generator, where the calls for BEST functions are replaced with subroutines coded in symbolic language (NEAT). The NEAT compiler is then used to produce a machine-language program. Facilities provided by the currently-offered set of BEST functions include such operations as input-output, file control, arithmetic, paper tape code translation, report writing, and sorting. The minimum configuration required to utilize the BEST program generator is 10,000 slabs of memory and either five magnetic tape units or two CRAM units (any model).

The NEAT COBOL Compiler accepts nearly all of Required COBOL-61 (there are minor exceptions) and most of the COBOL-61 Electives. The compiler requires at least 10,000 slabs of core storage and either 2 CRAM units or 5 magnetic tape units. COBOL source statements are translated into NCR 315 machine language object programs at an average rate of 10 to 20 statements per minute. A useful, non-standard addition to the COBOL language is the LOCATE verb, which enables the COBOL programmer to utilize CRAM units for file storage. Object program efficiency is strongly influenced by the data arrangements in core storage and in the files. These data arrangements are prescribed by the COBOL programmer, and guidelines are available which help him to maximize efficiency by arranging the data in accordance with the NCR 315's internal structure.

STEP (Standard Tape Executive System) is an input-output control and supervisory routine for NCR 315 magnetic tape systems; PACE (Packaged CRAM Executive) is its counterpart for systems that utilize CRAM memory. Both systems are capable of controlling run-to-run changeovers, program loading, restarts, and overlays, as well as all routine tape and CRAM input-output operations. The Librarian routine creates and maintains a program library tape or CRAM deck in which each program includes all the information required by STEP or PACE.

The Tape and CRAM Sort Generators utilize parameters specified in control cards to generate sorting routines that use from 4 to 8 tape units or 1 to 4 CRAM units, respectively. Either fixed- or variable-length records can be sorted according to either fixed- or variable-length keys. The user can insert his own coding to add, delete, or edit selected records during the first and/or last pass. Restart points are established at the end of each merge pass.

Other available software for the NCR 315 includes a well-planned library of Scientific and Engineering Subroutines; a FORTRAN II compiler; FAST (a load-and-go algebraic compiler); a simulator of the IBM 305 RAMAC system; a variety of diagnostic and printout routines; and a set of "canned" programs for specific applications such as demand deposit accounting, on-line savings, accounts payable, inventory management, and PERT.

DATA STRUCTURE

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Slab:	12 bits + parity	basic addressable location; holds 3 digits or 2 characters.
R-registers (32):	18 bits	address modification by indexing.
J-registers (32):	18 bits	specify destinations for conditional jumps.
CRAM Band:	1,550 or 560 slabs	record location in CRAM storage.
CRAM Card:	7 or 56 bands.	
CRAM Deck:	256 or 128 cards	on-line capacity of one CRAM Unit.

.2 INFORMATION FORMATS

Type of Information	Representation
Instruction:	2 or 4 slabs.
Fixed point number:	1 to 8 slabs; i.e., 3 to 24 decimal digits.
Floating point number:	5 slabs; i.e., 3 digits for exponent and 11 digits plus sign for fraction.
Alphameric item:	1 to 8 slabs; i.e., 2 to 16 characters.

SYSTEM CONFIGURATION

Every NCR 315 EDP system includes the following units:

- Central Processor — available in four different models, each equipped to accommodate specific groups of input, output, file, and inquiry devices, as summarized in Table I.
- Console — includes I/O typewriter and option switches.
- Core Storage — available module sizes are summarized in Table II.
- Various peripheral devices — the available peripheral devices are summarized in Table III, with their rated speeds, configuration rules, and references to the report sections where detailed descriptions will be found.

TABLE I: CENTRAL PROCESSOR MODELS

Processor Model	Paper Tape, Punched Cards, Line Printers	MICR Sorter-Readers	CRAM, Magnetic Tape	Inquiry and Communications Devices
315-3:	yes	no	yes	no
315-4:	yes	yes	yes	no
315-35:	yes	no	yes	yes
315-45:	yes	yes	yes	yes

TABLE II

Core Storage Model	Size in Slabs	Maximum Number in System
316-2	5,000	1
316-301	10,000	1
316-302	10,000	3*
316-4	15,000	1

* The 316-302 module can be used only in conjunction with the 316-301 module; maximum system storage capacity is 40,000 slabs.

TABLE III: PERIPHERAL DEVICES

Device	Maximum Number in System(1)	Model Number	Reference
Input/Output Console	1(2)	472-1: Punched Paper Tape Reader and Punch; 1000 cps and 110 cps 472-2: Card Reader; 400 cpm 472-3: Both of the above	601:071 601:071 601:071
Punched Paper Tape Reader	2(3)	361-201; 600 cps	601:072
Punched Paper Tape Punch	2(3)	371-201; 120 cps	601:073
Card Reader	1	380-3; 2000 cpm	601:074
Card Read/Punch	2	376-7; 300/50-270 cpm 376-8; 400/88-360 cpm	601:077 601:077
Card Punches, Line Printers, and Printer-Listers	4	376-2; 100 cpm 376-101; 250 cpm 340-3; 690 lpm 340-502; 650 lpm 340-512; 650/1800 lpm 340-503; 805 lpm 340-601; 1000 lpm	601:075 601:076 601:081 601:082 601:082 601:082 601:083
Magnetic Tape Units	16(4)	334-101, 334-102 (12 KC) 334-131, 334-132 (33 KC) 333-102 (83 KC) 333-101 (120 KC)	601:091 601:091 601:091 601:091
CRAM Storage Units	16	353-1 (100 KC; 5.5 million characters) 353-2 (38 KC; 8 million characters) 353-3 (38 KC; 16 million characters)	601:042 601:043 601:043
MICR Sorter-Reader and Optical Reader	4	402-3 (750 dpm) 407-1 (1,200 dpm) 420-1 (2,160 lpm)	601:102 601:103 601:104
Teletype Inquiry Systems	16 buffers; 8 adapters per buffer 1 controller; 100 adapters	356-1 Central Inquiry Buffer 359-3 Teletype Adapter 359-4 Monitor Adapter 321-1 Central Communications Controller Teletype Adapter Teleprinter (Kleinschmidt) Adapter	601:105 601:105
On-Line Savings System	16 buffers; 8 scanners per buffer; 16 window machines per scanner.	356-3 Central Inquiry Buffer 359-1 Adapter 438-2 Scanner-Selector 428-3 Window Machine Controller	601:106
Universal Interconnecting Device	—	435-2	601:103

(1) This column shows the total number of devices of a particular group that can be incorporated in an NCR 315 system. Restrictions between groups are indicated in the following footnotes.

(2) The Input/Output Console cannot be used on-line with a like device; e.g., a Model 472-2 or 472-3, which contains a card reader, cannot be used on-line with a Model 380-3 Card Reader.

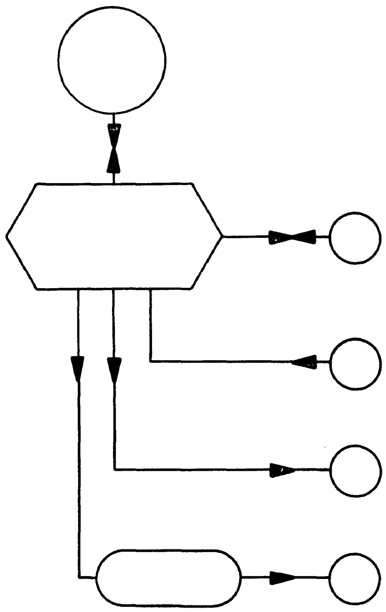
(3) Switching between these devices is done manually; both cannot be on-line at the same time.

(4) Only eight magnetic tape units can be connected directly to the Processor. With either one or two Model 324-1 Magnetic Tape Simultaneity Controllers, up to 16 tape units can be connected.

(Contd.)

.1 CARD SYSTEM; CONFIGURATION I

Deviations from Standard Configuration: . . . . card reader is 100% faster.
card punch is 25% faster.
console typewriter is standard.
32 index registers are standard.



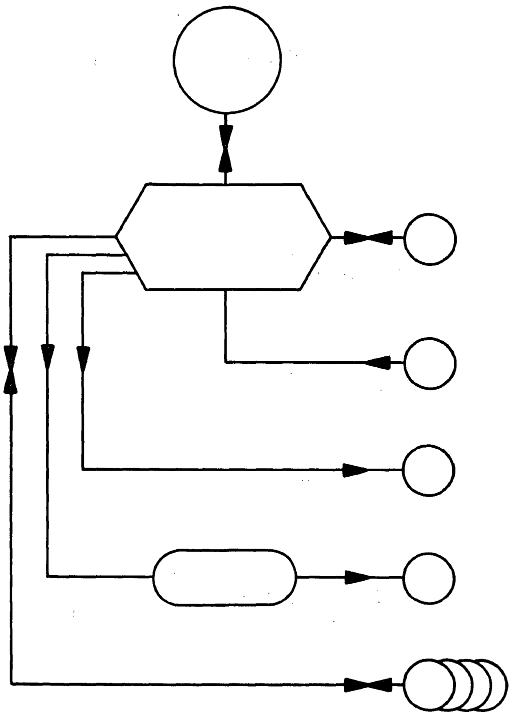
Equipment	Rental
316-2 Core Storage: 5,000 slabs	$ 1,100
315-3 Central Processor and Console with Typewriter	1,400
380-3 Card Reader: 2,000 cards/min	750
340-601 Printer and Buffer: 1,000 lines/min	1,600
354-101 Card Punch Buffer 376-101 Card Punch: 250 cards/min	850

Optional Features Included: . . . . none.

TOTAL RENTAL:	$ 5,700

.2 4-TAPE BUSINESS SYSTEM; CONFIGURATION II

Deviations from Standard Configuration: . . . . printer is 30% faster.
magnetic tape is 20% slower.
card reader is 20% slower.
console typewriter is standard.
32 index registers are standard.
multiply-divide hardware is standard.



Equipment	Rental
316-2 Core Storage: 5,000 slabs	$ 1,100
315-3 Central Processor and Console with Typewriter	1,400
472-2 Card Reader: 400 cards/min	450
340-3 Printer and Buffer: 690 lines/min	1,425
354-101 Card Punch Buffer 376-2 Card Punch: 100 cards/min	575
334-101 (1) Magnetic Tape Unit 334-103 (3) Magnetic Tape Units: 12,000 characters/sec	975

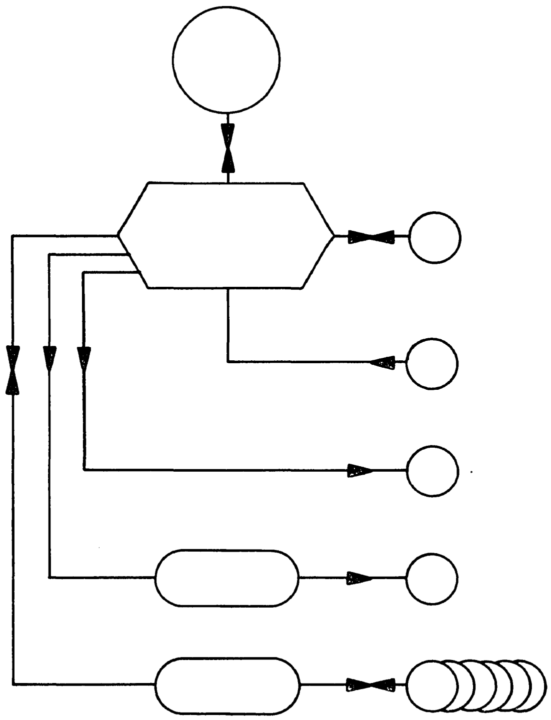
Optional Features Included: . . . . none.

TOTAL RENTAL: $ 5,925

(Contd.)

.3 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . printer is 38% faster.
32 index registers are standard.
card reader is 20% slower.



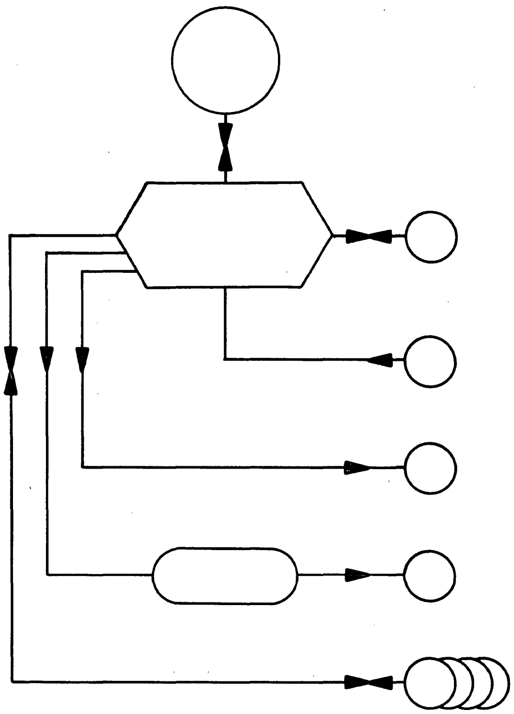
Equipment	Rental
316-301 Core Storage: 10,000 slabs	$ 1,600
315-3 Central Processor and Console with Typewriter	1,400
472-2 Card Reader: 400 cards/min	450
340-3 Printer and Buffer: 690 lines/min	1,425
354-101 Card Punch Buffer 376-2 Card Punch: 100 cards/min	575
324-1 Magnetic Tape Simultaneity Controller	695
334-131 (2) Magnetic Tape Units: 334-132 (4) Magnetic Tape Units: 33,400 characters/sec	2,000

Optional Features Included: . . . . none.

TOTAL RENTAL: $ 8,145

.31 4-CRAM BUSINESS SYSTEM; SPECIAL CONFIGURATION IIIC

Deviations from Standard Configuration III: . . . . 4 CRAM units are used in place of 6 magnetic tape units.
printer is 38% faster.
card reader is 20% faster.
CRAM read or write operations cannot be overlapped with computation.
32 index registers are standard.



Equipment	Rental
316-301 Core Storage: 10,000 slabs	$ 1,600
315-3 Central Processor and Console with Typewriter	1,400
472-2 Card Reader: 400 cards/min.	450
340-3 Printer and Buffer: 690 lines/min.	1,425
354-101 Card Punch Buffer 376-2 Card Punch: 100 cards/min.	575
353-2 CRAM Units (4): 38,000 characters/sec	2,800

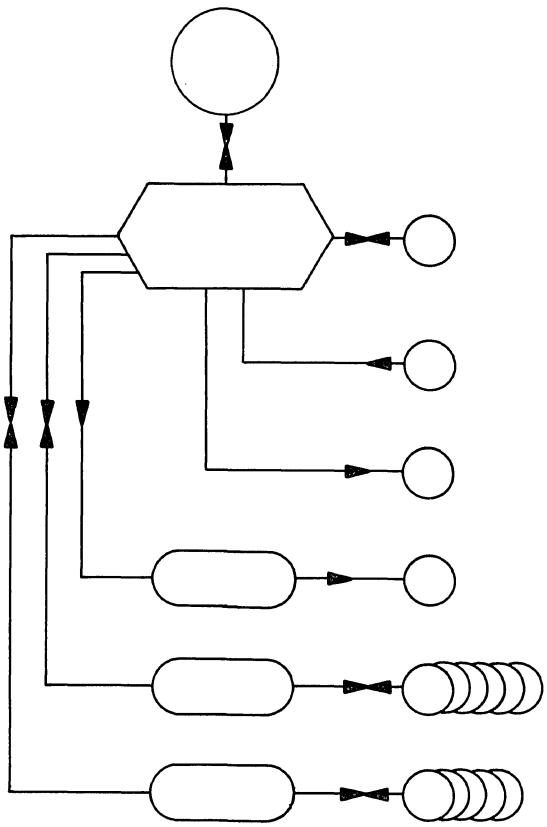
Optional Features Included: . . . . none.

TOTAL RENTAL: $ 8,250

(Contd.)

.4 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configurations: . . . . card reader is 100% faster.
card punch is 25% faster.
magnetic tape is 38% faster.



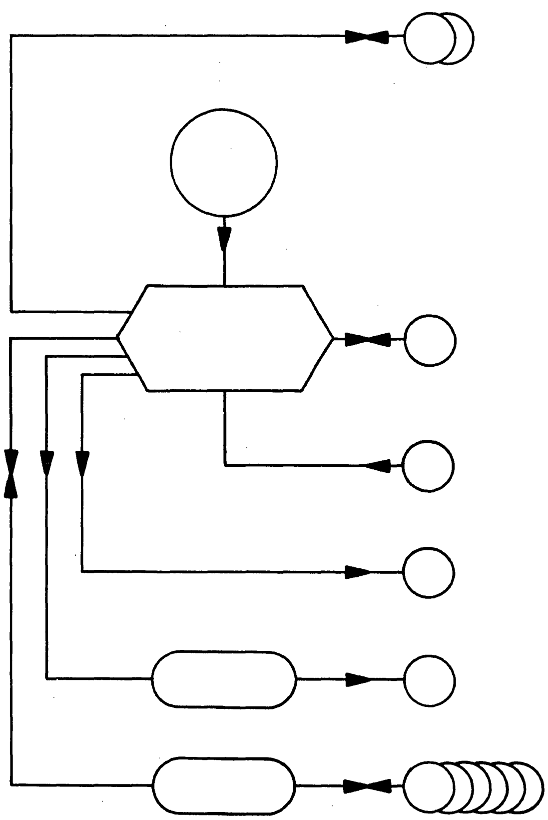
Equipment	Rental
316-301 Core Storage: 10,000 slabs; 316-302 Core Storage: 10,000 slabs	$ 3,400
315-3 Central Processor and Console with Typewriter	1,400
380-3 Card Reader: 2,000 cards/min	750
340-601 Printer and Buffer: 1,000 lines/min	1,600
354-101 Card Punch Buffer; 376-101 Card Punch: 250 cards/min	850
324-1 Magnetic Tape Simultaneity Controller	695
333-102 Magnetic Tape Units (6): 83,400 characters/sec	4,950
324-1 Magnetic tape Simultaneity Controller	695
333-102 Magnetic Tape Units (6): 83,400 characters/sec	4,950

Optional Features Included: . . . . none.

TOTAL RENTAL:	$19,290

.5 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Deviations from Standard Configuration: . . . . card reader is 20% slower.
printer is 38% faster.
magnetic tape is 20% slower.
32 index registers are standard.
auxiliary storage is 61% larger.



Equipment	Rental
353-3 CRAM units (2): 32,200,000 characters	$ 1,650*
316-301 Core Storage: 10,000 slabs	1,600
315-3 Central Processor and Console with Typewriter	1,400
472-2 Card Reader: 400 cards/min	450
340-3 Printer and Buffer: 690 lines/min	1,425
354-101 Card Punch Buffer 376-2 Card Punch: 100 cards/min	575
324-1 Magnetic Tape Simultaneity Controller	695
334-131 (2) Magnetic Tape Units: 334-132 (4) Magnetic Tape Units: 33,400 characters/sec.	2,000

Optional Features Included: . . . . none.

TOTAL RENTAL: $ 9,795

* Four Model 353-1 CRAM units (22 million characters total) can be substituted for higher performance. Total system rental in this case would be $11, 945.

INTERNAL STORAGE: CORE STORAGE

.1 GENERAL

.11 Identity: . . . . Core Storage.
NCR 315:
Models 316-2, 316-301, 316-302, and 316-4.
NCR 315-100:
Models 316-102, 316-103, 316-104, and 316-302.

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

.13 Description

Core storage for the NCR 315 (or NCR 315-100) is available in three module sizes of 5,000, 10,000 and 15,000 slabs. The total working store may consist of any of the following:

- One Model 316-2 (316-102) module of 5,000 slabs:
- One Model 316-4 (316-104) module of 15,000 slabs:
- One Model 316-301 (316-103) module of 10,000 slabs, plus from zero to three additional Model 316-302 (316-302) modules of 10,000 slabs each.

(Note that the model numbers of the corresponding modules for the 315-100 are shown in parentheses above. The remainder of this report section references only the 315 model numbers for the sake of clarity. The characteristics of the various 315-100 core storage modules are the same as those of the corresponding 315 modules.)

Total core storage capacity of an NCR 315 system, therefore, can range from 5,000 to 40,000 slabs. Each slab contains 12 data bits plus 1 parity bit and can store two 6-bit alphameric characters or three 4-bit decimal digits. Each instruction occupies either two or four consecutive slabs. Cycle time is six microseconds for each access to one 12-bit slab.

The Model 316 Core Storage described here is used for data and instruction storage. An independent 6-microsecond core storage unit, associated with the Processor, contains the accumulator, the 32 index registers, the 32 jump registers, and a number of program-testable "flags." These two core stores can be accessed simultaneously, which gives the NCR 315 a speed advantage over some systems that use the data store to hold logic registers.

.14 Availability: . . . . . . 15 months.

.15 First Delivery: . . . . March, 1962 (with NCR 315).

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic cores.

.22 Physical Dimensions

.221 Magnetic core type storage —
Array size: . . . . . 50 by 52 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: . . . sense wire.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates —
Unit of data: . . . . . 1 slab.
Conversion factor: . 12 bits.
Data rate: . . . . 166,667 slabs/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity:	316-2	316-301 or 316-302	316-4.
Slabs:	5,000	10,000	15,000.
Characters:	10,000	20,000	30,000.
Digits:	15,000	30,000	45,000.

.32 Rules for Combining Modules

Storage size, slabs	Storage modules required
5,000:	316-2.
10,000:	316-301.
15,000:	316-4.
20,000:	316-301 plus one 316-302.
30,000:	316-301 plus two 316-302s.
40,000:	316-301 plus three 316-302s.

.4 CONTROLLER: . . . . no separate controller.

.5 ACCESS TIMING

.51 Arrangement of Heads: . . . . one access mechanism per system.

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

.53 Access Time Parameters and Variations

.531 For uniform access —
Access time: . . . . . 4 μsec.
Cycle time: . . . . . . 6 μsec.
For data unit of: . . 12 bits (plus parity bit).

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

.7 PERFORMANCE

.71 Data Transfer

Pairs of storage unit possibilities —
With self: . . . . yes.
With CRAM: . . . . . yes.

.72 Transfer Load Size

With self: . . . . 1 to 999 slabs.
With CRAM: . . . . . . 1 to 1,550 slabs.

.73 Effective Transfer Rate

With self: . . . . 83,000 slabs/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address*:	check	halt.
Receipt of data:	parity check	program jump.
Recovery of data:	parity check	program jump.
Dispatch of data:	send parity bit.	
Conflicting commands:	not possible.	
Physical record missing:	not possible.	

* This refers to a bit combination that cannot be decoded as an address. If a given address is greater than machine capacity, the effective address is modulo memory size.

INTERNAL STORAGE: CRAM, MODEL 353-1

.1 GENERAL

.11 Identity: . . . . Card Random Access Memory, Model 353-1. CRAM.

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

.13 Description

The 353 CRAM (Card Random Access Memory) unit can be considered and used as both an internal storage unit with the capabilities of a drum or disc store, and as an input-output unit with the capabilities of one or more magnetic tape units. (see Section 601:101). Three different CRAM models are currently available; they differ primarily in recording mode, recording density, and number of cards per cartridge. Model 353-1 is analyzed in detail in this section. The important differences between this model and Models 353-2 and 353-3 are presented in Section 601:043, which follows. Up to sixteen CRAM Units can be used with an NCR 315.

The storage medium is a deck of up to 256 magnetic oxide coated Mylar cards that are suspended in a changeable cartridge. The cards are supported by rods that fit into notches on both sides of the cards and by selector rods fitting eight Ω shaped notches on the top of each card. The card number of each card is determined by the side on which each Ω leg has been cut off. Each of the legs of the eight Ω shaped notches is assigned the value of 0 or 1. An eight-bit binary card address causes the selector rods to move to the corresponding side of each Ω. The card that has had its Ω legs cut off in exactly the same pattern as the 1s and 0s in the address is then unsupported in this position, and it falls into the drop chute.

The handler consists of the cartridge chamber, a drop chute, a drum, and a return chute. A card is dropped from the deck in the cartridge chamber down the drop chute to the drum. It is held on the drum by vacuum. Three-quarters of a second after the last time it is used, or one drum revolution after the next Drop Card operation, the card is stripped from the drum, and its momentum carries it up the return chute and back into the cartridge. There is no need for the cards to be replaced in any particular sequence; the selector rods can select the cards from random positions.

Each Model 353-1 CRAM card has seven data bands on it, and each band contains six data tracks, a parity track, and a clock track. Each band can hold from one to 1,550 words of data, giving a total capacity of more than 5.5 million alphameric characters or 8.3 million digits per cartridge. This is comparable in storage volume with a reel of magnetic tape, a small disc file, or several drums.

When a CRAM card is on the drum, it does not completely surround the drum, so that after reading a band, there are at least 12 milliseconds available for computing before the card can be accessed again.

In the Model 353-1 CRAM, data is recorded as one block per band, from consecutive locations in core storage. Each row recorded on a band consists of a 6-bit section of a 12-bit core slab (essentially an alphameric character or 1.5 numeric digits) and a parity bit. A check character is also recorded at the end of the block. The parity bits and the check character are checked during the reading and the writing of the block, as the read head follows the write head.

Model 353-1 CRAM timing considerations include the following parameters: time from drop command until read or write command, 235 milliseconds; average access time to a card on the drum, 24.3 milliseconds; and peak transfer rate, 100,000 characters per second. Maximum effective data transfer rate is 42,300 characters per second. Although these parameters hold for each individual unit, the interrupts that occur just before read or write time and the ability to drop cards in all of the CRAMs in the system independently make it possible to achieve effective transfer speeds as high as 67,000 characters per second, using two or more Model 353-1 CRAMs.

The address of a six-way jump table is provided in each CRAM instruction. The jump table is used in the event any unusual condition occurs during the execution of a CRAM instruction. These conditions include: write interlock, read error, write error, control mark, not loaded, and wrong card. The occurrence of more than one of these conditions also sets the overflow indicator. The write interlock is imposed whenever a cartridge is loaded into a CRAM and must be released by an operator.

.14 Availability: . . . . 4 months.

.15 First Delivery: . . . . . June, 1962.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic cards.

.22 Physical Dimensions

.222 Drum —
Diameter: . . . . 7 inches.
Thickness or length: . 3.5 inches.
Number on shaft: . . . 1.

.223 Card —
Length: . . . . 14 inches.
Width: . . . . 3.25 inches.
Number: . . . . 256 cards per cartridge; up to 16 units on-line with 1 cartridge per unit.

.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: . yes.

.25 Data Volume per Band of 7 Tracks

Slabs:. . . . . 1,550.
Characters: . . . . . . 3,100.
Digits: . . . . 4,650.
Instructions: . . . . . . 387 to 775.

.26 Bands per Physical Unit: . . . . 7.

.27 Interleaving Levels: . no interleaving.

.28 Access Techniques

.281 Recording method: . . fixed heads.
.282 Reading method: . . . fixed heads.
.283 Type of access —

Description of stage	Possible starting stage
Drop card to drum:.	yes.
Lead edge of card approaches read or write head of drum:	yes.
Leading edge of card passes heads:	not until next revolution.

.29 Potential Transfer Rates

.291 Peak bit rates —
Cycling rates: . . . . . 1,235 rpm.
Track/head speed: . . 380 inches/sec.
Bits/inch/track: . . . 262.5.
Bit rate per track: . . 100,000 bits/sec track.
.292 Peak data rates —
Unit of data: . . . . . alphameric character.
Conversion factor: . 6 data bits/char.
Data rate: . . . . 600,000 bits/sec or 100,000 char/sec.

.3 DATA CAPACITY

.31 Module and System Sizes (Model 353-1)

	Minimum Storage	Maximum Storage
Identity:	1 CRAM	16 CRAMs.
Slabs:	2,777,600	44,441,600.
Characters:	5,555,200	88,883,200.
Decimal digits:	3,332,800	133,324,800.
Instructions:		
2-slab:	1,388,800	22,220,800.
4-slab:	694,400	11,110,400.
Cartridges:	1	16.
Cards:	256	4,096.
Modules:	1	16.

.32 Rules for Combining Modules:. . . . . any number up to 16 CRAM units can be connected.

.4 CONTROLLER

.41 Identity: . . . . built into Processor.

.42 Connection to System

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

.43 Connection to Device

.431 Devices per controller: . . . . . . 16.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 1,550 slabs.
.442 Input-output area: . . all core storage.
.443 Input-output area access: . . . . by slab, character, or digit.
.444 Input-output area lockout: . . . . none.
.445 Synchronization: . . . semi-automatic.
.446 Synchronizing aids: . interrupt when ready.
.447 Table control: . . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks —
Heads per stack: . . 8.
Stacks per yoke:. . . 7.
Yokes per module: . 1.
.512 Stack movement: . . . none.
.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations —
By single stack: . . . . 1 band per card.
By all stacks: . . . . 1 card (7 bands).

.53 Access Time Parameters and Variations

.532 Variation in access time —

Stage	Average, msec	Example, msec
Card not on drum —		
Drop card:	235.00	235.00
Pause after interrupt:	2.64	2.64
Read or write S slabs:	0.025	31.00*
Read or write check character:	0.11	0.11
		268.75
Card already on drum —		
Wait for interrupt:	0 to 48.6	24.30
Pause after interrupt:	2.64	2.64
Read or write S slabs:	0.925	31.00*
Read or write check character:	0.11	0.11
		58.05

* Based on reading or writing a full band of 1,550 slabs.

(Contd.)

.6 CHANGEABLE STORAGE

.61 Cartridges

.611 Cartridge capacity: . 1 to 256 cards.
.612 Cartridges per module: 1.
.613 Interchangeable: . . . yes.

.62 Loading Convenience

.621 Possible loading—
While computing system in use: . . . yes.
While storage system in use: . . . . . yes (if the individual CRAM Unit is free).
.622 Method of loading: . . operator procedure.
.623 Approximate change time: . . . . 0.5 to 1.0 min.
.624 Bulk loading: . . . . . 1 cartridge at a time.

.7 PERFORMANCE

.71 Data Transfer

Pairs of storage unit possibilities—
With core storage: . yes.
With self: . . . . no.

.72 Transfer Load Size

With core storage: . . 1 to 1,550 words.

.73 Effective Transfer Rate

With core storage: . . . 42,300 char/sec (based upon transfer of 80,000 characters from 1 CRAM unit to core storage).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	ignore instruction.
Recording of data:	read after write parity	error jump.
Recovery of data:	track and row parity check	error jump.
Conflicting commands:	check	error jump.
Physical record missing:	see "no card on drum".	
Read empty card:	check	error jump.
Write lockout:	check	error jump.
Wrong card:	none.	
No card on drum:	check	error jump.
Unit disabled:	check	error jump.

INTERNAL STORAGE: CRAM, MODELS 353-2 AND 353-3

.1 GENERAL

.11 Identity: . . . . Card Random Access Memory, Model 353-2 and Model 353-3. CRAM.

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

.13 Description

The Models 353-2 and 353-3 CRAM Units are mechanically similar to Model 353-1, as described in Section 601:042, and function in the same manner. The differences are primarily in recording mode and recording density. The only difference between Models 353-2 and 353-3 is that the former has 128 cards per cartridge, while the latter has 256.

The recording mode of the original Model 353-1 CRAM is 7 bands per card, 8 tracks (6 data, 1 parity, and 1 clocking) per band, at a density of 262 rows per inch. Models 353-2 and 353-3, on the other hand, record 56 bands across the card, with only 1 track per band, at a density of 700 rows per inch. Seven sequential rows (bits) are used to record one character (or 1.5 decimal digits) and a parity bit. This combination of serial (rather than parallel) recording and increased density reduces the number of slabs per band to 560 but increases the number of slabs per card by approximately 190%, to 31,360. Therefore, although Model 353-2 holds only half as many cards as Model 353-1 (128 vs. 256), it has about 45% more storage capacity. Model 353-3, with 256 cards, has about 190% more storage capacity than Model 353-1.

The serial method of recording reduces the peak data transfer rate to 38,000 characters per second in Models 353-2 and 353-3. The maximum effective transfer rate for large quantities of data is 21,700 characters per second for one CRAM unit and up to 24,400 characters per second if the drop time is shared among two or more units.

Because of their mechanical similarity to Model 353-1, as described in Section 601:042, only the important differences are presented in detail here for Model 353-2 and Model 353-3. Unless otherwise stated, all entries pertain to both Model 353-2 and Model 353-3.

.25 Data Volume per Band of 1 Track

Slabs . . . . 560.
Characters . . . . 1,120.
Digits. . . . . 1,680.
Instructions. . . . . 140 to 280.

.26 Bands per Physical Unit: . . . . 56 bands per card.

.29 Potential Transfer Rates

.291 Peak bit rates —
Cycling rate: . . . . . . 1,235 rpm.
Track/head speed: . . 380 inches/sec.
Bits/inch/track: . . . . 700.
Bit rate per track: . . 266,000 bits/sec/track.

.292 Peak data rates —
Unit of data: . . . . . . alphameric character.
Conversion factor: . . 7 bits per character.
Data rate: . . . . 38,000 characters/sec.

.3 DATA CAPACITY

.31 Module and System Sizes, Model 353-2

	Minimum Storage	Maximum Storage
Identity:	1 CRAM	16 CRAMS.
Slabs:	4,014,080	64,225,280.
Characters:	8,028,160	128,450,560.
Decimal digits:	12,042,240	192,675,840.
Instructions —		
2-slab:	2,007,040	32,112,640.
4-slab:	1,003,520	16,056,320.
Cartridges:	1	16.
Cards:	128	2,048.
Units:	1	16.

Module and System Sizes, Model 353-3

	Minimum Storage	Maximum Storage
Identity:	1 CRAM	16 CRAMS.
Slabs:	8,028,160	128,450,560.
Characters:	16,056,320	256,901,120.
Decimal digits:	24,084,480	385,351,780.
Instructions —		
2-slab:	4,014,080	64,225,280.
4-slab:	2,007,040	32,112,640.
Cartridges:	1	16.
Cards:	256	4,096.
Units:	1	16.

.7 PERFORMANCE

.72 Transfer Load Size: . . 1 to 560 slabs.

.73 Effective Transfer Rate: . . . . 21,700 characters/sec (based upon transfer of an 80,000-character contiguous block from 1 CRAM unit to core storage).

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . File Processor. Model 315-3.

Bank-File Processor. Model 315-4.

File Inquiry Processor. Model 315-35.

Bank-File Inquiry Processor. Model 315-45.

.12 Description

The Processor is controlled by single address instructions and operates in decimal arithmetic. The operands can vary in size from one to eight slabs, as specified in the instructions. A 12-bit slab may represent three digits or two characters. The accumulator is also variable in length and assumes a size sufficient to contain all the digits of its contents except high-order non-significant zeros. A minus sign counts as an extra digit. There is no automatic floating point arithmetic. A special binary addition instruction operates on six-bit groups or an entire field. Usually, editing is controlled by special editing masks. Typical instruction times for six-digit operands are 48 microseconds for addition and 582 microseconds for multiplication.

The Processor is available in four different models, each equipped to accommodate a specific group of input, output, file, and inquiry devices, as summarized in the following table:

Processor Model	Paper Tape, Punched Cards, Line Printers	MICR Sorter-Readers	CRAM, Magnetic Tape	Inquiry and Communications Devices
315-3:	yes	no	yes	no
315-4:	yes	yes	yes	no
315-35:	yes	no	yes	yes
315-45:	yes	yes	yes	yes

The Processor has its own magnetic core store, separate from the data store, which contains the index, jump, and accumulator registers plus several other indicators. Two of the 32 index registers may not be used for address modification, and one of the remaining 30 is used by some operations to store the address of the last operand accessed. Almost all addresses are modified by an index or jump register unless they refer to the two unusable index registers, in which case the addresses are treated as literals.

Some instructions reference a set of jump registers. Each such instruction tests for any of a set of conditions. When any one of these conditions is detected, a jump is made to the address found in the corresponding jump register. A facility is provided that automatically saves the contents of the sequence counter before it is replaced by a jump address.

Instructions are provided to load, unload, augment, and rearrange the index and jump registers singly or in groups. All of the special indicators, such as sign, overflow, and comparison indicators, can be set, reset, and interrogated. Instructions are provided that treat any character in storage as a single bit indicator.

Input-output operations are controlled by one of two methods. The first is the direct control method used with punched tape, magnetic tape, and the console. This method stops the Processor until the peripheral unit has completed the indicated operation. The second method is the use of interrupt controls. The card reader has a permanent interrupt capability. The MICR reader, card punch, printer, and CRAM unit all have individual interrupt indicators called "Unit Demand Flags." If a Unit Demand Flag is turned on by a program, it will signal the Processor the next time the associated peripheral unit can accept an input-output command. The Processor has a master Demand Permit Flag that can disable all interrupt signals. When an interrupt signal is received, the instruction in progress is completed, the master Demand Permit Flag is turned off, and the contents of a special jump register are used to direct the program to an interrupt routine. This routine must store the status of the program, determine which of the units caused the interruption (by means of test instructions), and then take appropriate action. These functions have been integrated into standard routines which require relatively little time and increase the input-output capacity of the system.

Optional Features

The Automatic Recovery Option (ARO) permits branching to a recovery routine upon occurrence of some conditions that would normally cause a processor halt. It consists of an adjustable timer, normally set for 500 milliseconds, that is

.12 Description (Contd.)

started when any command is initiated. Should the timer not be restarted by the initiation of a subsequent command prior to the expiration of the set interval, a processor, memory, or peripheral malfunction is indicated. Control is transferred to one of three locations (specified in certain jump registers) depending upon the condition causing the malfunction. The three sets of conditions are:

(1) Main or Auxiliary Memory error, or program count error.

(2) Program error other than as listed in (1).

(3) Peripheral or Processor malfunction.

Software routines can be used to try to keep the job running or to notify the operator of a malfunction. ARO can be enabled or disabled by a push-button on the console. When ARO is activated, the rest of the console becomes inoperative.

.13 Availability: . . . . 8 months.

.14 First Delivery: . . . . February, 1962.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point—			
Add-subtract:	automatic	decimal	3 to 24 by 3 digits.
Multiply Short:	automatic	decimal	3 to 24 by 3 digits.
Divide No remainder:	none.		
Remainder:	automatic	decimal	3 to 24 by 3 digits.
.212 Floating point—			
Add-subtract:	subroutine	decimal	1 and 4 slabs.
Multiply:	subroutine	decimal	1 and 4 slabs.
Divide:	subroutine	decimal	1 and 4 slabs.
.213 Boolean:	none.		
.214 Comparison—			
Numbers:	automatic	binary	1 to 8 slabs.
Letters:	automatic	binary	1 to 8 slabs.
Mixed:	automatic	binary	1 to 8 slabs.

Collating sequence: . . . . 0 to 9, then A to Z, with special symbols interspersed (see 601:141.100).

.215 Code translation—

Provision	From	To	Size
automatic:	4-bit numeric	6-bit alpha	up to 24 char.
automatic:	6-bit alpha	4-bit numeric	up to 24 char.

.216 Radix conversion:. . . none.

.217 Edit format—

	Provision	Comment	Size
Alter size:	automatic	as result of inserting editing symbols	edited data may not exceed 16 char.
Suppress zero:	automatic	leading zeros replaced by spaces	1 to 8 slabs.
Round off:	automatic	shift and round	1 to 8 slabs.
Insert point:	automatic	through use of edit format control	1 to 8 slabs after editing.
Insert spaces:	automatic	(as above)	(as above)
Insert $:	automatic	(as above)	(as above)
Float:	none.		
Protection:	programmed	automatic (through use of edit format control following Suppress Zero instruction.)	1 to 8 slabs after editing.

.218 Table look-up—

	Provision	Comment
Equality:	semi-automatic	binary comparison (see .214 above) or scan up to 999 12-bit slabs or selected characters within each slab until a character is found with the specified property; in scanning, characters may be in 4-bit or 6-bit code.
Greater than:	semi-automatic	(as above)
Greatest:	none.	
Least:	none.	
Less than:	semi-automatic	(as above)

.219 Others—

Move:	automatic	0 to 999 slabs.
Fill:	automatic	0 to 999 slabs.

.22 Special Cases of Operands

.221 Negative numbers: . . minus sign and absolute value, or one's complement.
Sign, in core storage:
+ unspecified;
- in high order digit position.
Sign, in accumulator: setting of flip-flop.

.222 Zero: . . . . + and - zero; treated the same.

.223 Operand size determination: . . . . specified in instructions.

.23 Instruction Formats

.231 Instruction structure: 2 or 4 slabs.

.232 Instruction format—
Single stage (2-slab) instructions:

Name:	X	F	C	A
Size (bits):	5	3	4	12

.232 Instruction format (Contd.)

Double stage (4-slab) instructions:

Name:	X	F	C	A	Y	Q	G	B
Size (bits):	5	3	4	12	5	3	4	12

.233 Instruction parts

Name	Purpose
X, Y:	jump or index register designation. X = 15 denotes either that A is literal or that F, Q and G contain part of the operation code.
F:	size of operand or part of operation code.
C:	operation code.
A:	operand or address of operand.
Q, G:	part of operation code; Q and G exist only in 4-slab instructions.
B:	the second operand, the address of the second operand, a count or other information needed by the instruction; appears only in 4-slab instructions.

.234 Basic address structure: . . . . 1+0.

.235 Literals—
Arithmetic: . . . . . . -99 to 999.
Comparisons and tests: . . . . any two 6-bit or three 4-bit characters.
Incrementing modifiers: . . . . . -99 to 999.

.236 Directly addressed operands

.2361

Internal storage type	Minimum size	Maximum size	Volume accessible
Core:	1 slab	8 slabs	1,000 slabs.

.2362 Increased address capacity

Method	Volume accessible
Indexing:	40,000 slabs.

.237 Address indexing
.2373 Indexing rule: . . . . addition, modulo memory size.
.2374 Index specification: within modified instruction.
.2375 Number of potential indexers: . . . . . . 30.
.2376 Addresses which can be indexed: . . . . . all.
.2377 Cumulative indexing: . . . . . . none.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . available for jump instruction only.
.2381 Recursive: . . . . . . no.
.2382 Designation: . . . . . included in operation code.
.2383 Control: . . . . none.
.2384 Indexing with indirect addressing: . . . . . none.
.239 Stepping
.2391 Specification of increment: . . . . . in stepping instruction.
.2392 Increment sign: . . . + or -.
.2393 Size of increment: . -99 to 999.
.2394 End value: . . . . . . in (or addressed by) step instruction.
.2395 Combined step and test: . . . . yes.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in decimal digits	Program usage
Index registers:	32	5	address modification.
Jump registers:	32	5	address of conditional jump.
Accumulator:	8	24	arithmetic, comparison.
Flags:	32	1 alpha char	special store and test for 2-state conditions.

.242

Category of storage	Total number of locations	Physical form	Cycle time, μsec
Index registers:	32	core storage	6.
Jump registers:	32	core storage	6.
Accumulator:	1	core storage	6.
Flags:	32	core storage	6.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1.
.315 Sequence control step size: . . . . 1 instruction.
.316 Accessibility to program: . . . . yes.
.317 Permanent or optional modifier: . no.

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

.33 Interruption

.331 Possible causes—
In-out units: . . . . . ready for use (CRAM, card reader).
In-out controllers: . . . . free (printer, card punch). loaded (MICR reader buffer).
Storage access: . . . none.
Processor errors: . none.
Other: . . . . permit tracing.

.332 Program control—

Individual control: .	by units.
Method:	set Unit Demand Flags.
Restriction:	card reader has no Unit Demand Flag.

.333 Operator control: . . . only for tracing interrupt.

.334 Interruption conditions: . . . . . . Demand Permit Flag and specific Unit Demand Flag must be set. For tracer interrupt, the appropriate console switch must also be set.

.335 Interruption process—

Disabling interruption:	yes.
Registers saved: . .	sequence counter only.
Destination:	fixed location.

.336 Control methods —

Determine cause: . .	test peripheral devices for "ready".
Enable interruption:	yes, by Set Demand Permit Flag instruction.

.34 Multiprogramming: . . possible on a limited basis, using own coding and hardware interrupt facilities.

.35 Multi-sequencing: . . none.

.4 PROCESSOR SPEEDS

Note: D, the number of decimal digits in the operands, must be a multiple of 3 and not greater than 24. In negative numbers, the minus sign occupies one digit position.

.41 Instruction Times in μsecs

.411 Fixed point—

Add-subtract:	36 + 2D.
Multiply:	$96 + 39D + 7D^2$.
Divide:	$672 + 83D + 9D^2$.

.412 Floating point (subroutines)—

Add-subtract:	1,100 average.
Multiply:	3,000 average.
Divide:	3,200 average.

.413 Additional allowance for—

Indexing:	0.
Re-complementing: .	2D.

.414 Control—

Compare:	like signs: 36 + 2D. unlike signs: 36.
Branch:	48 to 60, depending on instruction.

.415 Counter control—

Step and test:	60.

.416 Edit: . . . . 30 + 9D to about 90 + 9D.

.417 Convert—

4-bit to 6-bit:	54 + 3D.
6-bit to 4-bit:	66 + 4D.

.418 Shift: . . . . 42 to 894 (storing and reloading is faster than shifting in many cases).

.42 Processor Performance in μsecs

.421 For random addresses—

	Fixed point	Floating point*
c = a + b:	108 + 6D	1232.
b = a + b:	72 + 4D	1232.
Sum N items:	(36 + 2D)N	1232N.
c = ab:	$168+45D+7D^2$	3132.
c = a/b:	$744+89D+9D^2$	3332.

.422 For arrays of data—

$c_i = a_i + b_j$:	276 + 6D	1400.
$b_j = a_i + b_j$:	240 + 4D	1400.
Sum N items:	(144 + 2D)N	1274N.
$c = c + a_ib_j$:	$336 + 45D+7D^2$	4400.

* Subroutines.

.423 Branch based on comparison—

Numeric data:	294 + 2D.
Alphabetic data: . . .	294 + 3C.

.424 Switching—

Unchecked:	258.
Checked:	450.
List search:	462.

.425 Format control, per character—

Unpack:	7 (assuming prior code translation).
Compose:	14.

.426 Table look-up per comparison—

For a match:	180.
For least or greatest:	196 to 310.
For interpolation point:	210.

.427 Bit indicators —

Set bit in separate location:	54.
Set bit in pattern: . .	204.
Test bit in separate location:	84.
Test bit in pattern: .	162.

.428 Moving: . . . . 54 + 12S, where S is number of slabs moved.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator (testable by program).
Underflow (float-pt):	none.	
Zero divisor:	check	set Overflow indicator.
Invalid data:	none.	
Invalid operation:	check	stop Processor
Arithmetic error:	none.	
Invalid address:	not possible.	
Receipt of data:	parity check	error jump.

CONSOLE

.1 GENERAL

.11 Identity: . . . . Console.
(Part of NCR 315 or 315-100 Processor).

.12 Associated Units: . . . Console Typewriter.

.13 Description

The Console desk-top is 42 inches wide and 33 inches deep. It is permanently attached to the left side of the 315 Processor cabinet, forming a single unit 106 inches in overall width and 24 to 33 inches in depth. The typewriter keyboard and 22 control buttons are set into the desk-top near the left-hand end. A sloping panel extends across the Console just above desk-top height and contains 128 lamps which show the status of the Processor and the contents of its registers.

The console typewriter is similar to a conventional electric typewriter. A 42-key keyboard, in conjunction with the shift keys, permits all of the 63 permissible 6-bit character codes to be entered. The stored program can call for keyboard input in either the alpha mode (two 6-bit characters per slab) or the digit mode (three 4-bit digits per slab). An error halt occurs if a non-digit character is typed while in the digit mode.

The contents of up to 999 consecutive core slabs can be typed out, in either alpha or digit mode, at 10 characters per second under Processor control. The typewriter does not have an automatic carriage return facility, and programmed control of the output format (i.e., carriage returns and tabs) is possible only in the alpha mode. During normal operations the console typewriter will be used mainly to produce a log of operations and for occasional input of information such as today's date.

The console control buttons, in conjunction with the typewriter, permit the operator to:

- Initiate execution of the stored program at the address contained in R31 (the sequence control register).
- Place a new starting address into R31.
- Halt computation upon completion of the current instruction.
- Elect whether or not typed information shall be entered into core storage.
- Initiate loading of programs from either punched tape or cards.
- Set Option Switches 0 through 7, whose status can be tested by the stored program.
- Select either the alpha or digit mode for console input and output.
- Specify whether console input or output is to or from Main Memory or Auxiliary Memory (the R-registers, J-registers, and Accumulator).
- Turn the Processor and Console power on or off.

The Console lamp panel shows the status of the Processor at any given time. Addresses and register contents are displayed in binary-coded-decimal form, using four lamps per decimal digit. Single lamps indicate conditions such as test or normal mode, alpha or digit mode, parity error, and peripheral unit malfunctions. Displays include:

- Current Main Memory address.
- Contents of the current Main Memory slab.
- Current instruction (in octal format).
- Settings of the Greater, Less, and Equal flags.
- Current Auxiliary Memory address and its contents.
- Sign and effective length of the Accumulator.
- Indications of which peripheral units are currently transmitting or receiving data.

INPUT-OUTPUT: INPUT-OUTPUT CONSOLE

.1 GENERAL

.11 Identity: . . . . Input/Output Console:
Model 472-1 (includes 1000 cps paper tape reader and 110 cps paper tape punch).
Model 472-2 (includes 400 cpm card reader).
Model 473-3 (includes paper tape punch, paper tape reader, and card reader).

.12 Description

The Input-Output Console houses several moderate-speed input-output devices, including a paper tape reader, a paper tape punch, and/or a punched card reader. Three models are available, containing combinations of these devices as described in the following paragraphs. The Input/Output Console is available only with the NCR 315 (not with the 315 RMC). Only one Input/Output Console can be connected to an NCR 315 Processor. Duplicate card reading, paper tape reading, or paper tape punching facilities cannot be incorporated in a 315 system already having those facilities in an Input/Output Console.

.121 Model 472-1

Included in this model are a paper tape reader and a paper tape punch. Peak reading speed is 1,000 rows per second, and peak punching speed is 110 rows per second. The normal manner of operation is reading or punching 1-inch (8-channel) tape in one of two program-settable modes. The "character" mode utilizes six tracks for data and a seventh for odd parity (checked when reading but not stored in core); the eighth track is ignored. The 6-bit characters are read into or punched from consecutive storage locations (2 characters per slab). The "slab" mode of operation utilizes all eight tracks of data; the high-order 4 bits of a slab are set to zero when reading and ignored when punching. Parity is not checked or generated in this mode. Any code of up to eight levels can be read or punched using programmed translation routines. Tape of other widths (5-, 6-, or 7-level) can be read or punched using the above modes; however, changing from one tape width to another requires a service engineer to adjust the mechanisms.

Blocks of from 1 to 999 rows can be read or punched, and the processor is fully occupied during a paper tape operation except for the last row of a block. Therefore, the usual method of programming a paper tape operation is to read or punch one character at a time. Under these conditions, a minimum of 0.785 millisecond between consecutive characters when reading and 4.85 milliseconds when punching are available for computation (normally code translation). If these intervals are not exceeded, paper tape reading or punching can proceed at the peak rates of 1,000 or 110 characters per second, respectively.

Supply reels of up to 1,000 feet of tape can be accommodated by the punch unit, but there are no take-up reel facilities. The reader cannot accommodate reels, but provisions are made to facilitate the use of rolls of tape. Either paper or plastic tape can be used by both units.

The 315 Processor stalls during a paper tape read operation upon detection of no tape in the reader, broken tape, end of tape, or reader power off. A parity error while reading causes a branch to the address specified in the jump register identified in the instruction. During a paper tape punching operation, the Processor stalls six inches from the end of the tape, when the tape is in the punch, if the tape breaks, or if power to the punch is turned off.

.122 Model 472-2

A modification of the English-built Elliot card reader is incorporated in the Model 472-2 Input-Output Console. Cards are read serially by column, utilizing 12 photocells. There are no automatic code conversion facilities in this reader; each card column is stored as a 12-bit binary image in one core storage slab. There are no restrictions on the bit configurations that can be read; i.e., column-binary reading is possible.

Instructions are provided to feed a card and read from 0 to 159 columns (80 per card) or to read 0 to 159 columns from cards previously fed. If cards are read one column at a time, a minimum of 0.886 millisecond is available between columns for computation (normally code translation). In addition, at least 23.6 milliseconds are available between successive cards for computation. Reading less than 80 columns per card increases the available computation time between cards. The maximum rate of 400 cards per minute can be maintained if the next feed instruction is given prior to reading column 25 of the current card.

An alternate version of this card reader can read 90-column cards at the same peak speed of 400 cards per minute. Programming considerations are similar to those for the 80-column version.

The 315 Processor stalls if the input stacker is empty, if a card is misfed, if the power to the card reader fails, or if the instruction calls for reading columns from a card that has not been fed. If a column is missed when reading, control will be transferred to the address specified in the jump register identified in the instruction.

.123 Model 472-3

This model incorporates the paper tape reader, paper tape punch, and card reader, as described above, in a single cabinet.

INPUT-OUTPUT: PAPER TAPE READER AND PUNCH

.1 GENERAL

.11 Identity: . . . . Model 361-201 Paper Tape Reader.
Model 371-201 Paper Tape Punch.

.12 Description

.121 Model 361-201 Paper Tape Reader

This paper tape reader (similar to the reader used in NCR 390 systems) can read 5-, 7-, or 8-level tape photoelectrically at a peak speed of 600 characters per second. Any tape code can be read, and code translation can be performed by the stored program while the reader is operating at full speed. Supply and takeup reels with a capacity of approximately 1, 000 feet each are provided. Rewinding, at 80 inches per second, can be initiated by a button on the control panel. Two readers can be connected on-line and alternated (by manual selection) to maintain a constant stream of punched tape input. An NCR 315 system cannot include both the Model 361-201 Reader and the Input/Output Console Paper Tape Reader.

The programming characteristics of this model are similar to those of the paper tape reader on the Input/Output Console (Section 601:071). Up to 999 characters can be read from punched tape by a single input instruction, but the usual practice is to read only 1 character at a time in order to make the time between successive characters (at least 1 millisecond) available for computation (usually code translation). The reader can stop on a single character, without any loss of data. When the tape is stopped, the net loss due to restarting is approximately 2. 5 milliseconds. A parity check can be performed upon 7-level codes only.

.122 Model 371-201 Paper Tape Punch

Model 371-201 is an NCR-developed paper tape punch with a peak speed of 120 characters per second. Tape with 5, 7, or 8 levels can be punched in any code, with code translation performed by the program. The supply and takeup reels have capacities of approximately 1, 000 feet each. Two punches can be connected on-line and alternated by manual switching. An NCR 315 system cannot include both the Model 371-201 Punch and the Input/Output Console Paper Tape Punch.

The programming characteristics of the Model 371-201 Punch are similar to those of the paper tape punch in the Input/Output Console (Section 601:701). Up to 999 characters can be punched by a single output instruction. Usually, however, only one character is punched at a time in order to make the time between successive characters (at least 3 milliseconds) available for computation (normally code translation).

STANDARD EDP REPORTS

INPUT-OUTPUT: CARD READ PUNCHES

.1 GENERAL

.11 Identity: . . . . Model 376-7 Card Read Punch (IBM 1442 Model 1).
Model 376-8 Card Read Punch (IBM 1442 Model 2).
Model 354-6 Card Read Punch Adapter.

.12 Description

The Model 376-7 and 376-8 Card Read Punches are the IBM 1442 Model 1 and Model 2, respectively. The 1442 is a combination input-output unit for standard 80-column cards. From a single 1,200-card input hopper, the cards are fed serially by column past a photoelectric reading station, past a punching station, and into one of two 1,300-card radial stackers.

A 1442 can handle a single card file and can read only, punch only, or read data from and punch results into the same card. Two Card Read Punches can be connected to an NCR 315 system equipped with a single Card Read Punch Adapter, permitting the card input and output functions to be completely separated, if desired.

Peak card reading speeds (with no punching) are 300 and 400 cards per minute for Models 376-7 and 376-8, respectively. Punching speeds depend upon the number of consecutive columns punched in each card:

Number of Columns Punched	Cards/minute, Model 376-7	Cards/minute, Model 376-8
1	270	360
10	179	270
20	130	210
40	84	146
80	50	88

When reading and punching are done on the same card, the overall operation can proceed at the same speed as punching alone.

The time available for computing during each Model 376-7 read-only cycle varies linearly from 55 milliseconds when all 80 columns are read to 157 milliseconds when only one column is read. The corresponding range for Model 376-8 is 40 to 118 milliseconds.

During the punch-only cycle, only the card positioning time is available for computing: 210 milliseconds for Model 376-7 and 160 milliseconds for Model 376-8. Computing time available during a combined read and punch operation depends on the number of columns read and is the same as for read-only operation.

For a more complete description of the IBM 1442 Card Read Punch, see Section 414:071 of the IBM 1440 Computer System Report.

INPUT-OUTPUT: 380-3 CARD READER (2,000 CPM)

.1 GENERAL

.11 Identity: . . . . High-Speed Card Reader. Model 380-3.

.12 Description

The Model 380-3 Card Reader can read standard 80-column cards at a peak speed of 2,000 cards per minute. Cards are fed from a 5,000-card input tray by a conveyor belt, transported serially by column past a photoelectric reading station by a vacuum capstan, and fed into a 5,000-card output tray. The cards are turned so that they arrive in the output tray in the same order in which they were fed. Cards can be loaded and unloaded while the reader is operating.

Instructions are provided to feed a card and read from 0 to 159 columns, or to read from 0 to 159 columns from cards previously fed. Translation between Hollerith card code and NCR 315 internal character code can be performed automatically by the reader; in this mode, two 6-bit character codes are stored in each core slab. Alternatively, each card column can be read without translation and transmitted to core storage as a 12-bit binary image occupying a full slab. This untranslated mode permits any column code (including pure column binary) to be read, with the necessary code translation being performed by the stored program.

When reading only one column at a time, only about 100 microseconds of computing time are available between consecutive columns. In most cases, it is not practical to attempt to utilize this inter-column time for computation. Therefore, little effective overlapping of computing with card reading is possible: when reading all 80 columns of each card at peak speed, as little as 6 milliseconds of each 30-millisecond card cycle may be available for computation.

The peak speed of 2,000 cards per minute will be maintained only if the Feed instruction for each card is issued before column 60 of the previous card passes the read head. An error jump to a location specified in the Read instruction is performed if any card column is "missed" (i.e., allowed to pass the read station without being "captured" by a Read instruction). When an invalid character code is sensed while reading in the translate mode, the character "x" is transmitted to core storage and the Overflow Flag is turned on.

The optional IBM Translator Feature for the 380-3 Card Reader provides automatic translation from Hollerith card code to either IBM-compatible magnetic tape code or NCR 315 internal code, depending upon the setting of a manual translation-mode switch.

Only one card reader, either Model 380-3 or 472-2 (Section 601:071) can be used on-line in an NCR 315 system at a time.

.13 Availability: . . . . 8 months.

.14 First Delivery: . . . . February, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . vacuum capstan.
.212 Reservoirs: . . . . . . none.
.213 Feed drive: . . . . . . conveyor belt.
.214 Take-up drive: . . . . conveyor belt.

.22 Sensing and Recording Systems

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

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . . 12.
Method of use: . . . . . 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: . . . . 1 to 159 columns (80 per card).
.322 Parallel by: . . . . . . 12 rows.
.324 Track use: . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding: . . . . any column code; see Paragraph .53.

.34 Format Compatibility: . . . . with most 80-column punched card equipment.

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

.4 CONTROLLER

.41 Identity: . . . . no separate controller.

.42 Connection to System: . . . . only 1 card reader per system can be on-line at a time.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to 159 columns.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . by slab or character.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . automatic.
.447 Synchronizing aids: . . . optional interrupt when leading edge of card reaches reading station.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks: . . . . 80 columns per card.

.52 Input-Output Operations

.521 Input: . . . . feed a card and read 0 to 159 columns, or read 0 to 159 columns from cards previously fed, with or without automatic code translation.
.522 Output: . . . . none.
.523 Stepping: . . . . see next entry.
.524 Skipping: . . . . last 0 to 80 columns of a card can be skipped (fed without reading).
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . automatic translation of Hollerith card code to NCR 315 internal code, or programmed translation of 12-bit card column images stored in consecutive core slabs.

.54 Format Control: . . . . none.

.55 Control Operations: . . request interrupt; select automatic translation.

.56 Testable Conditions: . . missed column.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . 2,000 cards/minute.
.622 Inportant parameters —
Start time (feed command till leading edge interrupt): . . . 30 msec average.
Computing time between columns: . . 0.10 msec minimum.
Computing time between cards: . . . 6.0 msec minimum, plus 0.22 msec per column not read.

.624 Effective speed: . . . . . 2,000 cards per minute if each card is fed before column 60 of previous card has been read.
1,600 cards per minute maximum when cards are fed and read one at a time.

.63 Demands on System

Reading 1 full card at a time —
Component: . . . . Processor.
Msec per card: . . . . 24.0 maximum.
Percentage at peak speed: . . . . 80.0 maximum.

Reading 1 column at a time —
Component: . . . . Processor.
Msec per card column: . . . . 0.144.
Percentage at peak speed: . . . . 57.8 maximum.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . none; only full-size cards can be read.

.72 Other Controls: . . . . . the following buttons are provided: Operate, Feed Set, Reset, Forward, Reverse.

.73 Loading and Unloading

.731 Volumes handled: . . . . hopper and stacker hold 5,000 cards each.
.732 Replenishment time: . . approximately 2 minutes; reader does not need to be stopped.
.733 Adjustment time: . . . . none.
.734 Optimum reloading period: . . . . 2.5 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	dual read	error jump.
Invalid code:	check (translate mode only).	transmit "x" and set Overflow Flag.
Exhausted medium:	check	Processor halt.
Imperfect medium:	check	Processor halt.
Misfeed:	check	Processor halt.
Feed jam:	check	Processor halt.
Missed column:	check	error jump.
Instruction to read from card not fed:	check	Processor halt.

INPUT-OUTPUT: 376-2 CARD PUNCH (100 CPM)

.1 GENERAL

.11 Identity: . . . . Summary Card Punch.
Model 376-2.
(IBM 523).

.12 Description

Model 376-2 is NCR's designation of the 100-card-per-minute IBM 523 Gang Summary Punch.

Up to four card punches (not including Card Read Punches) or printers, in any combination, can be connected to an NCR 315. Each punch is completely buffered and controlled by a Model 354-101 Card Punch Buffer. There are two basic punching modes, selected by a manual switch on the Buffer:

- Translate Mode — the contents of 40 core slabs (80 characters) are transmitted to the Buffer, converted from NCR 315 internal code to Hollerith card code, and punched, one character per column.
- Direct Mode — the contents of 80 core slabs are transmitted to the Buffer, and the binary image of each 12-bit slab is punched into 1 card column. In combination with programmed code translation, this mode permits the use of any card column code.

After each card has been fully punched, the punch becomes "ready" and can initiate a demand interrupt signal. The rated 100-card-per-minute speed will be maintained if the next Punch instruction is issued within 13.3 milliseconds (Direct Mode) or 14.1 milliseconds (Translate Mode) after the interrupt.

An error jump to a location specified in the Punch instruction is performed if an error prevented the previous card from being punched. Error conditions which will prevent punching include: punch power off, misfeed, card jam, hopper empty, stacker full, or (when plugboard-selected) double punch or blank column. Each of these error conditions causes the punch to become "not ready" until the condition is corrected by the operator. If a Punch instruction is issued to a punch which is "not ready," the Processor will be delayed until the punch becomes "ready."

.13 Availability: . . . . . . 4 months.

.14 First Delivery: . . . . March, 1962 (with NCR 315).

.2 PHYSICAL FORM

Drive is by pinch rollers. Punching is done row by row. A reading station, used for checking only, is located 15 rows beyond the punch station.

.3 EXTERNAL STORAGE

Standard 80-column cards are used. Standard Hollerith card code is used in the Translate Mode, and a binary image of one 12-bit slab is punched into each card column in the Direct Mode.

.4 CONTROLLER

.41 Identity: . . . . Card Punch Buffer.
Model 354-101.

.42 Connection to System

.421 On-line: . . . . any combination of Card Punches or Printers, up to a total of 4.

.422 Off-line: . . . . usable as standard IBM 523 Gang Summary Punch.

.43 Connection to Device

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

.44 Data Transfer Control

.441 Size of Load: . . . . 1 card; 40 slabs in Translate Mode or 80 slabs in Direct mode.
.442 Input-output areas: . . . . . core storage.
.443 Input-output area access: . . . . by slab or character.
.444 Input-output area lockout: . . . . yes; total output load is transmitted to buffer before Processor can continue.
.445 Table control: . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 80 columns per card.
.512 Block demarcation
Output: . . . . end of card.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . punch 1 card on punch last selected by a SELP instruction, in either Translate or Direct Mode.

.53 Code Translation

Translate Mode: . . . . . automatic translation of NCR 315 internal code (2 characters per slab) to Hollerith card code.
Direct Mode: . . . . translation by program; binary image of each 12-bit slab is punched into 1 card column.

.54 Format Control

Control: . . . . by plugboard.
Format alternatives: . . . 8.
Rearrangement: . . . . . . yes.
Suppress zeros: . . . . . . yes.
Insert point: . . . . yes.
Insert spaces: . . . . yes.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . . yes.
Offset card: . . . . no.
Select stacker: . . . . . . no.
Select format: . . . . yes.
Select code: . . . . yes; Translate or Direct mode.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . . yes.
Hopper empty: . . . . yes.
Stacker full: . . . . yes.

.62 Speeds

.621 Nominal or peak speed: . . . . 100 cards/minute.
.622 Important parameters:
Card cycle: . . . . 600 msec.
Buffer load time —
Translate Mode: . . . . 0.9 msec.
Direct Mode: . . . . . . 1.7 msec.
.623 Overhead: . . . . 1 clutch point per cycle; speed falls to 50 cards/minute if Punch instruction is not issued within 13.3 (Direct Mode) or 14.1 (Translate Mode) milliseconds after demand interrupt signal.
.624 Effective speeds: . . . . . 100-C cards/minute, where C is number of clutch points missed per minute.

.63 Demands on System

Component	Condition	msec per card	Percentage
Processor:	Translate Mode	0.9	0.15
	Direct Mode	1.7	0.28

.72 Other Controls (on Card Punch Buffer)

Function	Form	Comment
Local:	button	permits off-line use.
Decode:	button	selects Translate or Direct Mode.
Operate:	button	permits on-line use and selection by Processor.
Unit Select:	4-position rotary switch	assigns unit number (0 through 3)

.73 Loading and Unloading

.731 Volumes handled
Hopper: . . . . 1,000 cards.
Stacker: . . . . 1,200 cards.
.732 Replenishment time: . . . . 1 minute; punch does not need to be stopped.
.733 Adjustment time: . . . . . . none.
.734 Optimum reloading period: . . . . 10 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	plugboard programmed checks for double punch or blank column	error jump; punch halt.
Output block size:	size is fixed.	
Invalid code:	see "Recording."	
Exhausted medium:	check	error jump; punch halt.
Invalid medium:	check	error jump; punch halt.
Timing Conflicts:	check	inhibit Processor until punch becomes ready.
Card jam:	check	error jump; punch halt.
Misfeed:	check	error jump; punch halt.
Stacker full:	check	error jump; punch halt.

INPUT-OUTPUT: 376-101 CARD PUNCH (250 CPM)

.1 GENERAL

.11 Identity: . . . . Model 376-101 Card Punch.

.12 Description

The Model 376-101 Card Punch is an adaptation of a Control Data Corporation card punch. Peak punching speed is 250 cards per minute. Up to four printers and card punches, in any combination, can be connected on-line to an NCR 315 computer system.

This card punch utilizes the Model 354-101 Card Punch Buffer; consequently, the demand on the central processor is about 0.9 millisecond per card punched.

Complete details of the Model 376-101 Card Punch have not been released to date.

INPUT-OUTPUT: PRINTER (690 LPM)

.1 GENERAL

.11 Identity: . . . . High-Speed Printer. Model 340-3.

.12 Description:

The Model 340-3 High-Speed Printer is an unclutched, fully-buffered unit. Up to four printers or card punches, in any combination, can be connected to an NCR 315 system.

This printer has 120 printing positions. Top speed is about 690 lines per minute when printing alphameric data, and 940 lines per minute when printing numeric data. No adjustments are required to achieve the higher numeric speed.

Of the 64 possible characters, 56 print as basic characters, and the remaining 8 as basic characters overprinted with a plus sign. Forms control is provided by a paper tape loop with 15 possible codes on it. The Processor requests either a skip to one of the paper tape codes or a paper advance of from 0 to 15 lines. At the termination of the skip, printing occurs.

A useful feature of this printer is a control that halves the print drum speed. This option is included to enable the printer to achieve superior printing quality. Because the skipping speed is unaffected, the effective speed is somewhat greater than half of normal speed.

When the printer has performed a print command, it transmits a "ready" signal to the processor. When the data is all numeric, only one-quarter of the normal print cycle is used before the "ready" signal is sent. Should the processor send another numeric print command shortly after the "ready" signal is received, the paper spacing can be done in the remaining three-quarters of the cycle. This feature essentially increases the printing speed by 50 per cent.

Any desired characters can be ordered at a nominal cost over the standard character set.

.13 Availability: . . . . 4 months.

.14 First Delivery: . . . . . . March, 1962

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive, front and rear tractors; paper punched both sides.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . . on-the-fly hammer stroke against engraved print wheels.
.222 Sensing system: . . . . . . none.

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

.231 Maximum number—
Interleaved carbon: . . . original and 5 copies.
.233 Types of master—
Multilith: . . . . yes.
Xerox: . . . . yes.
Spirit: . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . 120.
Heads/stack: . . . . 1.
Method of use: . . . . . . 1 line at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special*:	20	, &. - ! ; " + % = $ ( ) / * # < >
Alternatives:		available.
FORTRAN set:		yes.
Basic COBOL set:		yes.
Total:	56.	

* The eight other possible character configurations print as unique letters over-printed by a plus sign.

.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.
.322 Parallel by: . . . . 120 characters at 10 per inch.

.33 Coding: . . . . NCR 315 internal code.

.35 Physical Dimensions

.351 Overall width: . . . . 4 to 22 inches.
.352 Length: . . . . indefinite.
.353 Maximum margins: . . . . left and right margins variable, up to 10 inches in excess of printing width.

.4 CONTROLLER

.41 Identity: . . . . Printer Buffer. Model 357-1.

.42 Connection to System

.421 On-line: . . . . any combination of printers or card punches, up to a total of 4.
.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 line of 120 characters.
.442 Input-output areas: . . . . any contiguous 60-slab area of core storage.
.443 Input-output area access: . . . . by character or slab.
.444 Input-output area lockout: . . . . automatic.
.445 Table control: . . . . none.
.446 Synchronization: . . . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 120 characters.
.512 Block demarcation Output: . . . . implicit; fixed block size.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . fixed block size; 1 block at a time, forward only.
.523 Stepping: . . . . step and print only; step size variable from 1 to 15 lines.
.524 Skipping: . . . . skip to 1 of 15 codes in paper tape loop, then print.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . automatic, in controller.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . . . yes.
Select format: . . . . no.
Select code: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . . . no.
End of medium marks: . yes.
End of page: . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . speed switch on low (for high quality printing).
II: . . . . speed switch on normal.

.62 Speeds

.621 Nominal or peak speed: I - 380 lines/min alphameric or 470 lines/min numeric.
II - 690 lines/min alphameric or 940 lines/min numeric.

.622 Important parameters

	I	II
Drum revolution:	128 msec	64 msec.
Drum speed:	470 rpm	940 rpm.
Numeric section:	32 msec	16 msec.
Skipping speed:	14 in/sec	14 in/sec.
Feed N lines:	12(N + 1) msec	12(N + 1) msec.

Note: The buffer scans each line and switches between alphameric and numeric operation automatically.

.623 Overhead—
Alphameric: . . . . unclutched operation and nonsynchronized character selection.
Numeric: . . . . unclutched operation and synchronized character selection.

.624 Effective speeds—
Alphabetic
I: . . . . 5,040/(12.3+N) lines/minute.
II: . . . . 5,040/(6.3+N) lines/minute.
N = no. of lines advanced per line printed.
Numeric
I: . . . . 470, 235, 156, 117, 94 lines/minute (see graph).
II: . . . . 940, 470, 313, 235, 188, 156 lines/minute (see graph).

.63 Demands on System

Component: . . . . Processor.
Condition: . . . . load Printer Buffer.
Msec per line: . . . . 1.22.
Percentage: . . . . 0.8 to 1.9, depending upon mode.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Paper tape loop	change loop	operator.
Horizontal adjustment:	moveable form tractors	operator.
Vertical:	micrometer	operator.
Paper thickness	micrometer	operator.

(Contd.)

.72 Other Controls

Function	Form	Comment
Speed:	2-speed switch	lower speed produces superior quality printing.

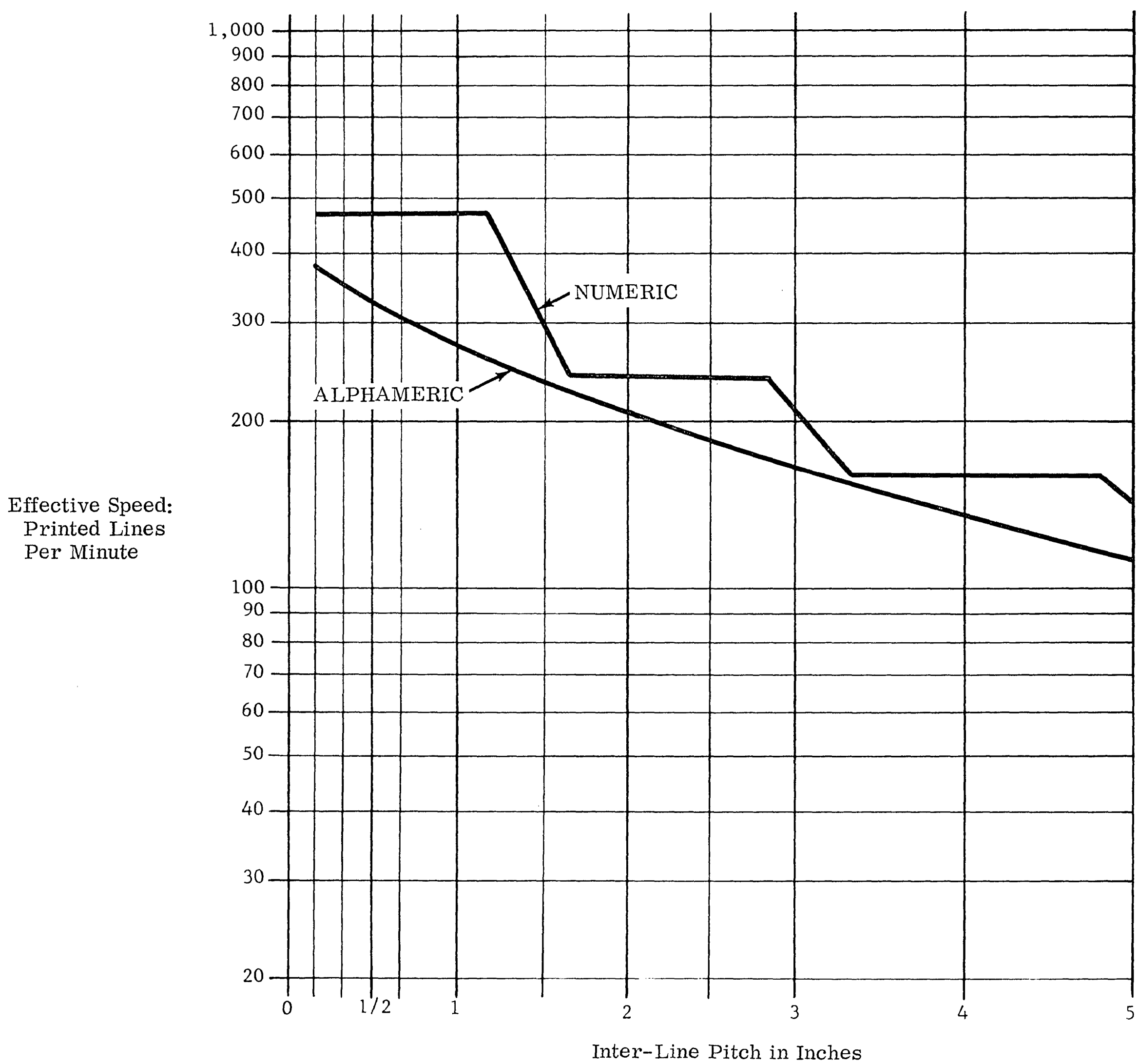
.73 Loading and Unloading

.731 Volumes handled: . . . . 14-inch stack of paper.
.732 Replenishment time: . . 0.5 to 1 minute; printer needs to be stopped.
.733 Adjustment time: . . . . . 0 to 1 minute.
.734 Optimum reloading period: . . . . 100 minutes.

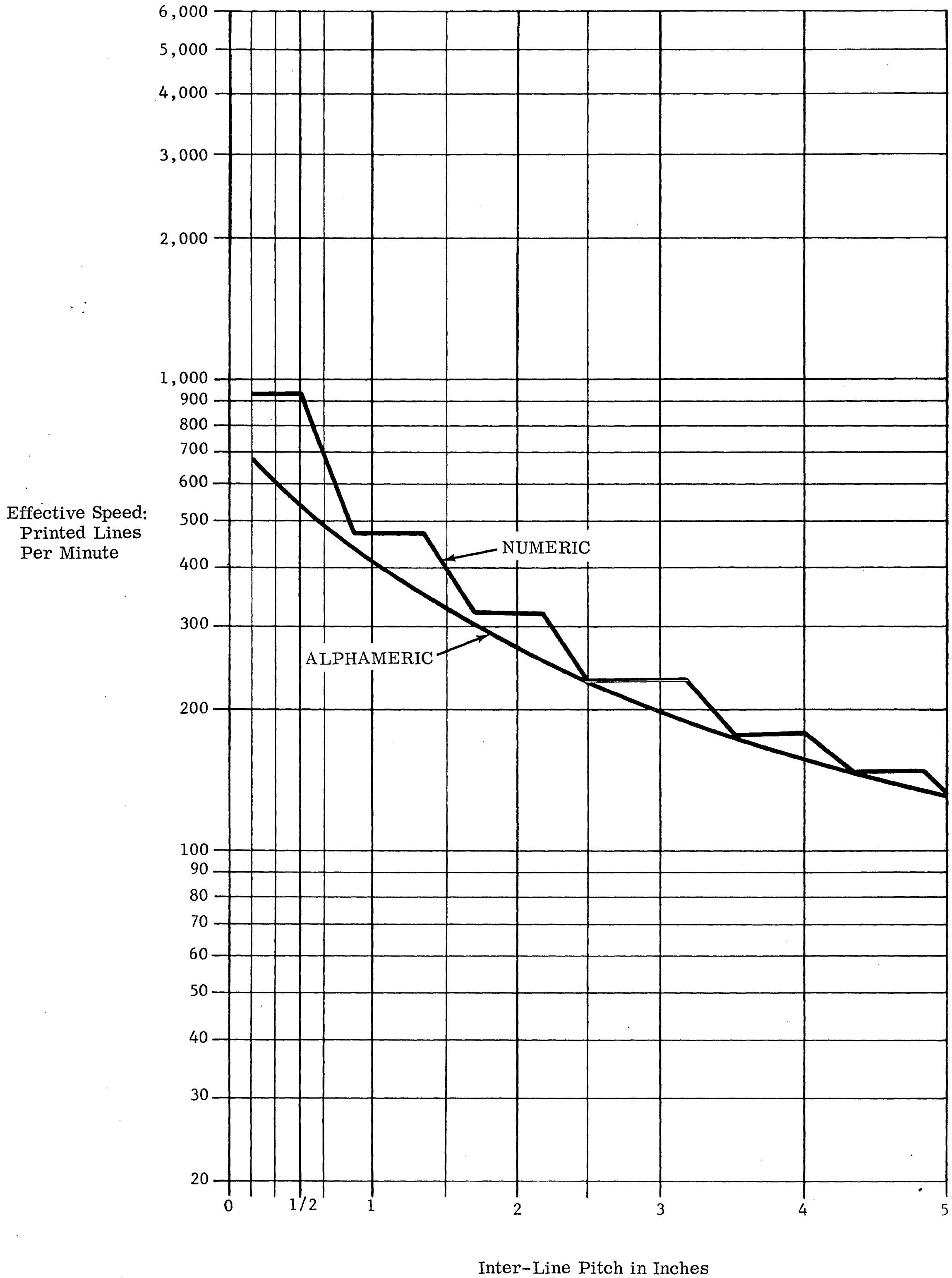
.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Output block size:	fixed size.	
Invalid code:	check.	
Exhausted medium:	check	program jump.
Imperfect medium:	none.	
Timing conflicts:	not possible.	
End of page:	check	program jump.
Busy:	check	program jump.
Disabled:	check	program jump.

EFFECTIVE SPEED — MODEL 340-3 PRINTER
(HALF SPEED MODE)



EFFECTIVE SPEED — MODEL 340-3 PRINTER
(FULL SPEED MODE)



INPUT-OUTPUT: PRINTER-LISTERS

.1 GENERAL

.11 Identity: . . . . High Speed Printer-Listers:
Model 340-502
Model 340-512
Unbuffered Printer:
Model 340:503

.12 Description

These three printers are variations of the same basic unit, differing only in type-line and capability to function as a lister. The two type-lines are:

- Standard type-line, with 120 alphameric printing positions; operation in the List mode is not possible with this type-line.
- Lister type-line, with 96 alphameric positions on the left and 24 numeric positions (0 through 9 plus hyphen and space) on the right side of the printed page.

Model 340-512 has the lister type-line and can function as either a fully-buffered 24-position numeric lister or as an unbuffered 120-position alphameric or numeric line printer. Peak speeds are 1,850 single-spaced lines per minute in the List Mode (printing in only the right-hand 24 positions), 650 lines per minute in the Alpha mode, and 805 lines per minute in the Numeric mode.

Model 340-502 has the standard type-line, but can be modified to take the lister type-line; it can then function either as a printer or as a lister.

Model 340-503 has a modified version of the standard typeline and cannot be modified to function as a lister.

These printers are usually operated in one of the following four program-selected modes:

- Alpha, skip-after-printing: Forms movement is time-shared, permitting overlapped computation times of 17.5 milliseconds for the first line skipped and 11.1 milliseconds for each additional line skipped. One full revolution of the print drum is required to print an alphameric line by the 340-502 and 340-512 Printers. The resulting maximum effective speed is 650 single-spaced lines per minute.

  The characters on the 340-503 print drum are arranged differently from the other two models. The numerals, letters (except Z), and seven special characters are arranged in a contiguous set. The remainder of the drum revolution can be used for forms spacing. When printing only the 42 characters in the restricted set described above, enough time is available for forms spacing to permit printing at the rate of 805 single-spaced lines per minute. As more of the characters not in the restricted set are printed, the effective printing rate approaches 650 single-spaced lines per minute.
- Alpha, skip-after-printing: Forms movement is time-shared, permitting computation during 17.5 milliseconds of each 94.1-millisecond cycle at single spacing, and resulting in a maximum effective speed of 650 lines per minute. Another 11.1 milliseconds of computation time are available for each additional line skipped.
- Alpha, skip-before-printing: No time sharing is possible; the command setup time is longer than the above case, reducing the maximum effective speed to 640 lines per minute. This mode is used mainly for program compatibility with the buffered Model 340-3 High Speed Printer.
- Numeric, skip-after-printing: One all-numeric line is printed during each revolution of the print cylinder, and 52.4 milliseconds of each 74.5-millisecond print cycle are available for computation. Single, double, or triple spacing is possible at the maximum speed of 805 lines per minute.
- List, skip-after-printing (requires lister type-line): The Processor is tied up for only 1.44 milliseconds of each 32.4-millisecond line cycle; the remaining time is available for computation. Printing is all-numeric, in a maximum of 24 positions, at a peak rate of 1,850 lines per minute.

.13 Availability: . . . . 8 months.

.14 First Delivery: . . . . . October, 1962.

INPUT-OUTPUT: PRINTER (1,000 LPM)

.1 GENERAL

.11 Identity: . . . . Model 340-601 Printer (1, 000 lpm).

.12 Description

The Model 240-601 High-Speed Printer is a speeded-up version of the Model 340-3 Printer described in Section 601:081. The print drum speed has been increased to 1, 000 revolutions per minute, and the spacing of the characters on the print drum has been rearranged in a manner similar to that of the 340-503 Unbuffered Printer. Using the reduced character set consisting of the numerals, letters (except Z), and seven special characters, the maximum printing rate is 1, 000 single-spaced lines per minute. If a further reduced character set of the 10 digits and 6 special characters is used, up to 3 lines can be skipped after each printed line while maintaining the 1, 000-line-per-minute rate.

Other characteristics and programming considerations are similar to those of Model 340-3, except that the half-speed print feature is not available in the Model 340-601 Printer.

Up to four printers and card punches, in any combination, can be incorporated in an NCR 315 system.

The central processor is occupied for only 1.34 milliseconds for each line printed. (A full 60-slab load is sent to the print buffer for each line to be printed, regardless of the actual length of the print line.)

.13 Availability: . . . . 12 months.

.14 First Delivery: . . . . . November, 1964.

INPUT-OUTPUT: MAGNETIC TAPE HANDLERS

.1 GENERAL

.11 Identity: . . . . Magnetic Tape Handlers:
Models 334-101 and 334-102 (12KC).
Models 334-131 and 334-132 (12/33.4KC).
Model 332-204 (24/66KC).*
Model 333-101 (83/120KC).
Model 333-102 (30/83KC).

*No longer produced but has limited availability.

.12 Description

NCR has expanded and altered its line of magnetic tape handlers and has made the entire current line available for NCR 315, 315-100, and 315 RMC computer systems. A total of four distinct tape handlers are available, varying in recording densities and tape speeds. Peak speeds range from 12,000 to 120,000 characters per second. In addition, the now out-of-production Model 332-204 (24/66KC) Magnetic Tape Handler will have a limited availability due to present inventory and future returns. NCR continues to offer a choice of odd or even parity in most models, but has discontinued the 333-bits-per-inch recording density. A summary of the characteristics of the models currently offered is presented in Table I.

All NCR magnetic tape units are programmed in a similar manner. Block sizes are variable from 1 to 7,999 slabs. The contents of each 12-bit slab are recorded in 2 tape rows; code translation, when necessary, must be performed by the stored program. A parity bit is appended to each row, and a parity row is appended to each block on tape. These are checked during reading and also by a read-after-write check when writing.

The even parity mode is provided for compatibility with tapes recorded in the IBM BCD mode. As in IBM systems, the BCD code consisting of zeros in all channels cannot be used because of the even parity and self-clocking features. In the odd parity mode, all of the 64 possible data code combinations can be used.

Each magnetic tape instruction includes the address of a jump table, which specifies six different addresses to which control is to be transferred if specific unusual conditions arise during execution of the tape operation. When no unusual condition arises, the jump table is ignored and the next consecutive instruction is executed. The Standard Tape Executive Program (Section 601:191) is generally used to deal with the unusual tape conditions, such as read error, write error, write lockout, end-of-tape warning, busy, rewinding, and control mark (a special one-word record). When two or more of these unusual conditions occur simultaneously, the Overflow Flag is turned on as a warning.

Magnetic Tape Simultaneity Controller

The Model 324-1 Magnetic Tape Simultaneity Controller, an optional unit, can greatly improve the flexibility of magnetic tape operations in an NCR 315 system. Without the 324-1 Controller, a maximum of eight Magnetic Tape Handlers can be connected to a 315 Processor, and no overlapping of Processor operations with magnetic tape reading or writing is possible. The 324-1 Controller permits time-sharing of the core storage between magnetic tape and Processor operations. One or two 324-1 Controllers can be connected, and each can control up to eight Magnetic Tape Handlers. (Two 324-1 Controllers are called a 324-2 Controller.) With two 324-1 Controllers, read-write-compute simultaneity is

TABLE I: CHARACTERISTICS OF NCR MAGNETIC TAPE HANDLERS

Model No.	Tape Speed, inches per sec	Recording Density, bits per inch	Parity	Peak Speed, char. per sec	Interblock Gap Lengths			Efficiency, %(3)		Demand on Core Storage, %(4)	Rewind Speed, inches per sec
					inches	msec(1)	chars. (2)	100-char. blocks	1,000-char. blocks		
334-101 and 334-102(5)	60	200	odd or even	12,000	0.75	12.5	150	40.0	86.9	4.8	250
334-131 and 334-102(6)	60	200 556	odd odd or even	12,000 33,400	0.75 0.75	12.5 12.5	150 417	40.0 19.3	86.9 70.6	4.8 13.3	250
332-204(7)	120	200 556	odd odd or even	24,000 66,700	0.75 0.75	9.4 9.4	226 627	30.9 13.8	81.5 61.4	9.6 26.7	240
333-101	150	556 800	odd or even odd or even	83,400 120,000	0.75 0.75	5.0 5.0	417 600	19.3 14.3	70.6 62.5	33.4 48.0	350
333-102	150	200 556	odd odd or even	30,000 83,400	0.75 0.75	5.0 5.0	150 417	40.0 19.3	86.9 70.6	12.0 33.4	350

(1) Time in milliseconds to traverse each interblock gap when reading or writing consecutive blocks.
(2) Number of character positions effectively occupied by each interblock gap.
(3) Effective speed at the indicated block size, expressed as a percentage of peak speed.
(4) Demands shown are for NCR 315 and 315-100 that systems utilize the Model 324-1 Magnetic Tape Simultaneity Controller. Without this device, demand for all models is 100%. For demands on the NCR 315 RMC Processor, see Section 603:111.
(5) Model 334-101 contains the control electronics for itself and up to four Model 334-102 tape units.
(6) Model 334-131 contains the control electronics for itself and up to four 334-132 tape units.
(7) Model 332-204 is no longer being produced but will have a limited availability.

.12 Description (Contd.)

possible between two tape units connected to different controllers and the central processor. See Paragraph 601:091.43 for detailed configuration rules and Section 601:111 for the effect upon simultaneous operations. Tape handlers of different tape speeds cannot be intermixed in a 315 system.

Unless otherwise stated, the following report entries apply to all models.

.13 Availability: . . . . 8 to 12 months.

.14 First Delivery

334-101: . . . . February, 1964.
334-131: . . . . third quarter, 1965.
333-101: . . . . November, 1964
333-102: . . . . third quarter, 1965.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller.
.212 Reservoirs —
Number: . . . . 2.
Form: . . . . vacuum columns.
Capacity: . . . . 4 feet of tape.
.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: . . . no.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . . write.
Stacks: . . . . 1.
Heads/stack: . . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . read.
Distance: . . . . 0.25 inch after write head.
Stacks: . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.25 Range of Symbols: . . any six-bit code.

.3 EXTERNAL STORAGE

.31 Form of storage

.311 Medium: . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . row, at 200, 556, or 800 per inch, depending on the model.
.322 Parallel by: . . . . . . 7 tracks.

.324 Track use —
Data: . . . . 6.
Redundancy check: . 1.
Timing: . . . . self-clocking.
Total: . . . . 7.
.325 Row use —
Data: . . . . 2 to 15,998 rows.
Redundancy check: . 1.
Gap: . . . . 0.75 inches.

.33 Coding: . . . . any six-bit code; 2 tape rows per NCR 315 slab.

.34 Format Compatibility: with previous NCR magnetic tape units at 200 or 556 rows/inch only. with IBM 729 series and 7330 Magnetic Tape Units.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.5 inch.
.352 Length:
Reel of 1.0-mil tape: 29 to 3,600 feet.
Reel of 1.5-mil tape: 29 to 2,400 feet.

.4 CONTROLLER

.41 Identity: . . . . basic tape control capabilities are built into Processor. The optional Magnetic Tape Simultaneity Controller, Model 324-1, permits simultaneous magnetic tape and Processor operations.

.42 Connection to System

.421 On-line: . . . . 0, 1, or 2 Model 324-1 Controllers.
.422 Off-line: . . . . none.

.43 Connection to Device

With no Model 324-1 Controller: . . . . . . up to 8 Magnetic Tape Handlers, connected directly to Processor.
With 1 Model 324-1 Controller: . . . . . . up to 16 Magnetic Tape Handlers; 8 connected to 324-1 and 8 to Processor.
With 2 Model 324-1 Controllers: . . . . . up to 16 Magnetic Tape Handlers, 8 per 324-1.

Note: Up to 8 tape handlers can be connected to both the Processor and a 324-1 Controller, and operated either "on-line" (directly with Processor) or "off-line" (via the 324-1 Controller). Tape handlers of different speeds cannot be intermixed in a 315 system.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 7,999 slabs.
.442 Input-output areas: . . entire core store.
.443 Input-output area access: . . . . by slab or character.

(Contd.)

.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Block demarcation —
Input: . . . . 0.75 inch gap, or slab count in instruction.
Output: . . . . slab count in instruction.

.52 Input-Output Operations

.521 Input: . . . . read 1 block, forward only.
.522 Output: . . . . write 1 block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . 1 block, forward or backward.
.525 Marking: . . . . beginning of tape marker. end of tape marker. 1-word record.
.526 Searching: . . . . none.

.53 Code Translation: . . matched codes; any required translation must be programmed.

.54 Format Control: . . . none.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . no.
Select code: . . . . . . no.
Rewind: . . . . yes.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . automatic halt.
Busy device: . . . . . . yes.
Output lock: . . . . . . yes.
Nearly exhausted: . . yes; 18 feet before end.
Busy controller: . . . yes.
End of medium marks: . . . . write only.
Rewinding: . . . . yes.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: . . . . . see Table I.
.622 Important parameters: see Table I.
.623 Overhead: . . . . see Interblock Gap Lengths, Table I.
.624 Effective speeds: . . . see Table I and graphs.

.63 Demands on System: . . . . see Table I.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Rewind:	button	initiates rewind.
Use Lockout:	button	prevents reading or writing.
Write:	button	prevents writing.
Mode Switch:	2-position switch	selects density and parity mode.
Unit Select:	9-position switch	assigns a number to the handler (one position is blank).

.73 Loading and Unloading

.731 Volumes handled —

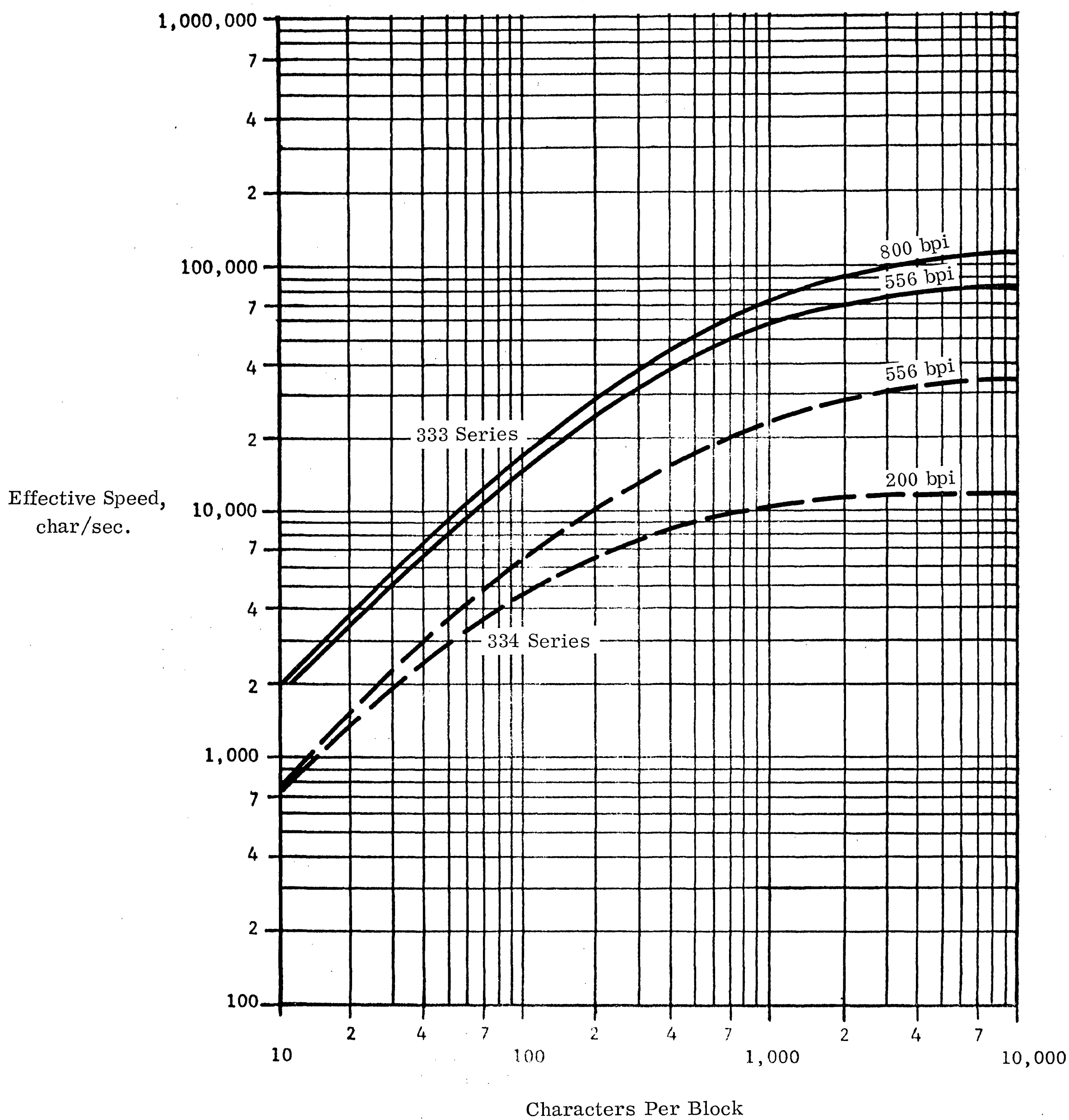
Storage	Capacity
Reel of 1.0 mil tape:	3,600 feet.
Reel of 1.5 mil tape:	2,400 feet.

.732 Replenishment time: . 0.5 to 1 minute; unit needs to be stopped.
.733 Adjustment time: . . . none.
.734 Optimum reloading period: . . . . 3.1 to 12 minutes, depending on the model and reel size.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	track and row parity check	program jump.
Reading:	read after write parity check	program jump.
Output block size:	check	Processor halt.
Invalid code:	not possible.	
Exhausted medium:	check	program jump.
Imperfect medium:	check	program jump.
Lockout:	check	program jump.

EFFECTIVE SPEED: MAGNETIC TAPE HANDLERS
333 Series and 334 Series



INPUT-OUTPUT: CRAM

.1 GENERAL

.11 Identity: . . . . Card Random Access Memory (CRAM).
Model 353-1.
Model 353-2.
Model 353-3.

CRAM is fully described in Sections 601:042 and 601:043, where it is treated as an internal storage device. Because the replaceable cartridges permit unlimited file sizes and intercommunication among computer systems in much the same manner as magnetic tape, CRAM can also be considered as an input-output device.

Up to 16 CRAM units can be connected on-line to an NCR 315 system, providing from 5.5 million to 16 million characters of random access storage per unit, depending upon the model. Any combination of models can be used. Peak data transfer rate for the Model 353-1 CRAM is 100,000 characters per second; its maximum effective transfer rate is 42,300 characters per second under the conditions used to derive the graphs on the next page. Peak data transfer rate for Models 353-2 and 353-3 is 38,000 characters per second; their maximum effective transfer rate is 21,700 characters per second.

CRAM has two main advantages as an input-output device. One is the capability to store several files in one cartridge advantageously, since the access time for all cards is the same. The other advantage is the capability to process only active records; i.e., random processing. This type of processing requires proper placement of the record in storage and complex addressing methods for maximum efficiency.

The disadvantages of using CRAM as an input-output device are the relatively long access time (up to 235 milliseconds) and the lack of any overlapping of CRAM read/write operations with processing.

.6 PERFORMANCE

.62 Speeds

	Model 353-1	Model 353-2, Model 353-3
.621 Nominal or peak speed:	100,000 char/sec	38,000 char/sec.
.622 Important parameters —		
Time from card drop to interrupt:	235 msec	235 msec.
Time from interrupt to read/write:	2.64 msec	2.64 msec.
Time to read or write 1 character: .	0.01 msec	0.026 msec.
Time to read or write entire band: . .	31.11 msec	29.61 msec.
Drum revolution time:	48.6 msec	48.6 msec.
Maximum characters per band:	3,100	1,120
.623 Overhead —		
Interval between bands:	14.85 msec	14.85 msec.
Minimum card drop time (allowing for overlap with previous card):	172 msec	172 msec.

.624 Effective speed, (char/sec) —
For blocks smaller than one band (all models): . . . . . (1,000CB)/(172 + 48.6B)
C: . . . . number of characters read per band.
B: . . . . number of bands read per card.

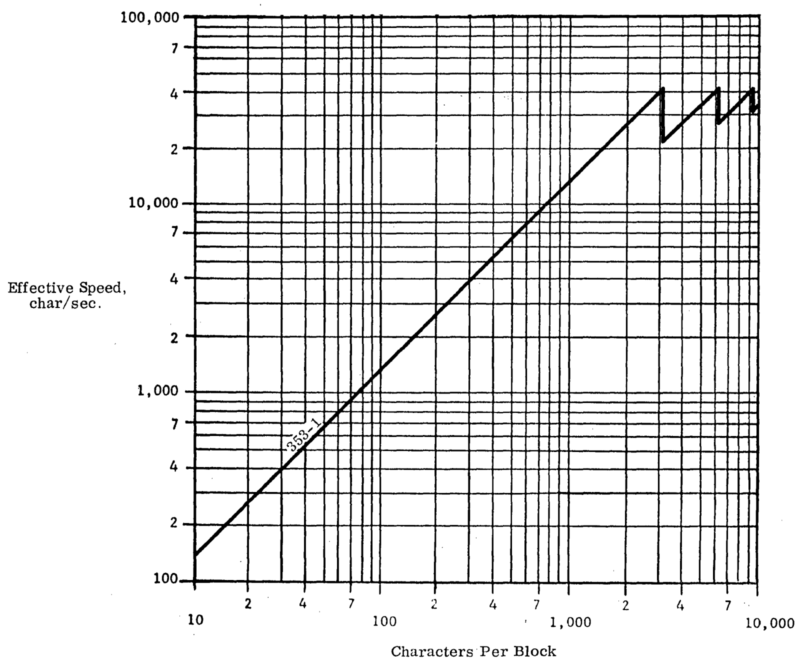
Note: The above effective speed is based on continuous reading or writing by one CRAM unit with maximum overlap with the previous card. Alternate accesses to multiple CRAM units can overlap drop times and improve effective speeds. For effective speeds on blocks larger than one band, see the graphs on page 601:101:900.

.63 Demands on Processor

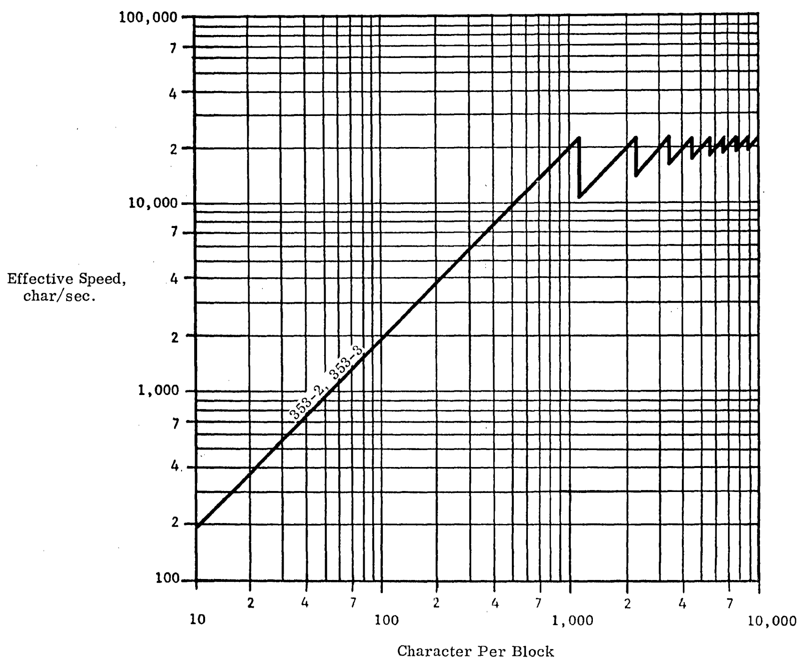
Model	Operation	Msec per band	Percentage
353-1:	drop a card	0	0
	read a band	2.75 + 0.01C	5.6 to 69.3
353-2, 353-3:	drop a card	0	0
	read a band	2.75 + 0.026C	5.6 to 66.6

C: . . . . number of characters per band.

EFFECTIVE SPEED: CRAM MODEL 353-1



EFFECTIVE SPEED: CRAM MODELS 353-2 AND 353-3



NOTE: The above graphs are based on:

(1) Reading cards continuously by one CRAM unit.

(2) Each logical block being stored on one or more full bands; i.e., no packing of more than one block to a band.

(3) Attaining maximum time-sharing of card drop time (63 milliseconds).

INPUT-OUTPUT: MICR SORTER-READER (750 DPM)

.1 GENERAL

.11 Identity: . . . . Pitney-Bowes National MICR Sorter-Reader. Model 402-3 (Buffered). Model 402-4 (Unbuffered).

.12 Description

This magnetic ink character sorter-reader reads up to 750 documents per minute. The documents can be from 5.25 to 10.00 inches long. Characters printed in magnetic ink in Font E-13B are recognized.

Only the 10 numerical characters and 4 special symbols can be read. A document may contain up to 56 characters. Control characters delimit the fields and are not stored; other control characters may delimit sub-fields and are stored.

The Model 402-3 Sorter-Reader uses the Model 355-1 MICR Sorter-Reader Buffer and interrupts the processor for only 0.762 millisecond per document to unload the buffer and to designate a pocket. Up to four Model 402-3 sorters and their buffers can be connected to an NCR 315.

The Model 402-4 Unbuffered Sorter offered with the NCR 315-100 is the same basic unit as the Model 402-3, but without buffering; it is not currently offered for the NCR 315.

Unrecognizable characters cause an ampersand, period, or hyphen to be stored and a special jump executed on a test instruction. If a control character is not present in a field, that field is ignored. If a field is too large or too small, it is truncated or filled with spaces. All these errors cause special jumps later.

When used on-line, the 12 stacker selectors are under program control. They are labeled 0 to 9, Special, and Reject.

An interrupt occurs when a buffer is loaded. To maintain full speed, the buffer must be unloaded within 25 milliseconds and the stacker selected within another 53.4 milliseconds after the interrupt.

.13 Availability: . . . . 2 months.

.14 First Delivery: . . . . . April, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . conveyor.
.212 Reservoirs —
Number: . . . . 1.
Form: . . . . conveyor.
Capacity: . . . . 3 checks.
.213 Feed drive: . . . . conveyor.
.214 Take-up drive: . . . . . . conveyor.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . . magnetic heads.

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

.24 Arrangement of Heads

Use of station: . . . . . . read.
Stacks: . . . . 1.
Heads/stack: . . . . 1.
Method of use: . . . . . . character at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	0.	
Special:	4	A.B.A. standard.
Alternatives:	0.	
Total:	14.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper documents.
.312 Phenomenon: . . . . magnetic ink printing.

.32 Positional Arrangements

.321 Serial by: . . . . character.
.322 Parallel by: . . . . only one row.
.323 Track use: . . . . all for data.
.324 Row use: . . . . all for data.

.33 Coding: . . . . MICR Font E-13B magnetic ink type font.

.34 Format Compatibility: with most devices equipped for MICR Font E-13B.

.35 Physical Dimensions

.351 Overall width: . . . . . . 2.5 to 4.5 inches.
.352 Length:
Length: . . . . 5.25 to 10 inches.
Thickness: . . . . 0.003 to 0.007 inches.
.353 Maximum margins: . . . standard MICR.

.4 CONTROLLER

.41 Identity: . . . . MICR Sorter-Reader Buffer. Model 355-1.

.42 Connection to System

.421 On-line: . . . . 4.
.422 Off-line: . . . . as independent document sorter.

.43 Connection to Device

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

.44 Data Transfer Control

.441 Size of load: . . . . 56 characters.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . by slab or character.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . . none.
.446 Synchronization: . . . . . automatic.
.447 Synchronizing aids: . . . interrupt when buffer full.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 56 characters.
.512 Block demarcation —
Input: . . . . end of check.

.52 Input-Output Operations

.521 Input: . . . . read 28 slabs (56 characters) from selected Sorter Buffer into designated core storage area. Documents are fed continuously until Stop Sorter instruction is issued.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . automatic, into NCR 315 internal code, 2 characters per slab.

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

.55 Control Operations

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

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . . yes.
End of medium marks: no.
Too late to read: . . . . yes.
Too late to sort: . . . . . yes.
Hopper empty: . . . . . . no.
Stacker full: . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: 750 checks/minute.

.622 Important parameters —
Time between successive interrupts: 80 msec.
Unload buffer: . . . . . 668 μsec.
Time available after interrupt to read next check: . . . . . . 25 msec.
Time available between interrupt and pocket selection: . . 78.4 msec minimum.
.623 Overhead: . . . . none.
.624 Effective speeds: . . . . 750 checks/min.

.63 Demands on System

Component	Condition	msec per check	Percentage
Processor:	unload buffer	0.668	0.84
Processor:	designate pocket	0.094	0.12

.7 EXTERNAL FACILITIES

.71 Adjustments and Controls: . . . . see NCR Publication MD-315-20, pp. 40-44.

.73 Loading and Unloading

.731 Volumes handled —
Hopper: . . . . 2,000 to 2,200 documents.
Stacker: . . . . 1,200 to 1,500 documents.
.732 Replenishment time: . . 1 to 3 minutes; sorter does not need to be stopped.
.734 Optimum reloading period: . . . . 3 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	check	replace bad character with special symbol and error jump.
Input area overflow:	not possible.	
Invalid code:	check	same as read error.
Exhausted medium:	check	stop.
Imperfect medium:	check	stop.
Timing conflicts		
Too late to read: / Too late to pocket:	check	select reject pocket and error jump.
Misfeed:	check	stop.
Check jam:	check	error jump.
Field wrong size:	check	error jump.
Control code missing:	check	error jump.
Any stacker full:	check	stop.
Missed check:	see timing conflict.	

INPUT-OUTPUT: MICR SORTER-READER (1,200 DPM)

.1 GENERAL

.11 Identity: . . . . MICR Sorter-Reader, Model 407-1.
Sorter Buffer, Model 355-3.

.12 Description

The Model 407-1 MICR Sorter-Reader is a new unit recently announced by NCR for off-line sorting and on-line sorting and reading of documents encoded with MICR Font E-13B magnetic ink characters. The peak speed of this unit is 1,200 documents per minute.

The 407-1 has 18 pockets for receiving documents, instead of the usual 12 or 13, and is capable of extensive off-line operations. During off-line sorting operations, documents can be selected into one of six pockets other than the normal pockets, 0 through 9. The selection is based on the contents of the partial or full fields specified by plugboard wiring. The 407-1 can recognize the last significant digit of a field and direct already-sorted documents into the eleventh ("zero-kill") pocket. This feature reduces the number of passes per document to a minimum. Unreadable documents are automatically directed into the reject pocket.

When the 407-1 is used on-line, all 18 pockets are under program control.

Documents measuring from 2.75 by 4 inches to 4 by 8.75 inches can be handled intermixed at the peak rate of 1,200 documents per minute. The permissible thickness of documents is from 0.0025 to 0.01 inch. The feed hopper can hold 3,000 documents, and each pocket can hold 2,000 documents. Documents can be added or removed without stopping the reader. Error-detection facilities, and the resulting actions, are similar to those of the 750-dpm sorter-reader described in section 601:102.

When the 407-1 is functioning on-line, the information read from a document is transferred to a 56-character buffer (Model 355-3). The contents of the buffer are transmitted to core memory upon command by the program. Once started, the sorter-reader feeds and reads documents at a constant rate of 1,200 documents per minute. An interrupt occurs when the buffer has been fully loaded. If the contents of the buffer are not transferred to memory within 10 milliseconds after the interrupt, the information from the previous document will be lost. The pocket-selection decision must be given within 38 milliseconds after unloading the buffer to prevent sorting errors. If the available processing time is insufficient, the MICR-encoded data must be transcribed to magnetic tape or CRAM for later processing.

The NCR 315 Processor is occupied for 0.72 milliseconds in unloading the 56-character buffer and for 0.084 milliseconds to select the pocket. Thus, the processor is delayed 1.6% of the time during MICR document reading operations.

The 407-1 Sorter-Reader can be installed in existing NCR 315 systems, but modifications to the central processor and to the 355-1 buffer are necessary. In addition, existing control programs must be modified if the 407-1 Sorter-Reader is to be used in place of the 750-dpm model.

The 407-1 Sorter-Reader can optionally be equipped with an endorsing feature that will imprint each document with the batch number, date, and endorsement. The batch number and date can be printed without the endorsement at the option of the operator.

INPUT-OUTPUT: OPTICAL READER

.1 GENERAL

.11 Identity: . . . . Optical Reader. Model 420-1.

.12 Description

The Model 420-1 Optical Reader can read journal tapes produced by cash registers, adding machines, or accounting machines at the rate of 26 lines per second. Each line on the tape may contain up to 32 characters. The peak reading speed, therefore, is 832 data characters per second.

By means of the plugboard, the sequence of characters can be rearranged and additional fixed characters can be emitted. A "Read a Line" instruction always causes a total of 56 characters (28 slabs) to be transmitted from the reader buffer to the 315 Processor, of which no more than 32 characters can be data read from the tape. Any 2 of the 32 character positions in a line can be designated as "decision columns" by plugboard wiring. Any selected character or combination of characters in these two positions can inhibit transmission of the entire line to the Processor.

The Model 420-1 Optical Reader accepts the 10 numeric digits and 6 special symbols of the NCR self-checking Optical Font. The digit forms are somewhat stylized but easily readable by humans. Alphabetic characters cannot be read.

The paper transport mechanism moves the tape past the optical read head and automatically rewinds it. The tape is transported past the read head at a maximum speed of 6.5 inches per second. Tapes from 1-5/16 to 3-1/4 inches in width and up to 1200 inches in length can be accommodated. The leader and trailer on each tape must be at least 10 inches long. Total handling time should not exceed 30 seconds per tape.

If the reader is unable to recognize any character as one of the 16 valid symbols, it stops the tape, backs it up, and reads the line again. If the error persists after a maximum of seven tries, the line can be rejected in one of two modes. A rejected line can be marked by stamping an ink-mark on the back of the tape, in which case reading will continue automatically. However, if the "Stop on Reject" console switch has been depressed, the reader will halt, permitting the operator to enter the rejected line manually. A maximum of 20 characters can be entered manually, using switches located on the console. Alternatively, a special character, selected from among six choices by means of a dial on the console, can be substituted for the unrecognizable character and the line accepted. The "Stop on Reject" switch will override this mode if the unreadable character is in a "decision column." Three special counters indicate the total number of lines read, the number of "back-ups" to re-read a line, and the number of lines rejected.

A maximum of four Optical Readers can be connected to an NCR 315 system, and all four can operate simultaneously at full speed. The readers are connected to the Processor through the MICR Sorter trunk, so a total of up to four Optical Readers and MICR Sorters, in any combination, can be connected. The following Processor instructions have the same functions whether addressed to an Optical Reader or to a MICR Sorter:

SELS	Select Sorter (or Optical Reader)
SETU:S	Set Unit Demand in Sorter (or Optical Reader)
CLRU:S	Clear Unit Demand in Sorter (or Optical Reader)
RCK	Read a Check (or Line)

The MICR Sorter instructions STRT:S, PKT, and STOP:S have no effect when addressed to an Optical Reader.

A "Read a Line" instruction transfers the 56 characters in the reader buffer into core storage, and requires 668 microseconds of Processor time. The Optical Reader then reads the next line from the tape and stores its contents in the buffer, during which time there are no demands upon the Processor. When the buffer is filled, the reader becomes "ready" and (optionally) sends an interrupt signal to the Processor. If the next "Read a Line" instruction is issued within 4 milliseconds after the interrupt, the peak speed of 26 lines per second will be maintained. Total time between successive interrupts averages 38.5 milliseconds.

The Model 420-1 Optical Reader can be used online with NCR 310 and 390 EDP systems as well as with the NCR 315 and 315-100. It can also be used off-line, with an NCR Model 371-1 Paper Tape Punch (rated at 110 characters per second) as its output unit.

INPUT-OUTPUT: TELETYPE INQUIRY SYSTEM

.1 GENERAL

.11 Identity: . . . . Teletype Inquiry System.

Model 356-1 Central Inquiry Buffer (1-character, alphameric).

Model 359-3 Communication Line Adapter (5-level Teletype).
Model 358-3 Auxiliary Cabinet.

Model 321-1 Central Communications Controller.

Teletype Adapter.

Teleprinter (Kleinschmidt) Adapter.

Unbuffered Inquiry Feature (low-cost alternative to the above units).

.12 Description

.121 Central Inquiry Buffer

The Teletype Inquiry System permits two-way communication at 10 characters per second between an NCR 315 and one or more Model 28 Teletypewriters or Automatic Send/Receive units located at the computer site or any distance away from it.

Up to 16 Model 356-1 Central Inquiry Buffers can be connected to a Model 315-35 or 315-45 Processor. Each buffer, in turn, can control up to eight Teletype Communication Line Adapters, or CLATs. (Each Model 359-3 unit consists of a pair of CLATs.) The buffer contains space for two CLATs. The 348-3 auxiliary cabinet must be used if more than two CLATs are incorporated in a system.

The maximum number of Central Inquiry Buffers and CLATs that a particular NCR 315 system can service will depend upon the volume of inquiries, the gross character rate, and the amount of core memory available for message processing and storage. Each character of each inquiry message is handled individually by the Inquiry Control System (see Section 601:192). Each time a demand interrupt signals the arrival of a message character in a buffer, the following operations occur:

- The present status of the main program is preserved (accumulator contents, flag settings, etc.).
- The character is read from the buffer, translated into 315 internal code, tested to determine whether it is a control or data character, and stored in a message area.
- If the end of message has not been reached, the status of the main program is restored and control is returned to it.
- If the end of message has been reached, control is transferred to the user program that will prepare an output message.
- The Inquiry Control System will then translate and transmit the output message, one character at a time, to the remote Teletype unit. Output, like input, can be time-shared with internal processing.

An average of 5 milliseconds of Processor time is required to process each character of an input or output message. Teletype transmission rate is usually 10 characters per second, or 100 milliseconds per character, while input rate from a manual keyboard will usually not exceed 3 to 4 characters per second.

There are three basic plans for Teletype Inquiry Systems using the Central Inquiry Buffer and Communication Line Adapters.

Plan A

A CLAT can be connected directly to a modified Model 28 Teletypewriter via full duplex lines. The modification allows the CLAT to inhibit further input transmission from the Teletypewriter until the Processor has unloaded the last character transmitted from the buffer. The CLAT locks out the keyboard by means of a signal sent over the other side of the full duplex line. The Teletypewriters can be located at the computer site, or a limited distance away if "non-channelized" full duplex lines (i.e., lines which are not routed through the communications company's switchgear) are available.

Plan B

When "non-channelized" circuits are not available, a Model 28 R/T (Reperforator Transmitter-Distributor) set must be inserted into each line, at the computer site, to serve as a mechanical input buffer. In this plan, the modification described in Plan A is not required, and less expensive half duplex lines can be used. The R/T set, which is connected to the input side of the CLAT, consists of a paper tape punch and reader with a tape loop between them. When the Processor is unable to accept further input, the CLAT will disengage the reader clutch without affecting the punch mechanism. Thus, characters punched during this period are stored in the paper tape loop until the Processor is ready to accept them. Buffering of the output to the remote Teletype unit is not required, so the output line from the CLAT can be connected directly to the communication company's lines.

.121 Central Inquiry Buffer (Contd.)

Telex Plan

The Western Union "Telex" (Dial-Up) system can be used in the same fashion as Plan B. In this arrangement, the NCR 315 Processor has its own subscriber number and can be called by any other station in the Telex system. Calls may be screened by the Processor to determine whether the call is from an authorized number.

.122 Central Communications Controller

A new device recently announced by NCR, the Model 321-1 Central Communications Controller, can greatly improve the performance of an NCR 315 Teletype Inquiry System. Only one Model 321-1 Controller can be connected to a Model 315-35 or 315-45 Processor, but up to 100 communications adapters can be controlled by this device. Adapters presently announced include a Teletype adapter and Teleprinter (Kleinschmidt) adapter. Systems using the Model 321-1 Controller cannot use magnetic tape units with peak transfer rates in excess of 70,000 characters per second.

The Model 321-1 Controller accesses memory directly, sharing memory cycles with the processor. An average of 5 memory cycles (30 microseconds for the 315) is required for each character of a message. Two tables, located in a fixed location in memory, are used to control inquiries. One table — one slab per adapter — contains information on the status of each data line, including indications of end-of-message character, parity error, input or output interrupt, and which of the two character positions of a slab the next message character will be obtained from or placed in. The second table — five slabs per adapter — contains the starting addresses in memory of input or output areas. These starting addresses are initially set by the program and are automatically incremented by the Model 321-1 Controller.

All data lines can be active simultaneously; a scanner within the controller continuously scans the lines for activity. The maximum total data rate capability (sum of all active line rates) of the Model 321-1 Controller is 12,000 characters per second. The main program is interrupted only after a complete message has been received or sent.

The Teletype adapter can be used with 5-, 6-, or 8-level Teletype devices (Models 28, 29, 32, 33, or 35) either singly or in party-line arrangements such as the Bell Telephone 83B2 Plan or Western Union Plan 115A. An adapter is required for each independent device and each party line. Note that use of the Model 321-1 Controller requires neither modifications to the Teletype devices nor an intermediate storage device (such as the paper tape punch and reader required for distant communication with the Central Inquiry Buffer).

NCR has indicated that additional adapters will be made available for various types of data communication facilities.

An executive routine will be available to handle interrupts and extraneous conditions, but details are not available to date. This routine is expected to be functionally similar to the control routine for the Model 356-1 Central Inquiry Buffer, as described in Section 601:192.

Optional features that will be offered for use in connection with a Model 321-1 Central Communications Controller include a real-time clock available to the programmer and automatic polling facilities for certain party-line operations.

.123 Unbuffered Inquiry Feature

The Unbuffered Inquiry Feature is offered as a low-cost alternative to the Teletype Inquiry Systems described above. Any Teletype unit with bit-serial output (e.g., Models 28, 29, 32, 33, or 35) can be connected to the 315 Processor's Paper Tape Reader and Punch trunks, and a party line arrangement is possible. No Central Inquiry Buffers or CLATs are used with this feature, so no multiplexing is possible. The 315 Processor is fully occupied and can perform no other functions from the beginning of an inquiry until the reply has been generated and transmitted.

INPUT-OUTPUT: ON-LINE SAVINGS SYSTEM

.1 GENERAL

.11 Identity: . . . . On-Line Savings System.

Central Inquiry Buffer (17-character, numeric only): Model 356-3.

Pair of Communication Line Adapters (numeric only): Model 359-1.

Communication Line Adapter (Master): Model 359-4.

Auxiliary Cabinet: Model 358-3.

Peripheral Scanner-Selector: Model 438-3.

Branch Controller: Model 438-3.

On-Line Window Machine: Model 42-501.

Window Machine Controller: Model 428-2.

.12 Description

The On-Line Savings System provides tellers with direct access through communication lines to customer account information stored in CRAM memory in an NCR 315 system. The input-output device is the familiar NCR Class 42 Window Posting Machine, with a few additional keys and lights to permit on-line use.

Each Model 42-501 Window Machine requires one Model 428-2 Controller. Up to 16 Window Machines can be connected to a Model 438-3 Peripheral Scanner-Selector at each banking site. If more than 16 Window Machines are needed at a single site, more Scanner-Selectors can be used. Each Scanner-Selector is connected to the 315 system via:

(1) a data subset at the banking site;

(2) a full duplex voice-grade communications line to the computer site;

(3) a data subset at the computer site;

(4) a Communication Line Adapter; and

(5) a Central Inquiry Buffer.

Up to 16 Central Inquiry Buffers can be connected to a Model 315-35 or 315-45 Processor. Each buffer, in turn, can control up to eight Communication Line Adapters, or CLAs. (Each Model 359-1 unit consists of a pair of CLAs.) The buffer contains space for two CLAs. The 358-3 Auxiliary Cabinet must be used if more space is needed. The data subsets are required for Peripheral Scanner-Selectors located at the computer site as well as those at remote locations.

Teletype inquiry and communication equipment can be used in an on-line savings system by connecting it to any available trunks of a Model 356-3 Central Inquiry Buffer via Model 359-3 Teletype Communication Line Adapters. When this is done, the Model 356-3 buffer services the teletype lines in exactly the same way as the Model 356-1 one-character alphameric Central Inquiry Buffer described in Section 601:105.

The NCR 315 Airline Reservations System utilizes exactly the same components as the On-Line Savings System, except that the Airline Reservations Sales Set (a modified NCR 171-50 adding machine with indicator lamps) is used in place of the Class 42 Window Machine.

The Central Inquiry Buffer scans each communication line at the rate of 10 microseconds per line. When it receives an input request from a Peripheral Scanner-Selector, it locks onto that line and allows a 17-digit message to be transmitted into the buffer. Transmission is serial by bit, at up to 2,000 bits per second. A parity check on each character and a sum check on the entire message are made. If a transmission error is detected, the message will be automatically re-transmitted up to 10 times if necessary. When the buffer is filled, it sends a demand interrupt signal to the Processor, which then reads the message into core storage.

The total time required to handle one basic transaction is estimated to be 11.5 seconds. A maximum of one-third of a second of internal processing time will be required for each transaction. The system can be expanded to a total of 2,048 Window Machines and up to 2,000,000 accounts in on-line CRAM memory.

The first NCR 315 On-Line Savings System went into operation in Fall, 1963.

On-Line Savings System (Party-Line)

In this alternative arrangement, from 1 to 16 Model 42-501 Window Machines at a particular banking site can be connected to a Series 438-3 Branch Controller of the appropriate capacity (e.g., the Model 438-306 Branch Controller can accommodate up to 6 Window Machines). Up to 8 Branch Controllers, at the same or different sites, can be connected serially (in party-line fashion) to a Model 359-4 Communication Line Adapter (Master) and a Model 356-3 Central Inquiry Buffer. Each Branch Controller is connected to the adjacent Branch Controllers in the party line series or to the computer via a full duplex voice-grade communications line with a data subset at each end. Data transmission is at the rate of 1,200 bits per second. NCR recommends this type of arrangement for most applications.

INPUT-OUTPUT: UNIVERSAL INTERCONNECTING DEVICE

.1 GENERAL

.11 Identity: . . . . Universal Interconnecting Device.
Model 435-201 (one module).
Model 435-202 (two modules).
Model 435-203 (three modules).

.12 Description

The Universal Interconnecting Device is used for physically switching peripheral units between two NCR 315, NCR 315-100, or NCR 315 RMC computer systems in any combination. Three versions are available, differing in the number of switching modules they contain. Model 435-201 contains one module; Model 435-202, two modules; and Model 435-203, three modules. Switching is done by solenoid-operated switches which are actuated manually by means of pushbuttons located on the console panel of the Interconnecting Device.

Peripheral units to be switched are cable-connected to the Interconnecting Device, which in turn is cable-connected to the respective computer systems. Each module can switch one peripheral device or a group of up to eight magnetic tape units or CRAM units. The Universal Interconnecting Device permits two NCR computer systems located in close proximity to each other to share a group of peripheral devices; it cannot provide a direct computer-to-computer connection.

SIMULTANEOUS OPERATIONS

BUFFERED OPERATIONS

The peripheral devices in the following list are buffered. Once data has been transferred to or from the buffer, the remainder of the operation is essentially independent of all other operations and can occur simultaneously with computing* or other input-output operations.

- Card Punch — Models 376-2 and 376-101.
- Printer — Models 340-3 and 340-601.
- Lister — Model 340-512 (right-hand 24 positions, numeric listing only).
- MICR Sorter-Reader — Model 402-3 or Model 407-1.
- Optical Journal Reader — Model 420-1.
- Communications Devices — all devices connected via the 356-1 or 356-3 Central Inquiry Buffer or the 321-1 Central Communications Controller.
- Magnetic Tape Units — all models connected via the Model 324-1 or 324-2 Magnetic Tape Simultaneity Controller.

UNBUFFERED OPERATIONS

The peripheral devices listed below are unbuffered and depend on the central processor for control. Except for certain special operations such as magnetic tape rewinding, forms advancing on the printers, and CRAM card dropping, the operation of one of these devices precludes the operation of any other device in this list. However, there is usually some time available for computing during the data transfer operations of each device.

- Card Reader — Models 472-2, 472-3, and 380-3.
- Card Read Punch — Models 376-7 and 376-8.
- Paper Tape Reader and Punch — all models.
- Printer — Models 340-502, 340-503, and 340-512 (except in listing mode; see above list).
- Console Typewriter.
- CRAM — all models.
- Magnetic Tape Units — all models connected directly to the processor. Note that the processor is fully occupied for the entire duration of a read or write operation on magnetic tape units so connected.
- Communications Devices — all devices connected via the Unbuffered Inquiry Feature.

PROCESSOR DEMANDS

Details about the demands imposed by each peripheral device upon the NCR 315 Central Processor are presented in the appropriate sections of this Computer System Report; see Sections 601:071 through 601:106.

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* The central processor, of course, is momentarily delayed whenever data is transferred between the peripheral buffer and core storage; see "Processor Demands," above.

INSTRUCTION LIST

INSTRUCTION					OPERATION
OP	V	L	X/Y	A/B	
					ARITHMETIC
ADD		L	X	A	A + (@) ⟶ (@) or (A) + (@) ⟶ (@)
SUB		L	X	A	(@) - A ⟶ (@) or (@) - (A) ⟶ (@)
ADD	M	L	X	A	(@) + A ⟶ A or (@) + (A) ⟶ (A)
DIV		L	X	A	(@)/A ⟶ Left hand (@) } Remainder ⟶ or (@)/(A) ⟶ Left hand (@) } Right hand (@)
MULT		L	X	A	(@) xA ⟶ (@) or (@) x (A) ⟶ (@)
BADD		L	X	A	(@) + A ⟶ (@), binary addition or (@) + (A) ⟶ (@), binary addition mod 64; no carries.
					LOGIC
COMP		N	X	A	(X) is compared with A or (A + X) and the greater, less, or equal flag is set accordingly.
SETF	+				Set accumulator sign plus.
SETF	-				Set accumulator sign minus.
SETF	0				Set overflow flag on.
SETF	D				Set demand (i.e., peripheral device interrupt) permit on.
SETF	T				Set tracer permit flag on.
SETF	LH		X	A	Set left hand character of (A + X) to non-zero (i.e., on). A space character is inserted.
SETF	RH		X	A	Set right hand character of (A + X) to non-zero (i.e., on). A space character is inserted.
CLRF	LH		X	A	Set right hand flag (character) of (A + X) off, i.e., to zero.
CLRF	RH		X	A	Set left hand flag of (A + X) to zero.
TEST	G		X	A	If G (greater) flag is on, jump to the instruction whose address is A + (X), and leave the return address in index register 15.
TEST	L		X	A	Same as TEST G except that the jump is made if the L flag (less than) is on.
TEST	E		X	A	Same as TEST G except that the jump is made if the E flag (equal) is on.
TEST	-		X	A	Same as TEST G except jump if sign flag is negative.
TEST	0		X	A	Same as TEST G except that the jump is made if the overflow flag is on.
TEST	D		X	A	If the demand permit flag is on, jump to the instruction whose address is A + (X), and turn the flag off.
TEST	T		X	A	If the tracer permit flag is on, jump to the instruction whose address is A + (X), and turn the flag off.
PAST	V		X	A L	The accumulator is stored, right justified, in part of the area L words in size starting at A. V describes particulars.
	XL				Except the LH character of the A-area.
	XR				Except the RH character of the A-area.
	XB				Except both end characters of the A-area.
LOAD	V		X Y	A L	Convert an area of memory L words in size and starting at A, from 6-bit code to 4-bit code and leave the result in the accumulator. V describes particulars.
	SPACE				Load and condense entire A-area.
	XL				Except the LH character of the A-area.
	XR				Except the RH character of the A-area.
	XB				Except both end characters of the A-area.
STDA			X	A L	4-bit code characters in the accumulator are converted to 6-bit code and stored in L words of memory starting at A.

@ represents the accumulator.

INSTRUCTION					OPERATION
OP	V	L	X/Y	A/B	
TEST	T LH		X JUMP	A ADDRESS	If the left hand character of (A + X) is not zero, jump to the location specified by JUMP ADDRESS.
SHFT	V		X	A	Perform the shift specified by V, shifting the accumulator (A + X) or A places.
	DL				Shift left, 4-bit code.
	DR				Shift right, 4-bit code.
	RR				Shift right with roundoff, 4-bit code.
	LC				Left circular shift, 4-bit code.
	RC				Right circular, 4-bit code.
	AL				Left shift, 6-bit code. Enter spaces at the right.
	AR				Right shift, 6-bit code. Enter zeros at left.
TEST	RH		X JUMP	A ADDRESS	If the right-hand character of (A + X) is not zero, jump to the location specified by JUMP ADDRESS.
TEST	SW		 Y	A B	Test console option switch number (A) or A. If it is on, jump to location B + Y.
JUMP			X	A	Jump to location A + X. Provide a return.
JUMP	I		X	A	Jump to the address stored in (A + X). Provide a return.
JUMP	IP				Jump to the address stored in (A + X). Do not provide a return.
SKIP				N	Jump forward or backward N words. Do not provide a return.
DLR					Return to the point at which the program was interrupted.
MLRA				N	Return to the point N slabs before or after the place from which the last jump with return provided was made.
EDIT		L	X	A	Edit (A) into the accumulator according to a format control previously loaded into the accumulator.
SUPP		L	X	A	Leading zeros in the L-word A area are replaced with spaces.
CNT			X Y	A G	Add G to index register Y and store the result in index register Y. Then compare register Y against (A) completely or against A mod 1000 and set the greater, less than, or equal flag as appropriate.
SCND	V_1V_2		X Y	A L	Compare accumulator and (A), digit by digit (4-bit code), until a digit is found with the property specified by V_1. V_2 specifies the digits in each word which are to be compared. L is the number of words which are to be compared. If no digit is found which meets the specified condition, jump to the location specified in jump register Y.
	GV_2				Test for digits greater than corresponding digit in accumulator.
	FV_2				Test for digits equal.
	LV_2				Test for digits less than.
	V_1SPACE				Compare all digits.
	V_17				Compare all digits.
	V_16				Compare left and middle digits, ignore right hand digit.
	V_15				Compare left-hand and right-hand digits.
	V_14				Compare left-hand digit.
	V_13				Compare middle and right hand digits.
	V_12				Compare middle digit.
	V_11				Compare right-hand digit.
SCNA	V_1V_2		X Y	A L	Same as SCND except that the comparison is performed on alphameric (6-bit code characters). There are, therefore, only two characters to a word. V_1 is the same as for SCND.

INSTRUCTION					OPERATION
OP	V	L	X/Y	A/B	
	V_1SPACE				Compare both characters in each word.
	$V_1$3				Same as V_1 SPACE.
	$V_1$2				Compare left-hand character of each word.
	$V_1$1				Compare right-hand character.
LD		L	X	A	(A) ⟶ (@) or A ⟶ (@)
ST		L	X	A	(@) ⟶ (A) or (@) ⟶ A
LD	R		X Y	A N	Transcribe N successive pairs of words from memory starting at (A) into N successive index registers starting with register Y.
LD	J		X Y	A N	Same as LD R except that LD J loads jump registers.
SLD	V		X Y	A N	Transcribe the memory pair (A) into each of N successive registers starting with register Y. Type of register defined by V.
	R				Index registers.
	J				Jump registers.
ST	V		X Y	A N	Transcribe N successive registers starting with register Y into N successive memory pairs (A), (A + 2), etc. Type of register defined by V.
	R				Index registers.
	J				Jump registers.
AUG	V		X Y	A N	The contents of N successive registers starting with register Y are augmented by the contents of the corresponding one of N successive memory pairs. Type of register defined by V.
	R				Index registers.
	J				Jump registers.
SAUG	V		X Y	A N	The contents of each of N successive registers starting with register Y are augmented by the contents of memory pair (A). Type of register is defined by V.
	R				Index registers.
	J				Jump registers.
MOVE	V_1V_2		X Y	 N	Transcribe the contents of N successive registers starting with register Y into N successive registers starting with register X. V_1 defines the type of sending register. V_2 defines the type of receiving register.
	RR				Index register to index register.
	RJ				Index register to jump register.
	JR				Jump register to index register.
	JJ				Jump register to jump register.
MOVE	V		X Y	A B	Transcribes N successive slabs from an A-area to a B-area in memory. N is in the accumulator. V describes particulars of the MOVE.
	B				A and B are the addresses of the beginning of each area. Move data starting at the beginning.
	E				A and B are the addresses of the end of each area. Move data starting at the end.
SPRD	V		 Y	A B	Transcribes A itself into each word of an N-word B-area in memory. N is in the accumulator. V describes particulars.
	B				B is the address of the beginning of the area. Fill starting at the beginning.
	E				B is the address of the end of the area. Fill starting at the end.

@ represents the accumulator.

INSTRUCTION					OPERATION
OP	V	L	X/Y	A/B	
					INPUT-OUTPUT
CLRU	V		X	A	Inhibit interrupt (clear unit demand flag) in unit number A of
			00		the type of peripheral device named by V.
	C				CRAM.
	P				Printer or Card punch.
	S				Sorter.
	Q				Inquiry buffer.
SETU	V		X	A	Permit interrupt (set unit demand flag) in unit number A of
			00		the type of peripheral device named by V.
	C				CRAM.
	P				Printer or card punch.
	S				Sorter.
	Q				Inquiry buffer.
SELC	V		X	A	Select the CRAM unit and drop the card defined by (A).
			Y	J	Jump to J under the conditions defined by V.
	DP				The next read or write instruction is intended for the present card. Jump if a card is now dropping on this unit.
	DN				The next read or write instruction is intended for the next card. Jump if a card is now dropping.
	T				Do not drop a card. Jump if unit is ready.
	R				Do not drop a card. Release present card. Jump if unit is not loaded.
SELP			X	A	Select printer or card punch number (A) or A. Jump to
			Y	J	J if unit is ready.
SELS			X	A	Same as SELP except that SELS selects a sorter.
			Y	J	
SELQ			X	A	Same as SELP except that SELQ selects an inquiry
			Y	J	buffer.
RCC			X	A	Read a CRAM card into memory starting at location A. List
			Y	I	of abnormal jump destinations starts in jump register Y. Control information starts at location I in memory.
WCC			X	A	Write a CRAM card into memory starting at location A.
			Y	I	Y and I have same meaning as in RCC.
RCOL	V		X	A	Read N columns into memory starting at A. Abnormal
			Y	N	jump address is in jump register Y. Perform the additional operation defined by V.
	SPACE				No additional operation.
	F				Feed a card before reading. If column 1 of the present card has already been read, feed next card and continue reading present card.
	T				Read in translate mode. Can be used only for high speed card reader.
	TF				Read in translate mode and feed a card as for V = F. Can be used only for high speed card reader.
PPT	V		X	A	Punch N rows of paper tape from memory starting at
				N	location A. Punch in mode V.
	C				Punch in 6-channel-plus-parity mode.
	S				8-channel mode.

INSTRUCTION					OPERATION
OP	V	L	X/Y	A/B	
RPT	V		X Y	A N	Read N rows of paper tape into memory starting at location A. Abnormal jump addresses start in jump register Y. Read in mode V.
	C				6-channel-plus-parity mode.
	CX				6-channel-plus-parity mode. If the first character is a tape feed, execute abnormal jump and do not read.
	S				8-channel mode.
PNCH			X Y	A S	Punch a punched card from memory starting at A. Abnormal jump address is in jump register Y. S controls use of selectors on punch plugboard.
PRNT			X Y	A MF	Print a line on whichever printer was last selected. Print the information starting at memory location A. Abnormal jump addresses start in jump register Y. Move paper as specified by M and F.
HALT	D		X 00	A	Halt and accept input from the console typewriter. Store input in 4-bit code starting at memory location A.
HALT	A		X 00	A	Same as HALT D except that input is stored in 6-bit code.
TYPE	V		X	A N	Type N words from memory starting at location A on the console typewriter. V defines mode.
	D				Type 4-bit code from memory.
	A				6-bit code.
	AP				6-bit code with programmed format.
RMT			X Y	A I	Read N words from magnetic tape handler number H into memory starting at location A. H and N are in memory starting at location I. Abnormal jump addresses start in jump register Y.
WMT			X Y	A I	Write magnetic tape. X, A, Y, and I have the same meaning as in RMT.
BACK			- Y	- I	Backspace one block on magnetic tape H. H is in memory at location I. Abnormal jump addresses start in jump register Y.
WIND	V		- Y	- I	Rewind the magnetic tape on handler H. H is in memory at location I. Abnormal jump addresses start in jump register Y. V defines additional operation.
	SPACE				No additional operation.
	L				Rewind with interlock.
STRT	S		- 00	-	Start whichever sorter was last selected.
RCK			X Y	A	Read a check into memory starting at location A. Abnormal jump addresses start in jump register Y.
PKT			X Y	A	Place the current check into pocket A of whichever sorter was last selected. Abnormal jump destination address is in jump register Y.
STOP	S		- 00	-	Stop whichever sorter was last selected.

DATA CODE TABLE NO. 1

Character(1)	Octal	Character(1)	Octal
0	00	+	40
1	01	J	41
2	02	K	42
3	03	L	43
4	04	M	44
5	05	N	45
6	06	O	46
7	07	P	47
8	10	Q	50
9	11	R	51
@	12	%	52
,	13	=	53
SP	14	$	54
&	15	(	55
.	16	)	56
-	17	/	57
!	20	*	60
A	21	#	61
B	22	S	62
C	23	T	63
D	24	U	64
E	25	V	65
F	26	W	66
G	27	X	67
H	30	Y	70
I	31	Z	71
;	32	<	72
"	33	>	73
? (M)	34	' (U)	74
: (N)	35	[(V)	75
← (O)	36	] (W)	76
↑ (P)	37	\ (X)	77

(1) The basic printer character set contains 56 characters. Non-printing characters are printed as a base letter overprinted with a +. The base letters are indicated in parentheses beside each non-printing character.

DATA CODE TABLE NO. 2

.1 USE OF CODE: . . . . 80 column punch cards (NCR code).

Note: An alternate punch card code, differing only in representation of some special symbols, is used for IBM-compatible operation (see, for example, Page 401:143.100).

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Space	&	-	0
9-3-0		<		
8-0		)		
0	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	0	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
4-2	←			
8-3	#	.	$	,
8-4	@	;	*	%
8-5	"	\	[	=
7-5	:			
8-7	!	↑	'	]
3-4-5	(			
7-2-1	?			

PROBLEM ORIENTED FACILITIES

.1 UTILITY ROUTINES

.11 Simulators of Other Computers

IBM 305 RAMAC

Reference: . . . . NCR Data Processing Newsletter #54, March 14, 1962.
Date available:. . . . . May, 1962.
Description:

The 315 Simulator of the IBM 305 RAMAC is a coordinated group of routines designed to run programs already prepared for an IBM 305 system on an NCR 315. Minimum NCR 315 configuration is 10,000 slabs of core storage, a card reader, card punch, and printer, and 1 CRAM unit per 5 million characters of RAMAC disc storage to be simulated.

The IBM 305 system to be simulated can consist of a 305 Processing Unit with 5 or 10 million characters of disc storage and most of the available special features, a 380 Console (card reader and typewriter) with straight 80-80 plugboard, a 323 Card Punch with 80-80 plugboard, and a 370 Printer with 80-80 plugboard.

An assembler and simulator program are used to convert the wiring list for the 305's process control plugboard into the appropriate NCR 315 instructions. When the 305 program uses output plugboards other than the straight 80-80 type, the user must write NEAT programs to simulate their effects. Typical IBM 305 programs can be expected to run about three times as fast on an NCR 315, using the simulator, as on the 305.

.12 Simulation by Other Computers

By NCR 304: . . . . written to permit debugging of NCR 315 programs prior to delivery of the 315; no longer in use.

.13 Data Sorting and Merging

Tape Sort Generators —

Sort 1T

Reference: . . . . NCR publications MD315-62 and MD 315-502.
Record size: . . . . . . 2 to 999 slabs.
Block size: . . . . 2 to 9,999 slabs.
Key size: . . . . 1 to 8 fixed-length keys of 1 to 8 slabs each, or 1 variable-length key.
File size: . . . . any length.
Number of tapes: . . . 4, 6, or 8.
Date available: . . . . February, 1962.
Description:

The Sort 1T Generator produces programs to sort records on magnetic tape, using parameters specified in control cards. The sort programs will operate with 10,000 to 40,000 slabs of core storage and 4, 6, or 8 tape handlers (for a 2-way, 3-way, or 4-way merge, respectively). The generated sort programs are about 5,000 slabs long, and are divided into 3 segments so that only 4,000 slabs of core storage are required at any time. Either fixed-length or variable-length records can be sorted according to either fixed-length or variable-length keys. The user can insert his own coding to add, delete, edit, expand, or contract records during the first and/or last pass. Restart points are automatically established at the end of each merge pass. The Tape Sort Generator and all the sort programs it produces are compatible with STEP, the Standard Tape Executive Program. An interface with ICS (Section 601:192) is provided for running a sort program in conjunction with an inquiry program.

Sort 2T

A simplified tape sort routine is available for NCR 315 systems with only 5,000 slabs of core storage. The simplified sort does not allow variable-length records, multi-reel files, or insertion of own coding.

Sort 3T

A special version of Sort 1T is available for use with systems having one or two 324-1 Magnetic Tape Simultaneity Controllers. Faster sorts are possible with this routine due to the overlapping of computing and magnetic tape operations.

Sort 4T

A special sort routine is available for NCR 315-100 systems without the Multiply-Divide feature.

CRAM Sort Generators —

Sort 1C

Reference: . . . . NCR publication F-7013.
Record size: . . . . . . 2 to 999 slabs.
Block size: . . . . 2 to 1,546 slabs.
Key size: . . . . 1 to 8 individual keys of 1 to 8 slabs each.
File size: . . . . any length.
Number of CRAM units: . . . . 1, 2, or 4.
Date available:. . . . . April, 1962.
Description:

The Sort 1C Generator produces programs to sort records stored on CRAM cards, using parameters specified in control cards. The sort programs

.13 Data Sorting and Merging (Contd.)

will operate with 10,000 to 80,000 slabs of core storage and 1, 2 or 4 353-1 CRAM units; the larger configurations result in faster sorting. Either fixed-length or variable-length records can be sorted. The first slab of each variable-length record must contain the length of the record (in slabs). The user can insert his own coding to add, delete, edit, expand, or contract records during the first and/or last pass. Restart points are automatically established at the end of each merge pass. The CRAM Sort Generator and all the sort programs it produces are compatible with PACE, the Packaged CRAM Executive routine.

The random access nature of CRAM storage means that a multi-way merge of the strings of sorted data records can be accomplished with only 1 or 2 CRAM units on-line. The effective merge order is determined by the record length and amount of core storage available.

Sort 2C

A simplified CRAM sort routine is available for NCR 315 systems with only 5,000 slabs of core storage and one Model 353-1 CRAM unit. It employs a 2-way merge technique.

Sort 3C

A high-speed, 2-way-merge sort routine is available for NCR 315 systems with 10,000 or 20,000 slabs of core storage and two Model 353-1 CRAM units. Variable-length keys and records are permitted. NCR estimates the sorting times using this routine are approximately half those obtained with Sort 1C.

Sort 4C, 5C, 6C

Special versions of Sorts 1C, 2C, and 3C are available for systems employing Model 353-2 or 353-3 CRAM units. Sorts 4C, 5C, and 6C are functionally similar to Sorts 1C, 2C, and 3C, respectively.

.14 Report Writing: . . . . see BEST, Section 601:152.

.15 Data Transcription

Magnetic Tape Printout Routine
Reference: . . . . NCR 315 Programming Memo #46, publication MD 315-511.
Date available: . . . . . January, 1962.
Description:

This routine prints the contents of all or any selected blocks of a magnetic tape file on the on-line printer, in both alpha and digit format. The tape blocks may be fixed or variable in length, with a maximum length of 3,000 slabs. The routine will operate on an NCR 315 with 5,000 slabs of core storage.

The contents of 15 slabs are printed per line. Each line of output contains the relative address of the first slab, the 15 slabs in digit form (i.e., 45 digits), a slash symbol, and the same 15 slabs in alpha form (i.e., 30 characters). The block number and block length are also printed for each block. Use of the seven console Option Switches conditions the routine to print only those tape blocks (or sections of blocks) that satisfy criteria typed in by the operator (e.g., blocks whose keys are equal to a specified value).

CRAM Printout Routine
Reference: . . . . NCR 315 Programming Memo #49, publication MD 315-511.
Date available: . . . . . January, 1962.
Description:

This routine prints the contents of one CRAM file, selected records within a file, or an entire CRAM deck. The contents of 15 slabs are printed on each line in both alpha and digit format; the data output format is the same as that of the Magnetic Tape Printout Routine described above. By means of the console Option Switches and typewriter, the routine can be conditioned to print only those blocks (or sections of blocks) that satisfy specified criteria (e.g., blocks whose keys are equal to a typed-in value). Blocks may be fixed or variable in length, with a maximum length of 1,550 slabs, or 1 CRAM band. At least 10,000 slabs of core storage are required to use the CRAM Printout Routine. The routine is also capable of listing, in special formats, the contents of the Skip Directory, File Directory, and Program Directory (if any) for each CRAM deck.

.16 File Maintenance

Librarian
Reference: . . . . NCR publication MD 315-61.
Date available: . . . . . February, 1962.
Description:

The Librarian is a routine designed to create and maintain a library tape (or CRAM deck). The librarian is compatible with STEP (or PACE when CRAM storage is used), uses STEP (or PACE) in its own processing, and furnishes the STEP (or PACE) System Supervisor (Section 601:191) with the information it needs to function as a scheduling and operating system. Control instructions on punched cards or paper tape are used to control the functions of the Librarian, which can perform insertions, deletions, corrections, or straightforward copying of the library. The Librarian will accept programs on magnetic tape, CRAM cards, punched cards, or paper tape, as produced by either the NEAT Compiler or by a previous Librarian run. Programs produced by the NEAT Assembler are not directly acceptable; they must be reassembled into the proper format (approximately 1,000 slabs per block) by the NEAT Compiler.

.17 Others

.171 Floating Point Arithmetic Subroutines

All of the following subroutines can be entered by means of NEAT macro-codes and use 5 consecutive slabs to hold each floating point number (11 decimal digits and sign for the fraction; 3 digits for positive exponents; 2 digits and minus sign for negative exponents).

.171 Floating Point Arithmetic Subroutines (Contd.)

Macro-code: . . . . ADD:F.
Function: . . . . Floating Add.
Time, milliseconds: . . 1.0 average.
Storage required: . . . . 106 slabs.

Macro-code: . . . . SUB:F.
Function: . . . . Floating Subtract.
Time, milliseconds: . . 1.0 average.
Storage required: . . . . 108 slabs.

Macro-code: . . . . MUL:F.
Function: . . . . Floating Multiply.
Time, milliseconds: . . 3.0 average.
Storage required: . . . . 50 slabs.

Macro-code: . . . . DIV:F.
Function: . . . . Floating Divide.
Time, milliseconds: . . 3.2 average.
Storage required: . . . . 64 slabs.

Macro-code: . . . . NORM:F.
Function: . . . . Normalize.
Time, milliseconds: . . 0.5 to 3.9.
Storage required: . . . . 54 slabs.

Macro-code: . . . . POLY:F.
Function: . . . . Polynomial.
Time, milliseconds: . . 0.6 to 3.9N, for evaluation of a polynomial of degree N.
Storage required: . . . . 150 slabs.

Macro-code: . . . . SQRT:F.
Function: . . . . Square Root.
Time, milliseconds: . . 13.3 average.
Storage required: . . . . 97 slabs.

Macro-code: . . . . EXPT:F.
Function: . . . . Exponential, Base 10.
Time, milliseconds: . . 14.1 average.
Storage required: . . . . 180 slabs.

Macro-code: . . . . EXPE:F.
Function: . . . . Exponential, Base e.
Time, milliseconds: . . 16.1 average.
Storage required: . . . . 180 slabs.

Macro-code: . . . . LOGT:F.
Function: . . . . Logarithm, Base 10.
Time, milliseconds: . . 12.5 average.
Storage required: . . . . 190 slabs.

Macro-code: . . . . LOGE:F.
Function: . . . . Logarithm, Base e.
Time, milliseconds: . . 14.5 average.
Storage required: . . . . 190 slabs.

Macro-code: . . . . SIN:F.
Function: . . . . Sine.
Time, milliseconds: . . 17.0 average.
Storage required: . . . . 329 slabs for Sin-Cos package.

Macro-code: . . . . COS:F.
Function: . . . . Cosine.
Time, milliseconds: . . 18.0 average.
Storage required: . . . . 329 slabs for Sin-Cos package.

Macro-code: . . . . ASIN:F.
Function: . . . . Arc Sine.
Time, milliseconds: . . 22.0 average.
Storage required: . . . . 283 slabs for Inverse Sin-Cos package.

Macro-code: . . . . ACOS:F.
Function: . . . . Arc Cosine.
Time, milliseconds: . . 21.5 average.
Storage required: . . . . 283 slabs for Inverse Sin-Cos package.

Macro-code: . . . . ATAN:F.
Function: . . . . Arc Tangent.
Time, milliseconds: . . 24.7 average.
Storage required: . . . . 299 slabs.

.172 Matrix Algebra Subroutines (floating point)

Macro-code: . . . . MI:F.
Function: . . . . Matrix Inverse.
Time, milliseconds: . . $3.1M^3$ (where M is number of rows in the matrix).
Storage required: . . . . (1268 + M) slabs.

Macro-code: . . . . MT:F.
Function: . . . . Matrix Transpose.
Time, milliseconds: . . 0.30 (M·N) for rectangular matrix of size M by N.
Storage required: . . . . 90 slabs.

Macro-code: . . . . MM:F.
Function: . . . . Matrix Multiply.
Time, milliseconds: . . 3.5 (M·N·S) (where S is number of elements of the second matrix).
Storage required: . . . . 654 slabs.

A number of other floating point Scientific and Engineering Subroutines are available, including complex arithmetic, coordinate conversion, multiple regression, and Trapezoid Rule integration. See NCR publication MD 315-43A for full descriptions.

.173 Application Packages

Programs to handle the following specific applications are currently offered for the NCR 315, and more are being developed.

Demand Deposit Accounting
Mortgage Loan Accounting
Investment Loan Accounting
Accounts Payable
Accounts Receivable
Newspaper
Corrugator
On-Line Savings
On-Line Airline Reservations
Inventory Management
Wholesale Food Distribution
Linear Programming and the Transportation Problem
PERT.

PROBLEM ORIENTED FACILITY: BEST

.1 GENERAL

.11 Identity: . . . . Business EDP Systems Technique.
BEST.
99-3 system.

.12 Origin: . . . . National Cash Register Company.

.13 Reference: . . . . The 99-3 System: Procedures and Instructions for Use of Parameter sheets.

.14 Description

BEST is a technique developed by NCR to speed the programming and debugging of programs to perform routine business data processing functions. NCR estimates that BEST can be applied to over 50% of programming jobs. BEST provides an open-ended set of logical functions for such operations as input-output, arithmetic, paper tape code translation, report writing, and sorting. A more complete listing of the functions currently available in BEST is presented in Table I.

Having logically defined a job in terms of BEST functions, the programmer fills in a series of parameter sheets, laid out in rigid formats. Cards, key-punched from the parameter sheets, are input to the BEST program generator. The generator replaces the calls for BEST functions with symbolic language (NEAT) coding. The output of the generator is translated by the NEAT Compiler into a machine-language deck, ready to run. The minimum configuration for the use of the BEST Generator is 10,000 slabs of memory and either five magnetic tape units or two CRAM units (any model). Programs can be generated to run on any configuration NCR 315 computer system.

In effect, the BEST generator is a series of subroutines coded in NEAT language. The parameter cards (one card for each parameter sheet) specify the data fields to be operated upon and the specific operation to be performed. Only the desired functions need to be included, and multiple entries of the same function are permitted. The programmer must specify in detail the layout of a data field in each function referencing that field. Provisions are made for the inclusion of the user's own coding, in NEAT language, to handle special conditions or operations not yet included in the BEST system.

In all, BEST presently includes 36 different sets of parameter sheets and two data layout sheets — which could represent a stocking and handling problem in some installations. Most of the functions have only one parameter sheet associated with them. NCR emphasizes that additional functions are being added as the need arises, and that each new version of BEST will be "backward-compatible"; i.e., programs constructed using one version of BEST can be handled by all later versions.

Three of the more significant BEST functions are:

- Report — provides totaling on up to 20 fields for up to 8 levels of control breaks. Up to six title lines can be specified for each page, including page number, date, and record identification if desired. In addition, a comments line can be specified for each control break total. The Report function requires a set of 31 parameter sheets, mostly for the specification of titles, comments, and print line layout.
- Regiment — translates paper tape input and structures the output record. Facilities are provided to handle NCR 390, NCR 304, Telegraph, G. P. C., and IBM codes.
- Sort — the NCR Sort Generator for magnetic tape has been incorporated into BEST in virtually the same form as described in Paragraph 601:151.13. Facilities for first-pass and last-pass processing — called "intervention routines" by NCR — are included, but the absolute starting addresses of both routines must be provided on the parameter sheets. Provision for automatically providing these addresses for BEST-generated intervention routines is planned.

Numerous validity checks are made by the generator to help insure that the parameter sheets have been filled in correctly and the cards key-punched correctly. The diagnostics currently available to the BEST programmer are limited. However, a Validate function is planned which will provide such facilities as reasonability checks on parameters and tracing of the object program.

Most questions on the parameter sheets also state the possible answers, reducing the chances for erroneous replies. Two areas that might cause problems are:

- The layout of a data field must be specified in every function referencing it. This redundancy, while possibly providing greater flexibility in planning a job, also increases the chances for errors.
- The Arithmetic function expects the data areas to be in digit format. The Alpha to Digit function must be used to convert input in character format to the proper digit form. Omission of the latter function will cause errors.

One of the primary features of BEST is that, given correct parameter cards, correct detail coding will be generated. Thus, when debugging a program, the programmer must check only the parameter cards or sheets and/or the logical construction of the job. Corrections can be made only by recompiling.

NCR states that over 10,000 programs have been generated using BEST, with an average saving in programming and debugging time of 50% over hand coding techniques. NCR estimates that the effici-

.14 Description (Contd.)

ency of coding generated by BEST is about equivalent to that of hand coding written by a programmer with two years' experience.

BEST was originally developed as a programming aid for NCR Data Processing Centers to make profitable the handling of many small jobs — the bulk of a data processing center's work load. The highly structured nature of BEST does not offer the flexibility obtained with programming languages such as COBOL or assembly languages. However, this rigidity, in effect, provides a guide to the programmer. The documentation necessary to generate a BEST program provides an easy-to-understand reference for persons unfamiliar with that particular program. One useful extension of BEST currently being developed by NCR is the capability to produce flow charts, in terms of BEST functions, directly from the parameter cards used to generate the program.

TABLE I: BEST FUNCTIONS

Type of Function	Number of Functions	Description
Input-Output	12	Includes provision for input from punched cards, punched paper tape(1), magnetic tape, and CRAM. Includes provision for output on punched cards, magnetic tape, line printer, console typewriter(2), and CRAM,
Control	6	Includes provision for including a memory dump, for inserting sections of own code, for generating sorts(3), for testing option switches, and for including subroutines.
Arithmetic	3	Includes provision for addition, subtraction, multiplication, division, comparison and testing of two fields, and for keeping running totals of up to 14 fields within a data record.
Data Manipulation	7	Includes facilities for conversion between alpha and digit formats; for moving a data record from one field to another with insertion of spaces, zeros, or rearrangement of fields; for generation of constants; and for translating paper tape input and structuring the output.
Report	2	Includes provision for generating reports (see text), and for specifying the content of one or more title lines from the input data itself.
Collate and Sequence	2	Includes provision for merging or match-merging of two input files (unmatched records from the two input files can be output separately or together), and for checking the sequence of input records of a file on from 1 to 8 keys (sequence may be ascending, descending, or equal relative to the internal collating order).
Flag	5	Includes facilities for changing and checking for control flags, and for setting, changing, and testing programmer flags.
Linking	1	Provides linkage to executive routine (either PACE or STEP) for ending the job.

(1) No paper tape output function is available in Version 49, now distributed, but a Punch Paper Tape function is planned.

(2) Output on console typewriter can be preset messages or selective output of various areas of storage.

(3) Automatic insertion of sections of own coding in sort routines is not yet implemented; programmers must presently specify on the sort parameter sheets the absolute starting addresses of such routines.

Note: The execution of many of the BEST functions can be made conditional upon the value or presence of control characters within a field.

PROCESS ORIENTED LANGUAGE: NEAT COBOL

.1 GENERAL

.11 Identity: . . . . NEAT COBOL for NCR 315.

.12 Origin: . . . . National Cash Register Company.

.13 Reference: . . . . NEAT COBOL, F-7411. NEAT COBOL Supplement, F-7011.

.14 Description

COBOL 61 is the most widely implemented pseudo-English common language for business applications. NEAT COBOL for the NCR 315 includes all of required COBOL 61 (with one minor exception mentioned in Paragraph .142) and most of Elective COBOL 61.

Three important elective verbs included are:

- COMPUTE — permits arithmetic operations to be expressed in a concise notation similar to that of FORTRAN. For example, the COBOL operations:

  SUBTRACT B FROM A GIVING T

  DIVIDE C INTO T GIVING X

  can alternatively be expressed as:

  COMPUTE X = (A - B)/C.

- ENTER — Permits the use of NEAT assembly language coding within an NCR 315 COBOL program.

- INCLUDE — permits routines to be called from a library, eliminating the necessity for repetitive coding of frequently-used routines.

Facilities included in NEAT COBOL but not in the standard COBOL 61 language include the provision for use of floating-point operands (with no restrictions on intermixing floating and fixed-point operands), and inclusion of special instructions that facilitate data transfers to and from the random-access CRAM units.

.141 Availability: . . . . 1961.

.142 Deficiencies with Respect to Required COBOL 61

(1) No editing is performed upon literals.

.143 Extensions to COBOL 61

(1) Floating-point operands can be specified and can be intermixed without restrictions among fixed-point operands.

(2) Special instructions are included to facilitate data transfers to and from the random-access CRAM units through the use of multiple input and output areas.

.144 COBOL 61 Electives Implemented (see paragraph 4:161.3 in Users' Guide)

Key No.	Electives	Comments
	Characters and Words	
1	Formula characters	+, -, *, **, =.
2	Relationship 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.
11	Sequenced-on	Gives a list of keys.
	Record Description clauses and/or options	
13	Table-length:	Allows variable length tables and arrays ("depending on" clause not implemented).
14	Item-length	Allows variable length items.
16	RANGE IS	Gives value range of item or character.
19	Item-length	Allows variable length item (also see 16) ("depending on" clause not implemented).
20	Conditional-range	Allows a conditional value to be a range.
	Verbs	
22	COMPUTE	Algebraic formulae can be used.
24	ENTER	Non-COBOL computer languages can be used.
25	INCLUDE	Calls library routines.
	Verb options	
27	LOCK	Locks rewound tapes.
28	MOVE CORRESPONDING	Moves and edits relevant records.
30	ADVANCING paper	Gives specific paper advance.
31	STOP	Non-alphabetic display provision.
32	Formulas	Algebraic formulae can be used.
33	Operand-size	Up to 18 digits.
34	Relationship	IS UNEQUAL TO, EQUALS, and EXCEEDS.
35	Tests	IF data-name IS NOT ZERO.
36	Conditionals	Implied objects with implied subjects.
37	Compound conditions	AND's or OR's.
38	Complex conditions	
39	ON SIZE ERROR	Provides extension of error routines.
	Environment Division options	
42	SPECIAL NAMES	Specifies for ACCEPT and DISPLAY verbs.
43	File Description	Can be taken from library.
46	I/O Control	Allows programmer control ("APPLY" not implemented).
	Identification Division	
	none	
	Special Features	
48	LIBRARY	Allows calls of library routines.
49	SEGMENTATION	Priorities of 50 upwards only.

(Contd.)

.145 COBOL 61 Electives not Implemented (see Paragraph 4:161.3 in Users' Guide)

Key No.	Electives	Comments
	Characters and Words	
4	Long literals	The maximum size is 120 characters.
	File Description clauses	
10	Label formats	Labels must be standard, omitted, or completely programmed. Manufacturer's comment: "Non-standard conventions or labels are not permitted because STEP and PACE provide completely integrated I/O executive systems which require standard conventions."
12	Hash totals	Hash totals cannot be created. Manufacturer's comment: "Hash totals are not necessary. The row and track parity, together with record counts, provide adequate checking."
	Record Description clauses and/or options	
15	Bit usage	Items cannot be specified in binary.
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. (See 10 above.)
	Verbs	
23	DEFINE	The user cannot define new verbs.
26	USE	No non-standard auxiliary I/O error handling or label handling routines can be inserted.
	Verb options	
29	OPEN REVERSED	Tapes cannot be read backwards.
	Environment Division options	
40	SOURCE-COMPUTER	No computer description can be given.
41	OBJECT-COMPUTER	No computer description can be given.
44	PRIORITY is	Priorities cannot be given.
45	I/O Control	Input-output control cannot be taken from the library. Manufacturer's comment: "It is unlikely that such a detailed description would be applicable to another run."
	Identification Division	
47	DATE	The current date is not inserted automatically. Manufacturer's comment: "The current date is always printed on the top line of the listing."

PROCESS ORIENTED LANGUAGE: FORTRAN II

.1 GENERAL

.11 Identity: . . . . NCR 315 FORTRAN II.

.12 Origin: . . . . National Cash Register Company.

.13 Reference: . . . . not published to date.

.14 Description

FORTRAN II is the most widely-used process oriented language for scientific programming. Complete details of NCR 315 FORTRAN II are not available to date; however, the following specifications are known.

NCR 315 FORTRAN II includes most of the FORTRAN II language as described for the IBM 7090 (see Section 408:161), with several useful extensions. Some of the more important restrictions and extensions relative to IBM 7090 FORTRAN II are presented in the following paragraphs.

Diagnostics to be provided include detection of many syntax and semantic errors. Upon recognizing such errors, the compiler will print an error message indicating the type of error and identifying the offending character. Compilation will always be carried to the end, resulting in complete diagnostics. A listing of illegally-nested DO loops, undefined or multiply-defined labels, and memory allocation conflicts will be provided at the end of the program source listing. A post-mortem dump will be available at execution time that will list the value of all variables and their memory locations. Correlation can be made by means of a memory map generated at compile time.

.141 Availability

Compiler: . . . . April, 1965.

.142 Restrictions Relative to IBM 7090 FORTRAN II as Described in Section 408:161.

(1) No double precision floating point arithmetic facilities will be provided; however, normal precision will be 12 digits.

(2) No facilities for Boolean or complex arithmetic will be provided.

(3) No facility will be provided to check for arithmetic overflows.

.143 Extensions Relative to IBM 7090 FORTRAN II as Described in Section 408:161.

(1) Subscripted subscripts will be allowed.

(2) Some mixing of modes in expressions will be allowed.

(3) Labels of up to eight characters will be allowed.

(4) Floating-point incrementing and backward indexing (negative step) will be allowed in DO loops.

(5) Provision for arrays of any number of dimensions will be allowed.

(6) Subscripts will be allowed to have zero and negative values.

PROCESS ORIENTED LANGUAGE: FAST

.1 GENERAL

.11 Identity: . . . . Flexible Algebraic Scientific Translator. FAST.

.12 Origin: . . . . The Woodward Governor Company.

.13 Reference: . . . . NCR publication SP-1103, Flexible Algebraic Scientific Translator.

.14 Description

FAST is a limited algebraic language intended for small NCR 315 installations having punched card or paper tape input-output facilities and (optionally) one CRAM unit. The two compilers for the FAST language, FAST I and FAST III, are described in Section 601:184.

Arithmetic statements are written in a manner similar to FORTRAN. Operators are provided for addition, subtraction (or negation), multiplication, and division of fixed-point and floating-point numbers. Fixed or floating-point operations are distinguished by preceding the arithmetic operator with the symbol "#" for fixed-point operations. All floating-point operands are 12 digits in length, and fixed-point operands can be up to 12 digits in length. Since the type of an operand is not identified by its label (as in FORTRAN), the programmer must take care not to unintentionally mix fixed and floating-point operands. As in FORTRAN, the normal interpretation of the order of operations of an algebraic statement is left to right, and parentheses can be used to specify a different ordering.

Provisions are made for one-dimensional arrays and one level of subscripting. Most operations permit simple variable fixed-point subscripting. Subroutines can be included, but they usually must be written into the program at least once. (Special provisions for sharing subroutines between programs are described later.) A number of machine instructions, including arithmetic (but not division), compare, test, jump, and shift instructions, have been implemented directly as symbolic operators; these instructions perform the same functions as when coded directly in machine language. One interesting facility is the HEX operator, which permits up to 20 single-stage machine instructions in absolute format to be included in the source program. This facility will probably be used primarily for jump register control in user-coded input-output and error routines, since great confusion can arise through use of both absolute and symbolic addressing in the same program.

Sequence control is established by an unconditional jump statement and by three-way branch statements based upon a comparison of two stated operands. Both fixed-point and floating-point comparisons are implemented. Statements can be numbered for reference by other parts of a program. A simple loop control statement increments a counter by a specified fixed-point variable or constant (either positive or negative), compares this count with a specified fixed-point variable or constant, and branches to a specified statement based on the result of the comparison. The state of the counter is available for further use after the loop is terminated.

Input-output facilities are limited to one input and one output device. Input is by punched paper tape or punched cards, depending on the compiler version selected Each card image can contain multiple data items. Fixed-point numbers can be read in and converted to floating-point format automatically. The only output device provided for in the FAST language is a line printer. Fixed-point and floating-point numbers can be printed one per line, or alternatively they can be stored in an output area for printing multiple fields per line. Also available is an operator for advancing the paper in the printer to the top of the next page.

A plotting facility is provided. A specified symbol, which can be different for each point plotted, is stored in the print-line character position corresponding to the value of a specified operand. Operands can be either fixed or floating-point. Numbers must be scaled between 0 and 119 inclusively. A + symbol is printed when a point falls beyond the printed page, and an * symbol when two points overlay one another. Columnar information can be printed beside the plot if desired.

Debug facilities are limited to a print-out of the results of each statement along with the location of the statement. This print-out occurs for each statement following a TRACE statement until an NTRACE statement is encountered. A statement-location table provided by the compiler enables a programmer to identify specific statements. The trace may be inhibited by a control card preceding the data or from the console.

Several special facilities are provided for programs written to be run on an NCR 315 with one CRAM unit. Included are provisions for input and printing of alphabetic fields. Alphabetic constants can also be written in the program. No other direct facilities are provided for handling alphabetic information, but the symbolic operation code for the machine-language compare instruction can be used to compare two alphabetic fields. Other special facilities for systems with a CRAM unit in this group permit reading or writing of CRAM files, segmentation of programs by using overlays, and saving of subroutines on a CRAM file for use by subsequent programs.

MACHINE ORIENTED LANGUAGE: NEAT* ASSEMBLER

.1 GENERAL

.11 Identity: . . . . NEAT* Assembler.

.12 Origin: . . . . NCR.

.13 Reference: . . . . MD 315-40B, Sept. 1962.

.14 Description

.15 Publication Date: . . . . July, 1961.

.2 LANGUAGE FORMAT

This is a machine oriented language designed for use with small systems, and within the NEAT* Compiler. It requires a 5,000-slab core store, punched tape or punched card input-output equipment, a printer, and one magnetic tape or CRAM unit. The output includes complete listings and a copy of the object program ready for loading. There are no macro operations, but pseudo operations are used to control assembly. The target computer may have any configuration, and all its facilities can be used.

.21 Diagram

Instructions:

Page	Identification
1 3	75 80

Line	Reference	OP	V	L	X	A	Y	B	Remarks
4 6	7 12	13 16	17	19	21	23 32	33	35 44	45 74

.22 Legend

Page: . . . . page number of sheet of coding.
Identification: . . . . . identification of program.
Line: . . . . number of line of coding; used with page for error check but not sort.
Reference: . . . . symbolic name of data item or line of coding.
OP and V: . . . . the operation code or mnemonic instruction.
L: . . . . length, in words, of the operand.
X: . . . . index register (or jump register) associated with A.
A: . . . . address of first operand.
Y: . . . . index register (or jump register) associated with B.
B: . . . . address of second operand or necessary additional information.
Remarks: . . . . remarks or comments the programmer wishes to make.

.23 Corrections: . . . . correct source deck or tape and re-assemble.

.24 Special Conventions

.241 Compound addresses: . BASE ± ADJUSTMENT, where BASE is any label and ADJUSTMENT is any number; total address field may not exceed 10 characters.
.242 Multi-addresses: . . . . none.
.243 Literals: . . . . 15 in X column denotes literal in A column.
.244 Special coded addresses: . . . . * in A field denotes "this address."
.245 Other Remark: . . . . * at left of reference field denotes remarks line.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . 195 if source program is on cards; 212 if on paper tape.
.312 Common label formation rule: . . . . yes.

.32 Universal Labels

.313 Reserved labels: . . . . none.
.315 Designators
Alphameric constants (6-bit code): . . . . . pseudo-op ALPHA.
4-bit code constants: pseudo-op DIGIT.
5-digit address constant: . . . . pseudo-op PAIR.
3-digit address constant: . . . . pseudo-op SLAB.
.316 Synonyms permitted: . . yes.
.321 Labels for procedures
Existence: . . . . optional.
Formation rule
First character: . . . any letter or numeral.
Last character: . . . any letter or numeral.
Others: . . . . at least 1 letter.
Number of characters: . . . . 1 to 6.
.322 Labels for library routines: . . . . none.
.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.

*NEAT is a service mark of the National Cash Register Company (National's Electronic Autocoding Techniques).

.4 DATA

.41 Constants

.411 Maximum size constants
Integer
Decimal: . . . . 24 decimal digits.
Octal: . . . . none.
Hexadecimal: . . . . . none.
Fixed numeric
Decimal: . . . . treated as integer.
Octal: . . . . none.
Hexadecimal: . . . . . none.
Floating numeric: . . . none.
Alphabetic: . . . . 24 chars.
Alphameric: . . . . . . 24 chars.
.412 Maximum size literals
Integer
Decimal: . . . . range from -99 to 999.
Octal: . . . . none.
Hexadecimal: . . . . . none.
Fixed numeric
Decimal: . . . . none.
Alphabetic: . . . . 2 chars.
Alphameric: . . . . . . 2 chars.

.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: . . . . implicit.
.433 Copy layout: . . . . none.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . yes.
Number: . . . . 150.
Example: . . . . ADD.
.512 Absolute
Existence: . . . . yes.
Number: . . . . 150.
Comment: . . . . in form of alphameric constants.
.513 Pseudo-ops
Existence: . . . . yes.
Number: . . . . 10.
Example: . . . . SAVE.

.52 Macro-Codes: . . . . . . none.

.53 Interludes: . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . pseudo-operations.
Label adjustment: . . . pseudo-operations.
Annotation: . . . . pseudo-op or position.
.542 Allocation counter
Set to absolute: . . . . yes.
Set to label: . . . . . . yes.
Step forward: . . . . . . yes.
Step backward: . . . . . yes.
Reserve area: . . . . . yes.
.543 Label adjustment
Set labels equal: . . . . yes.
Set absolute value: . . yes.
Clear label table: . . . no.
.544 Annotation
Comment phrase: . . . yes.
Title phrase: . . . . . . yes.

.6 SPECIAL ROUTINES AVAILABLE: . . . . . see Section 601:151.

.7 LIBRARY FACILITIES: . . . . . . none.

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . none.

.82 Pseudos

Code	Description
ALPHA:	defines alphameric (6-bit) constant.
DIGIT:	defines numeric (4-bit) constant.
PAIR:	defines a 5-digit address-constant.
SLAB:	defines a 3-digit address-constant.
SGL:	creates a single-stage instruction with op code zero.
SAVE:	reserves an area of memory.
ORG:	sets assembler location counter.
EQU:	defines a symbolic label.
REMARK:	defines a comment line.
END:	defines end of program and first instruction to be executed.

MACHINE ORIENTED LANGUAGE: NEAT* COMPILER

.1 GENERAL

.11 Identity: . . . . NEAT* Compiler.

.12 Origin: . . . . NCR.

.13 Reference: . . . . MD 315-41A, MD 315-44.

.14 Description

The NEAT Compiler is an advanced symbolic assembly system designed for use on NCR 315 computers with at least 10,000 slabs of core storage, 4 magnetic tape handlers or 1 CRAM unit, a punched tape or card reader, and a high speed printer. Source program input may be from punched cards, punched tape, or magnetic tape. The object program can be added to the Program Library, the Data Design Library, or the Macro Generator Library on either magnetic tape or CRAM. A copy of the object program can also be punched into cards or tape if desired. All object programs produced by the NEAT Compiler are compatible with the STEP and PACE operating systems described in Section 601:191.

The programmer uses a standard Programming Sheet (page 601:172.810) for both procedural coding and data definition. Other standard forms are used for Magnetic Tape (or CRAM) File Specifications (primary and alternate handler number, size and location of input-output area, maximum record length, etc.) and for Compiler Control (types of input and output, target computer memory size, etc.).

Three classes of instructions are available to the NEAT Compiler programmer:

- NCR 315 machine instructions — These instructions specify particular computer operations by means of mnemonic operation codes and either absolute or symbolic addresses. Double stage (four-slab) instructions are written on a single line, with commas separating the A, B, and Y operands. Constants can be generated by simply including their literal values as the operands of the instructions which reference them.

- Control instructions — These are pseudo-instructions which control the assembly process but generate no object program instructions.

- Macro instructions — These instructions are replaced in the object program by a series of machine instructions drawn from the expandable Macro Generator Library. Approximately 80 macro subroutines are currently available from NCR, and more will be added as necessary. Functions of the available macros include: control of input-output operations, code translation, index register manipulation, diagnostic operations, loading of overlays, and floating point arithmetic.

The NEAT Compiler requires a complete description of the data to be processed by the object program. A complex hierarchical structure of files, records, groups, sub-groups, and fields can be conviently defined through the use of level indicators similar to those of COBOL. A "data level" includes all the fields described below it which have level numbers larger than its own level number. Redefinition facilities permit two or more data entities to share the same core storage areas. Predefined, "canned" data descriptions can be called from the Data Design Library; this facility can save coding time and promote the adoption of standardized record formats.

.15 Publication Date: . . . . March, 1962.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . see Programming Sheet, Page 601:172.900.

.22 Legend

Page and Line: . . . . . define sequence of lines.
Reference: . . . . symbolic name of data item or line of coding.
Op and V: . . . . operation code.
Length (instructions): . length of an instruction operand.
Level (data): . . . . level number of a data item.
X: . . . . R-Register designation.
Operands (instructions): . . . . all additional information required by the particular instruction; multiple operands are separated by commas.
Length, Type (data): . . length and type (alpha, digit, numeric, or floating point) of a data item.
Remarks: . . . . any comments desired by the programmer, to be included in output listings; separated from Operands field by a space.
Identification: . . . . . . program ID, for external use only.

.23 Corrections: . . . . allow gaps between coding sheet line numbers to permit insertions. Source program entries can be sorted internally according to page and line numbers. If two or more lines are identically numbered, only the last line read will be used. The OMIT pseudo permits deletion of one or more lines.

* NEAT is a service mark of the National Cash Register Company (National's Electronic Autocoding Techniques).

.24 Special Conventions

.241 Compound addresses: . any combination of labels and/or numbers, separated by + or - and terminated by a space or comma.
.242 Multi-addresses: . . . . required in certain instructions; separated by commas.
.243 Literals:. . . . . preceded by #R for address literal, #A for alpha literal, #D for digit (4-bit code) literals, or #N for decimal digit literals.
.244 Special coded addresses: . . . . * in Operand field denotes "this address."
.245 Remarks: . . . . * in Reference field denotes entire line is a Remark.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . no practical limit.
.312 Common label formation rule: . . . . yes.
.313 Reserved labels: . . . . none.
.314 Other restrictions: . . . none.
.315 Designators: . . . . none.
.316 Synonyms permitted: . . yes; EQUATE pseudo-op.

.32 Universal Labels

.321 Labels for procedures
Existence: . . . . mandatory if referenced by other procedures.
Formation rule
First character: . . . any letter or numeral.
Others: . . . . any letter or numeral.
Number of characters: . . . . . 1 to 10; no spaces allowed.
.322 Labels for library routines: . . . . same as procedures (Paragraph .321).
.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.
.327 Labels for macros: . . same as procedures.

.33 Local Labels: . . . . . . labels within a library (macro) subroutine are local to that subroutine; formation rules are the same as for universal labels.

.4 DATA

.41 Constants

.411 Maximum size constants
Integer
Decimal: . . . . 42 digits (14 slabs).
Octal: . . . . not used.
Hexadecimal: . . . . . not used.
Fixed numeric
Decimal: . . . . 24 digits (8 slabs).
Octal: . . . . not used.
Hexadecimal: . . . . . not used.
Floating numeric: . . . none.
Alphameric: . . . . . . 42 characters (21 slabs).

.412 Maximum size literals
Integer
Decimal: . . . . 24 digits (8 slabs).
Octal: . . . . not used.
Hexadecimal: . . . . not used.
Fixed numeric
Decimal: . . . . 24 digits (8 slabs).
Octal: . . . . not used.
Hexadecimal: . . . . . not used.
Floating numeric: . . . none.
Alphameric: . . . . . . 16 characters (8 slabs).

.42 Working Areas

.421 Data layout: . . . . implied by use.
.422 Data type: . . . . see .432 below.
.423 Redefinition: . . . . yes

.43 Input-Output Areas

.431 Data layout: . . . . explicit layout.
.432 Data type: . . . . level number, length, and type are specified on coding sheet.
.433 Copy layout: . . . . by inclusion of predefined layouts from library.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . generally used.
Number: . . . . approximately 150.
Example: . . . . ADD.
.512 Absolute
Existence: . . . . only as alphameric constants.
Number: . . . . approximately 150.

.52 Macro-Codes

.521 Number available
Input-Output: . . . . . . approximately 40.
Arithmetic: . . . . approximately 10.
Math functions: . . . . approximately 20.
Restarts: . . . . 0.
R-Register manipulation: . . . . 3.
Diagnostics: . . . . . . 3.
Overlay control: . . . . 1.
Interrupt control: . . . 2.
.522 Examples
Simple: . . . . RDUMP.
Elaborate: . . . . MRMT FILE2, AREA4.
.523 New macros: . . . . assembled by NEAT Compiler and inserted into Macro Generator Library.

.53 Interludes: . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . pseudo-ops.
Label adjustment: . . . pseudo-ops.
Annotation: . . . . see .544 below.
.542 Allocation counter
Set to absolute: . . . . ORIGIN pseudo-op.
Set to label: . . . . ORIGIN pseudo-op.
Step forward: . . . . . . SAVE pseudo-op.
Step backward: . . . . . no provision.
Reserve area: . . . . . SAVE pseudo-op.

(Contd.)

.543 Label adjustment

Set labels equal:	EQUATE pseudo-op.
Set absolute value:	EQUATE pseudo-op.
Clear label table:	no provision.

.544 Annotation

Comment phrase:	following space in Operands field of any line.
Title phrase:	* in Reference field.

.6 SPECIAL ROUTINES AVAILABLE: . . . . . . see Paragraphs 601:172.82 and 601:151.17 for descriptions of available macro subroutines.

.7 LIBRARY FACILITIES

.71 Identity: . . . . System Library.

.72 Kinds of Libraries: . . . expandable libraries for Programs, Data Descriptions, and Macro Generators.

.73 Storage Form: . . . . . . magnetic tape or CRAM.

.74 Varieties of Contents: . assembled programs, data descriptions, and macro generators are stored in separate, expandable libraries.

.75 Mechanism

.751 Insertion of new item: . Librarian routine (601:151.16).
.752 Language of new item: . NEAT Compiler language.
.753 Method of call: . . . . . macro-instructions.

.76 Insertion in Program

.761 Open routines exist: . . no.
.762 Closed routines exist: . yes.
.763 Open-closed is optional: . . . . no.
.764 Closed routines appear once: . . . . yes.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Code	Description
NEXT:	advances index registers.
MLD:R:	loads index registers.
MLD:J:	loads jump registers.
MRMT:	reads one magnetic tape record or less.
MRMT:I:	reads N characters from magnetic tape.
NEXT:IN:	advances index registers and refills input area.
NEXT:OU:	advances index registers and empties output area.
MWMT:I:	writes a record on tape in IBM code.
MWMT:	writes a record on magnetic tape.
MWIN:L:	rewind.
FIND:CR:	searches for a specified control mark on tape.
WRIT:CM:	writes a specific control mark on tape.
MARK:	counts the blocks in a specified file.
LOC:	locates a specified block in a file.
MBAC:	backspaces one block.
OPEN:	opens a specified file — performs set-up.
CLOSE:	closes a file and rewinds tape.
MRPT:	reads paper tape in 7-channel code.
MRCD:	reads a punched card and translates.
NEXTSP:	reads in and accesses each record in a Source-Destination file.
WRITSP:	sets up write of current block of Source-Destination file.
NEXTK:	read in and accesses each record in a Source-Destination file.
DELETR:	deletes a record from a block of a Source-Destination file.
SERTR:	inserts a record in a block of a Source-Destination file.
CHNG:	replaces a record in a block of a Source-Destination file.
FINALC:	writes an output block on a Source-Destination file consisting of the information remaining in the I/O area of that file.
DYDUMP:	prints contents of memory and all flags and registers.
TRACE:	prints address of each instruction executed whenever console monitor switch and processor Trace Permit Flag are on.
DENT:	preserves contents of certain registers and flags when Demand Interrupt occurs.
DEXT:	restores contents of registers and flags saved by DENT.
FILE:	causes compiler to build file tables named.
FINISH:	calls System Supervisor at completion of object program.
CALL:	calls an overlay into memory.
RDUMP:	writes rescue dump on destination file.
DROPM:	selects a CRAM and drops a card.
RDMCDP:	drops a CRAM card and reads card presently on drum.
WTMCP:	writes on CRAM card presently on drum.

.81 Macros (Contd.)

Code	Description
WTMCDP:	selects a CRAM and drops a card, and then writes on another card presently on drum.
MRPT:	reads paper tape in 1 of 4 different codes and translates to internal code.
MPPT:	punches paper tape in 1 of 5 different codes.

.82 Pseudos

Code	Description
SAVE:	value of first operand is added to location counter.
ORIGIN:	sets location counter.
LITORG:	specifies the origin of a portion of the program which will not be overlaid.
EQUATE:	equates one symbolic name to another.
RREG:	assigns a symbolic name to an index register.
JREG:	assigns a symbolic name to a jump register.
ALPHA:	defines 6-bit code constants.
DIGIT:	defines 4-bit code constants.
NUMB:	defines a right-justified decimal number.
PAIR:	defines a 5-character (2-slab) address.
SLAB:	defines a 3-digit (1-slab) address.
SGL:	defines a 2-slab instruction with operation code zero.
OVRLAY:	the following instructions are an overlay.
REMARK:	defines a remarks line.
PAGE:	spaces listing to top of next page.
UNLIST:	suppresses listing from point of occurrence.
LIST:	counteracts effect of UNLIST.
END:	indicates end of program.
OMIT:	deletes symbolic coding.
NOPRNT:	suppresses printing of the coding generated by macro-instructions.

NCR*

315 NEAT*
COMPILER

PROGRAMMING SHEET

Program ______ Prepared by ______

______ Date ______ Page ___ of ___

PAGE	LINE		REFERENCE		OP	V	LENGTH LEVEL	X	INSTRUCTIONS: OPERANDS DATA DEFINITIONS: LENGTH, TYPE	REMARKS REMARKS	IDENTIFICATION
1 2 3	4 5 6	7	8 9 10 11 12 13 14 15 16 17	18	19 20 21 22	23 24	25 26	27 28	29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48	49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74	75 76 77 78 79 80

F-7302 6-62 *TRADE MARK *SERVICE MARK PRINTED IN U.S.A.

PROGRAM TRANSLATOR: NEAT COBOL

.1 GENERAL

.11 Identity: . . . . NEAT COBOL for NCR 315.

.12 Description:

The NCR 315 COBOL translator processes NCR 315 COBOL source language programs (as described in Section 601:161) into machine code, via NEAT assembly language. At present, only the LIBRARY facility has not been implemented in COBOL. On an NCR 315 equipped with tape, the translation process takes approximately 2 to 6 seconds per statement depending on the number of statements in the program. Faster translation is obtained on a CRAM-equipped 315.

The object program can control all NCR 315 equipment except the MICR reader and remote inquiry units. Efficiency in the object program can be obtained by the following:

- Observing the style rules, summarized in paragraph .54, which provide for good use of index registers.
- Considering the data structure in the computer itself when designing data-areas and only breaking the 12-bit words when unavoidable.
- When using CRAM, remembering the time lags involved, and arranging the program to issue LOCATE orders well in advance of the time when the located record is to be used.

.14 Maintainer: . . . . NCR.

.15 Availability: . . . . released in 1963.

.2 INPUT

.21 Language

.211 Name: . . . . NEAT COBOL for NCR 315.
.212 Exemptions: . . . . only NCR standard tape conventions included.
hash totals not allowed.
segmentation not yet available.

.22 Form

.221 Input media: . . . . 80-column punched cards.
paper tape.
.222 Obligatory ordering: . . none, provided that enough line numbers are used so that the initial sorting produces a correct result.
.223 Obligatory grouping: . . by division.

.23 Size Limitations:

.231 Maximum number of source statements: . . 4,500 with tape version.
8,500 with CRAM version.
.232 Maximum size source statements: . . . . not more than 100 operands.
.233 Maximum number of data items: . . . . 99,999 per section.
.234 Others —
Maximum number of operands mentioned in procedure: . . . . 39,000 - 200 x (No. of MOVE CORRESPONDING statements).
Maximum number of MOVE CORRESPONDING statements: . . . 25.
Maximum number of items within one MOVE CORRESPONDING statement: . . . . 200.

.3 OUTPUT

.31 Object Program

.313 Output media: . . . . . . magnetic tape, CRAM, cards, paper tape.

.32 Conventions: . . . . NEAT tape or CRAM conventions are observed, providing restart and I/O procedures.
The program is compatible with the NEAT package, including supervisory, debugging, and library procedures.

.33 Documentation

Subject	Provision.
Source program:	printout.
Object program:	printout.
Storage map:	via serial listing in order written.
Restart point list:	none.
Language errors:	printout when located.
Cross references:	listed.
Object program cross reference:	optional list.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

The Source Program is scanned and the data descriptions separated from the procedures.

The procedures are condensed to an intermediate code and then scanned to determine precedence in

.41 Phases and Passes (Contd.)

formulas and the logical paths of the program. This information is then passed to the appropriate generators, which also are provided with descriptions. The generator output is a valid NEAT Assembly Language program, and contains machine language and macros.

The Source Program is now scanned again to produce a printed listing, which includes:

1) The original program.
2) Error indications.
3) Cross Reference Tables and analyses.

A normal NEAT assembly follows, if desired.

.42 Optional Mode

.421 Translate: . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . yes.
.424 Patching: . . . . in NEAT assembly or machine code only.

.43 Special Features

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

.44 Bulk Translating: . . . . yes.

.45 Program Diagnostics: . . . . incorporated in Debugging Supervisory System using NEAT coding.

.46 Translator Library: . . not available.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.513 Approximate expansion of procedures: . . . . . 1 to 3.

.52 Translation Time (Tape version)

.521 Normal translating: . . 2.4 seconds per statement, for 50-statement programs; varying from 3 to 6 seconds per statement for larger programs. This may be increased if much sorting is called for.
.522 Checking only: . . . . . . 50 percent of above figures.
.523 Translation time (CRAM version): . . . data not available, but stated to be faster than the times quoted above.

.53 Optimizing Data

No direct optimizing data, such as frequency statements, can be written in the language. However, a programmer can influence the efficiency of the object program by observing the style rules quoted in the next paragraph.

.54 Object Program Performance

Type	Time	Space
Elementary algebra:	unaffected	unaffected.
Complex formulae:	unaffected	unaffected.
Deep nesting:	unaffected	unaffected.
Heavy branching:	worse than hand coding if GO TO statements used. better than hand coding if conditional statements used.	
Complex subscripts:	unaffected if handled by PERFORM clauses, otherwise worse than hand coding.	
Data editing:	unaffected unless broken words are called for.	
Overlapping operations:	must be considered while the COBOL program is being written, by timely use of the LOCATE instruction for CRAM.	

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . NCR 315.
5 tape units or 2 CRAMS.
10,000 words of storage.
.612 Larger configuration advantages: . . . . better tape movement and faster sorts.

.62 Target Computer

.621 Minimum configuration: . . . . any NCR 315.
.622 Usable extra facilities: . . . . all NCR 315 units except check reader and remote inquiring devices.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	preliminary sort.	
Duplicate names:	yes	error printout.
Improper format:	yes	error printout.
Incomplete entries:	yes	error printout; attempt to correct in some cases.
Target computer overflow:	none.	
Inconsistent program:	none.	

PROGRAM TRANSLATOR: NEAT ASSEMBLER

.1 GENERAL

.11 Identity: . . . . NEAT Assembler.

.12 Description

The NEAT Assembler is a two-pass symbolic system designed for use in NCR 315 systems with as little as 5,000 slabs of core storage, punched card or paper tape input-output, a printer, and one magnetic tape or CRAM unit. Source program input and object program output are on punched cards or paper tape. The source statements can be read in, stored on magnetic tape or CRAM, and edited prior to the assembly run if desired. Object programs produced by the NEAT Assembler cannot be incorporated directly into a standard NCR 315 library tape or CRAM deck; they must be reassembled into the proper format (approximately 1,000 slabs per block) by the NEAT Compiler.

.13 Originator: . . . . NCR.

.14 Maintainer: . . . . NCR.

.15 Availability: . . . . . . July, 1961.

.2 INPUT

.21 Language

.211 Name: . . . . NEAT Assembler language (Section 601:171).
.212 Exemptions: . . . . . . none.

.22 Form

.221 Input media: . . . . . . punched cards, paper tape, magnetic tape, or CRAM.
.222 Obligatory ordering: . in sequence by page and line numbers.
.223 Obligatory grouping: . none.

.23 Size Limitations

.231 Maximum number of source statements: no practical limit.
.232 Maximum size source statements: . . . . . . 80 characters (1 card).
.233 Maximum number of data items: . . . . . . 100 labels in 5,000-slab core store; more in larger stores.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . NCR 315 machine language.
.312 Language style: . . . . binary.
.313 Output media: . . . . . punched cards or paper tape.

.32 Conventions

.321 Standard inclusions: none.
.322 Compatible with: . . . STEP and PACE input-output control facilities.

.33 Documentation

Subject	Provision
Source program: . .	listing.
Object program: . . .	listing.
Storage map:	listing.
Restart point list: .	listing.
Language errors: . .	noted in listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes: . 2-pass assembler.

.42 Optional Mode

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

.43 Special Features

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

.44 Bulk Translating: . . . no.

.45 Program Diagnostics

.451 Tracers: . . . . yes.
.452 Snapshots: . . . . yes.
.453 Dumps: . . . . yes.

.46 Translator Library: . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space	Comment
STEP:	650 slabs	tape I/O control.
PACE:	1,240 slabs	CRAM I/O control.

.512 Space required for each input-output file: . . . . variable.
.513 Approximate expansion of procedures: . . . . 1.0 (one machine instruction per source statement).

.52 Translation Time

.521 Normal translating: . approx. 1 + 0.0015S minutes, where S is number of source program statements (printer-limited).

.53 Optimizing Data: . . . none.

.54 Object Program Performance: . . . . unaffected (same as hand coding).

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . 5,000-slab core store.
punched card or paper tape reader and punch.
printer.
1 magnetic tape or CRAM unit.

.612 Larger configuration advantages: . . . . . . larger core store permits more labels.

.62 Target Computer

.621 Minimum configuration: . . . . any NCR 315.

.622 Usable extra facilities: . . . . all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	noted in listing.
Unsequenced entries:	check	noted in listing.
Duplicate names:	check	noted in listing.
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	none.	
Inconsistent program:	none.	

.8 ALTERNATIVE TRANSLATORS: . . . none.

PROGRAM TRANSLATOR: NEAT COMPILER

.1 GENERAL

.11 Identity: . . . . NEAT Compiler.

.12 Description

Operation of the NEAT Compiler requires an NCR 315 with at least 10,000 slabs of core storage, 1 CRAM unit or 4 magnetic tape handlers, a card or paper tape reader, and a printer. Compilation will be faster if 2 CRAM units or 5 magnetic tape handlers are available. A special compiler, capable of using the complete language but requiring increased compile time, is available for systems with 5,000 slabs of core storage and 4 magnetic tape handlers. Object programs produced by the NEAT Compiler are fully compatible with the Librarian routine and with the STEP and PACE supervisory and input-output control systems. An unusual feature of the NEAT Compiler is its ability to sort unsequenced source statements according to coding sheet page and line numbers, thereby facilitating corrections.

.13 Originator: . . . . NCR.

.14 Maintainer: . . . . . . NCR.

.15 Availability: . . . . . . currently in operation.

.2 INPUT

.21 Language

.211 Name: . . . . NEAT Compiler language (Section 601:172).
.212 Exemptions: . . . . . . none.

.22 Form

.221 Input media: . . . . . . punched cards, paper tape, CRAM, or magnetic tape.
.222 Obligatory ordering: . must be in sequence by page and line numbers unless a sort is called for on Compiler Control form.
.223 Obligatory grouping: . header.
file specifications.
symbolic coding.
END pseudo-op.

.23 Size Limitations

.231 Maximum number of source statements: . no practical limit.
.232 Maximum size source statements: . . . . . . 80 characters (1 card).
.233 Maximum number of data items: . . . . . . 10,000 in CRAM version; over 25,000 in tape version.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . NCR 315 machine language.
.312 Language style: . . . . binary.
.313 Output media: . . . . . punched cards, paper tape, magnetic tape, or CRAM.

.32 Conventions

.321 Standard inclusions: . STEP and/or PACE routines as required.
.322 Compatible with: . . . Librarian (601:151.16) and STEP and PACE supervisory and input-output systems (601:191).

.33 Documentation

Subject	Provision
Source program: . .	listing.
Object program:. . .	listing.
Storage map:	listing.
Restart point list: .	listing.
Language errors: . .	noted in listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Phase 1: . . . . gather macro data.
Phase 2: . . . . assign operation codes.
Phase 3: . . . . assign addresses.
Phase 4: . . . . complete the assembly and output the object program.

.42 Optional Mode

.421 Translate: . . . . yes.
.422 Translate and run: . . no.
.423 Check only: . . . . no.
.424 Patching: . . . . no.
.425 Updating: . . . . yes; see 601:172.23.

.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.

.45 Program Diagnostics: see Paragraph 601:191.5.

.451 Tracers: . . . . yes.
.452 Snapshots: . . . . yes.
.453 Dumps: . . . . yes.

.46 Translator Library

.461 Identity: . . . . Macro Library.
.462 User restriction: . . . none.
.463 Form
Storage medium: . . magnetic tape or CRAM.
Organization: . . . . alphabetic by name.
.464 Contents
Routines: . . . . yes.
Functions: . . . . . . yes.
Data descriptions: . yes (from Data Design Library).
.465 Librarianship
Insertion: . . . . special run.
Amendment: . . . . . special run.
Call procedure: . . . use of macro name in procedural statement causes insertion of appropriate routine.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space	Comment
STEP:	632 slabs	tape I/O control.
PACE:	1,240 slabs	CRAM I/O control.

.512 Space required for each input-output file: . . . . variable.
.513 Approximate expansion of procedures: . . . . 1.0 to 2.0, depending upon rate of macro usage.

.52 Translation Time

.521 Normal translating: . . . . . . 2 + 0.02S minutes, where S is number of source program statements (i.e., cards or lines); based on manufacturer's estimate for system with 10,000-slab core store and 2 CRAM Units.

.54 Object Program Performance: . . . . unaffected (same as hand coding).

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . . 10,000-slab core store.
punched card or paper tape reader.
printer.
1 CRAM unit and 4 magnetic tape handlers.
.612 Larger configuration advantages: . . . . . . 2 CRAM units or 5 tape handlers increase compilation speed.

.62 Target Computer

.621 Minimum configuration: . . . . 10,000-slab core store.
punched card or paper tape input-output.
.622 Usable extra facilities: . . . . all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Comment
Missing entries:	check	noted in listing.
Unsequenced entries:	check	optional sort of source program.
Duplicate names:	check	noted in listing.
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	none.	
Inconsistent program:	none.	

.8 ALTERNATIVE TRANSLATORS: . . none.

PROGRAM TRANSLATOR: FAST

.1 GENERAL

.11 Identity: . . . . Flexible Algebraic Scientific Translator.
FAST I (Paper Tape Version).
FAST I (Punched Card Version).
FAST III (Paper Tape Version).
FAST III (Punched Card Version).

.12 Description

Two compilers are provided for the FAST language described in Section 601:163. FAST I is for card or paper tape oriented installations with no CRAM unit and does not permit overlay, rerun, CRAM, or alphabetic operations. FAST III permits use of all facilities of the FAST language. Both compilers are available in two versions, one for paper tape and one for punched cards.

The FAST translators operate from card images read from either cards or paper tape. The translators produce the object program (on cards or paper tape for FAST I and on CRAM for FAST III), a listing of the source language, and a list of variable and statement numbers and their locations.

The translators are contained in self-loading card decks, paper tapes, or CRAM. Loading of the translator is initiated by a console bootstrap operation.

Both translators are capable of processing batch jobs; i.e., translating several source programs without the need to reload the translator each time. The last program translated by the FAST III (CRAM) translator is available for immediate execution. Both translators require 10,000 slabs of memory, a printer, a card reader, and a card punch (or paper tape reader and punch). In addition, FAST III requires one CRAM unit. The target computer for both translators must have the same minimum configuration as the translating computer. Neither translator can make use of any additional memory or peripheral devices.

.13 Originator: . . . . Woodward Governor Company.

.14 Maintainer: . . . . National Cash Register Co.

.15 Availability: . . . . November, 1963.

.2 INPUT

.21 Language

.211 Name: . . . . FAST.

.212 Exemptions: . . . . FAST III can utilize the full language as described in Section 601:163.
FAST I cannot accept the CRAM operations (including overlay and rerun facilities) or alphabetic operations.

.22 Form

.221 Input media: . . . . paper tape or punched cards, depending on the version.

.222 Obligatory ordering: . . DIMENSION and INDEX statements must occur prior to references to the variables defined in these statements.
Procedure coding (subroutines) must occur prior to a call for the subroutines.

.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . up to 199 numbered statements can be included.

.232 Maximum size source statements: . . . . 40 symbols (symbolics and operators) excluding spaces.

.233 Maximum number of variables: . . . . 138.

.234 Others —
Maximum number of constants: . . . . 50 6-digit fixed point; 50 12-digit fixed point and floating point.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . . NCR 315 machine language.

.313 Output media —
FAST I: . . . . paper tape or punched cards, depending on the version.
FAST III: . . . . CRAM.

.32 Conventions

.321 Standard inclusions: . . subroutine package, including floating point and I/O control facilities.

.33 Documentation

Subject	Provision
Source program:	list.
Object program:	none.

.33 Documentation (Contd.)

Subject	Provision
Storage map:	list of variable locations and of statement number locations.
Restart point list:	none.
Language errors:	print error symbols.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes: . . one pass.

.42 Optional Mode

.421 Translate: . . . . yes.
.422 Translate and run: . . . FAST III only.
.423 Check only: . . . . no.
.424 Patching: . . . . no.
.425 Up-dating: . . . . no.

.43 Special Features: . . . . none.

.44 Bulk Translating: . . . . yes.

.45 Program Diagnostics

.451 Tracers: . . . . Inclusion of a TRACE statement in the source program causes a print-out of the results of the succeeding statements along with the location of the statement. Tracing is halted by a NTRACE statement. The trace may be inhibited by a control card preceding the data or by deactivating the Trace Mode switch on the console.
.452 Snapshots: . . . . none.
.453 Dumps: . . . . none.

.46 Translator Library: . . The only library facilities are a group of subroutines for I/O control and floating point arithmetic.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	FAST I	FAST III
Compiler Subroutines Package:	4,500 slabs	3,525 slabs.
Print and Plot Output Area:	62 slabs	62 slabs.
Card or Paper Tape Input Area:	included in Package	40 slabs.
Program Constants:	included in Package	475 slabs.
Other:	143 slabs	98 slabs.

.513 Approximate expansion of procedures: . . . . . approximately 9 slabs per statement.

.52 Translation time: . . . 0.5 + 0.01S minutes (400-cpm Card Reader).
0.5 + 0.004S minutes (2,000-cpm Card Reader).
(S = number of statements in source program.)

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . less efficient than hand coding with respect to both space and execution time; no quantitative estimate released by NCR.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration —
FAST I: . . . . 10,000 slabs of core memory, printer, and either paper tape reader and punch or card reader and punch.
FAST III: . . . . 10,000 slabs of core memory, printer, 1 CRAM unit, and either paper tape reader and punch or card reader and punch.

.612 Larger configuration advantages: . . . . none.

.62 Target Computer

.621 Minimum configuration: . . . . . same as translating computer.

.622 Usable extra facilities: none.

.7 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	none.	
Duplicate names:	none.	
Improper format:	check	print error symbol.
Incomplete entries:	check	print error symbol.
Target computer overflow:	check	print error symbol.
Inconsistent program:	check	print error symbol.
Label table overflow:	check	print error symbol.
Constant table overflow:	check	print error symbol.
Statement number table overflow:	check	print error symbol.
Statement too long:	check	print error symbol.

.8 ALTERNATIVE TRANSLATORS: . . . none; but note that programs written for the FAST I compiler can be translated by the corresponding version of FAST III.

OPERATING ENVIRONMENT: STEP AND PACE

.1 GENERAL

.11 Identity: . . . . Standard Tape Executive Program. STEP.*

Packaged CRAM Executive. PACE.*

*STEP and PACE are service marks of the National Cash Register Company.

.12 Description

STEP is an operating routine for NCR 315 magnetic tape systems, and PACE is its counterpart for NCR 315 CRAM systems. STEP and PACE are quite similar in concept and structure. All NCR 315 assemblers and compilers can produce object programs designed to be run with either STEP or PACE, or both. The Librarian routine (see 601:151.16) is used to create and maintain a library tape or CRAM deck in which each program contains all the information required by STEP or PACE.

Both STEP and PACE are composed of the following routines:

- Kernel — controls basic input-output operations and deals with read and write errors. The Kernel is in core storage whenever a program uses magnetic tape and/or CRAM units; it occupies approximately 450 slabs for tape and 1,000 slabs for CRAM.

- System Supervisor — controls run-to-run changeovers, pre-run setup, and program loading. The Supervisor is called into core storage upon conclusion of a program, and is overlaid by the next requested program.

- Extremity — controls relatively infrequent file operations such as opening, closing, label checking, and end-of-reel. The Extremity routine is called into core storage as an overlay whenever one of its functions is required.

- Rescue — establishes restart points by dumping the contents of core storage plus pertinent processor status information on a specified Rescue File on magnetic tape or CRAM cards; occupies approximately 215 (tape) or 250 (CRAM) slabs of core storage in those programs where its functions are required.

- Restart — allows the operator to restart a run from any restart point previously established by the Rescue routine; loaded only when restarting is required.

- Daily Start — inputs and stores date information at the start of each day's processing, then calls in the System Supervisor.

- Cartridge Initializer (PACE only) — creates and writes deck number, card number, and band number on every band of a CRAM deck. (PACE reserves the first two cards of every CRAM deck as substitute bands to be used when a flawed band is addressed by the program. The first band on card 000 contains a Skip Directory that indicates which substitute band is to be used.)

The STEP and PACE systems expect all magnetic tape and CRAM operations to be initiated by macro-codes; the programmer is not advised to write any machine language tape or CRAM instructions. Other macro-codes initiate tracing, dynamic dumps, program overlays, and preservation (and subsequent restoration) of register contents and flag settings when a demand interrupt occurs. For a complete list of the available macro-codes, see Paragraph 601:172.81.

The last instruction executed in every program run under control of STEP or PACE is the FINISH macro, which calls the System Supervisor into core storage and transfers control to it. The Supervisor then locates the next program. STEP assumes that the programs are arranged on the library tape in the order in which they will normally be run. PACE includes, in the header of each program, the name of the program that will normally be executed next. By means of a complex dating scheme, the Supervisor determines whether or not the next program is to be run on this particular day. The operator has the option of overriding this decision and instructing the Supervisor either to run or not to run the selected program, or to run another specified program in its place. The Supervisor then loads and initiates execution of the stored program.

.13 Availability: . . . . . . currently in use.

.14 Originator: . . . . NCR.

.15 Maintainer: . . . . NCR.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . . magnetic tape or CRAM cards.
.212 Independent programs: any input medium.
.213 Data: . . . . any input medium, as incorporated in program.
.214 Master routines (STEP & PACE): . . . . magnetic tape or CRAM cards.

.22 Library Subroutines: . . incorporated in programs at assembly time.

.23 Loading Sequence: . . . see last paragraph of Description, above.

.3 HARDWARE ALLOCATION

.31 Storage: . . . . as defined by programmer in NEAT programs.

.32 Input-Output Units: . . . as specified by programmer.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: as incorporated in user's program.

.42 Multiprogramming: . . Facilities are provided for media conversions; see also ICS, Section 601:192.

.43 Multi-sequencing: . . . none.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	check	try again – printout.
Allocation impossible:	no.	
In-out error — single:	check	try again.
In-out error — persistent:	check	several options available.
Invalid instructions:	some checks	halt.
Program conflicts:	some checks	halt.
Arithmetic overflow:	hardware check	set indicator.

.45 Restarts

.451 Establishing restart points: . . . . automatic (if desired) at end of each tape reel or CRAM deck; or whenever the programmer desires by use of the RDUMP macro.

.452 Restarting process: . . semi-automatic.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . TRACE macro prints the address of each instruction executed whenever Console Monitor Switch and Processor Trace Permit Flag are on.

.512 Snapshots: . . . . DYDUMP (Dynamic Dump) macro prints contents of specified core areas and all flags and registers.

.52 Post Mortem: . . . . . . utility routines are available for dumping core storage, tape files, and CRAM files on the on-line printer.

.6 OPERATOR CONTROL

.61 Signals to Operator: . . automatic, on console typewriter.

.62 Operator's Decisions: . console keyboard and switches.

.63 Operator's Signals

.631 Inquiry: . . . . no provision.

.632 Change of normal progress: . . . . override scheduled program and type in name of another program to be run instead.

.7 LOGGING: . . . . console typeouts.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: any NCR 315 system with magnetic tape (for STEP) or CRAM (for PACE).

.812 Usable extra facilities: all.

.813 Reserved equipment —
STEP: . . . . 632 slabs of core storage and Jump Registers 0 through 5.

PACE: . . . . approximately 1,240 slabs of core storage, Index Registers 24 and 25, Jump Registers 6 through 11, and the first 2 cards of every CRAM deck.

.82 System Overhead

.821 Loading time: . . . . . less than 1 second to load necessary STEP or PACE routines for any program.

.822 Reloading frequency: . . STEP or PACE routines are included with each program at assembly time and called into core storage as required.

.83 Program Space Available: . . . . . . all of core storage less STEP and/or PACE requirements as defined in Paragraph .813.

.84 Program Loading Time: . . . . limited by speed of input device (usually tape or CRAM).

.85 Program Performance: . . . . running overhead is "trivial" for both STEP and PACE, according to NCR.

OPERATING ENVIRONMENT: ICS

.1 GENERAL

.11 Identity: . . . . Inquiry Control System.
ICS.
Executive Program.

.12 Description

Inquiry Control System is NCR's designation for a combination of hardware and software making up a communications system capable of processing regular job programs and remote inquiries in a multiprogramming mode; i.e., the interruption and restarting of a job program to process a remote inquiry is handled automatically without need for operator intervention.

The data communications hardware available for NCR 315 systems is described in Section 601:105. The software consists of a special version of PACE (the executive routine for CRAM-oriented systems; see Section 601:191) and an Executive Program. The Executive Program described in this section is designed to service systems employing a 356-1 Inquiry Buffer and associated teletype devices. Details have not been released to date concerning software for systems utilizing the newly-announced 321-1 Central Communications Controller, but it is expected to be functionally similar to the Executive Program described in this section, except that it will not provide for automatic fetching of records.

The file referenced by an inquiry is organized sequentially by account number or some other numerical control field. Multi-cartridge files can be used if multiple CRAM units are available. Two types of directories are maintained to allow the Executive Program to locate and access the relevant record: a Master Directory and one or more Detail Directories. The Master Directory contains one segment for each Detail Directory. Each segment contains the card and track number of the associated Detail Directory, along with the last account number referenced by that Detail Directory. The Detail Directories contain a segment for each track of a portion of the Master Record File, specifying the last account number on each track. The number of the CRAM unit holding the associated portion of the Master File is contained only once in a Detail Directory; therefore, multiple CRAM units cannot be referenced by a single Detail Directory.

Since the Master File is in sequential order by account number, the search technique is to find the segment in the Master Directory and then the associated Detail Directory containing the smallest directory account number that is larger than the inquiry account number. Alternatively, the user can elect to program the accessing function himself. In that case, the format of the directories and the searching technique are up to the user.

The Executive Program controls such functions as: (1) safe-storing the main program preparatory to receiving a message character or processing a complete message, (2) translating between 315 internal code and teletype 5-level code, (3) performing a character count check on the input message (optional), (4) fetching the pertinent record from a CRAM file (optional), and (5) verifying the account number (optional).

Specific areas are reserved in memory for:

- Main Program — the job program being processed when no inquiry is being processed.
- PACE.
- Executive Program.
- User Program — the program coded by the user for processing an inquiry.
- Teletype input-output areas.
- CRAM buffer area — for the detail Directory and account records.
- Master Directory.
- Other — for storage of constants and other information for the executive routines.

All of the preceding are in core storage simultaneously, except that the CRAM buffer area overlays a portion of the Main Program area. When the Main Program occupies this area, it is transcribed to CRAM storage prior to servicing the inquiry, as described in the following paragraphs.

A scanner unit within the 356-1 Buffer continuously scans the data lines for activity. When an active line is found, the one-character storage register is filled and an interrupt signal is sent to the processor. The Executive Program then controls the following sequence of events:

- Safe-stores the contents of all registers and the accumulator, and the status of the processor flags.
- Accepts the message character from the Inquiry Buffer (and also a second character which specifies the sending unit).
- Determines whether the message character is a control character or a data character.
- Translates (if data character) from teletype code to 315 internal alpha (6-bit) code.
- Stores the translated character in the appropriate input area (as determined by the accompanying second character from the buffer).

.12 Description (Contd.)

- Restores the information previously safe-stored and returns control to the Main Program.

The above sequence of events requires about five milliseconds of processor time and must be executed for each character in a message. Control characters are not translated or stored; they are ignored except for the beginning-of-message (left bracket) and end-of-message (right bracket) characters.

When an end-of-message character is recognized during the analysis phase of the message-handling routine, the beginning address of the input message is stored in Index Register 27 and further interrupts are inhibited by turning off the Processor Demand Permit flag. If the programmer has elected to allow the Executive Program to obtain the required account record, the following sequence of events occurs:

- The Master Directory is searched for the location (card and track number) of the appropriate Detail Directory.
- The Detail Directory card is dropped. If the Main Program has overwritten the CRAM buffer area, this area is written on the track of the Detail Directory card reserved for this purpose. The relevant Detail Directory is then read into the buffer area and searched for the location of the requested account record.
- The account record card is dropped and the relevant track is read into the CRAM buffer area.
- The track is searched for the account record concerned, and Index Register 26 is loaded with the beginning address of this record.
- Control is transferred to the User Program for processing this record and forming an output message.

Once an output message has been assembled, control is returned to the Executive Program for transmission to the requesting teletype unit via a sequence of events similar to that for input. The Executive Program automatically supplies the letters and figures shift codes, but the User Program must provide for any other control codes desired.

When the output of a message has been initiated, the safe-stored information is replaced, the Demand Permit flag is turned on to enable interrupts, and control is returned to the Main Program at the point it was interrupted. If an output message is longer than the assigned output area, control can be returned to the User Program after transmission of the first segment.

Note that the processor is completely occupied from the time a complete inquiry message has been assembled until a reply has been initiated.

Three error conditions are recognized by the Executive Program:

(1) Input character count error - sends a "try again" message to the teletype device.

(2) Account not present error — branches to a specified location in the User Program when the account referenced is either not in the directories or not in the Master File.

(3) CRAM read error — branches to a specified location in the User Program when unable to successfully perform a CRAM read operation.

Errors (2) and (3) are recognized only if the Executive Program is used to access the referenced record. In this case the User Program must provide two entries (with standard labels) to accommodate the error conditions.

The particular manner in which the interrupt system is implemented in the NCR 315 places serious limitations upon the Main Programs that can be run in conjunction with the Inquiry Control System. When the processor is interrupted, a branch is made to the address contained in Jump Register 30. The normal method of finding out which peripheral device caused the interrupt is by testing each device in turn until one is found that is ready. NCR has chosen not to make use of this technique, but instead places the beginning address of the Executive Program in Jump Register 30 when initializing the system. This requires that all Unit Demand flags except those in the Inquiry Buffers be turned off, preventing use of any overlapping of peripheral operations with computation unless the programmer times his program very carefully, a technique that is not practical in many business problems. Also, since the processor must be in a dynamic state to permit a demand interrupt, a main program must be present at all times (even if it is only a jump loop) to permit the acceptance of inquiries. Note that the machine halt instruction also removes the processor from the dynamic state; therefore, a programmed halt must be a loop centered around an instruction such as testing an option switch. Otherwise, an inquiry could not be accepted during a halt condition. NCR also recommends that long-duration commands such as magnetic tape and console typewriter operations be avoided, if possible.

The output from the NEAT compilers (including assembly language, FORTRAN, and COBOL source programs) can be made compatible with the Inquiry Control System at assembly time.

.13 Availability: . . . . currently in use.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (601:201.100)

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 varying record sizes in the master file. Standard Problem D shows the effects of increasing 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.

In Standard Configuration I, both the master and detail files are on cards. Since the usual practice is to input only active master-file records (records for which there is a corresponding detail card), only the performance at an activity ratio of 1.0 is meaningful. In all problems, the card punch is the controlling factor.

In Standard Configuration II, the master files are on magnetic tape. Only the printer is buffered, and the tape and card operations are performed sequentially with no overlapping. There is no time available for computing during the magnetic tape operations, but there is some read/compute overlap during the card read operations. At moderate and high activities, except for Problem D, the amount of overlap available is sufficient to allow all the peripheral devices to operate at their maximum effective speeds. The controlling factor in this range for Problems A, B, and C is the combination of the two master-file tapes and the detail card file. At low activity ratios, the amount of time available between detail cards is insufficient to permit all the internal processing to be performed during this time, and the central processor becomes the controlling factor.

The activity ratio at which the central processor becomes limiting in Configuration II depends upon the amount of computation per record and the blocking factor of the master file. (Actually, it depends on the size of a master-file record since the block length is held constant in these problems.) In general, as the amount of computation increases (Problem D) or the blocking factor decreases (Problem C), the activity ratio below which the central processor is the limiting factor becomes higher. In Problem D, the central processor is the limiting factor at all activity ratios.

Standard Configuration III is functionally similar to Configuration II except for the use of faster magnetic tape units and one Model 324-1 Magnetic Tape Simultaneity Controller. This controller permits read/compute and write/compute simultaneity between any one of the magnetic tape units and the central processor. It also allows a magnetic tape unit and the card reader to operate concurrently. At moderate and high activity ratios for Standard File Problems A, B, and C, the card reader is the controlling factor. As the activity ratio is decreased, the percentage of overlapped compute time decreases more quickly than the amount of required processing, and a point is reached where the central processor becomes the controlling factor. At lower activity ratios, the amount of overlapped time available for computing is again more than enough for the required processing, and the two master-file tape units are the controlling factor. The increased computation and high I/O demands on the processor cause the central processor to be the controlling factor in Problem D for all conditions evaluated.

The same general considerations apply to the activity ratio "break points" for Configuration III as to those for Configuration II.

Standard Configuration IIIC is a special configuration that illustrates the use of CRAM in place of magnetic tape. The decision that four CRAM units are equivalent to six magnetic tape units is somewhat arbitrary. The capability to have multiple files on-line in a single CRAM unit, with equal access times to any of them, clearly indicates that one CRAM unit is logically equivalent to more than one magnetic tape unit in most applications. The reduced file size allowable when placing multiple files in a single CRAM cartridge prevents one CRAM unit from taking the place of all tape units. For the purposes of this analysis, the two master files were placed on different CRAM units to take advantage of overlapping card drop times. Two input and two output areas were used as buffers for CRAM operations to minimize rotational delays through utilization of the interrupt capability of the CRAM units. It should be noted that in this application CRAM is being used as a sequential device (analogous to a magnetic tape unit), and not as a random access device.

The CRAM read and write operations and the card read operations can only be performed sequentially. There is enough overlapped computing time available, however, so that the combination of the CRAM units and card reader is the controlling factor at all activities for Standard File Problems A, B, and C at high and moderate activity ratios. At low activity ratios the central processor becomes the controlling factor. In Problem D the central processor is the controlling factor at all activity ratios.

In Standard Configuration IV, faster magnetic tape units and two Model 324-1 Magnetic Tape Simultaneity Controllers are used, along with the 2,000-cpm card reader and 1,000-lpm printer. The two Simultaneity Controllers permit full read/write/compute overlap between the magnetic tape units and the central processor. Also, all four peripheral operations can proceed in parallel. At moderate and high activity ratios, the printer is the controlling factor in all Standard File Problems. At low ratios, the central processor becomes the controlling factor for all Problems.

SORTING (601:201.200)

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 for System Configuration II (four magnetic tape units), and a three-way merge was used for Configurations III and IV. The effects of increased tape speed and increased simultaneity due to the addition of one or two Model 324-1 Magnetic Tape Simultaneity Controllers in Configurations III and IV, respectively, are evident from the graph on page 601:201.200.

Times for NCR's Magnetic Tape Sort Generator are shown in graph 601:201.220, using a two-way merge for Configuration II, a three-way merge for Configuration III, and a four-way merge for Configuration IV. The times include the advantages gained through use of the Model 324-1 Magnetic Tape Simultaneity Controller where appropriate.

The CRAM Sort Generators have been revised, and no quantitative estimate of their performance is available at this time.

MATRIX INVERSION (601:201.300)

The standard estimate for inverting a non-symmetric, non-singular matrix was computed by the simple method described in Paragraph 4:200.312 of the Users' Guide. NCR's subroutines for floating-point arithmetic operations, with a precision of 12 digits, are used. The results are shown in the graph on page 601:201.300.

Times for the NCR's Matrix Inverse subroutines are shown in the graph on page 601:201.320.

GENERALIZED MATHEMATICAL PROCESSING (601:201.400)

Standard Mathematical Problem A is an application in which there is one stream of input data, a fixed computation to be performed, and one stream of output results. Two variables are introduced to demonstrate how the time for a job varies with different proportions of input, computation, and output. The factor C is used to vary the amount of computation per input record. The factor R is used to vary the ratio of input records to output records. The procedure used for the Standard Mathematical Problem is fully described in Section 4:200.2 of the Users' Guide.

Computations are performed in the floating-point arithmetic mode, using the subroutines described in Paragraph 601:151.171. These subroutines provide 12-digit precision.

In all configurations the input device is a card reader and the output device is a line printer. Configurations I and IV use the same card reader and printer (380-3 and 340-601, respectively); consequently, they have the same performance on Mathematical Problem A. Similarly, Configurations II, III, and IIIC utilize the same combination of card reader and printer (472-2 and 340-3, respectively) and have the same performance on this problem. The results are presented in the graph on page 601:201.400.

Except for one point mentioned later, there is little appreciable difference between the results for different ratios of output records to input records for any of the configurations. This is because the time involved in preparing and outputting a line of print is small compared with the time involved in computing the results. For configurations I and IV, the central processor is the controlling factor under all conditions except for small computation loads ($C<0.4$) when $R = 1$. Under these conditions, the printer is the limiting factor. The central processor is the limiting factor in configurations II, III, and IIIC for all conditions evaluated.

(Contd.)

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)

	ITEM		CONFIGURATION I		II		III		IIIC		IV		REFERENCE
1 Input-Output Times	Char/block	(File 1)	54		880		880		1,056		880		4:200.12
	Records/block	K (File 1)	0.5		10		10		12.		16		
	msec/block	File 1 = File 2	30/240		85.8		38.8		30.6		15.6		
		File 3	30		150		150		150		30		
		File 4	115		143		143		143		115		
	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	18.3/0.9		85.8		3.5		30.6		3.5		
		File 3	24		126.4		126.4		126.4		24		
		File 4	2.2		1.3		1.3		1.3		2.2		
2 Central Processor Times	msec/block	a_1	0.55		0.55		0.55		0.55		0.55		4:200.1132
	msec/record	a_2	1.60		1.60		1.60		1.60		1.60		
	msec/detail	b_6	0.53		0.53		0.53		0.53		0.53		
	msec/work	$b_5 + b_9$	7.28		7.28		7.28		7.28		7.28		
	msec/report	$b_7 + b_8$	2.95		2.95		2.95		2.95		2.95		
3 Standard File Problem A F = 1.0			C.P.	Punch	C.P.	I/O	C.P.	Printer	C.P.	I/O	C.P.	Printer	4:200.114
		a_1	0.6		0.6		0.6		0.6		0.6		
		a_2 K	0.8		16.0		16.0		18.2		16.0		
		a_3 K	5.4		107.6		107.6		129.1		107.6		
		File 1: Master In	18.3		85.8	85.8	3.5		30.6	30.6	3.5		
		File 2: Master Out	.9	240	85.8	85.8	3.5		30.6	30.6	3.5		
		File 3: Details	12.0		1,264.0	1,500.0	1,264.4		1,516.8	1,800.0	240		
		File 4: Reports	1.1		13.0		13.0	1,430	15.6		22	1,150	
		Total	39.1	240	1,572.8	1,671.6	1,408.2	1,430	1,763.4	1,861.2	393.2	1,150	
4 Standard File Problem A Space	Unit of measure	(slabs)											4:200.1151
		Std. routines	80		710		710		1,320		710		
		Fixed	0		0		0		0		0		
		3 (Blocks 1 to 23)	360		360		360		360		360		
		6 (Blocks 24 to 48)	1,620		1,620		1,620		1,620		1,620		
		Files	416		1,960		1,960		2,312		1,960		
		Working	40		40		40		40		40		
		Total	2,516		4,690		4,690		5,652		4,690		

WORKSHEET DATA TABLE 2 (STANDARD MATHEMATICAL PROBLEM A)

	ITEM		CONFIGURATION I and IV	II, III and IIIC	REFERENCE
5 Standard Mathematical Problem A	Fixed/floating point		Floating point*	Floating point*	4:200.413
	Unit name	input	380-3 Card Reader	472-2 Card Reader	
		output	340-601 Printer	340-3 Printer	
	Size of record	input	80 characters	80 characters	
		output	120 characters	120 characters	
	msec block	input T_1	30	150	
		output T_2	115	143	
	msec penalty	input T_3	24	126.4	
		output T_4	2.2	1.3	
	msec/record	T_5	3.55	3.55	
	msec/5 loops	T_6	45.51	45.51	
	msec/report	T_7	1.51	1.51	

* Standard NCR floating-point arithmetic subroutines are used.

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

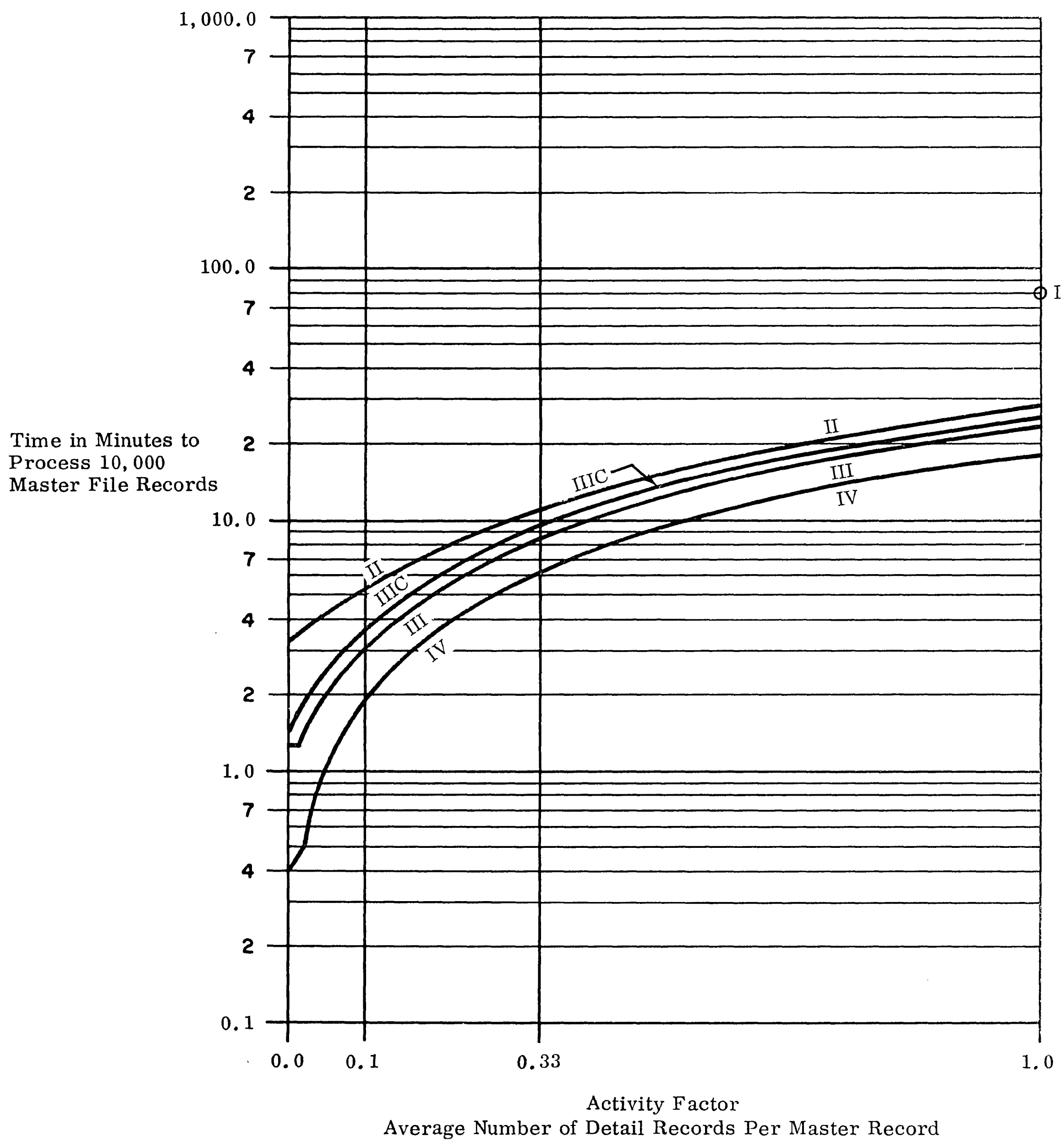
.111 Record sizes
- Master file: . . . . 108 characters (packed into 44 slabs).
- Detail file: . . . . 1 card.
- Report file: . . . . 1 line.

.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: . . . . 2,516 slabs.
- Configuration II: . . . . 4,690 slabs.
- Configuration III: . . . 4,690 slabs.
- Configuration IIIC: . . 5,652 slabs.
- Configuration IV: . . . 4,690 slabs.



(Roman numerals denote standard System Configurations.)

.12 Standard File Problem B

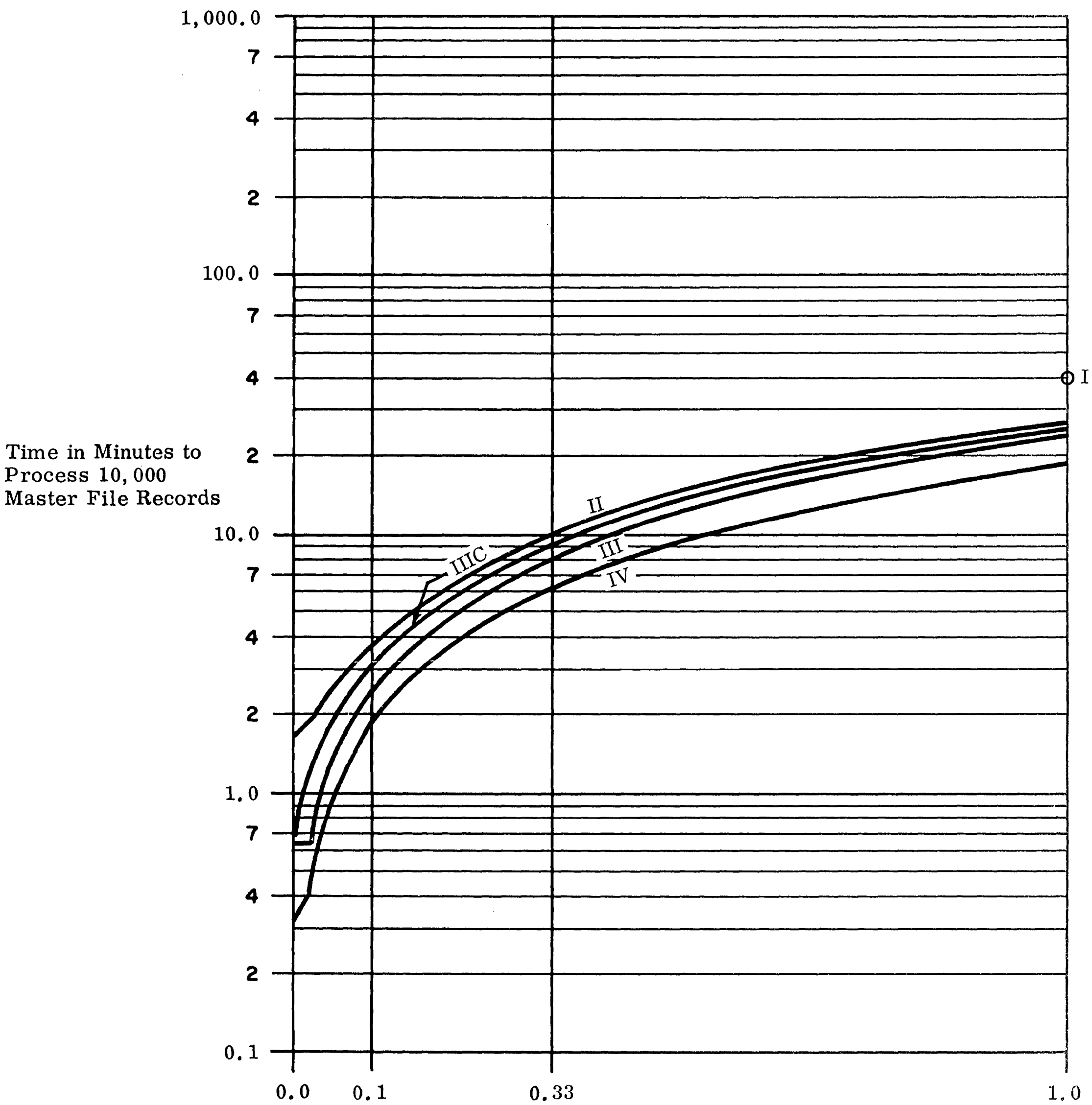
.121 Record sizes

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.



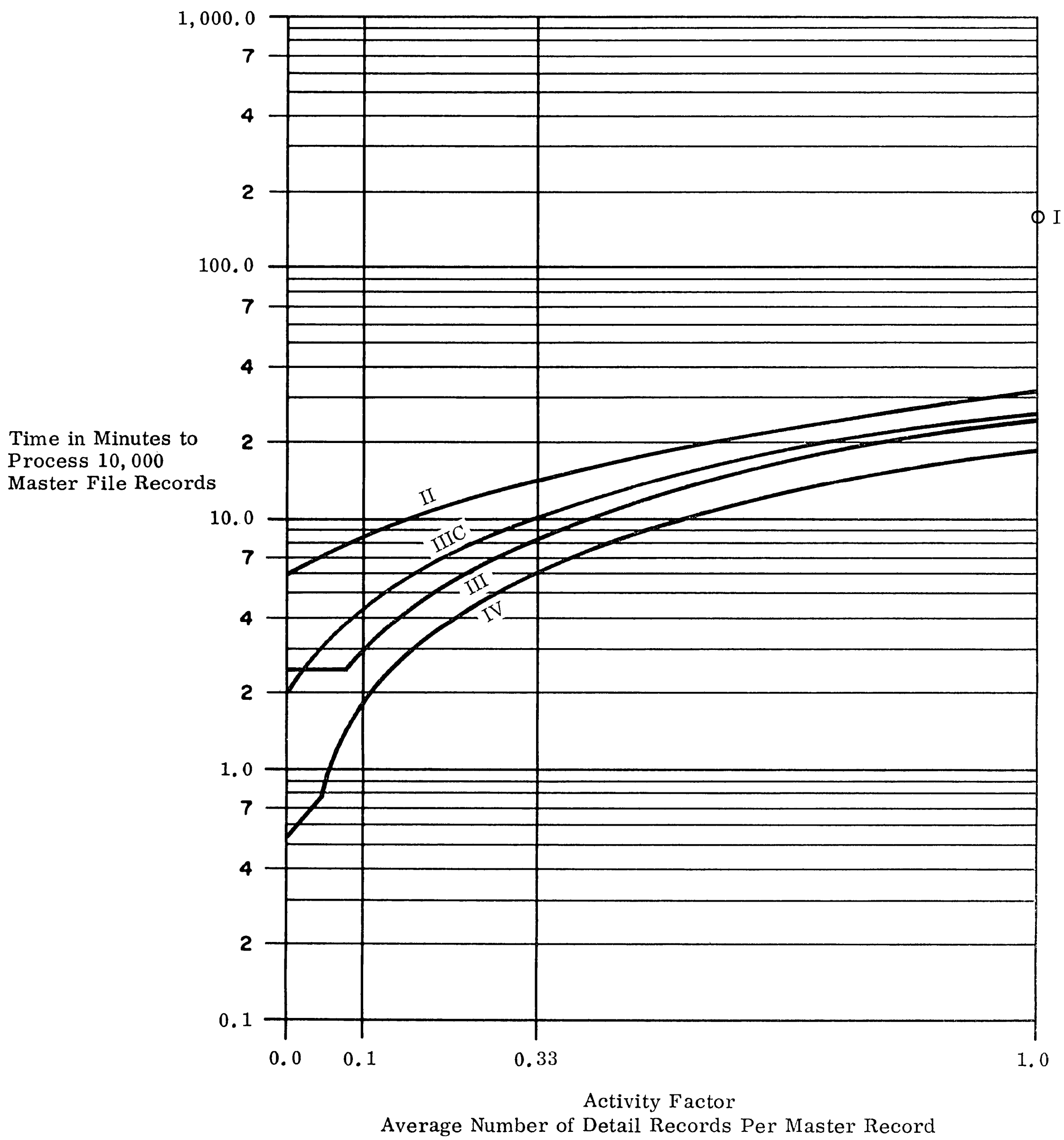
(Roman numerals denote standard System Configurations.)

(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.

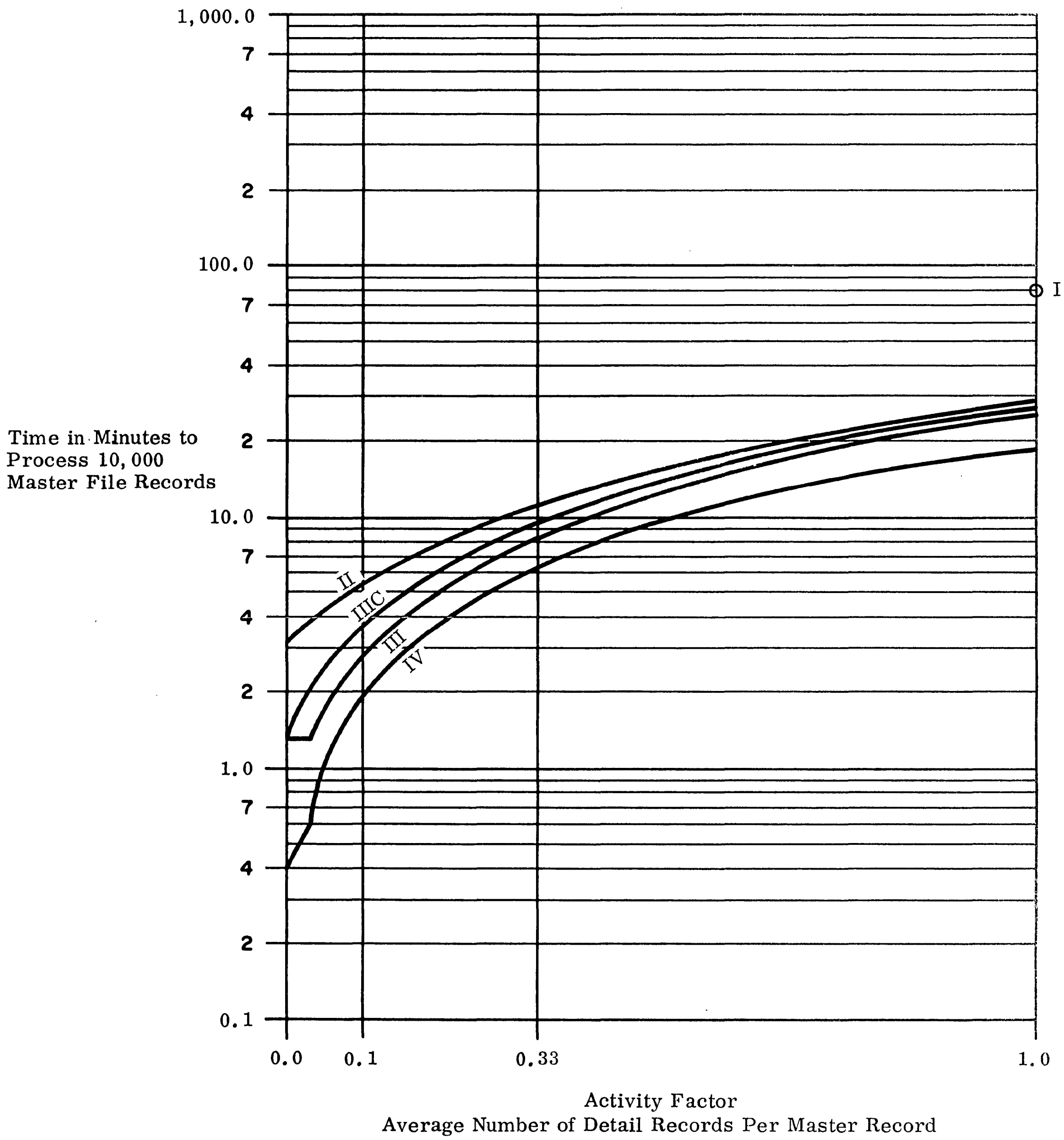


(Roman numerals denote standard System Configurations.)

.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.



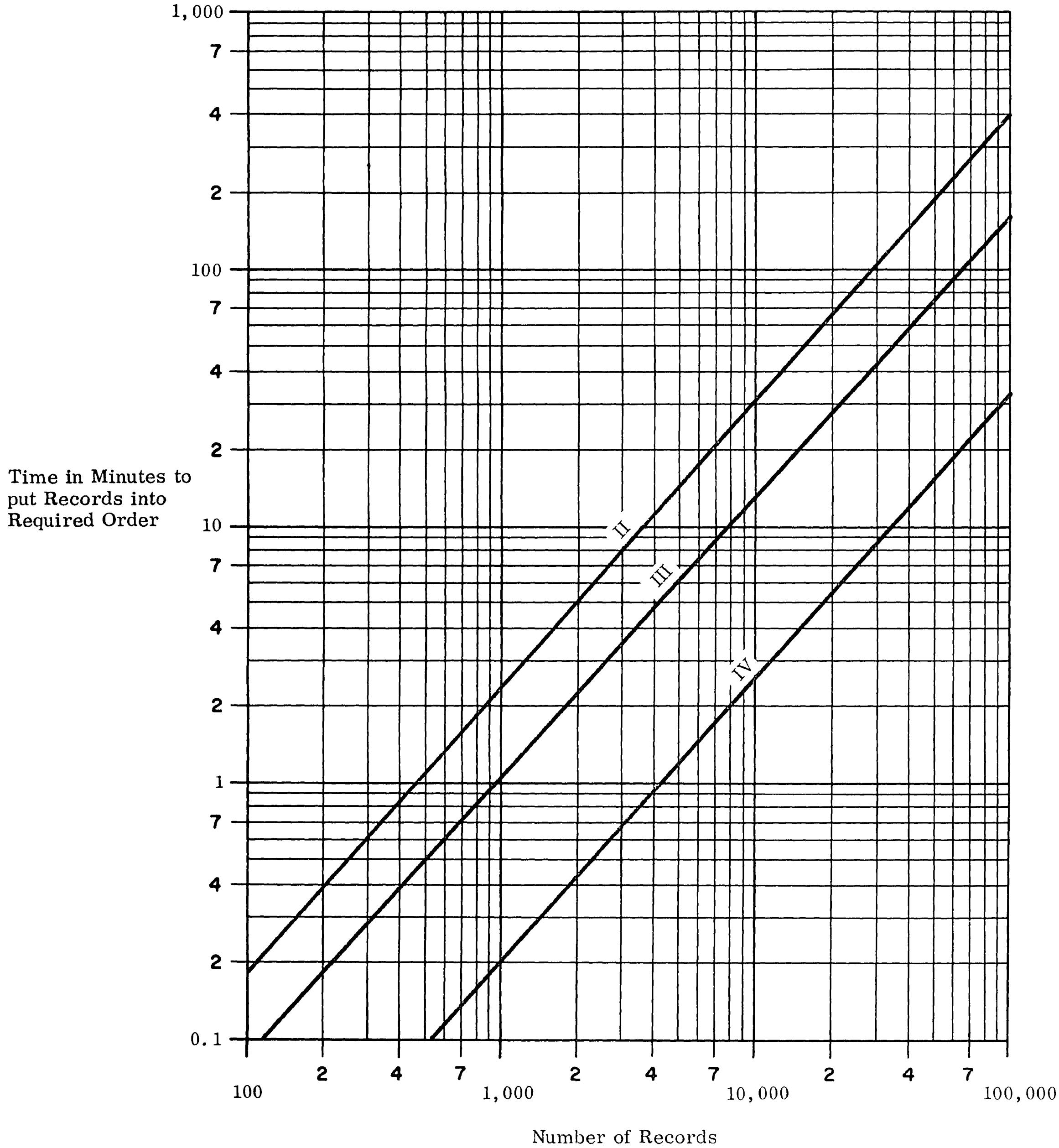
(Roman numerals denote standard System Configurations.)

(Contd.)

.2 SORTING

.21 Standard Problem Estimates

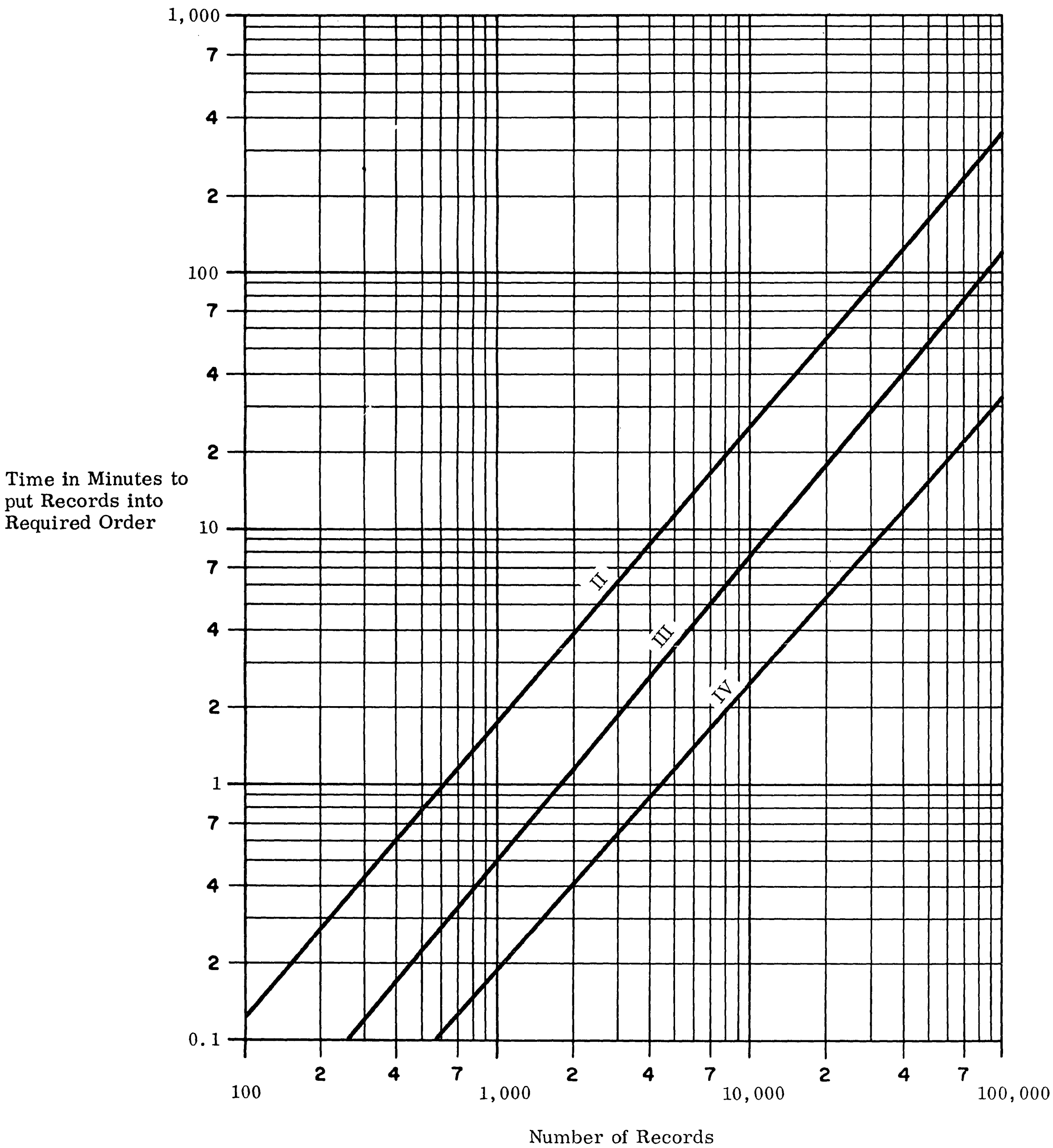
.211 Record size: . . . . 80 characters.
.212 Key size: . . . . 8 characters.
.213 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.
.214 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

.22 Magnetic Tape Sort Generator Times

.221 Record size: . . . . 80 characters.
.222 Key size: . . . . 8 characters.
.223 Timing basis: . . . . . . timing information furnished by NCR.
Configuration II: . . . 2-way merge.
Configuration III: . . . 3-way merge.
Configuration IV: . . . 4-way merge.
.224 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

(Contd.)

.3 MATRIX INVERSION

.31 Standard Problem Estimates

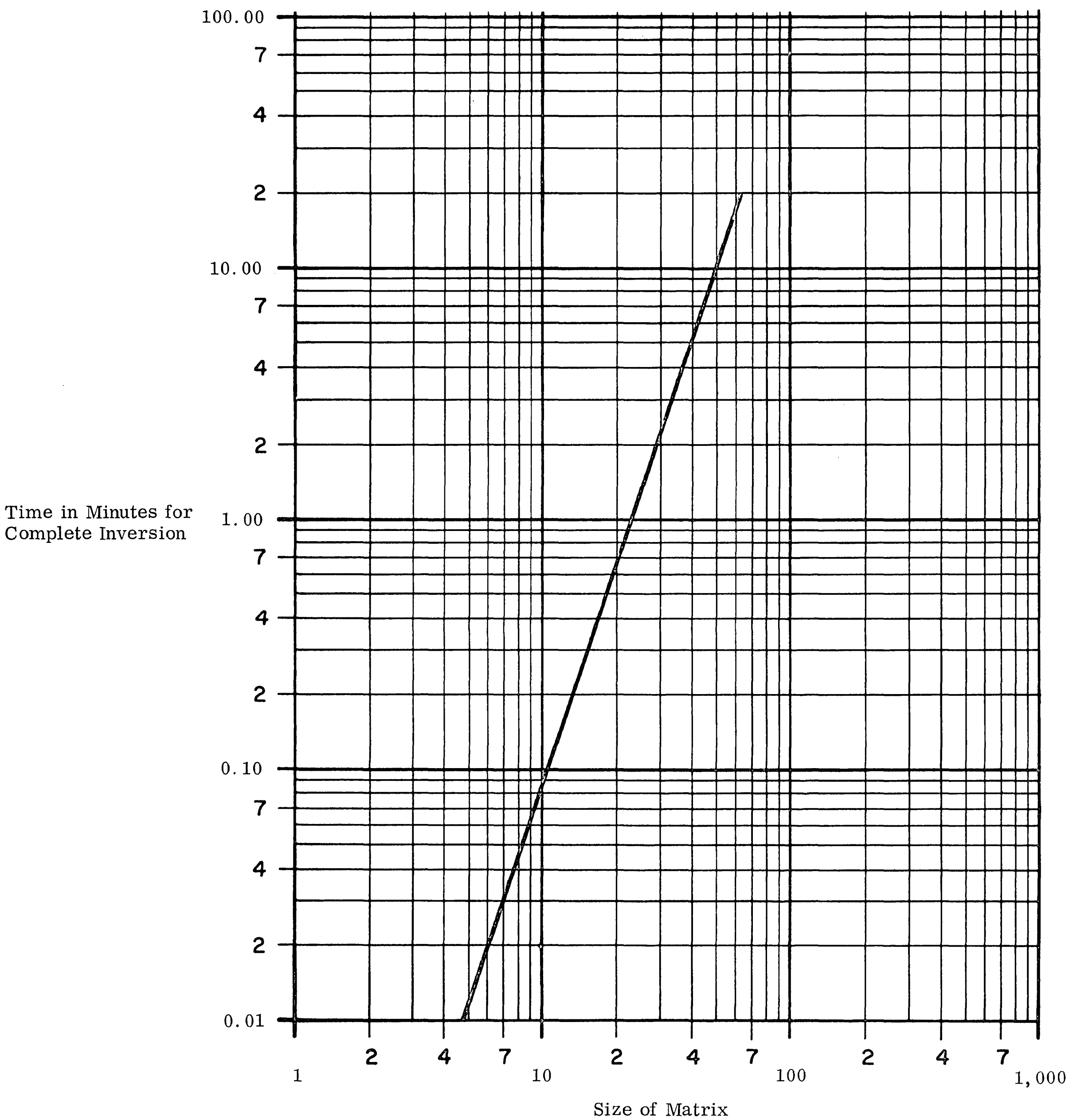
.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.312; based on standard floating point arithmetic subroutines described in Paragraph 601:151.171.

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

.314 Maximum matrix size —

5,000-slab core storage:	19 x 19.
10,000-slab core storage:	29 x 29.
20,000-slab core storage:	43 x 43.
40,000-slab core storage:	62 x 62.

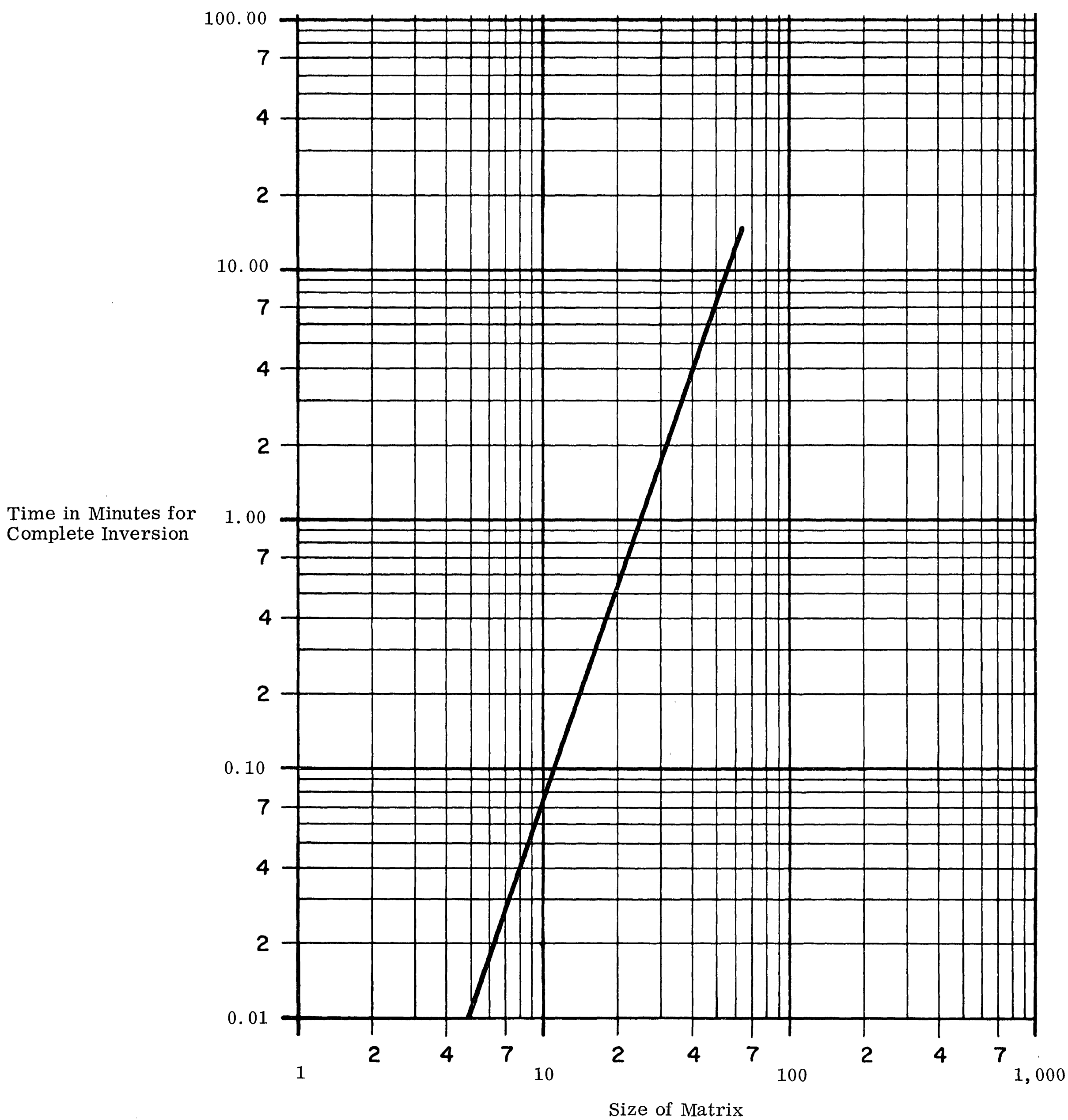


.32 Matrix Inverse Times

.321 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.322 Timing basis: . . . . . . timing formula in NCR publication MD 315-505; see description in Paragraph 601:151.172.

.323 Graph: . . . . see graph below.



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AUERBACH

.4 GENERALIZED MATHEMATICAL PROCESSING

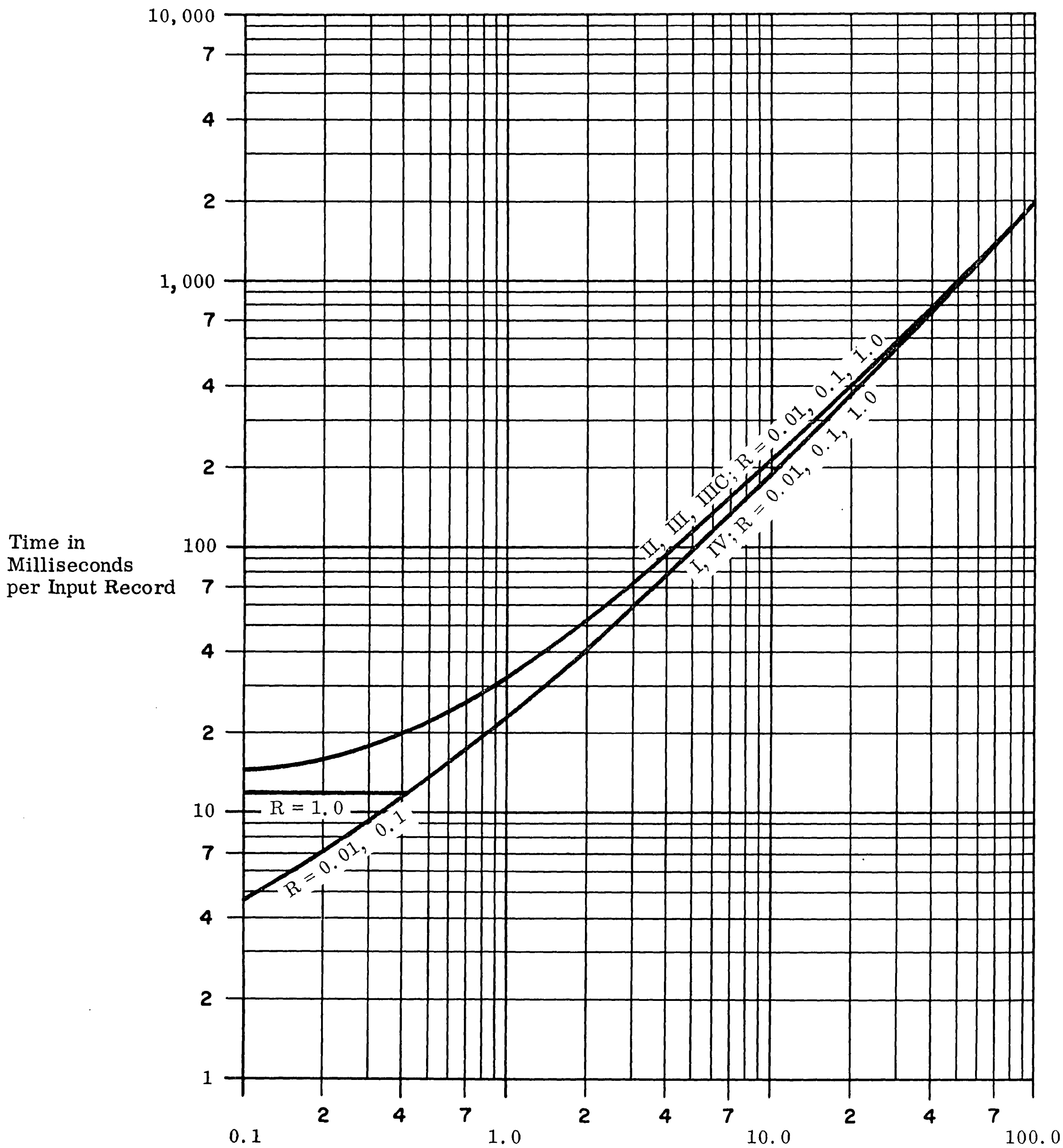
.41 Standard Mathematical Problem A Estimates

.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; computation is in floating-point mode (subroutines, 12-digit precision).

.413 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



(Roman Numerals denote Standard System Configurations.
R = number of output records per input record.)

PHYSICAL CHARACTERISTICS

Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
Processor (all 315 and 315-100 models)	106	24	52	1,433	3.5	12,000
Processor and Console, Model 315-501 (315 RMC)	67	35	44	800	2.2	12,000
Core Storage (all modules — single cabinet contains all of core storage)	43	24	52	715	2.1	7,100
Rod Memory Unit (315 RMC)	43	24	52	500	2.2	7,100
CRAM:						
353-1	35	24	61	784	3.9	13,000
353-2, 353-3	43	24	61	853	4.6	15,000
472-1, 472-2, or 472-3 Input/Output Console	43	24	48	529	0.9	3,000
361-201 Paper Tape Reader	25	24	56	450	0.7	2,500
371-201 Paper Tape Punch	25	24	56	300	0.7	2,500
380-3 Card Reader	63	33	42	900	5.2	17,700
376-2 Card Punch or 376-101 Card Punch	43	24	44	648	1.0	3,400
354-1 Card Punch Buffer	43	24	52	500	0.7	2,500
376-7 or 376-8 Card Read Punch	43	24	49	525	*	*
354-6 Card Read Punch Controller	22	24	52	350	2.0 +2.0/leg	6,800
340-3 Printer (includes 357-1 Buffer)	80	24	52	1,535	2.5	8,500
340-502, 340-503, or 340-512 Printer-Lister	38	24	53	1,100	2.2	7,500
340-601 Printer	48	24	53	1,200	2.2	7,500
334-101 or 334-131 Magnetic Tape Unit	24	19	61	400	1.9	6,800
334-102 or 334-132 Magnetic Tape Unit	24	19	61	325	0.8	2,500
332 Series Magnetic Tape Unit	30	24	60	550	2.1	7,100
333 Series Magnetic Tape Unit	28	33	72	800	3.5	8,500
324-1 Magnetic Tape Simultaneity Controller	21.5	24	52	400	1.0	3,400
402-3 MICR Sorter-Reader	180	30	37	2,500	6.5	17,000
407-1 MICR Sorter-Reader	139	56	54	3,670	7.2	17,700
355-1 MICR Sorter Buffer	43	24	52	530	1.0	3,000
420-1 Optical Journal Reader	65	29	44	1,020	2.5	8,500

* The 376-7 or 376-8 Card Read Punches receive power from the 354-6 Controller.

Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
Universal Interconnecting Device (all models)	30	24	26	100	0.05	—
321-1 Central Communication Controller (includes space for 3 Adapter Cages)	43	24	52	550	1.2	4,000
Auxiliary Cabinet (contains space for 4 Adapter Cages, each containing up to 10 adapters)	21	24	52	220	1.0	3,400
356-1 Central Inquiry Buffer	43	24	52	625	1.1	3,700
356-3 Central Inquiry Buffer	43	24	52	600	1.2	4,100
358-3 Auxiliary Cabinet (contains space for up to six adapters)	22	24	52	250	—	—
428-3 Window Machine Controller	13	13	10	10	†	—
Branch Controller (all models)	46	9	36	300	0.7	1,725

† Receives power from the Branch Controller.

General Requirements

Temperature (operating range): . . . . 72° ± 3°F.
Relative humidity (operating range): . . . . 50% ± 5%.
Power: . . . . 110 volt, 1-phase, 60 cycle; and 208/120 wye volt, 3-phase, 60 cycle.

PRICE DATA

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Central Processors	315-3	File Processor	1,400	180	90,000
	315-4	Bank-File Processor	1,500	190	95,000
	315-35	File Inquiry Processor	1,650	200	100,000
	315-45	Bank-File Inquiry Processor	1,750	210	105,000
		Options			
		CRAM Use Lockout Feature(1)	50	0	2,000
		Unbuffered Inquiry Adapter	75	10	3,250
		Automatic Recovery Option(1)	100	5	5,000
Core Storage	316-2	Memory; 5,000 slabs	1,100	20	55,000
	316-301	Memory; 10,000 slabs	1,600	20	75,000
	316-302	Memory; additional 10,000 slabs	1,800	20	80,000
	316-4	Memory; 15,000 slabs	2,800	40	132,000
Random Access Storage	353-1	CRAM; 100 KC, 5.5 million characters	900	158	38,000
	353-2	CRAM; 38 KC, 8.0 million characters	700	120	30,000
	353-3	CRAM; 38 KC, 16.1 million characters	825	150	35,500
		Options			
		CRAM Use Lockout Feature(1)	15	0	600
		Automatic Recovery Option (1)	30	15	1,500
Input-Output		Punched Card and Punched Tape			
	472-1	Input/Output Console (includes 1,000-cps paper tape reader and 110-cps paper tape punch)	450	50	15,000
	472-1	Input/Output Console (includes 400-cpm card reader)	450	83	20,000
	472-3	Input/Output Console (includes paper tape reader, paper tape punch, and card reader)	900	133	35,000
		90-column adapter for console reader	-	-	200
	361-201	Paper Tape Reader; 600 cps	250	50	9,800
	371-201	Paper Tape Punch; 120 cps	250	50	9,800
	376-7	Card Read Punch; 300/50 cards/min (requires 354-6 controller)	375	21.50	23,900
	376-8	Card Read Punch; 400/88 cards/min (requires 354-6 controller)	500	27.50	25,200
	354-6	Card Read-Punch Controller	150	10	6,600
	380-3	Card Reader; 100 cards/min	750	125	35,000
		IBM Translator feature	35	5	1,400
	376-2	Card Punch; 100 cards/min (requires 354-101 buffer)	125	16.25	7,940
	376-101	Card Punch; 250 cards/min (requires 354-101 buffer)	400	90	22,500
	354-101	Card Punch Buffer	450	30	25,000

(1) This feature, when incorporated, is required on both the central processor and each CRAM unit.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Input-Output (Contd.)		Printers			
	340-3	Printer; 690 lines/min (includes buffer)	1,425	260	72,500
	340-502	Printer-Lister; 650 lines/min	995	230	43,750
	340-512	Printer-Lister; 650/1800 lines/min	995	230	43,750
	340-503	Printer — Unbuffered; 650 lines/min	650	90	30,000
	340-601	Printer; 1000 lines/min (includes buffer)	1,600	125	75,000
		Special characters, per character	-	-	350
		Magnetic Tape			
	334-101	Magnetic Tape Unit with controller; 12 KC; controls, in addition, up to four 334-102's	300	70	12,400
	334-102	Magnetic Tape Unit without controller; 12 KC	225	60	9,100
	334-131	Magnetic Tape Unit with controller; 33 KC; controls itself and up to four 334-132's	400	80	16,000
	334-132	Magnetic Tape Unit without controller; 33 KC	300	70	12,500
	333-101	Magnetic Tape Unit; 120 KC	975	140	40,000
	333-102	Magnetic Tape Unit; 83 KC	825	140	36,000
	324-1	Magnetic Tape Simultaneity Controller	695	58	32,000
	324-2	Magnetic Tape Double Simultaneity Controller	1,390	117	64,000
		Other			
	402-3	MICR Sorter-Reader; 750 documents/min (requires 355-1 Buffer)	1,700	458	45,000
	355-1	MICR Sorter Buffer (controls up to four 402-3 Sorter-Readers)	450	30	23,500
	407-1	MICR Sorter-Reader; 1200 documents/min (requires 355-3 Buffer)	2,100	4,170	95,000
		Endorser Feature for 407-1	300	44	12,000
	355-3	MICR Sorter Buffer (controls up to 4 407-1 Sorter-Readers	250	30	15,000
	420-1	Optical Journal Reader	1,900	18	75,000
	435-201	Universal Interconnecting Device (1 module)	125	9	5,000
	435-202	Universal Interconnecting Device (2 modules)	190	13	7,500
	435-203	Universal Interconnecting Device (3 modules)	250	18	10,000
		Communications Equipment			
	321-1	Central Communication Controller (includes space for 3 Adapter Cages)	850	100	36,000

(Contd.)

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Input-Output (Contd.)		Auxiliary Cabinet (contains space for 4 Adapter Cages)	250	30	10,000
		Adapter Cage (contains space for 10 Adapters)	30	6	1,200
		Teletype Adapter	15	3	600
		Teleprinter (Kleinschmidt) Adapter	15	3	600
	356-1	Central Inquiry Buffer (1 character, alphanumeric); controls up to 8 adapters	675	60	28,200
	356-3	Central Inquiry Buffer (17 characters, numeric); controls up to 8 adapters	975	65	40,500
	359-3	Communication Line Adapter — Teletype	175	19	7,100
	359-4	Communication Line Adapter — Monitor	130	20	5,500
	358-3	Auxiliary Cabinet	160	10	6,450
	428-3	Window Machine Controller	30	6	1,300
		Branch Controller for:			
	438-302	2 window machines	220	40	9,500
	438-304	4 window machines	245	40	10,500
	438-306	6 window machines	270	40	11,500
	438-308	8 window machines	295	40	12,500
	438-310	10 window machines	320	40	13,500
	438-312	12 window machines	345	40	14,500
	438-314	14 window machines	370	40	15,500
	438-316	16 window machines	395	40	16,500

CONTENTS

* Refer to indicated section of the NCR 315 Computer System Report.

INTRODUCTION

The NCR 315-100 was announced in July, 1963, as an economy version of the NCR 315 computer system using essentially the same central processor and core memory. The multiply-divide facility and various input-output control features of the 315 were made optional, and a low-cost, low-performance line of peripheral devices was made available for the 315-100. The purpose of this, of course, was to reduce the cost of obtaining an installation's first computer system from NCR. Recently, the full line of NCR 315 peripheral equipment was made available for 315-100 systems. This has greatly reduced the effective differences between the 315 and 315-100.

The performance of the 315-100 central processor and core storage is essentially identical with the performance of the corresponding components of the original NCR 315 system. Thus, programs can be freely interchanged between a 315 system and a 315-100 system having equivalent facilities, peripheral equipment, and core memory. All of the software available for the 315 can be used with 315-100 systems.

To emphasize the close relationship between the NCR 315 and 315-100 computer systems, this report presents the information that pertains specifically to the 315-100, with frequent references to the NCR 315 report (Computer System Report 601) for the information common to both systems. See the Introduction to the NCR 315 report (page 601:011.101) for brief descriptions of the facilities and characteristics of the various hardware and software components of the 315 line.

SYSTEM CONFIGURATION

Every NCR 315-100 EDP system includes the following units:

- Central Processor — Model 315-101. (For input, output, file, and inquiry devices other than punched card and paper tape equipment, special adapters must be used.)
- Console — includes I/O typewriter and option switches.
- Core Storage — one of the following modules:

  316-102 — 5,000 slabs.

  316-103 — 10,000 slabs.

  316-104 — 15,000 slabs.

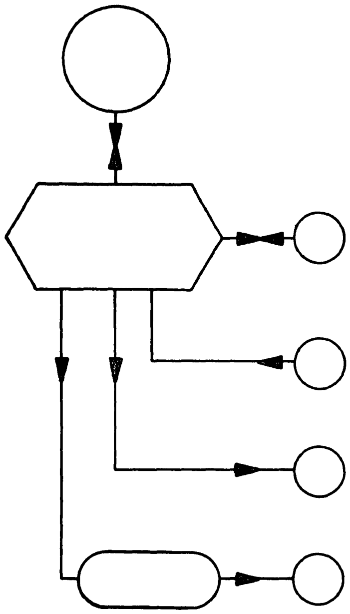
  In addition, systems utilizing the 316-103 memory module can add up to three 10,000-slab 316-302 modules, providing a maximum capacity of 40,000 slabs of core storage.

- Various peripheral devices — all peripheral devices listed for the NCR 315 in Section 601:031, Table III, can also be used in a 315-100 system. In addition, the unbuffered MICR Sorter/Reader, Model 402-4, is available for NCR 315-100 systems.

The maximum number of each type of peripheral device that can be connected to an NCR 315-100 computer system is the same as for a 315 system; see page 601:031.002.

.1 CARD SYSTEM; CONFIGURATION I

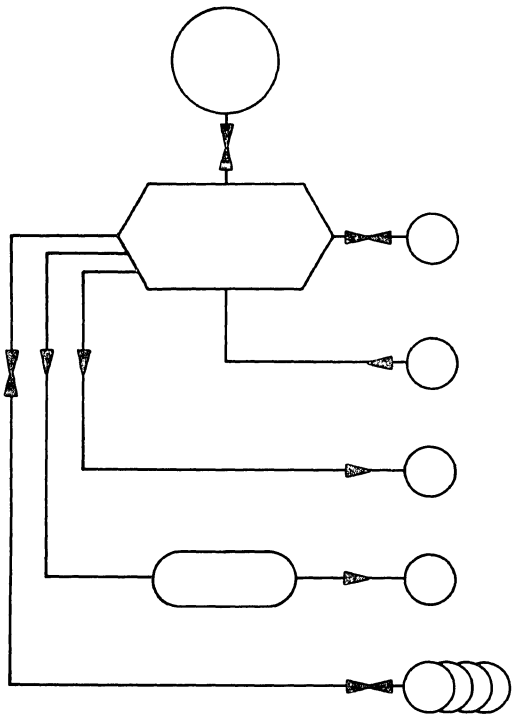
Deviations from Standard Configuration.........card reader is 100% faster.
card punch is 25% faster.
console typewriter is standard.
32 index registers are standard.



Equipment	Rental
316-102 Core Storage: 5,000 slabs 315-101 Central Processor and Console with Typewriter	$1,600
380-3 Card Reader: 2,000 cards/min	750
340-601 Printer and Buffer: 1,000 lines/min	1,600
354-101 Card Punch Buffer 376-101 Card Punch: 250 cards/min	850
Optional Features Included:...................Multiply-Divide	200
TOTAL RENTAL:	$5,000

.2 4-TAPE BUSINESS SYSTEM; CONFIGURATION II

Deviations from Standard Configuration: . . . . printer is 30% faster.
magnetic tape is 20% slower.
card reader is 20% slower.
console typewriter is standard.
32 index registers are standard.



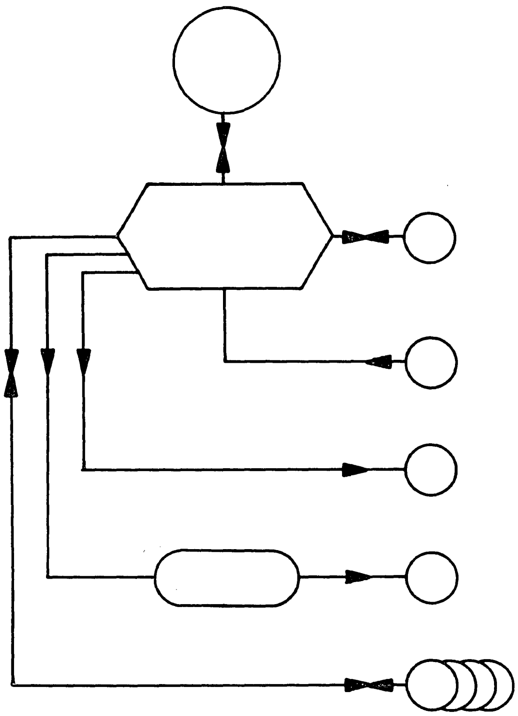
Equipment	Rental
316-102 Core Storage: 5,000 slabs. 315-101 Central Processor and Console with Typewriter and Low Speed File Adapter	$1,700
472-2 Card Reader: 400 cards/min	450
340-503 Unbuffered Printer: 805 lines/min	650
354-101 Card Punch Buffer 376-2 Card Punch: 100 cards/min	575
334-101 (1) Magnetic Tape Unit 334-102 (3) Magnetic Tape Units: 12,000 characters/sec	975

Optional Features Included: . . . . none.

TOTAL RENTAL	$4,350

.3 4-CRAM BUSINESS SYSTEM; SPECIAL CONFIGURATION IIIC

Deviations from Standard Configuration III: ..... 4 CRAM units are used in place of 6 magnetic tape units.
printer is 38% faster.
card reader is 20% slower.
CRAM read or write operations cannot be overlapped with computation.
32 index registers are standard.



Equipment	Rental
316-103 Core Storage: 10,000 slabs 315-101 Central Processor and Console with Typewriter and CRAM File Adapter	$2,300
472-2 Card Reader: 400 cards/min	450
340-3 Buffered Printer: 690 lines/min	1,425
354-101 Card Punch Buffer 376-2 Card Punch: 100 cards/min	575
353-2 CRAM units (4): 38,000 characters/sec	2,800

Optional Features Included: .... Multiply-Divide 200

TOTAL RENTAL: $7,750

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . Basic Processor, Model 315-101.

.12 Description

The 315-101 Basic Processor is an economy version of the central processors used in NCR 315 systems. The multiply-divide feature is optional at extra cost with the 315-101 Processor. Subroutines are furnished for systems not having this hardware feature. Otherwise, the 315-101 Processor has the same processing capabilities and speeds as the NCR 315 central processors described in Section 601:051.

Unlike the 315 processors, which are offered in several models differing in the types of peripheral devices they can control, only one processor model is offered for 315-100 systems. In its basic form, the 315-101 Processor can control only punched card and punched paper tape devices and line printers. Various adapters for the 315-101 Processor permit the connection of most of the peripheral devices offered for NCR 315 computer systems. Section 602:071 contains a list of the adapters necessary to connect different types of peripheral devices to a 315-101 Processor. These adapters can be field-installed to facilitate expansion of a 315-100 system.

Refer to Section 601:051 of the NCR 315 Computer System Report for a detailed description of the processing capabilities and performance of the NCR 315 processors. Subroutine times for fixed-point multiplication and division are as follows:

Multiply — 3.5 + 1.8D milliseconds.
Divide — 17.6 + 1.2D milliseconds.

D = number of digits in multiplier or quotient.

The multiply subroutine occupies 195 slabs of storage, and the divide subroutine occupies 221 slabs.

.13 Availability: . . . . 4 months.

.14 First Delivery: . . . . . . December, 1964.

PERIPHERAL EQUIPMENT

All NCR 315 peripheral devices are now available for use in NCR 315-100 systems. See Sections 601:042, 601:043, and 601:072 through 601:107 for detailed descriptions of these peripheral devices, including their time demands upon the central processor.

Many peripheral devices require that a special adapter be added to the 315-101 Processor. In general, only one adapter of each type is required in a 315-100 computer system. Table I lists the various peripheral devices and the adapters they require.

TABLE I: NCR 315-100 PERIPHERAL ADAPTERS

Type of Peripheral Device	Adapter Required
Punched card devices, punched paper tape devices, and line printers	None
CRAM, Models 353-2, 353-3	CRAM File Adapter
CRAM, Model 353-1	CRAM File Adapter, High-Speed File Adapter
Magnetic Tape Units, 334 Series	Low-Speed File Adapter
Magnetic Tape Units, 333 Series	High-Speed File Adapter
Magnetic Tape Units using Magnetic Tape Simultaneity Controller	Simultaneity Adapter in addition to the appropriate File Adapter
MICR Sorter-Reader, Model 402-3	MICR Buffer Adapter
Communications devices using Model 321-1 Controller or Model 356-1 or Model 356-3 Inquiry Buffer	Inquiry Buffer Adapter
Unbuffered communications devices	Unbuffered Inquiry Adapter

602:151.100

NCR 315-100
Software

SOFTWARE

The NCR 315-100 computer system uses the same software as the NCR 315 system. Please refer to Sections 601:151 through 601:192 of the NCR 315 Computer System Report for detailed descriptions of the available facilities.

SYSTEM PERFORMANCE

GENERAL

The performance of NCR 315 and NCR 315-100 computer systems of like equipment configurations is essentially identical. Because the 315-100 is being marketed as an economy version of the 315, we have analyzed its performance in only three small-scale configurations: I, II, and IIIC. (In Special Configuration IIIC, four CRAM units replace the six magnetic tape units specified for Standard Configuration III.)

A Model 340-503 unbuffered printer is used in Configuration II. In effect, this makes Configuration II a sequential processing system capable of only one input-output operation at a time and with only a small amount of overlapped computing time available. Note also that Standard Configuration II does not include the optional Multiply-Divide feature. Standard NCR subroutines are used instead.

GENERALIZED FILE PROCESSING (602:201.100)

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 varying record sizes in the master file. Standard Problem D shows the effects of increasing 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.

In Standard Configuration I, both the master and detail files are on punched cards. Since the usual practice is to input only active master-file records (records for which there is a corresponding detail card), only the performance at an activity ratio of 1.0 is meaningful. In all problems, the card punch is the controlling factor.

In Standard Configuration II, the master files are on magnetic tape. None of the peripherals are buffered, and all I/O operations are performed sequentially with no overlapping. There is no time available for computing during the magnetic tape operations, but there is some time available for overlapped computing during the card reader and printer operations. At moderate and high activities, the amount of overlap available is sufficient, except in Problem D (high computation), to allow all the peripheral devices to operate at their maximum effective speeds. At low activity ratios, for all problems, the amount of time available between detail cards is insufficient to permit all the internal processing to be done during this time, and the central processor becomes the controlling factor.

The activity ratio at which the central processor becomes limiting in Configuration II depends on the amount of computation per record and the blocking factor of the master file. (Actually, it depends on the size of a master record since the block length is held constant in these problems.) In general, as the amount of computation increases (Problem D) or the blocking factor decreases (Problem C), the activity ratio below which the central processor is the controlling factor becomes higher.

Standard Configuration IIIC is a special configuration that illustrates the use of CRAM in place of magnetic tape. The decision that four CRAM units are equivalent to six magnetic tape units is somewhat arbitrary. The capability to have multiple files on-line in a single CRAM unit, with equal access times to any of them, clearly indicates that one CRAM unit is logically equivalent to more than one magnetic tape unit in most applications. The reduced file size allowable when placing multiple files in a single CRAM cartridge prevents one CRAM unit from taking the place of all tape units. For the purposes of this analysis, the two master files were placed on different CRAM units to take advantage of overlapping card drop times. Two input and two output areas were used as buffers for CRAM operations to minimize the rotational delays through utilization of the interrupt capability of the CRAM units. It should be noted that in this application CRAM is being used as a sequential device (analogous to a magnetic tape unit), and not as a random access device.

The CRAM read and write operations and the card read operations can only be performed sequentially. As in Configuration II, the limited amount of compute overlap results in the central processor becoming the controlling factor at low activity ratios (all problems) and when large amounts of computation are performed (Problem D). The activity ratio below which the central processor becomes the controlling factor depends upon considerations similar to those outlined for Configuration II.

SORTING

The performance of an NCR 315-100 computer system in a sorting application is the same as that of an NCR 315 system of similar configuration. See the graphs on page 601:201.200 and 601:201.220, and also the general notes pertaining to Sorting on page 601:201.002, for the sorting performance of the NCR 315.

MATRIX INVERSION

The matrix inversion performance of an NCR 315-100 computer system equipped with the Multiply-Divide feature is the same as that of an NCR 315 system. See page 601:201.300 for the performance of the 315 on this problem.

WORKSHEET DATA TABLE 1 (Standard File Problem A)

	ITEM		CONFIGURATION I		CONFIGURATION II		CONFIGURATION IIIC		REFERENCE
1 Input-Output Times	Char/block	(File 1)	54		880		1156		4:200.112
	Records/block	K (File 1)	9.5		10		12		
	msec/block	File 1 = File 2	30/240		85.8		30.6		
		File 3	30		150		150		
		File 4	115		148		143		
	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	18.31.9		85.8		30.6		
		File 3	24		126.4		126.4		
		File 4	2.2		75		1.3		
2 Central Processor Times	msec/block	a_1	0.55		0.55		0.55		4:200.1132
	msec/record	a_2	1.60		1.60		1.60		
	msec/detail	b_6	0.53		0.53		0.53		
	msec/work	$b_5 + b_9$	7.28		55.70		7.28		
	msec/report	$b_7 + b_8$	2.95		2.95		2.95		
3 Standard File Problem A F = 1.0	msec/block for C.P. and dominant column.		C.P.	Punch	C.P.	I/O	C.P.	I/O	4:200.114
		a_1	0.6		0.6		0.6		
		a_2 K	0.8		16.0		19.2		
		a_3 K	5.4		591.8		129.1		
		File 1: Master In	18.3		85.8	85.8	30.6	30.6	
		File 2: Master Out	0.9	240	85.8	85.8	30.6	30.6	
		File 3: Details	12.0		1,264.0	1,500.0	1,516.8	1,800.0	
		File 4: Reports	1.1		750.0	1,480.0	15.6		
		Total	39.1	240	2,794.0	3,151.6	1,763.4	1,861.2	
4 Standard File Problem A Space	Unit of measure	(slabs)							4:200.1151
		Std. routines	80		1,000		1,320		
		Fixed	0		0		0		
		3 (Blocks 1 to 23)	360		360		360		
		6 (Blocks 24 to 48)	1,620		1,620		1,620		
		Files	416		1,960		2,312		
		Working	40		40		40		
		Total	2,516		4,980		5,652		

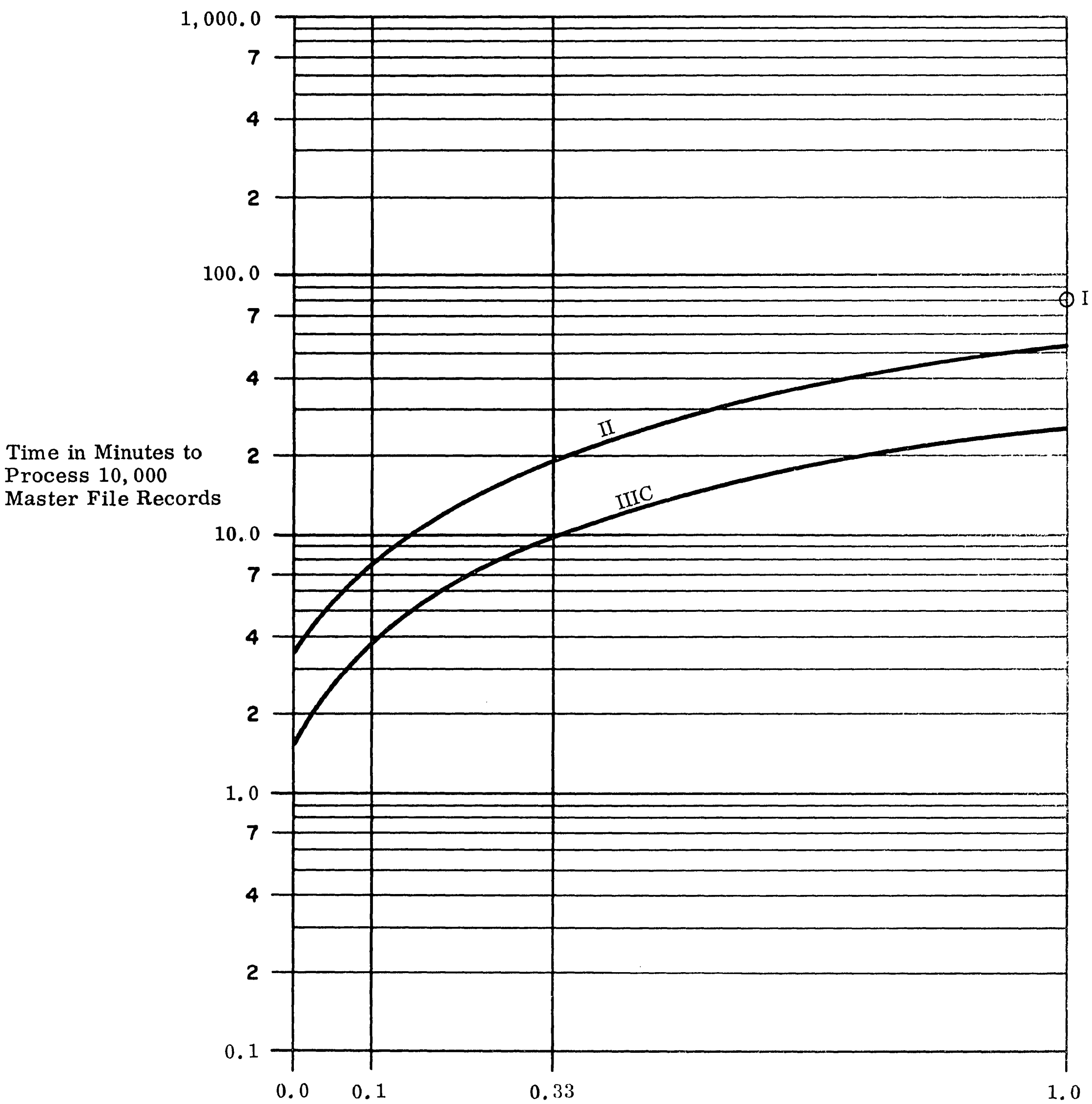
(Contd.)

.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: . . . . 2,516 slabs.
Configuration II: . . . . 4,980 slabs.
Configuration IIIC: . . 5,652 slabs.



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

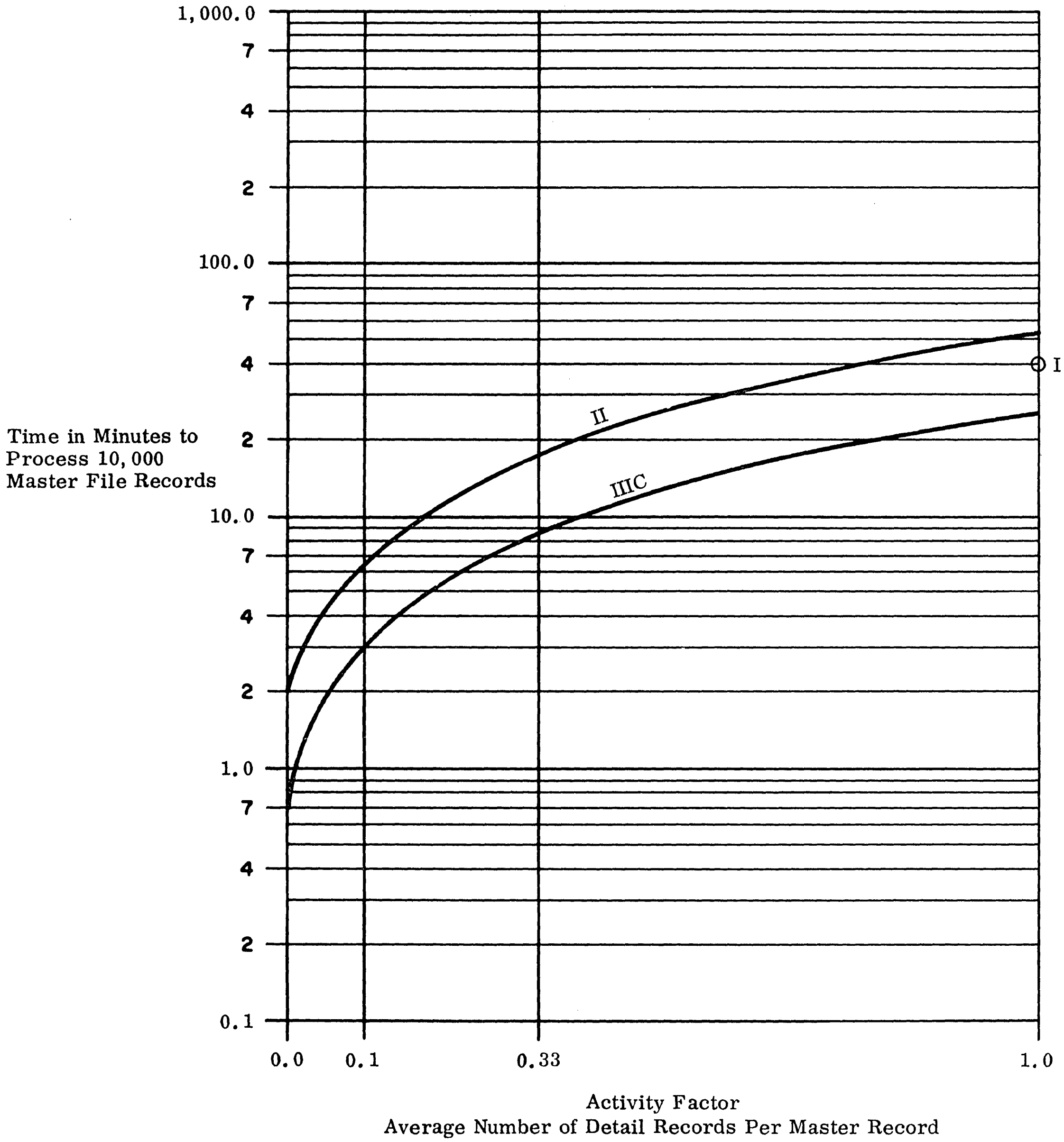
.12 Standard File Problem B

.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.)

AUERBACH

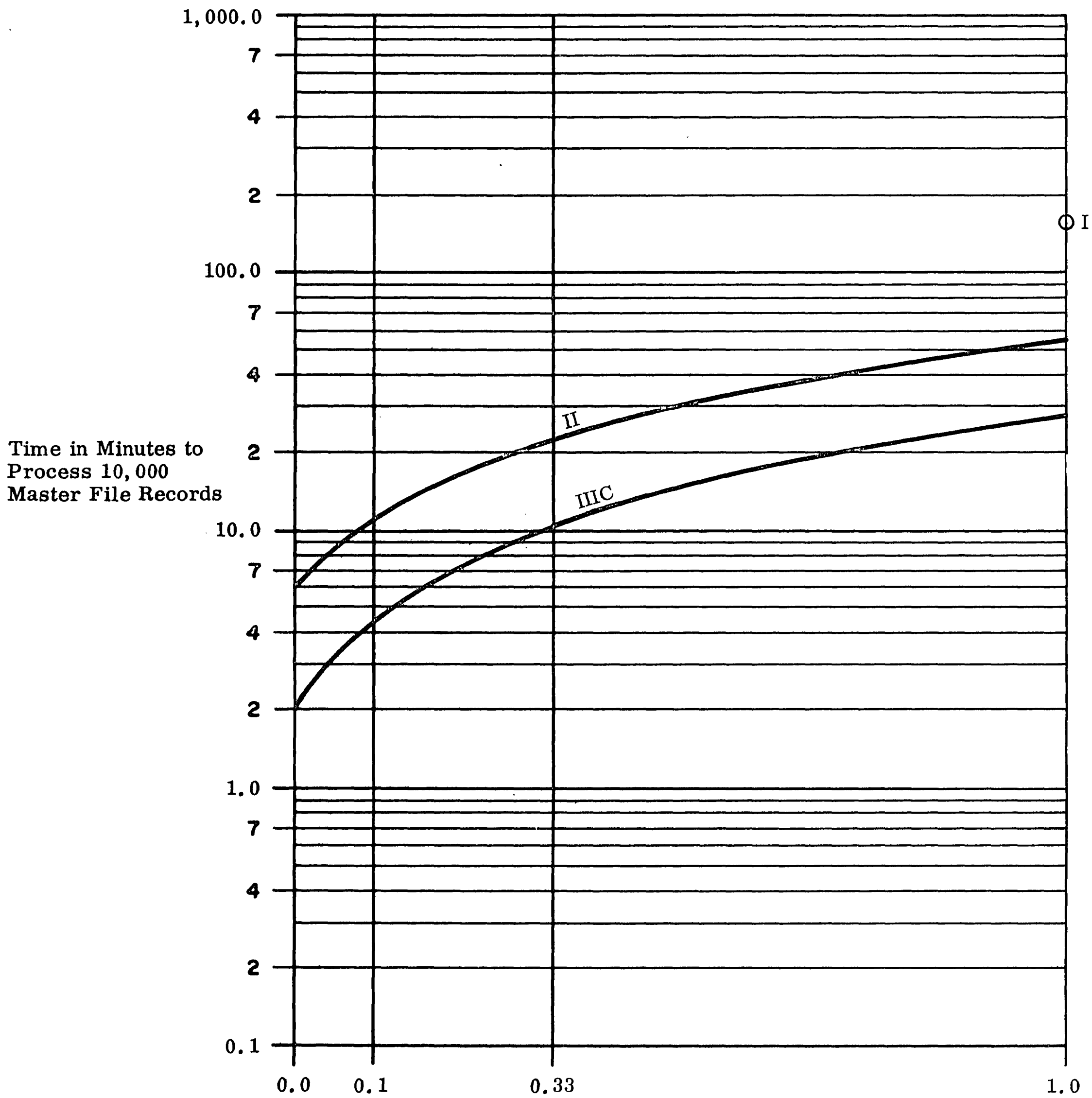
.13 Standard File Problem C

.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.)

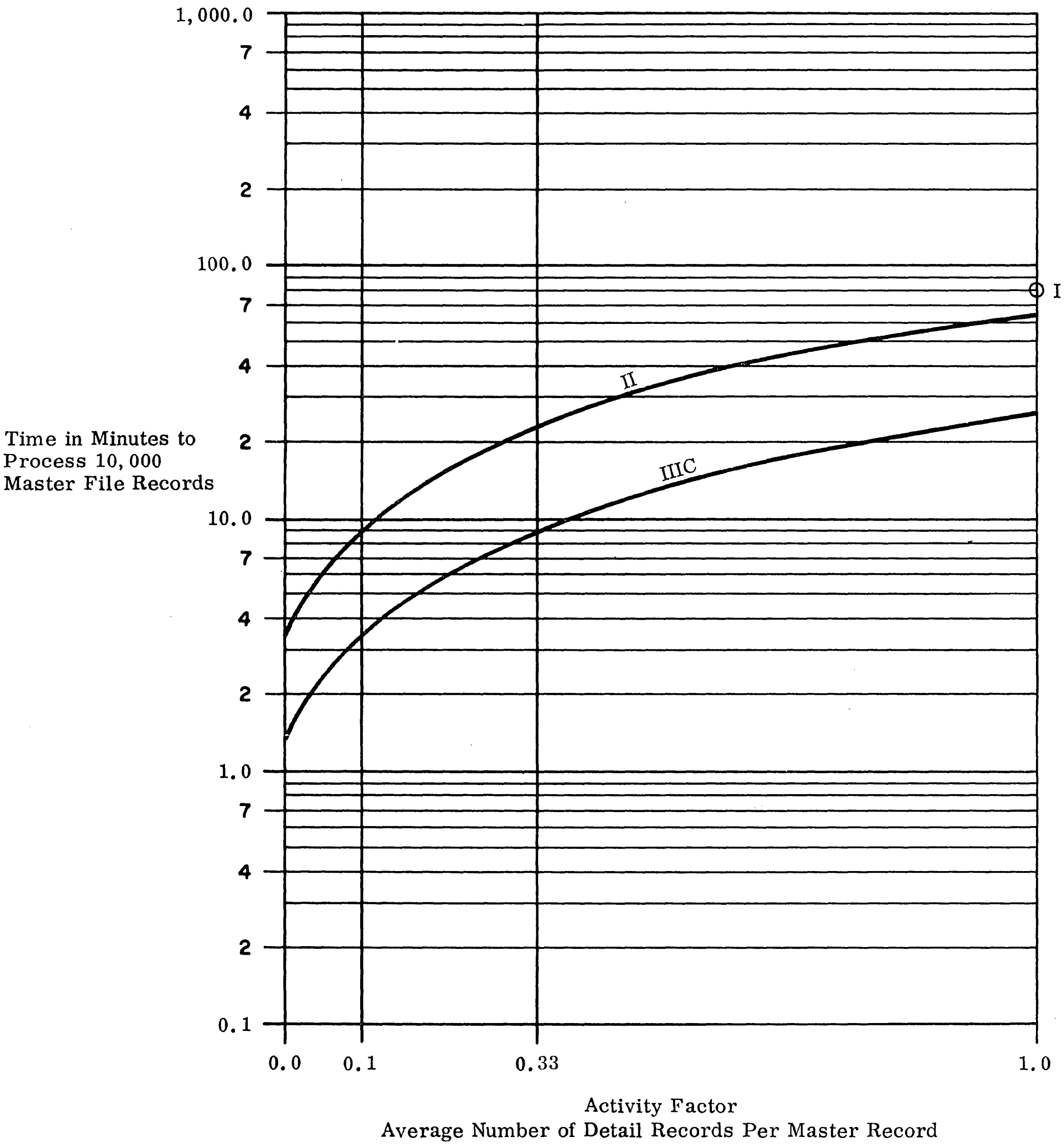
.14 Standard File Problem D

.141 Record sizes —
- Master file: . . . . 108 characters.
- Detail file: . . . . 1 card.
- Report file: . . . . 1 line.

.142 Computation: . . . . treble.

.143 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.14.

.144 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

PRICE DATA

CLASS	IDENTITY OF UNIT: No.	IDENTITY OF UNIT: Name		PRICES: Monthly Rental $	PRICES: Monthly Maintenance $	PRICES: Purchase $
CENTRAL PROCESSOR	315-101	Basic Processor; includes Console and Typewriter		*	*	*
		Optional Features				
		Low-Speed File Adapter	(1)	100	15	5,000
		CRAM File Adapter	(2)	100	10	5,000
		High-Speed File Adapter	(3)	400	25	20,000
		Simultaneity Adapter	(4)	100	10	5,000
		MICR Buffer Adapter	(5)	100	10	5,000
		Inquiry Buffer Adapter	(6)	250	10	10,000
		Unbuffered Inquiry Adapter	(7)	75	10	3,250
		Automatic Recovery Option		100	5	5,000
		CRAM Use Lockout Feature		50	—	2,000
		Multiply-Divide		200	20	9,200
INTERNAL STORAGE	316-102	Memory, 5,000 slabs		1,600*	190*	82,600*
	316-103	Memory, 10,000 slabs		2,200*	190*	104,400*
	316-104	Memory, 15,000 slabs		3,000*	265*	144,100*
	316-302	Memory, additional 10,000 slabs	(8)	1,800	20	80,000
INPUT-OUTPUT	402-4	MICR Sorter-Reader; 750 documents/min (unbuffered)		1,700	458	45,000

Note: The peripheral units offered for the NCR 315 computer system can also be used in 315-100 systems. See the Price Data section of the NCR 315 report, page 601:221.101, for price data on all peripheral devices.

* Price of Basic Processor is included in the prices of the indicated Memory units.

(1) Required for 334 Series Magnetic Tape Units.

(2) Required for all CRAM units.

(3) Required for 333 Series Magnetic Tape Units and 353-1 CRAM unit.

(4) Required for 324-1 and 324-2 Magnetic Tape Simultaneity Controllers.

(5) Required for 355-1 MICR Sorter-Reader Buffer.

(6) Required for 356-1 and 365-3 Central Inquiry Buffers and 321-1 Central Communications Controller.

(7) Required for connection of unbuffered Teletype devices.

(8) The 316-102 Memory Unit can be used only in conjunction with the 316-103 Memory unit. Up to three 316-302 Memory units can be added to a 316-103.

CONTENTS

* Refer to indicated section of the NCR 315 Computer System Report.

INTRODUCTION

The NCR 315 Rod Memory Computer was announced in July, 1964, as the first commercially-available, general-purpose computer system utilizing a thin-film storage medium for the entire working memory. The higher speed of this memory makes the 315 RMC about 7.5 times as fast internally as the older NCR 315 and 315-100 central processors, with which it is program-compatible. The 315 RMC also offers additional processing capabilities beyond those of the other two systems in the 315 line and is a logical candidate for replacement of an NCR 315 system when the needs of the installation outgrow the capabilities of the 315 central processor. System rentals for the NCR 315 RMC range from approximately $8,000 to over $20,000 per month.

To emphasize the similarities between the NCR 315 and the 315 RMC, only the information that pertains uniquely to the 315 RMC is presented in this report. Material common to both systems is presented in the NCR 315 report (Computer System Report 601), and there are numerous references to this material in the 315 RMC report.

Compatibility

The 315 RMC is the third in the NCR 315 line of program-compatible computer systems. Non-time-dependent programs originally written for a 315 or 315-100 system can be run by a 315 RMC system having equivalent memory and peripheral equipment. Programs written for the 315 RMC which make use of its added hardware capabilities will need modification before they can be run on either a 315 or 315-100.

Hardware

The Rod Memory is composed of beryllium-copper "rods", 0.015 inch in diameter, coated with an iron-nickle substance and wound with solenoids at periodic intervals along the rod. Each memory location is called a "slab" and is composed of 12 data bits and 1 parity bit — the same arrangement as in the NCR 315. Each slab can hold two 6-bit characters or three 4-bit decimal digits. Cycle time for each memory access of one slab is 800 nanoseconds (0.8 microsecond), making NCR's Rod Memory one of the fastest units currently available in its price range. Each Rod Memory unit has a storage capacity of 20,000 slabs. Up to four of these units can be used in a 315 RMC system, for a maximum storage capacity of 80,000 slabs (160,000 characters or 240,000 digits).

The control and processing functions, including interrupt facilities, for the 315 RMC have been implemented in the same manner as in the 315. However, only one model of the 315 RMC Central Processor is offered, and it contains the control logic for all peripheral devices. The auxiliary memory containing the accumulator, index registers, jump registers, and processor flags is of the same thin-film type as the main working storage and can be accessed simultaneously with the main memory.

The instruction repertoire is composed of the original NCR 315 instruction repertoire plus some additional facilities. The added instructions include data movement instructions that aid in handling data communications input and output, floating-point arithmetic operations, and several control instructions. The data movement instructions provide automatic conversion between the one-character-per-slab or one-digit-per-slab format of Teletype input and output and the internal format of the 315 RMC. The floating-point operations include add, subtract, multiply, divide, and normalize. All floating-point results can be automatically rounded.

The instruction format of the 315 RMC is identical with that of the 315. Addresses in the instructions themselves can be no larger than 999; the index registers permit addressing up to 39,999 locations. The additional storage capacity of the 315 RMC is addressed by using two special instructions, called Memory Expand and Memory Contract. These instructions set a flag which indicates which section (upper 40K or lower 40K) of memory is currently being addressed. The other new control instructions provide facilities for automatically storing the contents of the accumulator and the status of the processor flags in a specified 14-slab area, and for loading the accumulator and setting the processor flags from the contents of a specified 14-slab area.

Other capabilities of the 315 RMC are the same as those of the NCR 315. A brief description of the basic characteristics of the 315 is contained in the Introduction to the NCR 315 report (Section 601:011).

Peripheral Equipment

All of the peripheral devices available for the NCR 315, except the Input/Output Consoles and the Card Read Punches, are also available for 315 RMC computer systems. The only card reader available for the 315 RMC is the 2,000-card-per-minute Model 380-3. The configuration rules for attaching peripheral devices to the 315 RMC are the same as for the 315. The Introduction to the NCR 315 report (Section 601:011) presents a brief description of the available equipment.

Software

All of the software described in the Introduction to the NCR 315 report (Section 601:011) is also available for the 315 RMC. In addition, NCR is developing software that will enable the 315 RMC to run several programs simultaneously in a multiprogramming mode; detailed specifications are not available to date.

SYSTEM CONFIGURATION

Every NCR 315 RMC computer system includes the following units:

- Central Processor — Model 315-501.
- Console — includes I/O typewriter and option switches.
- Memory — one 20,000-slab 316-502 Rod Memory Module, plus up to three additional 20,000-slab 316-504 Rod Memory Modules. (Maximum memory size is 80,000 slabs.)
- Peripheral Devices — all peripheral devices listed in Table III of Section 601:031 for the NCR 315, except for the following:

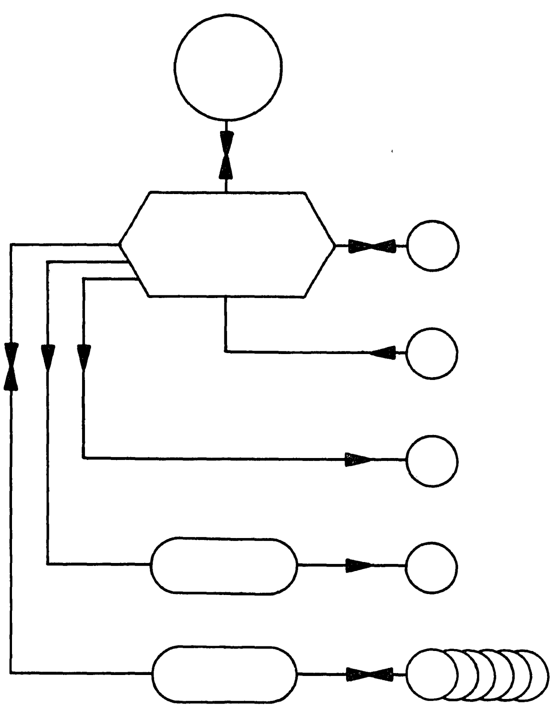
  Input/Output Consoles: Models 472-1, 472-2, and 472-3.

  Card Read Punches: Models 376-7 and 376-8.

Configuration rules for the number of devices that can be connected are the same as for the NCR 315; see page 601:031.002.

.3 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration:. . . . . card reader is 300% faster.
printer is 38% faster.
magnetic tape is 20% slower.
memory is 100% larger.
32 index registers are standard.



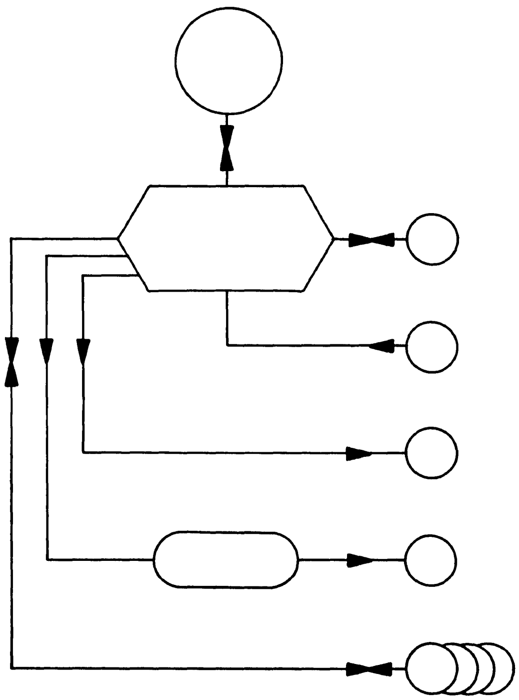
Equipment	Rental
316-502 Rod Memory: 20,000 slabs; 516-501 Central Processor and Console with Typewriter	$ 6,000
380-3 Card Reader: 2,000 cards/min	750
340-3 Printer and Buffer: 690 lines/min	1,425
354-101 Card Punch Buffer; 376-2 Card Punch: 100 cards/min	575
324-1 Magnetic Tape Simultaneity Controller	695
334-131 (1) Magnetic Tape Units: 334-132 (5) Magnetic Tape Units: 33,400 characters/sec	1,900

Optional Features Included: . . . . none.

TOTAL RENTAL: $11,345

.31 4-CRAM BUSINESS SYSTEM; SPECIAL CONFIGURATION IIIC

Deviations from Standard Configuration III: . . . . 4 CRAM units are used in place of 6 magnetic tape units.
printer is 38% faster.
card reader is 300% faster.
memory is 100% larger.
CRAM read or write operations cannot be overlapped with computation.
32 index registers are standard.



Equipment	Rental
316-502 Rod Memory: 20,000 slabs; 315-501 Central Processor and Console with Typewriter	$ 6,000
380-3 Card Reader: 2,000 cards/min	750
340-3 Printer and Buffer 690 lines/min	1,425
354-101 Card Punch Buffer; 376-2 Card Punch: 100 cards/min	575
353-2 CRAM units (4): 38,000 characters/sec	2,800

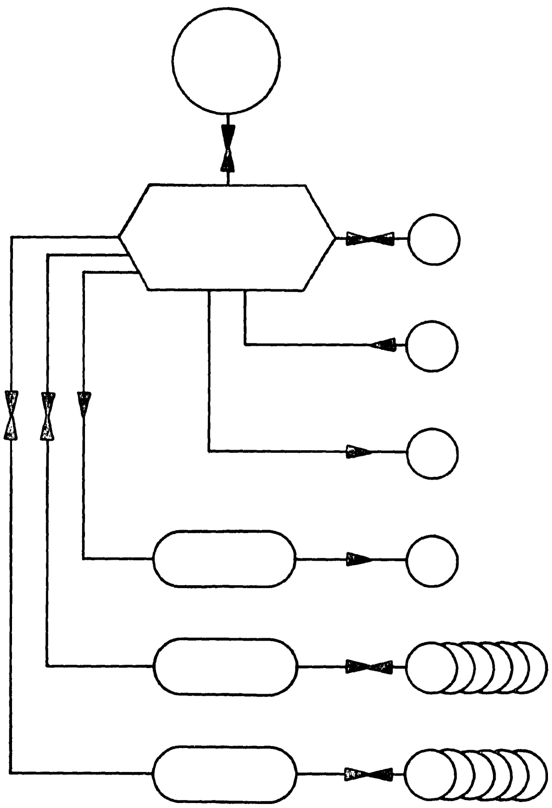
Optional Features Included: . . . . none.

TOTAL RENTAL: $11,550

(Contd.)

.4 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 100% faster.
card punch is 25% faster.



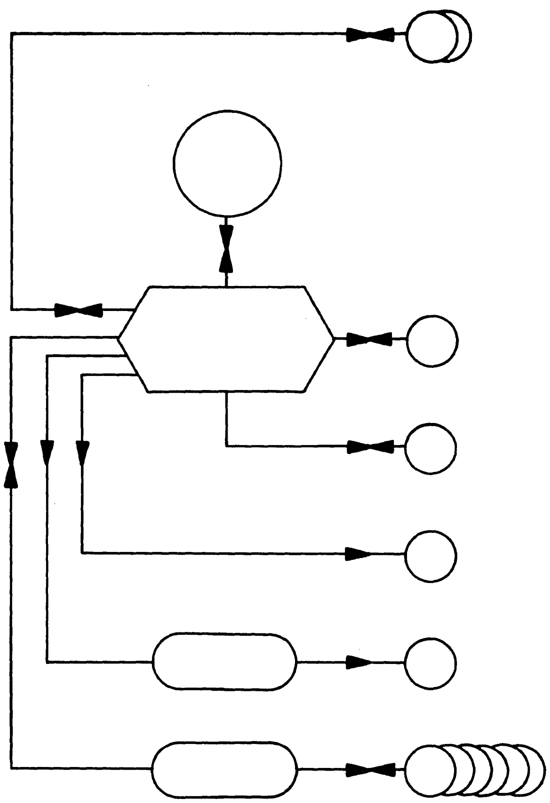
Equipment	Rental
316-502 Rod Memory: 20,000 slabs 315-501 Central Processor and Console with Typewriter	$ 6,000
380-3 Card Reader: 2,000 cards/min	750
340-601 Printer and Buffer: 1,000 lines/min	1,600
354-101 Card Punch Buffer 376-101 Card Punch: 250 cards/min	850
324-1 Magnetic Tape Simultaneity Control	695
333-102 Magnetic Tape Units (6): 83,400 characters/sec	4,950
324-1 Magnetic Tape Simultaneity Controller	695
333-102 Magnetic Tape Units (6): 83,400 characters/sec	4,950

Optional Features Included: . . . . none.

TOTAL RENTAL: $20,490

.5 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Deviations from Standard Configuration: . . . . card reader is 300% faster.
printer is 38% faster.
32 index registers are standard.
auxiliary storage is 61% larger.
memory is 100% larger.



Equipment	Rental
353-3 CRAM units (2): 32,200,000 characters	$ 1,650*
316-502 Core Storage: 20,000 slabs; 315-501 Central Processor and Console with Typewriter	6,000
380-3 Card Reader: 2,000 cards/min	750
340-3 Printer and Buffer. 690 lines/min	1,425
345-101 Card Punch Buffer; 376-2 Card Punch: 100 cards/min	575
324-1 Magnetic Tape Simultaneity Controller	695
334-131 (1) Magnetic Tape Units; 334-132 (5) Magnetic Tape Units: 33,400 characters/sec	1,900

Optional Features Included: . . . . none.

TOTAL RENTAL: $12,995

* Four Model 353-1 CRAM units (22 million characters total) can be substituted for higher performance. Total system rental in this case would be $15,145.

INTERNAL STORAGE: ROD MEMORY

.1 GENERAL

.11 Identity: . . . . 316-502 Rod Memory (20,000 slabs).

316-504 Additional Rod Memory (20,000 slabs).

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

.13 Description

The NCR 315 RMC is the first commercially-available computer system to employ a thin-film memory for its entire working storage. The memory is composed of beryllium-copper "rods", 0.015 inch in diameter, which are coated with an iron-nickel substance. Each 20,000-slab memory unit is composed of eight modules containing 1,056 rods each. Forty solenoid windings are placed at regular intervals along each "rod", providing the capability for storing "bits" of information. Each module then, has a storage capacity of 3,249 thirteen-bit slabs (12 data bits plus 1 parity bit), of which only 2,500 positions are used for data storage. The remainder serve as spares and, in one module of the first memory unit, as the auxiliary memory associated with the central processor. This auxiliary memory holds the accumulator, index registers, jump registers, and program-testable flags.

Up to four memory units of 20,000 slabs each can be incorporated into a 315 RMC computer system, providing a total storage capacity ranging from 20,000 to 80,000 slabs.

The 315 RMC's rod memory is functionally the same as the core storage of the original NCR 315. Each memory access is for one slab of 12 data bits plus 1 parity bit, and each slab can hold two 6-bit alphameric characters or three 4-bit decimal digits. Cycle time is 800 nanoseconds (0.8 microseconds) per memory access. Simultaneous accesses can be made to the main memory and the auxiliary (processor) memory as in the 315.

.14 Availability: . . . . 8 months.

.15 First Delivery: . . . . . . September, 1965.

.16 Reserved Storage: . . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . . thin film; see above Description.

.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.
.282 Reading method: . . . . . sense wire.
.283 Type of access: . . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates —
Cycling rate: . . . . . . 1,250,000 cps.
Unit of data: . . . . 1 slab per cycle.
Conversion factor: . . 12 bits (plus parity) per slab.
Data rate: . . . . 1,250,000 slabs/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	316-502	1 316-502 plus 3 316-504's.
Slabs:	20,000	80,000.
Characters:	40,000	160,000.
Digits:	60,000	240,000.
Instructions:	5,000 to 10,000	20,000 to 40,000.
Modules:	1	4.

.32 Rules for Combining Modules: . . . . one 316-502 unit plus up to three 316-504 units.

.4 CONTROLLER: . . . . . no separate controller.

.5 ACCESS TIMING

.52 Simultaneous Operations: . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access —
Access time: . . . . . . ?
Cycle time: . . . . 0.8 μsec.
For data unit of: . . . . 1 slab (12 bits plus parity bit).

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE

.72 Transfer Load Size

With self: . . . . 1 to 999 slabs.
With CRAM: . . . . 1 to 1,550 slabs or 1 to 560 slabs, depending on CRAM model.

.73 Effective Transfer Rate

With self: . . . . 622, 000 slabs/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	halt. *
Invalid code:	none.	
Receipt of data:	parity check	program jump.
Recovery of data:	parity check	program jump.
Dispatch of data:	send parity bit.	

* This refers to a bit combination that cannot be decoded as an address. If a given address exceeds machine capacity, the effective address is modulo memory size.

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . 315-501 Central Processor.

.12 Description

The 315-501 Central Processor used in an NCR 315 RMC computer system is functionally identical with the 315-45 Bank-File Inquiry Processor offered for NCR 315 systems except for the greatly increased speeds and other additional capabilities of the 315-501.

Refer to Section 601:051 of the NCR 315 Computer System Report for a detailed analysis of the capabilities of the 315-45 Processor. Only the additional capabilities and performance of the 315-501 Processor are described in this section.

The number, size, and functions of registers and flags are the same as in the NCR 315 Processors, but in the 315-501 they are held in Rod Memory rather than core memory. This auxiliary processor memory can be accessed simultaneously with the main memory, permitting address modifications (indexing only) to be made with no time penalty. The instruction format permits only a three-digit address portion in the instruction itself (as in the 315 Processors), but the index registers extend the range of addressable storage to 40,000 slabs. Additional memory, up to the maximum of 80,000 slabs, can be addressed by using two new instructions that specify which 40,000-slab segment of memory is to be referenced.

Several floating-point operations have been added to the basic instruction repertoire of the NCR 315, including add, subtract, multiply, divide and normalize. All floating-point arithmetic results can be automatically rounded if desired. Floating-point data format is the same as for the subroutines used in the NCR 315 — one slab for the exponent and four slabs for the fraction — permitting floating-point operands ranging from 10^{-99} to 10^{999}. All floating-point operations are of 12-digit precision.

Other instructions added to the basic NCR 315 instruction repertoire include provisions for data movement with format change (from 2 characters or 3 digits per slab to 1 character or digit per slab, and the reverse), and provisions for saving and restoring the contents of the accumulator and the status of the overflow and comparison result flags. The data movement instructions facilitate the handling of inquiry messages which are received and sent one character at a time, and which therefore require format conversions between the one-character-per-slab format used for data transmission and the normal NCR 315 internal format. The save and restore instructions facilitate switching between programs when operating in a multiprogramming environment (usually one main program and an inquiry program). The functions described in this paragraph require the use of time-consuming subroutines in the older NCR 315 processors.

The processor speeds listed in this section are based on the manufacturer's estimated instruction execution times, which indicate that overall processor execution speeds of the NCR 315 RMC will be 7.5 times as fast as those of the older NCR 315 and 315-100 processors.

Console

The console operating switches and lights provided for a 315 RMC computer system are mounted in a panel above the desk-height central processor cabinet. A work surface of 67 by 35 inches is provided; these dimensions include the space occupied by the console typewriter. The same switches, displays, and capabilities are provided by the 315 RMC console as by the 315 console. See Section 601:061 for a more detailed description of these facilities.

.13 Availability: . . . . 8 months.

.14 First Delivery: . . . . . September, 1965.

.4 PROCESSOR SPEEDS

Note: D, the number of decimal digits in the operands, must be a multiple of 3 and not greater than 24. In negative numbers, the minus sign occupies one digit position.

.41 Instruction Times in Microseconds

.411 Fixed point —
- Add-subtract: . . . . . . 4.8 + 0.27D.
- Multiply: . . . . 12.8 + 5.2D + $0.94D^2$.
- Divide: . . . . 90 + 11D + $1.2D^2$.

.412 Floating point —
- Add-subtract: . . . . . . 16.
- Multiply: . . . . 200 (average).
- Divide: . . . . 485 (average).

.413 Additional allowance for —
- Indexing: . . . . 0.
- Re-complementing: . . 0.27D.

.414 Control —
- Compare: . . . . like signs: 4.8 + 0.27D.
  unlike signs: 4.8
- Branch: . . . . 6.4 to 8, depending on instruction.

.415 Counter control —
- Step and test: . . . . . . 9.

.416 Edit: . . . . 4 + 1.2D to about 12 + 1.2D.

.417 Convert —
- 4-bit to 6-bit: . . . . . . 7.2 + 0.4D.
- 6-bit to 4-bit: . . . . . . 8.8 + 0.53D.

.418 Shift: . . . . 5.6 to 120.

.42 Processor Performance in Microseconds

	Fixed point	Floating point
.421 For random addresses —		
$c = a + b$:	14.6+0.8D	33.6
$b = a + b$:	9.6+0.53D	33.6
Sum N items:	(4.8+0.27)N	16N
$c = ab$:	$22.4+6D+0.94D^2$	217.6
$c = a/b$:	$100+11.9D+1.2D^2$	397.6
.422 For arrays of data —		
$c_i = a_i + b_j$:	37.8+0.8D	56.0
$b_j = a_i + b_j$:	32+0.53D	36.0
Sum N items:	(19.2+0.27D)N	30.4N
$c = c + a_ib_j$:	$44.6+6D+0.94D^2$	256.0

.423 Branch based on comparison —
Numeric data: . . . . . 39.2+2.27D
Alphabetic data: . . . . 39.2+0.40D

.424 Switching —
Unchecked: 34.4
Checked: . . . . 60.
List search: 61.6

.425 Format control, per character —
Unpack: . . . . 0.94 (assuming prior code translation).
Compose: 1.87

.426 Table look-up, per comparison —
For a match: . . . . . . 24.
For least or greatest: . . . . 26.2 to 41.3
For interpolation point: . . . . 23.

.427 Bit indicators —
Set bit in separate location: 7.2
Set bit in pattern: . . . 27.2
Test bit in separate location: 11.2
Test bit in pattern: . . 21.6

.428 Moving: . . . . 7.2 + 1.6S, where S is the number of slabs moved.

PERIPHERAL EQUIPMENT

All peripheral devices offered for NCR 315 computer systems are available for 315 RMC systems, except for the following:

- Input/Output Console, Models 472-1, 472-2, and 472-3.
- Card Read Punch, Models 376-7 and 376-8.

See Sections 601:042, 601:043, and 601:072 through 601:107 of the NCR 315 Computer System Report for a detailed description of each peripheral device.

See Section 603:111, Simultaneous Operations (this report), for information about the capabilities of an NCR 315 RMC system for the overlapping of input-output operations with computing and other input-output operations.

SIMULTANEOUS OPERATIONS

The capabilities for overlapping of operations in an NCR 315 RMC computer system are similar to those of the original 315 system. See Section 601:111 (NCR 315 report) for a list of the operations that can be overlapped.

In general, the time available for computing during an input-output operation in an NCR 315 system is independent of the speed of the main memory; i.e., the time available usually depends upon mechanical considerations within the peripheral device or upon the speed of a particular buffer. (See the individual report sections on the peripheral devices, starting at Section 601:071, for the amount of computing time available during the operating cycles of each peripheral device.) Two important exceptions to the preceding generality are magnetic tape operations using a 324-1 Magnetic Tape Simultaneity Controller and inquiry communication operations using a 321-1 Central Communications Controller. Both of these controllers operate on a cycle-sharing basis with the main memory. Thus, the demands on the 315 RMC Central Processor during these two operations are:

- Magnetic tape reading or writing — 0.53 microseconds per character (tape row) when using a 324-1 Magnetic Tape Simultaneity Controller.

- Inquiry communication operations — 4 microseconds per character when using a 321-1 Central Communications Controller.

INSTRUCTION LIST

The 315 RMC instruction repertoire includes all of the NCR 315 instructions, as listed in Section 601:121, plus the following instructions which are unique to the 315 RMC.

INSTRUCTION	DESCRIPTION
MOVE:EA	Move data, converting from 2-character-per-slab format to 1 character per slab.
MOVE:ED	Move data, converting from 3-digit-per-slab format to 1 digit per slab.
MOVE:CA	Move data, converting from 1-character-per-slab format to 2 characters per slab.
MOVE:CD	Move data, converting from 1-digit-per-slab format to 3 digits per slab.
MEM:E	Subsequent address references will be to the upper 40K segment of memory.
MEM:P	Subsequent address references will be to the lower 40K segment of memory.
FADD	Floating-point add.
FADD:R	Floating-point add with rounding.
FSUB	Floating-point subtract.
FSUB:R	Floating-point subtract with rounding.
FMUL	Floating-point multiply.
FMUL:R	Floating-point multiply with rounding.
FDIV	Floating-point division.
FDIV:R	Floating-point division with rounding.
NORM	Normalize 5-slab field into standard floating-point format.
SAVE	Store accumulator and processor flags in 14-slab area.
RESTORE	Restore information in 14-slab area.

SOFTWARE

The NCR 315 RMC computer system can use the same software as the original NCR 315 system. Please refer to Sections 601:151 through 601:192 for detailed descriptions of the available facilities.

NCR states that additional software is being developed to make use of the 315 RMC's capabilities for multiprogramming, but details have not been released to date. Therefore, the prospective user can only wonder how and when NCR will make it possible for him to take advantage of the 315 RMC's capabilities for multiprogrammed operation.

SYSTEM PERFORMANCE

GENERAL

The capabilities of NCR 315 computer systems for simultaneous operations are less extensive than those of most of the recently-announced systems in the same price range. As a result, the throughput of an NCR 315 system will often be limited by either: (1) a combination of input-output devices that cannot transfer data at the same time and must therefore operate sequentially rather than simultaneously; or (2) by the central processor (as a result of the relatively long processor delays during certain input-output operations).

The 315 RMC, despite its much higher internal speed, has the same limited input-output overlap capabilities as the original 315, so its throughput is equally likely to be limited by a combination of input-output devices whose functions cannot be overlapped. The greater internal speed enables a 315 RMC processor to make better use of the available computing time during input-output operations, but it may still be processor-bound in certain routine applications. It should be noted that the use of a buffered printer along with one or two Magnetic Tape Simultaneity Controllers can provide enough simultaneity, in many applications, to insure that the run will proceed at the maximum speed of the limiting peripheral device.

GENERALIZED FILE PROCESSING (603:201.100)

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 varying record sizes in the master file. Standard Problem D shows the effects of increasing 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.

Standard Configuration III incorporates one Model 324-1 Magnetic Tape Simultaneity Controller. This controller permits read/compute and write/compute simultaneity between the magnetic tape units and the central processor. It also allows a magnetic tape unit and the card reader to operate concurrently. At moderate and high activity ratios for all the Standard File Problems, the printer is the controlling factor. At lower activity ratios, the amount of overlapped time available for computing is more than enough for the required processing, and the two master-file tape units are the controlling factor.

Standard Configuration IIIC is a special configuration that illustrates the use of CRAM in place of magnetic tape. The decision that four CRAM units are equivalent to six magnetic tape units is somewhat arbitrary. The capability to have multiple files on-line in a single CRAM unit, with equal access times to any of them, clearly indicates that one CRAM unit is logically equivalent to more than one magnetic tape unit in most applications. The reduced file size allowable when placing multiple files on a single CRAM cartridge prevents one CRAM unit from taking the place of all tape units. For the purposes of this analysis, the two master files were placed on different CRAM units to take advantage of overlapping card drop times. Two input and two output areas were used as buffers for CRAM operations to minimize rotational delays. It should be noted that in this application CRAM is being used as a sequential device (analogous to a magnetic tape unit), and not as a random access device.

The CRAM read and write operations and the card read operations can only be performed sequentially. There is enough overlapped computing time available, however, so that at low activity ratios the combination of the CRAM unit and card reader is the controlling factor for all the Standard File Problems. At moderate and high activity ratios, the printer becomes the controlling factor.

In Standard Configuration IV, faster magnetic tape units and two Model 324-1 Magnetic Tape Simultaneity Controllers are used, along with the 2,000-cpm card reader and 1,000-lpm printer. The two Simultaneity Controllers permit full read/write/compute overlap between the magnetic tape units and the central processor. Also, all four peripheral operations can now proceed in parallel. At moderate and high activity ratios, the printer is the controlling factor in all the Standard File Problems. At low activity ratios, the central processor is fast enough to perform the required processing in the time available, and one master-file tape unit becomes the limiting factor in all Problems.

SORTING (603:201. 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 three-way merge was used for Configurations III and IV. The results are shown in the graph on page 603:201. 200.

Times for NCR's standard sort routines are not presently available for NCR 315 RMC systems. (See page 601:201. 220 for Magnetic Tape Sort Generator times for NCR 315 systems.)

MATRIX INVERSION (603:201. 300)

The standard estimate for inverting a non-symmetric, non-singular matrix was computed by the simple method described in Paragraph 4:200. 312 of the Users' Guide. Floating-point arithmetic, with a precision of 12 digits, is used. The results are shown on the graph on page 603:201. 300.

Times for the standard NCR matrix inversion subroutine are not presently known for the 315 RMC.

GENERALIZED MATHEMATICAL PROCESSING (603:201. 400)

Standard Mathematical Problem A is an application in which there is one stream of input data, a fixed computation to be performed, and one stream of output results. Two variables are introduced to demonstrate how the time for a job varies with different proportions of input, computation, and output. The factor C is used to vary the amount of computation per input record. The factor R is used to vary the ratio of input records to output records. The procedure used for the Standard Mathematical Problem is fully described in Section 4:200. 2 of the Users' Guide.

Computations are performed in floating-point arithmetic, with 12-digit precision.

In all configurations the input device is a card reader and the output device is a line printer. All Standard Configurations use the 2, 000-card-per-minute card reader. Configuration IV uses the 1, 000-line-per-minute-printer, and Configurations III and IIIC use the 690-line-per-minute printer.

The results are presented in the graph on page 603:201. 400. There is little appreciable difference between the cases of R = 0. 01 and R = 0. 1 (where R is the ratio of output records to input records) for any of the configurations. This is because the time involved in preparing and outputting a line of print is small compared to the time involved in computing the results. For these two values of R, the card reader (same in all configurations) becomes the limiting factor below computational loads of 0. 3 times the standard (C = 0. 3). Above this point, the central processor is the controlling factor.

For R = 1. 0. the printer is the controlling factor for small and moderate amounts of computation. In Configuration IV, the central processor is the controlling factor for computational loads greater than 5 times the standard. In Configurations III and IIIC, with the slower printer, the central processor becomes the controlling factor for computational loads greater than 6. 5 times the standard.

(Contd.)

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)									
	ITEM		CONFIGURATION						REFERENCE
			III		IIIC		IV		
1	Char/block	(File 1)	880		1,056		880		
	Records/block	K (File 1)	10		12		10		
	msec/block	File 1 = File 2	38.8		30.6		15.6		
		File 3	30		30		30		
Input-Output Times		File 4	143		143		115		
	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	0.47		30.6		0.47		
		File 3	24		24		24		
		File 4	1.3		1.3		2.2		
2	msec/block	a_1	0.07		0.07		0.07		
Central Processor Times	msec/record	a_2	0.21		0.21		0.21		
	msec/detail	b_6	0.07		0.07		0.07		4:200.1132
	msec/work	$b_5 + b_9$	0.97		0.97		0.97		
	msec/report	$b_7 + b_8$	0.39		0.39		0.39		
3			C.P.	Printer	C.P.	Printer	C.P.	Printer	
		a_1	0.1		0.1		0.1		
Standard File Problem A	msec/block	a_2 K	2.1		2.5		2.1		
	for C.P.	a_3 K	14.4		17.3		14.4		
	and	File 1: Master In	0.5		30.6		0.5		
F = 1.0	dominant	File 2: Master Out	0.5		30.6		0.5		4:200:114
	column.	File 3: Details	240.0	1,430	288.0	1,716	240.0	1,150	
		File 4: Reports	13.0		15.6		22.0		
		Total	270.6	1,430	384.7	1,716	279.6	1,150	
4	Unit of measure	(slabs)							
		Std. routines	710		1,320		710		
Standard File Problem A Space		Fixed	0		0		0		
		3 (Blocks 1 to 23)	360		360		360		
		6 (Blocks 24 to 48)	1,620		1,620		1,620		4:200.1151
		Files	1,960		2,312		1,960		
		Working	40		40		40		
		Total	4,690		5,652		4,690		

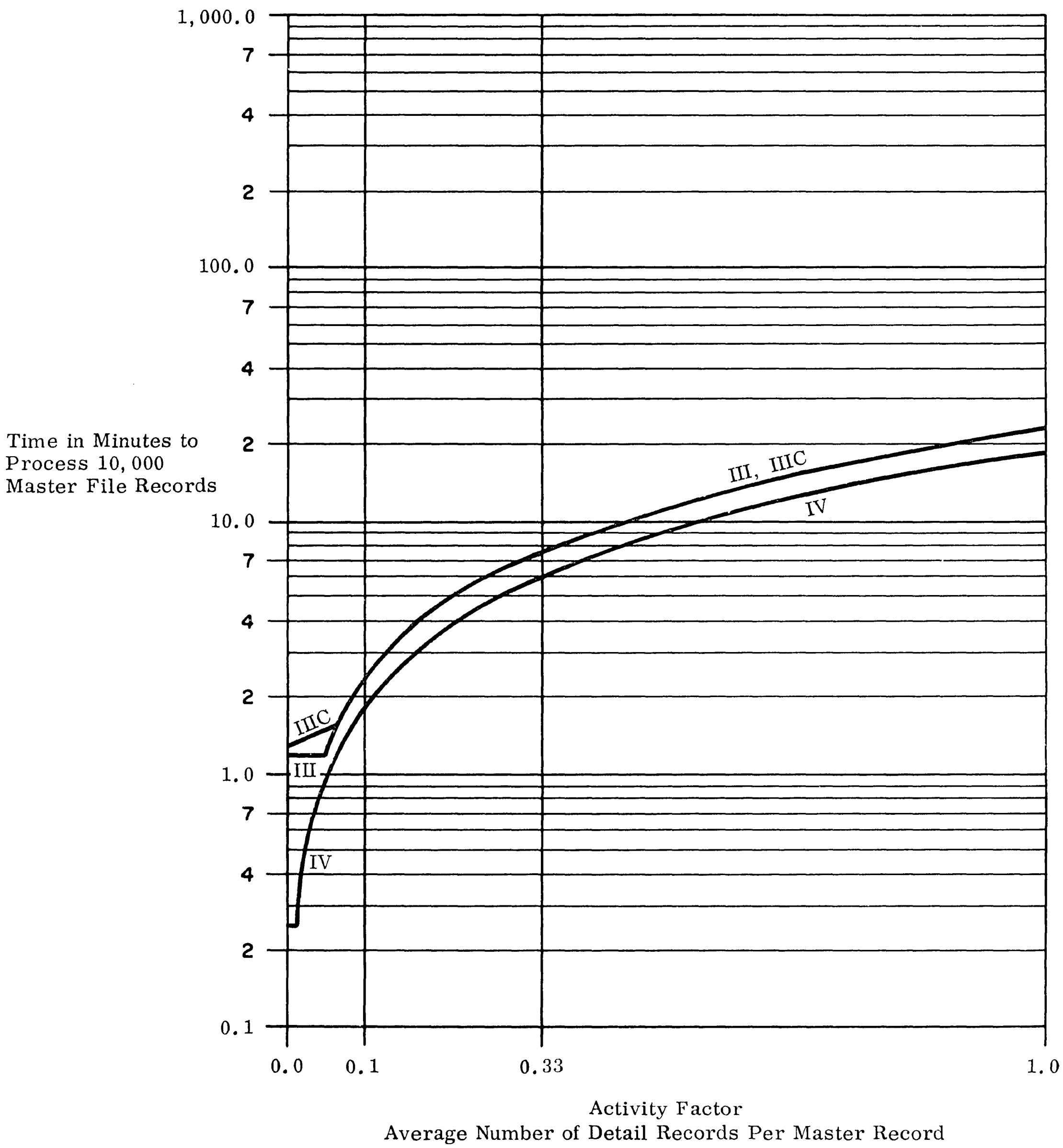
WORKSHEET DATA TABLE 2 (STANDARD MATHEMATICAL PROBLEM A)					
	ITEM		CONFIGURATION		REFERENCE
			IV	III, IIIC	
5	Fixed/Floating point		Floating point	Floating point	
	Unit name	input	380-3 Card Reader	380-3 Card Reader	
		output	340-601 Printer	340-3 Printer	
	Size of record	input	80	80	
Standard Mathematical Problem A		output	80	80	
	msec/block	input T_1	30	30	
		output T_2	115	143	4:200.413
	msec penalty	input T_3	24	24	
		output T_4	2.2	1.3	
	msec/record	T_5	0.47	0.47	
	msec/5 loops	T_6	16.93	16.93	
	msec/report	T_7	0.20	0.20	

.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: 4,690 slabs.
Configuration IIIC: . . 5,652 slabs.



(Roman numerals denote standard System Configurations.)

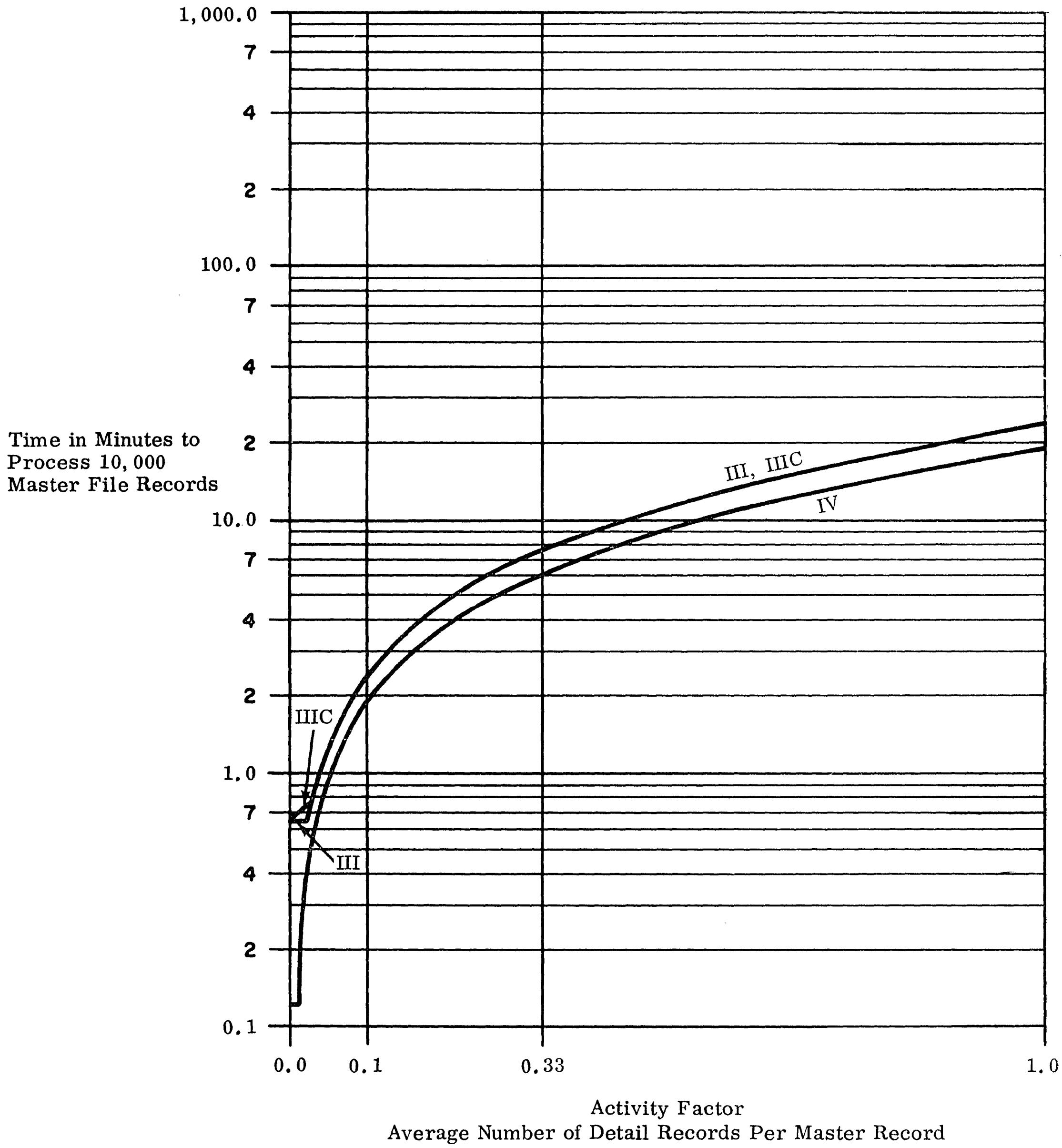
.12 Standard File Problem B

.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.)

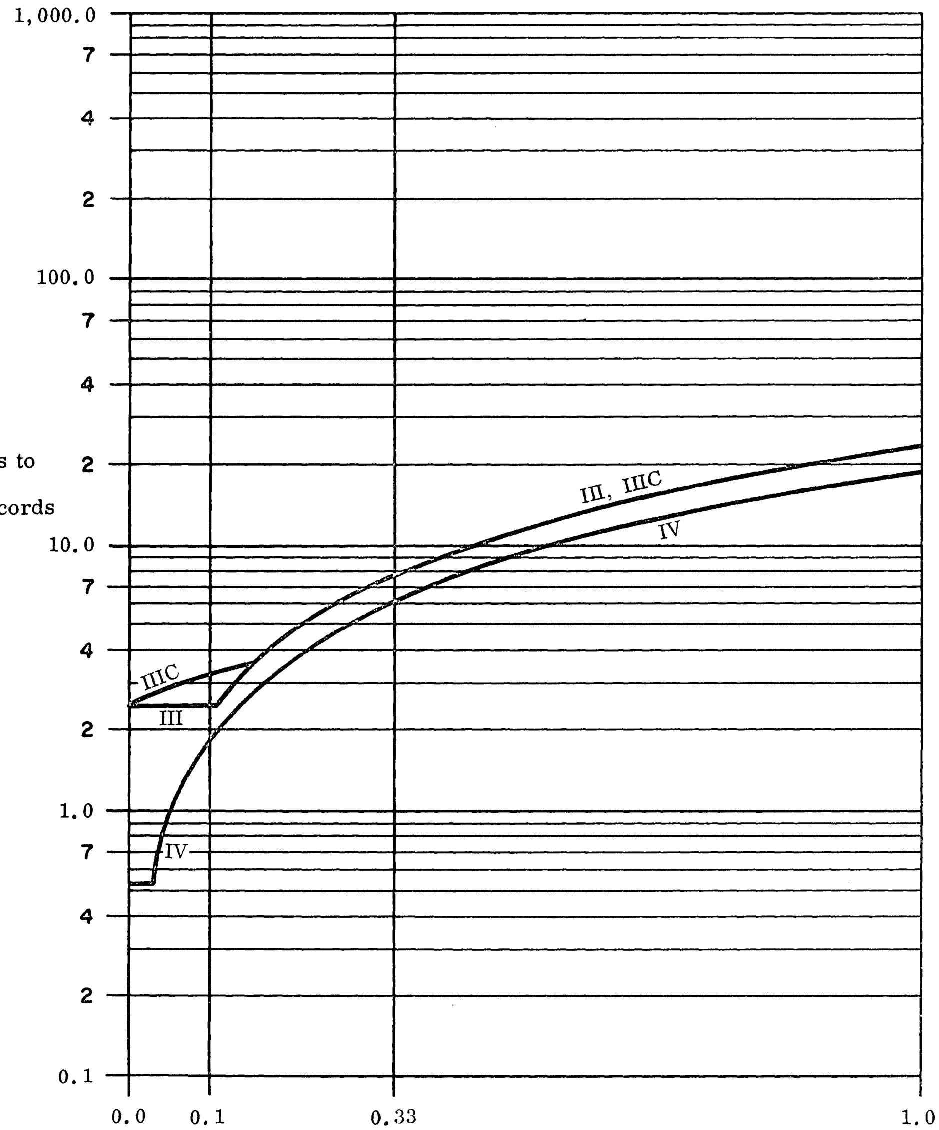
.13 Standard File Problem C

.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.)

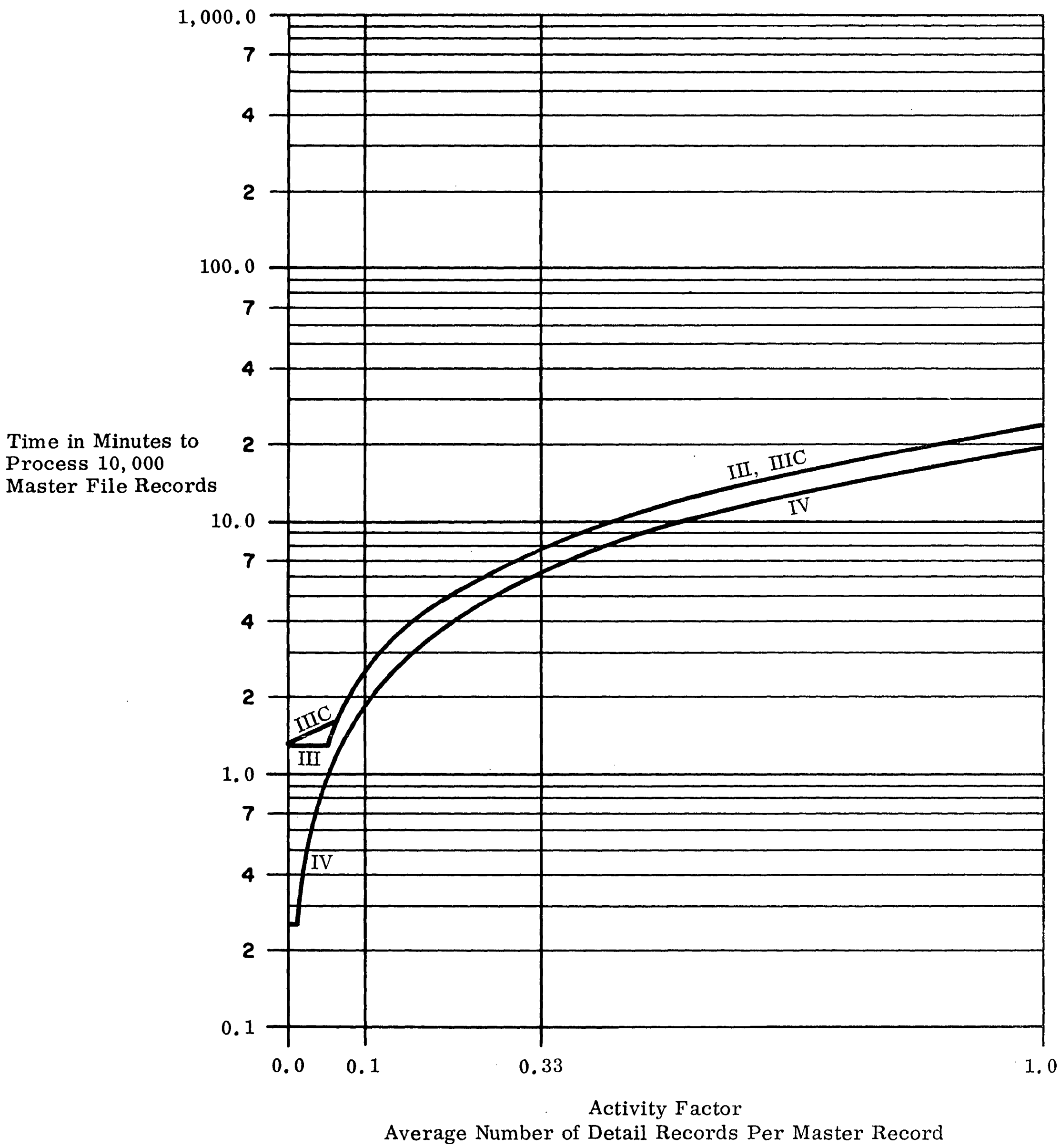
.14 Standard File Problem D

.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.)

AUERBACH

.2 SORTING

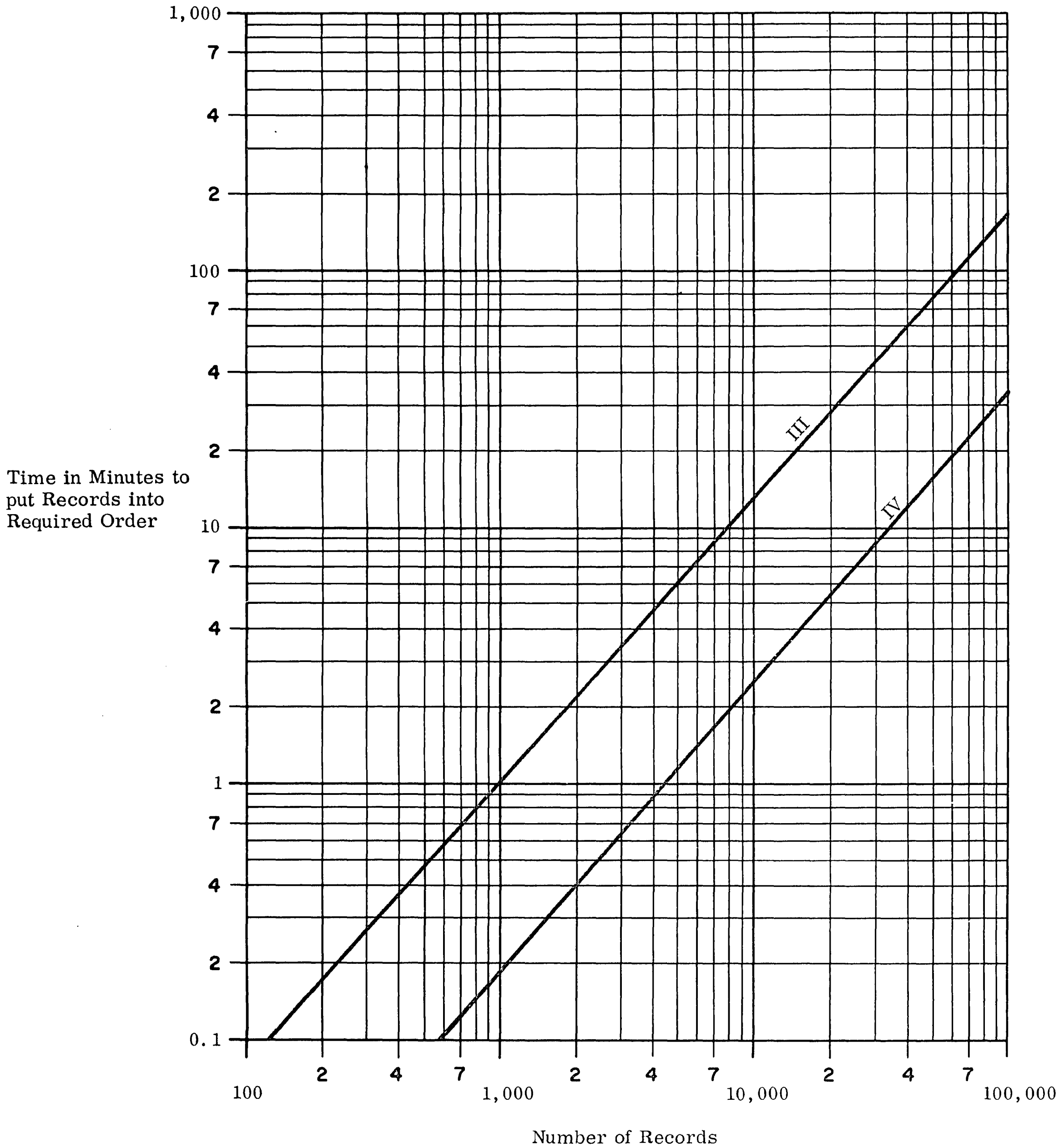
.21 Standard Problem Estimates

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

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

.213 Timing basis:. . . . . . . using estimating procedure outlined in Users' Guide, 4:200.213; 3-way merge.

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



(Roman numerals denote standard System Configurations.)

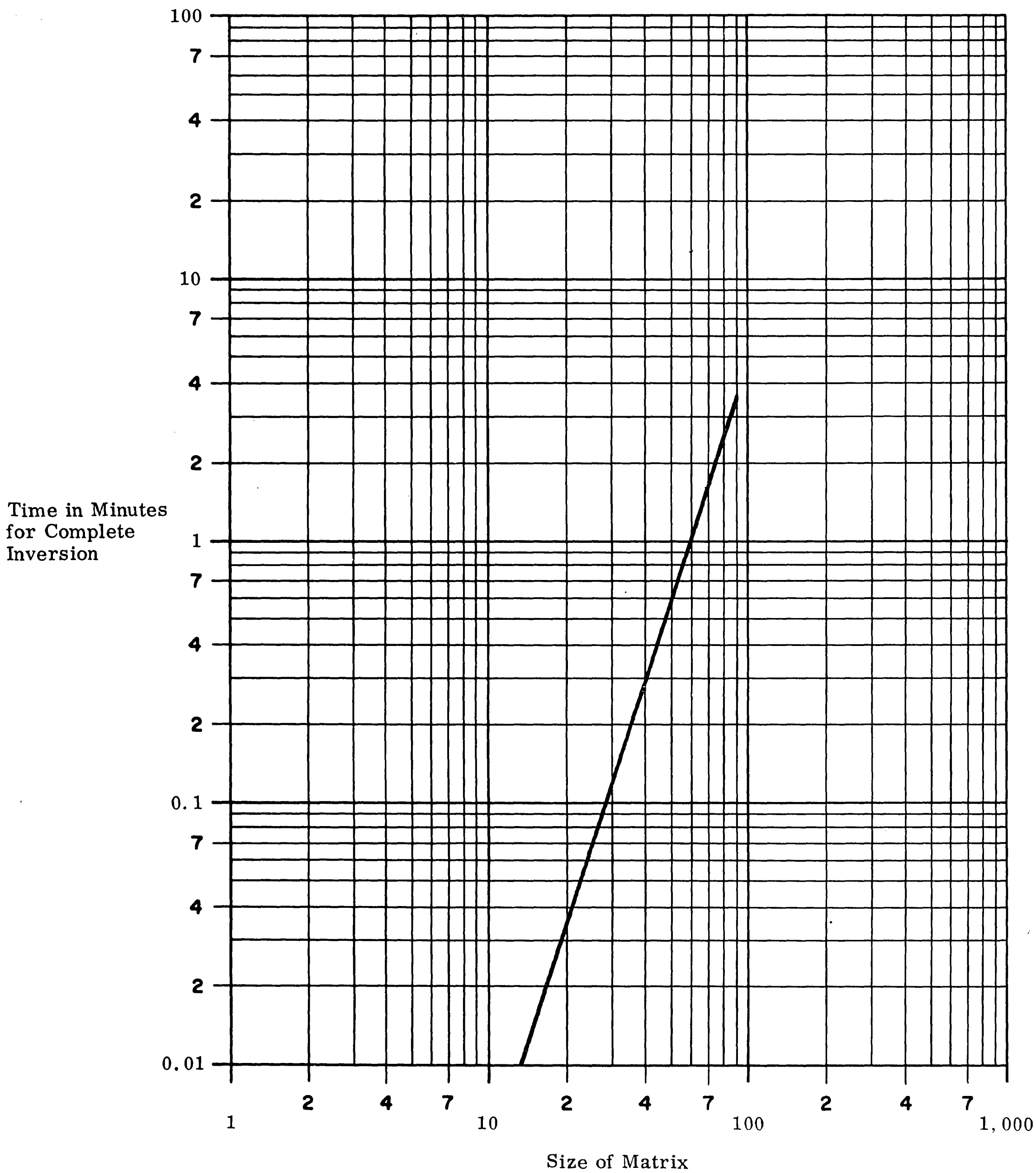
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis:. . . . . . . using estimating procedure outlined in Users' Guide, 4:200.312; 12-digit-precision floating-point arithmetic.

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



(Contd.)

.4 GENERALIZED MATHEMATICAL PROCESSING

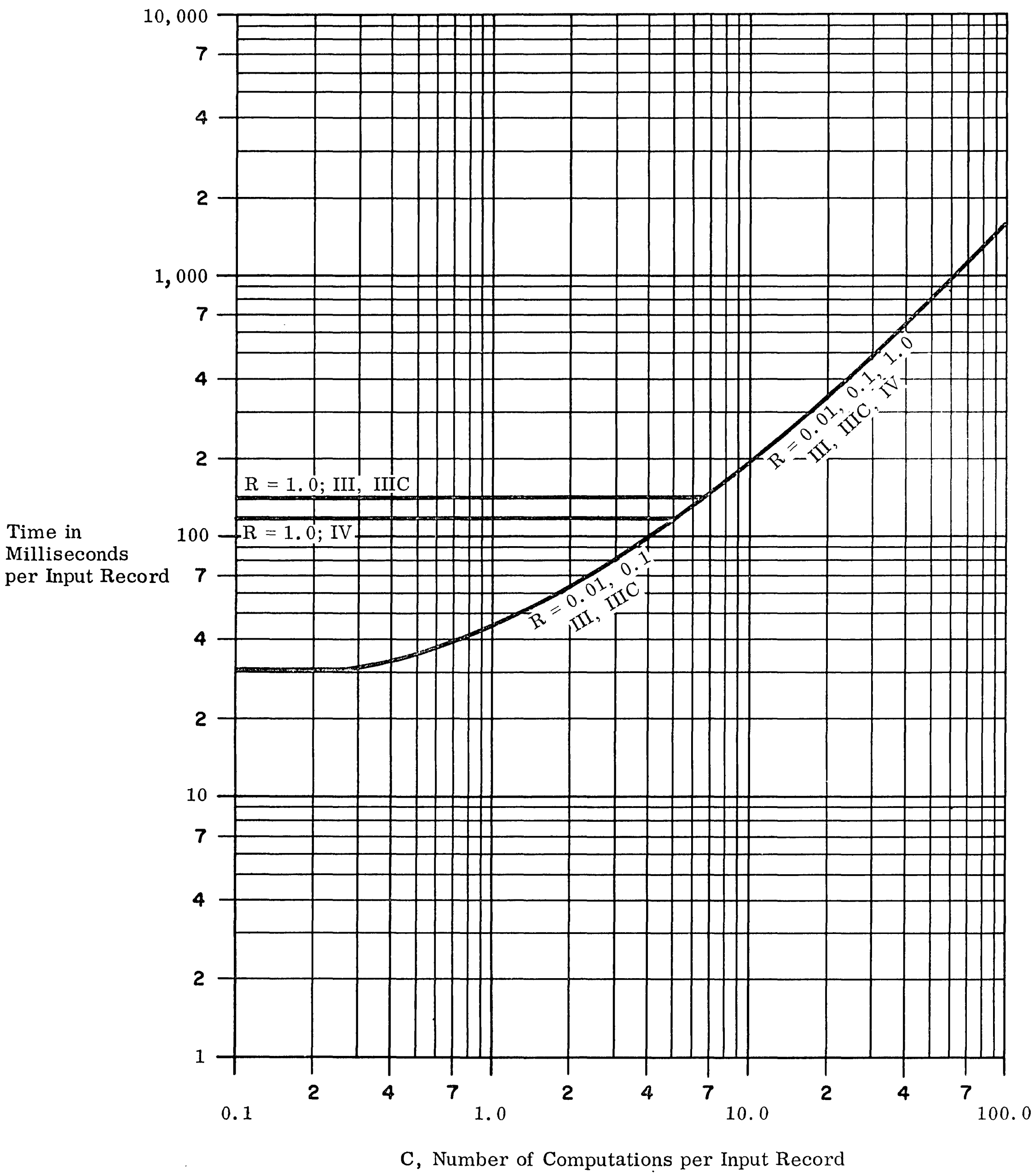
.41 Standard Mathematical Problem A Estimates

.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; computation is in floating-point mode with 12-digit precision.

.413 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.
R = Number of output records per input record.)

PRICE DATA

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	315-501	Central Processor: includes 316-502 20,000-slab Rod Memory Unit, Console, and Typewriter	6,000	220	270,000
		Optional Features			
		Automatic Recovery Option	100	5	5,000
		CRAM Use Lockout Feature	50	—	2,000
INTERNAL STORAGE	316-502	Rod Memory: 20,000 slabs	*	*	*
	316-504	Additional Rod Memory: 20,000 slabs: a maximum of three 316-504 units can be added to the basic 316-502 unit.	3,000	40	135,000

* The price of the 316-502 Rod Memory unit is included in the price of the 315-501 Central Processor.

Note: NCR 315 RMC computer systems can use all of the peripheral units offered for the NCR 315 except the Input/Output Consoles and the Card Read/ Punches. See the Price Data section of the NCR 315 report, page 601:221.101, for price data on all peripheral devices.

PB 250

Raytheon Company

STANDARD EDP REPORTS

AUERBACH INFO, INC.

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CONTENTS

CONTENTS (Contd.)

INTRODUCTION

The PB 250 is designed as a dual purpose system for use either as a standard small-scale scientific system or alternatively as part of a medium- to large-scale control system. Large numbers of input-output units can be connected, and the matching of the needs of any particular unit is handled entirely by the internal program. This provides the necessary flexibility for handling the varied types of input-output which may be utilized in control systems operation.

The same detailed tasks of adapting the input-output units to the Central Computer are also required for programming the PB 250 when it is operated as an independent scientific computing system. This requirement introduces an unusual amount of complexity in the preparation of input-output routines (see the discussion on I/O, section :070, and also the Instruction Code, section :121), which can be partly avoided by use of the CINCH interpreter.

As a scientific system, the PB 250 is suitable for configurations varying in size from a desk computer to a medium-speed tape-oriented system with six tape units. The storage capacity of the PB 250 can vary from 1,752 to 15,888 words, arranged in 3,072-microsecond-cycle delay lines. Each 22-bit word may hold either a 22-bit number or one instruction. Operations can be performed on single or double length operands, which provide 6 or 12 decimal digit precision, respectively. The delay lines may be obtained in almost any size up to 256 words each, but all addressing is based on a 256 word cycle, and most lines used are of this size.

The PB 250 uses a one-address instruction which has an unusual layout. The operand address is divided into two parts, separated by the operation code. This separation is maintained throughout machine coding both in absolute and assembly forms.

Approximately 50 operation codes are used in the instruction repertoire. Many of these instructions are required for controlling the input-output operations and the rescaling and normalizing of programmed floating-point data. The multiply and divide operations are variable length instructions in which the programmer must stipulate the number of bits to be processed in the multiplier or quotient. While normally only 21 or 22 bits would be used, the programmer is recommended by the manual to study the results that can be obtained using other numbers of bits.

There are two methods for controlling the normal sequencing of instructions: Address Sequenced, in which each instruction is followed by the instruction stored in the next address; or Time Sequenced, in which after completion of a particular instruction, the next instruction executed is the one that is immediately available in the same delay line. The time for almost any program instruction using the Address Sequenced technique is 3,084 microseconds while a Time Sequenced instruction may take from 24 to 276 microseconds for its execution, plus from 0 to 3,072 microseconds while accessing its operand. While the Address Sequenced method is slower, it is considerably easier to plan, document and debug.

The standard input-output equipment includes a Flexowriter with paper tape reader and punch. Optional input-output equipment units are:

. a 300 row per second paper tape reader.

. a 110 row per second paper tape punch.

. IBM compatible magnetic tape units, operating at 2,000 or 15,000 characters per second.

. an X-Y Plotter.

INTRODUCTION – Contd.

A High Speed Buffer is also available to connect the computer with a core storage or any other source cycle.

The software presently available to the user is extremely limited. Only 23 routines are currently listed as being available in the PB 250 library and 6 of these are used to control the input-output units. There is only one routine, at most, available for any particular unit, and only three mathematical routines (sine, cosine, arctangent) are listed.

Three programming systems are available:

. SNAP-1, an unoptimized assembly language which requires the programmer to have a full knowledge of the intricacies of PB 250 coding but does save him clerical worry.

. CINCH, a floating point interpretive system.

. ATRAN, a four pass compiler which converts ATRAN language to CINCH coding. It provides no documentation of the resulting object program.

The basic PB 250 rents for \$1,200 to \$1,275 per month depending upon whether it is to be supplied in a standard rack or as a table model, and whether it is to be powered directly from the main supply or via a trickle charging battery. The latter provides a safeguard a against power drop-out while the computer is operational and a means of operating where commercial power is not available.

The PB 250 can be connected on-line to another PB 250 system. Connection can be made by a pair of computers each having access, in the normal addressing scheme, to one storage line in each other's store. There are no storage interlocks. Such a multi-processor has effectively doubled the processing capacity of a single system as well as providing additional input-output channels. This facility is used primarily in real-time control systems. Additional processors can be connected if desired.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of location	Size	Purpose or use
Sector or word:	24 bits (22 data, 1 parity and 1 guard bit)	storage.
Fast access line:	16 sectors	fast access storage.
Long delay line:	256 sectors	storage.
Command lines:	1 fast access line 15 long lines	working storage for instructions.

.2 DATA FORMATS

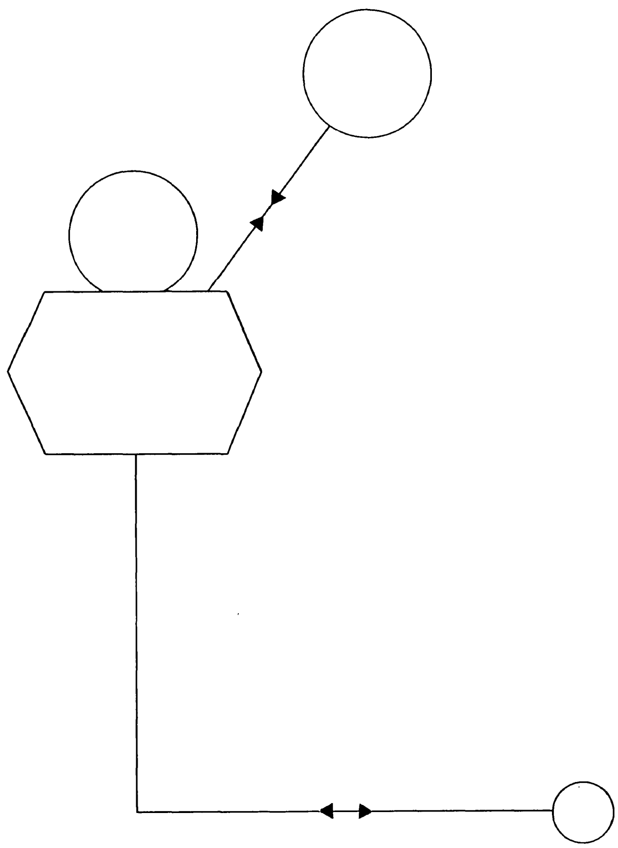
Type of information	Representation
Binary fixed point number:	21 bits + 1 sign bit.
Instruction:	22 bits.
Double precision number:	43 bits + 1 sign bit.

SYSTEM CONFIGURATION

§ 031.

.1 DESK SIZED SCIENTIFIC (CONFIGURATION IX)

Deviations from Standard System: . . . . none.

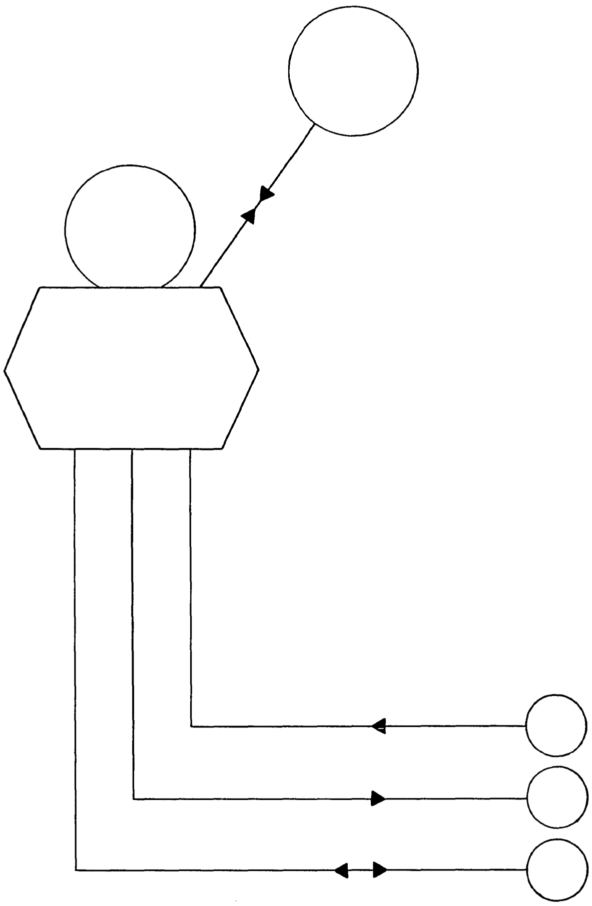


Equipment	Rental
Storage:	$ 75
10 long lines (2,560 words)	400
Processor:	$ 1,200
1 fast line (16 words)	
9 long lines (2,304 words)	
Flexowriter:	
Paper tape reader: 10 char/sec.	
Paper tape punch: 15 char/sec.	
Typewriter: 10 char/sec.	
Total Rental	$ 1,675

§ 031.

.2 PUNCHED TAPE/CARD SCIENTIFIC (CONFIGURATION X)

Deviations from Standard System: . . . . Reader 100 char/sec faster.
No floating point.

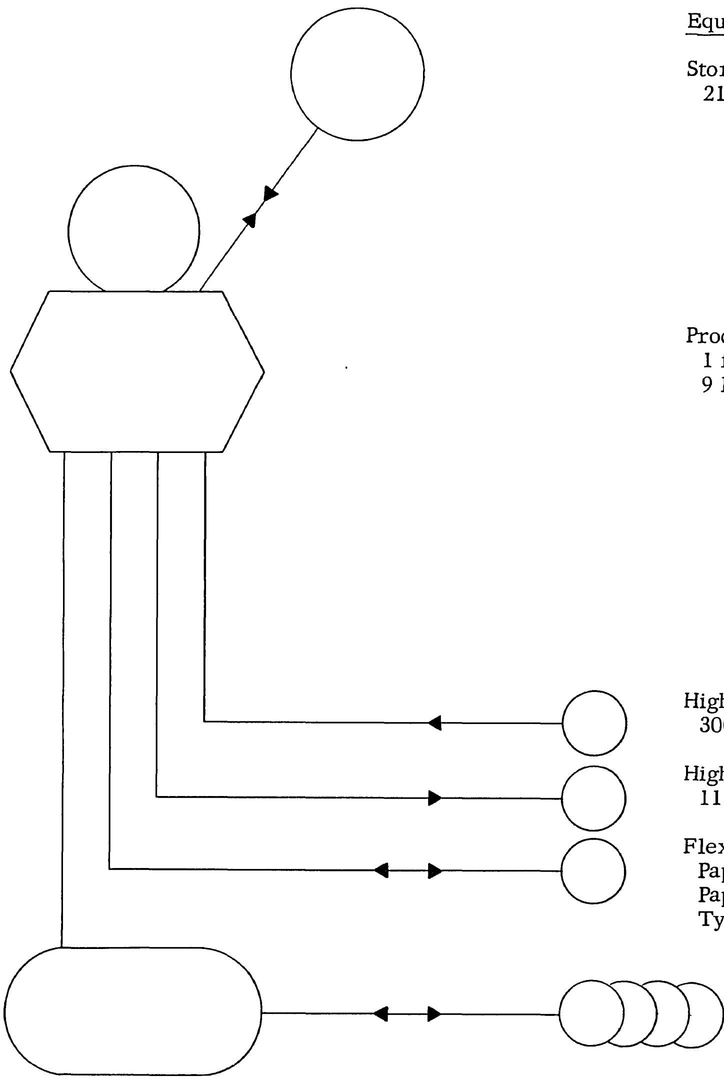


Equipment	Rental
Storage:	$ 75
21 long lines (5, 376 words)	840
Processor:	1, 200
1 fast line (16 words)	
9 long lines (2, 304 words)	
High Speed Reader:	190
300 char/sec.	
High Speed Punch:	150
110 char/sec.	
Flexowriter:	
Paper tape reader: 10 char/sec.	
Paper tape punch: 15 char/sec.	
Typewriter: 10 char/sec.	
Total Rental	$ 2, 455

§ 031.

.3 4-TAPE SCIENTIFIC (CONFIGURATION XI)

Deviations from Standard System: . . . . Reader 200 char/sec slower.
Punch 100 char/sec slower.
No floating point.



Equipment	Rental
Storage:	$ 75
21 long lines (5, 376 words)	840
Processor:	1, 200
1 fast line (16 words)	
9 long lines (2, 304 words)	
High Speed Reader:	190
300 char/sec	
High Speed Punch:	150
118 char/sec	
Flexowriter	
Paper tape reader: 10 char/sec.	
Paper tape punch: 15 char/sec.	
Typewriter: 10 char/sec.	
MT Control Unit 1	510
4 Magnetic Tape Units:	1, 780
15, 000 char/sec.	
Total Rental	$ 4, 745

INTERNAL STORAGE: DELAY LINE MEMORY

§ 041.

.1 GENERAL

.11 Identity: . . . . Delay Line Memory.

.12 Basic Use: . . . . . . working and auxiliary storage.

.13 Description:

The internal storage of the PB 250 is physically in the form of nickel delay lines. These are normally either 256 22-bit words long, or some factor of 256, although there is no physical restriction on this.

The minimum basic computer contains one "fast" line, of 16 words, and 8 long lines, each of 256 words. An extended system contains an additional 51 lines which can only be used as operand storage or auxiliary storage.

The address structure of the PB 250 is always related to a long line. Thus, if a word in a fast line is addressed, it will not be read until the corresponding sector on the master long line is ready for access, even though the selected sector has actually been previously available. Consequently, the advised usage of the fast line is solely for temporary operand storage.

Multi-processor configurations operate by sharing storage. Thus, the 512 locations addressed as lines 20 and 07 in computer A are the same 512 locations addressed as lines 07 and 20 in computer B. There is no built-in restriction on access to these locations for reading or writing by either computer.

.14 Availability: . . . . . 2 months.

.15 First Delivery: . . . . 1960.

.16 Reserved Storage

Purpose	Number of locations
Index register: . . .	1 line.
I-O control:	1 line for use with Magnetic Tape Control Unit.

.2 PHYSICAL FORM

.21 Storage Medium: . . . delay line.

.23 Storage Phenomenon: . acoustic.

.24 Recording Permanence

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

.25 Data volume per band of 1 track

Words (max): . . . . . . 256.
Characters (max): 1024 5-bit.
768 6- or 7-bit.
512 8-bit.
Digits: . . . . 1536.
Instructions (max): . . 256.

.26 Bands Per Physical Unit: . . . . 10.

.27 Interleaving Levels: . 1.

.28 Access Techniques

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

Description of stage	Possible starting stage
Await circulation of delay line: . . .	yes.
Transfer data into register:	yes.

.29 Potential Transfer Rates

.291 Peak bit rates
Bit rate per track: . . 2,000,000 bits/sec/track.
.292 Peak data rates
Cycling rates: . . . 2,000,000 cps.
Unit of data: . . . . word.
Conversion factor: . . . . 24.
Gain factor: . . . . 1.
Loss factor: . . . . 0.
Data rate: . . . . . . 83,333 words/sec.
Compound data rate: . . . . 83,333 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Lines with Min. Storage	Maximum Lines with Max. Storage
Words	2,320	2,370	15,888.
Instructions:	2,320	2,370	15,888.
Long Lines:	9	9	59.
Fast Lines:	1	51	1.

.32 Rules for Combining Modules: . . . . . Any line can contain any number of words from 1 to 256.
Up to 59 lines of any size. plus one basic fast line.

§ 041.

.4 CONTROLLER

.41 Identity: . . . . this role is undertaken by instructions.

.42 Connection to System

.421 On-line: . . . . normally one. In multi-computer systems each Central Processor controls its own internal storage, but has access to one line in the storage of the other processor.

.43 Connection to Device

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

.44 Data Transfer Control

Conditions
I: . . . . with I/O units.
II: . . . . within the internal store.

		I	II
.441	Size of load Direct:	8 bits.	22N bits. ($1 \leq N \leq 254$).
	Via External Shift Register:	22N bits. ($1 \leq N \leq 254$).	
.442	Input-Output area: Direct:	A register	any command line.
	Via External Shift Register:	any command line.	
.444	Input-Output area lockout:	none	automatic.
.445	Synchronization: . . .	by program	automatic.
.446	Synchronizing aids:	I: pulse to external unit.	II: -
.447	Table control:	no	no.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks: . . . 1 per line.

.512 Storage movement: . . circulation around delay line.

.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations
By single stack: . . . 1 line.

.515 Relationship between stacks and locations: . . . . least significant bits correspond to sector. most significant bits correspond to line.

.52 Simultaneous Operations: . . . . none.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, μsec	Example, μsec
Wait for access: .	0 to 3,072.	1,300.
Access single word:	12.	12.
Access double-length word: . .	24.	24.

.6 CHANGEABLE STORAGE: . . . . none.

.7 STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage unit possibilities
With self: . . . . . yes.
With external shift register: . . . . . yes.

.72 Transfer Load Size

With self: . . . . 1 to 256 words.
With external shift register: . . . . . . 1 to 254 words.

.73 Effective Transfer Rate

With self: . . . . 82,652 words/sec.
With external shift register: . . . . . . 82,652 words/sec.
With Magnetic Core: . . . . 85,000 words/sec.
Word: . . . . 22 bits.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none.	
Receipt of data:	parity check	stop computer.
Recording of data:	none.	
Recovery of data:	parity check	stop computer.
Dispatch of data:	sends parity bit.	
Timing conflicts:	test busy instructions.	

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . Central Processor.
PB 250.

.12 Description

The PB 250 Central Processor operates on one-address instructions. In general, the execution time of an instruction is either 12 microseconds or 264 microseconds. The 12 microsecond instructions are those which can be executed bit by bit as the data becomes available, and thus are completed as soon as all the data has arrived. The other instructions are those which normally require one word time per data bit; these include multiplication and division.

There are no floating point instructions in the Central Processor, but a number of instructions have been included which make floating point routines easy to construct.

An unusual instruction is the IAM instruction. This instruction effectively moves the contents of a table in storage down one place. It is designed to be used to avoid having to change addresses when working with sequential entries of a table. This is quite practical, and in paragraph .426 dealing with tables it will be seen that the same time, three milliseconds, is required for each operation in a table. It is necessary, however, for the tables to be operated on sequentially, and therefore, in any case where there is any increment other than one or where double precision or floating point representation is being used, this method cannot be used effectively.

The action of the "index register" must be understood in conjunction with the IAM instruction. The normal use of an index register is to store a value which is added to the operand address contained in an instruction. In the PB 250 the index register only contains one part of the address and this does not add to the equivalent portion in the instruction, but simply replaces it. Thus, an address of Channel 06, Sector 153 can be modified only to Channel X, Sector 153 when X is the contents of the index register.

This restricts the utility of the index register and effectively means that except when the IAM instruction is suitable, all instructions which have to be modified within a loop will have to be physically brought to the registers, have the modifier added, and stored back into the registers. When, as in the PB 250, there is a delay of up to 255 word times in obtaining access to operands, these actions can account for a major part of the time used by a program. In this connection, it is worth noting that the address structure of the fast lines in the PB 250 is such that it is not practical to use fast lines to speed up the modification of an instruction.

.12 Description (cont'd)

A characteristic of the PB 250 instructions is that the mnemonics, by which they are known, do not effectively describe them. In fact, this is because the actual instructions are not easy to comprehend. The Divide instruction, for instance, produces a result which may or may not be accurate in the 22nd place. To explain this instruction takes four pages in the manual, and no example is provided showing what instructions are needed to ensure an accurate quotient without having to restrict the operands. (It should be noted that the manual is being rewritten.)

Similarly the Translate Gray to Binary does not complete the translation. It leaves the programmer either with the correct result or its complement; and he must remember to find out which and to recomplement if needed. Other examples exist, but are not so serious as these (e.g., the use of RFU as an indicator, MUL as a register.)

By contrast to the complex arithmetic instructions, the input-output instructions are elementary. They work in conjunction with a one-character buffer, and the number of bits is controlled by constants in the internal store. This structure enables the PB 250 to be adapted to almost any configuration of input-output units without regard to any restrictions contained in the Central Processor logic. (See General Introduction, :011, regarding the dual role of the PB 250 as a general purpose computer or as a component of a system.)

The simplicity is awkward, however, when it comes to using specific input-output units. Since the instruction code must be flexible, it has to be microprogrammed within the computer operation. There are many ways in which this can be done for any specific input or output unit. The performance of such units depends on such programming.

The sequencing of instructions in the PB 250 is accomplished by one of two methods: Address Sequencing or Time Sequencing. The former is done by a sequence counter; the instruction in 15203 being performed immediately after the instruction in 15202. The latter is done by timing, in which after one instruction, control goes to the instruction in the same line which is immediately available. Thus, if the instruction in 15202 took 24 word times (which is 30 in octal) it would be followed by the instruction in 15232, not by the instruction in 15203 as above.

This is a very powerful facility giving advantages of six or more times faster operating speed in suitable cases. In general, it is found powerful in stretches of programming which have no logical jumps or loops and which deal with constants rather than variables. Such a case occurs in Processor Performance paragraph .424, where the times for using a given data item to select and execute an entry in a table are given. It will be seen that the time for

§ 051.

.12 Description (cont'd)

doing this increases only by 2 per cent if the data is checked for reasonability before being used. By contrast, on other computers, increases of 100 per cent are common.

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-subtract:	automatic	binary	21 or 42 bits.
	Multiply Long:	semi-automatic	binary	21-bit operand. 42-bit quotient.
	Divide Remainder:	semi-automatic	binary	42-bit dividend. 21-bit divisor. 21-bit quotient.
.212	Floating point			
	Add-subtract:	sub-routine	binary	various
	Multiply:	sub-routine	binary	various
	Divide:	sub-routine	binary	various
.213	Boolean			
	AND	automatic	binary	22-bit word.
	Inclusive OR:	automatic	binary	22-bit word.
.214	Comparison			
	Numbers:	equality-automatic		22-bit word.
	Absolute:	none.		
	Letters:	none.		
	Mixed:	none.		
	Collating sequence:	none.		

		Provision	From	To	Size
.215	Code translation:	sub-routine	gray code	binary	5 decimal digits.
		sub-routine	binary	gray code	?

.216 Radix conversion: . . . none.
.217 Edit format: . . . . . . none.
.218 Table look-up: . . . . . none.

.22 Special Cases of Operands

.221 Negative numbers: . . . 1 in most significant bit position. value given in two's complement form.
.222 Zero: . . . . one form only.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout

NAME	SECTOR ADDRESS	S.T.	OP CODE	LINE ADDRESS	I.T.
Size in bits	8	1	6	6	1

.233 Instruction parts

Name	Purpose
Sector address: . . .	sector specification.
S.T. (Sequence Tag):	choice of sequencing modes.
Operation code: . .	operation code.
Line address: . . .	line specification.
I.T. (Index Tag): . .	index register specification.

.234 Basic address structure: . . . . one address
.235 Literals: . . . . no.
.236 Directly addressed operands
.2361 Internal storage type: . Memory.
Minimum size: . . . 1 word.
Maximum size: . . . 2 words.
Volume accessible: . . . . . . all Memory.
.2362 Increased address capacity: . . . . . none.
.237 Address indexing
.2371 Number of methods: . 1.
.2372 Names: . . . . index tag.
.2373 Indexing rule: . . . the line address held in the index register is substituted for the line number in the instruction, see Description paragraph .12.
.2374 Index specification: . within the modified instruction.
.2375 Number of potential indexers: . . . . . 1.
.2376 Addresses which can be indexed
Type of address: . . any Memory.
Application: . . . . operand addresses in addition, subtraction, load and store instructions.
.2377 Cumulative indexing: . none.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . . none.
.239 Stepping: . . . . . . none. The index register is treated as any other word in the store. Combined "step by increment and test" takes five instructions.

.24 Special Processor Storage

§ 051.

.241 Category of storage

Category of storage	Number of locations	Size in bits	Program usage
"A" Register	1	21 plus sign	accumulator.
"B" Register:	1	21 plus sign	(a) lower half of double precision accumulator. (b) immediate access, temporary store.
"C" Register:	1	21 plus sign	immediate access, temporary store.
Index Register:	1	6 bits no sign	to replace (not modify) the line number in indexed instructions.

.242

Category of storage	Total number locations	Physical form	Access time µsec.	Cycle time µ sec.
A, B, C Registers and Index Register	4	delay lines	12	12.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 2; sequential counter and sequence tag addressing.

.313 Precedence rule: if an instruction contains a sequence tag, the next instruction is located by sequence tag addressing.

.315 Sequence control step size: . . . . n+1 addressing; one word tag sequence addressing; variable. The next instruction in time after the completion of the previous instruction is used.

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

.33 Interruption: . . . . . none.

.4 PROCESSOR SPEEDS

Conditions
I: . . . . Address Sequenced.
II: . . . . Time Sequenced.

.41 Instruction Times in µ secs

.411 Fixed point

	I	II
Single Precision		
Add-subtract:	3,084	1,548
Multiply:	3,084	1,812
++Divide:	3,084	1,812
Double Precision		
Add-subtract:	3,084	1,560

++ Using the Divide instruction, no allowance has been made for the correction of the results (see Instruction List section :121).

.412 Floating point: . . . . none.

.413 Additional allowance for
Indexing: . . . . . 0.
Indirect addressing: . . . . none.
Re-complementing: . . . . none.

.414 Control

	I	II
Compare:	3,084	24
Branch:	3,084	12

.415 Counter control: . . . none.

.416 Edit: . . . . none.

.417 Convert: . . . . none.

.418 Shift: . . . . 12 + 12N, where N is the number of bits shifted.

.42 Processor Performance in µ secs

.421 For random addresses

	Fixed point	Floating point
Single Precision, Address Sequencing		
c = a + b:	9,252	19,488.
b = a + b:	9,252	19,488.
Sum N items:	3,084N	10,236N.
c = ab:	12,336	19,176.
c = a/b:	12,336	19,284.
Single Precision, Time Sequencing		
c = a + b:	4,744	7,188.
b = a + b:	6,286	7,188.
Sum N items:	1,548N	6,168N.
c = ab:	4,766	6,876
c = a/b:	4,766	6,980
Double Precision, Address Sequencing		
c = a + b:	9,288	
b = a + b:	9,288	
Sum N items:	3,096N	
c = ab:	23,166	
c = a/b:	24,166	
Double Precision, Time Sequencing		
c = a + b:	4,780	
b = a + b:	6,322	
Sum N items:	1,560N	
c = ab:	11,184	
c = a/b:	12,184	

.422 For arrays of data

	Fixed point	Floating point
Single Precision, Address Sequencing		
$c_i = a_i + b_j$:	46,260	56,496
$b_j = a_i + b_j$:	46,260	56,496
Sum N items:	12,336N	19,494N
$c = c + a_ib_j$:	40,122	46,922
Single Precision, Time Sequencing		
$c_i = a_i + b_j$:	9,936	11,004
$b_j = a_i + b_j$:	9,936	11,004
Sum N items:	3,326N	4,116
$c = c + a_ib_j$:	6,652	7,340
Double Precision, Address Sequencing		
$c_i = a_i + b_j$:	46,296	
$b_j = a_i + b_j$:	46,296	
Sum N items:	12,348	
$c = c + a_ib_j$:	52,488	

§ 051.

.422 For arrays of data (cont'd)

Double Precision, Time Sequencing

$c_i = a_i + b_j$:	9,972
$b_i = a_i + b_j$:	9,972
Sum N items:	3,338N
$c = c + a_ib_j$:	13,220

.423 Branch based on comparison

Numeric data:	6,164.

.424 Switching

Unchecked:	4,704.
Checked:	4,800.
List search:	3,084(N+1).

.425 Format control per character

Unpack and compose

by subroutine designed for Flexowriter:	within Flexowriter overlap time.
by subroutine designed for fast reader:	?

.426 Table look-up per comparison

For a match:	3,084.
For least or greatest:	3,084.
For interpolation point:	3,084.

.427 Bit indicators

Set bit in separate location:	1,610.
Test bit in separate location:	1,724.

.428 Moving: 24 μ sec per 22-bit word. 40,000 words/sec.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	indicator	halt.
Underflow (float-pt):	?	
Invalid data:	not possible	
Invalid operation:	none	undefined.
Arithmetic error:	none.	
Invalid address:	?	
Receipt of data:	parity	halt.
Dispatch of data:	parity	halt.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity:

The Flexowriter keyboard and some special switches provide the major console facilities on the PB 250. In addition, a binary display is available on the computer itself, whose convenience depends on how the computer has been positioned in a particular installation.

.2 CONTROLS

.21 Power: . . . . switch and button.

.22 Connections to I/O Units: . . . . no Console facilities for changing such connections.

.23 Stops and Restarts: . . Enable switch halts computation.
"I" key sets operation address at 01000.

.24 Stepping: . . . . . . Enable switch and "C" key allow single instruction setting.

.25 Resets: . . . . Enable and Breakpoint switches operate in conjunction to clear parity flip-flop.

.26 Loading: . . . . initial bootstrap loaded by Fill switch on computer.
further programs loaded via the initial bootstrap, which loads the OUP which in turn loads a program.

.27 Special: . . . . none.

.3 DISPLAY

.31 Alarms: . . . . lamps for overflow and parity errors.

.32 Conditions: . . . . . none.

.33 Control Registers

A dynamic display by 14 lamps on the computer show part of the current effective instruction as under:

Operation: . . . . . operation code.
Operand: . . . . . . gives the line number portion of the instruction.
Command: . . . . . gives the line number of the instruction being executed.

No display of the remainder of the instruction or of the arithmetic register is possible.

.34 Storage: . . . . none.

.4 ENTRY OF DATA

.41 Into Control Register: . . . . not possible.

.42 Into Storage: . . . . . via keyboard under control of service routines.

.5 CONVENIENCES

.51 Communication: . . . none.

.52 Clock: . . . . none.

.53 Desk Space: . . . . . Flexowriter model only is mounted on desk.

.54 View: . . . . depends on local conditions.

INPUT-OUTPUT: GENERAL

§ 070.

The PB 250 Computer is specifically designed to be suitable for systems containing many types of input-output units. To allow maximum freedom to the user in choosing these units, the internal instructions generate and control all signals, timing intervals, parity or other checks as needed between the input-output units and the Central Processor.

From the point of view of a programmer utilizing the PB 250 as a general purpose computer, this means that he must utilize specially written routines to control each individual input-output device. The ones presently available do not provide for overlapping computation with input or output.

Because the address cycle time of the PB 250 is three milliseconds, any input-output unit requiring attention every six milliseconds or less will probably continue not to have overlapping routines written for it, while those with cycle times exceeding six milliseconds will probably have more overlapping routines developed in the future.

The potential value of such routines can be gauged by noting that the actual input or output of a character, including a Test and a Pulse I/O Unit, requires only 48 microseconds (i.e., under two percent of the address cycle time). Computation can be overlapped more than 90 percent on a unit with a 3 millisecond cycle.

This overlapped time is used within the routines for timing and translation purposes. It could also be used, but is not at the present time, for making parity checks. It is reasonable, therefore, to rate any input-output unit operating in the range of 100 to 2,000 characters per second as having an effective speed, including some translation capabilities, equal to its peak speed, and having a demand of 100 percent in the Central Processor.

For slower units (e.g., the Flexowriter) more overlapping is possible as is shown in the appropriate sections.

For units faster than 2,000 characters per second, extra buffer facilities will be required. At present only the MTU 1 has such a unit, but for some devices the High Speed Buffer may be used.

The PB 250 library currently contains only 6 input-output routines. The programmer has to handle all timing problems and safeguard data from interference during both input and output because errors will occur if the timing is incorrect.

INPUT-OUTPUT: FLEXOWRITER PUNCH

§ 071.

.1 GENERAL

.11 Identity: . . . . Flexowriter Paper Tape Punch.

.12 Description

The Friden Flexowriter paper tape punch operates at both a peak and effective speed of 15 characters per second. Normally this unit uses 6-track tape, but it can also use either 5-, 7-, or 8-track tape.

Characters are coded in either 5-, 6-, 7-, or 8-track codes and may contain data in decimal or binary format. All code translation is performed by the program. No punch check is provided by the equipment, and sum checks are usually programmed to prevent future operating with incorrect data.

The Flexowriter is an electric typewriter with paper tape reading and punching facilities. On-line, it functions as an integrated console and input-output unit, providing keyboard and paper tape input, typed and punched output. Off-line, it can be used to prepare, list, or duplicate punched tape. The various functions of the Flexowriter are described in the following report sections:

Console: . . . . . . :061.
Tape punch: . . . . . :071.
Tape reader: . . . . :072.
Printer: . . . . . . :081.

.13 Availability: . . . . . 30 days.

.14 First Delivery: . . . . 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.
.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: . . . . recording.
Stacks: . . . . 1.
Heads/Stack: . . . . . 8 plus sprocket.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

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

.32 Positional Arrangement

.321 Serial by: . . . . . . 1 to N rows at 10 rows/inch.
.322 Parallel by: . . . . . 5 to 8 tracks at standard spacing.
.324 Track use
Data: . . . . 5 to 8.
Timing: . . . . 1 (sprocket).
Total: . . . . 5 to 8 (plus sprocket track).
.325 Row use: . . . . data.

.33 Coding: . . . . PB 250 Flexowriter (Data Code Table No. 1). Any 5- to 8- track code, using programmed translation.

.34 Format Compatibility: . . . . any device using 5- to 8-track punched paper tape.

.35 Physical Dimensions

.351 Overall width: . . . . 0.6875, 0.875 or 1 inch.
.352 Length: . . . . indefinite.

.4 CONTROLLER

.41 Identity: . . . . this function is performed by the Central Processor.

.43 Connection to Device

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

.44 Data Transfer Control: . . . . as determined by routine.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks: . . . . as determined by routine.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . one char, max of 8 bits/char.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . . . none.

§ 071.

.53 Code Translation: . . . as determined by routine.

.54 Format Control: . . . none.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . no.
Select format: . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . no.
End of medium marks: no.

.6 PERFORMANCE

.61 Conditions

I: . . . . using standard routines.
II: . . . . hardware limitations only.

.62 Speeds

.621 Nominal or peak speed: 15 char/sec.
.622 Important parameters: . none.
.623 Overhead
Time: . . . . negligible.
Storage: . . . . 1 long delay line.
.624 Effective speeds: . . . 15 char/sec.
.63 Demands on System

Component	Condition	m. sec per char	Percentage
Central Processor:	I	25	37
	II	15	22

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . different tape widths.
Method: . . . . tape guides.

.72 Other Controls: . . . See Console, section :061.

.73 Loading and Unloading: . . . . there are no tape handling facilities provided.

.8 ERRORS, CHECKS AND ACTION: . . . . none, except those that can be incorporated in routines.

INPUT-OUTPUT: FLEXOWRITER READER

§ 072.

.1 GENERAL

.11 Identity: . . . . Flexowriter Paper Tape Reader.

.12 Description

The Friden Flexowriter paper tape reader operates at both a peak and effective speed of 10 characters per second. Normally this unit uses 6-track tape, but it can also use either 5-, 7-, or 8-track tape.

Characters are coded in either 5-, 6-, 7-, or 8-track codes and may contain data in decimal or binary format. All code translation is performed by the program. No read check is provided by the equipment, and sum checks are usually programmed to prevent operating with incorrect data.

The Flexowriter is an electric typewriter with paper tape reading and punching facilities. On-line, it functions as an integrated console and input-output unit, providing keyboard and paper tape input, typed and punched output. Off-line, it can be used to prepare, list, or duplicate punched tape. The various functions of the Flexowriter are described in the following report sections:

Console: . . . . :061.
Tape punch: . . . . :071.
Tape reader: . . . . :072.
Printer: . . . . :081.

.13 Availability: . . . . . 30 days.

.14 First Delivery: . . . . 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.
.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: . . . . sensing.
Stacks: . . . . 1.
Heads/stack: . . . . . 8.
Method of use . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

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

.32 Positional Arrangement

.321 Serial by: . . . . . . 1 to N rows at 10 rows/inch.
.322 Parallel by: . . . . . 5 to 8 tracks at standard spacing.
.324 Track use
Data: . . . . 5 to 8 (normally 6 for original input).
Redundancy check: . 0.
Timing: . . . . 1 (sprocket)
Control signals: . . . 0.
Unused: . . . . 0.
Total: . . . . 5 to 8 (plus sprocket track)
.325 Row use: . . . . any length block as data.

.33 Coding: . . . . PB 250 Flexowriter Data Code Table No. 1. Any 5- to 8-track code, using programmed translation.

.34 Format Compatibility: . any device using 5-, 6-, 7- or 8-track punched paper tape.

.35 Physical Dimensions

.351 Overall width: . . . . 0.6875, 0.875 or 1 inch.
.352 Length: . . . . indefinite length.

.4 CONTROLLER

.41 Identity: . . . . this function is performed by the Central Processor.

.43 Connection to Device

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

.44 Data Transfer Control: . as determined by routine.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks: . . . . as determined by routine.

.52 Input-Output Operations

.521 Input: . . . . one char, max. of 8 bits/char.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . . . no.

§ 072.

.53 Code Translation: . . . (a) eight track binary, being a matched code requiring no translation.
(b) Flexowriter or other code requiring translation by program.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . . no.
Select format: . . . . yes, via routine.
Select code: . . . . . yes, via routine

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device . . . . . no.
Nearly exhausted: . . . no.
End of medium marks . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . using standard routines.
II: . . . . hardware limitation only.

.62 Speeds

.621 Nominal or peak speed: . 10 char/sec.
.622 Important parameters: . none.
.623 Overhead
Time: . . . . negligible.
Storage of routine: . . 1 long delay line.
Working storage: . . Line 00.
.624 Effective speeds: . . . 10 char/sec.
.63 Demands on System

Component	Condition	*m.sec per char	Percentage
Central Processor:	I	65	65
	II	6	6

* No operations on data included.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . different tape widths.
Method: . . . . move tape guides.

.72 Other Controls: . . . see Console, section :061.

.73 Loading and Unloading: . there are no tape handling facilities provided.

.8 ERRORS, CHECKS AND ACTION: . . . . none, except those that can be incorporated in routines.

INPUT OUTPUT: HIGH SPEED PUNCH

§ 073.

.1 GENERAL

.11 Identity: . . . . High Speed Punch.
HSP-1.

.12 Description

The High Speed Punch records 5-, 6-, 7-, or 8-track paper tape at peak and effective speeds of 110 characters per second. Punch operations are controlled by programmed routines, and presently only one such routine is available in the PB 250 library (Cat. No. 109). This routine provides for output in octal binary format only.

.13 Availability: . . . . . 30 days.

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

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.
.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.
Stacks: 1
Heads/stack: . . . . . 8 plus sprocket.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
other opaque tapes.
.312 Phenomenon: . . . . . fully punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . . . row, at 10 rows/inch.
.322 Parallel by: . . . . . up to 8 data tracks plus sprocket track.
.324 Track use
Data: . . . . 5 to 8.
Redundancy check: . 0.
Timing: . . . . . . 1 (sprocket).
Control signals: . . . 0.
Unused: . . . . . . 0.
Total: . . . . 5 to 8 (plus sprocket track).
.325 Row use: . . . . all for data.

.33 Coding: . . . . as defined by program.

.34 Format Compatibility: . any device using 5-, 6-, 7-, or 8-track punched paper tape.

.35 Physical Dimensions

.351 Overall width: . . . . 0.875 or 1 inch.
.352 Length
Roll: . . . . 1,000 feet.

.4 CONTROLLER

.41 Identity: . . . . this function is performed by the Central Processor.

.42 Connection to System

.421 On-line: . . . . 1.

.43 Connection to Device

.431 Devices per computer: . . . . ? max; 1 selected at a time.
.432 Restrictions: . . . . ?

.44 Data Transfer Control: . . . . by routine.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . as defined by routine. usually one long delay line: 256 locations.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . one block.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . none.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . no.
Select format: . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . no.
End of medium marks: . . . . no.

§ 073

.6 PERFORMANCE

.61 Conditions

I: . . . . using HSP-1 routine.
II: . . . . counting hardware limitations only.

.62 Speeds

.621 Nominal or peak speed: . . . . 110 char/sec.
.622 Important parameters
Chars per 22 bit word: . . . . 3.
.623 Overhead
Time: . . . . 6 m.sec/block.
Storage: . . . . one long delay line (256 words).
.624 Effective speeds: . . . 110 char/sec.

.63 Demands on System

Component	Condition	m. sec per char.	Percentage
Central Processor:	I	9.1	100.
	II	0.048	0.05.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . . for two tape widths.
Method: . . . . tape guide movement.

.72 Other controls

Function	Form	Comment
Indicate low tape supply to operator:	lamp	not testable.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Roll:	1,000 feet.

.732 Replenishment time: . 2 to 3 mins.
unit needs to be stopped.
.733 Adjustment time: . . . 2 to 3 mins.
.734 Optimum reloading period: . . . . 18 mins.

.8 ERRORS, CHECKS AND ACTION: . . . . none, except those that can be incorporated in routines.

INPUT-OUTPUT: HIGH SPEED READER

§ 074.

.1 GENERAL

.11 Identity: . . . . Paper Tape Reader.
HSR-1.

.12 Description

This is a high speed Digitronics Model 3500 paper tape reader. A photoelectric sensing system is used in the reader and characters can be read at a rate of 300 per second. Characters can be read from 5-, 6-, 7-, or 8-channel tape.

There is only one routine presently available for the standard reader. This routine (Cat. No. 0108A) reads in a tape prepared by the Octal Utility Package binary punching routine at full speed.

.13 Availability: . . . . . 30 days.

.14 First Delivery: . . . . Feb 1962 (**).

.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: . . .none.
.222 Sensing system: . . . photoelectric.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

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

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
other opaque tapes.
.312 Phenomenon: . . . . . fully punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . . . row, at 10 rows/inch.
.322 Parallel by: . . . . . up to 8 tracks at standard spacing.

.324 Track use
Data: . . . . 5 to 8.
Redundancy check: . . 0.
Timing: . . . . 1 (sprocket).
Control signals . . . 0.
Unused: . . . . 0.
Total: . . . . 5 to 8 (plus sprocket track).
.325 Row use: . . . . all for data.

.33 Coding: . . . . as defined by program.

.34 Format Compatibility: any device using standard punched tape.

.35 Physical Dimensions

.351 Overall width: . . . . 0.6875, 0.875, or 1 inch.
.352 Length: . . . . indefinite.

.4 CONTROLLER

.41 Identity: . . . . this function is performed by the Central Processor.

.42 Connection to System

.421 On-line: . . . . 1.

.43 Connection to Device

.431 Devices per computer: . at least 2 max; 1 selected for input at a time.
.432 Restrictions: . . . . . ?

.44 Data Transfer Control: . by routine.

.5 PROGRAM FACILITIES AVAILABLE
(Using Routine No. 0108A)

.51 Blocks

.511 Size of block: . . . . . 256 words.
768 chars.
1 long delay line.
.512 Block demarcation: . . none.

.52 Input-Output Operations

.521 Input: . . . . read 1 block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . . no.
Select format: . . . . yes, via routine.
Select code: . . . . . yes, via routine.

§ 074.

.56 Testable Conditions

Disabled: . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . no.
End of medium marks: . no.

.6 PERFORMANCE

.61 Conditions: . . . . using Routine No. 0108A.

.62 Speeds

.621 Nominal or peak speed: . 300 char/sec.
.622 Important parameters
Start time: . . . . . 3 msec.
Stop time: . . . . . 2 msec.
.623 Overhead
Time: . . . . 5 m.sec/block.
Storage of routine: . . 1 long delay line.
Working storage: . . 6 fast storage words.
.624 Effective speeds: . . . 298 char/sec.

.63 Demands on System

Component: . . . . . . Central Processor.
m. sec per char: . . . . 3.3.
Percentage: . . . . . . 100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . for three tape widths.
Method: . . . . tape guide movement.

.72 Other Controls: . . . . none.

.73 Loading and Unloading

.731 Volumes handled: . . . no handling facilities.
.732 Replenishment time: . . 1 to 2 mins.
unit needs to be stopped.
.733 Adjustment time: . . . 1 min.
.734 Optimum reloading
period: . . . . indefinite.

.8 ERRORS, CHECKS AND ACTION: . . . . none.
routines may incorporate some checks.

INPUT-OUTPUT: CARD PUNCH COUPLER

§ 075.

.1 GENERAL

.11 Identity: . . . . Card Punch Coupler.

.12 Description

No firm specification of this unit is available.

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

INPUT-OUTPUT: CARD READER

§ 076.

.1 GENERAL

.11 Identity: . . . . Card Reader.
CR 2.

.12 Description

No firm specification of this unit is available.

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

INPUT-OUTPUT: FLEXOWRITER TYPEWRITER

§ 081.

.1 GENERAL

.11 Identity: . . . . Flexowriter Typewriter.

.12 Description

The Flexowriter is an electric typewriter with paper tape reading and punching facilities. On-line, it functions as an integrated console and input-output unit, providing keyboard and paper tape input, typed and punched output. Off-line, it can be used to prepare, list, or duplicate punched tape. The various functions of the Flexowriter are described in the following report sections:

Console: . . . . :061.
Tape punch: . . . . :071.
Tape reader: . . . . :072.
Printer: . . . . :081.

This report covers only the typewriter facilities of the Flexowriter. The Flexowriter can time-share its operations with the computer; however, the effectiveness of time-sharing is reduced because only one character is transferred at a time during input or output modes of operation.

The routines now available allow for up to 68 per cent free time on output but no overlap on input when the Flexowriter is operating at its peak speed of 10 characters per second.

.13 Availability: . . . . . 30 days.

.14 First Delivery: . . . . 1961.

.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: . . . engraved hammers.
.222 Sensing system: . . . . typewriter keyboard.
.223 Common system: . . . no.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . approx. 5.
.232 Types of master
Multilith: . . . . . yes.
Xerox: . . . . yes.
Spirit: . . . . yes.

.24 Arrangement of Heads: standard typewriter method.

.25 Range of Symbols

Numerals: . . . . . . 10 0 - 9.
Letters: . . . . 26 A - Z; upper and lower case.
Special: . . . . 23.
Alternatives: . . . . . none.
FORTRAN set: . . . . yes.
Basic COBOL set: . . . yes.
Total: . . . . 59.

.3 EXTERNAL STORAGE

.31 Form of Storage: . . . paper.

.32 Positional Arrangement: . . . . 10 positions/inch.
6 lines/inch.

.35 Physical Dimensions

.351 Overall width: . . . . . up to 11 inches.

.4 CONTROLLER

.41 Identity: . . . . this function performed by the Central Processor.

.43 Connection to Device

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

.44 Data Transfer Control: as determined by routine.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks: . . . . as determined by routine.

.52 Input-Output Operations: . . . . as determined by routine.

.53 Code Translation: . . as determined by routine.

.54 Format Control: . . . as determined by routine.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . no.
Select format: . . . . via tab stops only.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . no.
End of medium marks: no.

§ 081.

.6 PERFORMANCE

.61 Conditions

I: . . . . input.
II: . . . . output.

.62 Speeds

.621 Nominal or peak speed: . . . . 10 char/sec.
.622 Important parameters: none.
.623 Overhead

	I	II
Time:	6 m.sec/char	20 m.sec/char

Storage: . . . . . . one long delay line.
.624 Effective speeds: . . . 10 char/sec or less, depending on programming.

.63 Demands on System

Component	Condition	m. sec per char	or	Percentage
Processor:	I (Input)	6*	or	6.
Processor:	II (Output)	approx. 30*	or	29.

* minimum value, with good programming. No operation on data included.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . normal typewriter.

.72 Other Controls: . . . . see section :061.

.73 Loading and Unloading: . . . . normal typewriter operation.

.8 ERRORS, CHECKS AND ACTION: . . . . none, except those that can be incorporated in routines.

INPUT: INPUT-OUTPUT: LINE PRINTER

§ 082.

.1 GENERAL

.11 Identity: . . . . Line Printer.

.12 Description

No firm specification of this unit is available.

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

INPUT-OUTPUT: MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . Magnetic Tape Unit.
MTU 1.
MTU 2.

Magnetic Tape Control Unit.
MTC 1.

.12 Description

The Magnetic Tape Unit available with the PB 250 incorporates the Ampex FR 400 Tape Handler. Up to six of these units can be connected to the PB 250 either directly (when they are called MTU 1's) or via its Magnetic Tape Control Unit (when they are called MTU 2's).

Programming for these units must be carefully done since there is no automatic lateral or longitudinal parity generation. The programmer must provide for writing and timing the gaps between blocks.

Only one routine (Cat. No. 103) is presently available for the MTU 1. This routine allows for an effective input speed of 2,000 characters per second and 1,300 characters per second on output transfers. The format is compatible with suitable IBM binary tapes; and the tape speed is 10 inches per second. No overlap with computation is practical.

.13 Availability . . . . . ?

.14 First Delivery: . . . . MTU 1, March 1962 (***).
MTU 2, none yet.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . . . each approx 4 feet.

.22 Sensing and Recording Systems

.221 Recording system: . . magnetic head.
.222 Sensing system: . . . magnetic head.
.223 Common system: . . . read/write head.

.23 Multiple Copies: none.

.24 Arrangement of Heads

Use of station: . . . . reading or writing.
Stacks: . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . . 1 to N rows at 200 rows/inch.
.322 Parallel by: . . . . . 7 tracks.
.324 Track use
Data: . . . . 7.
Redundancy check: . 0.
Timing: . . . . . . 0 (restricted to self-clock usage).
Control signals: . . . 0.
Unused: . . . . 0.
Total: . . . . 7.
.325 Row use
Data: . . . . 1 to N.
Redundancy check: . 1.
Timing: . . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . . 0.

.33 Coding: . . . . as provided by routine.

.34 Format Compatibility: . . . . IBM binary with 1,024 char. blocks.

.35 Physical Dimensions

.351 Overall width: . . . . 0.50 inch.
.352 Length: . . . . 3,600 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . this function is performed by the Central Processor.

.43 Connection to Device

.431 Devices per computer: . . . . 6.

.44 Data Transfer Control: . . . . entirely by program.

.5 PROGRAM FACILITIES AVAILABLE: . . . . as provided by program.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . no.
Select format: . . . . yes, via routine.
Select code: . . . . . yes, via routine.

§ 091.

.56 Testable Conditions

Disabled:	no.
Busy device:	no.
Nearly exhausted: . .	no.
End of medium marks:	no.

.6 PERFORMANCE

.61 Conditions

I:	MTU 1.
II:	MTU II (MTU 1 with MTC 1).

.62 Speeds

		I	II
.621	Nominal or peak speed:	2,000 char/sec	15,000 char/sec.
.622	Important parameters		
	Reading/writing speed:	10 inches/sec	75 inches/sec.
	Rewind speed:	60 inches/sec	200 inches/sec.
	Gap between blocks:	0.75 inch	0.75 inch.
	Start-stop time: . . .	?	?
.623	Overhead		
	Time to write gap: . .	75 m.secs.	2 m.secs.
	Storage of control routine:	2 long lines	?.
	Temporary storage of data:	line 00, 04, 17	?.

.624 Effective speeds

I

Input:	2,000 char/sec.
Output:	1,300 char/sec.
Comment:	using routine no. 0103B.

II:	?

.63 Demands on System

Component	Condition	m.sec. per long line	Percentage
Central Processor	I (using routine)	862	100.
	II (using routines)	?	100.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form
Tape Speed:	button.
Forward/Backward:	button.
Stop:	button.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Spool:	3,600 feet.

.732 Replenishment time: . 2 to 3 minutes.

.734 Optimum reloading period: . . . .

I	II
up to 72 mins.	4 mins.

.8 ERRORS, CHECKS AND ACTION: . . . . none, except those that can be incorporated in routines.

INPUT-OUTPUT: X-Y PLOTTER

§ 101.

.1 GENERAL

.11 Identity: . . . . Digital Graph Recorder. PB 250.

.12 Description

The PB 250 Digital Graph Recorder is a two-axis recorder used for plotting one variable against another. The increment value is fixed at 0.01 inches and the equipment has a maximum capacity of 200 increments per second in either the +X, -X, +Y, or -Y direction, singly or in pairs. A further limitation is a maximum of 10 pen movements (up from, or down to, the paper) per second.

.12 Description (Cont'd)

There is a single routine available in the library. This routine operates at 200 adjacent points per second or, as a particular case, 1.25 plots per second at 0.5 inch intervals.

The plotting chart is 100 inches long in the X direction and 12 inches in the Y direction.

.13 Availability: . . . . . 60 days.

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

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . there are no special optional facilities needed.

.12 Description

The only simultaneous operation possible is between input-output devices and the Central Processor.

.12 Description (Cont'd.)

Theoretically a number of input-output operations can take place simultaneously, but this capability is severely limited by the complexity of the input-output arrangements. It is not, in general, possible to time share any operations unless a special routine has been written for each specific case. At present no routine in the PB 250 library services more than one input-output device, and only the Flexowriter output routine allows any overlapped internal processing.

INSTRUCTION LIST

§ 121.

INSTRUCTION					OPERATION
SECTOR	ST	OP	LINE	I	Title and Explanation
					Arithmetic - Fixed Time Instructions
M_S	*	14	M_L	I	ADD Addition (A) - (M) ⟶ (A)
M_S	*	15	M_L	I	SUB Subtraction (A) - (M) ⟶ (A)
M_S	*	16	M_L	I	DPA Double Precision Addition (AB) + (M, M + 1) ⟶ (AB)
M_S	*	17	M_L	I	DPS Double Precision Subtraction (AB) - (M, M + 1) ⟶ (AB)
					Arithmetic - Variable Time Instructions (S = number of sectors between position of instruction and sector address in instruction.)
SA	*	32	****O	I	MUL Multiply (B) x (C) ⟶ (AB) if S = 22 - (C) ⟶ (A), if S = 1, and bits 20-21 of B are 01.
SA	*	31	0***0*		DIV Divide (AB) / (C) ⟶ (B), remainder ⟶ (A) (See section .051:14 regarding the accuracy of this instruction.)
SA	*	31	0***1*		DVR Divide Remainder. This operation is designed to operate on a remainder as produced by the DIVide instruction. A special instruction sequence is needed to maintain accuracy, and the notes in .051:14 regarding the accuracy of the DIV instruction still apply.
SA	*	30	00		SQR Square Root $\sqrt{(AB)}$ ⟶ (B); if S = 22. (AB) must be positive.
					Logic - Fixed Time Instructions.
M_S	*	42	M_L	I	AMC AND M and C Place a 1 bit in B wherever both M and C have 1 bits.
M_S	*	46	M_L	I	AOC AND OR Combined Place a 1 bit in B wherever both M and C have 1 bits and also place a 1 bit in B wherever M has a zero bit and the original contents of B had a 1 bit.
M_S	*	47	M_L	I	EXF EXtract Field Preserve those bits in B where there is a zero in the corresponding bit position in M.
M_S	*	40	M_L	I	EBP EXtend Bit Pattern Starting from the right end (least significant) each position of M is checked; if the position contains a zero, the corresponding position of A is changed so that it is the same as the bit written to its immediate right.
M_S	*	56	M_L	I	CAM Compare C and M. Turn overflow indicator on if equal, off if unequal.

INSTRUCTION LIST—Contd.

§ 121.

INSTRUCTION					OPERATION
SECTOR	ST	OP	LINE	I	Title and Explanation
					Logic - Fixed Time Instructions (Continued).
M_S	1	37	M_L	I	TRU Transfer Unconditionally.
M_S	0	35	M_L	I	TAN Transfer if A is negative.
M_S	0	36	M_L	I	TBN Transfer if B is negative.
M_S	0	34	M_L	I	TCN Transfer if C is negative.
M_S	0	75	M_L	I	TOV Transfer on overflow.
		77			TES See input-output.
*	*	41	*	*	GTB Grey to Binary. 1 grey-coded character in A ⟶ Binary coded number in A or its ones complement.
					Input - Output.
SA	*	70	Signal	*	PTU Pulse To Specified Unit. A 5-bit identification signal together with a 1 bit "activate" pulse is used. The "activate" pulse is held until the sector address is reached, thus allowing timing of the pulse to match the timing requirement of the external relays.
*	*	57	*	*	CIB Clear Input Buffer. Zeroes are placed in the 8-character Input Buffer.
*	*	51	*	*	RTK Read Typewriter Keyboard
*	*	52	*	*	RPT Read Paper Tape The computer accepts one character from the flexowriter.
D	0	77	Test Value		TES Transfer on External Signal This tests for, and transfers on, the presence of the signal specified in the line number of the instruction. Such signals include: (a) Flexowriter input incomplete (b) Flexowriter output not ready (c) Magnetic tape gap signal (d) Magnetic tape reader clock input (e) High speed reader sprocket input (f) Breakpoint switch on signal.
*	*	53	*	*	RFU Read Fast Unit This instruction reads a character from any fast unit into the input buffer. It is necessary to use the Pulse to Specified Unit commands to send out and time the selection, starting and stopping of this unit. The Disconnect Input Unit command is used to terminate each RFU command.
Format Sector ≠ 376	*	55	*	*	LAI Load A from Input Buffer (a) The contents of the input buffer are placed within bits 14 through 21 of register A. A Format Word is used to mask out unwanted bits.
376	*	55	*	*	(b) If the Format Word is located in any sector 376, selective insertion of zeros into register A is possible.
SA	*	6 [CHAR. OUTPUT]		*	WOC Write Output Character. This is the major output instruction. The character to be written occupies part of the instruction. The unit to receive the character is specified by the entry in the line number field of the instruction either by itself or in conjunction with a previous Pulse to Output Unit Command.

INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION					OPERATION
SECTOR	ST	OP	LINE	I	Title and Explanation
					Input - Output (Continued) WOC Write Output Character (Continued) The WOC command must be used in conjunction with a timing constant so as to sustain the information until it has been received by the particular output unit.
SA	*	73	X	*	BSI Block Serial Input This instruction allows for up to 254 words of information to be loaded into the computer line X from some external shift register at the full 2 megacycle rate of the PB 250. Masking the information is done during input by comparison with the corresponding bit contents of the line containing the instruction. These bits include the parity and guard bits.
SA		72	X	*	BSO Block Serial Output This is the reverse of Block Serial Input.
*	1	4N	*	*	CLA, CLB, CLC Clear register A, B, or C.
M_S	*	ON	M_L	I	LDA, LDB, LDC Load (M) into register A, B, or C.
M_S	*	07	M_L	I	LDP Load Double Precision $(M, M+1) \longrightarrow (AB)$
M_S	*	1N	M_L	I	STA, STB, STC Store register A, B, or C, in M.
M_S	*	13	M_L	I	SDP Store Double Precision $(AB) \longrightarrow (M, M+1)$
*	*	01	*	*	IAC Interchange A and C $(A) \longrightarrow (C)$, $(C) \longrightarrow (A)$
*	*	02	*	*	IBC Interchange B and C $(B) \longrightarrow (C)$, $(C) \longrightarrow (B)$
*	*	03	*	*	ROT ROTate register $(A) \longrightarrow (C)$, $(C) \longrightarrow (B)$; $(B) \longrightarrow (A)$.
SA	*	26	X		MLX Move Line X Move S locations from Line X to Line 7.
SA	*	71	X		MCL Move Command Line Move S locations from the line containing the instruction to line X.
SA	*	33	1****	I	LRS Logical Shift Right Shift (AB) right S places, copying the parity bit into the most significant S places.
SA	*	20	*1***	I	NOR NORmalize (AB) normalized $\longrightarrow$(AB) S = maximum number of shifts.
SA	*	21	*1***	I	SLT Shift Left (AB) shifted left S bits; sign position undisturbed.
SA	*	22	*1***	I	SRT Shift Right (AB) shifted right S bits; sign bit undisturbed but copied into most significant S bits of AB.

INSTRUCTION LIST–Contd.

§121

INSTRUCTION					OPERATION
SECTOR	ST	OP	LINE	I	Title and Explanation
					Logical - Variable Time Instruction (S = number of sectors between instruction sector and sector address.)
SA	*	20	*0****		NAD Normalize and Decrement. (AB) normalized ⟶ (AB) (C) - number of shifts needed ⟶ (C) S = maximum number of shifts.
SA	*	22	*0***		RSI Right Shift And Increment (AB) / 2^S ⟶ (AB); Overflow is inhibited. (C) + S ⟶ (C)
SA	*	23	*0***		SAI Scale right And Increment As RSI, except that the operation ceases if (C) becomes non-negative before the full shift is completed.
SA	*	33	0****		SBR Shift B Right Shift bit 21 of A into B, and then continue shifting the new contents of B S - 1 places, bringing zeros into the most significant bits of B.
SA	*	21	*0***		LSD Left Shift and Decrement (AB) X 2^S ⟶ (AB); Overflow is inhibited. (C) - S ⟶ (C)

INSTRUCTION LIST NOMENCLATURE

Symbol	Definition
A:	Register A.
B:	Register B.
C:	Register C.
M:	Operand.
M_S:	Sector of an operand or transfer location.
M_L:	Line of an operand or transfer location.
D:	Sector of a transfer location being used with an implied line address.
I:	Index Register Tag.
S:	Number of sectors between instruction sector and sector address. In shift instructions this defines the maximum no. of shifts required.
SA:	Sector Address, being treated as a constant to determine length of instruction.
*:	Position not considered during instruction execution:

CODING SPECIMEN: ATRAN

§ 131.

.1 SOURCE PROGRAM

```
QUADRATIC$$
DIM:GG(4.3)$
LOD:GG$
I = 1$
PNT:1$
JK = 1$
JL = 2$
JM = 3$
Y = GG(I,JL)⌒2-4*GG(I,JK)*GG(I,JM)$
TST:Y$
MJP:3$
XA = (-GG(I,JL)+Y⌒.5)/(2*GG(I,JK))$
PRA:
X1 = $
PRF:(8C)XA$
```

.1 SOURCE PROGRAM (Cont'd)

```
XB = (-GG(I,JL)-Y⌒.5)/(2*GG(I,JK))$
PRA:X2 = $
PRF:(8C)XB$
PNT:4$
TST:I$
XEQ:4$
JMP:2$
HLT:END$
PNT:2$
I = I+1$
JMP:1$
PNT:3$
PRA:
THE ROOTS ARE IMAGINARY
$
JMP:4$ END:0$.
```

§ 132. CODING SPECIMEN: SNAP I

.1 CODING SHEET

pb SNAP SYMBOLIC CODING SHEET

PROBLEM: D. P. C-W Assembly DATE:

PROGRAMMER: PAGE 1 of 3

LOCATION				ADDRESS	TAG		REMARKS
START	L	D	P	$+1	S		
	T	O	F	A1			
	I	B	C				
	S	T	B	SPACE			Set space link -1
	S	T	A	PHASE			Set phase link -1
	C	L	A	READ	S		
	L	A	I	MASK	S		Character → A
READ	R	P	T	$ - 2	S		
	R	P	T	$ + 1			Reject last character
	T	E	S	30, $ - 1			
	T	E	S	30, READ			Wait for next character
	C	I	B	$ - 2	S		
MASK	O	C	T	77			
	C	A	M	$ + 1	S		
	O	C	T	56			
	T	O	F	CR			Exit if CR
	C	A	M	$ + 1	S		
	O	C	T	20			
SPACE	T	O	F	A1			Exit to space link
PHASE	I	B	C				Exit to phase link
	S	R	T	3			Phase link - 1
	I	A	C				Assemble by 3
	S	R	T	19			
	C	L	A	READ	S		Return to read
A1	S	L	T	14			Space link - 1
	S	T	B	M1			Save last 8 bits
	L	D	A	$ + 1	S		Set space link - 2
	T	O	F	A2			

§ 132.

.2 SYMBOLIC CODING

```
START    LDP     $+1          S
         TOF     A1
         IBC
         STB     SPACE
         STA     PHASE
         CLA     READ         S
         LAI     MASK         S
READ     RPT     $ - 2        S
         RPT     $+1
         TES     30, $ - 1
         TES     30, READ
         CIB     $ - 2        S
MASK     OCT     77
         CAM     $+1          S
         OCT 56
         TOF     CR
         CAM     $+1          S
         OCT 20
SPACE    TOF     A1
PHASE    IBC
         SRT     3
         IAC
         SRT     19
         CLA     READ         S
A1       SLT     14
         STB     M1
         LDA     $+1          S
         TOF     A2
         STA     SPACE
         CLA     READ         S
```

.3 ASSEMBLY PRINT OUT

```
PB 250 ASSEMBLY
IDENTIFICATION: CONTROL LIST ASSEMBLY
PHASE 1
INPUT:FLEX

PHASE 2
OUTPUT:FLEX

END OF JOB
```

.4 MACHINE PROGRAM

```
00002$001S0702;
00102$030 7502;
00202$000 0200;
00302$022 1202;
00402$023 1102;
00502$007S4500;
00602$014S5502;
00702$005S5200;
01002$011 5200;
01102$010 7736;
01202$007 7736;
01302$011S5700;
01402$+0000077;
01502$016S5602;
01602$+0000056;
01702$060 7502;
02002$021S5602;
02102$+0000020;
02202$030 7502;
02302$000 0200;
02402$030 2210;
02502$000 0100;
02602$052 2210;
02702$007S4500;
03002$047 2110;
03102$101 1202;
03202$033S0502;
03302$036 7502;
03402$022 1102;
03502$007S4500;
```

CODING SPECIMEN: CINCH

§ 133.

.1 CODING SPECIMEN

PB 250 CINCH CODING SHEET

PROGRAM NAME ______ PAGE ____ OF ____

PROGRAM NO. ______ SPECIAL I.D. ______

BY ______ DATE ______

L CODE	LOCATION	CODE	INSTRUCTION T	OP	IR	ADDRESS	SYM. OP CODE	NOTES
	9							Set Location
L	010 0			46		0160	TAC	Type headings
	010 1			02	C	0138	SIB	C+1 Run = 1
	2			03	C	0138	SIM	C+1
	3			04	C	0140	SIL	C+2050 Any large number.
	4			17		0002	RPT	
	5			10		0004	CAD	b
	6			07	G	0050	TSI	
	7		T	12		0004	ADD	$b/2 - b^2 + b$
	8							
	9							
	0							
	1							
	013 2			26		0004	TNT	Type B
	3			26		0006	TNC	Type R
	4			06	C	0104	MIT	start. Run = Run+1, go to start.
	5			00		0000	HCT	end.
	6							
	7							
L	013 8	D		+1				Constants
	9			2050				
	0			2				
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
L	016 0			ARU	N			Carriage control functions are (tab) and
	1			(tab	A	tab)R		(c/r). This message contains 11 characters
	2			B (		tab)R		and is stored in 0160 - 0163
	3			(c/	r	);		
	4	E						End of Tape.
	5							
	6							

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . Flexowriter keyboard.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 8 bits.

.22 Character Structure

.221 More significant pattern: . . . . . . 2 bits: A and B, A, B = 16, 32.

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

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	UPPER CASE				LOWER CASE			
	0	16	32	48	0	16	32	48
0		SP	)	:		SP	¢	;
1	π	J	A	/	1	j	a	$
2	$\sqrt{}$	K	B	S	2	k	b	s
3	L	=	T	C	ℓ	3	t	c
4	⊏	M	D	U	4	m	d	u
5	N	⊐	V	E	n	5	v	e
6	0	⎍	W	F	o	6	w	f
7	&	P	G	X	7	p	g	x
8	*	Q	H	Y	8	q	h	y
9	R	(	Z	I	r	9	z	i
10				UC				UC
11	STP	"	.	,	STP	'	.	,
12				LC				LC
13								
14		?	CR	TB		+	CR	TB
15		-		DEL		-		DEL

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 Other:

Mathematical
Reference: . . . . PB 250 Library.
Date available: . . . . current.
Description:
Three double precision routines are available (Multiply, Divide and Square Root) plus the elementary mathematical functions.

PROCESS ORIENTED LANGUAGE: ATRAN

§ 161.

.1 GENERAL

.11 Identity: . . . . Algebraic TRANslator. ATRAN.

.12 Origin: . . . . Packard Bell Computers.

.13 Reference: . . . . . Specification Manual.

.14 Description:

The ATRAN language is designed for uses similar to those of FORTRAN, and there is a considerable similarity in the syntax of the arithmetic statements. Otherwise, however, there is no relationship between the two languages.

The ATRAN language consists of unlabeled algebraic, input-output, data description statements and control point statements. Each algebraic statement is limited to two levels of parentheses. Any use of the trigonometric functions contained in the program requires a complete statement: e.g., y = Sin: x is the only permissible form. The naming of statements is done by interspersing "Control Point statements" between the other statements. Each control point is represented by a two-digit number; thus, a maximum of 99 control points can exist in a program.

The names of variables may be one or two letters. Initial letters, I, J, K, L, M, and N indicate fixed point variables.

Transfers of control are governed by sequences of two to five elementary statements. Separate instructions are used to control the size and point position of output data items, and input must be in CINCH standard format, which is fairly flexible. The Flexowriter is the only equipment used for input of the source program, although a High Speed Reader, if available, can be used to load the ATRAN phases.

No diagnostic or documentary aids are available for the ATRAN language.

Documentation is confined to remarks inserted in the source program for off-line listing.

.15 Publication Date: . . . August, 1962.

.2 PROGRAM STRUCTURE

.21 Divisions

Data Description: . . . DIMension statement, describing lists or arrays.

.21 Divisions (Contd.)

Control Point Statements: . . . . provide labels to identify points within the program, to allow jumps.

Procedure Statements: . . . . all other statements.

.22 Procedure Entities

Program: . . . . . . statements.
Statements: . . . . . words.

.23 Data Entities

Subscripted variable: . . . . variable and one or two subscripts.
Variable: . . . . . . fixed point part and exponent.
Subscript: . . . . . . positive integers.
Alphanumeric data: . . characters.

.24 Names

.241 Simple name formation
- Alphabet: . . . . . . A to Z; 0 to 9.
- Size: . . . . 2 chars max.
- Avoid key words: . . no.
- Formation rule: . . . numeric for control points. alphabetic for data.

.242 Designators
- Procedures: . . . . implied via Control Points 1 through 99.
- Data
  - Variables: . . . . first (or only) character must not be I through N.
  - Subscripts: . . . . first (or only) character must be I through N.
- Equipment
  - Flexowriter Reader: implied by "LOD" instructions.
  - Flexowriter Keyboard: . . . . . . implied by "PUT" and "PRx" instructions.
  - Flexowriter Punch . . . . . . implied by "PNx" instructions.
- Translator control: . . . . none.

.25 Structure of Data Names

.251 Qualified Names: . . . none.
.252 Subscripts
- Number per item: . . 2.
- Applicable to: . . . . floating point variables.
- Class may be
  - Special index variable: . . . . . . yes.
  - Any variable: . . . no.

§ 161.

.252 Subscripts (Contd.)
Class may be (Contd.)
Literal: . . . . . . no.
Expression: . . . . no.
Form may be
Integer only: . . . yes.
Signed: . . . . . . positive only.
Truncated fraction: . . . . no.
Rounded fraction: . no.
.253 Synonyms
Preset: . . . . no.
Dynamically set: . . no.

.26 Number of Names

.261 All entities: . . . . . 401.
.262 Procedures
Control points: . . . 99.
.263 Data
Floating variables plus subscripts and lists: . . . . . 175.
Integer & floating constants plus arrays: . . . . . . 127.
Subscripts plus subscript combinations: . . . . . . 31.

.27 Region of Meaning of Names: . . . . . . all universal.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: . . . . none.
.312 List by kind: . . . . . none.
.313 Qualify by adjective: . . . . none.
.314 Qualify by phrase: . . none.
.315 Qualify by code: . . . none.
.316 Hierarchy by list: . . none.
.317 Level by indenting: . . none.
.318 Level by coding: . . . none.
.319 Others
Define by naming convention: . . . . yes, using initial letter.
Define by format: . . yes.

.32 Files and Reels: . . . none.

.33 Records and Blocks: . . . . none.

.34 Data Items

.341 Designation of class: . . . . descriptor.
.342 Possible classes
Integer: . . . . . . only positive.
Fixed point: . . . . . only positive integer.
Floating point: . . . yes.
Alphabetic: . . . . . no.
Alphameric: . . . . no.
.343 Choice of external radix: . . . . no.
.344 Possible external radices: . . . . . . decimal.
.345 Justification: . . . . . left on output.
.346 Choice of code: . . . . no.
.348 Item size
Variable size: . . . no variation possible.
Range on input: . . . less than 100,000 in magnitude.
Alphameric: . . . . 18 characters (***).
.349 Sign provision: . . . . optional.

.35 Data Values

.351 Constants: . . . . . . none.
.352 Literals
Possible sizes
Integer: . . . . . . 0 through 99.
Fixed point: . . . . none.
Floating point: . . . less than 100,000 in magnitude with up to 5 places to right of decimal point.
Alphabetic: . . . . none.
Alphameric: . . . . none.
Designation: . . . . none; they must be included directly in the statement.
Sign provision: . . . optional.
.353 Figuratives: . . . . . none.
.354 Conditional variables: . none.

.36 Special Description Facilities: . . . . . none.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator list
+: . . . . add.
-: . . . . subtract.
*: . . . . multiply.
/: . . . . divide.
√: . . . . square root.
⎍: . . . . exponentiation.
=: . . . . is replaced by.
SIN: . . . . sine.
COS: . . . . cosine.
ASN: . . . . arcsine.
ACS: . . . . arcosine.
ATN: . . . . arctangent.
EXP: . . . . exponent.
LOG: . . . . log.
LGN: . . . . natural log.
ABS: . . . . absolute value.
.412 Operands allowed
Classes: . . . . . . all numeric.
Mixed scaling: . . . yes.
Mixed classes: . . . no.
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: . . . . $(a^b)^c$
.414 Rounding of results
On output: . . . . . rounding in 10th decimal place, irrespective of number of characters output.

§ 161.

.415 Special cases

x = -x:	x = 0 - x$
x = x + 1:	x = x + 1$
x = 4.7y:	x = 4.7*y$
x = 5 x 10^7 + y^2:	x = 5.0x10.0⌒7.0+y⌒2.0$
x = y integer part:	not practical.

.416 Typical examples: A=B*[(A(J, K)*C(I)-H/D(L)⌒E)-(3.7*G)]$
X=[√(B*B-4*A*C)-B]/[2*A]$

.42 Operations on Arrays: none.

.44 Data Movement and Format: number of places and decimal point can be stipulated within each output instruction.

.45 File Manipulation: none.

.46 Operating Communication: none.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	hardware	halt with indication of error.
In-out:	sum check	halt with indication of error.
Invalid data:	no check	none.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: any control point; e.g., PNT :03

.512 Unconditional jump: any control point; e.g., JMP:03

.513 Switch: none.

.514 Setting a switch: none.

.515 Switch on data: explicit test of each value.

.52 Conditional Procedures

.521 Designators
- Condition: TST instruction.
- Procedure: implied.

.522 Simple conditions
- Expression v Expression: no.
- Variable v Variable: no.
- Variable v Literal: yes.
- Variable v Figurative: no.
- Variable v Condition: yes.

.523 Conditional relations: none.

.524 Variable conditions: positive.
negative.
zero.
not zero.

.525 Compound conditionals: none.

.526 Alternative designator: none.

.528 Typical examples
- Prepare A for testing. If positive, jump to Pnt 46: TST:A$. PJP:46.
- Prepare K for testing. If K = 8 jump to :03: TST:K. XEQ:8. JMP:03.

.53 Subroutines: none.

.54 Function Definition by Procedure: none.

.55 Operand Definition by Procedure: none.

.56 Loop Control: must be programmed.

.6 EXTENSION OF THE LANGUAGE: none.

.7 LIBRARY FACILITIES: none.

.8 TRANSLATOR CONTROL: none.

.9 TARGET COMPUTER ALLOCATION CONTROL: none; all allocation is done by CINCH Interpreter.

MACHINE ORIENTED LANGUAGE: SNAP I

§ 171.

.1 GENERAL

.11 Identity: . . . . SNAP I
Symbolic Non-optimizing Assembly Program.

.12 Origin: . . . . Packard Bell Electronics.

.13 Reference: . . . . . Packard Bell Computers.

.14 Description

This is simple one-to-one assembly language with mnemonic operation codes and no macros. The manipulation of addresses and locations across delay lines of the store must still be carefully controlled by the programmer. Relative addressing is restricted to one delay line at a time.

.15 Publication Date: . . . July 1962.

.2 LANGUAGE FORMAT

.21 Diagram

LOCATION	OP	ADDRESS	TAG	REMARKS

.22 Legend

LOCATION: . . . . . . a symbolic or an absolute address expressed in octal notation.

OP: . . . . a mnemonic for a machine code or pseudo-operation.

ADDRESS: . . . . . . (a) an operand address expressed in symbolic, absolute, or relative terms.
(b) a literal to be used as an operand.

TAG: . . . . defines if time sequencing and/or indexing is to be used, by the use of S, I, SI codes.

.23 Corrections: . . . . . no special procedures.

.24 Special Conventions

.241 Compound addresses: . expressed relative to any symbolic address, within the same line, i.e., READ-16.

.243 Literals
BCD pseudo code: . . allows the translation and storage of 1 to 3 alphanumeric characters, or of one control character (carriage return, etc.).
DEC pseudo code: . . allows the translation of a six digit decimal constant to binary form, with possible scaling.

.244 Special coded addresses: . . . . . . $ indicates "This address."

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . 256.
.312 Common label formation rule: . . . . . . up to 5 alphameric characters; one of which must be alphabetic.
.313 Reserved labels: . . . none.
.315 Designators: . . . . . no special rules.
.316 Synonyms permitted: . yes.

.32 Universal Labels

.321 Labels for procedures
Existence: . . . . . optional.
Formation rule: . . up to five alphameric characters; including at least one alphabetic.
.323 Labels for constants
Existence: . . . . . optional.
Formation rule: . . . same as for procedures.
.326 Labels for variables
Existence: . . . . . optional.
Formation rule: same as for procedures.

.33 Local Labels: . . . . all universal.

.4 DATA

.41 Constants

.411 Maximum size constants

Machine form	External language
Integer	
Binary:	decimal, under 2,097,152.
Fixed numeric	
Scaled binary: . .	decimal, under 2,097,152 ignoring the decimal point, with scaling value Q, where $0 \leq Q \leq 21$.
Floating numeric: . .	not available.
Alphabetic:	6-bit code, stored at maximum of three per word. Translation dependent upon preceding lower case or upper case symbols.

§ 171.

.42 Working Areas

.421 Data layout: . . . . . implied by use.
.422 Data type: . . . . . . implied by use.

.43 Input-Output Areas

.431 Data layout: . . . . . defined by hardware.
.432 Data type: . . . . . . implied by use.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . mandatory.
Number: . . . . . . 59.
Example: . . . . . . MUP for "multiply".
.512 Absolute
Existence: . . . . . not available.

.52 Macro-Codes: . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . by absolute label or pseudo.
Label adjustment: . . by pseudo.
Annotation: . . . . . none.
.542 Allocation counter
Set to absolute: . . . yes.
Set to label: . . . . no.
Step forward: . . . yes, within any one line.
Step backward: . . . yes, within any one line.
Reserve area: . . . yes, using BSS pseudo-operation.

.543 Label adjustment
Set labels equal: . . yes.
Set labels relative: . yes, within the same line.
Set absolute value: . yes.
Clear label table: . . no.
.544 Annotation: . . . . . none available.
.545 Other: . . . . none.

.6 SPECIAL ROUTINES AVAILABLE: . . . . none.

.7 LIBRARY FACILITIES: . . . . none.

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . none.

.82 Pseudos

Code	Description
BCD:	stores a given three character alphameric literal in standard format.
BSS:	reserves a block of locations starting at the present setting of the location counter.
DEC:	stores a decimal literal in binary format.
END:	terminates a program.
EQU:	defines a symbolic location with reference to a previously defined symbol, an absolute location, or the present setting of the location counter.
OCT:	stores an octal literal in binary format.
ORG:	sets the location counter.
SKP:	advances the location counter.

MACHINE ORIENTED LANGUAGE: CINCH

§ 172.

.1 GENERAL

.11 Identity: . . . . CINCH Interpreter. PBC 1006.

.12 Origin: . . . . Packard Bell Computers.

.13 Reference: . . . . . . CINCH Interpreter, PBC 1006.

.14 Description

The CINCH Interpreter language is basically similar to machine language instructions. The scope of the interpreter operations is much greater than that of the PB 250 instruction repertoire and resembles a sophisticated machine code. All input takes place under the direct control of special characters in the data words, and no checking is provided during input. Numeric output is under program control while alphanumeric output is controlled by special characters contained in the data word. The programmer can insert tracing instructions at will and suppress tracing from the console. Although one or more fast lines are available, no facilities are provided by which a programmer can take advantage of them. The standard macros, however, do use these lines to give improved performance.

It is possible to enter machine code from CINCH, but writing in machine code for incorporation in CINCH requires extreme care on the part of the programmer.

There are few direct documentation facilities in CINCH other than the print-outs of diagnostics. It is possible to dump a running program on the punched paper tape, but this takes place in binary format and cannot be read by the CINCH programmer. Print-outs of specified storage locations are possible using either data or command format.

.15 Publication Date: . . . March, 1961.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . . one of two types of typed line on plain stationery.

Part	T	OP	I	ADDR	C/R
Size, char.	1	2	1	4	1

Part	T	OP	ADDR	C/R
Size, char.	1	2	4	1

.22 Legend

T (Trace Tag): . . . . indicates if instruction is to be printed during processing.
OP (OP Code): . . . . 2 numeric char specifying the operation.
I (Index Tag): . . . . . one alphabetic tag, A through G, specifying an index register to be used to modify the address of the operand.
ADDR (Address): . . . address of operand.
C/R (Carriage Return): specifies the end of the instruction.

.23 Corrections: . . . . . rewrite.

.24 Special Conventions: . . none.

.3 LABELS

.31 General

.311 Maximum number of labels
Instructions: . . . . 4,095.
Constants: . . . . . 2,047.
.312 Common label formation rule: . . . four-digit number between 0000 and 4,095.
.313 Reserved labels
For 0000: . . . . . . interpreter pseudo-accumulator.
.314 Other restrictions: . . . $3I + 6N + A \leq 12,285$.
I = no. of instructions.
N = no. of numeric values.
A = no. of alphameric characters used in literals.
.315 Designators: . . . . . none.
.316 Synonyms permitted: . no.

.32 Universal Labels: . . . all.

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

.4 DATA

.41 Constants

.411 Maximum size constants
Integer: . . . . . . not available.
Fixed numeric: . . . not available.
Floating numeric: . . 10 decimal digits.
Alphabetic: . . . . as required.
Alphameric: . . . . as required.
.412 Maximum size literals
Integer: . . . . . . 10 decimal digits.
Floating numeric
Binary: . . . . . . 10^{38}.
Alphabetic: . . . . . no practical limit.
Alphameric: . . . . no practical limit.

§ 172.

.42 Working Areas

.421 Data layout: . . . . . specified in program.
.422 Data type: . . . . . . always floating point.
.423 Redefinition: . . . . . no.

.43 Input-Output Areas

.431 Data layout: . . . . . explicit reference.
.432 Data type:
Input: . . . . control char A, C, D, L, X.
Output: . . . . . . specific instructions.
.433 Copy layout: . . . . . no.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . only as comments on coding sheets.
Number: . . . . . . 15.
Example: . . . . . RPT; Read Paper Tape.
Comment: . . . . . these must also be written as absolute instructions for entry to the computer.
.512 Absolute
Existence: . . . . . mandatory.
Number: . . . . . . 15.
Example: . . . . . 17; Read Paper Tape.
Comment: . . . . . the absolute code is equivalent to the machine code, but does not have the same value, i.e., Read Paper Tape code is 52 in machine language.

.52 Macro-Codes

.521 Number available
Input-output: . . . . 9.
Arithmetic: . . . . . 2.
Math functions: . . . 8.
Index controls: . . . 5.
Logic: . . . . 8.
Interpreter controls: 3.
.522 Examples
Simple: . . . . . . DIV (M)
Divide the accumulator by (M).
Elaborate: . . . . . MIT F 0500
Modify Index Register F and Transfer to 0500 if the index limit has been passed.

.53 Interludes: . . . . . no.

.54 Translator Control

.541 Method of control
Allocation counter: . see .542.
Label adjustment: . no.
Annotation: . . . . no.

.542 Allocation counter
Set to absolute: . . . by $ control character on tape.
Set to label: . . . . no.
Step forward: . . . one per instruction input. two per constant input.
Step backward: . . . no.
Reserve area: . . . no.
.543 Label adjustment: . . none; all labels have fixed positions in store; e.g., 0139 refers to PB 250 line 14 sector 213.
.544 Annotation: . . . . . none.
.545 Other
Control diagnostics: . yes.
Control output precision: . . . . . yes.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . . . . as provided by installation.
.612 Method of call: . . . . unconditional transfer with automatic use of an Index Register to store address of original transfer instruction.

.62 Special Functions

.621 Facilities: . . . . . . as provided by installation.
.622 Method of call: . . . . as in .612.

.63 Overlay Control: . . . not possible.

.64 Data Editing

.641 Radix conversion: . . binary to decimal.
.642 Code translation: . . none.
.643 Format control
Size control: . . . . via SFL pseudo code.
Special characters: . tab or carriage return are transferred after typing or punching data values.
.644 Method of call: . . . instruction.

.65 Input-Output Control: . none.

.66 Sorting: . . . . none.

.67 Diagnostics: . . . . . included only as macro instructions.

.671 Dumps: . . . . no.
.672 Tracers: . . . . . . using ETM and LTM pseudo operations.
.673 Snapshots: . . . . . using Trace Tag field in each individual instruction.

.7 LIBRARY FACILITIES

.71 Identity: . . . . installation provided.

.72 Kinds of Libraries

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

§ 172.

.73 Storage Form: . . . . paper tape.

.74 Varieties of Contents: . as provided by installation.

.75 Mechanism: . . . . . variable.

.8 MACRO AND PSEUDO TABLES

.83 CINCH Instruction Code

Code	Description
ADD (M): . . .	$(AC) + (M) \rightarrow (AC)$.
SUB (M): . . .	$(AC) - (M) \rightarrow (AC)$.
MUP (M): . . .	$(AC) \times (M) \rightarrow (AC)$.
DIV (M): . . .	$(AC) / (M) \rightarrow (AC)$.
ADA (M): . . .	$(AC) + \lvert(M)\rvert \rightarrow (AC)$.
DVM (M): . . .	$(M) / (AC) \rightarrow (AC)$.
CLA (M): . . .	$(M) \rightarrow (AC)$.
CSA (M): . . .	$-(M) \rightarrow (AC)$.
CAA (M): . . .	$\lvert(M)\rvert \rightarrow (AC)$.
STA (M): . . .	$(AC) \rightarrow (M)$.
STB (I) (M): . . .	$(I) \rightarrow (M)$.
TRU (M): . . .	Transfer to (M).
TAN (M): . . .	Transfer if (AC) is negative.
TAP (M): . . .	Transfer if (AC) is positive.
TAZ (M): . . .	Transfer if (AC) is zero.
TNZ (M): . . .	Transfer if (AC) is not zero.
CAM (M): . . .	Compare (AC) - (M); and set Comparison Switch to High, Low or Equal.
TCL (M): . . .	Transfer if Comparison Switch "Low".
TCH (M): . . .	Transfer if Comparison Switch "High".
TCE (M): . . .	Transfer if Comparison Switch "Equal".
TCU (M): . . .	Transfer if Comparison Switch not "Equal".
SBI (I) (M): . . .	$(M) \rightarrow (I)$.
SIM (I) (M): . . .	Set the increment of the index register to (M).
SIL (I) (M): . . .	Set the limit of the index register to (M).
MIT (I) (M): . . .	Increment and test the index register, transfer if index register limit passed.

.83 CINCH Instruction Code (Cont'd)

Code	Description
RPT (M): . . .	Read Paper Tape under control of control char on tape. Store in (M) onwards.
RTK (M): . . .	Read Typewriter Keyboard under control of typed control char. Store in (M) onwards.
TNT (M): . . .	Type (M) in data format, followed by tab.
TNC (M): . . .	Type (M) in data format, followed by CR.
PNT (M): . . .	Punch (M) in data format, followed by tab.
PNC (M): . . .	Punch (M) in data format, followed by CR.
TAC (M): . . .	Type alphanumeric characters from (M) onwards until control character found in storage.
PAC (M): . . .	Punch alphanumeric characters from (M) onwards until control character found in storage.
TXT (I) -: . . .	Type (I) followed by Tab.
PXT (I) -: . . .	Punch (I) followed by Tab.
SIN (M): . . . †	Sine $(M) \rightarrow (AC)$.
COS (M): . . . †	Cos $(M) \rightarrow (AC)$.
ATN (M): . . . †	Arctan $(M) \rightarrow (AC)$.
LNE (M): . . . †	Natural log $\lvert(M)\rvert \rightarrow (AC)$.
LOG (M): . . . †	Log $\lvert(M)\rvert \rightarrow (AC)$.
EXP (M): . . . †	$e^{(M)} \rightarrow (AC)$.
TEN (M): . . . †	$10^{(M)} \rightarrow (AC)$.
SQR (M): . . . †	$\sqrt{\lvert M\rvert} \rightarrow (AC)$.
HLT:	Halt.
NOP:	No operation.
	Enter Trace Mode; with breakdown switch down print out all subsequent instructions as they are executed until an LTM instruction is met with.
LTM:	Leave Trace Mode ... see ETM.
EXTM:	Transfer to PB 250 location M, thus leaving CINCH language programming.
SF LM:	Punch or type (M) character when instructed to transfer the fixed point part of a number.

† Not available in CINCH 1B, a restricted version which occupies 9 long lines (2 lines fewer than the full version).

PROGRAM TRANSLATOR: SNAP I

§ 181.

.1 GENERAL

.11 Identity: . . . . SNAP I Assembler.

.12 Description:

This is a straightforward two pass assembler. It operates from paper tape input to paper tape output. A machine code listing can be obtained from the tape on a Flexowriter. An error listing is typed out on the Flexowriter.

.13 Originator: . . . . . Packard Bell Electronics.

.14 Maintainer: . . . . . Packard Bell Computers.

.15 Availability: . . . . . July, 1962.

.2 INPUT

.21 Language

.211 Name: . . . . SNAP I.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . paper tape.
.222 Obligatory ordering: . must be in correct logical sequencing.
.223 Obligatory grouping: . none.

.23 Size Limitations

.231 Maximum number of source statements: . no direct limit; but no provision is made to assemble anything outside the command lines.
.232 Maximum size source statements: . . . . one instruction.
.233 Maximum number of data items: . . . . . see next entry.
.234 Others
Maximum number of symbols: . . . . . 256 (this includes data items, procedures, constants, labelled literals, etc.).

.3 OUTPUT

.31 Object Program

.311 Language name: . . . Octal Utility Package Command format.
.312 Language style: . . . 6-bit Flexowriter code.
.313 Output media: . . . . paper tape.

.32 Conventions

.321 Standard inclusions: . . none.
.322 Compatible with: . . . Octal Utility Package Command format.

.33 Documentation

Subject	Provision
Source program: . .	coding sheet.
Object program: . .	off-line Flexowriter listing.
Storage map: . . .	none.
Language errors: .	print-out during compilation, giving some indication of type of error.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

1st pass: . . . . . . forms symbol table, and checks for language and allocation errors.
2nd pass: . . . . . . prepares output tape and checks for further language errors.

.42 Optional Mode: . . . . none.

.43 Special Features: . . . none.

.44 Bulk Translating: . . . yes.

.45 Program Diagnostics: . none.

.46 Translator Library: . none.

.5 TRANSLATOR PERFORMANCE

Conditions
I: . . . . using Flexowriter input-output.
II: . . . . using High Speed Punch & Reader.

.51 Object Program Space

.511 Fixed overhead: . . . none.
.512 Space required for each input-output file: . . not applicable.
.513 Approximate expansion of procedures: . . . 1.

§ 181.

.52 Translation Time

.521 Normal translating

I: . . . . 18 mins translator loading time plus 4 secs per instruction.

II: . . . . 2 mins translator loading time plus 4 secs per instruction.

.53 Optimizing Data: . . . none.

.54 Object Program Performance: similar to standard Address Sequenced hand coding.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . PB 250 with Flexowriter and 13 long lines (3,328 locations).

.612 Larger configuration advantages: . . . . . faster loading using High Speed Reader.

.62 Target Computer

.621 Minimum configuration: . . . . minimum PB 250.

.622 Usable extra facilities: . . . . any.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Unsequenced entries:	input determines sequence.	
Duplicate names:	none.	
Improper format:	yes	print-out.
Incomplete entries:	yes	print-out.
Target computer overflow:	no.	
Inconsistent program:	no.	

.8 ALTERNATIVE TRANSLATORS: . . . . . . none.

PROGRAM TRANSLATOR: ATRAN

§ 182.

.1 GENERAL

.11 Identity: . . . . Algebraic TRANslator ATRAN.

.12 Description:

The ATRAN translator works in conjunction with the CINCH interpreter to produce a PB 250 program. Unlike most translators, the procedure used maintains the intermediate forms of the program in the computer storage throughout the process. Segments of the translator are overlaid sequentially on each other. No formal output program is produced; the final result of the translation is a CINCH language program already loaded into the computer. CINCH cannot print out a CINCH program unless it receives details as to which locations contain instructions and which contain data; this effectively means that there is no convenient documentation of object versions of ATRAN programs.

The restrictions of the ATRAN language have been discussed in Section :061.14. The translator presently available has a large number of further severe restrictions. The more important ones are listed in Paragraph :23 below; others exist but are not documented. While some of these can be avoided before assembling a source program, a few cannot, and "guesstimates" must be made.

The translation mode involving the overlaying of segments of the translator means that the entire translator must be loaded for each assembly. This is no great hardship (5 minutes (***)) if fast paper tape equipment is available, but if the standard Flexowriter, which takes 30 minutes (***), is used this becomes an appreciable factor in considering the efficiency of the ATRAN/CINCH system.

The final running of the system is done in an interpretive manner using the CINCH system. As with most interpreters, running overheads are high.

.13 Originator: . . . . . . Packard Bell Computers.

.14 Maintainer: . . . . . . Packard Bell Computers.

.15 Availability: . . . . . August, 1962.

.2 INPUT

.21 Language

.211 Name: . . . . ATRAN.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . paper tape.
.222 Obligatory ordering: . by sequence of operations.
.223 Obligatory grouping: . . . . dimension statements. procedure statements with control points interspersed.

.23 Size Limitations

Characters in a Statement: . . . . the number of characters in one ATRAN statement must not exceed 100. (This does not include tape feed, delete code, space, carriage return, or tab.)

Statements in the Problem: . . . . . . the total number of statements in an ATRAN program must not exceed 254.

Variables: . . . . . . the combined total of undimensioned variables, subscript variables, and one-dimensioned lists in an ATRAN program must not exceed 175.

Constants: . . . . . . the combined total of constants and two-dimensioned lists in an ATRAN program must not exceed 127.

Literals: . . . . . . the total number of characters contained in all literal messages appearing in an ATRAN program must not exceed 240. Nor must the number of messages exceed 64.

Control Points: . . . . the combined total of control point statements and subscript variables which appear on the left side of an equal sign must not exceed 125.

Subscripts: . . . . . the number of subscripts and distinct subscript combinations appearing in an ATRAN program must not exceed 31.

Program Size: . . . . the total CINCH memory required by the compiled program must not exceed 923 PB-250 storage locations.

Statements: . . . . . the combined total of CF1 type statements (defined to be all jumps and literal output statements) must not exceed 63.

§ 182.

.23 Size Limitations (cont'd)

Type 2 Statements: . . . the combined total of CINCH instructions generated by CF2 type statements (defined to be all statements that are neither CF1 type nor arithmetic) must not exceed 125.

Arithmetic Statements: The number of CINCH instructions generated by arithmetic statements must not exceed 512.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . CINCH.
.312 Language style: . . . . interpretive.
.313 Output media: . . . . . paper tape via CINCH Interpreter dump.

.32 Conventions: . . . . . none.

.33 Documentation

Subject	Provision
Source program: . . .	input could be listed off-line.
Object program: . . .	none.
Storage map:	none.
Restart point list: . .	none.
Language errors: . .	coded messages on Flexowriter. (The manual comments that these may be difficult to interpret.)

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

ATRAN
1st Pass: . . . . . . reads ATRAN source program tape, forms certain tables, and edits input into various canonical forms.
2nd Pass: . . . . . reduces canonical forms to standard form requiring 2 memory locations for each CINCH instruction.
3rd Pass: . . . . . . assigns CINCH index registers.
4th Pass: . . . . . . edits instructions into CINCH binary format.

ATRAN-CINCH
Either: . . . . dumps program onto paper tape.
Or: . . . . interprets and runs program.

.42 Optional Mode

.421 Translate: . . . . . . yes.
.422 Translate and run: . . yes.
.423 Check only: . . . . . yes, by halting the computer after first pass.
.424 Patching: . . . . . . no.
.425 Up-dating: . . . . . . no.

.43 Special Features

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

.44 Bulk Translating: . . . no.

.45 Program Diagnostics: . . . . although CINCH contains diagnostic routines, these cannot be reached except by manual patching.

.46 Translator Library: . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space: . . . . 923 locations available for CINCH instructions, data, and working storage.

.52 Translation Time

.521 Normal translating: . . ?

.53 Optimizing Data: . . . no optimization is undertaken.

.54 Object Program Performance: . . . . . . unaffected as compared to hand-written CINCH routines; see :192.85.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . basic PB 250 with Flexowriter.
.612 Larger configuration advantages: . . . . . faster loading of ATRAN and CINCH if fast paper tape reader is attached.

.62 Target Computer

.621 Minimum configuration: . . . . basic PB 250 with Flexowriter.
.622 Usable extra facilities: . . . . none.

§ 182.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Improper format:	check	error code printout.
Incomplete entries:	check	error code printout.
Target computer overflow:	none.	
Inconsistent program:	none.	

.8 ALTERNATIVE TRANSLATORS: . . . none.

OPERATING ENVIRONMENT: OUP III

§ 191.

.1 GENERAL

.11 Identity: . . . . Octal Utility Package III, OUP III. Trace I.

.12 Description

The Octal Utility Package III routine is the normal input and output routine used with the PB 250 for program loading. This routine accepts or dispatches instructions, numeric data, or OUP Binary data (Data Code Table No. 2), in the appropriate formats, from the Flexowriter or High Speed Reader, or to the Flexowriter or High Speed Punch. It performs the translation, arranges the layout, and controls the timing of the data transfers. Some subsidiary functions, such as clearing a delay line to zero, are also included.

.13 Availability: . . . . . current.

.14 Originator: . . . . . Packard Bell Computers.

.15 Maintainer: . . . . . Packard Bell Computers.

.16 First Use: . . . . . . 1961.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . . none.
.212 Independent programs: paper tape.
.213 Data: . . . . keyboard or paper tape.
.214 Master routines: . . . none.

.22 Library Subroutines: . same as independent programs.

.23 Loading Sequence: . . as loaded.

.3 HARDWARE ALLOCATION: . . . . incorporated in program.

.4 RUNNING SUPERVISION: . . . . . . incorporated in program.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . Trace I subroutine; for each executed instruction, output on Flexowriter.

.512 Snapshots: . . . . . . none.

.52 Post Mortem: . . . . none except binary dump on High Speed Punch.

.6 OPERATOR CONTROL

.61 Signals to Operator: . . incorporated in program.

.62 Operator's Decisions: . . . . coded type-ins.

.63 Operator's Signals: . . none.

.7 LOGGING: . . . . . . none.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: . . . . PB 250 with Flexowriter.
.812 Usable extra facilities: . . . . High Speed Reader 1 (HSR 1).
.813 Reserved equipment: . line 01 plus the last two sectors of line 05 and line 06 for OUP.

.82 System Overhead

Condition I: . . . . . using Flexowriter for loading.
Condition II: . . . . . using HSR 1 for loading.

		I	II
.821	Loading time:	3 minutes.	?
.822	Reloading frequency: .	normally left undisturbed in storage while running programs.	

.83 Program Space Available: . . . . all computer storage less 258 locations.

.84 Program Loading Time

I: . . . . 1 min, plus 900 millisecs per instruction, plus 100 millisecs per numeric digit, plus 7,720 millisecs per 256 word delay line in OUP binary format.
II: . . . . ?

OPERATING ENVIRONMENT: CINCH INTERPRETER

§ 192.

.1 GENERAL

.11 Identity: . . . . CINCH Interpreter. PB 250.

.12 Description

The CINCH Interpreter allows programs written in a simple, powerful language to be executed on the Packard Bell 250 computer. A CINCH programmer can develop and use a special CINCH library of subroutines if he finds it desirable. These routines are normally relatively coded to allow for ease of storage allocation. Any diagnostic aids required must be incorporated while writing a program.

The interpreter works in floating point throughout all operations, and output is in floating point format. The interpreter uses a 35 bit mantissa and 7 bit exponent. It is not possible, therefore, to obtain a greater precision than ten decimal digits while using the interpreter.

The performance of the interpreter is not documented in the standard manual. The overheads involved in using CINCH language may reach 800 (***) per cent when compared to good hand coding, and this must be considered when comparing machine coding with CINCH language.

Although there is no provision in the interpreter for using any input-output devices other than the Flexowriter, a good machine language programmer with adequate documentation on CINCH should be able to provide these facilities in a standard manner ready for inclusion in an installation subroutine library.

CINCH IB draft is a restricted version of the CINCH II interpreter. It operates in only 9 lines (2,304 words) instead of requiring 11 lines (2,816 words); and does not have the algebraic functions included. (See section :171.83).

ATRAN CINCH is an augmented version of the CINCH I interpreter. It is used to run ATRAN object programs. It adds two more operations, FIX and FLO, which set printing format to fixed or floating point mode respectively, and amends the SFL [Set Fraction Length] instruction.

.13 Availability: . . . . . March, 1961.

.14 Originator: . . . . . Packard Bell Computers.

.15 Maintainer: . . . . . Packard Bell Computers.

.16 First Use: . . . . . . 1962.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . none.

.212 Independent programs: . . . . yes, in CINCH language. Machine language is possible, but not recommended.

.213 Data: . . . . via keyboard or paper tape. listing obtained if entered from keyboard.

.214 Master routines: . . . paper tape.

.22 Library Subroutines: . . paper tape in relocatable binary or standard format.

.23 Loading Sequence: . . (a) CINCH master program tape.
(b) Program tape(s) and data tape(s) in any order.

.24 Interpreter Input

.241 Language
Name: . . . . CINCH II.
Exemptions: . . . . CINCH IB does not interpret the algebraic functions.

.242 Form: . . . . paper tape or keyboard.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . not possible.

.32 Input-Output Units: . . only Flexowriter available.

.4 RUNNING SUPERVISION

.44 Errors, Checks and Action

Error	Check or Interlock	Action
Loading input error:	check on binary or master tape only	indicate and halt.
Allocation impossible:	none.	
In-out error - single:	none.	
In-out error - persistent:	none.	
Storage overflow:	check	indicate and halt.
Program conflicts:	zero divisor check.	
Arithmetic overflow:	check	halt.
Underflow:	yes	set to zero.
Invalid address:	none.	

§ 192.

.45 Restarts: . . . . . . not possible.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . by continuous snapshots (see below).

.512 Snapshots: . . . . . any instruction containing a "Trace" tag is typed when executed.

.52 Post Mortem: . . . . Memory Print of instruction or data format at 60 instructions or 30 data items per minute. End of printing controlled by Breakpoint switch.

.6 OPERATOR CONTROL: . . . . as incorporated in program.

.7 LOGGING: . . . . . hand-written by operator, in conjunction with type-ins on the Flexowriter.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: . . . . PB 250 with Flexowriter and 2,560 words of storage.

.812 Usable extra facilities: extra storage, in 256-word lines only, up to 17 additional lines.

.813 Reserved equipment: . . . . 2,304 words storage, using CINCH IB. 2,816 words, using CINCH II.

.82 System Overhead

.821 Loading time: . . . . . 20 minutes via Flexowriter. ? minutes via High Speed Reader.

.822 Reloading frequency: . reloading only required when overwritten.

.83 Program Space Available

CINCH IB: . . . . . . $I + 2D \leq S-2,304$.
CINCH II: . . . . . . $I + 2D \leq S-2,816$.
I = no. of instructions; D = no. of data locations used; S = storage of PB 250 in words.

.84 Program Loading Time: . . . . I/70 minutes, where I is number of instructions

.85 Program Performance in μ sec.

.852	For random addresses	
	$c = a + b$:	43,000.
	$b = a + b$:	43,000.
	Sum N items: . . .	19,000 N.
	$c = ab$:	49,000.
	$c = a/b$:	55,000.
	$b = \sqrt{a}$:	64,000.
	$b = \log a$	290,000
	$b = e^a$:	141,000.
	$b = \sin a$:	292,000.
.853	For arrays of data	
	$c_i = a_i + b_j$:	61,000.
	$c = c + a_i b_j$:	91,000.
.854	Branch based on comparison:	196,000.
.855	Moving:	25,000.
.856	Data input per character:	100,000.
.857	Data output per item:	2,000,000.

NOTES ON SYSTEM PERFORMANCE

§ 201.

The performance of the PB 250 Computer is strongly dependent on software. The ratio of two performance times may be as great as 20-to-1, depending on the chosen methods of programming.

For data input, three methods are possible:

- Unbuffered Flexowriter (100 m.sec/char, no overlap possible).
- Buffered Flexowriter (40 m.sec/char, but only one character each 100 m.sec).
- High Speed Reader (3.3 m.sec/char, no overlap possible).

Only the second of these has a suitable routine available.

For data output, three methods are possible:

- Unbuffered Flexowriter (100 m.sec/char, no overlap with computation possible).
- Buffered Flexowriter (25 m.sec/char, but only one char each 100 m.sec).
- High Speed Punch (6 m.sec/char, only one char each 9 m.sec).

Routines are available for Flexowriter output in both the buffered and unbuffered methods. The routine for the High Speed Punch only produces output in machine oriented form suitable for re-input. It dumps one delay line at a time.

Central Processor Performance

Six varieties of scientific computation are possible:

a) One word fixed point, with Time Sequencing.

b) One word fixed point, with Address Sequencing (SNAP I).

c) Two word fixed point, with Time Sequencing.

d) Two word fixed point, with Address Sequencing.

e) One word precision floating point.

f) Thirty-eight bit precision floating point (CINCH Interpreter).

All of the above except (b) and (f) require detailed hand coding.

The following table illustrates the diversity of estimated times, for the Central Processor only, on the basic computations in Standard Mathematical Problem A and Standard Statistical Problem A. All times are expressed as ratios to the times for case (a).

§ 201.

	Mathematical	Statistical
a)	1.0	1.0
b)	1.8	5.2
c)	2.9	1.0
d)	6.1	5.2
e)	11.3	-
f)	19.8	23.0

.1 GENERALIZED FILE PROBLEMS

Not applicable.

.2 SORTING

Not applicable.

.3 MATRIX INVERSION

No standard routines are available for matrix inversion operations.

.4 STANDARD MATHEMATICAL PROBLEM A

This problem specifies eight digit precision and prefers floating point operation. Because the floating point time is long compared to fixed point, estimates have been made for both cases.

The use of two-word, 38-bit precision floating point is conveniently available only in CINCH. This factor forces the choice of input and output via the unbuffered Flexowriter. This problem estimate is made using Configuration IX which has the necessary equipment. No routines are available for Configurations X or XI.

The second problem estimate uses two word fixed point precision. This problem would use standard routines for computation and input-output operations. The problem is also restricted to Configuration IX for which the routines exist.

.5 STANDARD STATISTICAL PROBLEM A

Standard Statistical Problem A only requires single length precision. This enables straightforward hand coding to be used together with an unbuffered Flexowriter input in Configuration IX. Because the problem is simple and presumably important, it is reasonable to allow the advantages of Time Sequencing. It is also reasonable to assume that a special routine would be written to take advantage of the High Speed Reader in Configurations X and XI. An estimate has been made of the time such a routine would take.

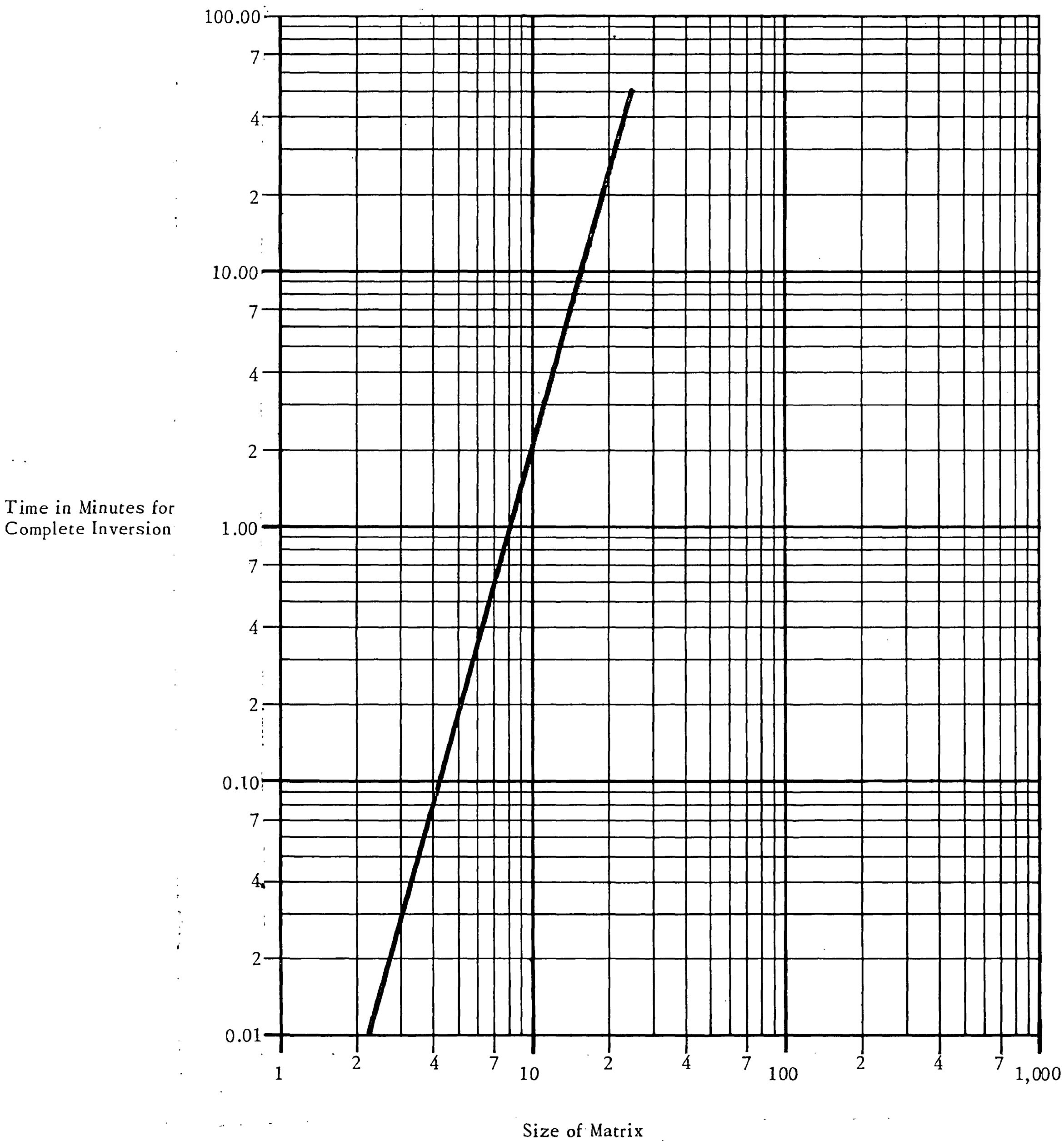
.3 MATRIX INVERSION

.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.



(210)

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

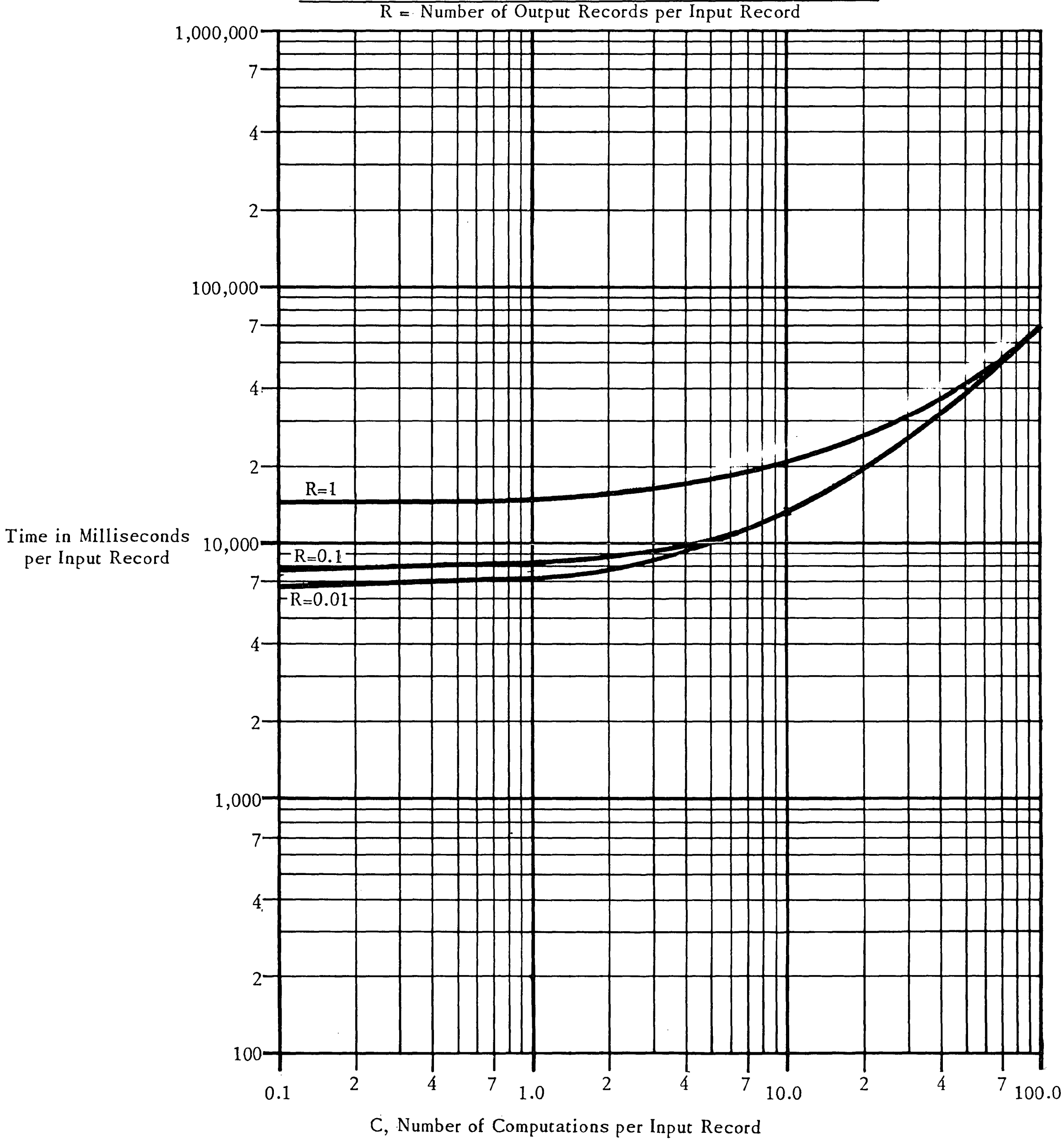
.411 Record sizes: . . . . . 10 signed numbers, average size 5 digits, max. size 8 digits.

.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, for Configuration IX, double length, with fixed point arithmetic.

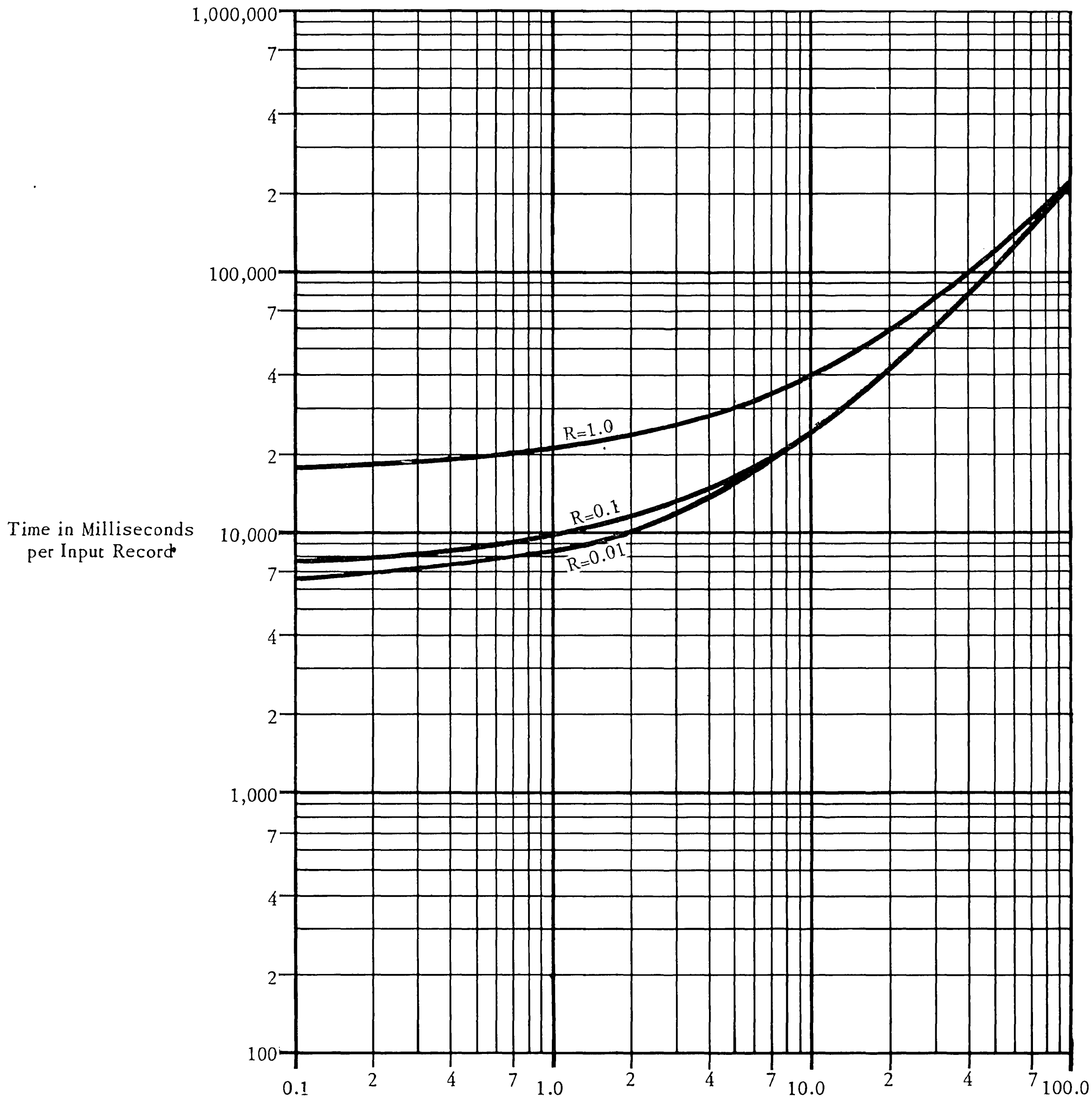
Configuration IX; Double Length (12 digit precision); Fixed Point.
R = Number of Output Records per Input Record



Standard Mathematical Problem A Estimates (Cont'd)

.415 Graph: . . . . see graph below, for Configuration IX, double length, with floating point arithmetic.

Configuration IX; Double Length (12 digit precision); Floating Point.
R = Number of Output Records per Input Record



C, Number of Computations per Input Records

.5 GENERALIZED STATISTICAL PROCESSING

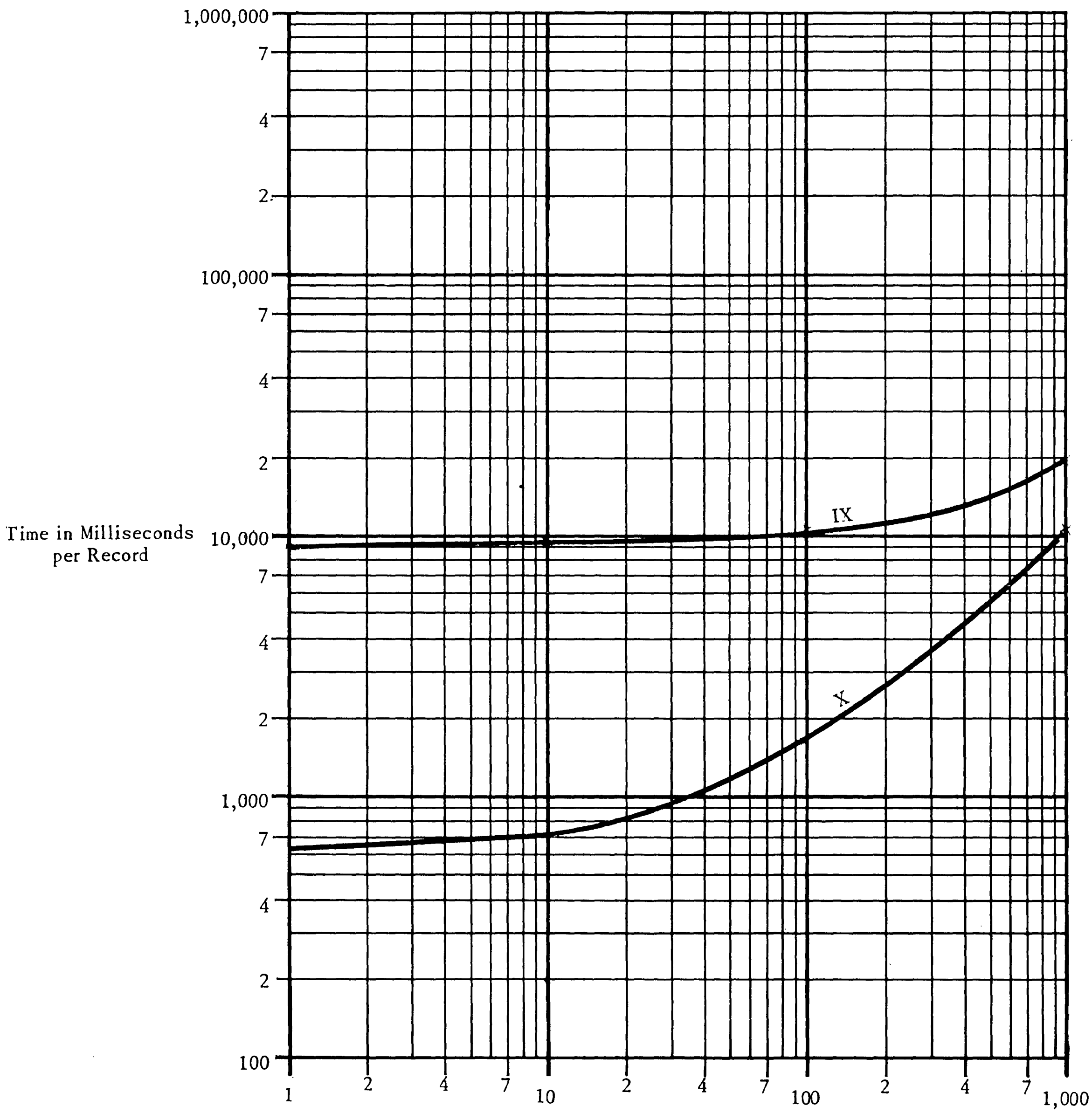
.51 Standard Statistical Problem A Estimates

.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

PB 250
PHYSICAL CHARACTERISTICS

PB 250 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Central Computer	Central Computer	High Speed Punch	High Speed Reader	Magnetic Tape Unit	Card Reader	Digital Graph Recorder
	Model Number		PB 250-PS7	PB 250-PS8	HSP 1	HSR 1	MTU 1	CR 2	DR 1
PHYSICAL	Height×Width×Depth, inches (See Note)		33¼ × 19 × 24	33¼ × 19 × ?	15¾ × 19 × ?	7 × ? × ?	40¼ × 19 × ?		18 × 14 × 12
	Weight, pounds		110	110	27	35	500		40
	Maximum cable lengths								
ATMOSPHERE	Storage Ranges	Temperature, °F.							
		Humidity, %							
	Working Ranges	Temperature, °F.							
		Humidity, %							
	Heat Dissipated, BTU/hr.		3,600	3,600	900	540	5,850		430
	Air Flow, cfm.								
	Internal filters								
ELECTRICAL	Voltage	Nominal	115	115	115	115	115	115	115
		Tolerance	?	?	?	?	?	?	
	Cycles	Nominal	60	60	60	60	60	60	60
		Tolerance							
	Phases and lines		Single phase	Single phase	Single phase	Single phase	Single phase	Single phase	Single phase
	Load KVA		0.100	0.100	0.250	0.150	1.625		0.125
NOTES	All units fit into standard 19-inch racks having a depth of 24 inches								

PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Central Processor	PB 250-PS 7	Computer with integral AC power supply and accompanied by Flexowriter. This processor has one fast and eight long delay lines giving a storage capacity of 2,049 22-bit words.	1,200		40,000
	PB 250-PS 8	Same as above, but with battery power supply.	1,275		41,500
Internal Storage	MSR 1N	Memory Module of one delay line.	40		1,200
	MX 1 MX 2	Memory Extension Chassis, for 24 or 23 Memory Modules	75		2,495
Input/Output	HSP 1	High Speed Punch, 110 char/sec.	150		4,950
	HSR 1	High Speed Reader, 300 char/sec.	190		4,550
	MTU 1	Magnetic Tape Unit	445		14,750
	MTC 1	Magnetic Tape Control Unit	510		17,000
	DR 1	Digital Graph Recorder	155		4,975
	CPC 1	Card Punch Coupler	90		2,500
	CR 2	Card Reader	145		4,062

PHILCO 2000-210

Philco Corporation

(A Subsidiary of Ford Motor Company)

STANDARD EDP REPORTS

AUERBACH INFO, INC.

PRINTED IN U. S. A.

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CONTENTS

CONTENTS (Contd.)

INTRODUCTION

§ 011.

The Philco 2000 is actually a series of three computer systems. There are three prime systems distinguished by different central processors: 210, 211, and 212. The differences in performance and price of the different systems are significant as shown in the respective Systems Performance Sections, 651:201, 652:201, and 653:201. There is a large body of common units, common interfaces, and common software. The following description applies generally to all the series; however, the final paragraph notes the major differences of the 2000-210.

The computer system is in the large-scale scientific and real-time class. Its design is oriented toward flexible off-line operations, with fast tape units, simultaneous operations and concern for fast processing speeds. The central processors have a range of 50,000 to 500,000 instructions per second and rentals in the order of $40,000 and up.

The Philco 2000 is designed for off-line operation of peripheral devices. The off-line operations may be executed by a separate computer, the Philco 1000, or by the special Universal Buffer Controllers (UBC).

The UBC unit is a versatile device, which contains a 1,024 word buffer store. The UBC may control any card, punched tape, magnetic tape, or printer off-line transcription, including magnetic-tape-to-magnetic-tape. A UBC can be used on-line to control data transfers to any one of seven peripheral units attached to it. In addition to the usual peripheral devices there is a high speed (2,000 cards per minute) reader.

Each 2000 computer configuration has one IOP (Input-Output Processor). This unit can control up to 16 input-output units. There may be up to four UBC's, and the remaining units may be magnetic tape. An IOP may contain from one to four assemblers. An assembler provides for independent simultaneous input-output transfers. In effect, each UBC can provide an extra simultaneous input-output transfer to any unit except magnetic tape, because loading or unloading a UBC buffer requires little time, and the UBC controls the peripheral device at its own pace.

One especially convenient feature of the IOP is the automatic assignment of any idle assembler to a data transfer request, thus relieving the programmer of optimizing assignments.

The Model 234 Magnetic Tape Units which must be used on the 2000-210 and 2000-211 operate at a peak speed of 90,000 characters per second. The block size is fixed at 1,024 characters. At full speed, using full blocks, the effective speed is 54,600 characters per second. Usually the standard problems have been timed for two cases: (1) blocked records and (2) unblocked records. On the 2000-212 an alternative tape unit, Model 334, is available with a peak speed of 240,000 characters per second.

All three central processors operate in parallel on 48-bit words. Single address instructions are packed two to a word. The number of index registers is optional on the 210 and 211 but in practice is standardized at eight. Eight registers, however, are standard on the 212. When an instruction uses a special bit to denote indexing, three bits of the high order end of the address are used to specify the register. This limits the value of the base address, but not the modifier.

There is a wide variety of fixed and floating point arithmetic instructions, but no editing or conversion facilities. Special two instruction loops can be performed very rapidly with no repeated access for instructions.

The computer operates asynchronously in all units and basic times vary from machine to machine, and in different cases similar instructions require different execution times. This report quotes ranges or averages of these times.

INTRODUCTION--Contd.

§ 011.

There are several varieties of core store available. They have different cycle times, and can be further varied by use of overlapped access. Drums are available on the systems and data transfers are arranged to be parallel by word, at high data rates, but may not be overlapped with other operations. Disc storage is available on the 2000-212.

The three central processors, 210, 211, and 212, are upward compatible for instruction repertoire and functional facilities. Therefore, all software is written to be used on all models, with some limitations on minimum configurations.

The main languages are TAC, ALTAC, and TOPS. TAC is a sophisticated symbolic machine oriented language including macros and facilities for generators. The generators include SORT and IOPS, an input-output system. ALTAC is a dialect of FORTRAN II. The ALTAC translator can translate FORTRAN II programs with usually few changes. Its major incompatibilities are Boolean operations and CHAIN functions. On the other hand, it includes extended conditionals. TOPS is a macro oriented language for file manipulation; it includes such facilities as updating and sorting. For individual data manipulation, TAC coding is used. TOPS includes its own operating environment.

There is an automatic supervisor routine, SYSD. This routine covers running, translating, and debugging. In fact, it is probably not reasonable to operate a 2000 without a supervisor.

There is a users' group called TUG. The library of routines is generally available and includes a large selection in the field of nuclear code programs.

The Philco 2000-210 in particular:

- uses only the 10 microsecond non-overlapped store.
- has no real-time facilities.
- has usually lower performance and price compared to the others.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Character:	6 bits	alphanumeric.
Frame:	14 bits	magnetic tape.
Word:	48 bits	location in core storage, magnetic drum.
Block:	128 words	magnetic tape, core storage, programmed.
Band:	4,096 words	magnetic drum.

.2 DATA FORMATS

Type of Information	Representation
Alphabetic:	1 char.
Instruction:	24 bits.
Instruction (input-output):	48 bits.
Number	
Fixed Point:	48 bits.
Floating Point	
Exponent:	12 bits.
Fixed point part:	36 bits.
BCD:	6 bit group.
Block:	128 words.

SYSTEM CONFIGURATIONS

§ .031

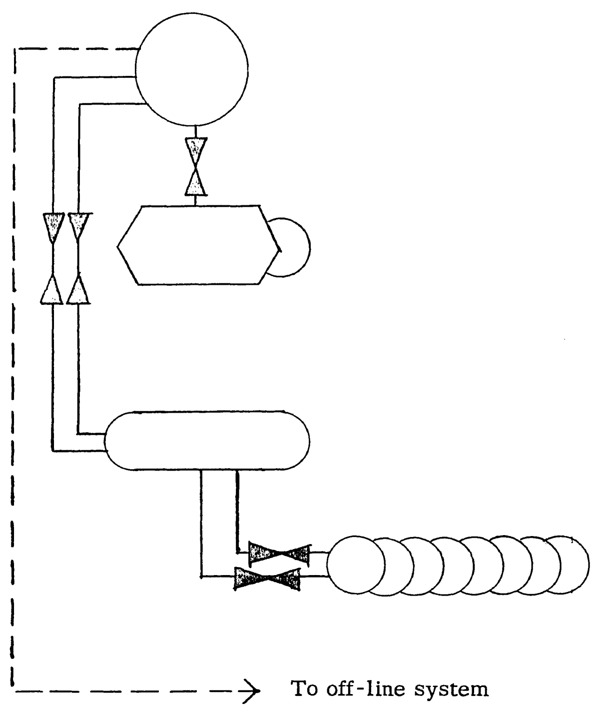
.3 VII B 10-TAPE GENERAL, PAIRED CONFIGURATION

Deviations from Standard Configuration

On-line: . . . . 2 more index registers.
magnetic tape, 30,000 char/sec faster.
card reader can be switched from off-line UBC.

Off-line: . . . . magnetic tape, 60,000 char/sec faster.
printer faster by 400 lines/min.
card reader by 1,500 cards/min.
1,024 characters only in UBC.

On-Line Equipment

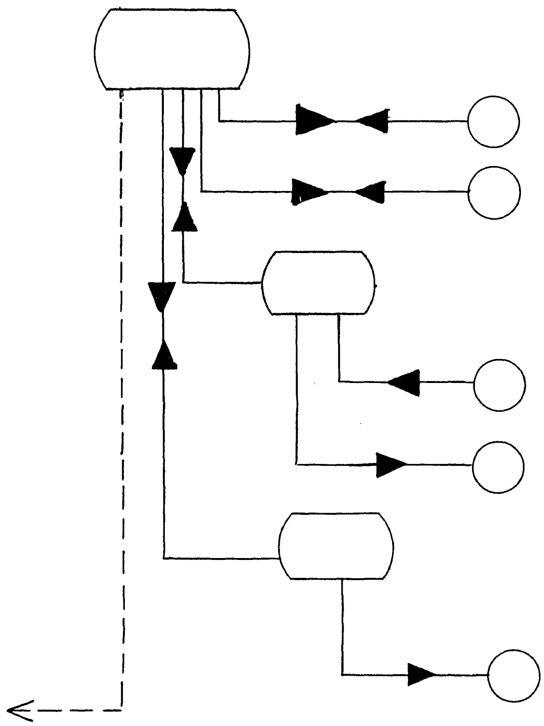


Equipment	Rental
Core Storage: 8,192 words	5,800
Model 210 Central Processor and Console	7,100
	650
Typewriter	900
Input-Output Processor: two multiplexed transmissions to and from magnetic tape.	4,400
8 Magnetic Tapes: 90,000 char/second	6,800
Total	25,650
Total, including off-line equipment:	$ 33,765

§ 031.

.3 VII B 10 - TAPE GENERAL, PAIRED CONFIGURATION (Contd.)

Off-line Equipment



Equipment	Rental
Universal Buffer Controller:	1,560
2 Magnetic Tapes: 90,000 char/second	1,700
Punch Card Controller:	1,365
Card Reader: 2,000 cards/minute	800
Card Punch: 100 cards/minute	350
Printer Controller: High Speed Printer: 900 lines/minute	2,340
Total	$ 8,115

Note: Off-line system may be replaced by the Philco 1000 computer system. This will permit more powerful off-line editing and computing capabilities, relieving the central processor of much of this work.

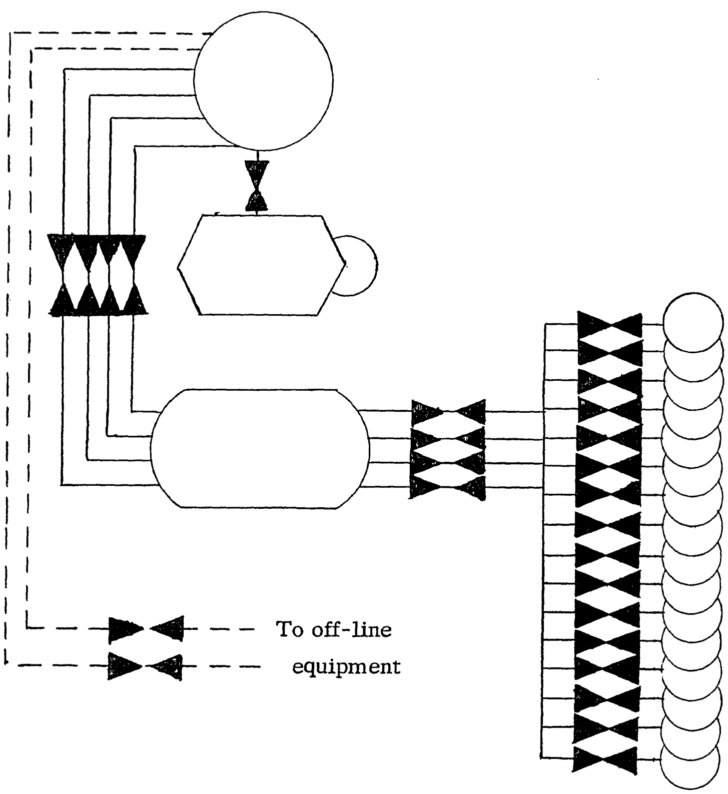
§ 031.

.4 VIII B 20-TAPE GENERAL, PAIRED CONFIGURATION

Deviations from Standard Configuration

On-line:	2 less index registers. magnetic tape 30,000 char/second slower. card reader can be switched from off-line UBC.
Off-line:	magnetic tape 30,000 char/second faster. card reader faster by 1,000 cards/minute. card punch slower by 100 cards/minute.

On-Line Equipment

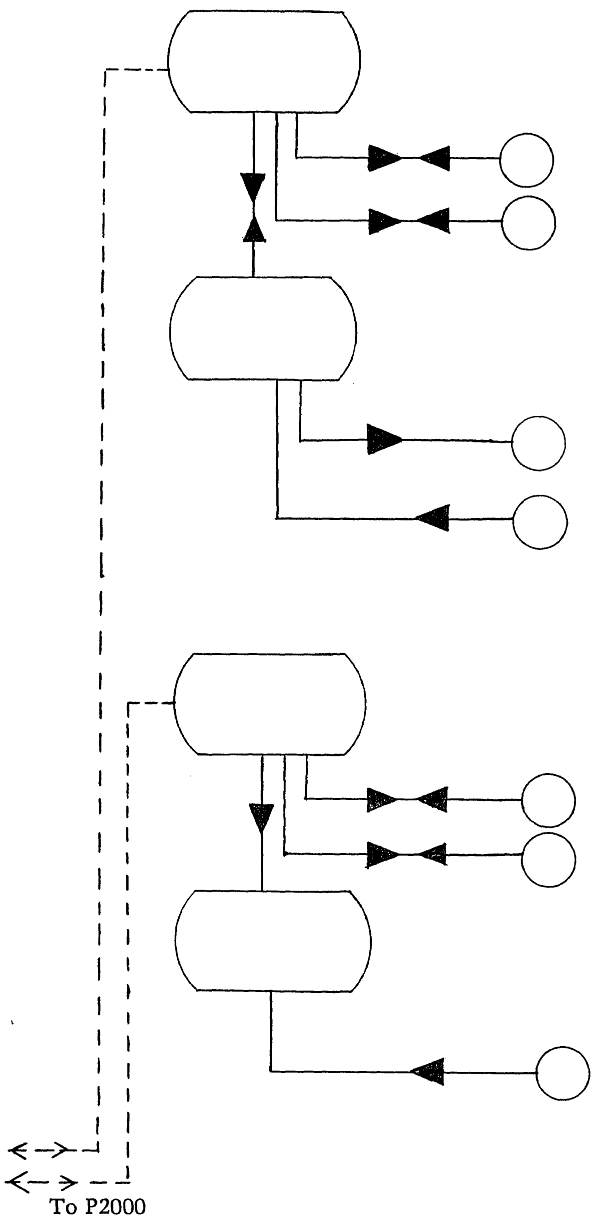


Equipment	Rental
Core Storage:	11,000
Central Processor and Console:	7,100 650
Typewriter	900
Input-Output Processor: Four multiplexed transmissions to and from magnetic tape.	8,400
16 Magnetic Tapes: 90,000 char/second	13,600
Total	41,650
Total, including off-line equipment:	$ 53,025

§ 031.

.4 VIII B 20-TAPE GENERAL, PAIRED CONFIGURATION (Contd.)

Off-Line Equipment



Equipment	Rental
Buffer Controller, Model 252:	1,560
2 Magnetic Tapes: 90,000 char/second	1,700
Punch Card Controller:	1,365
Card Reader: 2,000 cards/minute	800
Card Punch: 100 cards/minute	350
Buffer Controller, Model 252:	1,560
2 Magnetic Tapes: 90,000 char/second	1,700
Printer Controller: High Speed Printer: 900 lines/minute	2,340
Total	$ 11,375

INTERNAL STORAGE: CORE STORAGE

§ 041.

.1 GENERAL

.11 Identity: . . . . Core Storage.
10 μsec memory.
Models 2208, 2216, 2232.

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

.13 Description

Each core storage location in the 10-microsecond memory system holds a 48-bit word which may contain a fixed or floating point number, eight alphanumeric characters, two instructions, or one input-output instruction. A complete core storage cycle for one word is 10 microseconds. The cycle is split into two parts: 4 microseconds read and 6 microseconds write/restore. Both the store and the central processor have been designed to take advantage of split cycles, for example, when executing an "add to memory" instruction, only one access is made, and after the read, the store waits while the addition is performed and then the write/restore completes the cycle. All transfers are parallel by word. All banks of 8,192 words of storage use a common access control. Sequentially addressed locations are successively distributed throughout alternate memory banks, but there is no overlapping of access times.

Core storage access is shared with the central processor by four channels which gain access through an intermediate one word buffer. The priority for memory sharing by these channels is Input-Output Processor, Real-Time Channel, Word-at-a-Time Channel (Paper Tape Channel) and Magnetic Drum Channel.

Model 2208 Core Storage Memory contains 8,192 words. This is expandable to 16,384 words in the Model 2216 and a maximum of 32,768 words in the Model 2232 memory. The Model 2208 or 2216 may be expanded in the field.

.14 Availability: . . . . . . 12 months.

.15 First Delivery: . . . . December, 1959.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

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

.22 Physical Dimensions

.221 Magnetic core type storage
Array size: . . . . . . 64 bits by 64 bits.

.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 with split cycle.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 100,000 cps.
Unit of data: . . . . word.
Conversion factor: . . 48 bits/word.
Data rate: . . . . . . 100,000 words/sec.
Compound data rate: . . . . 100,000 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
Identity:	Model 2208	Model 2216	Model 2232
Words:	8,192	16,384	32,768
Characters:	65,536	131,072	262,144
Instructions:	16,384	32,768	65,536
Bits:	393,216	786,432	1,572,864
Modules (8,192):	1	2	4

.32 Rules for Combining Modules: . . . . all combinations are shown above.

.4 CONTROLLER

.41 Identity: . . . . built into core storage.

.42 Connection to System

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

.43 Connection to Device

.431 Devices per controller: . . . . . . 1, 2, or 4 8,192 word modules.
.432 Restrictions: . . . . . none.

§ 041.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks: . . . 1.
.512 Stack movement: . . . none.
.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations
By single stack: . . all.

.52 Simultaneous Operations: . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . 4 μsec.
Cycle time: . . . . . . 10 μsec.
For data unit of: . . . . 48-bit word.
.532 Variation in access time: . . . . second repeated access to one location in an instruction may be zero, due to split access.

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . . . yes.
With drum: . . . . . . yes.

.72 Transfer Load Size

With self: . . . . 1 word, or up to 4,095 words using repeat.
With drum: . . . . . . 4,096 words.

.73 Effective Transfer Rate

With self: . . . . 48,000 words/sec.
With drum: . . . . . . 58,500 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none	modulo size of store.
Receipt of data:	none.	
Recording of data:	none.	
Recovery of data:	none.	

INTERNAL STORAGE: MAGNETIC DRUM SYSTEM

§ 044.

.1 GENERAL

.11 Identity: . . . . Magnetic Drum Unit.
Model 272.
Magnetic Drum Controller.
Model 275.

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

.13 Description

The magnetic Drum System provides an auxiliary storage system connected directly to the working core storage. The system may consist of from 1 to 4 drums, each holding 32, 768 48-bit words. Loads of 1 to 4, 096 words are transferred via the lowest priority channel. Transmission of words is not interrupted until completion of the drum instruction.

A drum consists of eight bands of 4, 096 words each. Sequentially addressed words are in alternating locations, requiring two drum revolutions for transmission of an entire band. The drum instruction may specify any word in the band as the first of a load; automatic stepping to the first word of the next band takes place automatically.

Each band of 4, 096 words is recorded on 48-tracks, parallel by word. This arrangement produces a high transfer rate of 58, 500 words per second. This rate can be maintained for several successive bands without loss of time. In order to avoid conflicts for core store access, a drum transfer instruction waits until all current input-output transfers are complete. Then the central processor operation is delayed until the drum transfer is complete, to prevent other input-output transfers from being initiated.

From 1 to 4 drums may be connected to the Model 275 Drum Controller for a maximum drum storage capacity of 131, 072 words. Each Drum Controller contains provision for locking out transmission to: all of drum 1; all of drums 1 through 4; any band on drum 1; or the same band on drums 1 through 4.

.14 Availability: . . . . 12 months.

.15 First Delivery: . . . . June, 1960.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic drum.

.22 Physical Dimensions

.222 Drum
Diameter: . . . . . . 18.5 inches.
Length: . . . . 24 inches.
Number on shaft: . . . 1.

.23 Storage phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes, but write lockout available.
.242 Data regenerated constantly: . . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.25 Data volume per band

Words: . . . . 4, 096.
Characters: . . . . . . 32, 768.
Instructions: . . . . . . 8, 192.
Bits: . . . . 196, 608.

.26 Bands per physical unit: 8 plus spare tracks.

.27 Interleaving Levels: . . 2.

.28 Access Techniques

.281 Recording method: . . . fixed heads.
.282 Reading method: . . . . same.
.283 Type of access

Description of stage	Possible starting stage
Select drum and band:	yes.
Wait for drum rotation:	yes.
•Read or write word:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 1, 750 rpm.
Track/head speed: . . 169.5 inches/sec.
Bit rate per track: . . 119, 000 bits/sec/track.
.292 Peak data rates
Cycling rates: . . . . 29 cps.
Unit of data: . . . . . 4, 096 words.
Loss factor: . . . . . 2.
Data rate: . . . . . . 119, 000 words/sec.
Compound data rate: . 119, 000 words/sec.

§ 044.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	Model 275	
Drums:	1	4.
Words:	32,768	131,072.
Characters:	262,144	1,048,567.
Instructions:	65,536	262,144.
Bits:	1,572,864	6,191,456.
Modules	1	4

.32 Rules for Combining Modules

The drum system may consist of from 1 to 4 Model 272 Magnetic Drum Units. A Model 275 Magnetic Drum Controller can control from 1 to 4 drums.

.4 CONTROLLER

.41 Identity: . . . . Magnetic Drum Controller. Model 275.

.42 Connection to System

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

.43 Connection to Device

.431 Devices per controller: 4 drums.

.44 Data Transfer Control

.441 Size of load: . . . . . . 4,096 words.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . 1 word.
.444 Input-output area lockout: . . . . yes, until transmission is complete.
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . none.
.448 Testable conditions: . . transfer error.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks
Stacks per system: . . 8 to 256 in increments of 8.
Stacks per module: . . 8.
.512 Stack movement: . . . . none.
.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations
By single stack
With no movement: . 4,096.
By all stacks
With no movement: . 32,768 per module.
.515 Relationship between stacks and locations: . band (0 to 7). band position address (modulo 4,096).

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

.53 Access Time Parameters and Variations

.532 For variable access

Stage	Time, μ sec.
Select drum:	25,000 or 34,000.
Wait for drum rotation:	8 to 32,760.
Read or write word:	16.8.
Read or write band:	68,813.

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

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . no.
With core: . . . . . . yes.

.72 Transfer Load Size

With core: . . . . 4,096 words.

.73 Effective Transfer Rate

With core: . . . . 58,500 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording of data (amplification):	check	indicator; testable by program.
Timing conflicts:	check	indicator; testable by program.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . Central Processor. Model 210.

.12 Description

The 210 is an asynchronous, single address, binary mode processor that maintains arithmetic and program control in a Philco 2000 system. Word length is fixed at 48 bits. Parallel transfers occur between registers and storage. Arithmetic operations are performed with operands of 47 bits plus a sign bit; negative numbers are represented in two's complement form. All arithmetic operations are performed in an adder network utilizing shifting and binary addition. An Accumulator, Quotient and Data Register comprise the program-addressable arithmetic registers; a Jump Address Register, Repeat Counter, and up to 32 optional index registers are addressable for program control.

A total of 225 instructions is provided for arithmetic, control, and logical functions, including floating point operations, when optional floating point hardware is installed. These functions are stored two instructions per word. A lack of editing instructions necessitates additional programming effort for output formatting. Programming systems are available as part of the standard library provided.

Fixed point arithmetic (and optional floating point) provides single and double length products, and division with rounded quotients or remainders.

Logical operations include both exclusive and inclusive OR operations.

Fixed point addition and multiplication take, on the average, 15 and 92 microseconds respectively, and about 70,000 instructions per second can be executed. Floating point times are not significantly different.

Input-output instructions require a full 48-bit word. The particular function to be performed and the input or output channel to be used are specified by varying the bit configuration within designated fields of the word. Simultaneous compute-read-write is possible, the extent of this overlapping being determined by the particular model Input-Output Processor in the system. A special repeat instruction which can include control of index register stepping, provides for rapid running of loops of one or two instructions held in a single word.

Optional Features

Index Registers: 8, 16, or 32 index registers, each capable of retaining a 15-bit address which may be

.12 Description (Contd.)

Optional Features (Contd.)

automatically incremented by one each time that register is referenced. A 16th bit indicates the automatic incrementing mode when set to one. Index registers function modulo 32,767.

When index registers are used, there is an alternative instruction format. One bit indicates if indexing is specified, in which case the 15 bit address is divided into two parts: 3 bits to specify one of 8 index registers, and 12 to specify the value to be added to the index value. In general, all Philco 2000 installations obtain the option of 8 index registers. If 16 or 32 are obtained, the instruction format is 4 and 11 or 5 and 10 bits, respectively. The use of index registers therefore restricts the value of the address part in an instruction, particularly negative values.

Floating Point: Floating point circuitry allows all arithmetic operations to be performed in floating point mode, utilizing an operand containing a 36-bit fixed point part and a 12-bit exponent. Normalization is automatic. Exponent overflow and underflow is detected, causing automatic transfer of control to a fixed memory location.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . December, 1959.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-Subtract:	automatic	binary	48-bit.
	Multiply			
	Short-rounded:	automatic	binary	48-bit.
	Long:	automatic	binary	96-bit.
	Divide			
	No remainder-rounded:	automatic	binary	48-bit.
	Remainder:	automatic	binary	96-bit.
.212	Floating point			
	Add-Subtract:	automatic	binary	12 & 36-bit.
	Multiply			
	Short:	automatic	binary	12 & 36-bit.
	Long:	automatic	binary	12 & 72-bit.
	No remainder-rounded:	automatic	binary	12 & 36-bit.
	Remainder			
	Quotient:	automatic	binary	12 & 36-bit.
	Remainder:	automatic	binary	12 & 36-bit.
.213	Boolean			
	AND:	automatic	binary	0 to 48 bits.
	Inclusive OR:	automatic	binary	0 to 48 bits.
	Exclusive OR:	automatic	binary	0 to 48 bits.

§ 051.

.214 Comparison

Numbers:	automatic	equal,	1 word.
Absolute:	none	greater	
Letters:	automatic	than or	1 word.
Mixed:	automatic	equal	1 word.
Collating sequence:	0 to 9, A to Z with special characters interspersed; see Data Code Table No. 1.		

.215 Code translation: . . . automatic translation between Hollerith and internal Philco code provided in input-output equipment. Other translations (e.g., binary to octal, etc.) are programmed functions via standard subroutines.

.216 Radix conversion

Provision	From	To	Size
Subroutine	fixed point	floating point	48-bit.
Subroutine	floating point	fixed point	48-bit.
Subroutine	decimal	binary	48-bit.
Subroutine	binary	decimal	48-bit.

.217 Edit format

	Provision	Size
Alter size:	none.	
Round off:	none.	
Insert point:	none.	
Insert spaces:	none.	
Insert:	none.	
Float:	none.	
Protection:	none.	

.218 Table look-up

Equality:	subroutine	1 word.
Greater than:	none.	
Greatest:	none.	
Least:	none.	

.219 Others

Repeat: . . . . repeat 1 or 2 instructions, 0 to 4, 095 times.

Branch on odd or even, positive or negative numbers: . . . . . . automatic 1 bit shift, 0 to 63 times.

Check status of counters and fault registers in input-output system (skip instructions): . allows determination of acceptance and/or status of input-output order and status of input-output equipment on-line.

.22 Special Cases of Operands

.221 Negative numbers: . . . two's complement with sign as most significant bit in word.

.222 Zero: . . . . positive only; fixed point is 48 zeros in word; floating point zero contains a 1 bit in exponent sign.

.223 Operand size determination: . . . . fixed.

.23 Instruction Formats

.231 Instruction structure: . half word; 1 word for input-output orders.

.232 Instruction layout:

NAME	S	A	F	C
SIZE, BITS	1	15	1	7

Non-indexable

NAME	S	N	V	F	C
SIZE, BITS	1	3-5	10-12	1	7

Indexable

NAME	Not used	NBS	Not Used	IOP CH.	Not Used	NBP	FROM	TO
SIZE, BITS	12	4	4	4	12	4	4	4

Input-Output (tape)

NAME	S	UNIT	SC	CQ	F	C
SIZE, BITS	1	4	2	9	1	7

Skip

.233 Instruction parts

Name	Purpose
S :	selector list set to 1 indicates the instruction is indexable and the reduced address field is used; if set to 0, the full address field is used.
A :	address field.
F :	F bit is 1 in floating point instr. or in branch to instruction in right half of word.
N :	specifies index register referenced - field size varies with number of index registers in Central Processor.

.233 Instruction parts (Contd.)

Name	Purpose
V :	value added to contents of specified index register to form operand's effective addresses.
C :	command includes F-bit.
NBS :	number of blocks on MT to space over.
IOP CH :	logical MT number.
NBP :	number of blocks of MT to transfer.
FROM :	from device.
TO :	to device.
UNIT:	unit to check for count or faults.
SC :	subcommand of skip instruction.
CQ :	comparison quantity.

§ 051.

.234 Basic address structure: 1 + 0.

.235 Literals
- Arithmetic: . . . . . . none.
- Comparisons and tests: . . . . none.
- Incrementing modifiers (repeat and index register control): 12 bits (maximum value, 4, 095).

.236 Directly addressed operands

.2361 Internal Storage type: core.
- Minimum size: . . . . 1 word.
- Maximum size: . . . . 1 word.
- Volume accessible: . . 32, 768 words.

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

.237 Address indexing

.2371 Number of methods: . 1.

.2372 Names: . . . . indexing.

.2373 Indexing rule: . . . . . addition, modulo 32, 767.

.2374 Index specification: . . N field of indexable instruction.

.2375 Number of potential indexers: . . . . . . 8, 16, or 32 optional index registers.

.2376 Addresses which can be indexed: . . . . . all instructions except repeat, skip, and input-output.

.2377 Cumulative indexing: . none.

.2378 Combined index and step: . . . . yes; index register can be automatically incremented by one if counter bit is set to 1.

.238 Indirect addressing: . . none.

.239 Stepping

.2391 Specification of increment: . . . . . index register counter bit specifies automatic increment of 1 as referencing indexable instruction is executed.
stepping index register instructions hold increment or decrement to maximum value of 4, 095, data register may hold increment or decrement of 0 to 32, 767.

.2392 Increment sign: . . . . none; considered absolute value.

.2393 Size of increment: . . 0 to 32, 767.

.2394 End value: . . . . . . specified in test instruction.

.2395 Combined step and test: . . . . for increment or decrement of up to 32, 767.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in bits	Program usage
Processor:	3	48	arithmetic, data manipulation.
Processor:	2	15	program control.
Processor:	1	16	program control.
Processor:	8, 16, or 32	16	indexing
Processor:	1	48	instruction register.
Processor:	1	18	repeat control.
Processor:	1	48	hold input-output order.
I/O Processor:	1	8	assembler availability.
I/O Processor:	1, 2, 3, or 4	10	assembler fault.
I/O Processor:	1, 2, 3, or 4	12	assembler counter.
I/O Processor:	16	4	unit availability.

Note: I/O Processor counters and fault registers may be interrogated from the Central Processor.

.242

Category of storage	Total number locations	Physical form	Access time, μ sec
Processor:	17 to 41	flip-flop	approx. 0.1
I/O Processor:	4 to 25	flip-flop	approx. 0.1

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . . 1.

.314 Special sub-sequence counters
- Number: . . . . 1.
- Purpose: . . . . repeat counter.

.315 Sequence control step size: . . . . instruction pairs.

.316 Accessibility to routines: . . . . available immediately after a jump is performed.

.317 Permanent or optional modifier: . . . . none.

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

.33 Interruption: . . . . . . none.

.34 Multirunning: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ sec.

.411 Fixed point
- Add-subtract: . . . . 15.0.
- Multiply (Average): . 92.2.
- Divide (average): . . . 93.3.

§ 051.

.412 Floating point
- Add-subtract (average): . . . . . . 21.9.
- Multiply (average): . . 69.9.
- Divide (average): . . . 73.8.

.413 Additional allowance for indexing: . . . . . 0.0.

.414 Control
- Compare and branch (GO): . . . . 11.3.

.415 Counter control
- Step: . . . . 9.6 in separate instruction. 0.0 in indexed instruction.
- Step and test: . . . . . 9.6.
- Edit: . . . . none.

.417 Convert: . . . . none.

.418 Shift, N bit positions: . 8.5 + 1.6 N.

.42 Processor Performance in μsecs

.412 For random addresses	Fixed point	Floating point
$c = a + b$:	45.0	51.9.
$b = a + b$:	34.8	41.9.
Sum N items:	15.0	21.9.
$c = ab$:	122.2	99.9.
$c = a/b$:	123.3	103.8.
.422 For arrays of data	**Fixed point**	**Floating point**
$c_i = a_j + b_j$:	63.9	70.8.
$b_j = a_i + b_j$:	24.8	31.9.
Sum N items (under repeat control): . . .	10.0	10.0.
$c = c + a_i b_j$:	113.4	99.8.

.423 Branch based on comparison
- Numeric data: . . . . 93.9.
- Alphabetic data: . . . 103.2.

.424 Switching
- Unchecked: . . . . . . 56.3.
- Checked: . . . . 116.9.
- List search: . . . . . 14.0.

.425 Format control per character
- Unpack: . . . . 7.8 + 104 if converted.
- Compose: . . . . 90.5 + 209 if converted.

.426 Table look up per comparison
- For a match: . . . . . 14.0.
- For least or greatest: 21.1.
- For interpolation point: . . . . 14.0.

.427 Bit indicators
- Set bit in separate location: . . . . . . 11.1.
- Set bit in pattern: . . 11.1.
- Test bit in separate location: . . . . . . 11.3.
- Test bit in pattern: . . 140.6.

.428 Moving
- (word; register to register): . . . . . . 9.3.
- (word; core to core): . 30.0.
- (N words; core to core): . . . . 20.8 + 20.0 N.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	indicator.
Underflow:	check	error jump and alarm.
Zero divisor:	check	signal and indicator.
Invalid data:	none.	
Invalid operation:	check	stop.
Arithmetic error:	none.	
Invalid address:	check	stop and alarm.
Receipt of data:	parity check	indicator and alarm.
Dispatch of data:	parity check	indicator and alarm.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . Central Processor Console.

.12 Associated Units: . . . console typewriter, stands on console desk.

.13 Description:

The Console is mounted on the central processor desk type cabinet, and consists of an operating and display panel, and a console typewriter. The display panel is mounted vertically with a slanted operating control panel extending outward toward the operator. The console typewriter is located on an angled extension of the desk to the left of the operator.

All arithmetic and control registers are displayed, as well as a usual complement of fault indicators. Data and instructions may be entered manually from the console, requiring that the operator be familiar with the command configurations of all instructions. Supplementary display information is obtained from the Input-Output Processor (IOP) control panel; the system is inconvenient if placed anywhere the operator cannot see and easily reach both the console and IOP control panel.

The console typewriter is a modified Friden Flexowriter with the punched paper tape reader and punch made inoperative or removed. Entry and exit of data through the console typewriter is accomplished by programmed routines.

Output on the typewriter is rated by the manufacturer at 10 characters per second. Data to be typed or entered is sent in BCD form through the Data register one character at a time. The typewriter keyboard contains 64 Philco characters plus 3 control characters.

.2 CONTROLS

.21 Power

Name	Form	Function
Start:	button	starts power-on cycle.
Stop:	button	starts turn-off cycle in central processor.

.22 Connections: . . . . . none. Connection plugs and switches are located on I/O Processor control panel.

.23 Stops and Restarts

Name	Form	Function
Stop:	button	stops central processor at end of instruction being executed.
Advance:	button	starts central processor when Run or Step buttons have been depressed.

.24 Stepping

Name	Form	Function
Step:	button	allows execution of one instruction at a time each time Advance button is depressed.
Run:	button	sets automatic running mode.
Speed:	dial	when turned to off, processor is in Step mode.
I Control	button	next programmed instruction pair is to be transferred to the Program Register when Advance button is depressed. Used in Step mode.
IL Control	button	left instruction in Program Register is to be executed when Advance button is depressed. Used in Step mode.
IR Control	button	right instruction in Program Register is to be executed when Advance button is depressed. Used in Step mode.

.25 Resets

Name	Form	Function
Clear D Controls:	buttons	clear left and right address field, left and right command field of word in Data Register.
Clear PR Controls:	buttons	clear left and right address field, left and right command field of Program Register.
Pre-Clear Control:	button	clear all controls and error circuits; cause carriage return on console typewriter; set initial conditions for IOP and device on Paper Tape Channel.

§ 061.

.26 Loading: . . . . none.

.27 Sense Switches

Name	Form	Function
Break Control:	switch	allows breakpoint option.
Overflow On-Off Control:	switch	causes program to stop on overflow detection when switch is set to On and the next instruction is not an overflow branch.
TR Controls:	switches	allows manual setting of bit pattern to be transferred to Data Register at point specified in program by special transfer instruction. Forty-eight two-way toggle switches are provided.

.28 Special

Name	Form	Comment
MP Control:	switches	causes display of address of core storage location specified by switches when that location is accessed.
MP On-Off Control:	switch	stops central processor when address determined by MP control is accessed.
Jump control:		allows execution of jump instruction without affecting the contents of the Jump Register.
Index Selector Controls:	buttons	allows display of any eight index registers.

The following controls are on the Input-Output Processor control panel:

Name	Form	Comment
Assigned Address Controls:	16 plug-in controls	assigns the input-output channel number to the physical I/O unit.
Initiate Control:	button	executes an I/O instruction set up on the IOP control panel.
System Clear:	button	clears all IOP registers and counters, releases all assemblers.

.28 Special (Contd.)

Name	Form	Comment
Read FWD 1 Block Controls:	4 buttons	sets up a command to read one block of data in a forward direction from the indicated unit.
Space FWD 1 Block Controls:	4 buttons	sets up a command to space one block of data in a forward direction on the indicated unit.
Space BWD 1 Block Controls:	4 buttons	sets up a command to space one block of data in a backward direction on the indicated unit.
Clear Faults Controls	4 buttons	clears I/O errors in the specified assembler.
Assembler Displayed Control:	rotary switch	determines which assembler's registers will be displayed.
Assign Controls	20 buttons	assigns any assembler to any I/O channel.

.3 DISPLAY

.31 Alarms: . . . . four fault lights indicate: command fault; non-acceptance of I/O instruction; core storage temperature trouble; and floating point exponent overflow. An additional light indicates arithmetic overflow.

.32 Conditions: . . . . . none.

.33 Control Registers

Name	Information displayed; form displayed
I/O Display:	most recent I/O instruction executed; displayed in binary.
A Register Display:	contents of Accumulator Register; displayed in binary.
Q Register Display: .	contents of Quotient Register; displayed in binary.

§ 061.

.33 Control Registers (Contd.)

Name	Information displayed; form displayed
Data Register Display:	contents of Data Register; displayed in binary, separated and color coded by instruction address and command fields.
JA Display:	contents of Jump Address Register; displayed in binary.
MA Display:	address of core storage location most recently accessed; displayed in binary.
Program Register Display:	contents of Program Register (instruction pair being processed); displayed in binary, separated and color coded by address and command fields.
PA Display:	address of next instruction word to go to Program Register; displayed in binary.
Index Display:	contents of any eight index registers; displayed in binary.
I Cycle Display:	indicates next part of instruction cycle to perform; displayed in three single lights.
Jump Indicator:	indicates Jump Control is depressed.

.34 Storage

Name	Information Displayed
M Display:	contents of core storage location whose address is determined by the Memory Preset switches. Individual core storage locations are displayed by operator entering transfer instruction to an arithmetic register into the Program Register via Program Register Control buttons, depressing appropriate I Cycle button and Advance button.

.4 ENTRY OF DATA

.41 Into Control Registers

(a) Enter appropriate transfer instruction into Program Register by keying-in on Program Register Control buttons.
(b) Enter data into Data Register by keying-in on Data Register Control buttons.
(c) Depress Advance button to execute transfer instruction. One 48-bit word is transferred.

.42 Into Storage: . . . . . same as control registers.

.5 CONVENIENCES

.51 Communications: . . . none.

.52 Clock: . . . . program time display on console provides running time of a program in seconds; manually reset to zero.

.53 Desk Space: . . . . . adequate free work space in front of operating panel.

.54 View: . . . . unobstructed view in all directions by person seated at console.

INPUT-OUTPUT: 240 PAPER TAPE SYSTEM

§ 071.

.1 GENERAL

.11 Identity: . . . . Paper Tape System. Model 240.

.12 Description

The paper tape reader and punch are two separate units housed in the same cabinet with their controller. The photoelectric reader operates at 1,000 characters per second with a slower speed of 500 characters per second achieved by a switch control. This is a Burroughs reader. When reading strips, the 1,000 character per second speed cannot be used. Tape used is standard 11/16- or 7/8-inch opaque, non-oiled paper tape. The punch is a Teletype unit which operates at 60 characters per second. Optional features permit 5- or 7-level paper tape reading and punching, and 6-level tape reading by setting a parity check bypass switch. The external code is the same as the internal code. From 1 to 4,096 characters can be read or punched by one I/O instruction. No interblock gaps are required. The reader halts on the character following the last character transmitted or sensed. The five-bit code is treated as a six-bit character in a read operation by adding a zero bit in the most significant bit position.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . February, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pressure roller (reader); sprocket drive (punch).

.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . 1.5 to 2.0 ft.

.213 Feed drive: . . . . . . electric motor.

.214 Take-up drive: . . . . . electric motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.

.222 Sensing system: . . . . photoelectric.

.223 Common system: . . . no; separate read and punch units.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . . 7.
Method of use: . . . . . reads 1 row at a time.

Use of station: . . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . . 7.
Method of use: . . . . . punches 1 row at a time.

.25 Range of Symbols

Numerals:	10	0 to 9.
Letters:	26	A to Z.
Special:	28	special characters.
Total:	64.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape, opaque.

.312 Phenomenon: . . . . . . punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to 32,768 rows at 10 rows/inch.

.322 Parallel by: . . . . . . 5 or 7 tracks at standard spacing (5 or 7 tracks read or punched; parity punch ignored for 6-track tape).

.324 Track use

	7-level	6-level	5-level
Data:	6	6	5.
Redundancy check:	1	0	0.
Timing:	1(sprocket track)	1(sprocket track)	1(sprocket track).
Control signals:	0	0	0.
Unused:	0	0	0.
Total:	7(plus sprocket track).	6(plus sprocket track).	5(plus sprocket track).

.325 Row use
Data: . . . . all.
Redundancy check: . . 0.
Timing: . . . . 0.
Control signals: . . . 1 (end transmission prior to end of specified number of words to transmit).
Unused: . . . . 0.
Gap: . . . . 0.

§ 071.

.33 Coding: . . . . 6- and 7-level tape as in Data Code Table No. 1, one character to a row; 5-level type - any 5-bit code.

.34 Format Compatibility: . any paper tape device accepting standard 0.6875 inch 5-level or 0.875 inch 7-level tape.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.6875 or 0.875 inch.
.352 Length: . . . . 350 or 700 foot reels for reader; also short lengths (reader); 1,000 foot reels for punch.

.4 CONTROLLER

.41 Identity: . . . . no separate identity; part of Model 240 Paper Tape System.

.42 Connection to System

.421 On-line: . . . . 1; may not transmit during magnetic drum transmission.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 2 (1 reader, 1 punch).
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 4,096 rows.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . 1 word.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks: . . . . none.

.52 Input-Output Operations

.521 Input: . . . . 1 to 4,096 characters; cut-off by I/O instruction or "stop" character.
.522 Output: . . . . 1 to 4,096 characters; cut-off by I/O instruction or "stop" character.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . end of record by "stop" character, coded.
.526 Searching: . . . . none.

.53 Code Translation: . . . none.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . . yes.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: yes.
Parity check: . . . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . 1,000 char/sec. reading.
II: . . . . 500 char/sec. reading.

.62 Speeds

.621 Nominal or peak speed: 1,000 char/sec. read; 60 char/sec. punch.
.622 Important parameters
Start-stop time: . . . 1 millisecond on reading.
.623 Overhead: . . . . none.
.624 Effective speeds: . . . 989 char/sec. reading, 60 char/sec. punching for on-line and off-line operations.

.63 Demands on System: . . 0.1 percent reading 1,000 char/sec. on 2000-210, less on others.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . . tape width guide.
Method: . . . . movable guide.
Comment: . . . . mechanical indented slide.

§ 071.

.72 Other Controls

Reader

Function	Form	Comment
Select on-line or off-line mode of operation:	switch.	
Set speed to 1,000 char/sec or 500 char/sec:	switch.	
Determine 5- or 7-level tape:	switch.	
Rewind paper tape:	button	
Stop reading:	button.	
Resume forward reading:	button.	
Allow stop on parity error or bypass error:	switch	set to Bypass for 6-level tape.
Stop for or bypass "stop" character:	switch.	

Punch

Function	Form	Comment
Determine 5- or 7-level punching mode:	switch.	

Controller

Function	Form	Comment
Set controller for new paper tape operation:	button	clears counters and fault registers.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	700 ft.

.732 Replenishment time: . . 0.5 to 1.0 minute; unit needs to be stopped.

.733 Adjustment time: . . . 0.5 min. to adjust tape with guide.

.734 Optimum reloading period: . . . . 1.4 min. for reader; 33 min. for punch.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording (parity):	check	alarm, stop.
Reading:	check	alarm, stop.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	none.	
Exhausted medium:	check	automatic rewind or stop after rewind.
Imperfect medium:	none.	
Timing conflicts	none.	

INPUT-OUTPUT: 241 PAPER TAPE SYSTEM

§ 072.

.1 GENERAL

.11 Identity: . . . . Paper Tape System.
Model 241.

.12 Description

The paper tape reader and punch are two separate units housed in the same cabinet with the controller. The performance characteristics of the 241 are identical with the Model 240 Paper Tape System with respect to reading and punching speed. This device operates through a Universal Buffer Controller (UBC) allowing transfers of up to 128 words only.

Reading and punching of 5-, 6-, 7-, or 8- channel tape is permitted. The paper tape used is standard 11/16-, 7/8-, or 1-inch opaque, non oiled tape. The punch is a Tally Register Corporation Series 420 perforator. Reading halts on the character immediately following the last characters sensed. During the read operation, the five-bit code is treated as a six-bit character by adding a one-bit in the most significant bit position. The eight-bit code is placed in core storage as 12-bit coded characters containing four leading zeros.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . June, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pressure roller (reader).
sprocket drive (punch).
.212 Reservoirs
Number: . . . . 2 on reader.
Form: . . . . swinging arm.
Capacity: . . . . 1.5 to 2.0 ft.
.213 Feed drive: . . . . . . electric motor.
.214 Take-up drive: . . . . . electric motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . photoelectric.
.223 Common system: . . . no; separate read and punch units.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8.
Method of use: . . . . . reads 1 row at a time.

Use of station: . . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8.
Method of use: . . . . . punches 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

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

.32 Positional Arrangement

.321 Serial by: . . . . 1 to 128 rows at 10 per inch.
.322 Parallel by: . . . . . . 5, 7, or 8 tracks at standard spacing.
.324 Track use

	8-level	7-level	6-level	5-level
Data:	8	6	6	5.
Redundancy check:	0	1	0	0.
Timing:	1 (sprocket track)	1 (sprocket track)	1 (sprocket track)	1 (sprocket track).
Control Signals:	0	0	0	0.
Unused:	0	0	0	0.
Total:	8 (plus sprocket track)	7 (plus sprocket track)	6 (plus sprocket track)	5 (plus sprocket track).

.325 Row use
Data: . . . . all.
Redundancy check: . . 0.
Timing: . . . . 0 (end of transmission prior to end of specified number of words to transmit).
Control signals: . . . 1.
Unused: . . . . 0.
Gap: . . . . 0.

.33 Coding: . . . . 6- and 7-level tape as in Data Code Table No. 1, one character to a row; 5- and 8-bit tapes may have any coding or binary representation.

.34 Format Compatibility: . any paper tape device accepting standard 11/16-inch, 7/8-inch or 1-inch paper tape.

§ 072.

.35 Physical Dimensions

.351 Overall width: . . . . . 11/16, 7/8, or 1 inch.
.352 Length: . . . . 350 or 700 foot reels for reader, also short lengths (strips); 1,000 foot reels for punch.

.4 CONTROLLER

.41 Identity: . . . . no separate identity; part of Model 241 Paper Tape System.

.42 Connection to System

.421 On-line: . . . . 7 per UBC; only one controller may be active for UBC data transmission.
.422 Off-line

Use	Associated equipment
Punch card to paper tape to card: .	UBC, and Punch Card System.
Paper tape to magnetic tape or magnetic tape to paper tape:	UBC, and Magnetic Tape Unit.
Paper tape to printer:	UBC, and Printer System.

.43 Connection to Device

.431 Devices per controller: 2 (1 reader, 1 punch).
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 128 words.
.442 Input-output areas: . . UBC, for off-line; core storage for on-line operation.
.443 Input-output area access: . . . . full.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1,024 characters.
.512 Block demarcation: . . none at end of 1,024 characters; may be transmitted earlier by "stop" character.

.52 Input-Output Operations

.521 Input: . . . . 1 to 128 words; cutoff by I/O instruction or "stop" character.
.522 Output: . . . . 1 to 128 words; cutoff by I/O instruction or "stop" character.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . end of record by "stop" character, coded.
.526 Searching: . . . . none.

.53 Code Translation: . . . none.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code level: . . . yes.
Rewind reader: . . . . yes.
Unload reader: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: yes.
Parity check: . . . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . 1,000 char/sec reading.
II: . . . . 500 char/sec reading.

.62 Speeds

.621 Nominal or peak speed: 1,000 char/sec read; 60 char/sec punch.
.622 Important parameters:
Start-stop time: . . . 1 m.sec. for reading.
UBC transfer time to IOP (off-line only): 11.4 m.sec.
.623 Overhead: . . . . none.
.624 Effective speeds: . . . 1,000 char/sec reading, 60 char/sec punching for on-line operations; 989 char/sec reading, 60 char/sec punching for off-line operations.

.63 Demands on System: . . 0.1 percent reading 1,000 char/sec on 2000-210, less on others.

§ 072.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment:	tape width guide.
Method:	movable guide.
Comment:	mechanical indent slide.

.72 Other Controls

Reader

Reader controls are identical to those of Model 240 with the following controls not present in the Model 241 reader:

5- or 7-level tape mode switch, parity error bypass switch, "stop" character bypass switch.

The following additional controls are present:

Function	Form
Select mode of reading 5-level binary, or 5-, 6-, 7-, and 8-level paper tape:	dial.
Control entry of "stop" characters to normal or override mode:	switches.

Punch

Function	Form
Select mode of punching 5-level binary, or 5-, 6-, 7-, and 8-level paper tape:	dial.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	700 feet.

.732 Replenishment time: . . 0.5 to 1.0 minute. unit needs to be stopped.

.733 Adjustment time: . . . 0.5 min. to adjust tape width guide.

.734 Optimum reloading period: . . . . 1.42 minutes for reader; 33 minutes for punch.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	check	alarm, stop.
Receipt of data:	parity check	alarm, stop.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	none.	
Exhausted medium:	check	automatic rewind or stop after rewind.
Imperfect medium:	none.	
Timing conflicts	none.	

INPUT-OUTPUT: 258 CARD READER

§ 073.

.1 GENERAL

.11 Identity: . . . . Dual Station Card Reader. Model 258

.12 Description

The reader reads standard 80-column cards at a peak speed of 2,000 cards per minute. Code translation is performed by the Model 259 Punch Card Controller upon an expanded Hollerith code set of 64 possible characters. This reader is manufactured by Philco, and is based on the Uptime reader. There are two important extensions to the facilities: the incorporation of a plugboard, and a specially designed dual reading station.

Reading is accomplished photoelectrically with a comparison check made at the read station. Both readings occur at the same position. There is one lamp, but two photocells, for each column position. Parity checking occurs after translation; an override control in the controller allows parity error bypassing. A check for skewed cards is also made, and another control is provided to override this condition when desired. A 4,000 card capacity hopper and the same capacity stacker are provided.

Format control is provided in a small reader plugboard, fixed in the card controller. Up to eight fixed characters can be introduced into the controller buffer as part of the card information. The reader and controller may be used on-line or off-line through the Universal Buffer Controller (UBC). When on-line, the reader plugboard is overridden by the I/O instruction specifying the record sizes to become the block of 128 words in the UBC and internal core storage.

.13 Availability: . . . . 12 months.

.14 First Delivery: . . . . . December, 1959.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . picker (cam action).
.212 Reservoirs: . . . . . . none.

.22 Sensing and Recording Systems

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

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

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

Use of Station: . . . . . checking.
Distance: . . . . virtually same position.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80, another dual set of photocells, reading same row.

.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: . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding: . . . . expanded Hollerith code as in Data Code Table No. 2; binary coded characters as in Data Code Table No. 1; or other binary data.

.34 Format Compatibility

Other device or system	Code translation
All devices or systems using standard 80-column cards: . . .	not required with Hollerith-coded punched cards.

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

.4 CONTROLLER

.41 Identity: . . . . Punch Card Controller. Model 259.

.42 Connection to System

.421 On-line: . . . . 7 with UBC; 1 controller only may be operating on-line per UBC.

§ 073.

.422 Off-line

Use	Associated equipment
Punch card to magnetic tape:	Universal Buffer Controller. Magnetic Tape Unit.

.43 Connection to Device

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

.44 Data Transfer Control

.441 Size of load: . . . . . . off-line, 128 words from multiple cards under plugboard control specifying number of words per block.
on-line, 128 words under program specification of number of words per card and number of cards per block.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . 1 word.
.444 Input-output area lockout: . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card of 1 to 10 words.
.512 Block demarcation
Input: . . . . off-line, specified by plugboard: on-line, specified by I/O instruction.

.52 Input-Output Operations

.521 Input: . . . . read variable number of words into UBC buffer storage and fill remainder of storage with null characters. Cut off is available by control character recognition.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . off-line under plugboard control.
Format alternatives: . . indefinite.
Rearrangement: . . . . yes.
Suppress zeros: . . . . yes.
Insert point: . . . . . . yes.
Insert spaces: . . . . . yes.

.55 Control Operations

Disable: . . . . yes.
Request interrupt: . . . no.
Offset card: . . . . . . no.
Select stacker: . . . . no.
Select format: . . . . . yes.
Select code: . . . . . . yes; binary, binary coded characters.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
Hopper empty: . . . . . yes.
Stacker full: . . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: . 2,000 cards/min.
.622 Important parameters: . none.
.623 Overhead: . . . . asynchronous clutch.
.624 Effective speeds: . . . . 2,000 cards/min.

.63 Demands on System

Type of store
I: . . . . 10.0 μ.sec on 210, 211.
II: . . . . 10.0 μ.sec partitioned on 211μ
III: . . . . 1.5 μ. sec on 211.
IV: . . . . 1.0 μ. sec on 212.

	I	II	III	IV
μ. sec per full card:	0.1	0.8	0.02	0.01.
Percentage:	0.33	0.25	0.05	0.03.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

§ 073.

.72 Other Controls

Punched Card Controller - Read Controls

Function	Form	Comment
Off-line format control:	plugboard.	allows rearrangement and omission of columns and fields; permits up to 8 additional characters of fixed data to be substituted for data received from cards; specifies the number of words per card and cards per block to comprise the data entering the UBC buffer storage.
Place system in ready condition:	button.	clears fault and error indicators.
Allows operation to continue when skew error is detected:	button.	
Allow operation to continue when parity error is detected:	button.	
Allow reading instead of bypassing first card of every group to be transferred to the UBC:	button.	
Determine whether blank column should be read as a space character or zero character during code translation:	switch.	
Resume reader operation after non-mechanical fault is detected:	switch.	
Ignore control characters:	switch.	
Determine whether code translation is to occur:	switch.	
Halt reader:	button.	

.72 Other Controls (Continued)

Card Reader

Function	Form	Comment
Allow removal of output tray:	button.	
Cause ready motor to be turned off:	key.	
Starts reader motor:	key	
Permit continuation after a halt:	key.	
Interrupt a read operation:	key.	
Provide count of cards read:	counter with dial reset.	

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Stacker:	4,000 cards.
Hopper:	4,000 cards.

.732 Replenishment time: . . 0.5 minute; unit needs to be stopped when output tray is full.

.733 Adjustment time: . . . . 0.5 to 1.0 minute.

.734 Optimum reloading period: . . . . 2.0 minutes.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Reading:	check	alarm, stop.
Input area overflow:	none.	
Invalid code:	yes	alarm, stop.
Exhausted medium	interlock	alarm, stop.
Imperfect medium:	check	alarm, stop.
Timing conflicts	none.	
Card skew:	check	alarm, stop.

INPUT-OUTPUT: 265 CARD PUNCH

§ 074.

.1 GENERAL

.11 Identity: . . . . Card Punch.
Model 265.

.12 Description

This unit is a modified IBM 523 Summary Gang Punch. Cards may be punched in column alphanumeric or in column binary. The mode to be used is determined by a switch on the Punch Card Controller. Data punched is checked against the data in the buffer matrix of the controller.

The card punch is always used off-line with the Universal Buffer Controller (UBC) although provision exists for on-line operation. The format and block demarcation are controlled by a plugboard. Up to eight fixed characters can be supplied by plugboard wiring.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . December, 1959.

.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 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: . . . . . punching.
Distance: . . . . 1 card.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . compares punched data against buffer storage in Punch Card Controller.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . standard 80-column punch 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: . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding

Alphanumeric: . . . . . column code as in Data Code Table No. 2.
Binary: . . . . 4 card columns per 48-bit core storage word.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	automatically provided by Punch Card Controller when code mode required.

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

.4 CONTROLLER

.41 Identity: . . . . Punch Card Controller.
Model 259.

.42 Connection to System

.421 On-line: . . . . 7 with UBC; 1 controller only may be operating on-line per UBC.
.422 Off-line

Use	Associated equipment
Magnetic tape to punch card:	UBC, Magnetic Tape Unit.

.43 Connection to Device

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

§ 074.

.44 Data Transfer Control

.441 Size of load: . . . . . . off-line; 128 words to multiple cards under plugboard control specifying number of words per card and number of cards per block.
on-line; 128 words under program specification of number of words per card and number of cards per block.

.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . 1 word.
.444 Input-output area lockout: . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card of 1 to 10 words in column code mode; 1 to 20 words in column binary mode.
.512 Block demarcation
Output: . . . . off-line, specified by plugboard; on-line, specified by I/O instruction.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . punch variable number of words from UBC buffer storage. Cutoff is available by control character recognition.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . off-line under plugboard control; on-line under program control.
Format alternatives: . indefinite.
Rearrangement: . . . . yes.
Suppress zeros: . . . . yes.
Insert point: . . . . . . yes.
Insert spaces: . . . . . yes.

.55 Control Operations

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

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Output lock: . . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
Hopper empty: . . . . . yes.
Stacker full: . . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: 100 cards/min.
.622 Important parameters: none.
.623 Overhead: . . . . single clutch point.
.624 Effective speeds: . . . 100 cards/min.

.63 Demands on System

Type of store
I : . . . . 10.0 μsec on 210, 211.
II : . . . . 10.0 μ sec partitioned on 211.
III: . . . . 1.5 μ sec on 211.
IV: . . . . 1.0 μ sec on 212.

	I	II	III	IV
M. sec per card:	0.1	0.8	0.02	0.01.
Percentage:	0.017	0.013	0.003	0.002.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.72 Other Controls

Punched Card Controller - punch controls

Function	Form	Comment
Off-line format control:	plugboard	allows rearrangement and omission of columns and fields; permits up to 8 additional characters of fixed data to be punched on cards; specifies the number of words per card and cards per block to comprise the data to be punched.
Place system in ready condition:	button	clears fault and error indicators.
Allow operation to continue when parity error is detected:	button.	

§ 074.

.72 Other Controls (Cont'd)

Function	Form	Comment
Resume punch operation if fault other than mechanical fault is detected:	switch.	
Disregard control characters:	switch.	
Determine card punching to be code mode or image (binary) mode:	switch.	

Card Punch

Function	Form	Comment
Feed cards without punching them:	button.	
Interrupt punch operation:	button.	
Allow restart after a halt:	button.	

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	700 cards.
Stacker:	700 cards.

.732 Replenishment time: . . 0.25 to 0.50 mins. punch does not need to be stopped.

.734 Optimum reloading period: . . . . 7 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-punch	stop, alarm on controller.
Parity on data to punch:	check	stop, alarm.
Output block size:	counter.	
Invalid code:	check	stop, alarm.
Exhausted medium:	check	stop, alarm.
Imperfect medium:	none.	
Timing conflicts:	skew check	stop, alarm.

INPUT-OUTPUT: 2256 PRINTER SYSTEM

§ 081

.1 GENERAL

.11 Identity: . . . . Printer Unit.
Model 256.

Printer Control Unit.
Model 254.

.12 Description

The 2256 Printer System is a pair of units, a printer and a controller.

The Model 256 Printer is an Anelex Printer built into a cabinet with control circuitry. The printer requires an additional Printer Control Unit, Model 254, which in turn operates only through a Universal Buffer Controller (UBC). Maximum print speed is 900 lines per minute for alphameric data with the option of a slower operating speed of 600 lines per minute. Skipping occurs at 9,000 lines per minute. Each line prints a maximum of 120 characters from a set of 64 printable characters, four of which normally exercise control functions only.

The print line is of variable length when assembled in internal storage by the programmer. Each block of data, written on magnetic tape or transmitted on-line to a UBC, can be any number of lines the programmer desires, with a restriction that a line cannot be carried over into the next block.

The format of output may be controlled by program and by plugboard. The first character of each line specifies any paper movement before the associated line is printed, either no movement, one-line feed, or a skip to the next control hole in a selected channel of the paper tape loop. In addition to the control characters "end of line" and "end of block," there is a null character which is ignored by the printer and does not result in a space. The plugboard provides a facility to rearrange or duplicate positions on a line. It operates on all lines, and is therefore usually plugged in a one-to-one convention.

.13 Availability: . . . . . 12 months.

.14 First Delivery: . . . . December 1959.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive - paper punch both sides.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . . . . on-the-fly hammer stroke against engraved, sectioned print cylinder.
.222 Sensing system: . . . none.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . . . . . 6 (8 to 9 pound bond with 1 mil thick carbon paper).
.232 Types of master
Multilith: . . . . . yes.
Zerox: . . . . . . no.
Spirit: . . . . . . no.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . 1.
Heads/stack: . . . . 120.
Method of use: . . . prints 1 line at a time.

.25 Range of Symbols

Numerals: . . . . . 10 0 - 9.
Letters: . . . . . . 26 A - Z.
Special: . . . . . . 28 @ = ; ≡ & 1 + n .) % ?
" - $ * < # Δ / 1 , (>
: e ¬ ⌴
FORTRAN set: . . . yes.
Basic COBOL set: . . yes.
Total: . . . . 64.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . . continuous fanfold sprocket punched forms.
.312 Phenomenon: . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . . 1 line at 6 per inch.
.322 Parallel by: . . . . . 120 characters at 10 per inch.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . . all for data.

.33 Coding: . . . . 6 bits per character as in Data Code Table No. 1.

.34 Format Compatibility: . . . none.

§ 081

.35 Physical Dimensions

.351 Overall width: . . . . 4.0 to 20.0 inches.
.352 Length: . . . . indefinite, by one-sixth inch increments.
.353 Maximum margins
Left: . . . . 4 inches.
Right: . . . . 4 inches.

.4 CONTROLLER

.41 Identity: . . . . . . Printer Control Unit. Model 254.

.42 Connection to System

.421 On-line: . . . . . . 1 per Universal Buffer Controller.
.422 Off-line

Use	Associated equipment
Printing:	Printer Control Unit, Model 254. Universal Buffer Controller, Model 252 or Model 280. Printer, Model 256.

.43 Connection to Device

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

.44 Data Transfer Control

.441 Size of load: . . . . . 1 block of a variable number of lines.
.442 Input-output areas: . . core storage in the UBC.
.443 Input-output area access: . . . . . . all of UBC core storage only (128 words).
.444 Input-output area lockout: . . . . . . automatic in UBC.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . up to 120 characters per line.
.512 Block demarcation
Output: . . . . . . end-of-line character, programmer-specified.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . output 1 block of a variable number of lines.
.523 Stepping: . . . . . . programmer causes stepping by giving control character with no printable characters as a line.
.524 Skipping: . . . . . . advances, then prints; advancing controlled by 7-channel paper tape loop in conjunction with first character of line acting as a vertical format control character.
.525 Marking: . . . . . . all control characters can be printed in "Write-all" mode.

.53 Code Translation: . . none.

.54 Format Control

Control: . . . . . . generally program control with fixed plugboard wiring.
Format alternatives: . . . indefinite.
null character code.
end of line character code.

.55 Control Operations

Disable: . . . . . . yes, from UBC.
Request interrupt: . . no.
Select format: . . . . no.
Select code: . . . . no.

.56 Testable Conditions

Disabled: . . . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . yes.
End of medium marks: . . . . . . no.
Hopper empty: . . . yes.
Stacker full: . . . . no.
Edit error: . . . . . yes.
Parity error: . . . . yes.
Counter error: . . . yes.
Ribbon alignment: . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . 900 lines/min.
II: . . . . 600 lines/min.

.62 Speeds

.621 Nominal or peak speed:
I . . . . 900 lines/min.
II . . . . 600 lines/min.

.622 Important parameters:
Drum revolution
I . . . . 48.5 msec.
II . . . . 72.7 msec.
Paper stop + start time . . . . 18.0 msec.
Full paper speed . . 25 inch/sec.
6.66 msec/line.

§ 081

.623 Overhead: . . . . . asynchronous clutch.

.624 Effective speeds:

I	9,000/(9 + N) lines/min.
II	9,000/(14 + N) lines/min.
N	number of lines advanced between prints.

.63 Demands on System

Type of store

I	10.0 μ.sec on 210, 211.
II	10.0 μ.sec partitioned on 211.
III	1.5 μ.sec on 211.
IV	1.0 μ.sec on 212.

	I	II	III	IV
msec per full line	0.15	0.12	0.022	0.015
Percentage at 900 lines/min	0.22	0.18	0.033	0.022

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method
Paper tape loop: . .	change loop.
Horizontal adjustment: . . .	lateral adjustment crank.
Vertical:	micrometer.

.72 Other Controls

Function	Form
Resets printer: . .	button.
Clears fault registers:	button.
Provides a means of setting advance based on specific loop channel: . .	dial.
Edit error override:	toggle.
Parity check override:	toggle.

.73 Loading and Unloading

.731 Volumes handled

Storage:	input hopper.
Capacity:	10-inch stack of paper.

.732 Replenishment time: . . . . 0.5 to 1.0 min.
printer needs to be stopped.

.733 Adjustment time: . . 1.0 to 2.0 min.

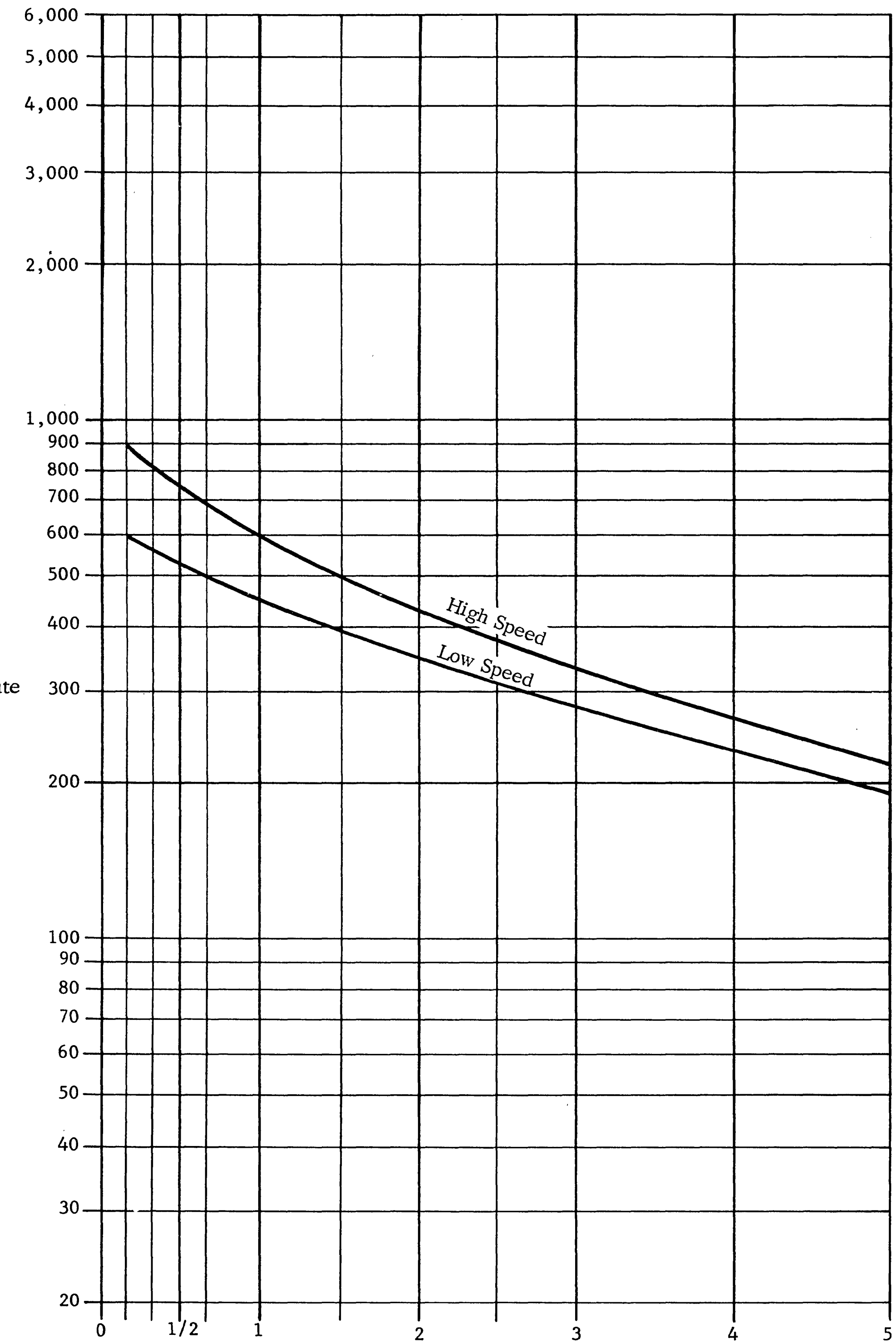
.734 Optimum reloading period: . . . . . . 147 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Receipt of data:	parity check	alarm, stop.
Output block size:	check	alarm, stop.
Invalid code:	check	alarm, stop.
Exhausted medium:	interlock	alarm, stop.
Imperfect medium:	none.	
Timing conflicts:	none.	

§ 081.

Effective Speed: Printed Lines Per Minute



Inter-Line Pitch in Inches

INPUT-OUTPUT: 90 KC MAGNETIC TAPE

§ 091.

.1 GENERAL

.11 Identity: . . . . 90 KC Magnetic Tape Transport.
Model 234.

.12 Description

These tape units are used in all Philco 2000 systems employing the Models 235, 236, 237, or 238 Input-Output Processor (IOP). They are also used on the Models 252 and 280 Universal Buffer Controller. The Model 234 (Ampex TM 2) tape units use one inch tape, which has a 750-character-per-inch longitudinal density. Tape is moved across the read-write heads at a speed of 120 inches per second. Record length is fixed in blocks of 512 data frames or rows (1,024 binary coded characters) plus longitudinal parity and block mark recording. Reels of tape are supplied pre-recorded with the necessary "sprocket tracks" and block marks which indicate the fixed block sizes and positions. An erase instruction is provided to erase the sprocket tracks and block marks for one block. An edit instruction is provided for re-recording of beginning and end-block marks from the point started to the end of tape. Editing of tape is more efficiently provided at the manufacturer's facilities. Data recorded may be any binary information held in the storage medium since no conversions occur during reading or recording.

Up to 16 tape units can be physically connected to an Input-Output Processor. Logical tape assignment is easily changed by assignment plugs on the IOP control panel. A varying degree of simultaneous tape operation is provided by the different IOP models; the Model 238 allowing four reads and/or writes to proceed simultaneously with central processor operation and on-line paper tape transmission.

The instantaneous transmission rate is 90,000 characters per second, with an effective transfer of about 54,600 characters per second. A 3,600 foot reel is capable of storing up to 19,200,000 binary coded characters. Forward and backward read is provided as well as the ability to space over blocks prior to reading or recording; the spacing and reading or recording being specified in one input-output instruction.

Checking features include character and channel parity, sprocket bit errors (timing or skew), missing beginning and end-block marks, and beginning and end-of-tape. All of these conditions set bits in the IOP fault registers and can be detected by the program. Parity and sprocket errors initiate automatic error cycles which attempt to overcome the errors. Two modes of error cycle are available in both reading and recording; the programmer specifying the particular mode in the input-output order initiated. When an error occurs in reading there is an automatic re-read. If this is also faulty, one mode stops the unit, the other does not. When an error occurs on recording, there is automatic re-write. If this re-write is also in error: one mode stops the unit; the other mode erases that block position, removing the position from further use, and tries at the next position. If the writing fails twice at the next position, this mode stops the unit. A program can test for these situations and release the unit.

Optional

One magnetic tape unit may be switchable on-line/off-line with the Model 280 Universal Buffer Controller.

.13 Availability: . . . . . 12 months.

.14 First Delivery: . . . . December, 1959 (FR 300).
late 1961 (TM 2).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . vacuum.
Capacity: . . . . each about 5.5 feet.
.213 Feed drive: . . . . . . motor.
.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic heads.
.222 Sensing system: . . . . magnetic heads.
.223 Common system: . . . two gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . recording.
Stacks: . . . . 1.
Heads/stack: . . . . . 16.
Method of use: . . . . 1 row at a time.

Use of station: . . . . sensing.
Distance: . . . . 0.39 inches.
Stacks: . . . . 1.
Heads/stack: . . . . . 16.
Method of use: . . . . 1 row at a time.

§ 091.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . . 514 rows at 375 rows/inch; includes 512 data rows of 2 characters each, 1 channel parity and 1 dummy row; two bits for timing and skew detection appear between each 2 rows.
.322 Parallel by: . . . . . 16 tracks.
.323 Bands: . . . . 2; 2 char/row.
.324 Track use
Data: . . . . 12.
Redundancy check:. . 2.
Timing: . . . . 2.
Control signals: . . . 0.
Unused: . . . . 0.
Total: . . . . 16.
.325 Row use
Data: . . . . 12.
Redundancy check:. . 2.
Timing: . . . . 2.
Control signals: . . . appear in same row as timing bits; signal beginning and ending block.
Unused: . . . . 0.
Gap: . . . . 0.9 inches.

.33 Coding: . . . . as in Data Code Table No. 1.

.34 Format Compatibility

Other devices or system	Code translation
Model 256 Printer system:	not required.
Models 258, 259, 265 Punched card system through Universal Buffer Controller:	by Punched Card Controller.

.35 Physical Dimensions

.351 Overall width: . . . . . 1.0 inch.
.352 Length
Reel: . . . . 600, 2,400 or 3,600 feet/reel, pre-recorded with block marks and sprocket tracks.

.4 CONTROLLER

.41 Identity: . . . . Input-Output Processor.
Model 235 (16 x 1). ‡
Model 236 (16 x 2). ‡
Model 237 (16 x 3). ‡
Model 238 (16 x 4). ‡
IOP.

‡ The first number in parentheses indicates the number of channels and the second number indicates the maximum number of data assemblers for the processor.

.42 Connection to System

.421 On-line: . . . . 1 IOP.

.43 Connection to Device

.431 Devices per controller: . . . . 16.
.432 Restrictions: . . . . up to 4 on/off-line Universal Buffer Controllers can be connected; reduces number of tape units by from 1 to 4.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to 16 blocks as specified by input-output instruction.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . . 1 word.
.444 Input-output area lockout: . . . . . . none.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: 128 words, 1,024 characters.
.512 Block demarcation
Input: . . . . begin and end-block marks, and interblock gap on magnetic tape; word count from core storage.
Output: . . . . same as input.

.52 Input-Output Operations

.521 Input: . . . . read from 1 to 16 blocks, forward or backward, from magnetic tape or 1 block from on-line Universal Buffer Controller; block inverted in core storage on backward read.
.522 Output: . . . . write from 1 to 16 blocks to magnetic tape or transmit 1 block to on-line Universal Buffer Controller.
.523 Stepping: . . . . none.
.524 Skipping: . . . . space forward or backward, 1 to 15 blocks, prior to reading forward or backward from magnetic tape; space forward 1 to 15 blocks prior to writing on magnetic tape; space 0 and read or write 0 if I/O instruction is interpreted as 16 blocks read or write.

§ 091.

.525 Marking: . . . . . . none.
.526 Searching: . . . . . . none.

.53 Code Translation: . . automatic, Hollerith to codes in Data Code Table No. 1, by 259 Punch Card Controller.

.54 Format Control: . . . none.

.55 Control Operations

Rewind: . . . . yes, independent of assemblers.
Unload: . . . . yes, independent of assemblers.

.56 Testable Conditions

Disabled (device on any of 16 channels): . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . yes.
Nearly exhausted: . . no.
Busy controller (assembler assigned to logical channel number): . . . . . yes.
End of medium marks: . . . . yes, beginning and ending of magnetic tape reel indicators.
Missing block demarcation: . . . . yes.
Parity error: . . . . . . yes.
Skew: . . . . yes, detected on magnetic tape.
Rewind: . . . . yes, any of 16 tape transports in a rewind status.
Count: . . . . yes, remaining blocks and words remaining to be processed.
Processor available: . . . . yes, assembler available and/or transmitting.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . 90,000 char./sec.
.622 Important parameters
Density: . . . . . . 750 char/inch.
Tape speed: . . . . 120 inches/sec.
Start-stop time: . . . 2.5 m.sec.
Full rewind time: . . 4.0 minutes/3,600 foot reel.
Interblock gap: . . . . 0.9 inches.
Fixed block length (including block markers): . . . . 1.90 inches
.624 Effective speeds: . . . 54,600 char/sec for full blocks.

.63 Demands on System

Type of store
I: . . . . 10.0 μ.sec on 210, 211.
II: . . . . 10.0 μ.sec partitioned on 211.
III: . . . . 1.5 μ. sec on 211.
IV: . . . . 1.0 μ.sec on 212.

Type of measurement
V: . . . . peak penalty.
VI: . . . . effective penalty.

	I	II	III	IV
M.sec per block	1.28	0.95(**)	0.192	0.128
Percentage				
V	11.2	8.4(**)	1.68	1.12
VI	6.7	5.1(**)	1.01	0.67

(**) Estimate based on nearly complete data and probably reliable.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Indicates unit has rewound tape without it locking out and requiring operator intervention:	button-indicator	button turns off indicator.
Indicates unit cannot be controlled remotely:	button-indicator	button turns off indicator.
Allows reducing or increasing rewind speed:	button-indicator.	
Allows recording on tape:	ring on tape reel.	
Releases tape reel brakes to allow manual reel turning:	buttons.	

.73 Loading and Unloading

.731 Volumes handled: . . . 18,750 blocks (19,000,000 char. approx.) potential maximum per 3,600 foot reel.
.732 Replenishment time: . . . 0.5 to 1.0 mins. device needs to be stopped.
.734 Optimum reloading period: . . . . 6.3 mins.

§ 091.

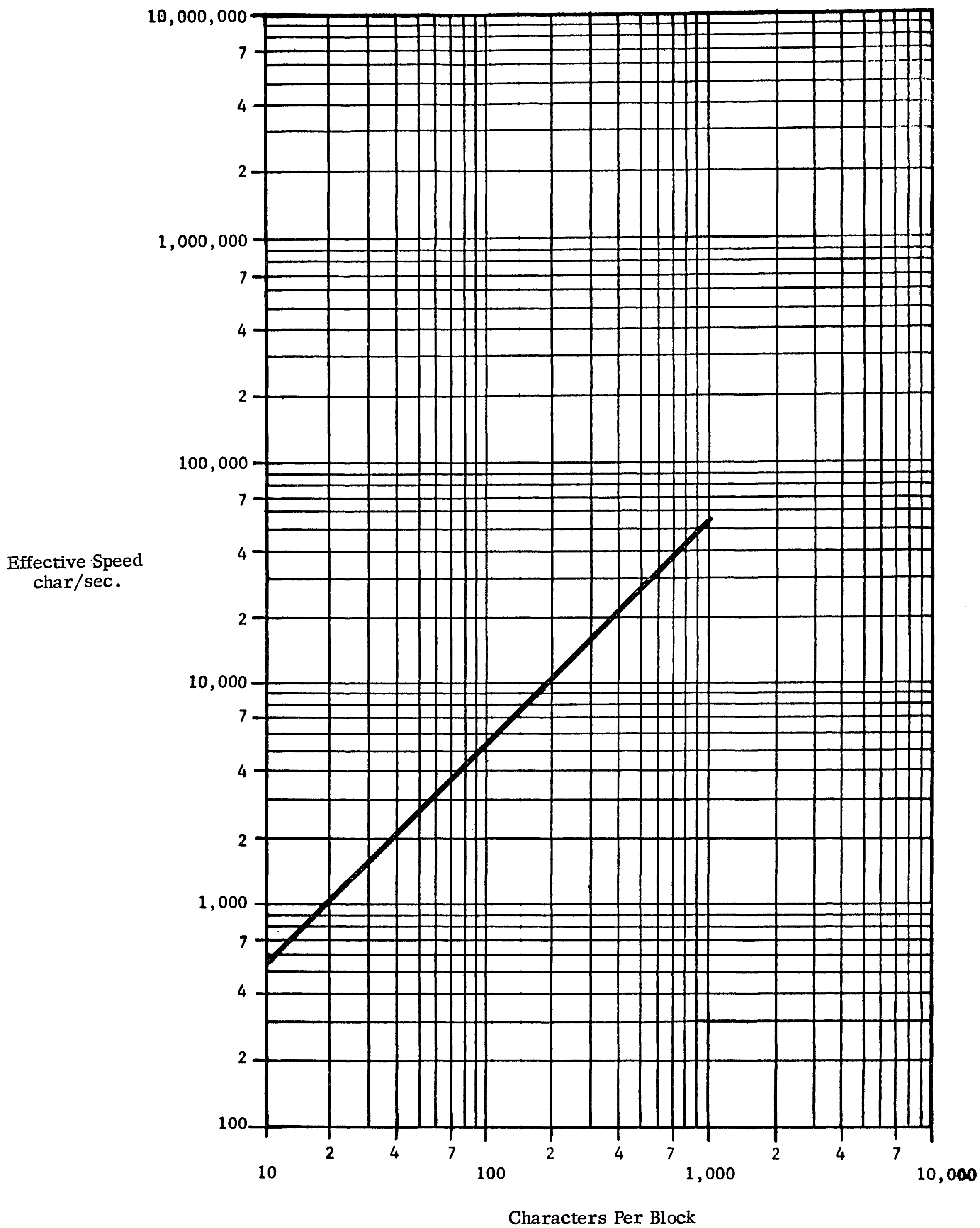
.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	character and longitudinal parity	automatic error correction. ‡
Reading:	character and longitudinal parity	automatic error correction. ‡
Input area overflow:	not possible	
Output block size:	not possible.	
Invalid code:	not possible.	
Exhausted medium:	mechanical	turns on indicator, terminates transmission, and inhibits further I/O processing for that channel. Operator or program intervention necessary for restart.
Imperfect medium:	check	‡‡
Timing conflicts:	check	automatic error correction. ‡
Unit disabled:	interlock	operator intervention.
Record enable:	check	set indicator.
Unit busy:	check	set indicator.
Unit rewinding:	check	set indicator.

‡Parity and timing errors during recording or reading cause initiation of an automatic error cycle, the particular sequence depending upon the mode specified for this cycle by the programmer. Imperfect areas on tape are erased (block marks removed) during recording if a re-recording is unsuccessful so that they are bypassed in subsequent tape operations. Re-reading is attempted in an error cycle occurring in a read operation. If successful, a fault indicator is set and is detectable, or the I/O operation continues; the I/O order given specifying which mode error cycle to carry out.

‡‡If detected as parity or timing error, tape undergoes automatic correction cycle; if detected as missing block mark, an indicator is set for program detection.

§ 091.



10,000,000
7
4
2
1,000,000
7
4
2
100,000
7
4
2
10,000
7
4
2
1,000
7
4
2
100
Effective Speed char/sec.
10
2
4
7
100
2
4
7
1,000
2
4
7
10,000
Characters Per Block

INPUT-OUTPUT: INPUT-OUTPUT PROCESSOR

§ 101.

.1 GENERAL

.11 Identity: . . . . . . Input-Output Processor,
Model 235 (16x1)
Model 236 (16x2)
Model 237 (16x3)
Model 238 (16x4)
IOP.

‡ The first number in parentheses indicates the number of channels and the second number specifies the maximum number of data assemblers for that processor.

.12 Description

One Input-Output Processor (IOP) is contained in each configuration.

An IOP can have a total of 16 devices attached to it. The devices may be any mixture of Model 234 Magnetic Tape Units or on/off-line Universal Buffer Controllers (UBC). There is a limit of four UBC's, (see diagram in Section 651:102.9).

An IOP may contain from 1 to 4 assemblers. Each assembler can independently control a data transfer. Thus from 1 to 4 data transfers can be multiplexed into core storage at a time.

There is no restriction on the freedom of any assembler to control any device. An automatic assignment of one of the idle assemblers is made for each data transfer. This feature does make efficient use of simultaneous operations much easier, often requiring no thought.

Each assembler operates at about 90,000 characters per second, or 11,000 words per second, whether from tape or a UBC.

The demands made on core storage depend upon the model of store used in the system. For each type of store, four demands are quoted in percentages for the four combinations of two pairs of alternatives. The first alternative is one or four assemblers running at a time. The second alternative is either peak demand over a period of less than a block time, or effective demand over several consecutive blocks allowing for inter-block gaps.

Types of store
I: . . . . 10.0 μ sec on 210 or 211.
II: . . . . 10.0 μ sec partioned on 211.
III:. . . . . 1.5 μ sec on 211.
IV:. . . . . 1.0 μ sec on 212.

	I	II	III	IV
One assembler				
Peak	11	8(**)	1.7	1.1.
Effective	7	5(**)	1.0	0.7.
Four assemblers				
Peak	45	34(**)	6.7	4.5
Effective	28	21(**)	4.1	2.8

Counter and fault registers in each data assembler allow program interrogation of the status of an I/O instruction. Data validity is checked during IOP transmission with parity errors being detected and automatic error correction attempted (see 651:091.12). I/O unit and assembler status registers in the IOP give the programmer flexible checking facilities.

(**) Estimate based on nearly complete data and probably reliable.

.13 Availability: . . . . 12 months.

.14 First Delivery: . . . December, 1959.

.4 CONTROLLER: . . . discussed in Section 651:091.4.

.5 PROGRAM FACILITIES: discussed in Section 651:091.4.

.6 PERFORMANCE:. . . discussed in Section 651:091.4.

.7 EXTERNAL FACILITIES: . . . . discussed in Section 651:061.

.8 ERRORS, CHECKS AND ACTION: . . . . discussed in Section 651:091.8.

INPUT–OUTPUT: UNIVERSAL BUFFER CONTROLLER

§ 102.

.1 GENERAL

.11 Identity: . . . . Universal Buffer Controller.
Model 252.
Model 280.
UBC.

.12 Description

The Universal Buffer Controller (UBC) provides the Philco 2000 system with an on-line or off-line data transcription capability using I/O devices of different operating speeds. It serves as a buffer device for one block of data at a time which it transmits either to another I/O device or to the Input-Output Processor (IOP). Up to seven devices, exclusive of the IOP when on-line, can be connected to the controller, (see figure 651:091.12). Suppose the device connecting positions are numbered 1 through 7. A printer or punched card, paper tape or similar unit can be attached to any position, usually positions 1 through 5. Position 6 can be used for off-line transcription with any other position and usually has a magnetic tape unit attached. A magnetic tape unit in this position can only be used off-line. Position 7 can be switched, in either direction, to connect directly to the IOP and release the UBC from the IOP. When a magnetic tape unit is attached, it can be switched to the IOP or to off-line transcription with any device attached to the UBC. In particular tape-to-tape transcription can be performed between positions 6 and 7.

In most installations, UBC's are used only as off-line controllers. While two devices may be operative at one time in an off-line data transcription, only one may be doing an on-line transfer.

A useful feature of the UBC is its ability to separate and further transmit blocks containing a control character which equals any one of 16 possible data select codes.* A switch can be set so that all blocks in an off-line transcription are examined for the value of their one-character data select code. Only those equal to the selected value, out of 16 possible values, are transcribed. The others are discarded.

This feature allows for printing of up to 16 different reports from a reel of magnetic tape produced by one or more computer runs, and contributes to economy of magnetic tape operation.

The Model 280 differs from the Model 252 UBC in that it provides switching for two tape units to make either of them on-line to the Input-Output Processor. In all other respects the two models are identical. The operating speed of the UBC is restricted to the speed of the slowest I/O device concerned in operation during any one data transcription. The one block buffer core storage is capable of transferring data at the magnetic tape peak speed of 90,000 characters per second. The buffer has a capacity of 128 words.

When the UBC is used on-line, there is a program selection of the particular unit to be controlled. This selection means that only as many UBC's as are required for simultaneous operations need be installed, not one for each unit to be used.

Because it is only a buffering device, off-line data editing and formatting is not available. All such tasks must be performed by the central processor. Future replacement of the UBC system by the Philco 1000 System will provide greater off-line conversion power.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . December, 1959.

.4 CONTROLLER

.42 Connection to System

.421 On-line: . . . . 4, restricted by number of assemblers in Input-Output Processor.

.422 Off-line

Use	Associated equipment
Magnetic tape to magnetic tape transcription: . . .	Model 234 Magnetic Tape Unit.
Card to magnetic tape transcription and magnetic tape to card:	Model 234 Magnetic Tape Unit, Model 258 Card Reader, Model 259 Punch Card Controller, and Model 265 Card Punch.
Magnetic tape to printer:	Model 234 Magnetic Tape Unit, and Model 256 Printer System.

.43 Connection to Device

.431 Devices per controller: 7.
.432 Restrictions: . . . . . . only 2 may be tape units. Tape unit needs special switch to be used on-line.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 block.
.442 Input-output areas: . . core storage.

§ 102.

.443 Input-output area access: . . . . 1 word.
.444 Input-output area lockout: . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1, 024 characters.

.52 Input-Output Operations

.521 Input: . . . . 1 block.
.522 Output: . . . . 1 block to magnetic tape unit, Punch Card Controller or Printer Controller. Record designators interpreted by these units.
.523 Stepping: . . . . 1 block, forward or reverse.
.524 Skipping: . . . . space over 1 block at a time under manual control; transmit or bypass a block under data select feature.
.525 Marking: . . . . second character of first word of block is a data select and/or stop code.
.526 Searching: . . . . data select code equal to number of data select button depressed on UBC operating panel; predetermined stop-code values.

.53 Code Translation: . . . none, provided by Punch Card Controller or program.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . yes.
Unload: . . . . yes, transmit core storage buffer to receiving device.

.56 Testable Conditions (On-line)

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Output lock: . . . . . . yes.
Busy controller: . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . none.

.62 Speeds

.621 Nominal or peak speed: 90, 000 char/sec.

.624 Effective speeds: . . . speed of peripheral device during on-line operation; speed of slowest peripheral device during off-line operation.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.72 Other Controls

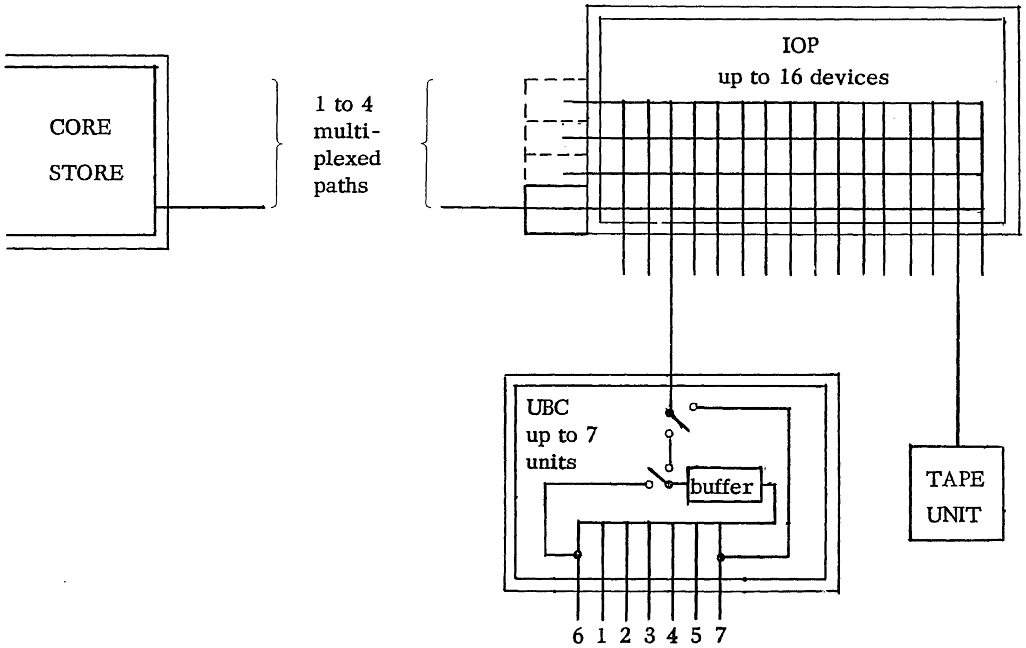
Name	Form	Function
On-line control	button	places UBC into on-line status.
Off-line control	button	places UBC into off-line status.
Magnetic tape controls	buttons	places either switchable on-line magnetic tapes on Model 280 UBC into on-line status.
Ready control	button	places UBC in ready mode.
Load cycle control	button	starts buffer load cycle.
Unload cycle control	button	starts unload cycle, resets indicators.
From device control	dial	assigns input device.
To device	dial	assigns output device.
Data select code controls	15 buttons	places UBC in data select mode and indicates data select code number to search for in each block.
Magnetic tape erase control	button	erases one block of magnetic tape in a reverse direction.
Execute control	button	performs operations set on control panel.
Continuous cycle control	button	provides continuous operation.
Tape rewind control	button	rewinds magnetic tape without lockout.
Conditional stop control	button	stops UBC when conditional stop character found.
Stop override control	button	prevents stop character from halting UBC during continuous mode operation.
Parity override control	button	prevents UBC stopping on parity error.
Write all control	button	permits all characters to be reproduced by designated I/O device.
Space forward control	button	fills buffer with one block from magnetic tape, but does not transmit the block.
Space reverse control	button	transmits a block to the UBC while magnetic tape is moving in the reverse direction.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording (parity):	check	1 automatic retry with magnetic tape, halt with other I/O devices.
Reading (parity):	check	same as for recording.
Invalid code:	check	alarm, stop.

§ 102.

.9 FIGURE


CORE
STORE
1 to 4
multi-
plexed
paths
IOP
up to 16 devices
UBC
up to 7
units
buffer
TAPE
UNIT
6 1 2 3 4 5 7

INPUT-OUTPUT: CONSOLE TYPEWRITER BUFFER

§ 103.

.1 GENERAL

.11 Identity: . . . . . . Console Typewriter Buffer. Model 209.

.12 Description

The Console Typewriter Buffer is an optional unit that is used to prevent the central processor from being delayed while the typewriter is in a type-out cycle. It consists of a 16-character buffer inserted between the central processor and the typewriter. Characters are shifted sequentially through the 16 positions as the preceding characters are transferred to the typewriter. The central processor is released immediately upon transfer of a character to the buffer. If the buffer is filled, transfer to the buffer does not occur until a character is transferred from the buffer to the typewriter.

.14 First Delivery: . . . March, 1962.

INPUT-OUTPUT: DIGITAL INCREMENTAL RECORDER

§ 104.

.1 GENERAL

.11 Identity: . . . . Digital Incremental Recorder.
Model 2281.
Model 2282.
Model 2283.
Model 2284.

.12 Description

The Digital Incremental Recorder is an X-Y plotter, supplied by Calcomp -- usually Model 565, capable of recording discrete points or continuous lines. There is a common interface for all Calcomp plotters, and others can be connected. The plotter system consists of from one to four recorders and a coupler which connects to any channel of a Universal Buffer Controller (UBS), allowing on-line recording or off-line transfer from any UBC connectable input device, to a recorder. The Model 2281 consists of a coupler and one recorder; the Model 2282, a coupler and two recorders; the Model 2283, a coupler and three recorders; and the Model 2284, a coupler and four recorders.

.12 Description (Contd.)

A continuous line can be plotted in both the X-axis and Y-axis directions. Recording of X-coordinates is done by horizontal pen movements relative to the paper surface; Y-coordinates are plotted by rotating a drum in either direction, across which sprocketed, continuous feed paper is moved. Discrete points can be plotted, and diagonal lines recorded by combinations of pen and drum movements.

Plotting speeds are 300 steps per second (3 inches per second) for continuous curves and 10 per second for discrete points. Pen movement can be in any direction. Data for several recorders can be intermingled in one block of 128 words. Each character transmitted to the coupler contains the designation of the recorder to be used as well as the movement to be made.

A plotting area of 11 inch width and up to 120 feet in length can be used. Interchangeable plotting pens for different colors are available.

INPUT-OUTPUT: ACCOUNTING CLOCK

§ 105.

.1 GENERAL

.11 Identity: . . . . Accounting Clock System. Model 293.

.12 Description

The Accounting Clock System provides a time reference available to the program via the Paper Tape Channel. This clock transmits in one word the month, day, hour, minute and tenth of minute. It automatically corrects the date for the length of month and has a switch to correct for the odd day during a leap year.

.12 Description (Contd.)

The Accounting Clock is controlled by the Paper Tape Controller. One bit in the I/O instruction designates whether the Paper Tape System or Clock is being referenced. Transmission of the time word cannot occur if the Paper Tape System is busy. The transmission register of the Paper Tape System is used to determine whether or not the transfer of the clock word is completed.

The clock word occupies the least significant 36 bits of the 48-bit word. All quantities are 4-bit binary coded decimal characters.

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS: . . . none.

.12 Description

The amount of simultaneous operations in a configuration can be high, due to the flexible I/O arrangements. Each configuration must be considered separately. The number of simultaneously operating units is then limited by the following criteria:

- A drum data transfer inhibits all other-unit-data transfers.
- The central processor is limited by the sum of the demands on the store by other units, see Sections 651: 071 to 651: 104.
- There may be one unit other than magnetic tape operating for each Universal Buffer Controller (UBC). There is a limit of four UBC's.
- There may be one magnetic tape unit operating for each assembler in an Input-Output Processor (IOP). There is a limit of four assemblers.
- A separate paper tape system, in addition to those operating off the UBC's, can be operating one input or output unit.
- A typewriter output either occupies the central processor full time or operates independently if a typewriter buffer is used.
- Magnetic tape rewind operations are independent of the IOP. Although it is possible for up to four tape units to be operating through the IOP and up to four UBC's to be controlling other units, some time must be given up by the IOP to providing, via assemblers, data transfers that empty or fill the UBC buffers. Nevertheless, in the most extreme case (i.e., four high speed card readers) the effective throughput of the IOP can be equivalent to 4 card readers and 3.75 tape units. Therefore, this penalty can usually be ignored.

The IOP makes automatic allocation of an idle assembler to each new input-output request. Assemblers become idle immediately after completing a UBC or magnetic tape transfer. This system frees the programmer from the need to plan assembler assignments in magnetic tape or other operations.

.2 CONFIGURATION CONDITIONS

.21 Conditions

U: . . . . number of UBC's.
P: . . . . number of assemblers in the IOP.
N: . . . . number of magnetic tape units.

.3 CLASSES OF OPERATIONS

Class	Member
A :	transmit to or from magnetic drum.
B :	compute.
C:	any input-output function on an on-line Universal Buffer Controller (i.e., read cards, punch cards, print).
D :	read or write on magnetic tape.
E :	read or punch paper tape.
F :	input or output on console typewriter.
G:	rewind magnetic tape.

.4 RULES

a (b + c + d + e + f + g): . . . . =0.
b: . . . . =at most 1.
c: . . . . =at most U.
d: . . . . =at most P.
e: . . . . =at most 1.
f: . . . . =at most 1.
g: . . . . =at most N.

.5 TABLE OF POSSIBLE SETS OF SIMULTANEOUS OPERATIONS

Class	Possible Modes of Simultaneous Operation				
A	1				
B		1	1	1	1
C		U	U	U	U
D		P	P	P	P
E		1	1	1	1
F		1	1	1	1
G		N-d	N-d	N-d	N-d

INSTRUCTION LIST

§ 121.

INSTRUCTION					
F	OP CODE			ADDRESS	OPERATION
					<u>ARITHMETIC</u>
					<u>Add-Subtract</u>
F					Indicates floating point operations; blank for fixed point.
	μ	π	Ω	M	These are a string of characters that specify an op-code by compounding each part. See below:
	A	π	Ω	M	Add (π) to (A).
	CA	π	Ω	M	Place (π) in A.
	S	π	Ω	M	Subtract (π) from (A).
	CS	π	Ω	M	Place — (π) in A.
	μ	Q	Ω		(π) is contents of Q.
	μ	M	Ω	M	(π) is contents of M.
	μ	D	Ω		(π) is contents of D (Note: + cannot be CA, CS, FCA or FCS when "π" is "D").
	μ	π		M	No options.
	μ	π	A	M	Take absolute value of (π).
	μ	π	S	M	Copy result in A to M.
	μ	π	AS	M	Take absolute value of (π) and copy result in A to M (Note: A and S options cannot be used when "π" is "D").
					Examples (out of the 68 possible):
F	AD				floating (A) + (D) $\longrightarrow$ A.
	SMAS			M	fixed (A) - $\lvert M \rvert \longrightarrow$ A, M.
					Note: Any inter-register or store transfer operation affects the contents of the D register.
					<u>Multiply</u>
F					Indicates floating point operations; blank for fixed point.
	μ	π	Ω	M	These are a string of characters that specify an op-code by compounding each part. See below.
	M	π	Ω		Multiply (Q) by (π), product in A and Q.
	μ	A	Ω		(π) is contents of A.
		M	Ω	M	(π) is contents of M.
	μ	π		M	No options.
	μ	π	A	M	Take absolute value of (π).
	μ	π	R	M	Round result in A and Q to result in A.
	μ	π	S	M	Copy partial result or rounded result in A to M.
	μ	π	AR	M	Take absolute value of (π) and round result to A.
	μ	π	AS	M	Take absolute value of (π) and copy partial result to M.
	μ	π	RS	M	Round result in A and Q to A and copy A to M.
	μ	π	ARS	M	Take absolute value of (π), round result and copy to M.

INSTRUCTION LIST—Contd.

§ 121.

INSTRUCTION				
F	OP CODE		ADDRESS	OPERATION
				Examples (out of the 16 possible):
F	MMRS		M	floating (Q) * (M) $\rightarrow A_R \rightarrow$ M.
	MAR			fixed (Q) * (A) $\rightarrow A_R$, (Q) restored to Q.
				Note: Any inter-register or store transfer affects the contents of the D register.
				Special Multiply Instructions
F				Indicates floating point operations; blank for fixed point.
	M π			Multiply (Q).
	μ AD		M	Multiply (Q) by (M) and add to (A); result appears in A.
	μ SU		M	Multiply (Q) by (M) and subtract (A); final result appears in A.
				Divide
F				Indicates floating point operations; blank for fixed point.
	D π	Ω	M	Divide (π) by (M); quotient in Q, remainder in A.
	μ AQ	Ω	M	Divide (A and Q) by (M); quotient in Q, remainder in A.
	μ A	Ω	M	Divide (A) by (M); quotient in Q, remainder in A.
	μ π	S	M	Divide (π) by (M) and copy quotient from A to M.
				Examples (out of the 8 possible):
F	D A	S	M	floating (A) / (M), quotient in Q $\rightarrow$ M.
	D A	Q		fixed (A, Q) / (M), quotient in Q.
				LOGIC
	μ π	Ω	M	These are a string of characters that specify an op-code by compounding each part. See below.
				Logical AND
	E π	Ω	M	Extract from (M) according to a mask in Q.
	μ T	Ω	M	Extract from (M) according to a mask in Q and transfer extracted bits to Ω. Other bits in A are zero.
	μ π	A	M	Ω is A register (D contains same extracted fields).
	μ π	D	M	Ω is D register.
	μ A		M	Extract from (M) according to a mask in Q and add extracted bits to corresponding bit positions in A.
	μ S		M	Extract from (M) according to a mask in Q and subtract extracted bits from corresponding bit positions in A.
	π I		M	Extract from (M) according to a mask in Q and replace corresponding bits in A by extracted bits; other bits in A remain unaffected.
	μ I	S	M	Copy (A) to M after insertion of extracted bits into A. Note: Ω = S may only be used with insert.
				Example (out of the 6 possible):
	E T	A	M	Extract from A according to mask in Q, transfer to A, remainder of A being zeros.
				Exclusive OR
	A W C S		M	(A) + (M), result in D, (D) copied to M; addition occurs without carries; (A) not affected.
				Inclusive OR
	D O R M S		M	A one bit in corresponding positions of either D or M or both results in a one bit in the corresponding position in M.

INSTRUCTION LIST—Contd.

§ 121.

	INSTRUCTION					OPERATION
	OP CODE				ADDRESS	
						Jumps
	J	π	Ω		M	Conditional or unconditional transfer of program control to instruction in M.
	μ	MP	Ω		M	Unconditional transfer of control to instruction in M.
						Jump to M if condition below is met; if not, proceed sequentially:
	μ	AEQ	Ω		M	(A) equal (Q).
	μ	AED	Ω		M	(A) equal (D).
	μ	AGQ	Ω		M	(A) greater than or equal (Q).
	μ	AGQF	Ω		M	(A) greater than or equal (Q), floating point comparison.
	μ	AGD	Ω		M	(A) greater than or equal (D).
	μ	AN	Ω		M	(A) are negative (less than zero).
	μ	AP	Ω		M	(A) are positive (includes zero).
	μ	AZ	Ω		M	(A) are zero.
	μ	QN	Ω		M	(Q) are less than zero, automatic left circular shift of (Q).
	μ	QP	Ω		M	(Q) are positive (includes zero), automatic left circular shift of (Q).
	μ	QE	Ω		M	(Q) are even, automatic right circular shift of (Q).
	μ	QO	Ω		M	(Q) are odd, automatic right circular shift of (Q).
	μ	DP	Ω		M	(D) are positive (includes zero).
	μ	O			M	overflow indicator is set to 1.
	μ	NO			M	overflow indicator is not set to 1.
	μ	BT			M	console breakpoint switch is set to JUMP; if set to HALT, halts and jumps when console ADVANCE is depressed; if switch set to IGNORE, proceeds sequentially.
	μ	π	L		M	Jump to left instruction in M.
	μ	π	R		M	Jump to right instruction in M.
						Examples (out of the 34 possible):
	JMPL				M	Jump unconditionally to the left instruction in M.
	JAGQL				M	Jump to left instruction in M if (A) greater than or equal (Q); if neither, proceed to next sequential instruction.
						INDEX REGISTER CONTROL
	μ	π	Ω	#		These are a string of characters that specify an op-code by compounding each part. See below.
						Set and preserve contents of index registers
	T	π	Ω			Transfer a value into or from an index register:
	μ	IX			N, X	From the reduced address field of the instruction to index register.
	μ	CX	Ω		, X	To counter bit of the index register.
	μ	π	S		, X	1 to index register counter bit.
	μ	π	Z		, X	0 to index register counter bit.
	μ	DX	Ω	#	, X	From a full address field of word in the D register.
	μ	XD	Ω	#	, X	From an index register to a full address field of the D register.
	μ	π	R	#	, X	To or from right half full address field of D register.
	μ	π	Ω	C	, X	F-bit to counter bit or counter bit to F-bit in D register - if not specified, neither bit is affected.
						Modify and Test Index Registers
	A	π	Ω		N, X	Add value to contents of index register.
	S	π	Ω		N, X	Subtract value from contents of index register.

INSTRUCTION LIST—Contd.

§ 121.

INSTRUCTION				OPERATION
OP CODE			ADDRESS	
μ	DX	Ω	N, X	Value to modify index register is in an address field of D.
μ	IXO	Ω	N, X	Value to modify index register is in reduced instruction address field. Overflow indicator is set to 1 when (X) is equal to address in Ω half of D register.
μ	π	L	N, X	Left address in D register word.
μ	π	R	N, X	Right address in D register word.
μ	IXJ		N, X	Value added to or subtracted from index register, if (X) not equal to address field in left half of D, jump to instruction whose address is specified in right half of D register.
				Example (out of 22 possible):
TXDLC			, X	Transfer (X) to left address field of D register, Xc to left F-bit.
				<u>Repeat</u>
μ	π			These are a string of characters specifying repeat mode of one instruction up to 4, 095 times.
RPT	π		N	Repeat the next sequential instruction N times.
μ	N		N	If the next instruction is indexable, perform in normal manner.
T	A		N	If next instruction is indexable, disregard automatic increment, use (X) + v as effective address, place (X) + v into X.
μ	S		N	If next instruction is indexable, disregard automatic increment, use (X) - v as effective address, place (X) - v into X.
RPT	π		N	Repeat the next two sequential instruction N times.
				First character of π refers to first instruction in repeat loop, second character to second instruction;
μ	NN			
μ	NA			
μ	NS			
μ	AN		N	N: no modification to normal indexable instruction operation.
μ	AA			
μ	AS			
μ	SN			A: Effective address = (X) + Iv, place (X) + Iv into X.
μ	SA			
μ	SS			S: Effective address = (X) - Iv, place (X) - Iv into X.
				<u>Shift</u>
μ	π	Ω		String of characters specifying an op-code by compounding. See below.
SR	π	Ω	N	Shift the contents of a register N bit positions to the right.
SL	π	Ω	N	Shift the contents of a register N bit positions to the left.
μ	A	Ω	N	Shift A register.
μ	Q	Ω	N	Shift Q register.
μ	AQ	Ω	N	Shift both A and Q.
μ	D	Ω	N	Shift D register (see note).
μ	π	N	N	When blank - shift as indicated above, includes sign bit; when N - numeric shift, sign bit not disturbed, right shift generates leading bits of same value as sign bit, trailing bits brought in as zeros.
S	CD		N	Circular shift of N bit positions in D register; leading bits brought into trailing bit positions.
				Note: Shifts in D register may only be to the right.

INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION			OPERATION
	OP CODE	ADDRESS	
			<u>Special Logic Instructions</u>
	SWD	M	If (M) is smaller than (A), place (M) into A, address of M into Jump Address register, O into F-bit of register.
	LWD	M	If (M) is greater than (A), place (M) into A, address of M into Jump Address register, O into F-bit of register.
	ICOS		Set inhibition on clearing overflow indicator before arithmetic instruction performance.
	ICOZ		Remove inhibition on clearing overflow indicator.
	INCAL	M	Increase left address field of M by 1.
	INCAR	M	Increase right address field of M by 1.
	NOPL	M	No operation.
	NOPR	M	No operation.
	HLTL	M	Halt.
	HLTR	M	Halt.
			<u>Test Status of I/O System</u>
	μ π		String of characters comprising an I/O status test instruction.
	SK π		Perform status test by comparison of the contents of some register against a predetermined comparison quantity. If condition is met, skips next sequential instruction.
	μ CA	Unit; Comparison quantity	IOP Assembler Counter.
	μ CUA	Unit; Comparison quantity	IOP Unit Availability.
	μ CAA	Unit; Comparison quantity	IOP Assembler Availability.
	μ CPT	Unit; Comparison quantity	Paper Tape Transmission.
	μ CRTI	Unit; Comparison quantity	Real-time input *
	μ CRTO	Unit; Comparison quantity	Real-time output *
	μ FA	Unit; Comparison quantity	IOP Assembler Fault.
	μ FB	Unit; Comparison quantity	Buffer Controller Fault.
	μ FD	Comparison quantity	Magnetic Drum Fault.
	μ FPT	Comparison quantity	Paper Tape Fault.
			Note: The above are macro forms equivalent to machine instructions.
			<u>DATA TRANSFERS</u>
	μ π		String of characters to define a clear operation.
	C π		Place zero in register.
	μ A		A register.
	Q		Q register.
	D		D register.
	M	M	Core storage location.
			* Note: Present, but not used on Model 210 with 10 μsec core storage because of absence of real-time units on this system.

INSTRUCTION LIST–Contd.

§ 121.

	INSTRUCTION OP CODE	ADDRESS	OPERATION
	μ π Ω		String of characters to define transfer operations.
	T π Ω		Copy contents of a register into another register.
	μ M Ω	M	From: core storage.
	A Ω		A register.
	Q Ω		Q register.
	D Ω		D register.
	μ π M	M	To: core storage.
	μ π A		A register.
	μ π Q		Q register.
	μ π D		D register.
			Note: M to M A to A Q to Q D to D are not allowed combinations.
			INPUT-OUTPUT
	TIO	M	Transfer I/O order in D register to I/O register and attempt to initiate the order. M designates core storage start location to or from which data is transferred.
			All Input-Output orders other than TIO occur in a standard format described in Section :051.23. No standard mnemonics exist. The op-code consists of binary patterns for the "From" and "To" device. These are: Core storage 0001 Magnetic tape 1001 - mode 1 Magnetic tape 1010 - mode 2 Magnetic tape 1011 - mode 3 Magnetic tape 1101 - mode 1, reverse Magnetic tape 1110 - mode 2, reverse Magnetic tape 1111 - mode 3, reverse I/O unit (on UBC) 0111 UBC 0011 Paper Tape System 0100 Magnetic drum 0010 Real-Time Scanner 0101 (Present, but not used on Model 210 with 10 μsec core storage).
			Special I/O control orders are used for the following:

Name	Command Configuration	Function
Stop	1111 1000	Releases an assembler in the IOP after any fault.
Resume	1000 1001	Continue order from point at which error occurred.
Rewind	1000 1010	Rewind magnetic tape unit.
Rewind with lockout	1000 1011	Rewind and lock out tape unit.

INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION			OPERATION
	OP CODE	ADDRESS	
			Release 1100 1100 Releases an assembler in the IOP if only parity or sprocket errors occur. -1 Read 1100 1100 Replace word in core storage with -1 whenever parity or sprocket error occurs during read. Erase 1100 1110 Erase one block with its block marks on magnetic tape. Edit 1100 1111 Erase magnetic tape and place new block marks on non-defective portions of tape.
	TCM	M	Transfer one character from console typewriter into six right bit positions of M and D.
	TDC		Transfer left six-bit character to console typewriter.

INSTRUCTION LIST NOMENCLATURE

Symbol	
M	Address of core storage location.
A	Accumulator register.
Q	Quotient register.
D	Data register.
$\mid M \mid$	Absolute value of contents of core storage location.
$\longrightarrow$	Place in.
(X)	Contents of X.
nX	Index register n.
nX_c	Index register n counter bit.
I	Instruction address.
I_v	Instruction address V field (refer to Section 651:051.232).
I_n	Instruction address N field (refer to Section 651:051.232).

CODING SPECIMEN: ALTAC

.1 CODING SPECIMEN

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COMPUTER DIVISION

ALTAC CODING FORM

Page 1 of 1

Program: Programmer: Date:

IDENTITY AND SEQUENCE (1–8)	L (9)	LOCATION (10–16)	ALTAC STATEMENT (17–80)
	I		SAMPLE
	*		AN ALTAC PROGRAM THAT WAS RUN ON THE PHILCO 212 COMPUTER IN ONLY
	*		82 SECONDS
			DIMENSION THETA(1200),THETAP(1200),BEG(1200) $
			PAUSE 11111 $
			DO 11 K=1,1000 $
			B=-1.818;EMD=.223E-4;ALPHA=4.089;EMO=1500.;T1=0.;T2=0.$
			B=B*1.E-7;KMAX=1200;STEP=.5*8.64E4 $
		20	TIMD=0.$
			TIME=0.$
			DO 10 J=1,KMAX $
			TP=TIME-TIMD $
			THETA(J)=ALPHA+B*TIME $
			THETAP(J)=THETA(J) $
			IF(T1-TIME)60,61,61 $
		60	IF(T2-TIME)61,61,63 $
		61	EMDT=EMD*TP $
			BEG(J)=ALPHA/(EMO-EMDT) $
			GO TO 10 $
		63	BEG(J)=0.$
			TIMD=T2-T1 $
		10	TIME=TIME+STEP $
		11	CONTINUE $
			PAUSE 17777 $
			END $

TF-25

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PHILCO CODING FORM

Page 1 of 1

Program: XAEXPQ | Programmer: I. B. GOLDBERG | Date: 12/11/61

IDENTITY AND SEQUENCE (1–8)	L (9)	LOCATION (10–16)	COMMAND (17–24)	ADDRESS AND REMARKS (25–80)
10			NAME	XAEXPQ$
	*	SUBROUT	INE TO C	OMPUTE m RAISED TO THE POWER n WITH m AND n INTEGERS
20	L	ARG1	HLT	$
30			HLT	$
40	L	XAEXPQ	TJM	EXIT$ STORE RETURN ADDRESS TO CALLING PROGRAM
50			SRAN	32$ REDUCE m MODULO 32768
60			TAM	ARG1$
70			TQA	$ TRANSFER n FROM Q TO A REGISTER
80			JAP	AP$
90			CM	ARG1$
100	R	AP	TMQ	4/1;12/0;32/1$
110			EIS	RA$
120			TMQ	D/1$
130	L	RA	RPTN	$
140			MM	ARG1$ RAISE m TO THE POWER n
150			TQA	$
160			SLAN	32$
170		EXIT	JMP	EXIT$
180	*		SYMBOUT	XAEXPQ$
190			ENDSUB	$

TF-25

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PHILCO CODING FORM

Page 1 of 1

Program: XAEXPQ | Programmer: I. B. GOLDBERG | Date: 12/11/61

IDENTITY AND SEQUENCE (1–8)	L (9)	LOCATION (10–16)	COMMAND (17–24)	ADDRESS AND REMARKS (25–80)
10			NAME	XAEXPQ$
	*	SUBROUT	INE TO C	OMPUTE m RAISED TO THE POWER n WITH m AND n INTEGERS
20	L	ARG1	HLT	$
30			HLT	$
40	L	XAEXPQ	TJM	EXIT$ STORE RETURN ADDRESS TO CALLING PROGRAM
50			SRAN	32$ REDUCE m MODULO 32768
60			TAM	ARG1$
70			TQA	$ TRANSFER n FROM Q TO A REGISTER
80			JAP	AP$
90			CM	ARG1$
100	R	AP	TMQ	4/1;12/0;32/1$
110			EIS	RA$
120			TMQ	D/1$
130	L	RA	RPTN	$
140			MM	ARG1$ RAISE m TO THE POWER n
150			TQA	$
160			SLAN	32$
170		EXIT	JMP	EXIT$
180	*		SYMBOUT	XAEXPQ$
190			ENDSUB	$

TF-25

CODING SPECIMEN: TAC

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE . . . . internal alphameric data; control characters for printer and card controller.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits/char.

.22 Character Structure

.221 More significant pattern: . . . . 2 bits; 32, 16.

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

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	+	-	Δ
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	@	n	⏋	[
11	=	.	$	,
12	;	)	*	(
13	≡	%	<	>
14	&	?	#	:
15	'	"	⊔	e

Control Characters

End of line: . . . . e.
End of block: . . . . ⏋
Null character: . . . . . . n.
Stop: . . . . [

DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE . . . . punched cards.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 1 column.

.23 Character Codes

<table>
<tr><th rowspan="2">UNDERPUNCH</th><th colspan="4">OVERPUNCH</th></tr>
<tr><th>None</th><th>12</th><th>11</th><th>0</th></tr>
<tr><td>None</td><td>BLANK OR Δ</td><td>+</td><td>-</td><td></td></tr>
<tr><td>12</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11</td><td></td><td></td><td></td><td></td></tr>
<tr><td>0</td><td>0</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td>1</td><td>A</td><td>J</td><td>/</td></tr>
<tr><td>2</td><td>2</td><td>B</td><td>K</td><td>S</td></tr>
<tr><td>3</td><td>3</td><td>C</td><td>L</td><td>T</td></tr>
<tr><td>4</td><td>4</td><td>D</td><td>M</td><td>U</td></tr>
<tr><td>5</td><td>5</td><td>E</td><td>N</td><td>V</td></tr>
<tr><td>6</td><td>6</td><td>F</td><td>O</td><td>W</td></tr>
<tr><td>7</td><td>7</td><td>G</td><td>P</td><td>X</td></tr>
<tr><td>8</td><td>8</td><td>H</td><td>Q</td><td>Y</td></tr>
<tr><td>9</td><td>9</td><td>Ị</td><td>R</td><td>Z</td></tr>
<tr><td>8-2</td><td>@</td><td>n</td><td>⌉</td><td>|</td></tr>
<tr><td>8-3</td><td>=</td><td>.</td><td>$</td><td>,</td></tr>
<tr><td>8-4</td><td>;</td><td>)</td><td>*</td><td>(</td></tr>
<tr><td>8-5</td><td>≡</td><td>%</td><td><</td><td>></td></tr>
<tr><td>8-6</td><td>&</td><td>?</td><td>#</td><td>:</td></tr>
<tr><td>8-7</td><td>'</td><td>"</td><td>⊔</td><td>e</td></tr>
</table>

PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers: . . . . . . none.

.12 Simulation by Other Computers: . . . . . none.

.13 Data Sorting and Merging

Sort Generator

Reference: . . . . . TM-17, Philco 2000 Sort Generator.
Record size: . . . . 1 to 192 words.
I/O load size: . . . . 2, 3, or 5 blocks of 128 words each.
Key size: . . . . . . 1 to N keys, each up to one full word (48 bits).
File size: 1 reel; multiple reels if own coding used.
Number of tapes: . . 2-way sort requires 5 tapes, 3-way sort requires 7 tapes; more tapes may be used if own coding is included.
Data available: . . . 1961.

Description

This routine generates 2- or 3-way sorts from a SORT statement in which 10 required and 3 optional parameters are specified. The statement may be written in long form using English words, or in an abbreviated "short" form. The programmer can include TAC coding for pre-sort and post-sort record manipulation, checking input labels and writing output labels, and to handle multiple reel input and output. These facilities are provided by the optional parameters in the SORT statement creating linkages to the TAC coding. The generator is included in TAC.

.15 Data Transcription: . . none.

.16 File Maintenance: . . none; refer to Process Oriented Language, TOPS II, Section 651:162.100.

.17 Other

PERT
Reference: . . . . . TM-19, Philco 2000 PERT System.
Date available: . . . 1962.

Description

This is a full PERT system which is capable of handling projects consisting of up to 7,000 activities and 3,500 events. It allows activities to be submitted in random order. It re-sequences them and creates the project network. Event names may be symbolic. One, two, or three time estimates for each event are optional.

The system provides a complete set of diagnostic and service routines. It checks each activity for a predecessor and successor and detects open-end events. A history tape is maintained, permitting modification and updating on subsequent runs. The input for subsequent runs may be obtained from this history tape or from punched cards. Changes to the initial data can be made by the use of a new ID card without destroying the original data.

The output includes, for each activity, the expected date, latest date, slack, scheduled date, actual completion date, and duration of an activity and its variance.

The maximum size of a project is a function of the size of core storage available on the particular Philco 2000 system running the PERT analysis. These are:

Store Size (Words)	Max. Number of Activities	Max. Number of Events
8,192	1,000	500
16,384	3,000	1,500
32,768	7,000	3,500

Linear Programming System (LP-2000)
Reference: . . . . . TM-7, Philco 2000 Linear Programming System.
Date available: . . . March, 1961.

Description:

This system provides for the solution of a linear programming problem. It accepts input data in the standard SHARE format with, at most, four cards added to the standard SHARE deck. Separate versions exist for Philco 2000 systems with 8,192, 16,384, and 32,768 words of core storage. They may be incorporated into any operating system or monitor. Internal storage is used rather than tape storage. This allows problems with up to 200 restraints to be solved on a 32,768-word system.

Single precision floating point arithmetic is used. Automatic switching to double precision occurs if numerical accuracy degenerates. The change in mode can also be made by use of control cards.

Parametric programming, multiple objective functions and requirement vectors, alteration of restraint equations or cost functions, and the resump-

§ 151.

.17 Other (Contd.)

PERT (Contd.)

tion of a problem from a history tape or binary deck are permitted.

Statistical System (STAT)
Reference: . . . . . TM-20, Philco 2000 Statistical System-STAT.
Date available: . . . July, 1962.

Description

This system computes standard statistical values. Simple regression computations provide correlation coefficients and standard error of estimates. Multiple regression obtains regression coefficients and standard F-test values. Polynomial and exponential approximations are also provided.

.17 Other (Contd.)

PERT (Contd.)

Input-Output Programming System (IOPS)
Reference: . . . . . TM-18, Philco 2000 Input-Output Programming System (IOPS).
Date available: . . . September, 1961.

Description

This system allows the programmer to incorporate input-output statements within TAC coding and have the necessary instructions generated during a TAC assembly. Input and output formats are described by format type statements similar to those in ALTAC. A full array of data conversion and editing is provided by descriptors and modifiers. Input and output is automatically buffered.

PROCESS ORIENTED LANGUAGE: ALTAC 3

§ 161.

.1 GENERAL

.11 Identity: . . . . Algebraic Translator to TAC.
ALTAC 3.

.12 Origin: . . . . Philco Computer Division, Programming R & D.

.13 Reference: . . . . ALTAC Manual.

.14 Description

Although similar to FORTRAN II in many respects, with minor modifications needed to make FORTRAN programs acceptable, ALTAC 3 is a more powerful system. ALTAC 3 contains several additional features not found in FORTRAN:

- Four dimension arrays are permitted.
- Subscripts may be any (not necessarily linear) fixed point expressions.
- Subscripts may themselves be subscripted.
- Compound statements, including a fairly general class of conditional statements, are permitted.
- Statement labels may be numeric or symbolic.
- A TABLEDEF statement allows array definition by means of TAC statements.

ALTAC 3 does not permit the Boolean operations that are part of FORTRAN II on the 7090, nor does it contain the CHAIN feature.

Additional features are a more general IF statement, and more SENSE statements. The methods of indicating comment cards is different from that of FORTRAN.

ALTAC statements may be of unlimited length, being terminated by a dollar sign. Statement numbers may be numeric or symbolic. Compound statements are permitted, several statements separated by semicolons appearing on one line. Both fixed and floating point variables can be used in a single expression. The range of floating point variables is substantially greater, varying from 10^{-600} to 10^{+600}.

Despite a difference in coding format between ALTAC and FORTRAN, FORTRAN II programs can be translated by ALTAC without a change in format by the use of an IDENTIFY statement.

In most cases the changes that must be made in FORTRAN II programs to permit them to be compiled by ALTAC 3 are the obvious ones that reflect machine differences. There is no minus zero in the Philco 2000, and programs which use tests on minus zero must be altered. Some other changes must be made in input-output statements because of the 48-bit word length as compared to the 36-bit word on the IBM 704/9/90 series.

.14 Description (Contd.)

ALTAC 3 requires that all EQUIVALENCE, COMMON and DIMENSION statements appear at the beginning of the source deck, in that sequence.

ALTAC 3 permits the very easy incorporation of TAC language inserts. Of course it cannot accept any programs containing SAP, FAP, or other machine language coding for another machine.

The translating and target computer configurations may be specified by an IDENTIFY statement.

.15 Publication Date: . . . . June, 1962.

.2 PROGRAM STRUCTURE

.21 Divisions

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 the same 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: lists the dimensions of one or more arrays. TABLEDEF: permits definition of an array in intermediate TAC language coding (same format as DIMENSION).

.22 Procedure Entities

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

.23 Data Entities

Arrays:	all variables.
Items:	floating point variables or constants. fixed point integer variables or constants. Hollerith item. alphameric item.

.23 Data Entities (Contd.)

Hollerith item: . . . . . alphameric item that can only be used for input-output or as an argument of a subroutine.
Alphameric: . . . . . alphameric item that can only be input during a run; it can be used for output, or as a format statement.

.24 Names

.241 Simple name formation
Alphabet: . . . . A to Z, 0 to 9.
Size: . . . . 1 to 7 char.
Avoid key words: . . . yes.
Formation rule: . . . first char must be letter.
.242 Designators
Procedures
Statement: . . . . . unsigned integer (1 to 5 digits) or alphameric label following TAC label formation rules.
Function: . . . . . . same as variable being defined. ‡

‡ Note: There are 2 cases:
1. Arithmetic function definitions and library functions (includes "built-in" functions - 4 to 7 letters, the last of which must be an F).
2. Function subprograms; 1 to 7 characters (if from 4 to 7 characters, the last must not be an F).

Subroutine: . . . . . none.
Data
Integer variables: . initial I, J, K, L, M, N.
Real variables: . . . any other initial letter.
Equipment
Card: . . . . implied by verbs READ, PUNCH.
Magnetic Tape: . . . use key word TAPE.
Printer: . . . . implied by verb PRINT.
Comments: . . . . . * in col. 9.
Translator control: . key words EQUIVALENCE, COMMON, DIMENSION, TABLEDEF.

.25 Structure of Data Names

.251 Qualified names: . . . none.
.252 Subscripts
Number per item: . . 0 to 4.
Applicable to: . . . . all variables.
Class may be: . . . . any fixed point expression.
.253 Synonyms
Preset: . . . . EQUIVALENCE statement.
Dynamically set: . . none.

.26 Number of Names

.261 All entities: . . . . . depends on size of available core storage.

.27 Region of Meaning of Names: . . . . all names are local to the subroutine or main program in which they are established unless they appear in a COMMON statement.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: . no.
.312 List by kind: . . . . . . no.
.313 Qualify by adjective: . . no.
.314 Qualify by phrase: . . . no.
.315 Qualify by code: . . . . yes, first letter of name.
.316 Hierarchy by list: . . . none.
.317 Level by indenting: . . none.
.318 Level by coding: . . . . none.
.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 +.9999E+99.

.32 Files and Reels: . . . . own coding.

.33 Records and Blocks

.331 Variable record size: . implied.
.332 Variable block size: . . fixed.
.333 Record size range: . . variable.
.334 Block size range: . . . 1 card (80 characters) or 1 printed line (120 characters plus editing characters) or 1 "block" of binary tape (with check sum and sentinel word.)
.335 Choice of record size: . READ, WRITE statement.
.336 Choice of block size: . fixed.
.337 Sequence control: . . . own coding.
.338 In-out error control: . automatic.
.339 Blocking control: . . . . FORMAT statement.

.34 Data Items

.341 Designation of class: . by name.
.342 Possible classes
Integer: . . . . yes.
Fixed point: . . . . . no.
Floating point: . . . . yes.
Alphabetic: . . . . . . yes.
Alphameric: . . . . . yes.
.343 Choice of external radix: . . . . FORMAT statement.
.344 Possible external radices
Decimal: . . . . yes.
Octal: . . . . yes.
.345 Justification: . . . . . . alpha automatic left justified.
.346 Choice of external code: FORMAT statement and READ, WRITE statements.
.347 Possible external codes
Decimal: . . . . yes.
Octal: . . . . yes.
Hollerith: . . . . yes.
Alphameric: . . . . . yes.

§ 161.

.348 Item size
Variable size: . . . . fixed.
Designation: . . . . . none.
Range
Fixed point numeric: fixed, 1 word.
Floating point numeric: . . . . . fixed, 1 word.
Alphameric: . . . . fixed, 1 word.
.349 Sign provision: . . . . . optional.

.35 Data Values:

.351 Constants
Possible sizes
Integer: . . . . yes, -32,767 to +32,767.
Fixed point: . . . . . no.
Floating point: . . . yes, $\pm 10^{-600}$ to $\pm 10^{+600}$ (approx.)
Alphabetic: . . . . . no.
Alphameric: . . . . no.
Subscriptable: . . . . no.
Sign provision: . . . . optional.
.352 Literals: . . . . only Hollerith fields in a FORMAT statement, or an alphameric argument.
Alphabetic: . . . . . . as in paragraph .351.
Alphameric: . . . . . as in paragraph .351.
Designation: . . . . . implied for numerics.
Sign provision: . . . . optional.
.353 Figuratives: . . . . . . none.
.354 Conditional variables: . computed GO TO.

.36 Special Description Facilities

.361 Duplicate format: . . . none.
.362 Re-definition: . . . . . COMMON statement. EQUIVALENCE statement.
.363 Table description
Subscription: . . . . . yes.
Multi-subscripts: . . separated by commas; each subscript can be a fixed point expression, including subscripted subscripts.
Level of item: . . . . variables.
Implied subscript at lower level: . . . . . no.
.364 Other subscriptible entities: . . . . tape units.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator List
+ : . . . . addition, also unary.
- : . . . . subtraction, also unary.
* : . . . . multiplication.
/ : . . . . division.
** : . . . . exponentiation.
= : . . . . replacement.
ABSF ( ) : . . . . . . absolute value.
INTF ( ) : . . . . . . integral part of.
MODF (A, B) : . . . . remainder A ÷ B.
MAXF (A, . . .) : . . . maximum value.
MINF (A, . . .) : . . . . minimum value.
DIMF (A, B) : . . . . . A - MINF (A, B. . . .).
LOGF ( ) : . . . . . natural log.

.41 Operator List (Contd.)

SINF ( ) : . . . . . . sine.
COSF ( ) : . . . . . . cosine.
EXPF ( ) : . . . . . . exponential (e).
SQRTF ( ) : . . . . . square root.
ATANF ( ) : . . . . . arctangent.
TANHF ( ) : . . . . . hyperbolic tangent.
FLOATF ( ) : . . . . float.
XFIXF ( ) : . . . . . fix.
.412 Operands allowed
Classes: . . . . numeric only.
Mixed scaling: . . . . yes.
Mixed classes: . . . . yes.
Mixed radices: . . . . no.
Literals: . . . . yes.
.413 Statement structure
Parentheses
a - b - c means: . . (a-b) - c.
a + b x c means: . . a + (bxc).
a ÷ b ÷ c means: . . (a÷b)÷c.
a^{b^c} means: . . . . . a** b** c is illegal; parentheses must be used.
Size limit: . . . . . . none.
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 = $5x10^7+y^2$: .	too large	X=5.E7+Y**2.
x = y :	K=XABSF(L)	X=ABSF(Y).
x = integral part (3.5):	K=XINTF(L)	X=INTF(Y).

.42 Operations on Arrays

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

.43 Other Computation: . . none.

.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 (integers): right justified in left hand address of word.
Alpha: . . . . left justified.
Filler rule
Numbers: . . . . . . blanks.
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.
Delete editing symbols: . . . . . . automatic.

§ 161.

.446 Editing possible (Contd.)
Insert editing symbols
Actual point: . . . . automatic.
Suppress zeroes: . . automatic.
Insert: . . . . automatic point.
Float: . . . . +, - signs only.
.447 Special moves: . . . . . none.
.448 Code translation: . . . automatic.
.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.
Search on key: . . . . . none.
Rewind: . . . . REWIND.
Unload: . . . . none.

.46 Operating Communication

.461 Log of progress: . . . . error messages on console typewriter and translation listing on off-line printer.
.462 Messages to operator: . console typewriter.
.463 Offer options: . . . . . PAUSE and octal display.
.464 Accept option: . . . . . use SENSE switch.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	IF clause	own coding.
In-out:	I/O package check on tape operation	type message and retry or halt.
Invalid data:	I/O package check.	type message and halt.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . statement.
.512 Unconditional jump: . . GO TO N.
.513 Switch: . . . . GO TO M, (11, 21, 130).
.514 Setting a switch: . . . . ASSIGN 21 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 v Expression: yes.
Expression v Variable: . . yes.
Expression v Literal: . . yes.
Expression v Figurative: always zero.
Expression v Condition: . no.
Variable v Variable: . yes.
Variable v Literal: . . yes.
Variable v Figurative: always zero.
Variable v Condition: . no.
Conditional value: . . . . no.

.523 Conditional relations
Equal: . . . . yes.
Greater than: . . . . . yes.
Less than: . . . . . . yes.
Greater than or equal: yes.
Less than or equal: . yes.
.524 Variable conditions: . . always zero.
.525 Compound conditionals: no.
.528 Typical Examples: . . . IF (X**2.5 - 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.
IF (X** 2.) E (3.), GO TO 37;
IF (X** 2.) GT (3.), GO TO 18; GO TO 29.

.53 Subroutines

.531 Designation
Single statement: . . . same as set.
Set of statements
First: . . . . SUBROUTINE.
Last: . . . . END.

.532 Possible subroutines: . any number of statements.
.533 Use in-line in program: no.
.534 Mechanism
Cue with parameters: CALL XXX (X, Y, Z).
Number of parameters: . . . . depends on source machine size.
Cue without parameter: . . . . . CALL XXX.
Formal return: . . . . RETURN at least once.
Alternative return: . . any number of RETURN statements allowed.
.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: . . . . . no limit on nesting of subroutines or functions.
.537 Automatic recursion allowed: . . . . none.

.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.
.544 Names
Parameter call by value: . . . . none.
Parameter call by name: . . . . yes.
Non-local names: . . use COMMON.
Local names: . . . . . all.
Preserved own variables: . . . . . . all.

§ 161.

.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. 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: . . . . . 63, nests must be arranged physically as well as logically.
.567 Jump out allowed: . . . yes.
.568 Control variable exit status: . . . . yes.

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

.7 LIBRARY FACILITIES

.71 Identity: . . . . TAC library.

.72 Kinds of libraries

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

.73 Storage Form: . . . . . magnetic tape.

.74 Varieties of Contents: . subroutines. functions. macros. generators.

.75 Mechanism

.751 Insertion of new item: . separate run.
.752 Language of new item: . binary relocatable, TAC or ALTAC language.
.753 Method of call: . . . . . named in procedures.

.76 Types of Routine

.761 Open routines exist: . . yes.
.762 Closed routines exist: . yes.
.763 Open-closed is variable: no.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . . yes; TAC.

.82 Optimizing Information Statements

.821 Process usage statement: . . . . . . none.

.822 Data usage statements: COMMON. EQUIVALENCE. TABLEDEF.

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

.84 Target Computer Environment: . . . . . IDENTIFY, or automatic.

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

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: none; DRUM statement not permitted.

.92 Address Allocation: . . . none.

.93 Arrangement of Items in Word in Unpacked Form: . . . . none.

.94 Assignment of Input-Output Devices: . . . yes.

.95 Input-Output Areas: . . automatic

PROCESS ORIENTED LANGUAGE: TOPS

§ 162.

.1 GENERAL

.11 Identity: . . . . TOPS 2.

.12 Origin: . . . . Philco Computer Division.

.13 Reference: . . . . . . TM 12-B.

.14 Description

TOPS is a sophisticated macro language for file maintenance operations, with elementary facilities for computation. It is mainly suitable for sorting, merging, updating files, and preparing tapes for off-line operations as in reports, etc. A TOPS program has two parts: a description of the files, records, sections and fields involved; and a program of macro statements.

TOPS is really an extension to TAC. It is designed to provide additional facilities to TAC and to utilize TAC coding as a part of TOPS programs as extensively as necessary. Therefore, there is little duplication of facilities over the two languages.

The data description, called the Dictionary, can be easily changed by substitution cards. Then the relevant programs must be recompiled but do not need alteration of the macros.

The macro statements are stylistically similar to complex macro codes. The operations provided range from sorts of a complete file to table lookup and decimal shifts. There is no use of subscripts for arrays.

A special LOAD macro can be used to call and enter new programs from the library tape, and is a simple way to implement segmenting.

See also the reports 651:133 (Coding Specimen), 651:182 (Translator), 651:192 (Operating Environment).

The layouts of the labels are compatible with the requirements of SYSD.

.15 Publication Date: . . . . TOPS 1, end 1960.
TOPS 2, November, 1961.

.2 PROGRAM STRUCTURE

.21 Divisions

Dictionary: . . . . a data description of all record layouts, one for each file.

.21 Divisions (Contd.)

Modal Statements: . . . define types of files, input, output, and working areas; control index assignments, buffering, and procedure when files are closed.
control statements to be used by operating system, for normal running or debugging, error exits, and rerun entries.

File Statements: . . . . file, record, section, and field operations and decisions to be executed, including interspersed TAC coding if required.

.22 Procedure Entities

Program: . . . . macro and file statements.
Modal statements: . . . dictionary name and parameters.
File statements: . . . . macro name and parameters.

.23 Data Entities

File: . . . . many records.
Record: . . . . several sections or fields.
Section: . . . . one or more fields, variable length.
Field: . . . . basic item; existence can be conditional on another field.

.24 Names

.241 Simple name formation
Alphabet: . . . . A to Z, 0 to 9.
Size: . . . . 1 to 7 char.
Avoid key words: . . . no.
Formation rule: . . . first char must be a letter.

.242 Designators
Procedures: . . . . . key names.
PROGRAM: . . . . . beginning of Modal statements.
ENDMODE: . . . . . end of Modal statements.
Statement: . . . . . ends with $.
END RUN: . . . . . end of program.
Data: . . . . two names; e.g., FILE FIELD.
INPUT: . . . . input buffer area, not Hollerith.
INPUTH: . . . . . . input buffer area, Hollerith.
INTERNAL: . . . . . working area.
LIST: . . . . totals area.
OUTPUT: . . . . . . output buffer area.
OUTPUTH: . . . . . output buffer area, for files with integral number of records per block.

§ 162.

.242 Designators (Contd.)
Data (Contd.)
OFFLINE: . . . . . output buffer area for off-line results.
UPDATE: . . . . . . input-output joint buffer-area.
Equipment: . . . . . . tape implied by any file modal statement.
Comments: . . . . . . asterisk in column 9.
Translator control: . key words; PROGRAM, TESTRUN, ENDMODE, ENDRUN, DEPART, RETURN.
TESTRUN: . . . . . calls special Monitor.
GPF: . . . . controls insertions deletions to library tape GPF, General Program File.

.25 Structure of Data Names

.251 Qualified names
Example: . . . . FANFIELD.
Multiple qualifiers: . always file name and section or field name.
Complete sequence: . always.
.252 Subscripts: . . . . none, but record index registers can be controlled.
.253 Synonyms: . . . . PRESET ONLY.

.26 Number of Names

Items: . . . . See TAC, Paragraph 651:184.234.
Data: . . . . no practical limit for data names.

.27 Region of Meaning of Names: . . . . universal to all programs using same data dictionary.
local within subprogram for symbolic addresses.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: . no.
.312 List by kind: . . . . . . no.
.313 Qualify by adjective: . . no.
.314 Qualify by phrase: . . . no.
.315 Qualify by code: . . . . yes; e.g., SB, signed binary.
.316 Hierarchy by list: . . . yes, within file.
.317 Level by indenting: . . no.
.318 Level by coding: . . . . yes; e.g., SECTION, with record.

.32 Files and Reels

.321 File labels: . . . . . . automatic, compatible with SYS.
.322 Reel labels: . . . . . . automatic, compatible with SYS.

.33 Records and Blocks

.331 Variable record size: . yes, preset or dynamic using IF statement in description.
.332 Variable block size: . . none.
.333 Record size range: . . variable, 128 words for sort restriction.
.334 Block size range: . . . fixed; 1,024 char.
.335 Choice of record size: . description.
.336 Choice of block size: . fixed.
.337 Sequence control: . . . none.
.338 In-out error control: . automatic.
.339 Blocking control: . . . . automatic.

.34 Data Items

.341 Designation of class: . description.
.342 Possible classes
Integer: . . . . yes.
Fixed point: . . . . . yes.
Floating point: . . . . no.
Alphabetic: . . . . . . no.
Alphameric: . . . . . yes.
.343 Choice of external radix: . . . . description.
.344 Possible radices
Decimal: . . . . optional sign.
Binary: . . . . optional sign.
Octal: . . . . unsigned.
Hexadecimal: . . . . . unsigned.
.345 Justification: . . . . align to right, truncate to left if destination smaller; do not alter excess positions if destination larger than source.
.346 Choice of code: . . . . description.
.347 Possible codes
Hollerith: . . . . see Data Code Table No. 2 (651:152).
BCD: . . . . see Data Code Table No. 1 (651:151).
.348 Item size
Variable size: . . . . preset.
Designation: . . . . . description.
Range
Fixed point numeric: 4,095 bits.
Floating point numeric: . . . . . none.
Alphameric: . . . . . 4,095 bits.
.349 Sign provision: . . . . . optional.

.35 Data Values

.351 Constants
Possible sizes
Integer: . . . . 1 to 4,095 bits.
Fixed point: . . . . . 1 to 4,095 bits.
Floating point: . . . none.
Alphabetic: . . . . . none.
Alphameric: . . . . 4,095 bits.
Octal binary: . . . . 4,095 bits.
Subscriptable: . . . . no.
Sign provision: . . . . optional.
.352 Literals: . . . . same as constants.
.353 Figuratives: . . . . . . none.
.354 Conditional variables: . none.

.36 Special Description Facilities

.361 Duplicate format: . . . no.
.362 Re-definition: . . . . . yes.

§ 162.

.363 Table description

- Subscription: . . . . . none, only used in table look-up.
- Level of item: . . . . field, preset common number of words for all entries.

.364 Other subscriptable entries: . . . . none.

.4 OPERATION REPERTOIRE

.41 Formulae: . . . . none.

.42 Operations on Arrays

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

- Step size: . . . . preset in description, field.
- Criteria: . . . . equal.

.43 Other Computation

.431 Operator List

- EFA: . . . . edit field to A register.
- EAF: . . . . edit A register to field.
- INSERT: . . . . set field equal to constant.
- SEB: . . . . set indicator bit.
- CEB: . . . . clear indicator bit.
- DSX: . . . . decimal "shift" (multiplication) of A register, holding binary.
- GSS: . . . . put record size in A register.
- IRS: . . . . set record size equal to value in location.
- DRS: . . . . set record size A equal to record size B.
- TLU: . . . . gives address found in table look-up.
- ALTER: . . . . inserts address into an instruction.

.432 Operands allowed: . . . items, records.
.433 Statement: . . . . only single simple statements.
.434 Rounding of results: . . only integers, none required.
.435 Special cases: . . . . . use TAC coding.

.44 Data Movement and Format

.441 Data copy example: . . MOVE FAN. RECORD; FANS.
.442 Levels possible: . . . . record. section. field.
.443 Multiple results: . . . . no.
.444 Missing operands

- Excess sources: . . . ESS, yes.
- Excess destinations: . ESS, yes.

.445 Size of operands

- Exact match: . . . . . no.
- Alignment rule: . . . align to right, truncate to left if destination smaller; do not alter excess positions if destination larger than source.

.446 Editing possible

- Change class: . . . . ESS, edit section to section.
  EFF, edit field to field.
- Change radix: . . . . DECEDIT, binary to decimal, insert point and suppress zeroes.
  DBT, decimal to binary.
  BTD, binary to decimal.
  ESS, edit section to section.
  HTB, BTH, HTD, DTH, DTS, STD, subroutines provide conversion between Hollerith, decimal and binary.
- Delete editing symbols: . . . . . . no.
- Insert editing symbols
  - Actual points: . . . . DECEDIT.
  - Suppress zeroes: . . DECEDIT and ZSP.
  - Insert other: . . . . none.
  - Float: . . . . none.

.447 Special moves

- FILL: . . . . to fill fixed size record or section with specified char.
- CF: . . . . clear field.

.448 Code translation: . . . uniform internal code.
.449 Character manipulation: edit moves or, when named, as separate fields.

.45 File Manipulation

- Open: . . . . AFF; on first TFM.
- Close: . . . . EPF.
- Advance to next record: TWM, copy remainder of record into work area.
  DFF, jump forward to start of next record or section.
  TFM, copy one record or section into work area.
  ANR, copy file to start of next record.
  DNR, same as ANR without copy.
  WFF, write file forward a record or section.
- Step back a record: . . see Paragraph .56.
- Set restart point: . . . none.
- Restart: . . . . none.
- Start new reel: . . . . . yes.
- Rewind: . . . . automatic by EPF if in file description.
- Unload: . . . . automatic by EPF if in file description.
- AIDSS: . . . . complete sort of file, internal.
- SEQUENCE: . . . . . . complete sort of file, 2-way merge.
- AORTA, SORTBC: . . . complete sort of file, split 2-way merge.

.46 Operating Communication

.461 Log of progress: . . . . automatic by supervisor.
.462 Messages to operator: . TYPEOUT.
.463 Offer options: . . . . . TYPEOUT.

§ 162.

.464 Accept option: . . . . . TYPEIN allows acceptance of words from console typewriter.

.47 Object Program Errors

Error	Discovery	Special Action
In-out:	automatic	attempt recovery and jump to preset address.
Invalid data:	automatic	label and edit checking.
File area inadequate:	automatic	jump to preset address when too many files open.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . any macro statement.
.512 Unconditional jump: . . GOTO.
.513 Switch: . . . . GOTO and ALTER.

.52 Conditional Procedures

.521 Designators
Condition: . . . . . . GOIF.
Procedure: . . . . . . name of destination.
.522 Simple Conditions
Expression v Expression: no.
Expression v Variable: . . no.
Expression v Literal: . . no.
Expression v Figurative: . no.
Expression v Condition: . no.
Variable v Variable: . . yes.
Variable v Literal: . . yes.
Variable v Figurative: . no.
Variable v Condition: . zero GOIFZ, or any constant.
Condition value: . . . . . . yes; GOIFE, jump if field exists.
.523 Conditional relations
Equal: . . . . implied.
Greater than: . . . . . implied.
Less than: . . . . . . implied.
Greater than or equal: implied.
Less than or equal: . implied.
.524 Variable conditions: . . zero, using GOIFZ.
.525 Compound Conditionals: none.
.526 Alternative designator: none.
.527 Condition on alternative: none.
.528 Typical examples: . . . GOIF FAN. FIELD1;FAN. FIELD2;X;Y;Z$ means go to X, Y, or Z depending on whether Field 1 is less, equal to, or greater than Field 2, which could also be any constant.

.53 Subroutines: . . . . . . using TAC TJM operator to form link.
can call standard routines to be included by SUBR operator from library.

.54 Function Definition by Procedure: . . . . none.

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

.56 Loop Control

.561 Designation of loop: . . from loop statement to specified symbolic name.
.562 Control by count
Literal: . . . . ?
Data: . . . . ?
Example: . . . . ?
.563 Control by step: . . . . no.
.564 Control by condition: . no.
.565 Control by list: . . . . no.
.566 Nesting limit: . . . . . none.
.567 Jump out allowed: . . . yes.
.568 Control variable exit status: . . . . no.

.6 EXTENSION OF THE LANGUAGE: . . full provision for programmer to write and use new macro statements which are then available for general use.

.7 LIBRARY FACILITIES

.71 Identity: . . . . GPF - system & object programs.
COMPDCT - file descriptions.
COMPLIB - macros & subroutines.

.72 Kinds of Libraries

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

.73 Storage Form: . . . . . magnetic tape.

.74 Varieties of Contents: . programs.
dictionaries.
macros, modal statements, subroutines.

.75 Mechanism

.751 Insertion of new item: . code columns in cards.
.752 Language of new item: . special format except for programs for which use TOPS or TAC.
.753 Method of call: . . . . . load macro.
file name list.
SUBR operator.
macro name.

.76 Types of Routine

.761 Open routines exist: . . yes.
.762 Closed routines exist: . yes.
.763 Open-closed is variable: no.

§ 162.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . . DEPART (usually TAC coding, others possible), RETURN, or T in special column.

.82 Optimizing Information Statements

.821 Process usage statements: . . . . . . none.

.822 Data usage statements: implied by macro statement; tends to eliminate some coding.

.83 Translator Environment: . . . . none.

.84 Target Computer Environment: . . . . . none.

.85 Program Documentation Controls: . . . . none.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: by breakup into small programs and data loads, segmenting on tape can be accomplished using LOAD macros.

.92 Address Allocation: . . start of program can be specified; other programs can be specified by using PROGRAM. ADDRESS.

.93 Arrangement of Items in Words in Unpacked Form: . . . . none.

.94 Assignment of Input-Output Devices: . . . automatic by supervisor.

.95 Input-Output Areas: . . automatic by supervisor for all working and multiple input-output areas.

PROCESS ORIENTED LANGUAGE: COBOL-61

§ 163.

.1 GENERAL

.11 Identity: . . . . COBOL-61.

.12 Origin: . . . . CODASYL committee.

.13 Reference: . . . . no manual released.

.14 Description

A COBOL-61 Translator for the Philco 2000 has been announced. It has not yet been released. The language specification is stated to be all of Required COBOL-61 plus the following electives. The numbers refer to the notation used in the Users Guide 4:161.3, COBOL Electives.

Characters and Words	Comment
#3 Semicolon	;, always ignored.
#4 Long literals	up to (?) characters long.
#5 Figurative Constants	HIGH-BOUND(S); LOW-BOUND(S).
#6 Figurative Constants	HIGH-VALUE(S); LOW-VALUE(S).

.14 Description (Contd.)

Characters and Words	Comment
Verbs	
#24 ENTER	Non-COBOL computer language.
#25 INCLUDE	calls library routines.
Verb Options	
#34 Relationship	IS UNEQUAL TO, EQUALS, and EXCEEDS.
Environment Division Options	
#43 File Description	can be taken from library.
#45 I/O Control	can be taken from library.
Special Features	
#48 LIBRARY	allows calls of library routines.

MACHINE-ORIENTED LANGUAGE: TAC

§ 171.

.1 GENERAL

.11 Identity: . . . . Philco 2000. Translator-Assembler-Compiler. TAC.

.12 Origin: . . . . Philco Computer Division, Programming R & D.

.13 Reference:. . . TAC Manual - Translator-Assembler-Compiler.

.14 Description

TAC is a basic assembly language which may be used on all Philco 2000 systems (210, 211, and 212) having a minimum of 8,192 core storage locations and five magnetic tapes. In addition to machine equivalent instructions, a series of macros, subroutines, and generators are provided in the standard TAC library. Binary subroutines from the library may be incorporated into the program during assembly, or called from a library tape at running time.

The mnemonics employed are well structured and easily remembered because of their "building-block" nature. Constants may be specified either in the address field of an instruction or as a labeled value. The designation of constants is fully provided by both value indicators and placement indicators, which position the values within the Philco 2000 word. Composite words can be formed by compounding several of the same or mixed constant types on one line of coding. A constant list or "Pool" is searched during assembly to avoid duplication of identical constants; the same address is assigned to all of the same symbolically written values. The ability to override the "Pooling" of constants is provided. There are special arrangements to deal with constants in "instruction" format.

Pseudos are employed to establish communication with other separately assembled relocatable programs. The final communication is established at running time by a loader to give an integrated, complete program. This permits the use of binary relocatable routines from a library tape, or in punched card form at running time. Common storage facility is also available. Generators are provided in the standard library to handle input-output, sorting, and report writing (see Section 651:151).

.15 Publication Date:. January, 1960.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . refer to specimen TAC coding sheet at end of this Section.

.22 Legend

Identity and sequence: . . . program identification and instruction sequencing (optional).
L (label): . . . . contains control characters for program identifier, common symbol assignment, subroutine calls, specification of left or right hand instruction, and remark identification.
Location: . . . . symbolic addresses of instructions or constants; should not begin with a numeric character.
Command:. . . . mnemonic code for operation to to be performed; beginning of constant.
Address and remarks: . . . actual or symbolic addresses of data to be operated upon, including specification of indexing; constants, remarks.

.23 Corrections:. . . spare lines on coding sheet and gaps in sequence numbers.

.24 Special Conventions

.241 Compound addresses:. . . addition, subtraction, multiplication, and/or division is permitted. The individual components may be symbols and/or absolute values (decimal or octal). No restrictions on the number of individual components, but no parentheses may be used.

.242 Multi-addresses: . . . . in macro instructions.

.243 Literals: . . . . yes, refer to description of constants.

.244 Special coded addresses:. . . (P) refers to address of present instruction.

.245 Other
Actual core storage addresses: . up to 5 decimal digit numbers, no justification needed.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . 1,500 for 8,192 word core store.
5,500 for 16,384 word core store.
13,500 for 32,768 word core store.

§ 171.

.312 Common label formation label: . . . . . yes.
.313 Reserved labels: . . . . 1SUBERR, 0x, 1x, 2x, 3x, 4x, 5x, 6x, 7x, (PMAX) are only standard reserved labels; others may be added or these can be deleted.
.314 Other restrictions: . . . . none.
.315 Designators: . . none.
.316 Synonyms permitted: . . . . by use of Same or ASGN pseudo-operation.

.32 Universal Labels

.321 Labels for procedures - program routines
Existence: . . mandatory when referenced by other procedures.
First character: . . . . alphabetic.
Others: . . . . alphanumeric.
Number of characters: . . . 1 to 8.
.322 Labels for library routines
Existence: . . mandatory.
Formation rule: . . . . same as procedures.
.323 Labels for constants (specified in "Location" field of coding form; for constants in "Address")
Existence: . . optional.
Formation rule
First character: . . alphanumeric (exclusive of special characters).
Last character: . . alphanumeric.
Others: . . alphanumeric (at least 1 alphabetic character; spaces not significant).
.324 Labels for files: none.
.325 Labels for records: . . . none.
.326 Labels for variables
Existence: . . mandatory.
Formation rule
First character: . . . alphanumeric (exclusive of special characters).
Last character: . . . alphanumeric.
Others: . . . alphanumeric.
Number of characters: . . 1 to 23 characters (at least one alphabetic char; spaces are not significant).
.327 Labels for procedures - instructions
Existence: . . . mandatory when referenced by other instructions.
Formation rule
First character: . . . . alphabetic.
Last character: . . . . alphanumeric.
Others: . . . . alphanumeric.
Number of characters: . . . 1 to 7 characters.

.33 Local Labels

.331 Region: . . . . . started by each NAME pseudo, but note that "C" in label column suppresses the NAME pseudo.
.332 Labels for procedures: . . . . same as universals.

.4 DATA

.41 Constants

.411 Maximum size constants

Machine Form	Coding Sheet Form
Integer	
Binary: . . .	15 decimal digits.
Binary: . . .	16 octal digits.
Binary: . . .	12 hex digits.
Binary: . . .	48 binary digits.
Fixed numeric	
Binary: . . .	15 decimal digits.
Binary: . . .	16 octal digits.
Binary: . . .	12 hex digits.
Binary: . . .	48 binary digits.
Floating numeric	
Floating point binary: . .	fixed point part - 35 fractional decimal digits. exponent part - 3 decimal digits.
Alphameric (6-bit binary coded): . . .	8 alphanumeric characters, or an indefinite numer of alphanumeric characters.
Instructions	
24-bit instruction, instruction pair, or 48-bit I/O instruction: .	mnemonic op-code and symbolic address.
15-bit address: . . .	symbolic address.
Patterns	
Binary pattern: . . .	16 octal, 12 hex or 48 binary digits.

.412 Maximum size literals: . . . . . same as "Maximum size constants."
.413 Constants or literals per line: . constants or literals may be compounded on a line of coding to form composite words consisting of several specified patterns. Patterns should not overlap. Values may be packed into single words by ability to specify termination location within the word for each literal or part of the constant.

.42 Working Areas

.421 Data layout: . . . implied by coding; if I/O Programming System was used, data will be in layout form specified by sequence of conversion descriptions.

§171.

.422 Data type: . . . . implied in program; if I/O Programming System was used, data will be in form specified by conversion descriptors.
.423 Redefinition: . . . yes, COMMON pseudo.

.43 Input-Output Areas

.431 Data layout: . . . same as "Working Areas."
.432 Data type: . . . . same as "Working Areas."
.433 Copy layout: . . . no.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . mandatory.
Number: . . . . 400.
Comment: . . . refer to Instruction List, Section :121.
.512 Absolute: . . . . 225.
.513 Command or literal specified (Input-Output orders)
Existence: . . . mandatory.
Number: . . . . indefinite.
Comment: . . . refer to Section : 051.23.

.52 Macro-Codes

.521 Number available
Input-output: . . 45.
Arithmetic:. . . none.
Math functions: . 1.
Error control: . 1.
Restarts:. . . . none.
File Control: . . 10.
Others:. . . . . 1.
Note: in addition, library permits addition or deletion of macros at any given time.
.522 Examples
Simple: . . . . PROCESS.
Elaborate:. . . RDFF.
.523 New Macros: . . librarian run.

.53 Interludes: . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . . pseudo-operations.
Label adjustment: . . . . pseudo-operations.
Annotation: . . pseudo-op or following instruction line terminator.
.542 Allocation counter
Set to absolute: yes.
Set to label: . . yes.
Step forward: . yes.
Step backward:. yes.
Reserve area: . yes.
.542 Label adjustment
Set labels equal: . . . . yes.
Set absolute value: . . . . yes.
Clear label table: . . . . no.
.544 Annotation
Comment phrase:yes.
Title phrase: . . yes.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . library subroutines for data conversions, BCD arithmatic, special purpose arithmetic such as double-precision floating point.
.612 Method of call: . subroutine call.

.62 Special Functions

.621 Facilities: . . . trig. functions.
log and exponential.
roots and powers.
numerical integration and differentiation.
statistics.
matrix.
linear programming and transportation problem.
interpolation.
solution of equations.
special mathematical functions.
.622 Method of call: . subroutine call.

.63 Overly Control: . controlled by Operating Environment, Section :191.

.64 Data Editing: . . in I/O Programming System; performs standard FORTRAN conversions plus several additional conversions on data for input and output.
.642 Format control
Zero suppression: . . . . yes.
Size Control: . yes.
Sign control:. . yes.
Special characters: . . . no.
.643 Method of call: . specification of units for I/O, format statement descriptors.

.65 Input-Output Control

.651 File labels:. . . no.
.652 Reel labels: . . yes, by I/O Programming System.
.653 Blocking: . . . . yes, by I/O Programming System.
.654 Error control: . yes.
.655 Method of call: . macro statement or automatic correction attempt in I/O Programming System generated coding.

.66 Sorting

.661 Facilities: . . . sort generator to produce 2 or 3 way merge; sort keys of partial or full words which may be scattered throughout the record; keys may be alphanumeric, binary, floating point or any combination; provision for own coded pre- and post-merge editing and file modification.
.662 Method of call: . "SORT" statement.

.67 Diagnostics: . . refer to Operating Environment, Section :191.

§ 171.

.7 LIBRARY FACILITIES

.71 Identity: . . . . TAC library.

.72 Kinds of Libraries

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

.74 Varieties of Contents: . . . . . open and closed subroutines, complete programs for operating system use, diagnostic routines, supervisor systems and interpreters, generators.

.75 Mechanism

.751 Insertion of new item: . . . . . yes, macros, generators, and subroutines.
.752 Language of new item: . . . . . symbolic or binary.
.753 Method of call: . . mnemonic all with parameters in address fields.

.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

Code	Description
CHKCOMP: . . .	check for completion of PROC I/O instruction.
CHKMT:	check status of PROC magnetic tape instruction.
DELCO:	delete complete I/O instructions from PROC list.
DELIN:	delete incomplete I/O instructions from PROC list.
DRUM:	generate magnetic drum instruction.
ERRORS: . . .	try recovery from parity or sprocket errors.
INIT:	initialize PROC.
POLYVAL: . . .	polynomial evaluation.
PRINT:	transmit edited block to on line printer.
PROCESS: . . .	cause search of PROC list to keep I/O functioning during long computation sequence.
RBFILE:	issues 2 backward read instructions and checks first for completion.
RBITEM:	checks for end of logical block on backward read after record has been read in.
RBRUNOUT: . .	checks for completion of last backward read instruction.
RDBUFF: . . .	transmit block from on-line UBC to core storage.
RDCD:	read a card from on-line reader into UBC.
RDFB:	controls backward reading of a tape with label blocks and fixed length record.
RDFF:	controls reading of a tape with label blocks and fixed length records.
RDMTB:	read n blocks in reverse mode from magnetic tape.
RDMTF:	read n blocks forward from magnetic tape.
RDPT:	read 1 block from paper tape system to UBC.
READPT:	read n words from on-line paper tape system into core storage.
RFFILE:	issues 2 read instructions and checks first for completion.
RFITEM:	checks for end of logical block after record has been read in.
RFRUNOUT: . .	check for completion of last read forward order.
RWDLO:	rewind magnetic tape unit with lockout.
RWD:	rewind magnetic tape unit.
SENTFILE: . . .	fills remainder of output record block with sentinel words, or writes full block of sentinel words if previous block completely filled by records.
SKCAA:	skip check assembler availability register.
SKCA:	skip check assembler counter.
SKCRTI:	skip check real-time input.
SKCRTO:	skip check real-time output.
SKCUA:	skip check unit availability register.
SKFA:	skip fault assembler fault register.
SKFB:	skip fault on-line UBC fault register.
SKFD:	skip fault magnetic drum fault register.
SKFPT:	skip fault on paper tape fault register.
SKFRTI:	skip fault on real-time input.
SKFRTO:	skip fault on real-time output.
TLUEQ:	table look-up for equality.
WRC:	punch one card on-line card system.
WRFILE:	writes block of records into magnetic tape.
WRF:	collects items in buffer area until block is filled, then writes out.
WRITEM:	checks for logical end of block before records are written out.
WRMT:	write n blocks on magnetic tape (PROC).
WRPT:	write n words on paper tape.
WRRUNOUT: . .	check for completion of last write instruction given.

§ 171.

.82 Pseudos

Code	Description
NAME:.	assign alphanumeric name to programmed sequence.
AFEND:	allows omitting instruction line terminator.
ASGN: ‡	allows definition of a symbol.
SAME:.	same as ASGN.
ASTOR:	reserves specified number of core storage words.
END:	end of assembly.
ENDGIN:. . . .	end of coding for a generator routine.
ENDSUB:. . . .	end of coding for a library subroutine.
ENDMACRO:. .	end of coding for a library macro.
SET: ‡	set specified value in allocation counter.
PAGE:.	advance assembly listing to beginning of next page.

.82 Pseudos (Contd.)

SPACE:	skip specified numer of lines on assembly listing.
SUBR:	subroutine call.
COMSTOR: ‡ . .	produces common working areas in core storage.
SYMBOUT:. . .	designates symbol as one which will be referenced from outside the bounds of the coded "NAME" sequence.
REFOUT: . . .	designates symbol as one to be referenced in a coded "NAME" sequence other than the one in which the pseudo appears.
DEFINE:. . . .	allows normal mnemonics to be redefined as other mnemonics, or new mnemonics to be defined.

‡ ASGN, ASTOR, COMSTOR and SET may involve unrestricted arithmetic on symbolic and/or absolute quantities.

80 - COLUMN CODING FORM
TRANSLATOR - ASSEMBLER - COMPILER

Page ______ of ______

Program:	Programmer:	Checked by:	Date:

IDENTITY AND SEQUENCE	L	LOCATION	COMMAND	ADDRESS AND REMARKS
1 2 3 4 5 6 7 8	9	10 11 12 13 14 15 16	17 18 19 20 21 22 23 24	25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

GI $\frac{434\text{-C}}{5/60}$ (A)

PHILCO® 2000

PROGRAM TRANSLATOR: ALTAC 3

§ 181.

.1 GENERAL

.11 Identity: . . . . ALTAC 3.

.12 Description

The ALTAC translator translates programs written in ALTAC 3, first into TAC and then immediately into any of the optional TAC translator outputs. The listings produced are the same as those produced by TAC together with the interspersed ALTAC statements. Independently written or compiled subprograms can be compiled or loaded together.

The ALTAC 3 translator supersedes ALTAC 2. In addition to the language extensions, the compiler implements the input-output statements in an interpretive mode (as in 7090 FORTRAN) rather than generating routines at compile time. The object programs produced are more compatible to FORTRAN produced programs.

This translator is not compatible with programs written for ALTAC 2. However, the programs do not require extensive alteration. The alteration mainly involves changes to the input-output statements.

Programs written in FORTRAN II can be translated by ALTAC 3 provided a restricted number of changes are made. The compiler will adapt to many changes of format automatically when a FORTRAN indicator is included. In fact, ALTAC and FORTRAN II coding can be interspersed, with appropriate designations.

.13 Originator: . . . . . . Philco Computer Division, Programming R and D.

.14 Maintainer: . . . . . . Philco Computer Division, Programming R and D.

.15 Availability: . . . . . . June, 1962

.2 INPUT

.21 Language

.211 Name: . . . . ALTAC 3.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . . off-line punched card or binary format on magnetic tape.
.222 Obligatory ordering: . . logical ordering.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . depends upon target computer size (in assembly phase).
.232 Maximum size source statements: . . . . . unlimited.
.233 Maximum number of data items: . . . . . depends upon table sizes.
.234 Others

Store size:	8,192	16,384	32,768.
Max. DO's in program:	106	200	200.
Max. variables in EQUIVALENCE/ COMMON:	258	750	750.
Max. unknowns in S/R or Function S/R: . .	31	255	255.
Approx. max. arrays in DIMENSION tables: .	200	400	400.
TAC limitation on names:	1,500	5,500	13,000.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . binary machine language.
.312 Language style: . . . . absolute or relocatable.
.313 Output media: . . . . . magnetic tape. punched cards (off-line).

.32 Conventions

.321 Standard inclusions: . . PIOS, interpretive Programming Input-Output Subroutines.
.322 Compatible with: . . . . SYSD and all current operating systems.

.33 Documentation

Subject	Provision
Source program: . . .	listing 1 off-line.
Object program: . . .	listing 1 off-line.
Storage map (symbol table):	listing 2 off-line.
Restart point list: . . .	no.
Language errors: . . .	listing 1 off-line.
Constant table:	listing 3 off-line.

§ 181.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

First phase
First pass: . . . . . translate to intermediate TAC with symbolic references to index registers, builds "DO nest" table.
Second pass: . . . . DO analysis, index assignment, loop housekeeping, general clean up.
Second phase: . . . . TAC assembly.

.42 Optional Mode

.421 Translate: . . . . . . yes.
.422 Translate and run: . . no. ‡
.423 Check only: . . . . . no. ‡
.424 Patching: . . . . . . no. ‡
.425 Up-dating: . . . . . . no. ‡

‡Available when used in operating system.

.43 Special Features

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

.44 Bulk Translating: . . . only for one main program and its sub-programs.

.45 Program Diagnostics: . available in operating environment "SYS" incorporating ALTAC.

.46 Translator Library

.461 Identity: . . . . TAC library.
.462 User restriction: . . . special group.
.463 Form
Storage medium: . . magnetic tape.
Organization: . . . . binary relocatable.
.464 Contents
Routines: . . . . . . open and/or closed, variable.
Functions: . . . . . yes.
Data Descriptions: . no.
.465 Librarianship
Insertion: . . . . . under special maintenance routine (PLUM).
Amendment: . . . . PLUM routine.
Call Procedure: . . . name of item recognized by translator.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . depends on installation - flexible.
.512 Space required for each input-output file: . . variable.
.513 Approximate expansion of procedures: . . . . variable 6 (* *).

.52 Translation Time (* *)

.521 Normal translating
2000-210: . . . . . . 0.25 + 0.005 S min.
2000-211
10 μ. sec store: . . 0.20 + 0.004 S min.
10 μ. sec partitioned: . . . . 0.15 + 0.0017 S min.
1.5 μ. sec store: . . 0.15 + 0.0005 S min.
2000-212: . . . . . . 0.15 + 0.0003 S min.

.53 Optimizing Data: . . . none.

.54 Object Program Performance

Type	Time	Space
Elementary algebra	unaffected	unaffected.
Complex formulae	unaffected	unaffected.
Deep nesting	increased	increased.
Heavy branching	unaffected	unaffected.
Complex subscripts	increased	increased.
Data editing	unaffected	unaffected.
Overlapping operations	none.	

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 8,192 word core storage, 7 magnetic tape units. 8 index registers.
.612 Larger configuration advantages: . . . . . greater table space.

.62 Target Computer

.621 Minimum configuration: 8,192 word core storage, Input-Output Processor (1 assembler), 8 index registers, floating point arithmetic, magnetic tapes as required by target program, off-line system for card, tape, printer transcription.
.622 Usable extra facilities: . 16,384 or 32,768 word core storage.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	printed message.
Unsequenced entries:	none.	
Duplicate names:	check	printed message.
Improper format:	check	printed message.
Incomplete entries:	check	printed message.
Target computer overflow:	check	printed message.
Inconsistent program:	check	printed message.
Source program format:	check	printed message.
Allowed DO loops exceeded:	check	printed message.

.8 ALTERNATIVE TRANSLATORS: . . . . none.

(* *) estimate that is probably reliable based on incomplete evidence.

PROGRAM TRANSLATOR: TOPS

§ 182.

.1 GENERAL

.11 Identity: . . . . TOPS 2.

.12 Description

The TOPS translator is designed to produce efficient object routines and rapid translation. The translator is held on a master program file called GPF. The translation is divided into four phases: preparation of input data, systems updating, dictionary updating, translation with listing. An enforced interval between translation and systems updating allows for desk-checking of the listing produced in pass 3, phase 4.

The translator uses an intermediate TAC language and gives the final listing in CODEDIT, in TAC assembler format. The source statements are incorporated in the object program listing as comments.

.13 Originator: . . . . Philco.

.14 Maintainer: . . . . . . Philco.

.15 Availability: . . . . . . November, 1961.

.2 INPUT

.21 Language

.211 Name: . . . . TOPS.
.212 Exemptions: . . . . . . none.

.22 Form

.221 Input media: . . . . . . punched cards transcribed to magnetic tape.
.222 Obligatory ordering: . . program cards must be in required sequence.
.233 Obligatory grouping: . . all modal statements must precede all file and field statements.

.23 Size Limitations

.231 Maximum number of source statements: . . unlimited.
.232 Maximum size source statements: . . . . . . determined by particular macro.
.233 Maximum number of data items: . . . . . . see TAC (651:184.233) and by entries in File Description - 1300 for 8K, 9000 for 32K.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . Running Program Language.
.312 Language style: . . . . binary machine code.
.313 Output media: . . . . . magnetic tape.

.32 Conventions

.321 Standard inclusions: . . linkages to Monitor.
.322 Compatible with: . . . . TOPS Monitor (COPS).

.33 Documentation

Subject	Provision
Source program: . . .	as comments on listing 2.
Object program: . . .	listing 2.
Storage map:	listing 2.
Restart point list: . .	none.
Language errors: . .	listing 2.
List of data descriptions:	listing 1, optional.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Phase 1, Pass 1
Inputs: . . . . Dictionary cards.
Program cards.
Library cards.
System cards.
Function: . . . . off-line conversion.
Output: . . . . AIDSINN tape.

Phase 1, Pass 2
Initiate: . . . . automatic by type-in.
Inputs: . . . . AIDSINN tape.
GPF tape, or PIT tape.
2 scratch tapes.
Function: . . . . sort and edit AIDSINN file.
Outputs: . . . . AIDSINP tape.
TOPSEDIT tape (errors, PIT log, COMPDCT listing, etc.).

Phase 1, Pass 3 (optional, can use GPF rather than PIT as systems tape)
Initiate: . . . . automatic by type-in.
Inputs: . . . . AIDSINP tape.
GPF tape and PIT tape.
Function: . . . . produce file of only those GPF programs as are necessary to process the AIDSINP file.
Outputs: . . . . PIT tape (schedules and programs).
TOPSEDIT tape.

§ 182.

.41 Phases and Passes (Contd.)

Phase 2, Pass 1
- Initiate: . . . . automatic by systems schedule or type-in.
- Inputs: . . . . GPF tape (general program file). PRL tape (from prior phase 4). AIDSINP tape.
- Function: . . . . update GPF file in alphabetic sequence.
- Outputs: . . . . updated GPF tape and duplicate (backup). TOPSEDIT tape.

Phase 2, Pass 2 (optional)
- Initiate: . . . . automatic by type-in.
- Inputs: . . . . GPF tape, or PIT tape. AIDSINP tape. COMPLIB tape (library file of modals, macros and subroutines).
- Function: . . . . update library file.
- Outputs: . . . . COMPLIB tape (updated library). TOPSEDIT tape.

Phase 3, Pass 1 (all of phase 3 optional, if no dictionary entries in AIDSINP file)
- Initiate: . . . . automatic by systems schedule, or type-in.
- Inputs: . . . . (GPF tape, or PIT tape). AIDSINP tape.
- Function: . . . . validates and edits changes to dictionary.
- Outputs: . . . . COMPINP tape (special format input to next pass).

Phase 3, Pass 2
- Initiate: . . . . automatic from pass 1.
- Inputs: . . . . (GPF tape, or PIT tape). COMPDCT tape (dictionary file). COMPINP tape.
- Function: . . . . computes new or changed dictionary items.
- Outputs: . . . . COMPINQ tape (dictionary format input to next pass).

Phase 3, Pass 3
- Initiate: . . . . automatic from pass 2.
- Inputs: . . . . (GPF tape, or PIT tape). COMPDCT tape. COMPINQ tape.
- Function: . . . . merge, change and delete to produce new dictionary.
- Outputs: . . . . COMPDCT tape (updated dictionary). TOPSEDIT.

Phase 4, Pass 1
- Initiate: . . . . automatic by system schedule or type-in.
- Inputs: . . . . (GPF tape, or PIT tape). AIDSINP tape. COMPLIB tape. COMPDCT tape.

.41 Phases and Passes (Contd.)

- Function: . . . . generate TAC coding from TOPS statements.
- Outputs: . . . . COMPOUT tape (TAC language input to pass 2).

Phase 4, Pass 2
- Initiate: . . . . automatic from pass 1.
- Inputs: . . . . (GPF tape, or PIT tape). COMPOUT tape. 1 scratch tape.
- Function: . . . . TAC identifier and generator.
- Outputs: . . . . RELCODE tape (relative coding input to pass 3).

Phase 4, Pass 3
- Initiate: . . . . automatic from pass 2.
- Inputs: . . . . (GPF tape, or PIT tape). RELCODE tape.
- Function: . . . . translate to machine language-produce listing.
- Outputs: . . . . RPL tape, (running program language). CODEEDIT tape (listing of object program with original TOPS statements as comments).

.42 Optional Mode

- .421 Translate: . . . . yes.
- .422 Translate and run: . . . no.
- .423 Check only: . . . . . . no.
- .424 Patching: . . . . TOM cards can be used to patch in TAC coding during TESTRUN and GPF update run.
- .425 Updating: . . . . dictionary and library GPF.

.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, all loaded together in Run 1 (see 651:182.41).

.45 Program Diagnostics: . effective in special TESTRUN compilation of program. Features are omitted when compiled for RUN monitor.

- .451 Tracers: . . . . TRACE, print of all jumps executed from one specified address to another, active for a specified number of executions after a specified number of inactive executions.
- .452 Snapshots: . . . . DUMP specifies a print of an area in core; SNAP specifies a print of registers. These are made for a specified number of executions after a specified number of inactive executions.

§ 182.

.453 Dumps: . . . . manual or error jump at end of run to complete dump.

.46 Translator Library

.461 Identity: . . . . COMPDCT.
COMPLIB.
GPF.

.462 User restriction: . . . none.

.463 Form
Storage medium: . . . magnetic tape.
Organization: . . . . . alphabetical by entry name in unique format.

.464 Contents
Routines: . . . . COMPLIB.
Functions: . . . . . . COMPLIB.
Data Descriptions: . . COMPDCT.
Programs: . . . . . . GPF.

.465 Librarianship
Insertion and Deletions: . . . . . . automatic in translator by control cards.
Amendment: . . . . . automatic in translator by control cards.
Call Procedure: . . . automatic in translator by usage, or in case of the GPF, by control card.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space	Comment
COPS (RUN Monitor):	800 words	contains program loader, file initializer, tape control, error control, interrun control.
COPS (TESTRUN Monitor):	1800 words	contains TRACE, DUMP and SNAPSHOT features.

.512 Space required for each input-output file: . . . 256 words per active file.

.513 Approximate expansion of procedures: . . . . 5 to 50.

.52 Translation Time: . . . 0.1 + 0.005S mins.
S = number of cards.

.53 Optimizing Data: . . . . several statements have parameters which allow the translator to reduce the amount of coding generated.

.54 Object Program Performance

Type	Time	Space
Elementary algebra:	not provided.	
Complex formulae:	not provided.	
Deep nesting:	unaffected	unaffected.
Heavy branching:	unaffected	increased.
Complex subscripts:	not provided.	
Data editing:	increased	increased.
Overlapping operations:	unaffected	unaffected.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 8,192 words storage.
5 tape units.
1 assembler.

.612 Larger configuration advantages: . . . . . . additional core or more assemblers will handle larger programs somewhat faster; more tape units reduce times significantly.

.62 Target Computer

.621 Minimum configuration: 8,192 words storage.
2 tape units.
1 assembler.

.622 Usable extra facilities: 32K core storage.
up to 16 tape units.
extra assemblers.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none	continue.
Unsequenced entries:	check	accepted as read.
Duplicate names:	check	continue - insert message in listing.
Improper format:	some checks	continue - insert message in listing.
Incomplete entries:	some checks	continue - insert message in listing.
Target computer overflow:	some checks	continue - insert message in listing.
Inconsistent program:	some checks	continue - insert message in listing.

.8 ALTERNATIVE TRANSLATORS: . . . none.

PROGRAM TRANSLATOR: TAC

§ 184.

.1 GENERAL

.11 Identity: . . . . Philco 2000.
Translator-Assembler-Compiler.
TAC.

.12 Description

TAC is a magnetic tape oriented system which may be easily incorporated into any current operating environment for the Philco 2000 series. It is probably not reasonable to use it without an operating system. The input to the translator may be in symbolic machine oriented code, TAC, and/or in a form previously translated into absolute or relocatable binary format. This last form of input enables library or other subroutines to be incorporated. The object routines produced can be recorded on a master tape in fixed or relocatable binary form ready for loading, or recorded on tape for off-line conversion to cards, in either fixed or relocatable binary form. All the different types can be used to load the program at run time.

There is a single integrated listing including the source program, the corresponding instructions in octal, error notations, sorted lists of references, and the table of POOL constants.

The various formats of input and output as well as the options required are either specified by the operating system in use, or by the operator through the console toggle switches. Any system errors in the translator are printed out on the typewriter.

Independently written subroutines can be translated together, and independently translated subroutines can be loaded together, provided that the proper cross-references have been noted.

The TAC translator has been altered to extend its facilities, but all previous programs are still compatible.

.13 Originator: . . . . . . Philco Computer Division, Programming R & D.

.14 Maintainer: . . . . . Philco Computer Division.

.15 Availability: . . . . . January, 1960.

.2 INPUT

.21 Language

.211 Name: . . . . TAC.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched card images on magnetic tape.
.222 Obligatory ordering: . . logical ordering.
.223 Obligatory grouping: . . logical grouping.

.23 Size Limitations

.231 Maximum number of source statements: . . varies with size of object machine.
.232 Maximum size source statements: . . . . . unlimited, usually one line for mnemonics and pseudos; variable for sort and library statements.
.233 Maximum number of data items: . . . . . see next entry.
.234 Others
Maximum number of labels: . . . . . . 1,500 for 8,192 word core store.
5,500 for 16,384 word core store.
13,500 for 32,768 word core store.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . binary machine language.
.312 Language style: . . . . binary; absolute or relocatable.
.313 Output media: . . . . . magnetic tape; optional off-line punched card for binary relocatable programs.

.32 Conventions

.321 Standard inclusions: . . jumps to operating environment.
.322 Compatible with: . . . binary relocatable compatible with other binary relocatable routines having proper controls.

.33 Documentation

Subject	Provision
Source program: . . .	off-line listing 1.
Object program: . . .	off-line listing 1.
Storage map (symbol tape):	off-line listing 2.
Restart point list: . .	none.
Language errors: . .	off-line listing 1.
Constant table: . . .	off-line listing 3.

§ 184.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

First Pass: . . . . . . translates commands and assigns storage allocation; builds symbol tables; stores generator, macro, and subroutine calls.

Library Phase: . . . . calls in generators and macros, generates coding, returns to first pass. First Pass returns back to library phase which then satisfies subroutine calls.

Second Pass: . . . . . produces program listing, and binary format for running program.

Note: The first pass and library phase may alternate many times because generators, macros and subroutines may themselves call on other entries in the library.

.42 Optional Mode

.421 Translate: . . . . . . yes.
.422 Translate and run: . . no. ‡
.423 Check only: . . . . . no. ‡
.424 Patching: . . . . no. ‡
.425 Up-dating: . . . . . . no. ‡

‡ Included within operating systems.

.43 Special Features: . . . none.

.44 Bulk Translating: . . . none.

.45 Program Diagnostics: . refer to Operating Environment, section :191.

.46 Translator Library

.461 Identity: . . . . TAC library.
.462 User restriction: . . . none.
.463 Form
Storage medium: . . magnetic tape and punched cards.
Organization: . . . . alphabetic order by routine name; each routine preceded by 3 to 8 character alphanumeric name.
.464 Contents
Routines: . . . . open and closed subroutines, complete programs for operating system use, diagnostic routines, supervisor systems and interpreters, generators.
Functions: . . . . . no.
Data Descriptions: . . no.
.465 Librarianship
Insertion: . . . . . . by library maintenance routine (PLUM).
Amendment: . . . . . PLUM routine.
Call Procedure: . . . name of item recognized by translator.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead
Name: . . . . Interim Operating System (SYSD).
Space: . . . . 512 words, lower core storage.
.512 Space required for each input-output file: . . . variable, according to object program.
.513 Approximate expansion of procedures: . . . . 1, exclusive of macros and generated coding.

.52 Translation Time (* *)

2000-210: . . . . $8 + 0.05$ S sec.
2000-211
$10\ \mu$.sec store: . . . $7 + 0.04$ S sec.
$10\ \mu$.sec partitioned: . $6 + 0.02$ S sec.
$1.5\ \mu$. sec store: . . $5 + 0.006$ S sec.
2000-212: . . . . $3 + 0.003$ S sec.

.53 Optimizing Data: . . . none.

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

(* *) estimate that is probably reliable based on incomplete evidence.

.6 COMPUTER CONFIGURATION

.61 Translating Computer

.611 Minimum configuration: 8,192 word core storage, 7 magnetic tapes, 8 index registers (only 5 tapes if no operating system is used).
.612 Larger configuration advantages: . . . . . greater table space.

.62 Target Computer

.621 Minimum configuration: 8,192 word core storage, Input-Output Processor (1 assembler), magnetic tapes as required by target program, 8 index register off-line system for card-to-tape transcription.
.622 Usable extra facilities: . . . . 16,384 or 32,768 word core storage.

§ 184.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	printed message.
Unsequenced entries:	no.	
Duplicate names:	check	printed message.
Improper format:	check	printed message.
Incomplete entries	check	printed message.
Target computer overflow:	check	printed message.
Inconsistent program:	check	printed message.
Lack of definition:	check	printed message.
Constant incorrectly specified:	check	printed message.
Line end symbol missing:	check	printed message.

.8 ALTERNATIVE TRANSLATORS: . . . none.

OPERATING ENVIRONMENT: SYSD

§ 191.

.1 GENERAL

.11 Identity: . . . . SYSD

.12 Description

Completely automatic operating features are provided by this extensive system which eliminate much operating overhead. Translation, running and debugging of programs can be controlled. There is continuous run-to-run control, and programs can be loaded from individual tapes or from the RPL (Running Program Library) tape. In addition there are several diagnostic aids, tracing, snapshots and post mortems. A logging facility is included plus utility routines for tape-to-tape transcription, tape checking, etc.

The system may be used on any Philco 2000 configuration with at least 8 magnetic tapes or 7 magnetic tapes and a Model 240 Paper Tape System. SYSD permanently occupies 512 locations of core storage. As sections, which are not part of the basic program, are required, they are read from the SYS program tape as one-block-length routines into a reserved 128-word core storage area within the SYSD area, and are then executed. The remainder of core storage is available to the programmer.

All operations are specified by control cards submitted by the programmer, or much less efficiently by control instructions entered via the console typewriter. Any succession of programs requiring translation and/or running is acceptable. Dumps or snapshots are provided in case of program failure. The system provides debugging aids such as selective dump, trace, and snapshot routines without recourse to external subroutines.

SYSD permits segmenting of binary relocatable programs which are too large for available core storage. The segments used in a running program may contain cross-referencing of one another, but this must be done either through the COMMON area of memory or via a master segment located in core storage during the segmentation process.

Routines for the handling of magnetic tapes, performing reading, writing, sentinel location and writing, and copying tapes are available. Automatic time logging of each job is provided, and accounting cards are produced for off-line card punching.

.13 Availability: . . . . . . currently available.

.14 Originator: . . . . Philco Computer Division, Programming R&D.

.15 Maintainer: . . . . . . Philco Computer Division, Programming R&D.

.16 First Use: . . . . ?

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . programs to be executed are loaded from a master tape of programs (RPL).

.212 Independent programs: from system input tape containing absolute or relocatable binary programs in punched card image form.

.214 Master routines: . . . . SYSD is initially loaded by operator manually entering a read instruction via the central processor console.

.22 Library Subroutines: . called from library tape at loading time or included with program deck as a relocatable binary deck.

.23 Loading Sequence: . . . determined by sequence called for on system control instructions and/or physical sequence of binary decks transcribed to system input tape.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . segmenting relocatable binary programs too large for available core storage into programs which can be overlayed.

.312 Occupation of working storage: . . . incorporated in program; may be designated at loading time for relocatable program.

.32 Input-Output Units

.321 Initial assignment: . . . incorporated symbolically in program.

.322 Alternation: . . . . . . incorporated symbolically in program.

.323 Reassignment: . . . . . change physical tape assignment on IOP and place reel on other unit.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: incorporated in program.

§ 191.

.42 Multi-programming: . . none.

.43 Multi-sequencing: . . . none.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	checks	alarm, automatic rejection.
Allocation impossible:	check	alarm, automatic rejection.
In-out error; single:	check	automatic tape error cycle.
In-out error; persistent:	check	alarm, automatic rejection.
Storage overflow:	check	alarm, automatic rejection.
Invalid instructions to operating system:	check	alarm, automatic rejection.
Program conflicts:	program check	program defined.
Overflow and underflow:	program check with fixed point arithmetic; check and interlock with floating point	program defined with fixed point, jump to fixed location with floating point.
Invalid operation:	check	alarm, stop.
Improper format:	check	alarm, automatic rejection.
Invalid address:	none.	
Reference to forbidden area:	none.	

.45 Restarts

.451 Establishing restart points: . . . . fixed system entries.
.452 Restarting process: . . automatic and/or console or typewriter entries.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . complete and/or selective tracing, chosen by programmer.
.512 Snapshots: . . . . yes, selected by programmer.

.52 Post Mortem: . . . . . automatic dump of specific data area when program trouble occurs; programmer specified various format post mortem dumps.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . yes, console type-outs.
.612 Action required by operator: . . . . . yes, console type-outs.
.613 Reporting progress of run: . . . . yes, console type-outs of all job functions, error messages and time data.

.62 Operator's Decisions: type-ins.
console forced jumps.
toggles.

.63 Operator's Signals

.631 Inquiry: . . . . none.
.632 Change of normal progress: . . . . methods are available to abandon a run and re-allocate equipment.

.7 LOGGING

.71 Operator Signals: . . . console typewriter.

.72 Operator Decisions: . . console typewriter.

.73 Run Progress: . . . . . console typewriter.

.74 Errors: . . . . console typewriter.

.75 Running Times: . . . . console typewriter and system produced accounting cards punched off-line.

.76 Multi-running Status: . none.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: 8,192 word core storage, Input-Output Processor (1 assembler), 8 magnetic tapes or 1 Model 240 paper tape unit and 7 magnetic tape units.
8 index registers.
.812 Usable extra facilities: additional facilities only affect size of program which may be loaded.
.813 Reserved equipment: logical tape units 1, 2, 3, 4, 5, 6, 7, 8; additional tapes are required for data, and library and program tapes in excess of those included in the reserved 8 tapes; 512 core storage locations.

.82 System Overhead

.821 Loading time: . . . . . negligible.
.822 Reloading frequency: . system need not be reloaded for each new job to be performed.

.83 Program Space Available: . . . . . . all core storage except first 512 locations.

.84 Program Loading Time: 5,000 words/sec (**).

.85 Program Performance: running overhead completely variable and is a function of the programmer specified operations to perform.

(**) Estimate based on nearly complete data and probably reliable.

OPERATING ENVIRONMENT: TOPS

§ 192.

.1 GENERAL

.11 Identity: . . . . TOPS 2.
COPS.
Complete Operating Procedures System.

.12 Description

The COPS supervisor for TOPS is a complete operating system that covers not only the running of programs, but also the various phases of translation. One master PIT tape is generated at the start. The master routine accepts card input and produces a new PIT tape which contains a session's schedule of runs. Special runs and test programs are run from the GPF. The programs can be run without PIT, or only using PIT in part giving any degree of automatic operation.

COPS provides complete run-to-run control, special diagnostic control, translation control, and input-output magnetic tape error control, operator communication, data label checking, and logging.

Facilities other than core storage and magnetic tape can be used only by incorporating TAC coding. COPS and SYSD are presently incompatible operating systems.

.13 Availability

TOPS 1: . . . . end 1960.
TOPS 2: . . . . November, 1961.

.14 Originator: . . . . Philco Computer Division.

.15 Maintainer: . . . . . . Philco Computer Division.

.16 First Use: . . . . 1960.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . magnetic tape "General Program File". GPF.
.212 Independent programs: none.
.213 Data: . . . . normal, magnetic tape only.
.214 Master routines: . . . . PIT magnetic tape.

.22 Library subroutines: . already incorporated in translation.

.23 Loading Sequence: . . . control cards, transcribed during prerun to AIDSINN tape containing one integrated schedule, also LOAD macros in programs.

.3 HARDWARE ALLOCATION

.31 Storage: . . . . no relocatable provisions, but there is provision for overlays using LOAD macro.

.32 Input-Output Units: . . automatic floating tape assignment.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: automatic.

.42 Multi-programming: . . none.

.43 Multi-sequencing: . . . none.

.44 Errors, Checks and Action

Error	Check or Interlock	Action
Loading input error:	automatic COPS label check	type out.
Allocation impossible:	automatic COPS	type out.
In-out error - single:	hardware	see 651:091.8.
In-out error - persistent:	automatic COPS	retry, or erase.
Storage overflow:	none	modulo store size.
Invalid instructions:	stall processor	alarm.
Arithmetic overflow:	none.	
Underflow:	none.	
Invalid address:	none	modulo store size.
Reference to forbidden area:	none.	

.45 Restarts

.451 Establishing restart points: . . . . own code.
.452 Restarting process: . . rewind all tapes, relabel and enter restart program named.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . TRACE, print of all jumps executed from one specified address to another, active for a specified number of executions after a specified number of inactive executions.

.512 Snapshots: . . . . DUMP specifies a print of an area in core storage; SNAP specifies a print of registers. These are made for a specified number of executions after a specified number of inactive executions.

§ 192.

.52 Post Mortem: . . . . . manual or error jump at end of run to complete dump.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . TYPE OUT.
.612 Action required by operator: . . . . . TYPE OUT, TOGGLE SWITCH.
.613 Reporting Progress of run: . . . . TYPE OUT.

.62 Operator's Decisions: . TYPE IN or forced jump.

.63 Operator's Signals

.631 Inquiry: . . . . none.
.632 Change of normal progress: . . . . forced jump.

.7 LOGGING

.71 Operator Signals: . . . TYPE OUT.

.72 Operator Decisions: . . TYPE OUT.

.73 Run Progress: . . . . . types out ID at start and end.

.74 Errors: . . . . TYPE OUT.

.75 Running Times: . . . . subroutine available using internal clock.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: 5 tapes. 8K storage.
.812 Usable extra facilities: extra storage, 16 tapes. others only by own coding in TAC.
.813 Reserved equipment: 800 words, normal, 1 tape. 1,800 words, testrun, 2 tapes.

.82 System Overhead

.821 Loading Time: . . . . . 15 sec. max.
.822 Reloading Frequency: . not necessary.

.83 Program Space Available: . . . . . . variable.

.84 Program Loading Time: 2,500 words/sec plus tape searching.

.85 Program Performance: negligible overhead.

PHILCO 2000-210
SYSTEM PERFORMANCE

PHILCO 2000-210 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1								
Worksheet	Item		Configuration					Reference
			VII B		VIII B			
1	Char/block	(File 1)	128 words		128 words			
	Records/block	K (File 1)	10		10			
	m.sec/block	File 1 = File 2	11.4		11.4			
		File 3	11.4		11.4			
		File 4	11.4		11.4			
Input-Output Times	m.sec/switch	File 1 = File 2	0		0			4:200.112
		File 3	0		0			
		File 4	0		0			
	m.sec penalty	File 1 = File 2	1.28		1.28			
		File 3	1.28		1.28			
		File 4	1.28		1.28			
2	m.sec/block	a1	0.241		0.241			
	m.sec/record	a2	0.694		0.694			
Central Processor Times	m.sec/detail	b6	0.720		0.720			4:200.1132
	m.sec/work	b5 + b9	3.972		3.972			
	m.sec/report	b7 + b8	21.996		21.996			
3	m.sec for C.P. and dominant column.	a1	0.24		0.24			
		a2 K	6.94		6.94			
		a3 K	266.88		266.88			
Standard Problem A		File 1 Master In	1.28	11.4	1.28			
F = 1.0		File 2 Master Out	1.28		1.28			4:200.114
		File 3 Details	1.28		1.28			
		File 4 Reports	1.28	22.8	1.28	22.8		
		Total	279.28	34.2	279.28	22.8		
4	Unit of measure	(word)						
		Std. routines	187		187			
		Fixed	0		0			
		3 (Blocks 1 to 23)	87		87			
Standard Problem A Space		6 (Blocks 24 to 48)	684		684			4:200.1151
		Files	1024		1024			
		Working	100		100			
		Total	2082		2082			

PHILCO 2000-210 SYSTEM PERFORMANCE –Contd.

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration			Reference
				VII B, VIII B blocked	not blocked		
5	Fixed/Floating point			Float	Float		4:200.413
	Unit name	input		tape 234	tape 234		
		output		tape 234	tape 234		
	Size of record	input		10 w	10 w		
		output		23 w	23 w		
Standard Mathematical Problem A	m.sec/block	input	T1	11.4	0.95		
		output	T2	11.4	2.28		
	m.sec. penalty	input	T3	1.28	0.11		
		output	T4	1.28	0.26		
	m.sec/record		T5	0.72	0.72		
	m.sec/5 loops		T6	3.967	3.967		
	m.sec/report		T7	2.611	2.591		
7	Unit name			tape 234	tape 234		4:200.512
	Size of block			128 words	128 words		
	Records/block		B	12	12		
Standard Statistical Problem A	m.sec/block		T1	11.4	11.4		
	m.sec penalty		T3	0.1	0.1		
	C.P.	m.sec/block	T5	0.039	0.039		
		m.sec/record	T6	0.160	0.160		
		m.sec/table	T7	0.453	0.453		

SYSTEM PERFORMANCE

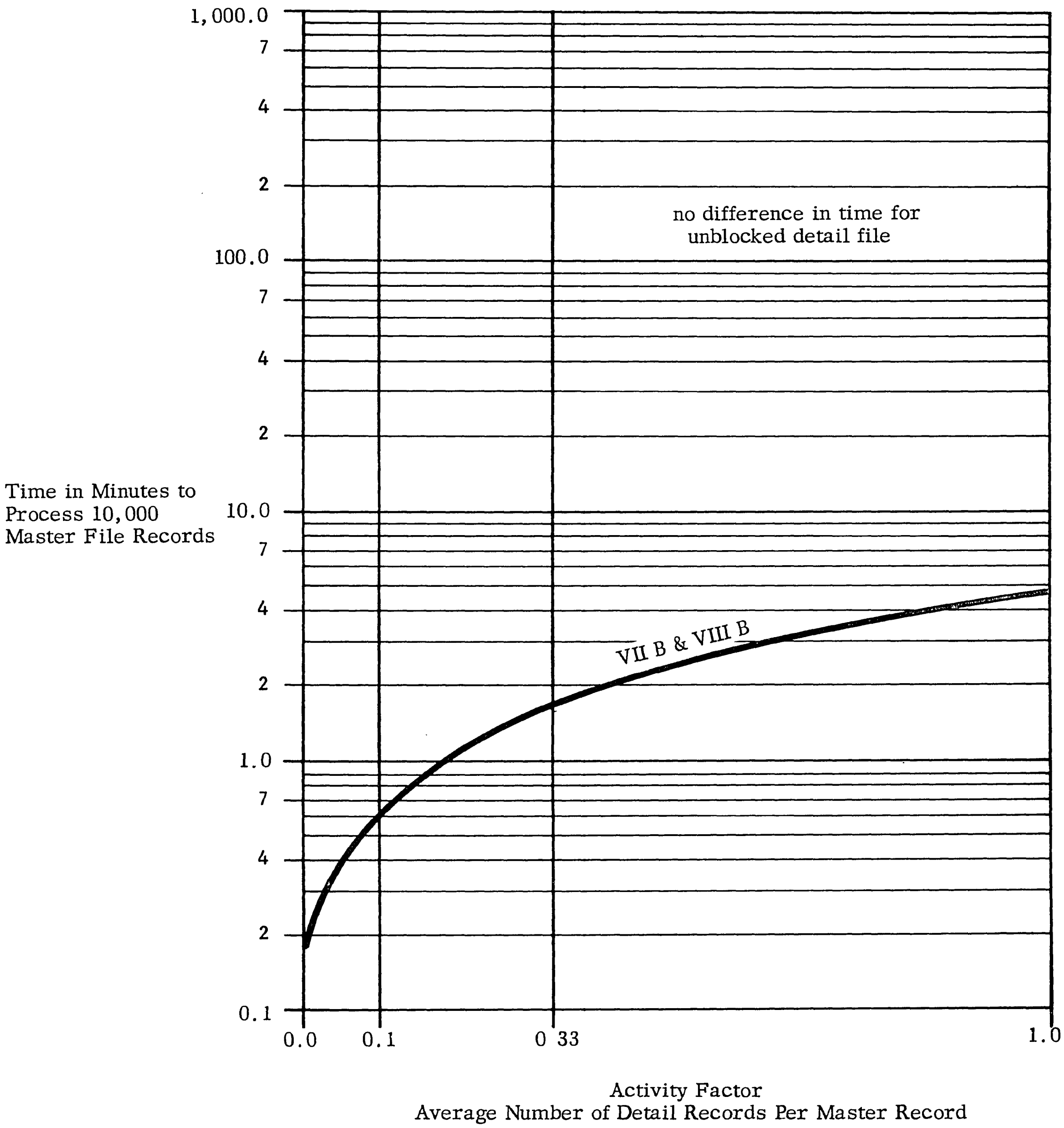
§ 201.

.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 VII B: . 3,000 words.
Configuration VIII B: . 3,000 words.



§ 201.

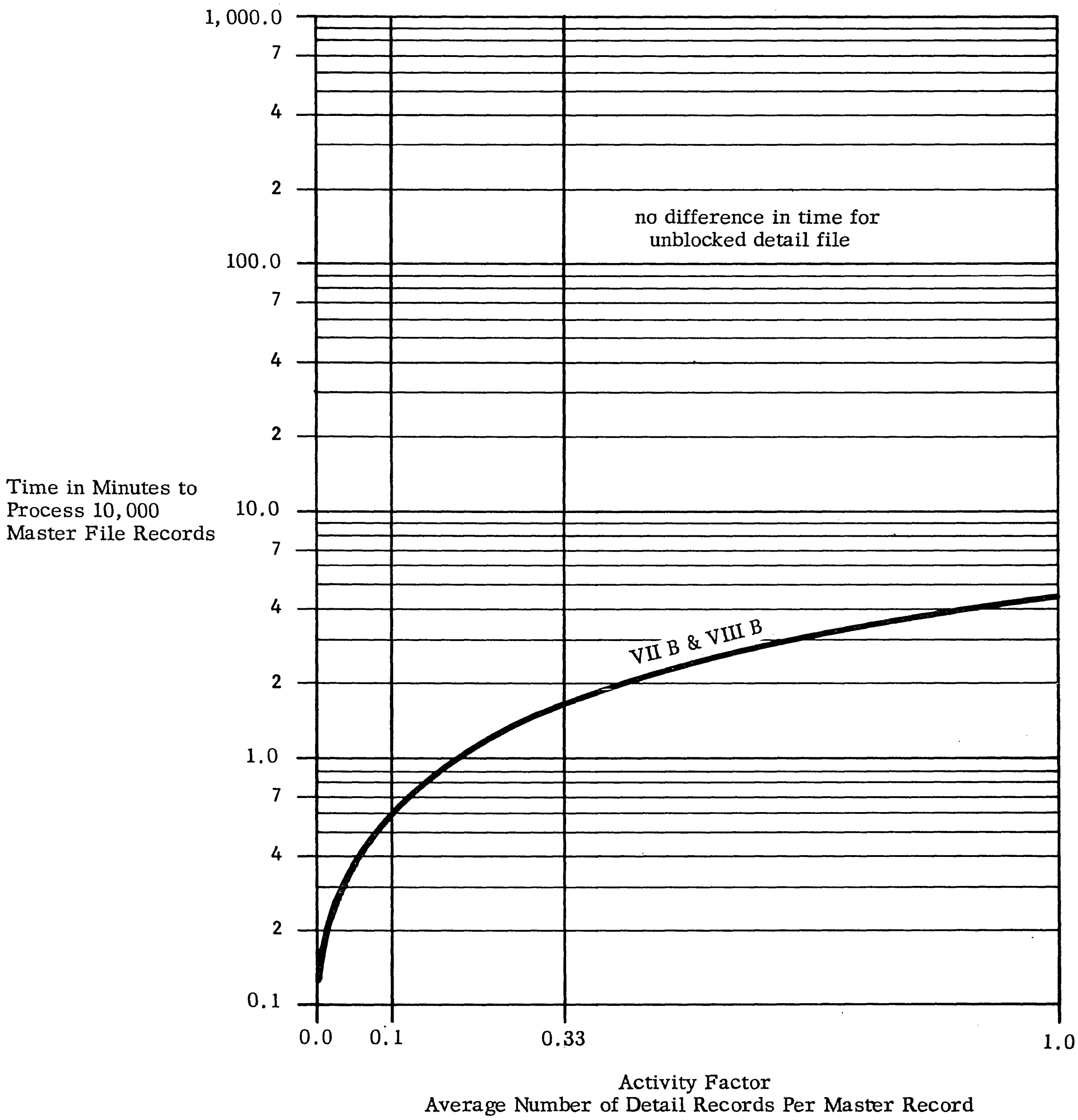
.12 Standard File Problem B

.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.

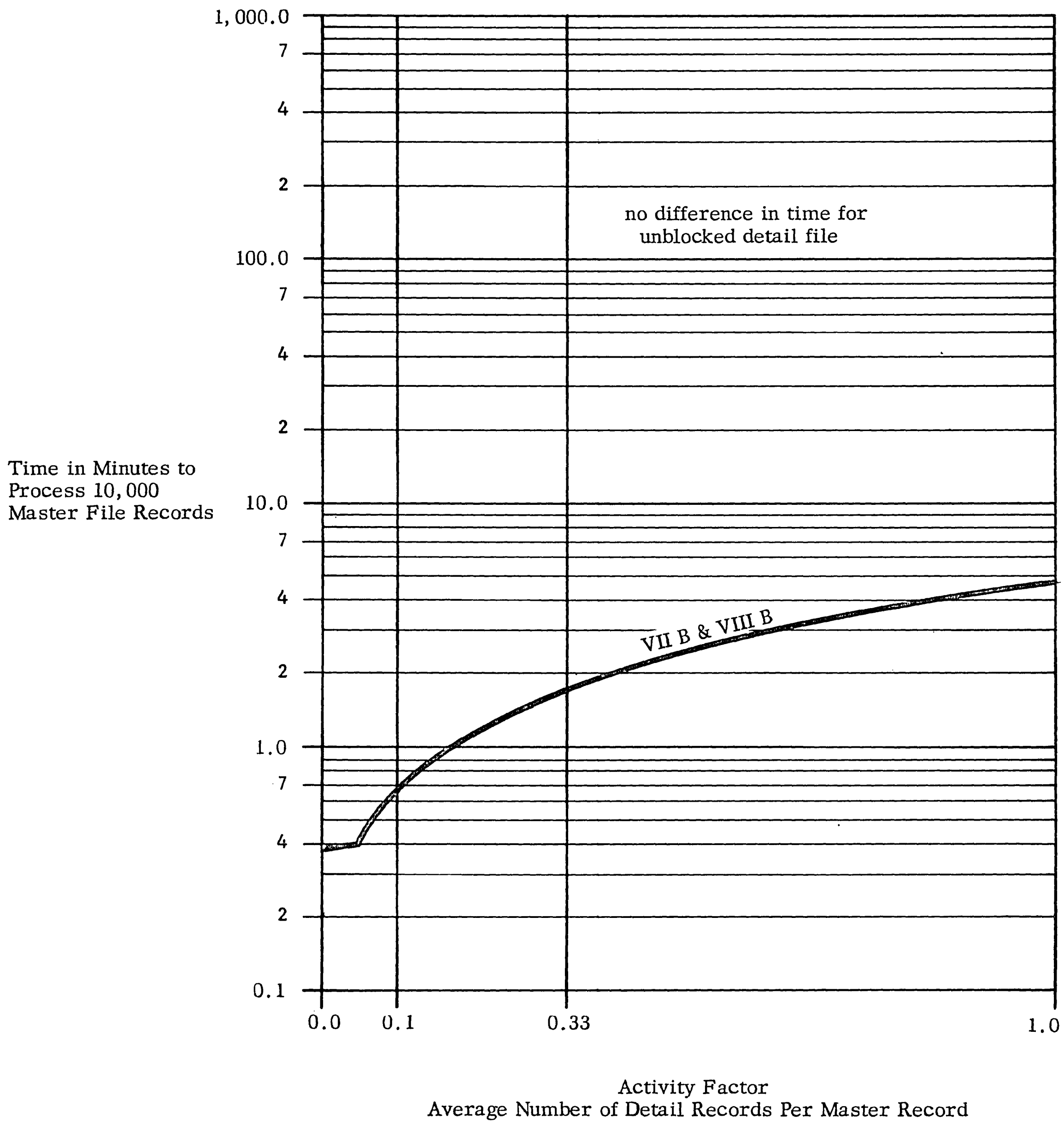


§ 201.

.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 estimated procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . see graph below.



§ 201.

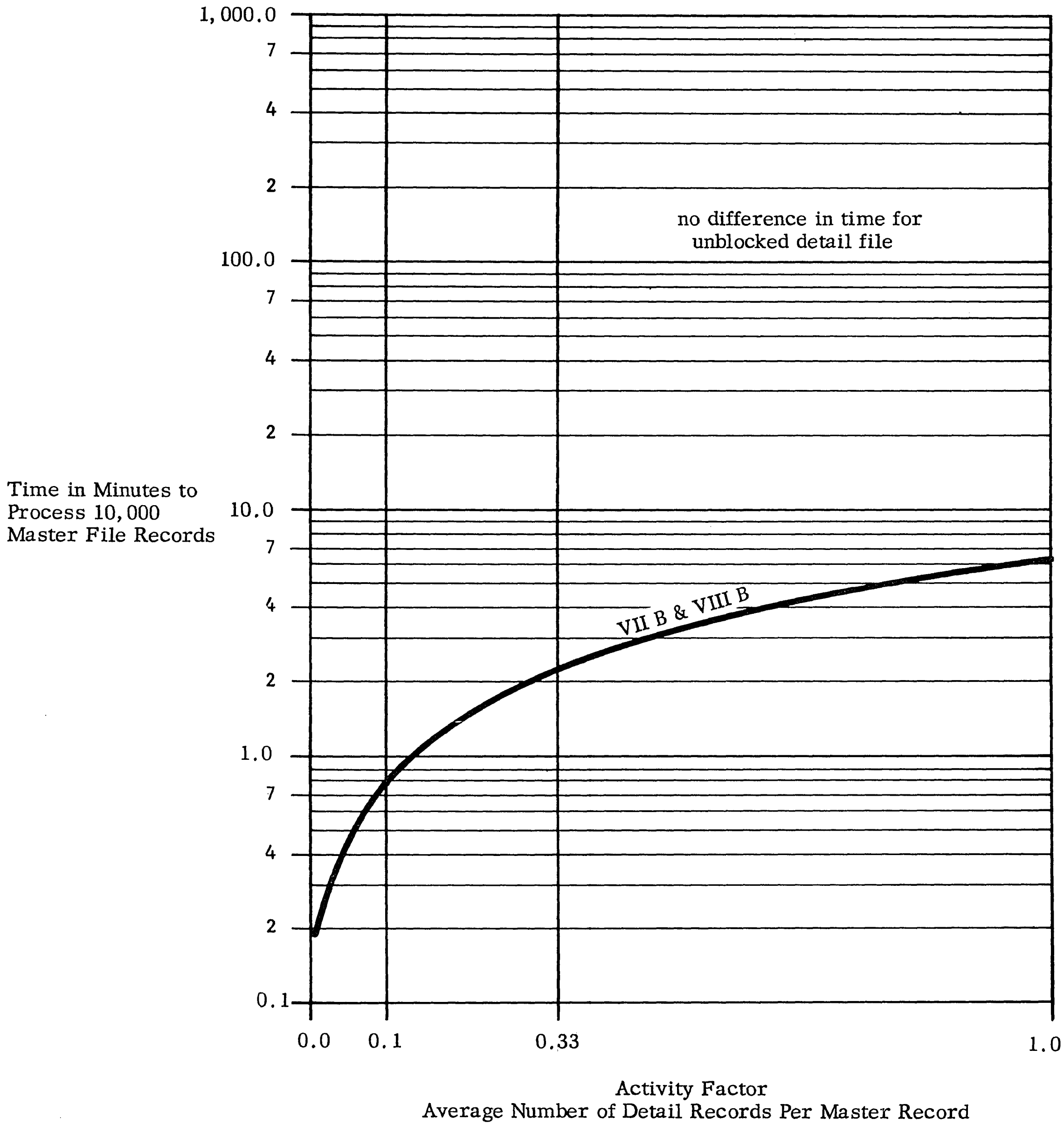
.14 Standard File Problem D

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

.142 Computation: . . . . . trebled.

.143 Timing Basis: . . . . . using estimated procedure outlined in Users' Guide, 4:200.13.

.144 Graph: . . . . see graph below.



§ 201.

.2 SORTING

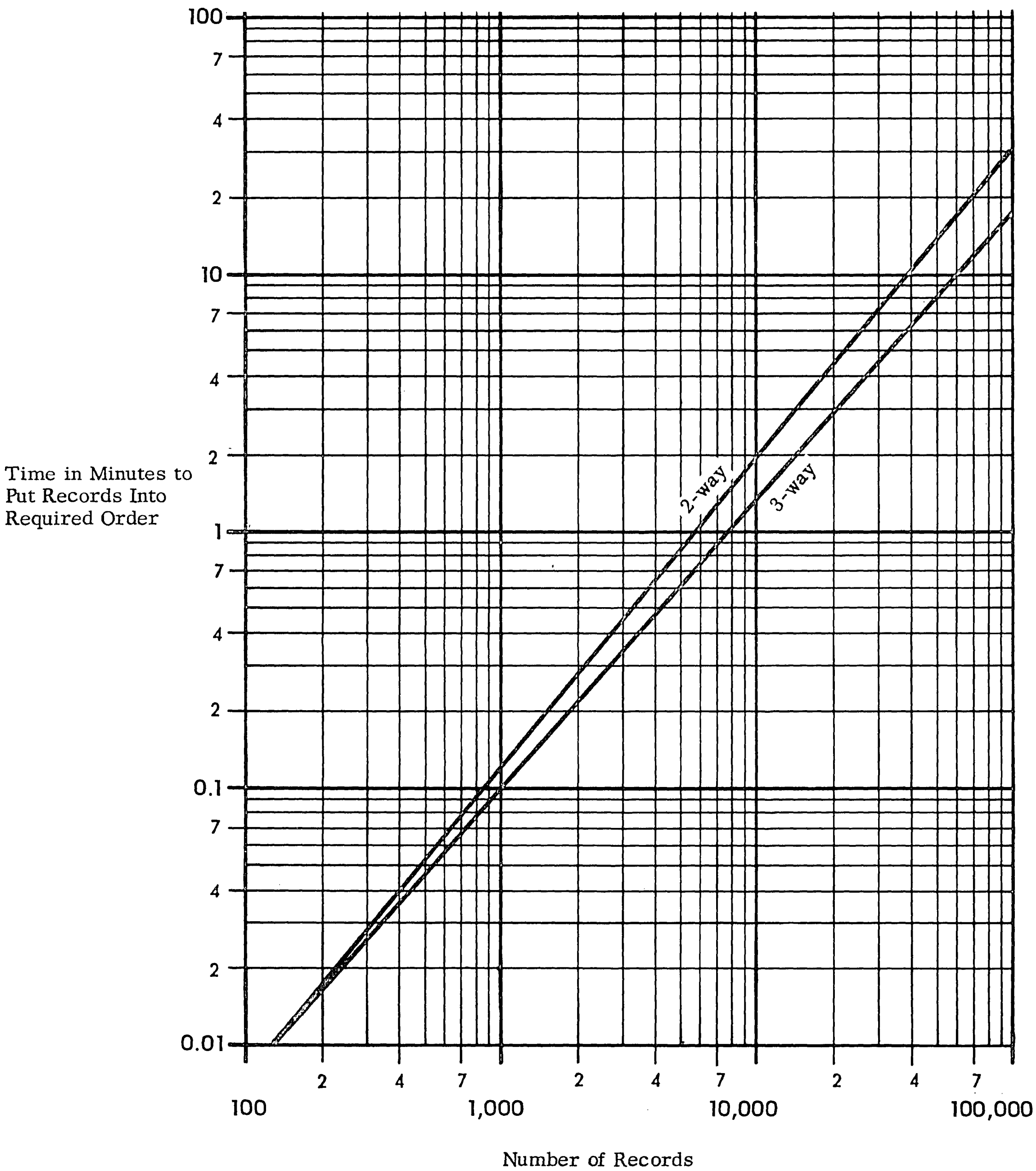
.21 Standard Problem Estimates

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

.212 Key Size: . . . . 8 characters.

.213 Timing Basis: . . . . . using estimated procedure outlined in Users' Guide, 4:200.213.

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



§ 201.

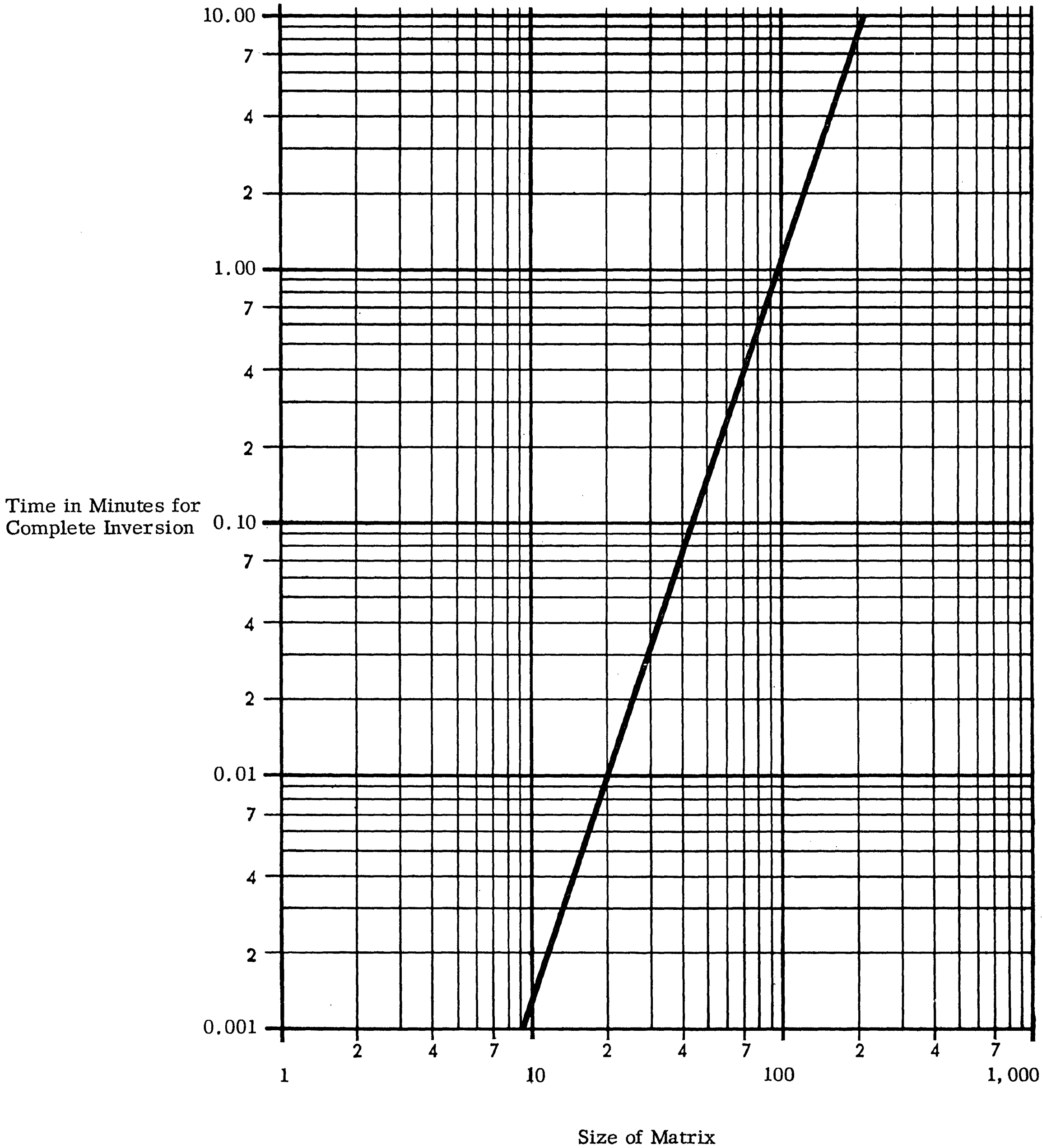
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic Parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing Basis: . . . . . using estimated procedure outlined in Users' Guide, 4:200.312.

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



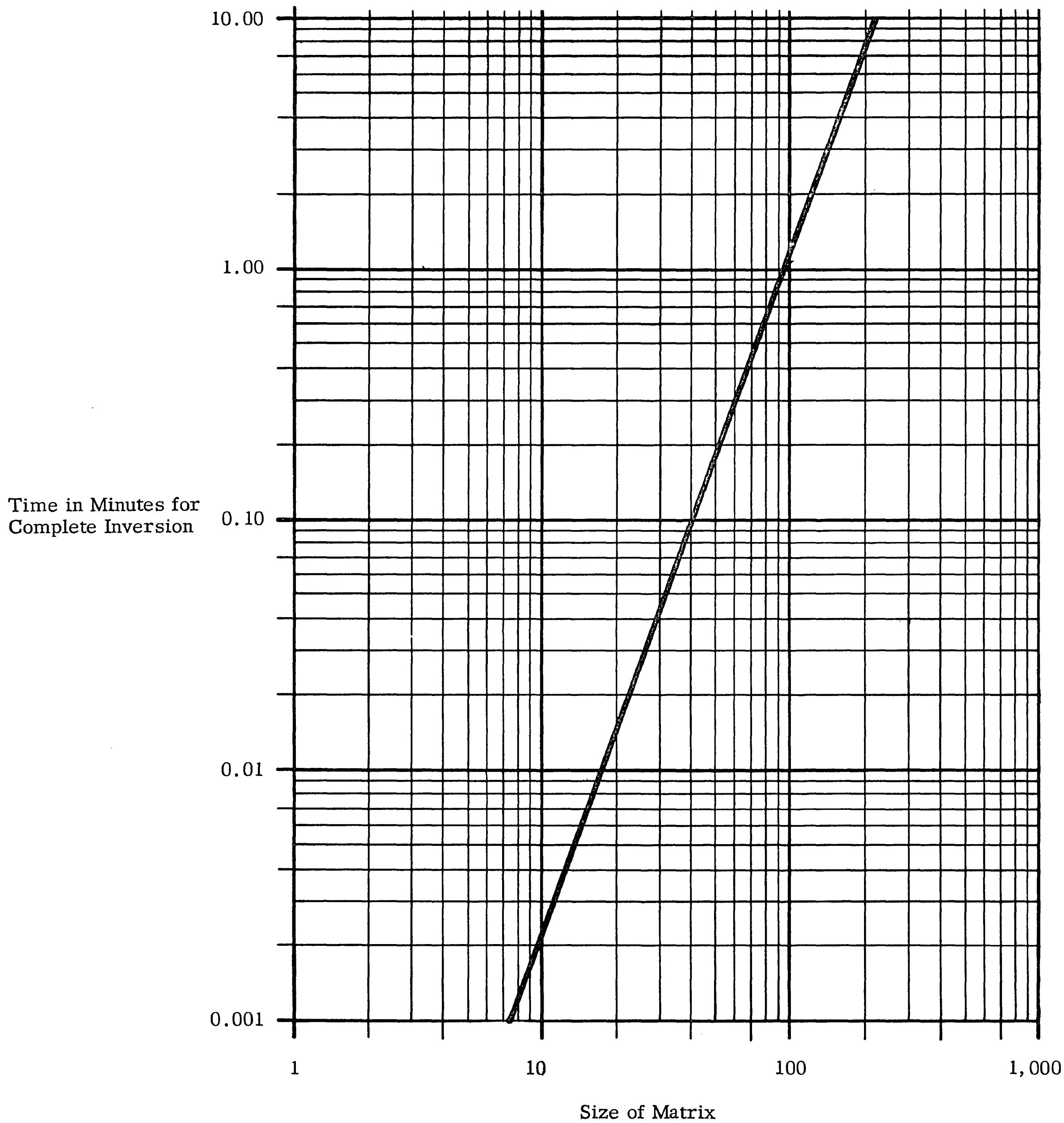
§ 201.

.32 Single Precision and Matrix Inversion Times

.321 Basic Parameters: . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.322 Timing Basis: . . . . Philco Computer Division Programming R & D Willow Grove, Pa.

.323 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.

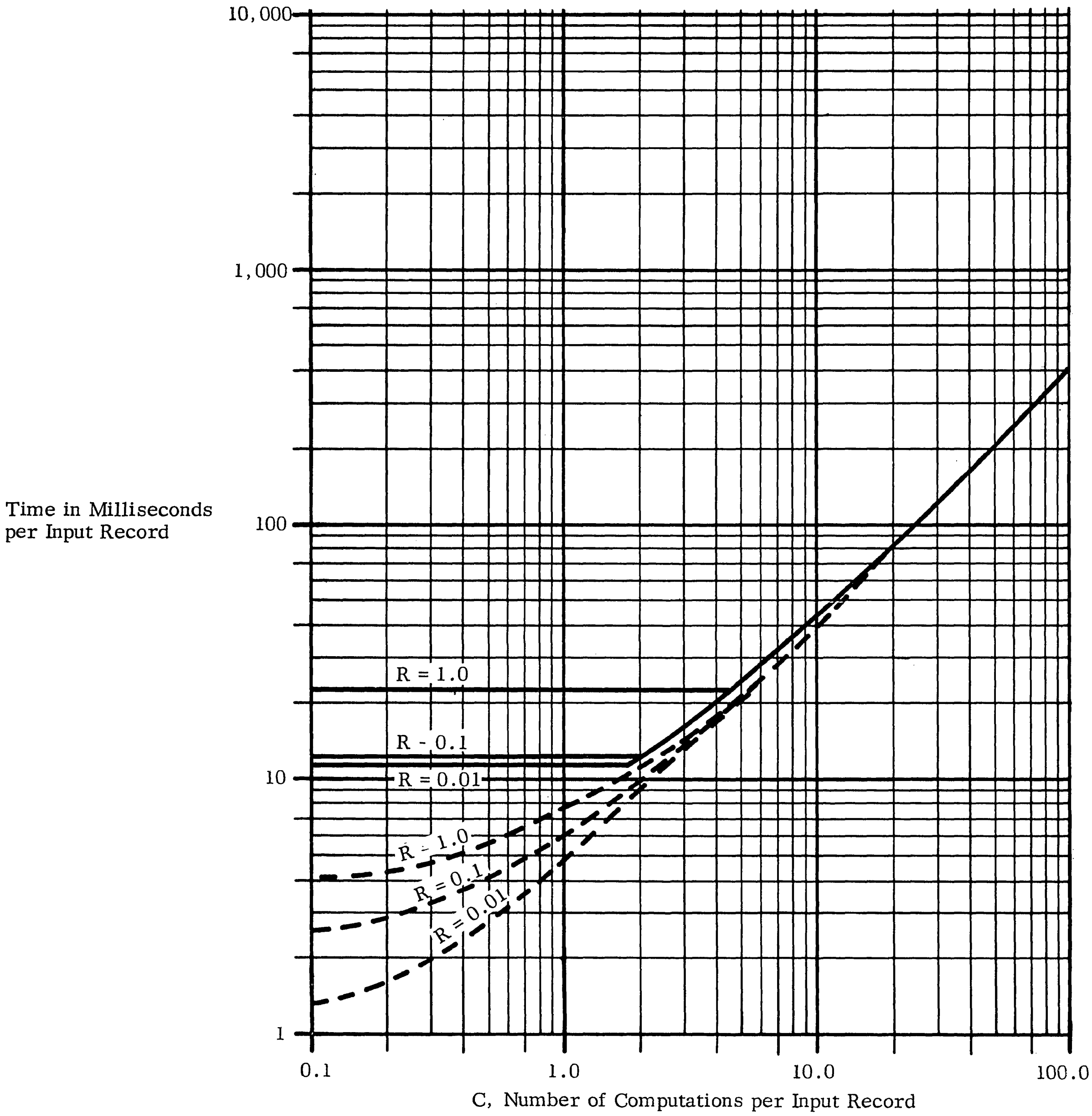
.412 Computation: . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.

Configuration VIIB, VIIIB; Single Length (12 digit precision); floating point.

R = Number of Output Records per Input Record



Broken lines indicate blocked records.

§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

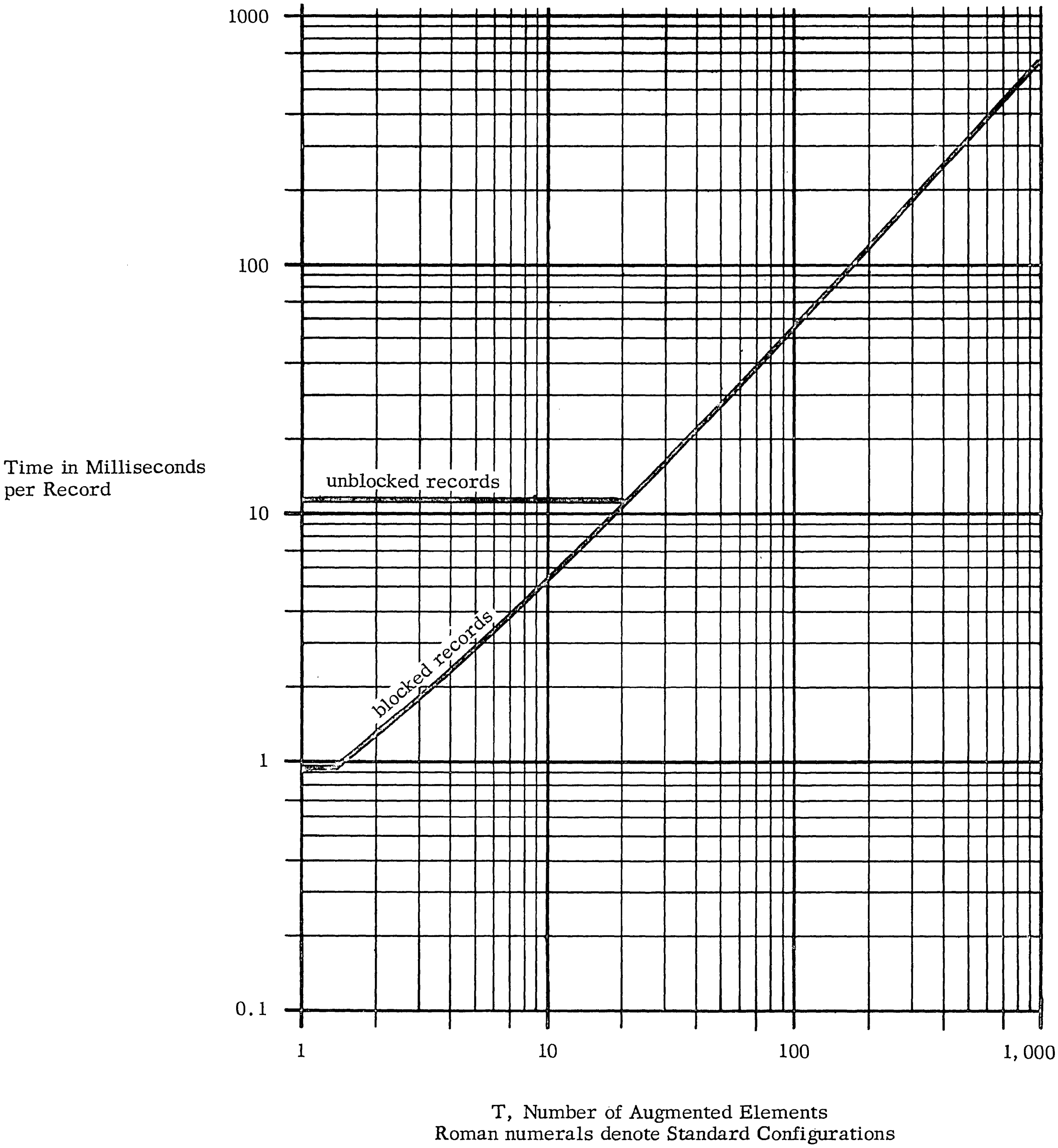
.51 Standard Statistical Problem A Estimates

.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.



PHILCO 2000-210/211/212
PHYSICAL CHARACTERISTICS

PHILCO 2000-210/211/212 PHYSICAL CHARACTERISTICS

			Arithmetic and Control						
IDENTITY	Unit Name		Central Processor	Power Supply	Typewriter Control	Core Storage	Core Storage	Core Storage	Core Storage
	Model Number		210	210	210	2208	2216	2232	222
PHYSICAL	Height × Width × Depth, in.		44 × 108 × 34	57 × 32 × 18	36 × 36 × 34	57 × 90 × 18.6	57 × 158 × 18	57 × 281 × 18	57 × 32 × 18
	Weight, lbs.		1,413	504	206	1,677	3,077	5,877	400
	Maximum Cable Lengths		?	?	?	?	?	?	?
ATMOSPHERE	Storage Ranges	Temperature, °F.		?					
		Humidity, %		?					
	Working Ranges	Temperature, °F.		*					
		Humidity, %		*					
	Heat Dissipated, BTU/hr.		←	6,130 (total 210)	→	6,070	9,950	17,600	200
	Air Flow, cfm.			?					
	Internal Filters			?					
ELECTRICAL	Voltage	Nominal		**					
		Tolerance		**					
	Cycles	Nominal		**					
		Tolerance		**					
	Phases and Lines			**					
	Load KVA			1.840 total		1.783	2.933	5.175	0.060
NOTES	* The total System must be maintained at a working temperature of 60 to 80°F. and humidity of 45 to 65%. ** The entire System operates from either a 208-volt AC, 60-cycle, 3 phase, 4-wire power source or from a 115-volt, 60-cycle, single phase, 3-wire service. A voltage tolerance of ±10% and a frequency tolerance of ±0.5 cycle are permitted.								

PHILCO 2000-210/211/212 PHYSICAL CHARACTERISTICS—Contd.

			Core Storage Unit with Control	Magnetic Drum	Magnetic Drum Controller	Paper Tape System	Paper Tape System	Punched Card Controller	Punched Card Reader	Punched Card Punch	Printer Control Unit	Printer	Magnetic Tape Unit	Magnetic Tape Unit	Input-Output Processor	Input-Output Processor	Input-Output Processor	Input-Output Processor	Universal Buffer Controller	Universal Buffer Controller	Accounting Clock	Console Typewriter Buffer	Digital Incremental Recorder	Digital Incremental Recorder	Digital Incremental Recorder	Digital Incremental Recorder
IDENTITY	Unit Name		Core Storage Unit with Control	Magnetic Drum	Magnetic Drum Controller	Paper Tape System	Paper Tape System	Punched Card Controller	Punched Card Reader	Punched Card Punch	Printer Control Unit	Printer	Magnetic Tape Unit	Magnetic Tape Unit	Input-Output Processor	Input-Output Processor	Input-Output Processor	Input-Output Processor	Universal Buffer Controller	Universal Buffer Controller	Accounting Clock	Console Typewriter Buffer	Digital Incremental Recorder	Digital Incremental Recorder	Digital Incremental Recorder	Digital Incremental Recorder
	Model Number		228	272	275	240	241	259	258	265	254	256	234	234 Off-line only	235	236	237	238	252	280	293	309	2281	2282	2283	2284
PHYSICAL	Height × Width × Depth, in.		57×97×40	57×45×39	57×32×18	57×61×18	57×61×18	57×61×18	49×68×18	51×40×26	57×90×18	57×48×42	75×23×24	75×23×24	57×90×18	57×90×18	57×118×18	57×118×18	57×61×18	57×61×18	32×32×18	?	?	?	?	?
	Weight, lbs.		2,307	1,800	700	860	860	1,147	773	624	1,485	1,800	604	680	1,400	1,400	2,039	2,039	1,020	1,080	150	?	?	?	?	?
	Maximum Cable Lengths		?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?								
ATMOSPHERE	Storage Ranges	Temperature, °F.																								
		Humidity, %																								
	Working Ranges	Temperature, °F.																								
		Humidity, %																								
	Heat Dissipated, BTU/hr.		16,100	2,930	4,300	6,070	6,250	5,090	2,740	4,700	19,600	Incl. in 254	7,150	9,000	3,920	3,920	5,660	5,660	2,740	2,740	340	?	?	?	?	?
	Air Flow, cfm.		?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	Internal Filters		?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
ELECTRICAL	Voltage	Nominal																								
		Tolerance																								
	Cycles	Nominal																								
		Tolerance																								
	Phases and Lines																									
	Load KVA		4.84	0.863	1.265	1.783	1.783	1.495	0.805	1.380	5.750	Incl. in 254	2,100	2.645	1.150	1.150	1.668	1.668	0.805	0.805	0.100	?	?			
NOTES																										

§ 221.

PRICE DATA

CLASS	IDENTITY OF UNIT		PRICES	
	No.	Name	Monthly Rental $	Purchase $
CENTRAL PROCESSOR	Model 210	Central Processor		
	210	Arithmetic and Control Unit	7,100	320,000
		Optional Features		
	1000	210 Floating Point Option	650	30,000
	1011	210 Index Registers (8)	900	40,000
STORAGE		$10\mu s$ Core Storage		
	2208	8,192 words	5,800	260,000
	2216	16,384 words	11,000	500,000
	2232	32,768 words	20,500	925,000
		Magnetic Drum Storage		
	272	Magnetic Drum Unit	1,600	72,000
	275	Magnetic Drum Controller	2,900	130,000
INPUT-OUTPUT	234	Magnetic Tape Unit (90KC)	850	38,000
	235	Input-Output Processor - 90KC (1 assembler)	3,300	150,000
	236	Input-Output Processor - 90KC (2 assembler)	4,400	200,000
	237	Input-Output Processor - 90KC (3 assembler)	6,500	300,000
	288	Input-Output Processor - 90KC (4 assembler)	8,400	380,000
	252	Off-Line Universal Buffer Controller	1,430	100,000
	280	On/Off-Line Universal Buffer Controller	1,560	110,000
	240	On-Line Paper Tape System	1,800	80,000
	241	Off-Line Paper Tape System	1,800	80,000
	2256	Printer System	2,340	160,000
	258	Dual Station Card Reader	800	48,000
	259	Punch Card Controller	1,365	95,000
	265	Card Punch (100 CPM)	350	15,000
	309	Typewriter Buffer	500	21,000
	2281	Digital Incremental Recorder	275	11,700
	2282	Digital Incremental Recorder	405	17,200
	2283	Digital Incremental Recorder	535	22,700
	2284	Digital Incremental Recorder	665	28,200

Note: The monthly maintenance rate is individually negotiated for purchased equipment. See Special Report, Section 23:010.100, second paragraph.

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CONTENTS

CONTENTS (Contd.)

INTRODUCTION

§ 011.

The Philco 2000 is actually a series of three computer systems. There are three prime systems distinguished by different central processors: 210, 211, and 212. The differences in performance and price of the different systems are significant as shown in the respective Systems Performance Sections, 651:201, 652:201, and 653:201. There is a large body of common units, common interfaces, and common software. The following description applies generally to all the series; however, the final paragraph notes the major differences of the 2000-211.

The computer system is in the large-scale scientific and real-time class. Its design is oriented toward flexible off-line operations, with fast tape units, simultaneous operations and concern for fast processing speeds. The central processors have a range of 50,000 to 500,000 instructions per second and rentals in the order of $40,000 and up.

The Philco 2000 is designed for off-line operation of peripheral devices. The off-line operations may be executed by a separate computer, the Philco 1000, or by the special Universal Buffer Controllers (UBC).

The UBC unit is a versatile device, which contains a 1,024 word buffer store. The UBC may control any card, punched tape, magnetic tape, or printer off-line transcription, including magnetic-tape-to-magnetic-tape. A UBC can be used on-line to control data transfers to any one of seven peripheral units attached to it. In addition to the usual peripheral devices there is a high speed (2,000 cards per minute) reader.

Each 2000 computer configuration has one IOP (Input-Output Processor). This unit can control up to 16 input-output units. There may be up to four UBC's and the remaining units may be magnetic tape. An IOP may contain from one to four assemblers. An assembler provides for independent simultaneous input-output transfers. In effect, each UBC can provide an extra simultaneous input-output transfer to any unit except magnetic tape, because loading or unloading a UBC buffer requires little time, and the UBC controls the peripheral device at its own pace.

One especially convenient feature of the IOP is the automatic assignment of any idle assembler to a data transfer request, thus relieving the programmer of optimizing assignments.

The Model 234 Magnetic Tape Units which must be used on the 2000-210 and 2000-211 operate at a peak speed of 90,000 characters per second. The block size is fixed at 1,024 characters. At full speed, using full blocks, the effective speed is 54,600 characters per second. Usually the standard problems have been timed for two cases: (1) blocked records and (2) unblocked records. On the 2000-212 an alternative tape unit, Model 334, is available with a peak speed of 240,000 characters per second.

All three central processors operate in parallel on 48-bit words. Single address instructions are packed two to a word. The number of index registers is optional on the 210 and 211 but in practice is standardized at eight. Eight registers, however, are standard on the 212. When an instruction uses a special bit to denote indexing, three bits of the high order end of the address are used to specify the register. This limits the value of the base address, but not the modifier.

There is a wide variety of fixed and floating point arithmetic instructions, but no editing or conversion facilities. Special two instruction loops can be performed very rapidly with no repeated access for instructions.

INTRODUCTION—Contd.

§ 011.

The computer operates asynchronously in all units and basic times vary from machine to machine, and in different cases similar instructions require different execution times. This report quotes ranges or averages of these times.

There are several varieties of core store available. They have different cycle times, and can be further varied by use of overlapped access. Drums are available on the systems and data transfers are arranged to be parallel by word, at high data rates, but may not be overlapped with other operations. Disc storage is available on the 2000-212.

The three central processors, 210, 211, and 212, are upward compatible for instruction repertoire and functional facilities. Therefore, all software is written to be used on all models, with some limitations on minimum configurations.

The main languages are TAC, ALTAC, and TOPS. TAC is a sophisticated symbolic machine oriented language including macros and facilities for generators. The generators include SORT and IOPS, an input-output system. ALTAC is a dialect of FORTRAN II. The ALTAC translator can translate FORTRAN II programs with usually few changes. Its major incompatibilities are Boolean operations and CHAIN functions. On the other hand, it includes extended conditionals. TOPS is a macro oriented language for file manipulation; it includes such facilities as updating and sorting. For individual data manipulation, TAC coding is used. TOPS includes its own operating environment.

There is an automatic supervisor routine, SYSD. This routine covers running, translating, and debugging. In fact, it is probably not reasonable to operate a 2000 without a supervisor.

There is a users' group called TUG. The library of routines is generally available and includes a large selection in the field of nuclear code programs.

The Philco 2000-211 in particular:

- uses either a 10 μsec store, partitioned or not, or a 1.5 μsec store.
- central processor times are closely related to core store times.
- real-time facilities are available.
- is significantly faster than the 210, but slower than the 212.

SYSTEM CONFIGURATION

§ 031.

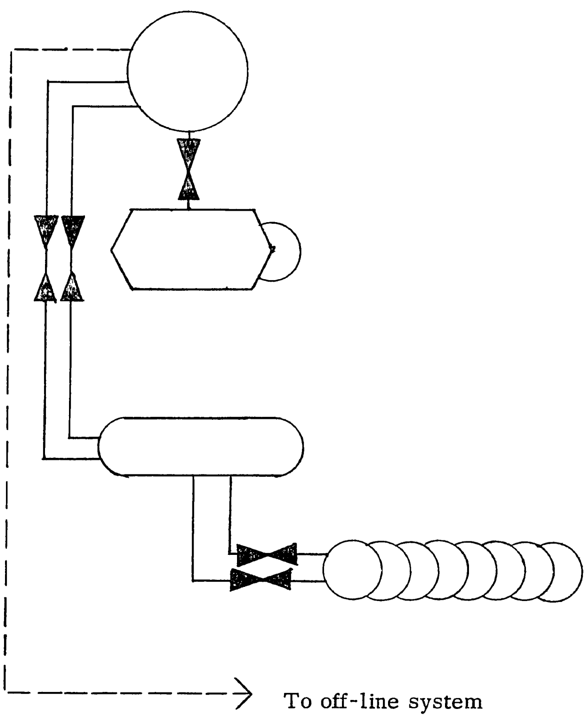
.3 VII B 10-TAPE GENERAL, PAIRED CONFIGURATION

Deviations from Standard Configuration

On-line: . . . . 2 more index registers.
magnetic tape, 30,000 char/sec faster.
card reader can be switched from off-line UBC.

Off-line: . . . . magnetic tape, 60,000 char/sec faster.
printer faster by 400 lines/min.
card reader by 1,500 cards/min.
1,024 characters only in UBC.

On-line Equipment

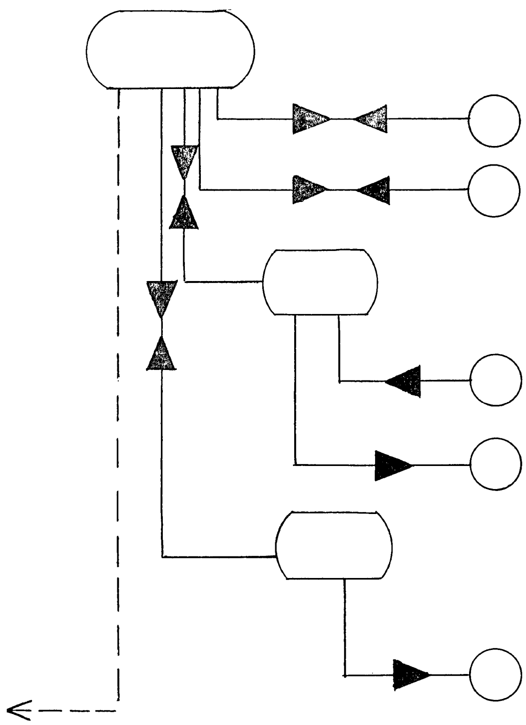


Equipment	Rental
Core Storage: 8,192 words	5,800
Model 211 Central Processor and Console	11,000
	900
Typewriter	1,300
Input-Output Processor: two multiplexed transmissions to and from magnetic tape.	4,400
8 Magnetic Tapes: 90,000 char/second	6,800
Total	30,200
Total, including off-line equipment:	$ 38,315

§ 031.

.3 VII B 10 - TAPE GENERAL, PAIRED CONFIGURATION (Contd.)

Off-line Equipment



Equipment	Rental
Universal Buffer Controller:	1,560
2 Magnetic Tapes: 90,000 char/second	1,700
Punch Card Controller:	1,365
Card Reader: 2,000 cards/minute	800
Card Punch: 100 cards/minute	350
Printer Controller: / High Speed Printer: 900 lines/minute	2,340
Total	$ 8,115

Note: Off-line system may be replaced by the Philco 1000 computer system. This will permit more powerful off-line editing and computing capabilities, relieving the central processor of much of this work.

§ 031.

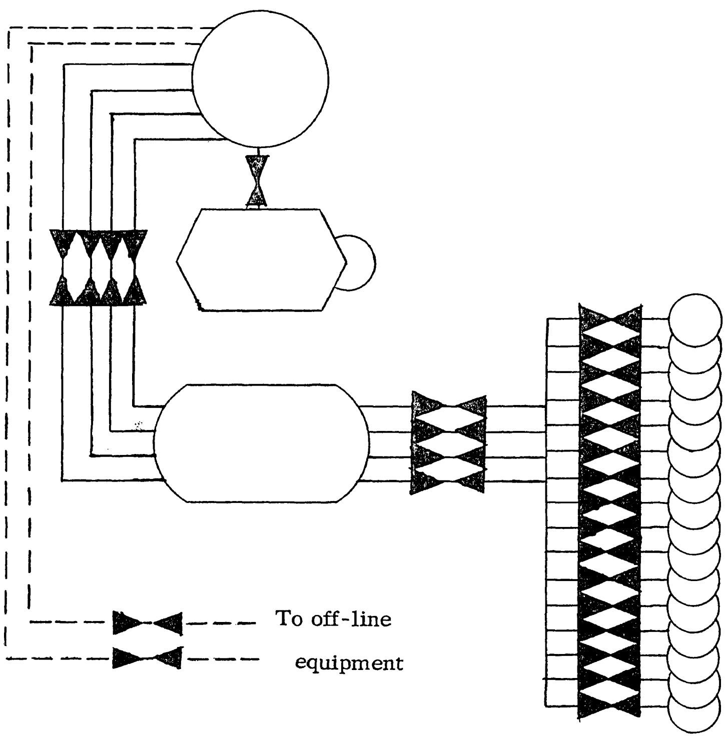
.4 VIII B 20-TAPE GENERAL, PAIRED CONFIGURATION

Deviations from Standard Configuration

On-Line: . . . . 2 fewer index registers.
magnetic tape 30,000 char/second slower.
card reader can be switched from off-line UBC.

Off-line: . . . . magnetic tape 30,000 char/second faster.
card reader faster by 1,000 cards/minute.
card punch slower by 100 cards/minute.

On-Line Equipment

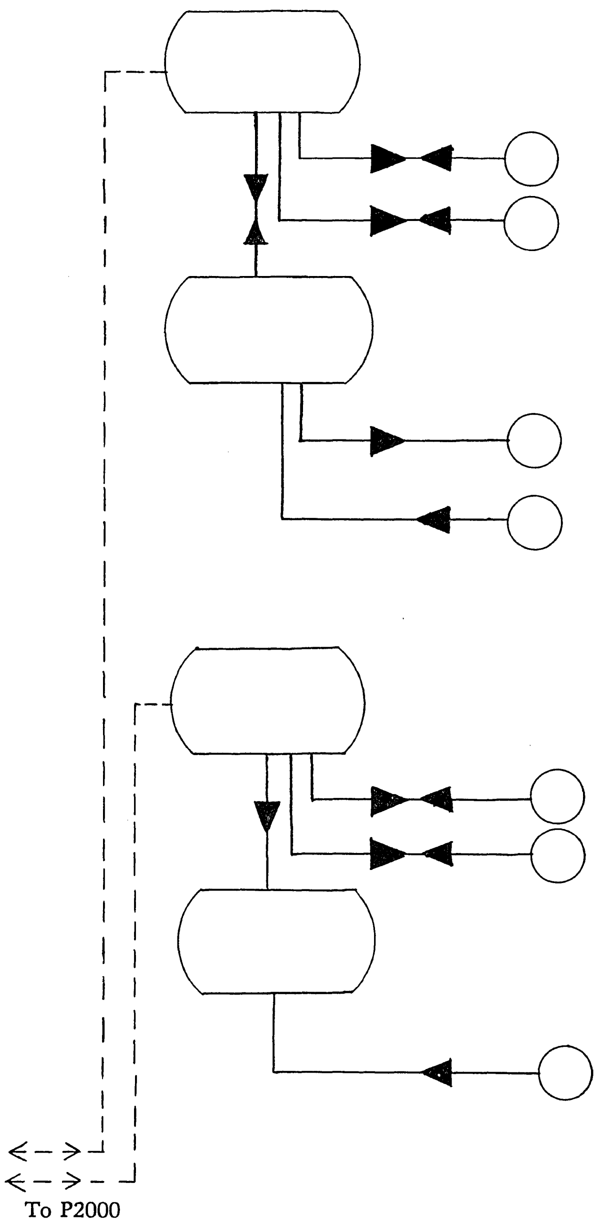


Equipment	Rental
1.5 μ sec. Core Storage:	17,900
Central Processor and Console:	11,000
	900
Typewriter	1,300
Input-Output Processor: Four multiplexed transmissions to and from magnetic tape.	8,400
16 Magnetic Tapes: 90,000 char/second	13,600
Total	53,100
Total, including off-line equipment:	$ 64,475

§ 031.

.4 VIII B 20-TAPE GENERAL, PAIRED CONFIGURATION (Contd.)

Off-Line Equipment



Equipment	Rental
Buffer Controller, Model 252:	1,560
2 Magnetic Tapes: 90,000 char/second	1,700
Punch Card Controller:	1,365
Card Reader: 2,000 cards/minute	800
Card Punch: 100 cards/minute	350
Buffer Controller, Model 252:	1,560
2 Magnetic Tapes: 90,000 char/ second	1,700
Printer Controller: High Speed Printer: 900 lines/minute	2,340
Total	$ 11,375

INTERNAL STORAGE: CORE STORAGE PARTITION

§ 042.

.1 GENERAL

.11 Identity: . . . . Partitioned 10 usec Core Storage.
P-10 Model 220.
Model 2216.
Model 2232.

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

.13 Description:

This is a partitioned version of the 16,384 or 32,768 word, 10 microsecond store. The access to each module of the store is independent, and a read phase of one access cycle in one part of the store can be overlapped with a write phase in another part. Otherwise, the operation and function is identical to the 10 microsecond store. The main differences, due to partitioning, are a reduction in the percentage demands by all peripheral units and an increase in speed of the central processor of about 25 to 40 percent.

.14 Availability: . . . . . 12 months.

.15 First Delivery: . . . . May 1961.

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Array size: . . . . . 64 bits by 64 bits.

.23 Storage Phenomenon: . . . . direction of magnetization.

.24 Recording Performance

.241 Data erasable by instruction: . . . . . 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 with overlap.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 100,000 cps.
Unit of data: . . . . . word.
Conversion factor: . . 48 bits/word.
Data rate: . . . . . . 100,000 words/sec.
Compound data rate: . . . . 100,000 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Maximum	Minimum
Identity:	Model 2232.	Model 2216.
Words:	32,768.	16,384
Characters:	262,144.	131,072.
Instructions:	65,536.	32,768.
Bits:	1,572,864.	786,432.
Modules:	4	2.

.32 Rules for Combining Modules: . . . . . . only combinations as shown above.

.4 CONTROLLER

.41 Identity: . . . . Model 220-1 and 220-2; partition for Model 2216 and Model 2232 Core Storage respectively.

.42 Connection to System

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

.43 Connection to Device

.431 Devices per controller: . . . . . . 2 or 4, 8,192 word modules.
.432 Restrictions: . . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks: . . . 2 or 4.
.512 Stack movement: . . . none.
.513 Stacks that can access any particular locations: . . . . 8,192.
.514 Accessible locations By single stack: . . . all.

.52 Simultaneous Operations: . . . . none.

§ 042.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . 4 μsec.
Cycle time: . . . . 10 μsec.
For data unit of: . . 48-bit word.

.532 Variation in access
time: . . . . access to separate modules may be overlapped.

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . yes.
With drum: . . . . . . yes.

.72 Transfer Load Size

With self: . . . . 1 word, or up to 4,095 words using repeat.
With drum: . . . . . . 4,096 words.

.73 Effective Transfer Rate

With self: . . . . . . 70,000 words/sec (**).
With drum: . . . . . . 58,500 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none.	modulo size of store.
Receipt of data:	none.	
Recording of data:	none.	
Recovery of data:	none.	

(**) Estimate based on nearly complete data and probably reliable.

INTERNAL STORAGE: 1.5μSEC. CORE STORAGE

§ 043.

.1 GENERAL

.11 Identity: . . . . 1.5 μsec. Core Storage.
Model 2108.
Model 2116.
Model 2132.

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

.13 Description:

This is a partitioned core store identical in operation and function to the 10 microsecond partitioned store (Section 262:042). The only differences are in timing. These differences reduce the percentage demands on the store by all peripheral units and increase the speed of operation of the central processor by a factor of about three over the 10 microsecond partitioned store.

.14 Availability: . . . . . 12 months.

.15 First Delivery: . . . . February 1962.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage: . . . . . . 48 + 8 bits/word.
2 words/strip.
1,024 strips/section.
4 sections/module.

.23 Storage Phenomenon: . . . . direction of magnetization.

.24 Recording Performance

.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: . . . linear select.
.283 Type of access: . . . . uniform with overlap.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 666,666 cps.
Unit of data: . . . . . 48-bit word.
Conversion factor (bits for unit): . . . 8 char/word.
Gain factor: . . . . . 2.
Data rate: . . . . . . 666,666 words/sec.
Compound data rate: . . . . 1,333,333 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
Identity:	Model 2108	Model 2116	Model 2132
Words:	8,192	16,384	32,768
Characters:	65,536	131,072	262,144
Instructions:	16,384	32,768	65,536
Bits:	393,216	786,432	1,572,864
Modules (8,192 words)	1	2	4

.32 Rules for Combining Modules: . . . . . all combinations are shown above.

.4 CONTROLLER

.41 Identity: . . . . built into core storage.

.42 Connection to System

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

.43 Connection to Device

.431 Devices per controller: . . . . . . 1, 2, or 4, 8,192 word modules.
.432 Restrictions: . . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks: . . . 1, 2 or 4.
.512 Stack movement: . . . none.
.513 Stacks that can access any particular location: . . . . . . 8,192.
.514 Accessible locations By single stack: . . . all.

.52 Simultaneous Operations: . . . . none.

§ 043.

.53 Access Time Parameters and Variations

.531 For uniform access
- Access time: . . . . 0.6 to 0.7 μsec.
- Cycle time: . . . . 1.5 μsec.
- For data unit of: . . 48-bit word.

.532 Variation in access time: . . . . access to separate modules may be overlapped.

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
- With self: . . . . . yes.
- With drum: . . . . . yes.

.72 Transfer Load Size
- With self: . . . . . 1 word, or up to 4,095 words using repeat.
- With drum: . . . . . 4,096 words.

.73 Effective Transfer Rate
- With self: . . . . . 111,111 words/sec.
- With drum: . . . . . 58,500 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none.	modulo size of store.
Receipt of data:	none.	
Recording of data:	none.	
Recovery of data:	none.	

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . Central Processor. Model 211.

.12 Description

The Model 211 Central Processor is a faster version of the Model 210. The increase in speed is accomplished by use of faster circuitry. In all programming aspects, the two central processors are identical, with upward compatibility of programs and software systems. The only paragraphs that differ from those describing the 210 are 652:051.33, .134, and .4.

The Model 211 can utilize any of several core storage systems: the 10 microsecond store, the partitioned 10 microsecond store (using the Model 220 Partition Controller), or the 1.5 microsecond store. By using the partitioned 10 microsecond or the 1.5 microsecond device, real-time data access and automatic interrupt can be incorporated into the 211 system. The Real-Time Scanner, Auto-Control Unit and Interval Timer provide this facility.

All other input-output devices as used in the 210 systems are employed in the 211 systems in an identical manner. The central processor console and operating controls are identical to the Model 210.

.13 Availability: . . . . . . 12 months.

.14 First Delivery: . . . . late 1960.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-Subtract:	automatic	binary	48-bit.
	Multiply			
	Short-rounded:	automatic	binary	48-bit.
	Long:	automatic	binary	96-bit.
	Divide			
	No remainder-rounded:	automatic	binary	48-bit.
	Remainder:	automatic	binary	96-bit.
.212	Floating point			
	Add-Subtract:	automatic	binary	12 & 36-bit.
	Multiply			
	Short:	automatic	binary	12 & 36-bit.
	Long:	automatic	binary	12 & 72-bit.
	No remainder-rounded:	automatic	binary	12 & 36-bit.
	Remainder			
	Quotient:	automatic	binary	12 & 36-bit.
	Remainder:	automatic	binary	12 & 36-bit.
.213	Boolean			
	AND:	automatic	binary	0 to 48 bits.
	Inclusive OR:	automatic	binary	0 to 48 bits.
	Exclusive OR:	automatic	binary	0 to 48 bits.
.214	Comparison			
	Numbers:	automatic	equal, greater than or equal	1 word.
	Absolute:	none		
	Letters:	automatic		1 word.
	Mixed:	automatic		1 word.
	Collating sequence:	0 to 9, A to Z with special characters interspersed; see Data Code Table No. 1.		

.215 Code translation: . . . automatic translation between Hollerith and internal Philco code provided in input-output equipment. Other translations (e.g., binary to octal, etc.) are programmed functions via standard subroutines.

.216 Radix conversion

Provision	From	To	Size
Subroutine	fixed point	floating point	48-bit.
Subroutine	floating point	fixed point	48-bit.
Subroutine	decimal	binary	48-bit.
Subroutine	binary	decimal	48-bit.

.217 Edit format

	Provision	Size
Alter size:	none	1 word.
Round off:	none.	
Insert point:	none.	
Insert spaces:	none.	
Insert:	none.	
Float:	none.	
Protection:	none.	

.218 Table look-up

Equality:	subroutine.
Greater than:	none.
Greatest:	none.
Least:	none.

.219 Others

Repeat: . . . . repeat 1 or 2 instructions, 0 to 4,095 times.

Branch on odd or even, positive or negative numbers: . . . . . . automatic 1 bit shift, 0 to 63 times.

Check status of counters and fault registers in input-output system (skip instructions): . . . . allows determination of acceptance and/or status of input-output order and status of input-output equipment on-line.

.22 Special Cases of Operands

.221 Negative numbers: . . . two's complement with sign as most significant bit in word.

§ 051.

.222 Zero: . . . . positive only; fixed point is 48 zeros in word; floating point zero contains a 1 bit in exponent sign.

.223 Operand size determination: . . . . fixed.

.23 Instruction Formats

.231 Instruction structure: half word; 1 word for input-output orders.

.232 Instruction layout:

NAME	S	A	F	C
SIZE, BITS	1	15	1	7

Non-indexable

NAME	S	N	V	F	C
SIZE, BITS	1	3-5	10-12	1	7

Indexable

NAME	Not used	NBS	Not Used	IOP CH.	Not used	NBP	FROM	TO
SIZE, BITS	12	4	4	4	12	4	4	4

Input-Output (tape)

NAME	S	UNIT	SC	CQ	F	C
SIZE, BITS	1	4	2	9	1	7

Skip

.233 Instruction parts

Name	Purpose
S :	selector list set to 1 indicates the instruction is indexable and the reduced address field is used; if set to 0, the full address field is used.
A :	address field.
F :	F bit is 1 in floating point instr. or in branch to instruction in right half of word.
N :	specifies index register referenced - field size varies with number of index registers in central processor.
V :	value added to contents of specified index register to form operand's effective addresses.
C :	command includes F-bit.
NBS :	number of blocks on MT to space over.
IOP CH :	logical MT number.
NBP :	number of blocks of MT to transfer.
FROM :	from device.
TO :.	to device.
UNIT :	unit to check for count or faults.
SC :	subcommand of skip instruction.
CQ:	comparison quantity.

.234 Basic address structure: 1 + 0.

.235 Literals

Arithmetic: . . . . . . none.

Comparisons and tests: . . . . none.

Incrementing modifiers (repeat and index register control): . . 12 bits (maximum value 4, 095).

.236 Directly addressed operands

.2361 Internal storage type: core.
Minimum size: . . . . 1 word.
Maximum size: . . . . 1 word.
Volume accessible: . . 32, 768 words.

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

.237 Address indexing

.2371 Number of methods: . 1.

.2372 Names: . . . . indexing.

.2373 Indexing rule: . . . . . addition, modulo 32, 767.

.2374 Index specification: . . N field of indexable instruction.

.2375 Number of potential indexers: . . . . . . 8, 16, or 32 optional index registers.

.2376 Addresses which can be indexed: . . . . . all instructions except repeat, skip, and input-output.

.2377 Cumulative indexing: . none.

.2378 Combined index and step: . . . . yes; index register can be automatically incremented by one if counter bit is set to 1.

.238 Indirect addressing: . . none.

.239 Stepping

.2391 Specification of increment: . . . . . index register counter bit specifies automatic increment of 1 as referencing indexable instruction is executed. Stepping index register instructions hold increment or decrement to maximum value of 4, 095. Data register may hold increment or decrement of 0 to 32, 767.

.2392 Increment sign: . . . . none; considered absolute value.

.2393 Size of increment: . . 0 to 32, 767.

.2394 End value: . . . . . . specified in test instruction.

.2395 Combined step and test: . . . . for increment or decrement of up to 5 digits (maximum value of 32, 767).

§ 051.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in bits	Program usage
Processor:	3	48	arithmetic, data manipulation.
Processor:	2	15	program control.
Processor:	1	16	program control.
Processor:	8, 16, or 32	16	indexing.
Processor:	1	48	instruction register.
Processor:	1	18	repeat control.
Processor:	1	48	hold input-output order.
I/O Processor:	1	8	assembler availability.
I/O Processor:	1, 2, 3, or 4	10	assembler fault.
I/O Processor:	1, 2, 3, or 4	12	assembler counter.
I/O Processor:	16	4	unit availability.

Note: I/O Processor counters and fault registers may be interrogated from the Central Processor.

.242

Category of storage	Total number locations	Physical form	Access time, μsec
Processor:	17 to 41	flip-flop	approx. 0.1
I/O Processor:	4 to 25	flip-flop	approx. 0.1

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . 1.

.314 Special sub-sequence counters
Number: . . . . 1.
Purpose: . . . . repeat counter.

.315 Sequence control step size: . . . . instruction pairs.

.316 Accessibility to routines: . . . . available immediately after a jump is performed.

.317 Permanent or optional modifier: . . . . none.

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

.33 Interruption

.331 Possible causes: . . . . any of 48 conditions in central processor, input-output, and/or real-time devices capable of emitting a signal are possible interrupt criteria. Interrupt occurs via the Model 401, 404 or 408 Auto-Control Unit.

.332 Control by routine
Individual control: . . interrupt by from 1 to 48 possible conditions.
Method: . . . . programmer sets mask in Auto-Control Unit.
Restriction: . . . . . none.

.333 Operator control: . . . operator may enter instruction via central processor console to set new mask in Auto-Control Mask Register.

.334 Interruption conditions: mask bits set to one; no interrupt if mask bit is zero.

.335 Interruption process: refer to Auto-Control Unit description, Section 652: 106.

.336 Control methods
Determine cause: . . masked interrupt bits from Auto-Control register are automatically transferred to core storage location MASK + 1 and may be examined by an executive routine to determine the particular interrupt condition.
Enable interruption: . an executive routine preserves and restores all registers, allowing a return to an interruptable routine.

.34 Multi-running: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

Conditions

I : . . . . 1.5 μsec store.
II : . . . . 10.0 μsec partitioned store, would have intermediate values.
III: . . . . 10.0 μsec store.

.41 Instruction Times in μsecs

		I	II	III
.411	Fixed point			
	Add-subtract:	3.6		15.0.
	Multiply:	44.5		53.0.
	Divide:	45.6		54.1.
.412	Floating point			
	Add-subtract:	7.6		16.1.
	Multiply:	34.4		42.9.
	Divide:	36.2		44.7.
.413	Additional allowance for			
	Indexing:	0.0		0.0.
.414	Control			
	Branch:	4.5		8.8.
	Compare and branch:	4.5		8.8.
.415	Counter control			
	Step:	3.0		7.3.
	Step and test:	3.0		7.3.
.418	Shift:	2.7+0.85N		2.0+ 0.85N.

.42 Processor Performance in μsecs

		I Fixed point	III Fixed point	I Floating point	III Floating point
.421	For random addresses				
	$c = a + b$:	8.0	45.0	12.0	46.1.
	$b = a + b$:	6.5	32.1	10.5	36.1.
	Sum N items:	3.6	10.0	7.6	11.1.
	$c = ab$:	48.9	83.0	38.8	72.9.
	$c = a/b$:	50.0	84.7	40.6	74.7.
.422	For arrays of data				
	$c_i = a_i + b_j$:	13.8	59.4	17.8	60.5.
	$b_j = a_i + b_j$:	5.1	22.1	9.1	26.1.
	Sum N items:	2.8	10.0	6.8	10.0
	$c = c + a_i b_j$:	54.8	71.8	50.1	67.1.

§ 051.

.423 Branch based on comparison

	I	III
Numeric data:	7.4+19.9 N	37.9+89.1 N.
Alphabetic data: . . .	7.4+22.1 N	37.9+96.4 N.

.424 Switching

Unchecked:	12.5	53.8.
Checked:	29.2	102.4.
List search:	4.0	11.8.

.425 Format control per character

Unpack:	3.0	6.6.
Compose:	42.1	149.6.

.426 Table look-up per comparison

For a match:	4.0	11.8.
For least or greatest:	1.5	10.0.
For interpolation point:	4.7	11.8.

.427 Bit indicator

Set bit in separate location:	2.8	10.6.
Test bit in separate location:	4.5	8.8.

.428 Moving: . . . . 4.5 20.0.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	indicator.
Underflow:	check	error jump and alarm.
Zero divisor:	check	signal and indicator.
Invalid data:	none.	
Invalid operation:	check	stop.
Arithmetic error:	none.	
Invalid address:	check	stop and alarm.
Receipt of data:	parity check	indicator and alarm.
Dispatch of data:	parity check	indicator and alarm.

INPUT-OUTPUT: AUTO CONTROL UNIT

§ 106.

.1 GENERAL

.11 Identity: . . . . Auto Control Unit.
Model 401.
Model 404.
Model 408.
ACU.

.12 Description

A Philco 211 system using either the partitioned 10 microsecond or the 1.5 microsecond core storage can incorporate real time capabilities by use of an Auto-Control Unit. This unit provides for automatic interrupt based on any of 48 different conditions arising within the computer system or some external source. A Real-Time Scanner associated with the Auto-Control unit is capable of scanning 1, 4 or 8 real time channels in the Models 401, 404 and 408, respectively. Scan time is 0.2 microseconds between successive channels. The acceptance or rejection of an interrupt is specified by the programmer setting a mask in the Auto-Control register. Receipt of an acceptable interrupt signal causes that corresponding bit, or bits, in the Auto-Control register to be cleared, and the remainder of the mask preserved in core storage. An executive routine is thus permitted to retain interrupt priorities. All central processor registers must be preserved and restored by the executive routine.

Two additional jump instructions are provided in the Model 211 Central Processor when used with the Auto-Control Unit. These permit unconditional jumps without disturbing the contents of the central processor Jump Address Register, allowing easy return to the interrupted routine.

INPUT-OUTPUT: INTERVAL TIMER

§ 107.

.1 GENERAL

.11 Identity: . . . . Interval Timer.
Model 402.

.12 Description

The Model 402 Interval Timer allows programmed reference to time information transmitted via the Auto-Control Unit. The Interval Timer can be set by program to any value not exceeding 25 bits, allowing up to 9.32 hours decrementing time. Once set, automatic one millisecond decrementing occurs until the timer is decremented to zero; then the Auto-Control Unit is signaled. In addition, the timer may be read out by issuance of a real-time I/O instruction.

§ 121.

INSTRUCTION LIST

NOTE: Two additional instructions are provided in the Model 211 for use with the Auto-Control Unit in real-time processing. All other instructions of the Model 211 Central Processor are identical with the Model 210. (See 651:121.101)

INSTRUCTION			OPERATION
F	OP CODE	ADDRESS	
	JL	M	Unconditional jump to left hand instruction in M; Jump Address Register is not disturbed.
	JR	M	Unconditional jump to right hand instruction in M; Jump Address Register is not disturbed.

PHILCO 2000-211
SYSTEM PERFORMANCE

PHILCO 2000-211 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration: VIII B unblocked		VIII B blocked		VII B unblocked		VII B blocked		Reference
1 INPUT-OUTPUT TIMES	Char/block	(File 1)	1,024		1,024		1,024		1,024		4:200.112
	Records/block	K (File 1)	10		10		10		10		
	m.sec/block	File 1 = File 2	11.4		11.4		11.4		11.4		
		File 3	11.4		11.4†		11.4		11.4†		
		File 4	11.4		11.4††		11.4		11.4††		
	m. sec/switch	File 1 = File 2	0		0		0		0		
		File 3	0		0		0		0		
		File 4	0		0		0		0		
	m. sec penalty	File 1 = File 2	0.92		0.92		1.28		1.28		
		File 3	0.92		0.07		1.28		0.11		
		File 4	0.92		0.03		1.28		0.22		
2 CENTRAL PROCESSOR TIMES	m. sec/block	a1	0.056		0.056		0.205		0.205		4:200.1132
	m. sec/record	a2	0.189		0.189		0.658		0.658		
	m. sec/detail	b6	0.264		0.264		0.614		0.614		
	m. sec/work	b5 + b9	1.168		1.168		3.165		3.165		
	m. sec/report	b7 + b8	5.146		5.146		18.488		18.488		
3 STANDARD PROBLEM A F = 1.0	m. sec for C. P. and dominant column.	a1	0.1		0.1		0.20		0.20		4:200.114
		a2 K	1.9		1.9		6.58		6.58		
		a3 K	66.1		66.1		222.67		222.67		
		File 1 Master In	0.9		0.2		1.28	11.4	1.28	11.4	
		File 2 Master Out	0.9		0.2		1.28		1.28		
		File 3 Details	9.2	114.0	0.2	11.4	12.8	114.0	1.1	11.4	
		File 4 Reports	9.2		0.7		12.8		2.2		
		Total	88.3	114.0	69.4	11.4	257.61	125.4	235.31	22.8	
4 STANDARD PROBLEM A SPACE	Unit of measure	(words)									4:200.1151
		Std. routines	187		187		187		187		
		Fixed	0		0		0		0		
		3 (Blocks 1 to 23)	87		87		87		87		
		6 (Blocks 24 to 48)	684		684		684		684		
		Files	1,024		1,024		1,024		1,024		
		Working	100		100		100		100		
		Total	2,082		2,082		2,082		2,082		

† 10 details per block. †† 5 reports per block.

PHILCO 2000-211 SYSTEM PERFORMANCE—Contd.

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration				Reference
				VII B unblocked	VII B blocked	VIII B unblocked	VIII B blocked	
5 STANDARD MATHEMATICAL PROBLEM A	Fixed/Floating point			Floating	Floating	Floating	Floating	4:200.413
	Unit name	input		234	234			
		output		234	234			
	Size of record, words	input		10	10			
		output		23	23			
	m. sec/record	input	T1	11.4	0.95	11.4	0.95	
		output	T2	11.4	2.28			
	m. sec penalty	input	T3	1.28	0.11			
		output	T4	1.28	0.26			
	m. sec/record		T5	0.58	0.58	0.23	0.23	
	m. sec/5 loops		T6	1.84	1.84	0.73	0.73	
	m. sec/report		T7	1.91	1.91	0.74	0.74	
7 STANDARD STATISTICAL PROBLEM A	Unit name				234			4:200.512
	Size of block, words				128			
	Records/block		B		12		12	
	m. sec/block		T1		11.4		11.4	
	m. sec penalty		T3		0.1		0.02	
	C. P.	m. sec block	T5		0.044		0.010	
		m. sec record	T6		0.152		0.029	
		m. sec table	T7		0.320		0.163	

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

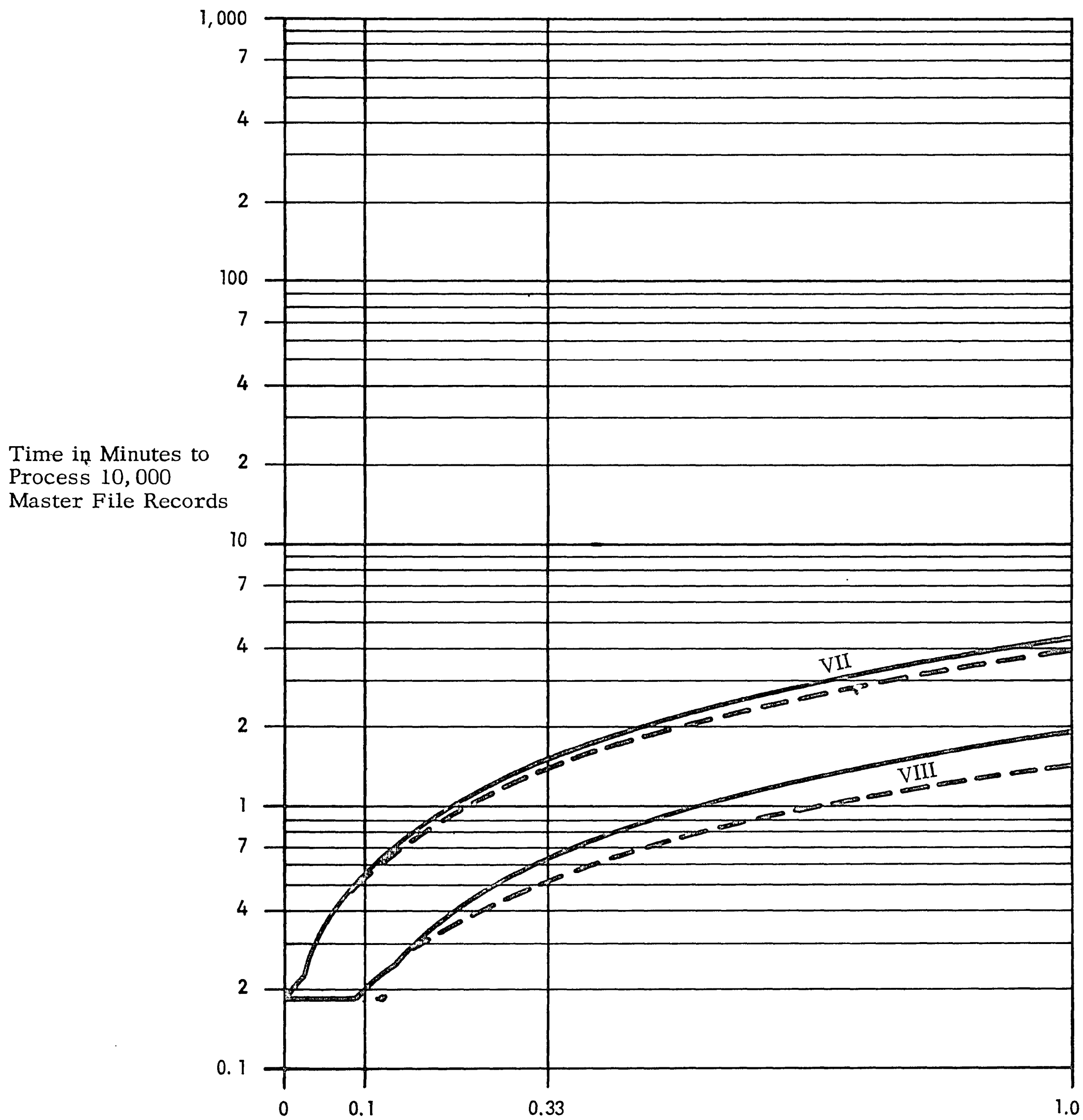
.111 Record Sizes
- Master File: . . . . . 108 characters.
- Detail File: . . . . . 1 card.
- Report File: . . . . . 1 line.

.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 VII B . . 3,000 words.
- Configuration VIII B . 3,000 words.



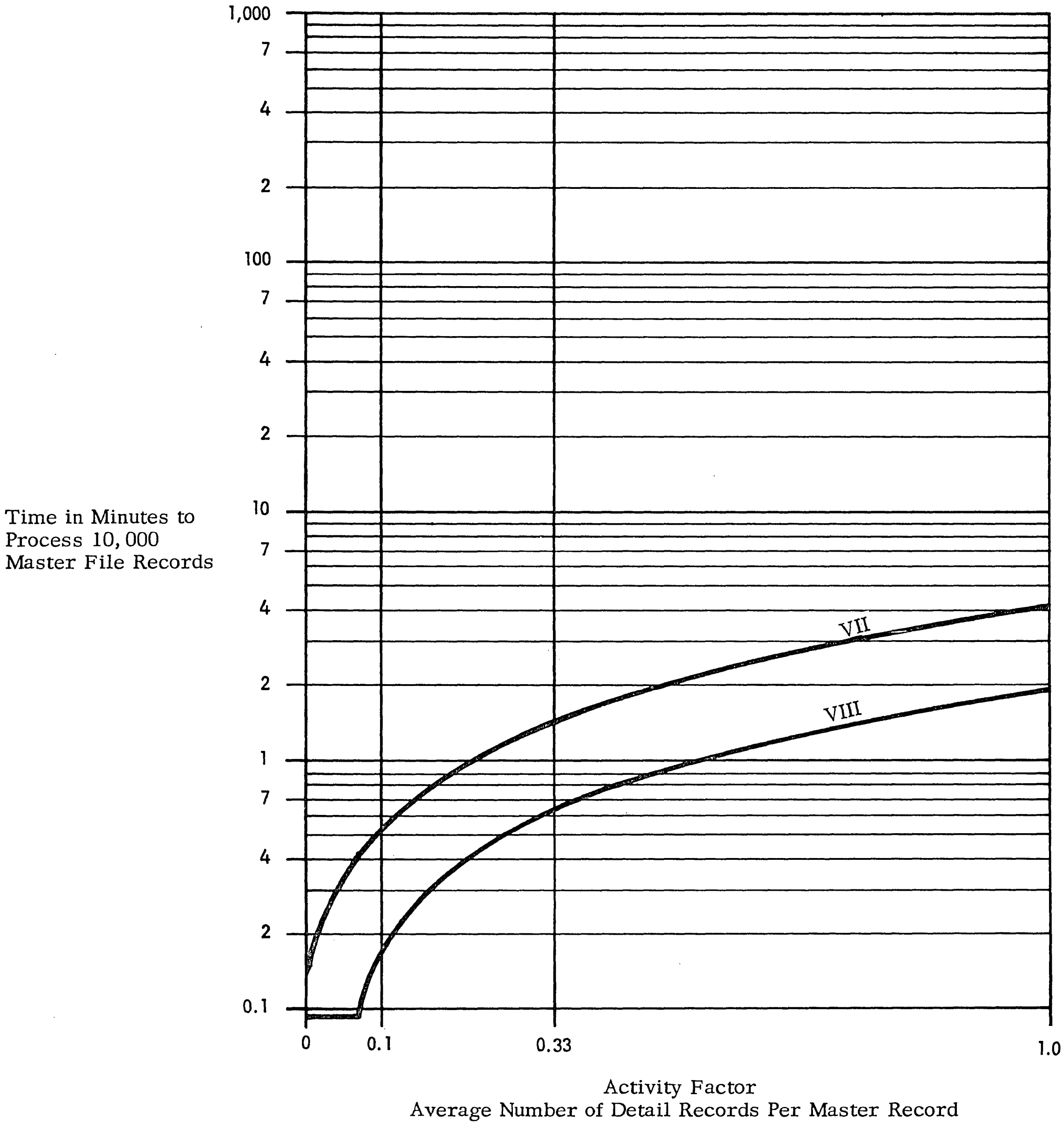
Activity Factor
Average Number of Detail Records Per Master Record
Broken line indicates blocked detail and report files

§ 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.

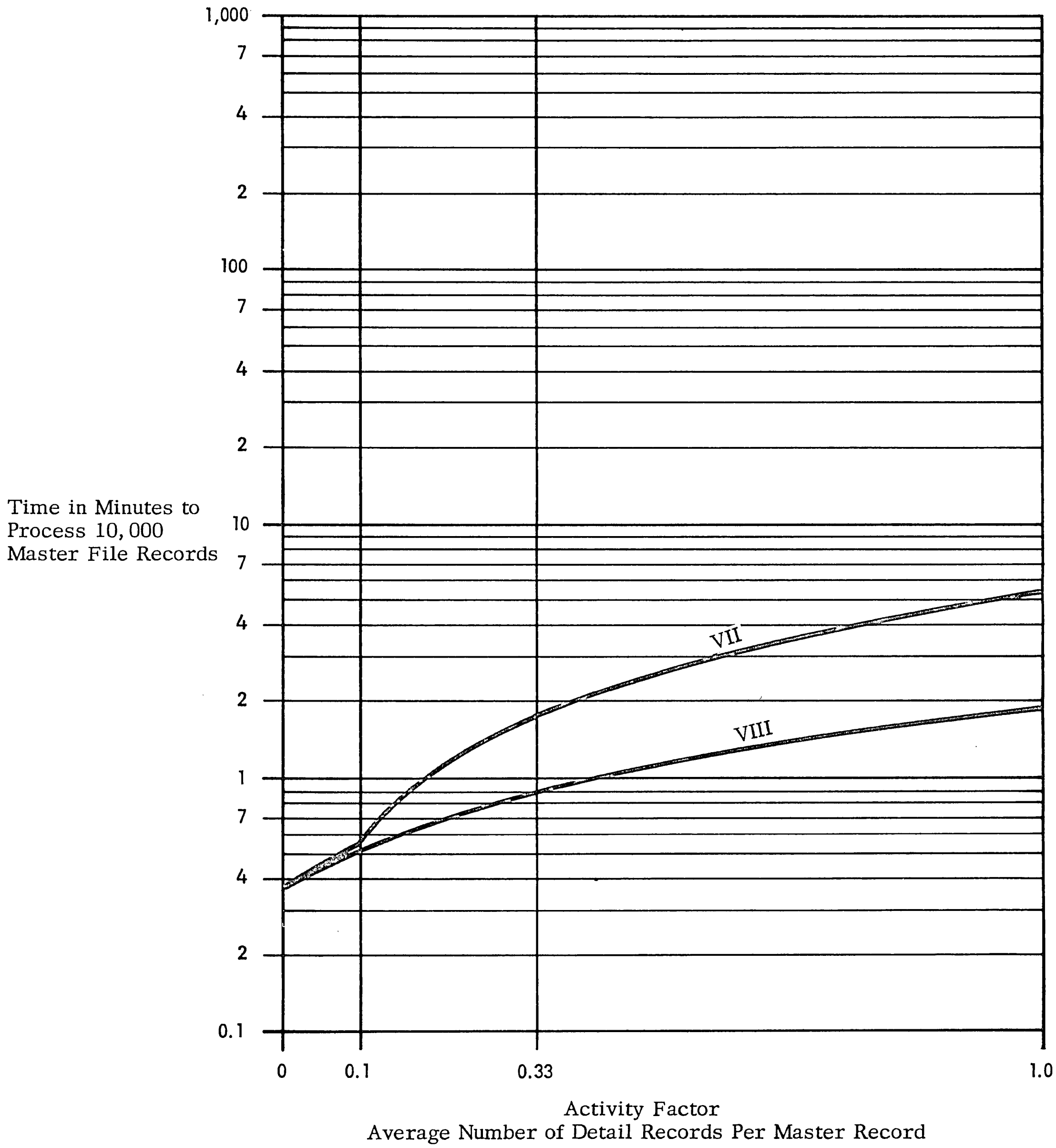


§ 201.

.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 estimated procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . see graph below.

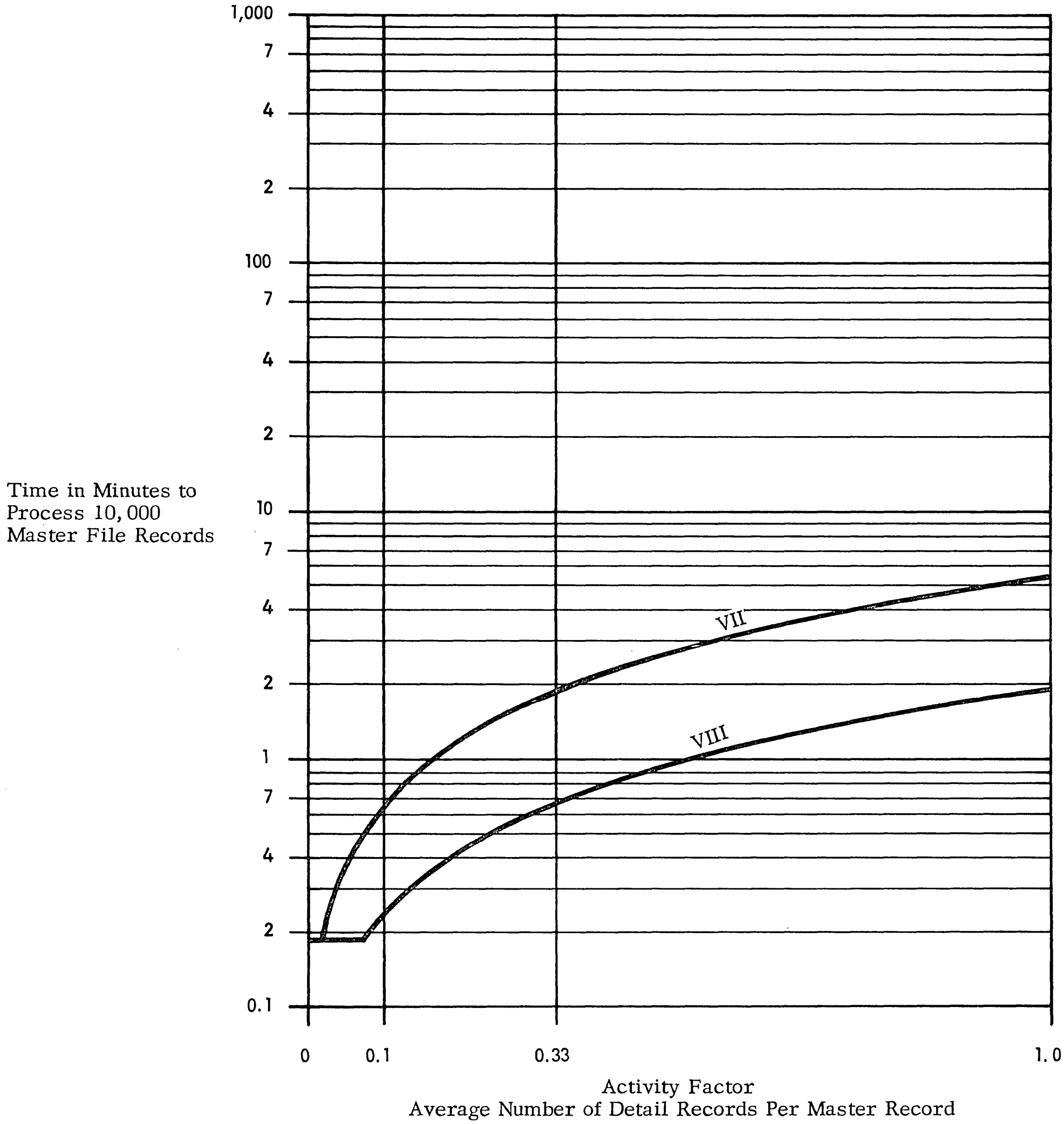


§ 201.

.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 estimated procedure outlined in Users' Guide, 4:200.13
.144 Graph: . . . . see graph below.

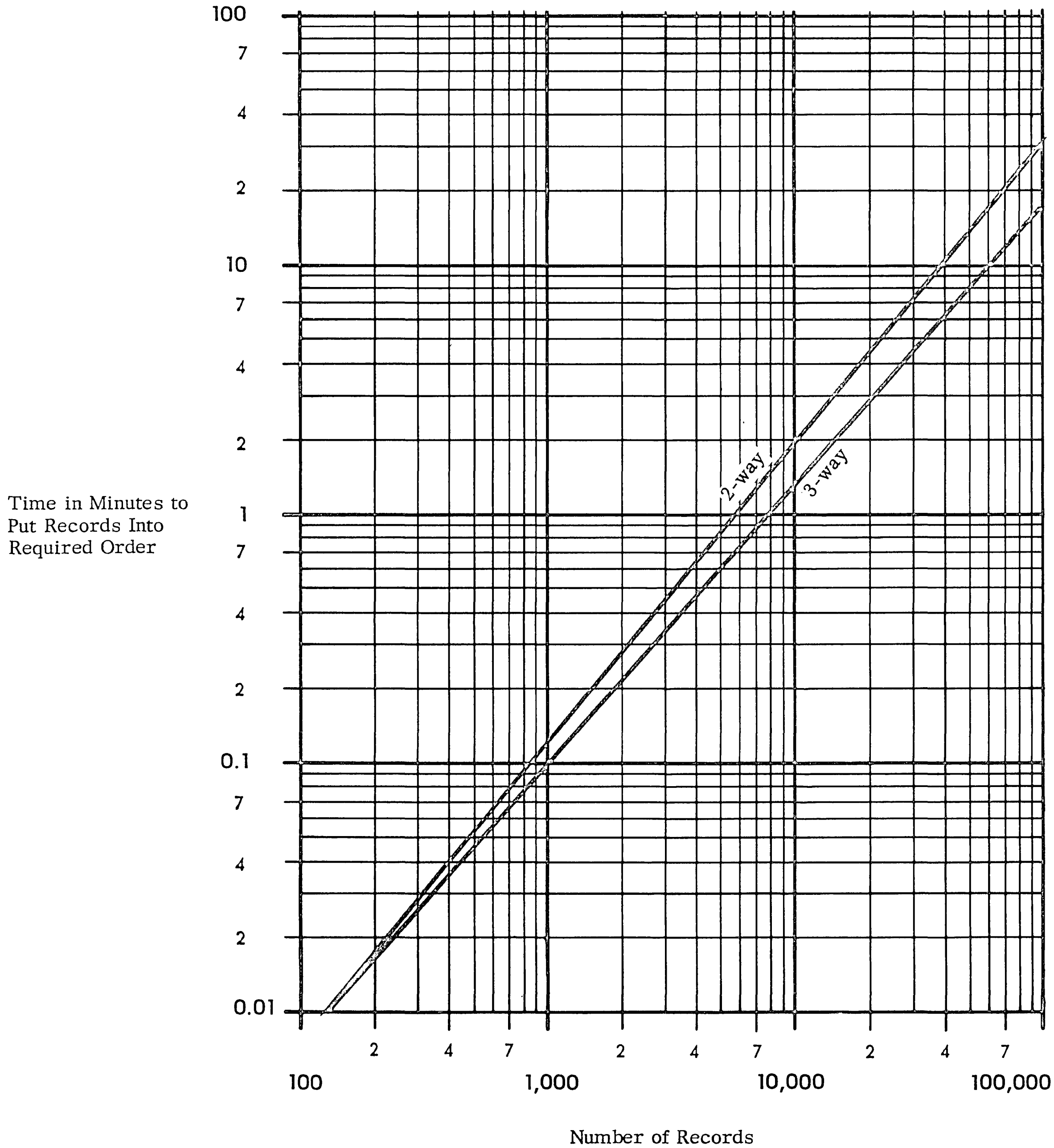


§ 201.

.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.
.212 Key size: . . . . 8 characters.
.213 Timing basis: . . . . . using estimated procedure outlined in User's Guide, 4:200.213.
.214 Graph: . . . . see graph below.



§ 201.

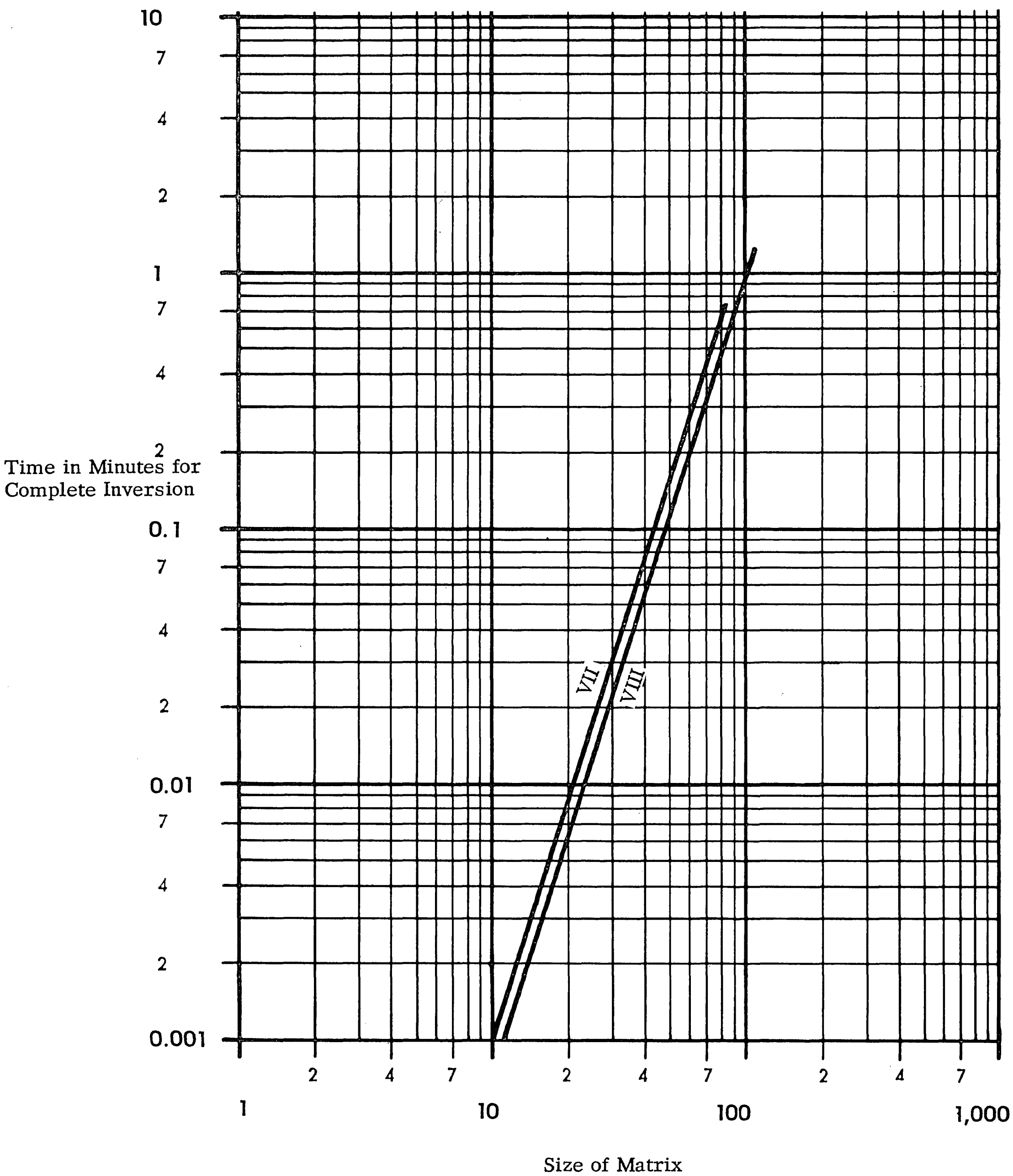
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic Parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing Basis: . . . . using estimated procedure outlined in Users' Guide, 4:200.312.

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

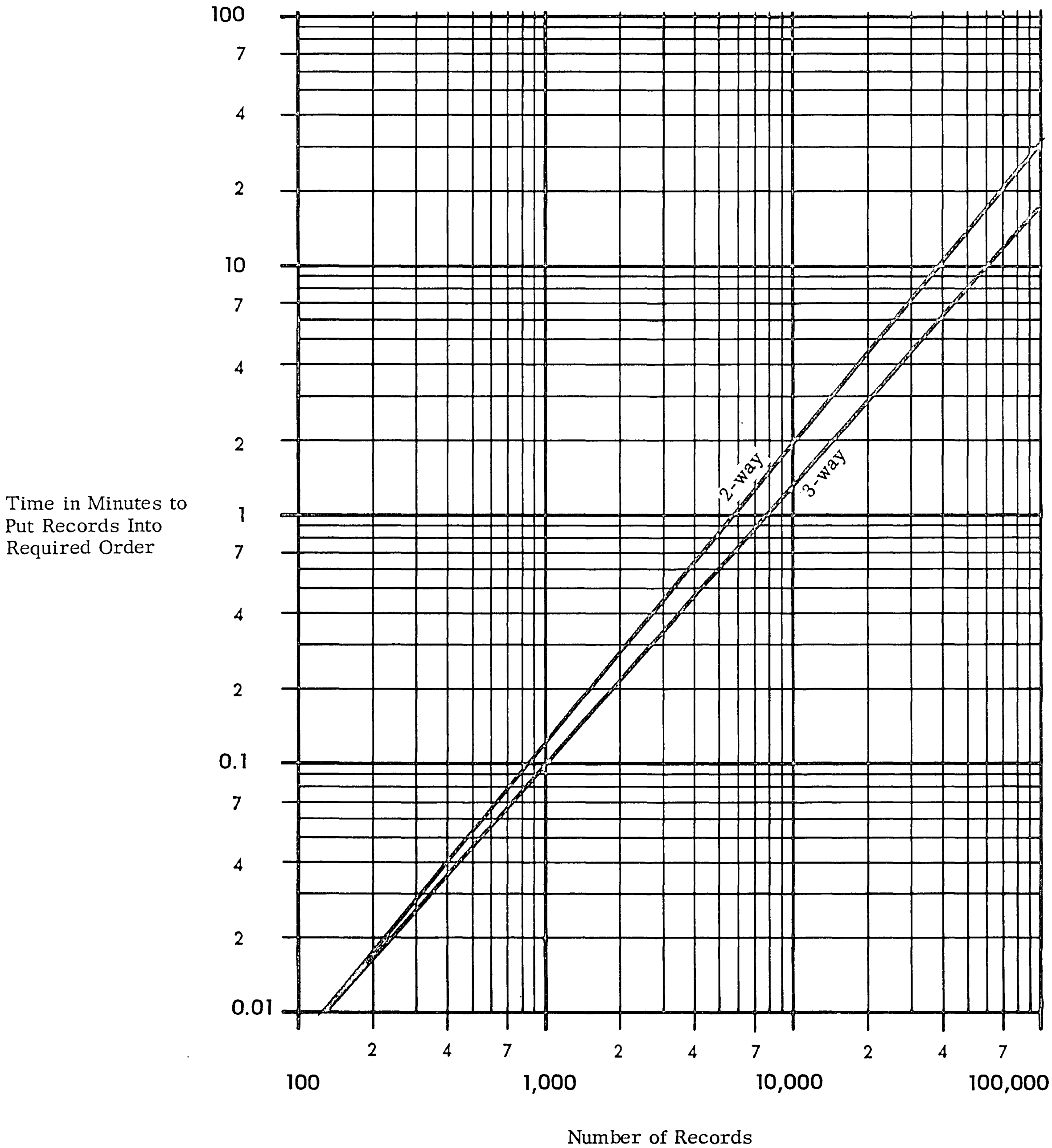


§ 201.

.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.
.212 Key size: . . . . 8 characters.
.213 Timing basis: . . . . . using estimated procedure outlined in User's Guide, 4:200.213.
.214 Graph: . . . . see graph below.



§ 201.

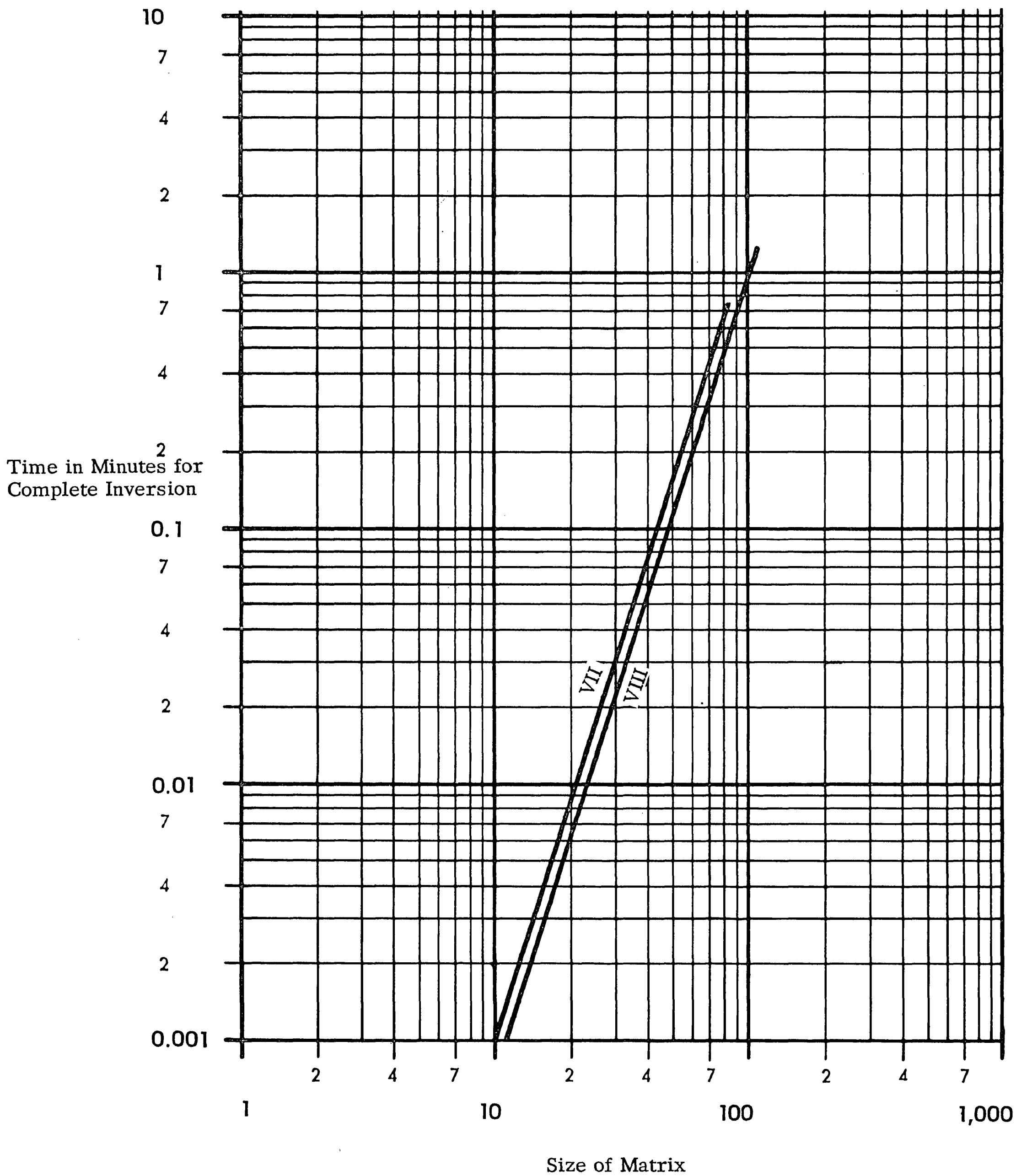
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic Parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing Basis: . . . . using estimated procedure outlined in Users' Guide, 4:200.312.

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



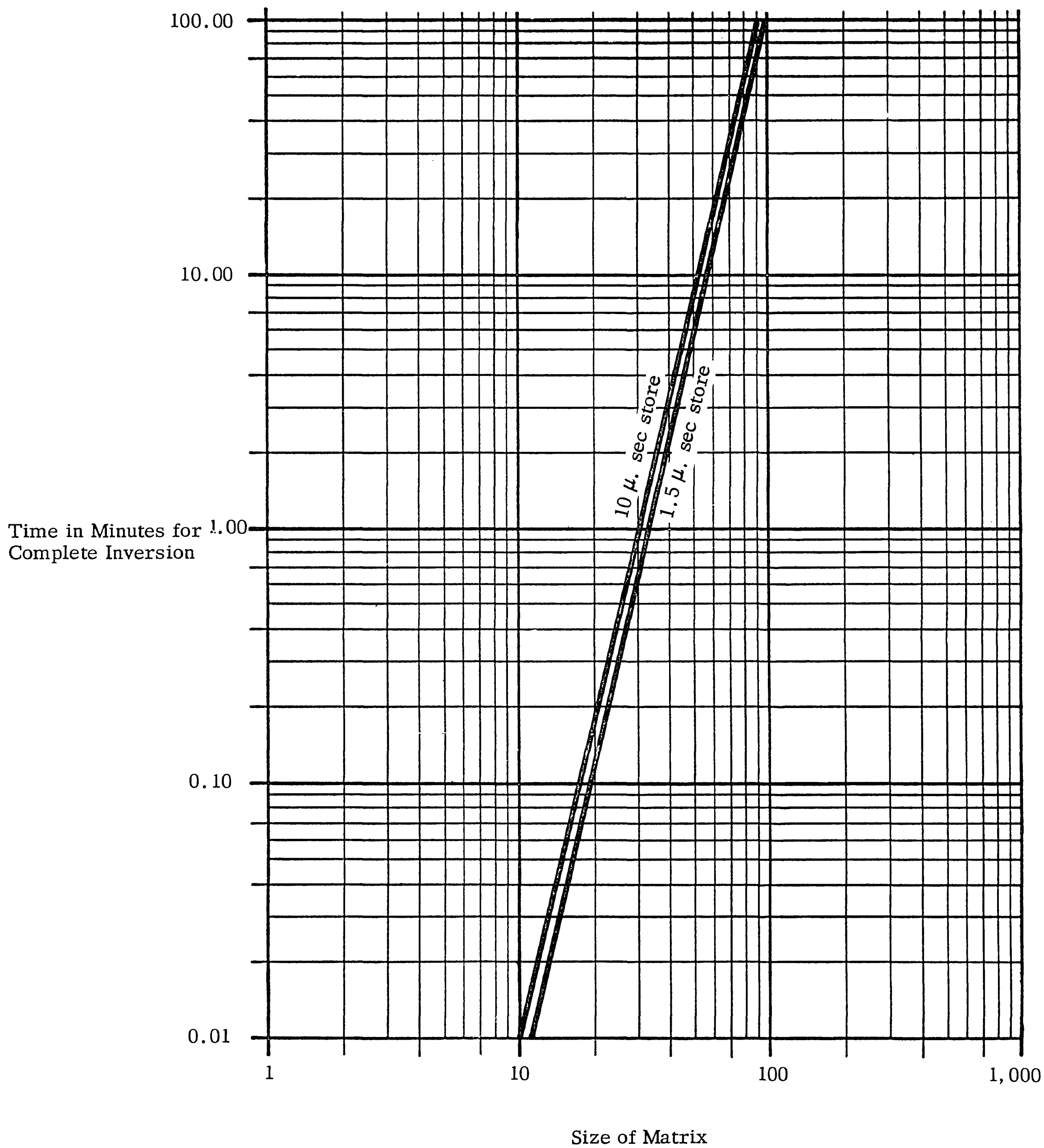
§ 201.

.32 Standard Routine Times

.321 Basic Parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.322 Timing Basis: . . . . . standard floating point.

.323 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.

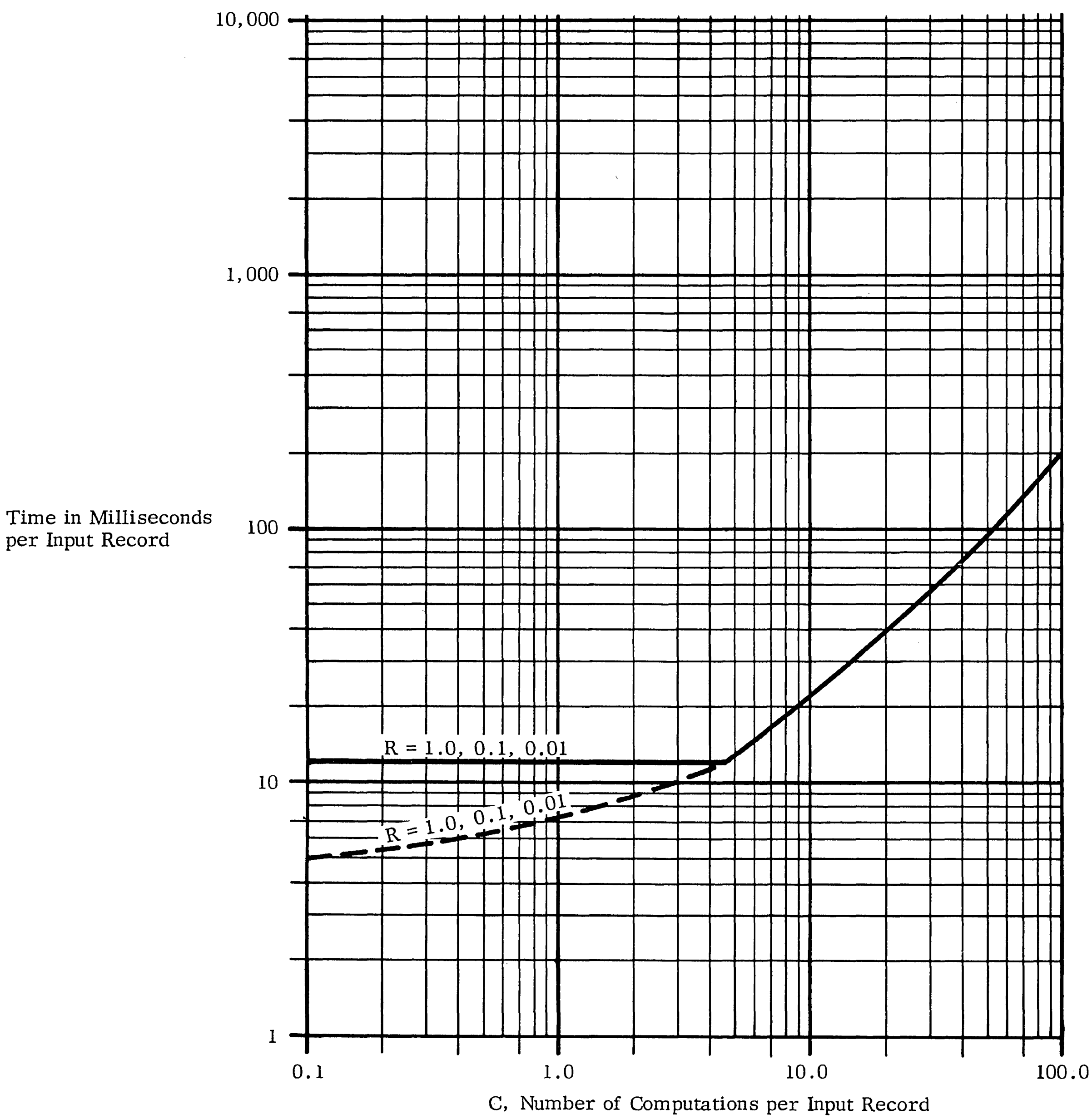
.412 Computation: . . . . . 5 fifth-order polynomials.
5 divisions.
1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: see graph below.

Configuration VIIB 10 u sec store; Single Length (12 digit precision); floating point.

R = Number of Output Records per Input Record



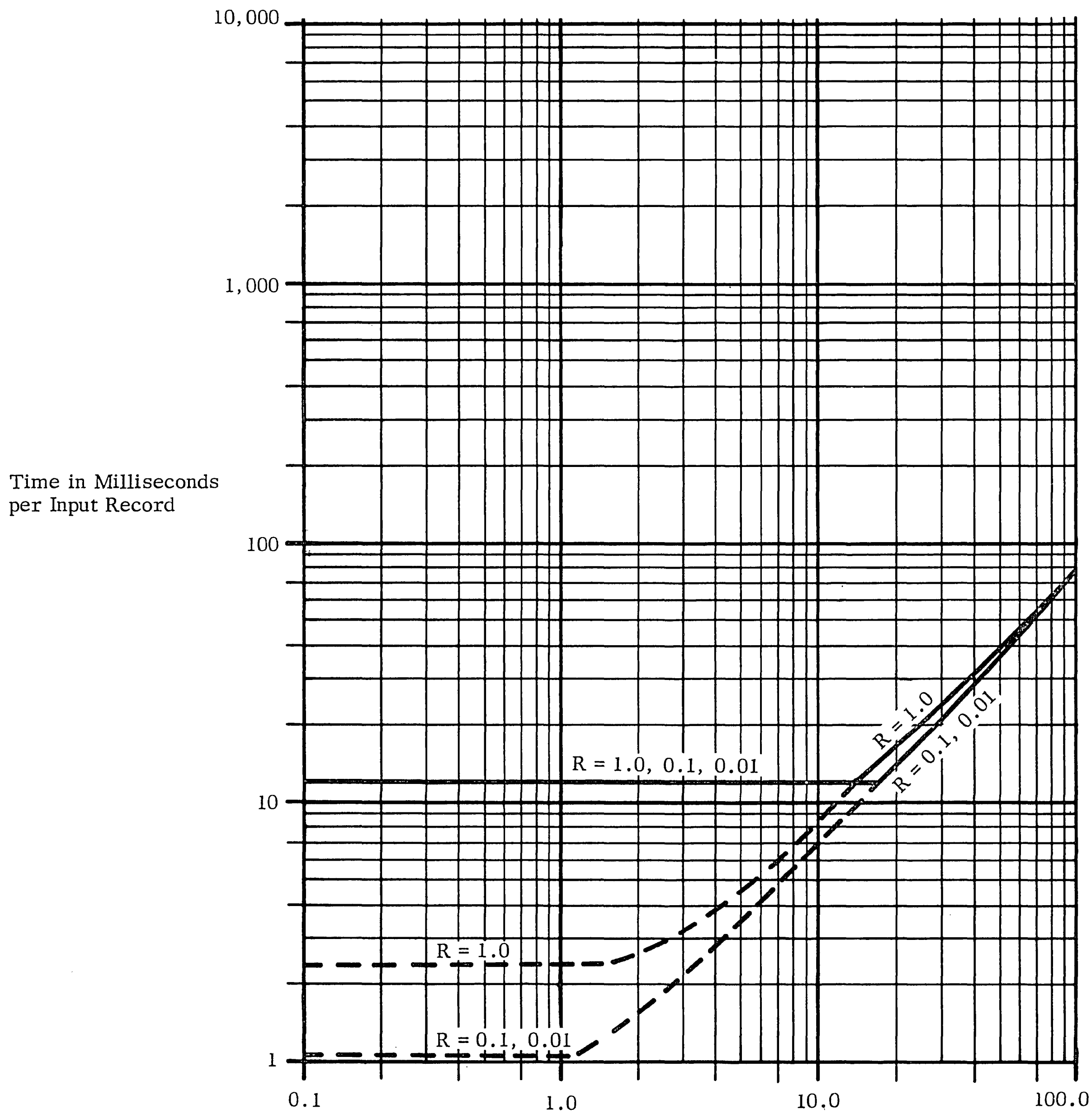
Broken lines indicate blocked records.

§ 201.

.415 Graph: . . . . see graph below.

Configuration VIIIB 1.5 u.sec store; Single Length (12 digit precision); floating point.

R = Number of Output Records per Input Record



C, Number of Computations per Input Record

Broken lines indicate blocked records.

§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

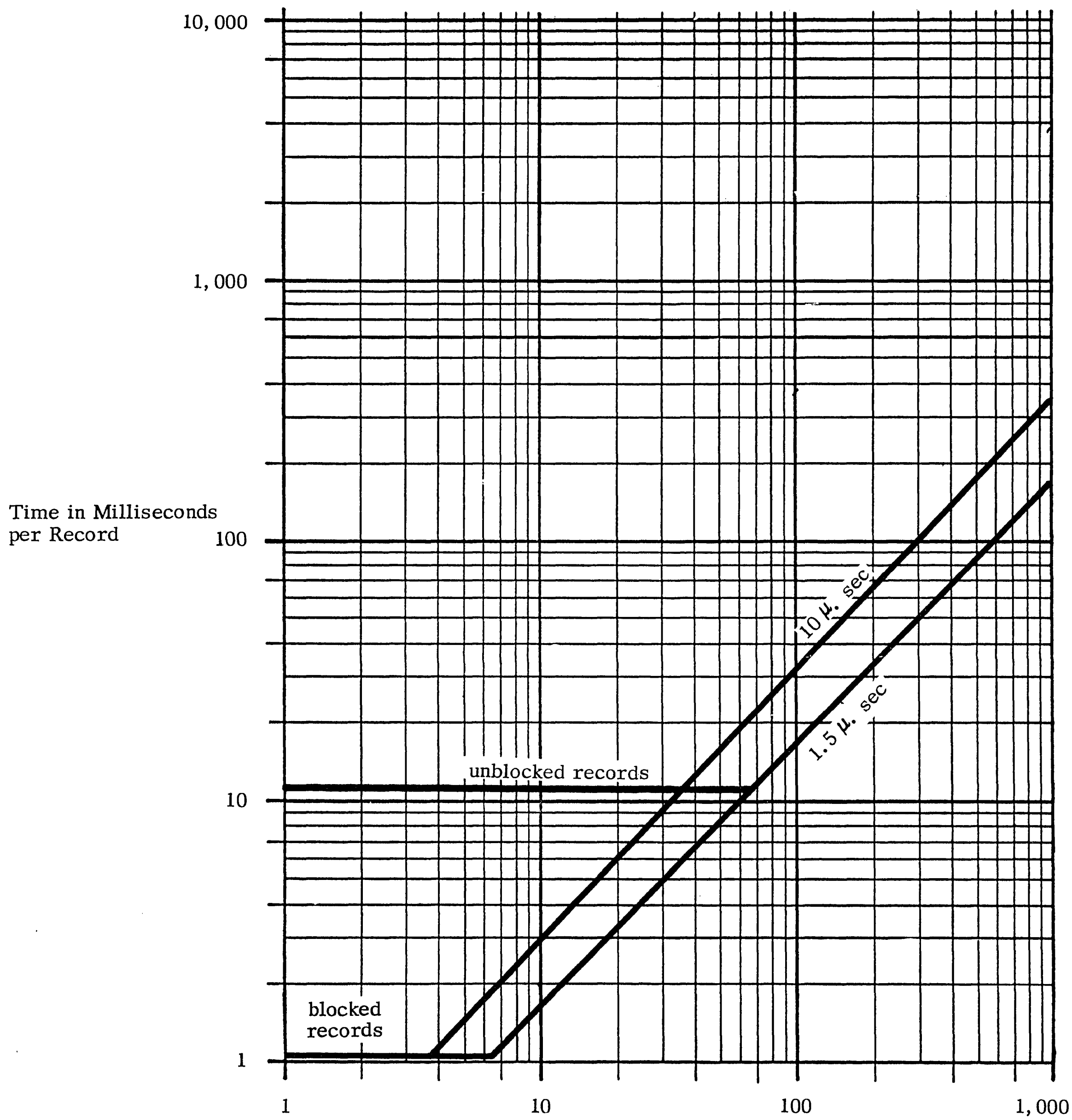
.51 Standard Statistical Problem A Estimates

.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 below.



T, Number of Augmented Elements
Roman numerals denote Standard Configurations

PHILCO 2000-211
PHYSICAL CHARACTERISTICS

PHILCO 2000-211 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Central Processor	Real Time Unit* (x1 Scanner)	Auto Control Unit (x4 Scanner)	Auto Control Unit (x8 Scanner)	1.5 μsec Core Store
	Model Number		211	401	404	408	2108, 2116, 2132
PHYSICAL	Height × Width × Depth, in.		44 × 108 × 34	75 × 61 × 24	75 × 61 × 24	75 × 61 × 24	?
	Weight, lbs.		1,413	500	650	800	
	Distance (feet) to other unit*						
ATMOSPHERE	Storage Ranges	Temperature, °F.					
		Humidity, %					
	Working Ranges	Temperature, °F.					
		Humidity, %					
	Heat Dissipated, BTU/hr.		9,775	4,430	6,130	7,830	
	Air Flow, cfm.						
	Internal Filters						
ELECTRICAL	Voltage	Nominal					
		Tolerance					
	Cycles	Nominal					
		Tolerance					
	Phases and Lines						
	Load KVA		2.875	1.300	1.800	2.300	
NOTES	*Max. physical distance from hole to hole in false floor (not cable length) using standard length cables.			* Includes Model 402 Interval Timer			

PHILCO 2000-211 PHYSICAL CHARACTERISTICS—Contd.

IDENTITY	Unit Name		Core Storage Adapter (16K)	Core Storage Adapter (32K)	Core Storage (1.5 μsec)	8K Remote Core Storage (1.5 μsec)	Digital Incremental Recorder
	Model Number		220-1	220-2	222	225	289
PHYSICAL	Height × Width × Depth, in.		75 × 32 × 24	74 × 61 × 24	57 × 32 × 18	75 × 49 × 28	10 × 18 × 15
	Weight, lbs.		500	1,000	496	1,600	33
	Distance (feet) to other unit*						
ATMOSPHERE	Storage Ranges	Temperature, °F.					
		Humidity, %					
	Working Ranges	Temperature, °F.					
		Humidity, %					
	Heat Dissipated, BTU/hr.		5,100	10,200	204	8,200	
	Air Flow, cfm.						
	Internal Filters						
ELECTRICAL	Voltage	Nominal					
		Tolerance					
	Cycles	Nominal					
		Tolerance					
	Phases and Lines						
	Load KVA		1.500	3.000	0.060	2.400	1.000
NOTES							

PRICE DATA

Only devices used in the 211 system and not used in the 210 system are given. Refer to the 210 system for prices of equipment which can also be part of the 211 system, Section 651:221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	Model 211	Central Processor			
	211	Arithmetic and Control Unit	11,000		500,000
		Optional Features			
	1100	211 Floating Point Option	900		40,000
	1111	211 Index Registers (8)	1,300		60,000
STORAGE	220	Partition for 2232 Core Storage (P-10)	6,000		263,000
		1.5μs Core Storage			
	2108	8,192 words	9,350		395,000
	2116	16,384 words	17,900		755,000
	2132	32,768 words	30,000		1,350,000
INPUT-OUTPUT		Real Time Devices			
	401	Auto Control Unit (x1 Scanner)	‡		‡
	404	Auto Control Unit (x4 Scanner)	2,950		133,500
	408	Auto Control Unit (x8 Scanner)	3,550		159,000
	402	Interval Timer	400		19,000

‡ Prices not yet available.

Note: The monthly maintenance rate is individually negotiated for purchased equipment. See Special Report, Section 23:010.100, second paragraph.

PHILCO 2000 - 212

Philco Corporation

(A Subsidiary of Ford Motor Company)

AUERBACH

STANDARD EDP REPORTS

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CONTENTS

CONTENTS (Contd.)

INTRODUCTION

§011.

The Philco 2000 is actually a series of three computer systems. There are three prime systems distinguished by different central processors; 210, 211, and 212. The differences in performance and price of the different systems are significant as shown in the respective Systems Performance Sections, 651:201, 652:201, and 653:201. There is a large body of common units, common interfaces, and common software. The following description applies generally to all the series; however, the final paragraph notes the major differences of the 2000-212.

The computer system is in the large-scale scientific and real-time class. Its design is oriented toward flexible off-line operations, with fast tape units, simultaneous operations and concern for fast processing speeds. The central processors have a range of 50,000 to 500,000 instructions per second and rentals in the order of $40,000 and up.

The Philco 2000 is designed for off-line operation of peripheral devices. The off-line operations may be executed by a separate computer, the Philco 1000, or by the special Universal Buffer Controllers (UBC).

The UBC unit is a versatile device, which contains a 1,024 work buffer store. The UBC may control any card, punched tape, magnetic tape, or printer off-line transcription, including magnetic-tape-to-magnetic-tape. A UBC can be used on-line to control data transfers to any one of seven peripheral units attached to it. In addition to the usual peripheral devices there is a high speed (2,000 cards per minute) reader.

Each 2000 computer configuration has one IOP (Input-Output Processor). This unit can control up to 16 input-output units. There may be up to four UBC's and the remaining units may be magnetic tape. An IOP may contain from one to four assemblers. An assembler provides for independent simultaneous input-output transfers. In effect, each UBC can provide an extra simultaneous input-output transfer to any unit except magnetic tape, because loading or unloading a UBC buffer requires little time, and the UBC controls the peripheral device at its own pace.

One especially convenient feature of the IOP is the automatic assignment of any idle assembler to a data transfer request, thus relieving the programmer of optimizing assignments.

The Model 234 Magnetic Tape Units which must be used on the 2000-210 and 2000-211 operate at a peak speed of 90,000 characters per second. The block size is fixed at 1,024 characters. At full speed, using full blocks, the effective speed is 54,600 characters per second. Usually the standard problems have been time for two cases: (1) blocked records and (2) unblocked records. On the 2000-212 an alternative tape unit, Model 334, is available with a peak speed of 240,000 characters per second.

All three central processors operate in parallel on 48-bit words. Single address instructions are packed two to a word. The number of index registers is optional on the 210 and 211 but in practice is standardized at eight. Eight registers, however, are standard on the 212. When an instruction uses a special bit to denote indexing, three bits of the high order end of the address are used to specify the register. This limits the value of the base address, but not the modifier.

There is a wide variety of fixed and floating point arithmetic instructions, but no editing or conversion facilities. Special one or two instruction loops can be performed very rapidly with no repeated access for instructions.

INTRODUCTION—Contd.

§011.

The computer operates asynchronously in all units and basic times vary from machine to machine, and in different cases similar instructions require different execution times. This report quotes ranges or averages of these times.

There are several varieties of core store available. They have different cycle times, and can be further varied by use of overlapped access. Drums are available on the systems and data transfers are arranged to be parallel by word, at high data rates, but may not be overlapped with other operations. Disc storage is available on the 2000-212.

The three central processors, 210, 211, and 212, are upward compatible for instruction repertoire and functional facilities. Therefore, all software is written to be used on all models, with some limitations on minimum configurations.

The main languages are TAC, ALTAC, and TOPS. TAC is a sophisticated symbolic machine oriented language including macros and facilities for generators. The generators include SORT and IOPS, an input-output system. ALTAC is a dialect of FORTRAN II. The ALTAC translator can translate FORTRAN II programs with usually few changes. Its major incompatibilities are Boolean operations and CHAIN functions. On the other hand, it includes extended conditionals. TOPS is a macro oriented language for file manipulation; it includes such facilities as updating and sorting. For individual data manipulation, TAC coding is used. TOPS includes its own operating environment.

There is an automatic supervisor routine, SYSD. This routine covers running, translating, and debugging. In fact, it is probably not reasonable to operate a 2000 without a supervisor.

There is a users' group called TUG. The library of routines is generally available and includes a large selection in the field of nuclear code programs.

The Philco 2000-212 in particular:

- uses a 1.5 μ sec overlapped store, which can be extended to 65,536 words, and includes parity checks.
- a special instruction format can be used to address directly all the core storage.
- disc storage can be added.
- has the fastest central processor of the group, ten times the speed of the 210.
- alternative 240 KC tapes are available with variable size recording loads.
- can have two IOP's, each with up to 4 assemblers.
- the 240 KC tapes can only be used off-line with a Philco 1000 computer.
- real-time facilities are available.
- can have a direct data transmission channel from its store to the store of a Philco 1000 computer.
- has only a few incompatibilities; division is exact, and "correction" sequences are not required, overflow fault logic is improved.
- the central processor overlaps instruction execution by a look-ahead of approximately four instructions.
- there are 14 additional instructions, including a repeat that can control 3 or 4 instructions.
- there is an additional Y bit in each index register to control the formation of effective addresses.

SYSTEM CONFIGURATION

§ 031.

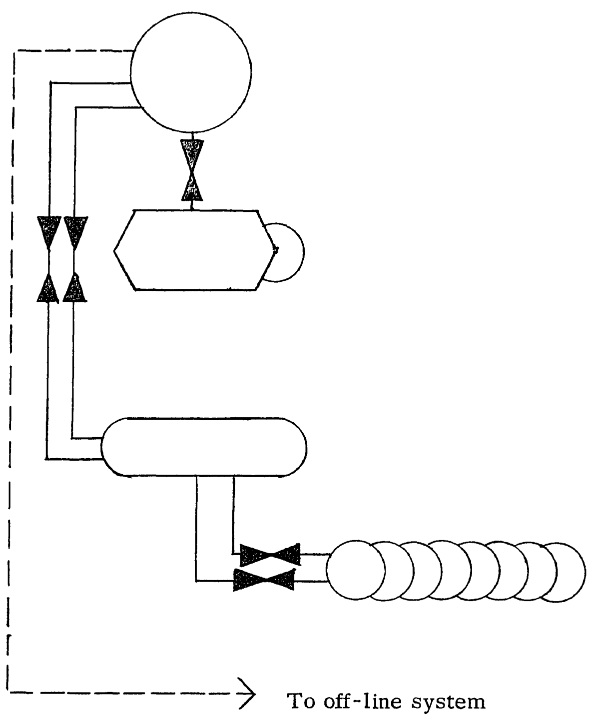
.3 VII B 10-TAPE GENERAL, PAIRED CONFIGURATION

Deviations from Standard Configuration

On-line: . . . . 2 more index registers.
magnetic tape, 30,000 char/sec faster.
card reader can be switched from off-line UBC.

Off-line: . . . . magnetic tape, 60,000 char/sec faster.
printer faster by 400 lines/min.
card reader by 1,500 cards/min.
1,024 characters only in UBC.

On-line Equipment

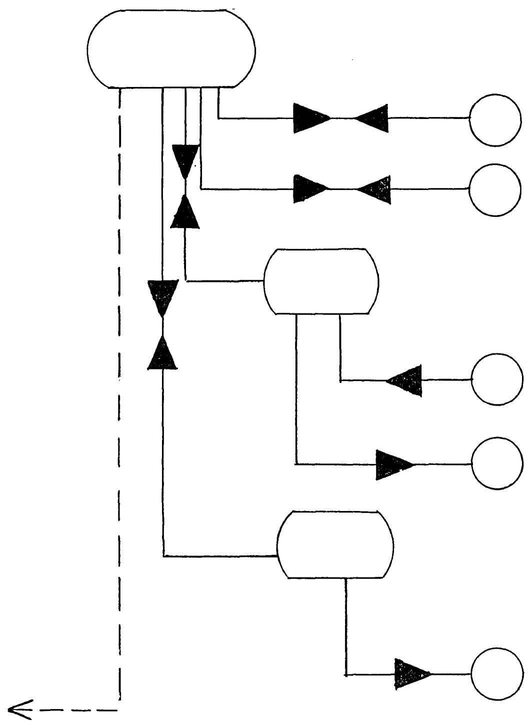


Equipment	Rental
1.5 μ sec Core Storage: 16,384 words	$ 11,000
Model 212 Central Processor and Console Typewriter	22,000
Input-Output Processor: two multiplexed transmissions to and from magnetic tape.	4,400
8 Magnetic Tapes: 90,000 char/second	6,800
Total	$ 44,200
Total, including off-line equipment:	$ 52,315

§ 031.

.3 VII B 10 - TAPE GENERAL, PAIRED CONFIGURATION (Contd.)

Off-line Equipment



Equipment	Rental
Universal Buffer Controller:	$ 1,560
2 Magnetic Tapes: 90,000 char/second	1,700
Punch Card Controller:	1,365
Card Reader: 2,000 cards/minute	800
Card Punch: 100 cards/minute	350
Printer Controller: High Speed Printer: 900 lines/minute	2,340
Total	$ 8,115

Note: Off-line system may be replaced by the Philco 1000 computer system. This will permit more powerful off-line editing and computing capabilities, relieving the central processor of much of this work.

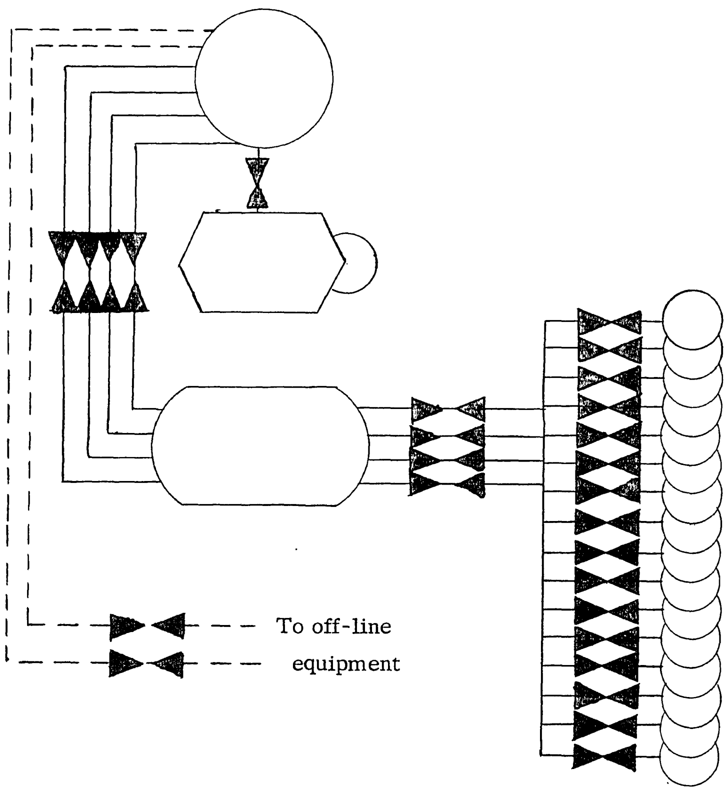
§ 031.

.4 VIII B 20-TAPE GENERAL, PAIRED CONFIGURATION

Deviations from Standard Configuration

On-line:	2 less index registers. magnetic tape 120,000 char/second faster. card reader can be switched from off-line UBC.
Off-line:	magnetic tape 180,000 char/second faster. card reader faster by 1,000 cards/minute. card punch slower by 100 cards/minute.

On-Line Equipment



Equipment	Rental
1.5 μ sec. Core Storage: 16,324 words	$ 11,000
212 Central Processor and Console: Typewriter	22,000
Magnetic Tape Controller: Four multiplexed transmissions to and from magnetic tape.	16,000 (**)
16 Magnetic Tapes: 90,000 char/second	19,200
Total	$ 68,200
Total, including off-line equipment:	$ 87,145

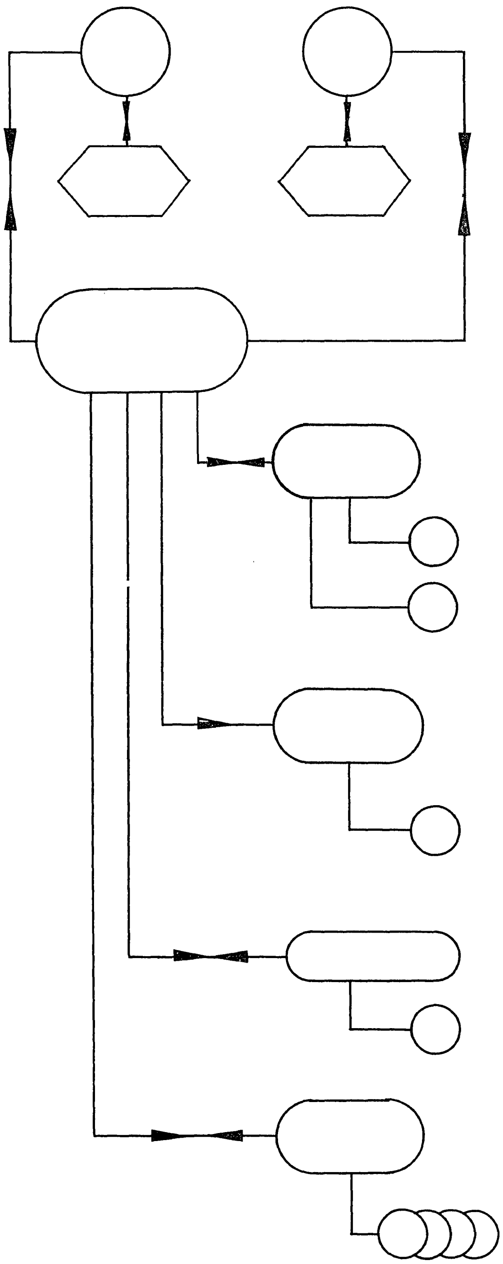
(**) Estimate by Editorial Staff based on nearly complete data and probably reliable.

§ 031.

.4 20-TAPE GENERAL, PAIRED CONFIGURATION VIII B (Contd.)

Off-line Equipment

Philco 1000



Equipment	Rental
Two 8,192 character core stores	$ 2,700
Two 101 Processors and Arithmetic Units	4,520 1,350
124 2x4 I/O Switch	250
160 Card Control	550
258 Card Reader 2000 cards/min.	800
265 Card Punch 100 cards/min.	350
150 Printer Control	275
151 Printer 900 lines/min.	1,800
180 Typewriter Control	400 (* *)
134 Magnetic Tape Control	750 (* *)
Four Magnetic Tape Units 240 KC	4,800
Total Rental:	$ 18,945

(* *) Estimate by Editorial Staff based on nearly complete data and probably reliable.

INTERNAL STORAGE: DISC SYSTEM

§042.

.1 GENERAL

.11 Identity: . . . . X1 Disc System # 311.
X2 Disc System # 312.
X3 Disc System # 313.
X4 Disc System # 314.

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

.13 Description

There are four models of disc store with capacities of 41,943,040; 83,886,080; 125,829,120 and 167,772,160 characters. These Bryant discs will have a peak transfer rate of 960,000 characters or 120,000 words per second, for loads of up to 32,768 words. Transfers may be made simultaneously with input-output and central processor operation.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . Central Processor.
Model 212.

.12 Description

The Model 212 is currently the fastest and most powerful central processor in the Philco 2000 series. Programs written for the 210 and 211 are generally compatible with the 212. A few special cases must be considered, and extra facilities have been added.

The 212 is approximately 10 times faster than the 210. The times are not significantly different when using the 1.0 m.sec store rather than the 1.5 m.sec store.

In this section the paragraphs that have been changed are .23; instruction format and indexing; .32, look-ahead; .4, processor speeds.

There are a few new instructions. The most important is EXTEND, which enables the instruction address to specify any location in the store, directly or when it is to be modified. EXTEND also provides indirect addressing.

There are new facilities for stepping index registers, which include using an instruction address as an increment or decrement.

There is a "double repeat" operation to allow 3 or 4 instruction loops to be repeated.

When transferring programs from a 210 or 211, the following points must be considered, apart from the obvious ones of compatible configurations.

- Division has been altered to produce exact quotients; correction routines should be removed.
- False multiplication overflows have been eliminated.
- Exponent fault results are slightly different.
- There is an extra "Y" bit in index registers.

.14 First Delivery: . . . . January, 1963.

.23 Instruction Formats

.231 Instruction structure: . half word usually.
one word for input-output.
one word for EXTEND to provide extra address length in instruction.

.232 Instruction layout:

NAME	S	A	F	C	
SIZE, BITS	1	15	1	7	Non-indexable

NAME	S	N	V	F	C	
SIZE, BITS	1	3-5	10-12	1	7	Indexable

NAME	Not used	NBS	Not Used	IOP CH.	Not used	NBP	FROM	TO	
SIZE, BITS	12	4	4	4	12	4	4	4	Input-Output (tape)

NAME	S	UNIT	SC	CQ	F	C	
SIZE, BITS	1	4	2	9	1	7	Skip

In addition to those instruction formats as used in the 210 and 211, the following format is also used on the 212 when addresses greater than 32,767 are referenced.

NAME	S	N	not used	RC =0	ID	C= "EXTEND"	V	C	no repeat control
SIZE, BITS	1	3	9	1	2	8	16	8	

NAME	RM	not used	RC =0	ID	C= "EXTEND"	V	C	repeat control
SIZE, BITS	8	5	1	2	8	16	8	

EXTEND instruction pair, not necessarily in same word, but adjacent half words

§ 051.

.233 Instruction parts

Name	Purpose
S:	selector list set to 1 indicates the instruction is indexable and the reduced address field is used; if set to 0, the full address field is used.
A:	address field.
F:	F bit is 1 in floating point instr. or in branch to instruction in right half of word.
N:	specifies index register referenced - field size varies with number of index registers in central processor.
V:	value added to contents of specified index register to form operand's effective addresses.
C:	command, includes F-bit.
NBS:	number of blocks on MT to space over.
IOP CH:	logical MT number.
NBP:	number of blocks of MT to transfer.
FROM:	from device.
TO:	to device.
UNIT:	unit to check for count or faults.
SC:	subcommand of skip instruction.
CQ:	comparison quantity.
RC:	specifies whether EXTEND format specifies Repeat Control of next instruction.
ID:	indirect address V.
RM:	repeat modification, 4 pairs of bits for up to 4 repeated instructions; 1 bit specifies normal/special, in special cases index register modifier is effective address; other bit specifies V is increment added to or subtracted from modifier.

.234 Basic address structure: . . . . . . 1 + 0.

.235 Literals
- Arithmetic: . . . . . . none.
- Comparisons and tests: . . . . none.
- Incrementing modifiers: . . . . . 12 bits (maximum value 4,095).

.236 Directly addressed operands

.2361 Internal Storage type: core.
- Minimum size: . . . 1 word.
- Maximum size: . . . 1 word.
- Volume accessible: . 32,768 words.

.2362 Increased address capacity

Method	Volume accessible
EXTEND instruction modification:	65,536 words.

.237 Address Indexing

.2371 Number of methods: . 3.

.2372 Names
- I : . . . . Normal.
- II : . . . . Normal with step +1.
- III: . . . . Replace with step +V or -V (uses control bits in index register).

.2373 Indexing rule
- I, II: . . . . V + I.R.
- III: . . . . I.R.

.2374 Index specification
- I : . . . . instruction, and C = 0, Y = 0.
- II : . . . . instruction, and C = 1, Y = 0.
- III: . . . . instruction, and Y = 1.

Note: C and Y bits held in index register except for EXTEND instruction (See RM part, Paragraph .232).

.2375 Number of potential indexers: . . . . . . 8.

.2376 Addresses which can be indexed: . . . . . all instructions except repeat, skip and input-output.

.2377 Cumulative indexing: none.

.2378 Combined index and step: . . . . yes; index register can be automatically incremented by one if counter bit is set to 1, or by address V of instruction.

.238 Indirect addressing

.2381 Recursive: . . . . . . yes.

.2382 Designation: . . . . . ID bits in EXTEND instruction format.

.2383 Control: . . . . until no ID bits set, or no EXTEND format.

.2384 Indexing with indirect addressing: . . . . . after indexing.

.239 Stepping

.2391 Specification of increment: . . . . . index register counter bit specifies automatic increment of 1 as referencing indexable instruction is executed. Stepping index register instruction holds increment or decrement to maximum value of 4,095. Data registers may hold increment or decrement of 0 to 32,767. EXTEND can specify address V as increment or decrement.

.2392 Increment sign: . . . . none; considered absolute value.

.2393 Size of increment: . . 0 to 32,767.

.2394 End value: . . . . . . specified in test instruction.

.2395 Combined step and test: . . . . for increment or decrement of up to 5 digits (maximum value of 32,767).

§ 051.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in bits	Program usage
Processor:	3	48	arithmetic, data manipulation.
Processor:	2	15	program control.
Processor:	1	16	program control.
Processor:	8, 16, or 32	16	indexing.
Processor:	1	48	instruction register.
Processor:	1	18	repeat control.
Processor:	1	48	hold input-output order.
I/O Processor:	1	8	assembler availability.
I/O Processor:	1, 2, 3, or 4	10	assembler fault.
I/O Processor:	1, 2, 3, or 4	12	assembler counter.
I/O Processor:	16	4	unit availability.

Note: I/O Processor counters and fault registers may be interrogated from the Central Processor.

.242

Category of storage	Total number locations	Physical form	Access time, μ sec
Processor:	17 to 41	flip-flop	approx. 0.1
I/O Processor:	4 to 25	flip-flop	approx. 0.1

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1.

.314 Special sub-sequence counters
Number: . . . . 1.
Purpose: . . . . repeat counter.

.315 Sequence control step size: . . . . instruction pairs.

.316 Accessibility to routines: . . . . available immediately after a jump is performed.

.317 Permanent or optional modifier: . . . . none.

.32 Look-Ahead

.321 Length of queue: . . . . approx. 4 instructions.

.33 Interruption

.331 Possible causes: . . . . any of 48 conditions in central processor, input-output, and/or real-time devices capable of emitting a signal are possible interrupt criteria. Interrupt occurs via the Model 401, 404, or 408 Auto-Control Unit.

.332 Control by routine
Individual control: . . interrupt by from 1 to 48 possible conditions.
Method: . . . . programmer sets mask in Auto-Control Unit.
Restriction: . . . . . none.

.333 Operator control: . . . operator may enter instruction via central processor console to set new mask in Auto-Control Mask Register.

.334 Interruption conditions: mask bits set to one; no interrupt if mask bit is zero.

.335 Interruption process: . refer to Auto-Control Unit description, Section 652:106.

.336 Control methods
Determine cause: . . masked interrupt bits from Auto-Control register are automatically transferred to core storage location MASK +1 and may be examined by an executive routine to determine the particular interrupt condition.
Enable interruption: . an executive routine preserves and restores all registers, allowing a return to an interruptable routine.

.34 Multi-running: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

Conditions: . . . . using either 1.0 or 1.5 μ sec core stores.

.41 Instruction Times in μ sec

.411 Fixed point
Add-subtract: . . . . 1.55.
Multiply: . . . . 4.50.
Divide: . . . . 9.80.

.412 Floating point
Add-subtract: . . . . 1.55.
Multiply: . . . . 4.70.
Divide: . . . . 12.30.

.413 Additional allowance for
Indexing: . . . . usually 0.2.
Indirect addressing: . 1.0.
Operand in register: . -1.0.
Re-complementing: . 0.

.414 Control
Branch: . . . . 2.55.
Compare and Branch: 3.55.

.415 Counter control
Step: . . . . 1.15.
Step and test: . . . . . 1.25.

.416 Edit: . . . . none.

.417 Convert: . . . . none.

.418 Shift: . . . . 0.3 + 0.18 N.

.42 Processor Performance in μ sec

.421 For random addresses	Fixed point	Floating point
c = a + b:	4.65	4.65.
b = a + b:	3.35	4.10.
Sum N items:	1.55	1.55.
c = ab:	7.60	7.60.
c = a/b:	12.90	15.40.

.422 For arrays of data	Fixed point	Floating point
$c_i = a_i + b_j$:	7.95	8.95.
$b_j = a_i + b_j$:	3.50	3.50.
Sum N items:	1.75	1.75.
$c = c + a_ib_j$:	6.75	7.75.

.423 Branch based on comparison
Numeric data: . . . . 11.90.
Alphabetic data: . . . 12.45.

§ 051.

.424 Switching
- Unchecked: . . . . . . 6.40.
- Checked: . . . . 10.85.
- List search: . . . . . 2.50.

.425 Format control per character
- Unpack: . . . . 0.71.
- Compose: . . . . 1.00 + 19.20 (mathematical and conversions).

.426 Table look up per comparison
- For a match: . . . . . 2.50.
- For least or greatest: 1.75.
- For interpolation point: 2.50.

.427 Bit indicators
- Set bit in separate location: . . . . . . 1.75.
- Test bit in separate location: . . . . . . 0.70.

.428 Moving: . . . . 0.75.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	indicator.
Underflow:	check	error jump and alarm.
Zero divisor:	check	signal and indicator.
Invalid data:	none.	
Invalid operation:	check	stop.
Arithmetic error:	none.	
Invalid address:	check	stop and alarm.
Receipt of data:	parity check	indicator and alarm.
Dispatch of data:	parity check	indicator and alarm.

INPUT-OUTPUT: 240 KC MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . Magnetic Tape Unit.
240 KC.
334.

.12 Description

These Ampex TM 5 tape units operate at peak speeds of 240, 000 characters per second. They have special facilities available (see third paragraph), but programs written for the Model 234 can be run on them without changes.

The Model 334 unit uses 1-inch wide magnetic tape with no prerecorded sprocket and block marks. Data is recorded in rows of 12 data bits or 2 characters. Packing density and tape speed will be arranged to produce a transfer rate of 120, 000 rows per second. For the purpose of this report, it has been estimated that the minimum likely performance can be calculated from an assumed packing density of 1, 000 rows per inch.

In addition to Model 234-compatible instructions to write or read fixed 128-word blocks, there are instructions to write or read a load of 1 to 16 blocks, each of a common size in the range 1 to 4, 096 words (i.e., a load of up to 65, 536 words in steps of one word). Between individual blocks written, where the tape does not stop, there is a gap of 0.45 inch; at the end of a load there is a gap of 0.65 inch. When reading, the tape may be stopped at the end of a load in any gap. At the start of a read operation, up to 15 blocks can be skipped.

Up to 32 Model 334 tape units can be connected to each 240 KC Tape Controller (TC). This unit has the same function as the Input-Output Processor (IOP). See Paragraph 651:101.

Extra tracks are recorded to provide error detection for 2 bits and error correction for 1 bit.. There is a read-after-write check.

Effective speeds depend upon the grouping of input and output blocks. The maximum speed attainable is approximately 230, 000 characters per second. (**)

.13 Availability: . . . . . . ?

.14 First Delivery: . . . . ?

.2 PHYSICAL FORM

.21 Drive Mechanism

(**) Estimate made by analyst and probably reliable.

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . vacuum.
Capacity: . . . . each about 5.5 feet.
.213 Feed drive: . . . . . . motor.
.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic heads.
.222 Sensing system: . . . . magnetic heads.
.223 Common system: . . . two gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . 1.
Heads/stack: . . . . . . 16.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Distance: . . . . 0.39 inch.
Stacks: . . . . 1.
Heads/stack: . . . . . . 16.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1, 000 rows/inch (**).
.322 Parallel by: . . . . . . 16 tracks.
.324 Track use
Data: . . . . 12.
Redundancy check: . . 4, single error correct, double error detect.
Timing: . . . . 0, self-clocking.
Control Signals: . . . 0.
Total: . . . . 16.
.325 Row use
Data: . . . . all.
Redundancy check: . . none.

.33 Coding: . . . . see Data Code Table No. 1 (651:141).

.34 Format Compatibility: . none.

(**) Estimate made by analyst and probably reliable.

§ 091.

.35 Physical Dimensions

.351 Overall width: . . . . . 1 inch.
.352 Length: . . . . up to 3,600 feet.

.4 CONTROLLER

.41 Identity: . . . . 240 KC Tape Controller. Model 334. TC.

.42 Connection to System

.421 On-line: . . . . 2 max, containing 2 or 4 independent assemblers, assigned automatically as required to each transfer request.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: up to 32 tape units.
.432 Restrictions: . . . . . . no other units.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 16 blocks, each 1 to 4,096 words.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . each word.
.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 4,096 words. alternative fixed 128 words.
.512 Block demarcation
Input: . . . . lesser block recorded or count in instruction.
Output: . . . . count in instruction.

.52 Input-Output Operations

.521 Input: . . . . 1 to 16 blocks.
.522 Output: . . . . 1 to 16 blocks.
.523 Stepping: . . . . up to 15 blocks preceding a read operation.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control

Control: . . . . program.
Rearrangement: . . . . no.
Suppress zeros: . . . . no.
Insert point: . . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . no.
Section sizes: . . . . . 1 to 4,096 words.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Output lock: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: . at both ends.
Parity error: . . . . . . yes.
Rewinding: . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . recorded as 1 block loads.
II: . . . . recorded as B block loads.
III: . . . . read as 1 block loads.
IV: . . . . read as B block loads.
N: . . . . number of characters per block.

.62 Speeds

.621 Nominal or peak speed: 240,000 char/sec.
.622 Important parameters
Full rewind time: . . ? min.
Block gap: . . . . . . 0.45 inches (= 900 char).
Load gap: . . . . 0.65 inch (= 1,300 char).
Packing density: . . . 2,000 char/inch (**).
Speed: . . . . 120 inch/sec (**).
.623 Overhead: . . . . 2.5 m.sec extra time to stop and then start in a gap (= 600 char).
.624 Effective speed (**)
I: . . . . 240,000 N/(N + 1,900) char/sec.
II: . . . . 240,000 NB/(NB + 900B + 1,000) char/sec.
I & III: . . . . same as I.
I & IV: . . . . 240,000 NB/(NB + 1,300B + 600) char/sec.
II & III: . . . . 240,000 N/(N + 1,500B + 300) char/sec.
II & IV: . . . . same as II.

.63 Demands on System

Component	Condition	m.sec per word	Percentage
Core store:	during transfer	0.00075 (**)	2.3.
	during gaps	0.0	0.0.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

(**) Estimate made by analyst and probably reliable.

§ 091.

.72 Other Controls

Function	Form	Comment
Indicates unit has rewound tape without it locking and requiring operator intervention:	button indicator	button turns off indicator.
Indicates unit cannot be controlled remotely:	button indicator	button turns off indicator.
Allows reducing or increasing rewind speed:	button indicator.	
Allows recording on tape:	ring on tape reel.	
Releases tape reel brakes to allow manual reel turning:	buttons.	

.73 Loading and Unloading

.731 Volumes handled
Storage: . . . . 3, 600 reel.
Capacity: . . . . 20, 000, 000 char recorded in 1, 000-char blocks.

.732 Replenishment time: . . 0. 5 to 1. 0 min. unit needs to be stopped.

.733 Adjustment time: . . . 0 min.

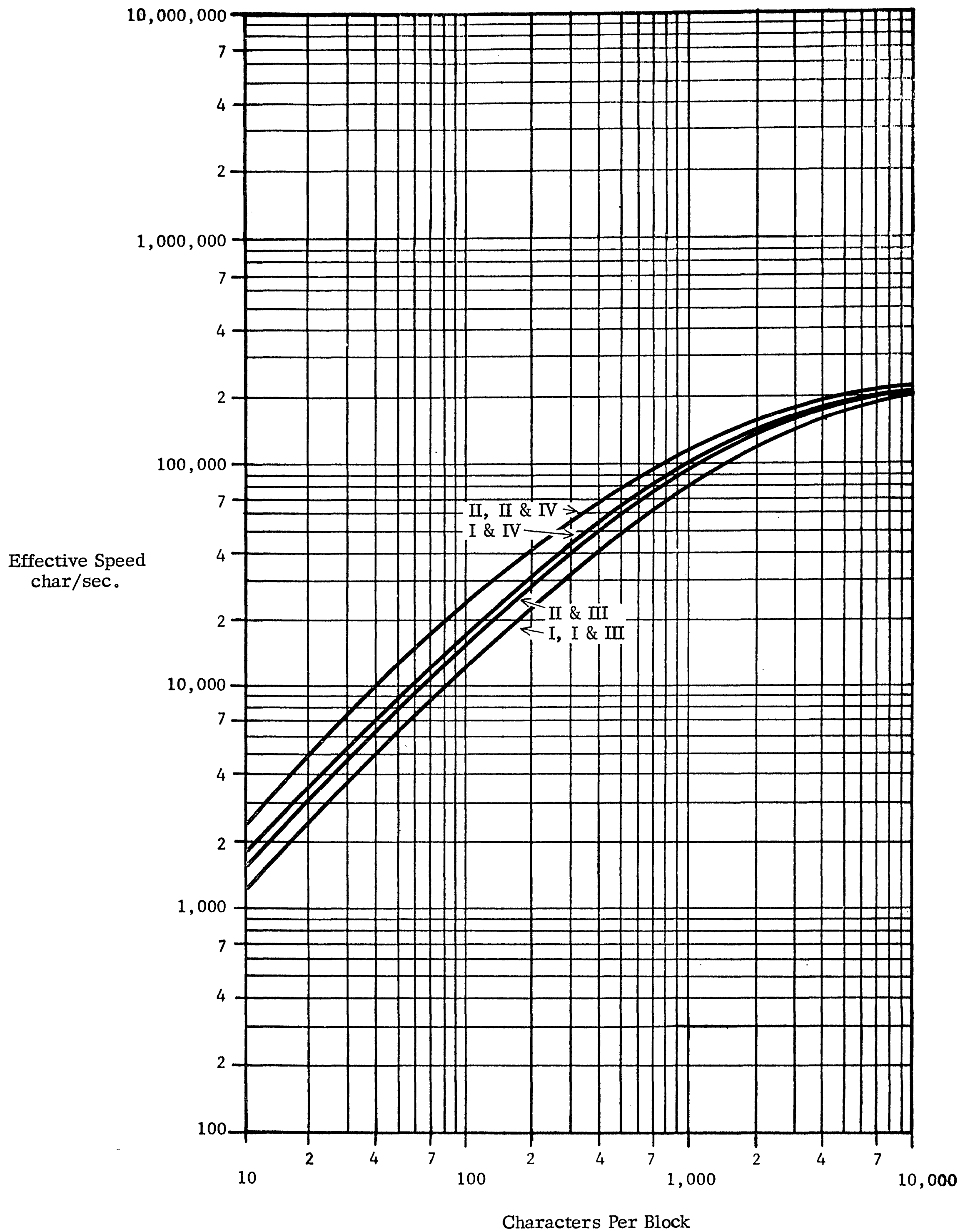
.734 Optimum reloading period: . . . . 6 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read after write	auto-correction.
Reading:	4-bit redundancy	1-bit correction. 2-bit indicator.
Input area overflow:	interlock	cut-off, indicator.
Output block size:	not possible.	
Invalid code:	not possible.	
Exhausted medium:	mechanical	turns on indicator, terminates transmission, and inhibits further I/O processing for that channel. Operator or program intervention necessary for restart.
Imperfect medium:	check.	
Timing conflicts:	check	automatic error correction.
Unit disabled:	interlock	operator intervention.
Record enable:	check	set indicator.
Unit busy:	check	set indicator.
Unit rewinding:	check	set indicator.

§ 091.

EFFECTIVE SPEED



I recorded as 1 block loads
II recorded as 16 block loads
III read as 1 block loads
IV read as 16 block loads

SIMULTANEOUS OPERATIONS

§111

.1 SPECIAL UNITS: . . . none.

.12 Description

When using 90KC magnetic tapes, the conditions and performance are not different from those specified for the 210 in 651:111.1. When using 240KC tapes, no other input-output units are connected.

The volume of simultaneous operations in a configuration can be high, due to the flexible I/O arrangements. Each configuration must be considered separately. The number of simultaneously operating units is then limited by the following criteria:

- The central processor is limited by the sum of the demands on the store by other units, see Sections 653:031 and 653:091.
- There may be one magnetic tape unit operating for each assembler in a Magnetic Tape Controller. There may be two or four assemblers in each of one or two controllers.
- A typewriter output either occupies the central processor full time or operates independently if a typewriter buffer is used.
- Magnetic tape rewind operations are independent of the IOP.
- Disc transfers are independent.

The controller makes automatic allocation of an idle assembler to each new input-output request. Assemblers become idle immediately after completing a magnetic tape transfer. This system frees the programmer from the need to plan assembler assignments in magnetic tape operations.

.2 CONFIGURATION CONDITIONS

.21 Conditions

C: . . . . number of Magnetic Tape Controllers.
P: . . . . number of assemblers in each controller.
N: . . . . number of magnetic tape units.

.3 CLASSES OF OPERATIONS

Class	Member
A:	transmit to or from magnetic disc.
B:	compute.
C:	read or write on magnetic tape.
D:	input or output on console typewriter.
E:	rewind magnetic tape.

.4 RULES

a(b + c + d + e + f + g): . =0.
b: . . . . =at most 1.
c: . . . . =at most U.
d: . . . . =at most P.
e: . . . . =at most 1.
f: . . . . =at most 1.
g: . . . . =at most N.

.5 TABLE OF POSSIBLE SETS OF SIMULTANEOUS OPERATIONS

Class	Possible Modes of Simultaneous Operation			
A	1	1	1	1
B	1	1	1	1
C	CP	CP	CP	CP
D	1	1	1	1
E	N-c	N-c	N-c	N-c

§ 121. INSTRUCTION LIST

INSTRUCTION			OPERATION
F	OP CODE	ADDRESS	
			To be able to repeat up to 4 instructions
	DRPT (LDRPT or RDRPT)	V	Double repeat V times. Affects the next 3 or 4 instructions if held in the left or right position of a word. V may not exceed 255. The high order bits of the address specify indexing of repeated instructions 2 bits each, either 00 normal. 01 normal. 10 as if C=0, Y=1. 11 as if C=1, Y=1.
			To improve index stepping and testing
	AXJL	M	Increment index register I_n by (M). Jump to (right D) if (IRN) less than (left D).
	AXJG	V	Increment index register I_n by (V) Jump to (right D) if (I_n) not less than (left D).
	SXJL	V	Same as AXJL except "decrement".
	SXJG	V	Same as AXJG except "decrement".
	TXDLY	V	Copy I_V to left D.
	TXDRY	V	Copy I_V to right D.
	TDXLY	V	Copy (left D) to I_V.
	TDXRY	V	Copy (right D) to I_V.
			To set C and Y bits
	TYXZ		Set C=0, Y=1 in I_n.
	TYXS		Set C=1, Y=1 in I_n.
	TCXZ		Set C=0, Y=0 in I_n.
	TCXS		Set C=1, Y=0 in I_n.
			Unconditional Jumps
	JL	M	Jump to left M.
	JR	M	Jump to right M.
			To East Access to Stores Larger than 32,768
	TIS	V_1 V_2 V_3	Set Memory Select Register to required 32,768 word blocks, V_1, V_2, and V_3 for I/O Operands, and Instructions respectively.
	TSM	M	Set contents of V_1, V_2, V_3 addresses parts of word in M to current values of Memory Select register.
	EXT		Extension to next instruction to provide indirect and direct addressing to 65,536 words, (see 653:051.232)

NOTES ON SYSTEM PERFORMANCE

§ 201.

The-times used for estimates are based on both the 1.0 and 1.5 μsec stores. The differences are not significant. The allowances for Central Processor penalties have been estimated for the 1.0 μsec store.

There is a distinct difference in operation between the 90KC (#234) and 240KC (#334) Tape Units used in configurations VIIB and VIIIB respectively. The #234 is restricted to fixed block lengths.

Where the standard problems specify one record per block in the Generalized File Problems, the problems have also been timed for blocked records on the detail and report files.

PHILCO 2000 - 212
SYSTEM PERFORMANCE

PHILCO 2000-212 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1											
Worksheet	Item		Configuration								Reference
			VII B unblocked		VII B blocked		VIII B unblocked		VIII B blocked		
1 INPUT-OUTPUT TIMES	Char/block	(File 1)	1,024		1,024		35,536		35,536		4:200.112
	Records/block	K (File 1)	10		10, 12, 6		320		320, 100, 50		
	m. sec/block	File 1 = File 2	11.4		11.4		140.0		140.0		
		File 3	11.4		0.9 †		5.7		1.4 †		
		File 4	11.4		1.8 ††		4.6		2.8 ††		
	m. sec/switch	File 1 = File 2	0		0		0		0		
		File 3	0		0		0		0		
		File 4	0		0		0		0		
	m. sec penalty	File 1 = File 2	0.128		0.128		5.3		5.3		
		File 3	0.128		0.011		0.011		0.011		
		File 4	0.128		0.022		0.022		0.022		
2 CENTRAL PROCESSOR TIMES	m. sec/block	a1	0.058		0.058		0.058		0.058		4:200.1132
	m. sec/record	a2	0.080		0.080		0.080		0.080		
	m. sec/detail	b6	0.080		0.080		0.080		0.080		
	m. sec/work	b5 + b9	0.422		0.422		0.422		0.422		
	m. sec/report	b7 + b8	2.523		2.523		2.523		2.523		
3 STANDARD PROBLEM A F = 1.0	m. sec for C. P. and dominant column.	a1	0.06		0.1		0.1		0		4:200.114
		a2 K	0.80		0.8		25.6		25		
		a3 K	30.23		30.2		966.4		966		
		File 1 Master In	0.13	11.4	0.1	11.4	5.3		5		
		File 2 Master Out	0.13		0.1		5.3		5		
		File 3 Details	1.28	114.0	0.1	57.0	3.7	1820	3		
		File 4 Reports	1.28		0.2		7.0		7	576	
		Total	33.9	125.4	31.6	68.4	1013.2	1820	1012	576	
4 STANDARD PROBLEM A SPACE	Unit of measure	(word)									4:200.1151
		Std. routines	187		187		187		187		
		Fixed	0		0		0		0		
		3 (Blocks 1 to 23)	87		87		87		87		
		6 (Blocks 24 to 48)	684		684		684		684		
		Files	1,024		1,024		1,024		1,024		
		Working	100		100		100		100		
		Total	2,082		2,082		2,082		2,082		

† 12 details per block. †† 6 reports per block

PHILCO 2000-212 SYSTEM PERFORMANCE—Contd.

K

WORKSHEET DATA TABLE 2								
Worksheet	Item			Configuration				Reference
				VII B unblocked	VII B blocked	VIII B unblocked	VIII B blocked	
5 STANDARD MATHE-MATICAL PROBLEM A	Fixed/Floating point			Floating				4:200.413
	Unit name	input		234	234	334	334	
		output		234	234	334	334	
	Size of record, words	input		10	10	10	10	
		output		23	23	23	23	
	m. sec/block	input	T1	11.4	0.95	5.7	141	
		output	T2	11.4	2.28	4.6	141	
	m. sec penalty	input	T3	0.13	0.01	0.005	2	
		output	T4	0.13	0.01	0.012	2	
	m. sec/record		T5	0.07	0.07	0.07	0.07	
	m. sec/5 loops		T6	0.40	0.40	0.40	0.40	
	m. sec/report		T7	0.26	0.26	0.26	0.26	
7 STANDARD STATISTI-CAL PROBLEM A	Unit name				234		334	4:200.512
	Size of block, words				128		4,096	
	Records/block		B		12		400	
	m. sec/block		T1	None	11.4	None	141 ÷ 400	
	m. sec penalty		T3		0.01		2	
	C. P.	m. sec block	T5		0.004		0.004	
		m. sec record	T6		0.016		0.016	
		m. sec table	T7		0.045		0.045	

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

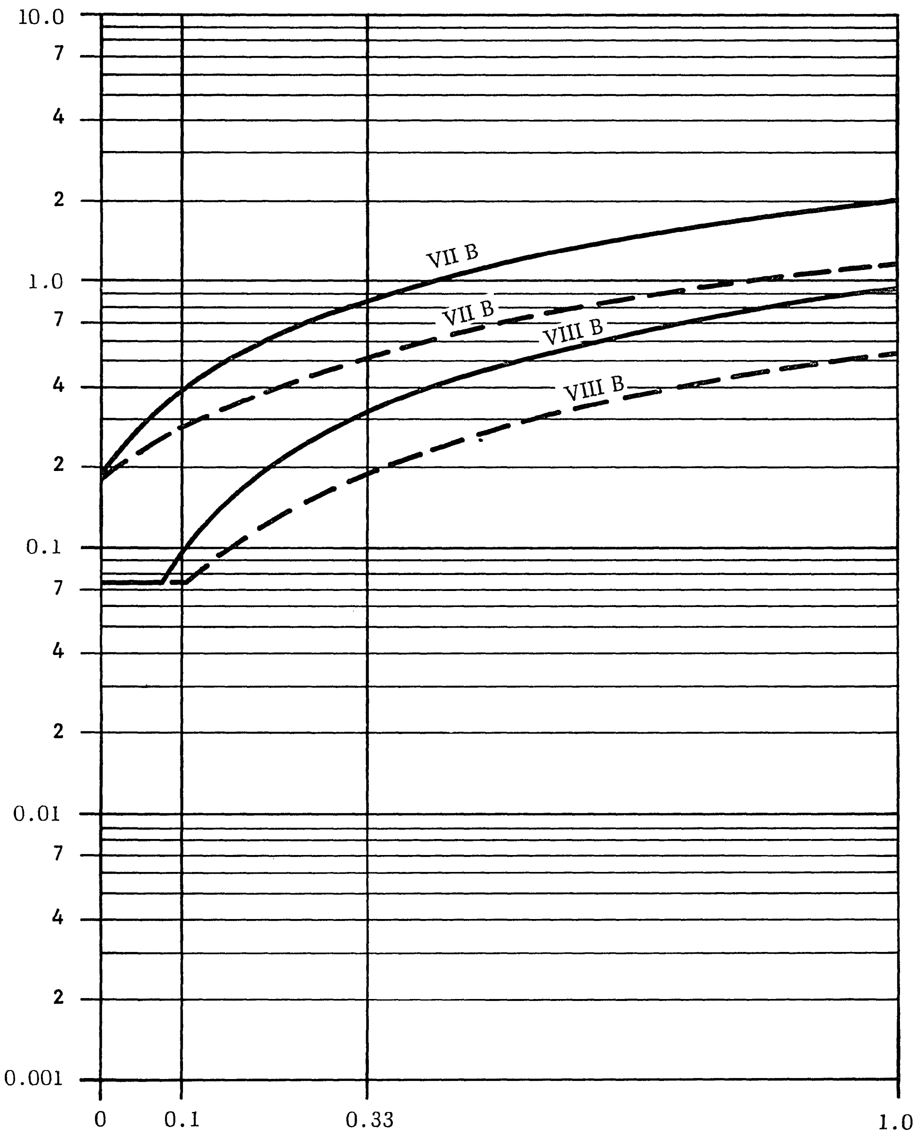
.111 Record Sizes
- Master File: . . . . 108 characters.
- Detail File: . . . . . 1 card.
- Report File: . . . . . 1 line.

.112 Computation: . . . . . standard.

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

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

Time in Minutes to Process 10,000 Master File Records



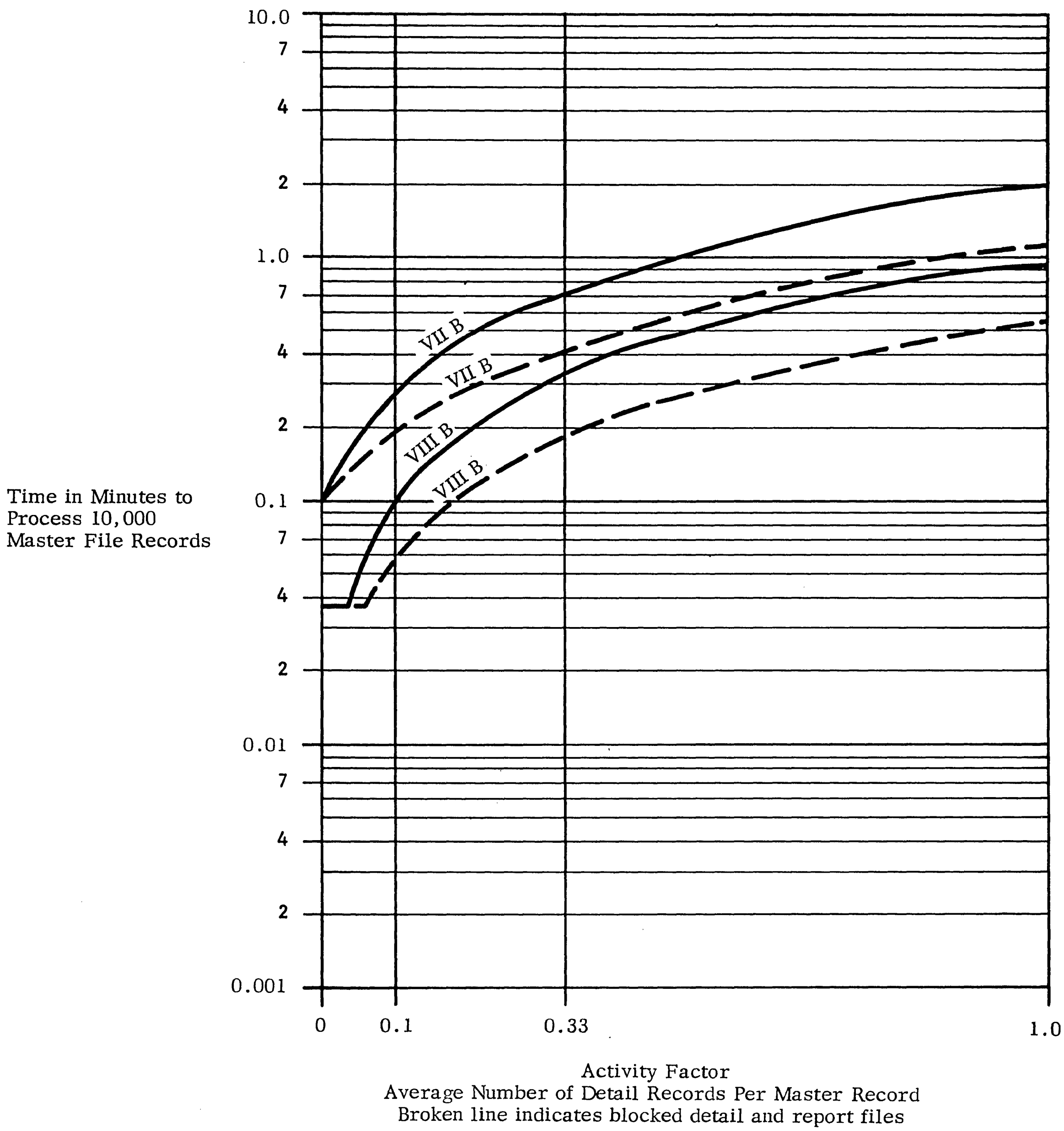
Activity Factor
Average Number of Detail Records Per Master Record
Broken line indicates blocked detail and report files

§ 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.

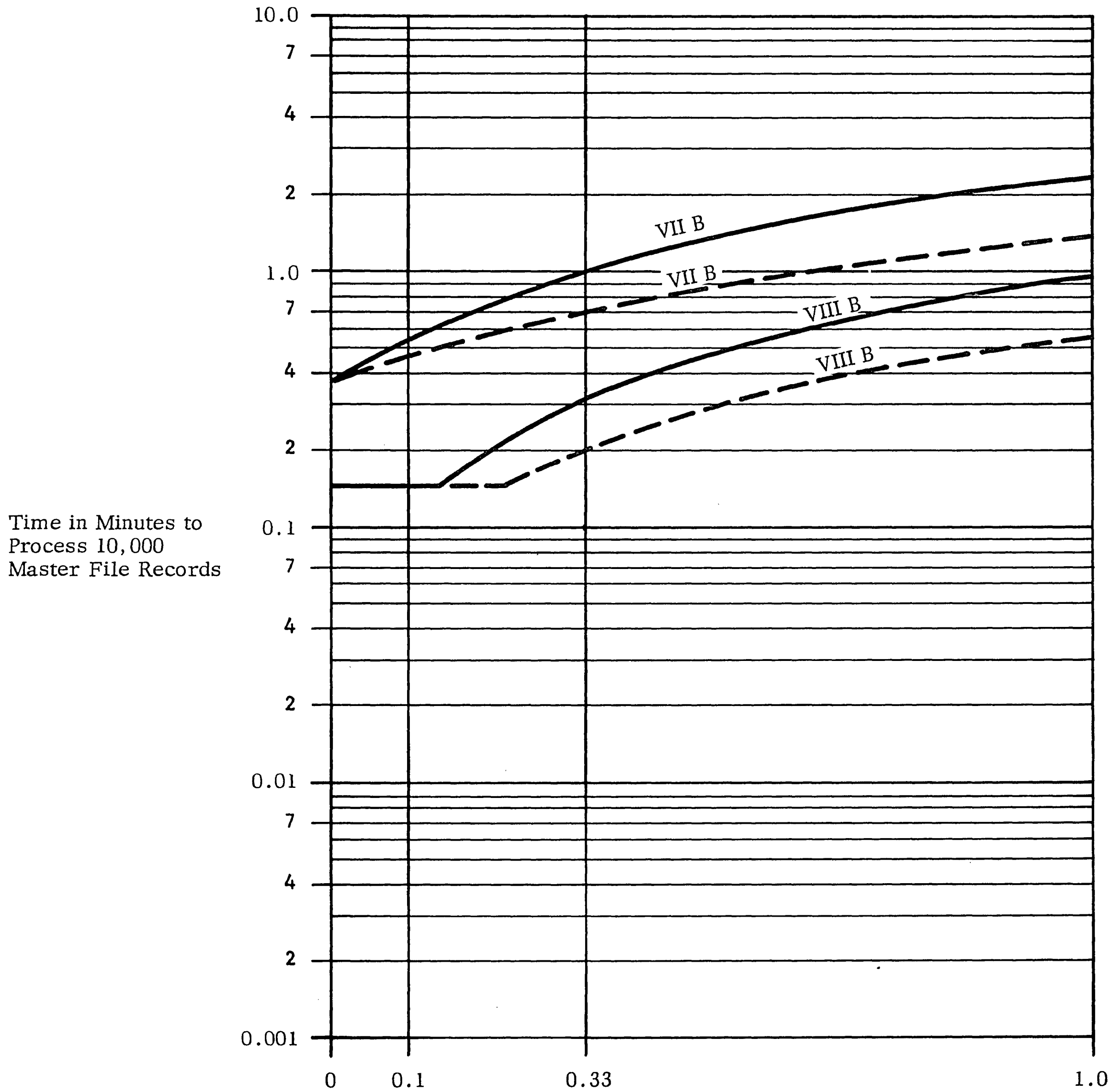


§ 201.

.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 estimated procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . see graph below.



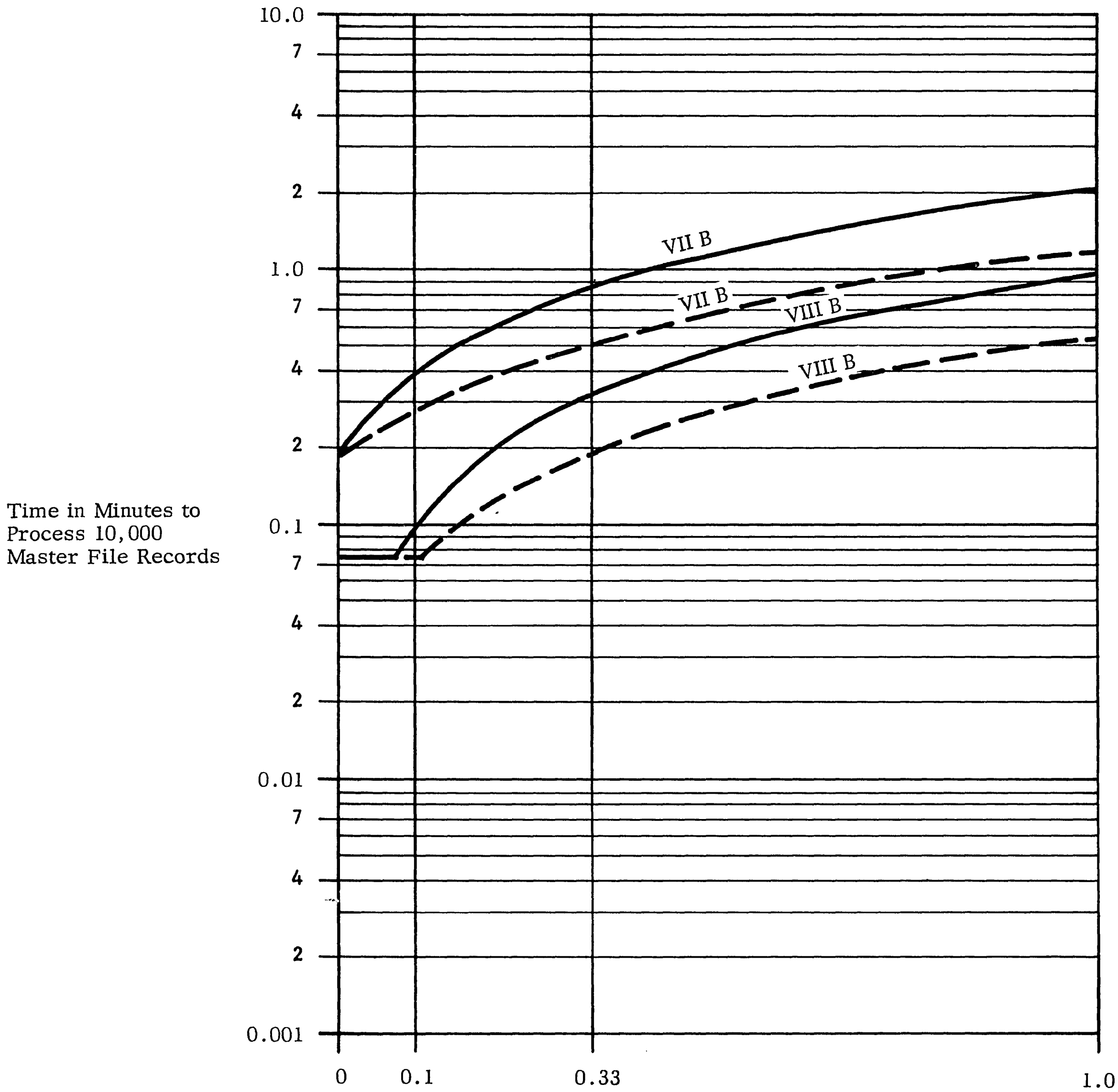
Activity Factor
Average Number of Detail Records Per Master Record
Broken line indicates blocked detail and report files

§ 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 estimated procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . see graph below.



Activity Factor
Average Number of Detail Records Per Master Record
Broken line indicates blocked detail and report files

§ 201.

.2 SORTING

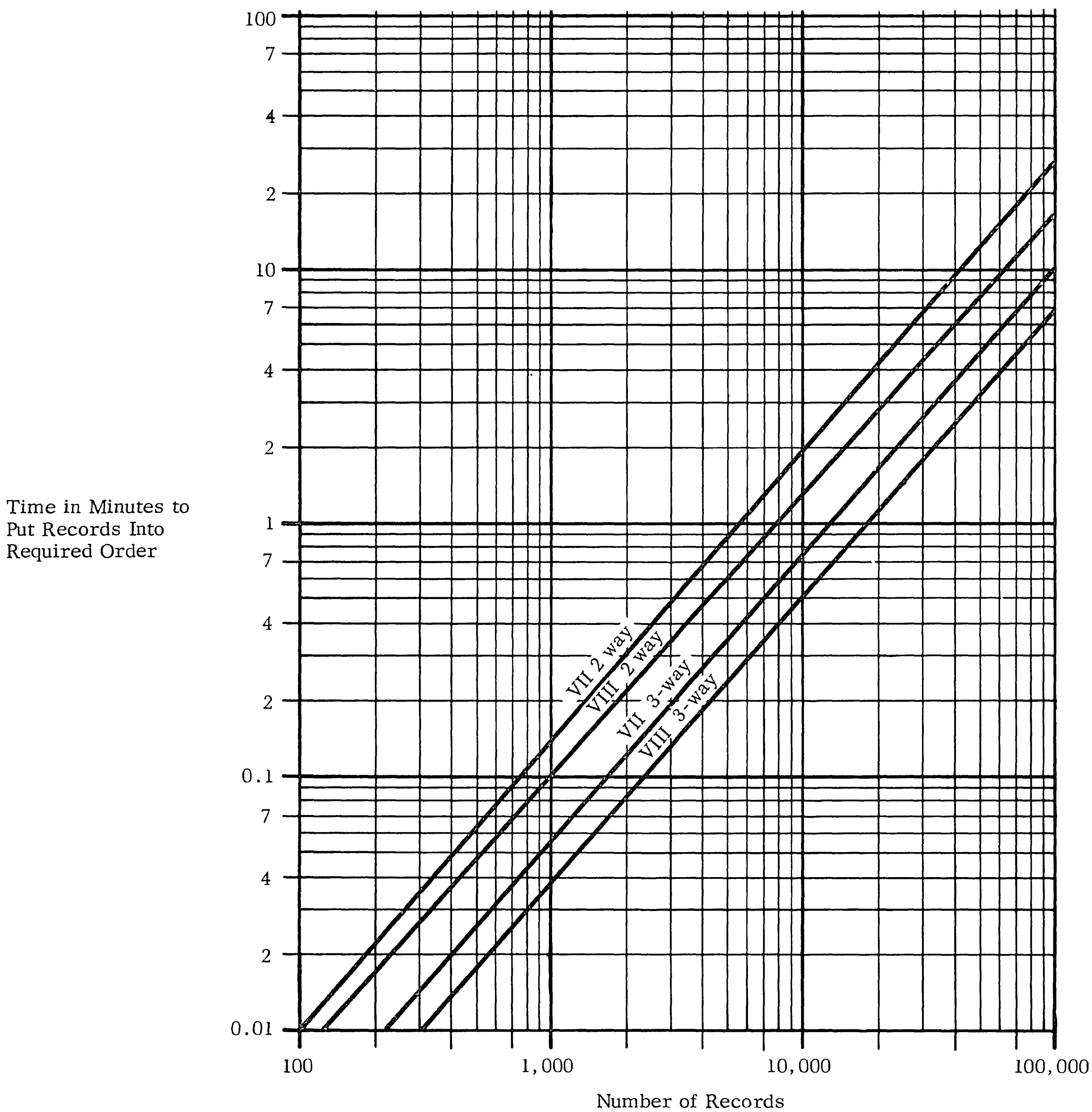
.21 Standard Problem Estimates

.211 Record Size: . . . . . 80 characters.

.212 Key Size: . . . . 8 characters.

.213 Timing Basis: . . . . . using estimated procedure outlined in Users' Guide, 4:200.213.

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



§ 201.

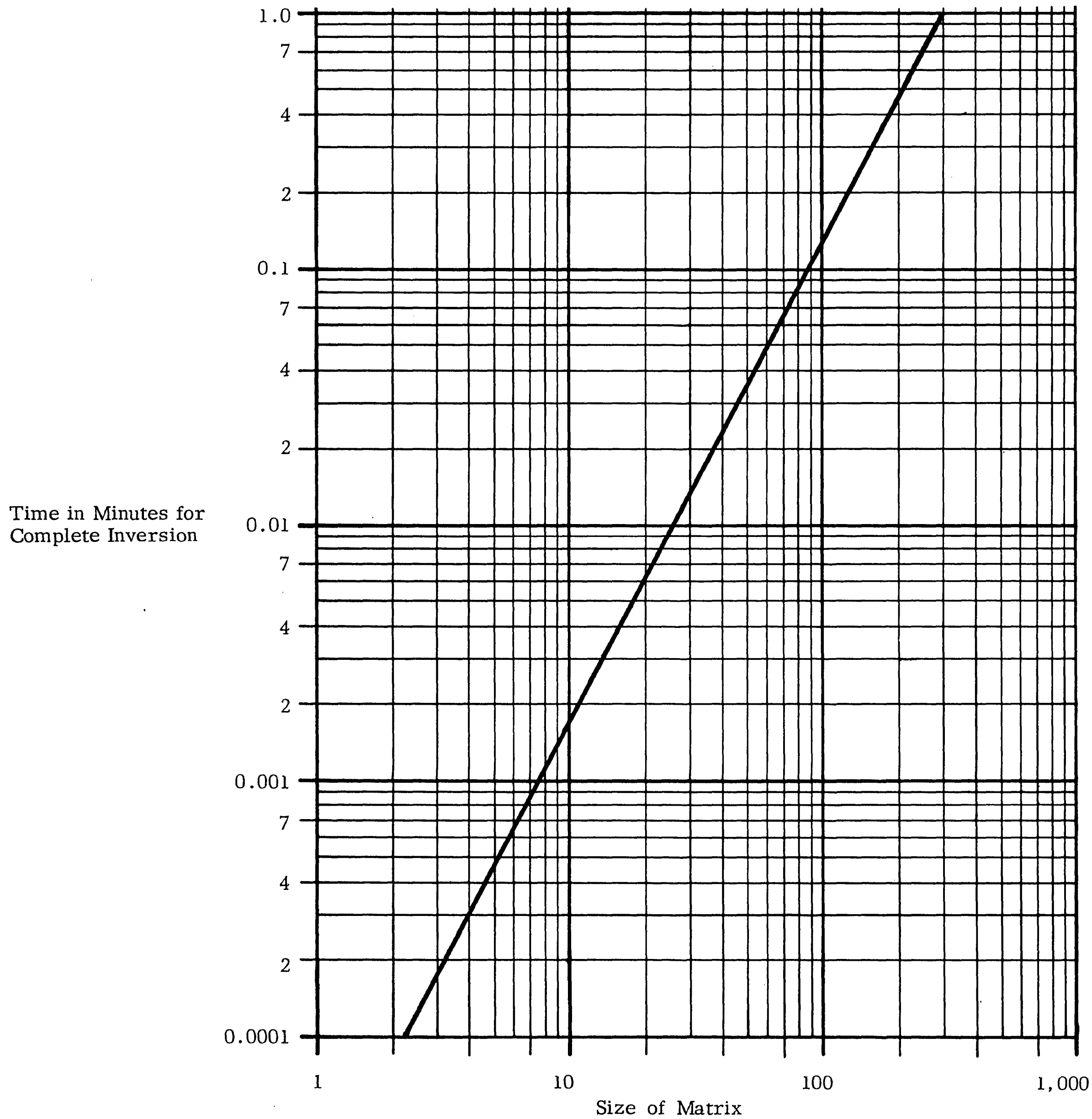
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic Parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing Basis: . . . . . using estimated 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.

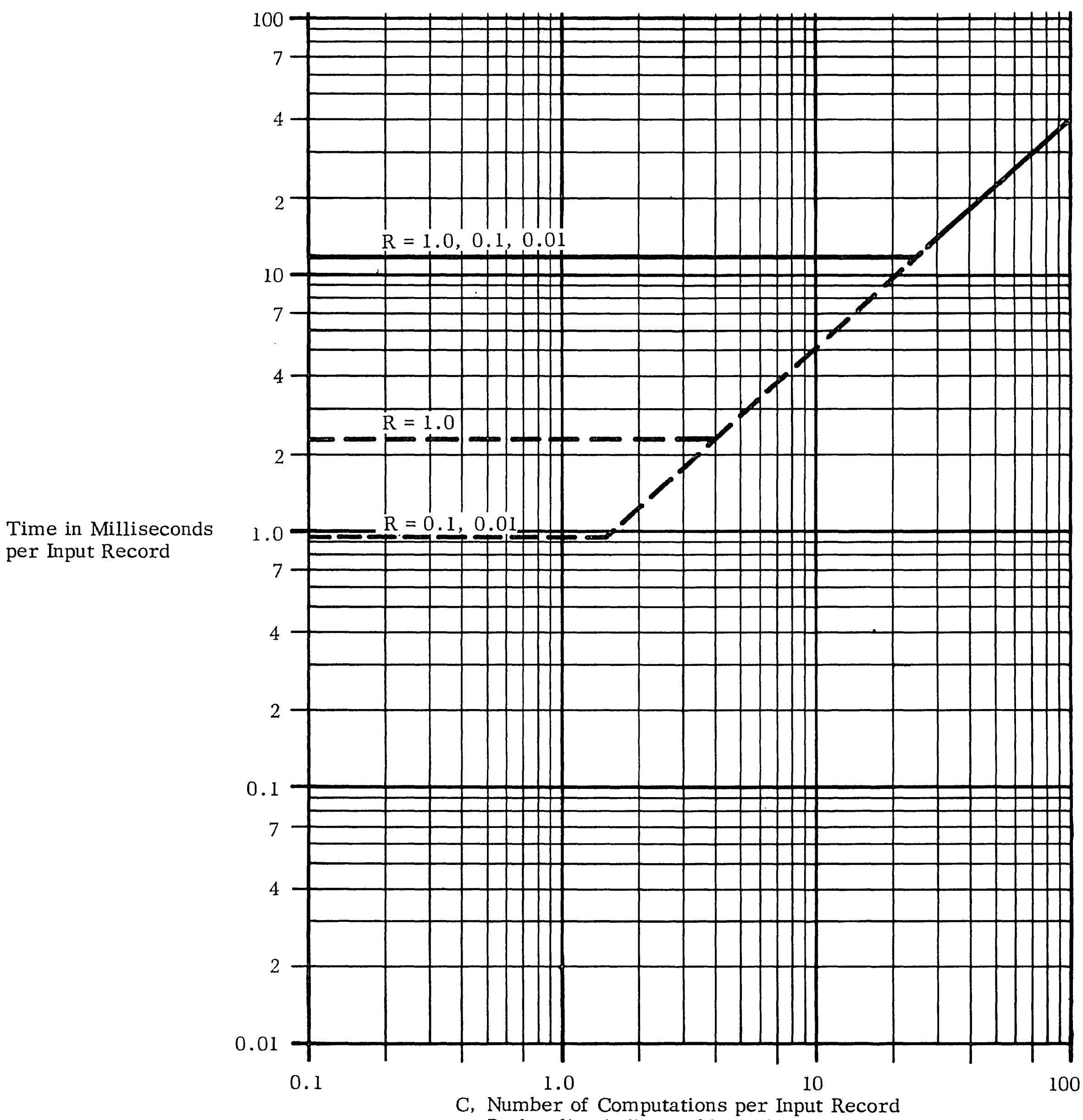
.412 Computation: . . . . 5 fifth-order polynomials.
5 divisions.
1 square root.

.413 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.

Configuration VIIB; 1 word Length (12 digit precision); floating point.

R = Number of Output Records per Input Record



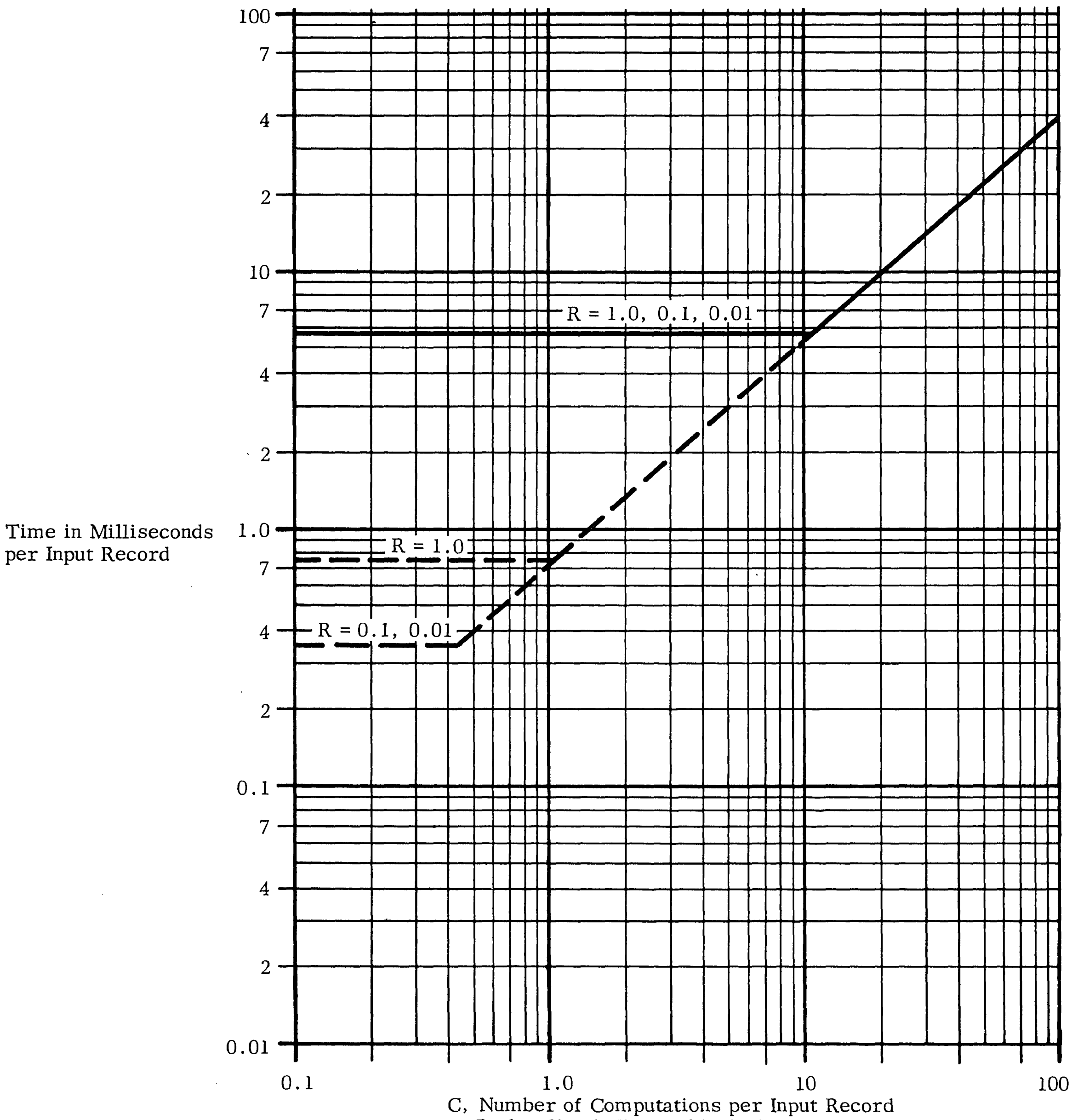
Broken line indicates blocked records.

§ 201.

.415 Graph: . . . . see graph below.

Configuration VIIIB; 1 word Length (12 digit precision); floating point.

R = Number of Output Records per Input Record



Broken line indicates blocked records.

§ 201.

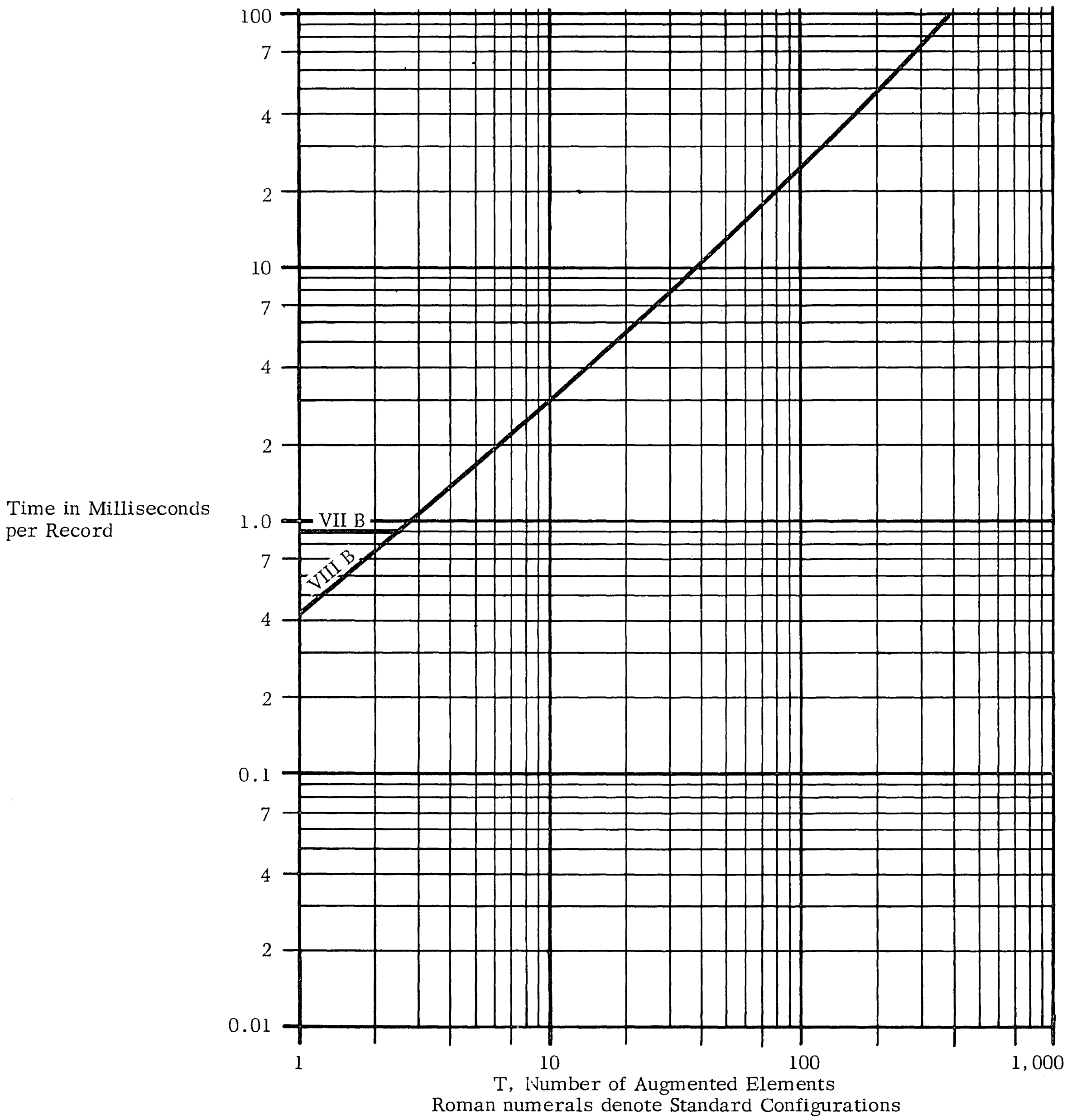
.5 GENERALIZED STATISTICAL PROCESSING

.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.



PHILCO 2000-212
PHYSICAL CHARACTERISTICS

PHILCO 2000-212 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Central Processor*	1 μsec Core Store	Magnetic Tape Unit	240 KC Input-Output Processor		Disc System
	Model Number		212	2016, 2032, 2065	334	336	338	2311, 2312, 2313, 2314
PHYSICAL	Height × Width × Depth, in.		75 × 144 × 39	68 × 24 × 25	68 × 26 × 31	68 × 77 × 31	68 × 130 × 31	?
	Weight, lbs.		4,500	600	900*	2,700	3,600	
	Distance (feet) to other units*		17 to 2032 Core Storage 15 to 2332 Core Storage 42 to Oper. Console 12 to 212 IOCU	22 To Central Processor	140 To 240KC I/O Processor			
ATMOS-PHERE	Storage Ranges	Temperature, °F.						
		Humidity, %						
	Working Ranges	Temperature, °F.						
		Humidity, %						
	Heat Dissipated, BTU/hr.		20,500					
	Air Flow, cfm.							
	Internal Filters							
ELECTRI-CAL	Voltage	Nominal						
		Tolerance						
	Cycles	Nominal						
		Tolerance						
	Phases and Lines							
	Load KVA		6.000		NA**	NA	NA	
NOTES	*Max. physical distance from hole to hole in false floor (not cable length) using standard length cables		*Includes Power Supply.		*Estimated. **Not Available.			

PHILCO 2000-212 PHYSICAL CHARACTERISTICS –Contd.

			Core Storage	Additional 8K Units	Core Storage (1.0 μsec)	Disc Controller	Disc Unit	Disc Auxiliary Unit
IDENTITY	Unit Name		Core Storage	Additional 8K Units	Core Storage (1.0 μsec)	Disc Controller	Disc Unit	Disc Auxiliary Unit
	Model Number		2032	2032	221	310	315	
PHYSICAL	Height × Width × Depth, in.		68 × 96 × 25	68 × 24 × 25	68 × 24 × 25	37 × 61 × 75	52 × 70 × 46	52 × 22 × 46
	Weight, lbs.		1,800*	600*	600*	1,000	3,000	1,000
	Distance (feet) to other units*		17 To 212 Central Processor			80 To I/O Control Unit	80 To Disc Controller	
ATMOSPHERE	Storage Ranges	Temperature, °F.						
		Humidity, %						
	Working Ranges	Temperature, °F.						
		Humidity, %						
	Heat Dissipated, BTU/hr.				10,200	7,100	9,850	1,960
	Air Flow, cfm.							
	Internal Filters							
ELECTRICAL	Voltage	Nominal						
		Tolerance						
	Cycles	Nominal						
		Tolerance						
	Phases and Lines							
	Load KVA				3.000	2.070	Run 2.875 Start 13.225	Run 0.575 Start 2.080
NOTES			*Estimated.	*Estimated.	*Estimated.			

§ 221.

PRICE DATA

Other prices are the same as listed in 651:221 and 652:221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	212	Central Processor	22,000		950,000
STORAGE		1 μ sec Memory			
	2016	(16 K)	‡		
	2032	(32K)	‡		
	2065	(65 K)	‡		
		Disc System			
	2311	XI	11,000		500,000
	2312	X2	‡		
	2313	X3	‡		
	2314	X4	‡		
INPUT-OUTPUT	334	240 KC Magnetic Tape Unit	1,200		54,000
	336	Magnetic Tape Controller (32x2)	8,500		385,000
	338	Magnetic Tape Controller (32x4)	‡		

‡ Prices not yet available

Note: The monthly maintenance rate is individually negotiated for purchased equipment. See Special Report, Section 23:010.100, second paragraph.

RCA 301

Radio Corporation of America

STANDARD EDP REPORTS

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CONTENTS

CONTENTS (Contd.)

INTRODUCTION

§ 011.

The RCA 301 is a small to medium scale, solid-state data processing system oriented toward business and scientific applications. The wide range of optional features which are available provide for expansion and simultaneous operations. System configuration rentals range from $3,500 to $25,000 per month, with typical systems renting for $9,000. The purely business-oriented processor is available with three sizes of core storage: 10,000, 20,000, or 40,000 alphameric characters (Model 303, 304, or 305, respectively). The Model 354 and 355 processors (for business and scientific applications) can perform automatic floating point operations and automatic eight-digit fixed point operations in addition to having all the facilities of the Model 303, 304, and 305 processors. The Model 354 and 355 processors are available with 20,000 and 40,000 alphameric characters of core storage, respectively. The 301 system is available with a wide range of peripheral equipments, including auxiliary disc storage. Its fixed length, 10-character instructions use a 2-address add-to-storage logic. In the standard processor, the data fields, which are variable-length (up to 44 characters), are processed serially by character.

Model 303, 304, and 305 Processors

The speed of the standard arithmetic unit (i.e., Models 303, 304, and 305) makes it suitable for general data processing but it performs mathematical operations slowly. Multiplication, division, and floating-point operations can be performed only by means of subroutines. Indexing is not available, but indirect addressing is provided. While there is no integrated editing facility, edit routines are rapid and straightforward, and a sufficient number of variable-length operations for handling alphameric items are available. These include convenient code translation operation and Boolean operations. Arithmetic operations are executed through the use of sum and difference tables which occupy 200 characters of core storage.

Model 354 and 355 Processors

The Model 354 and 355 processors contain additional high speed arithmetic circuits which allow automatic fixed and floating point operations to be performed on eight-digit operands in a two-address format. A double-length accumulator is provided. The operations which are possible are: add, subtract, multiply, divide, and indexing operations for fixed and floating point data. Additional instructions are provided for shifting and storing the contents of the accumulator and for incrementing the index registers. The index registers permit address modification, and loop control is provided by the Tally instruction or by other coding.

Processor Speeds

The time required for the Model 303, 304, and 305 processors to add 2 eight-digit numbers (including instruction access) is 273 microseconds, a rate of 3,660 additions per second. The same operation on the Model 354 and 355 processors requires 98 microseconds (no indexing; results left in accumulator), a rate of 10,200 additions per second.

Simultaneous operations can be carried out only through the use of optional equipment. The Simultaneous Mode Control permits two operations to proceed at a time. The device (any peripheral device) controlled via the Simultaneous Mode Control delays the Processor for 7 microseconds per character transferred. The second operation can be another peripheral device data transfer, or internal processing.

The 7-microsecond core store can be supplemented by Data Record Files (juke-box type discs) with up to 27.6 million characters or by Data Disc Files with up to 176 million characters of storage. While access to data in the Record Files can take several seconds, access to Disc File data requires approximately 0.1 second. Remote inquiry operations to the Data Record or Data Disc Files can be handled through the Interrogating Typewriter.

INTRODUCTION (Contd.)

§ 011.

Programming for the 301 is relatively straightforward except where dynamically variable length fields require continual adjustment of the N character used to specify operand length. Also, the programmer is restricted by the limited simultaneous operation facilities, which normally permit only one data transfer to be overlapped with internal processing.

Standard paper tape and punched card equipment is available, as well as a fast paper tape reader which reads at 1, 000 characters per second. Paper tape is normally read and punched at 100 characters per second. Punched card equipment can include two card readers, which operate at rates of up to 600 cards per minute, and a card punch which operates at 100 cards per minute. More recently, a card read punch unit (an IBM 1402) has become available as part of the equipment line. This unit can read 800 cards per minute and punch 250 cards per minute. Hollerith code to RCA 301 code translation is performed automatically. Two models of line printers are available, one with 120, the other with 160 character positions per line; these printers are capable of maximum speeds of 1, 000 and 1, 075 lines per minute, respectively.

A variety of magnetic tape units can be used with the 301 system. One or 2 cabinets of low-cost magnetic tapes are available, which operate at 10, 000 characters per second; each cabinet contains 3, 4, or 6 tape stations. Higher performance tape stations (33, 333 and 66, 667 characters per second) are available for use by the 301, and up to 14 such stations, which are also used on the RCA 501 system, can be connected.

RCA has recently announced an Optical Character Reader (Videoscan) which can read up to 1, 500 documents per minute. The Burroughs Magnetic Ink Character Reader can be connected to the 301 system to provide for input of magnetic ink documents at speeds of up to 1, 560 per minute. Adapters are available for connecting two IBM 729II Magnetic Tape Units.

The software for the 301 can accommodate three different situations; the program library can be held on cards, magnetic tape, or Data Records. In addition to standard assembly routines, subroutines, mathematical functions, and diagnostic routines, there is an elementary operating system appropriate for this size of computer, and an integrated testing procedure. COBOL-61 for the 301 magnetic tape system is available, as is the RCA 301 version of UMAC, the University of Miami Algebraic Compiler. A scientific interpreter is also available.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Character:	6 bits + parity bit	alphamerics.
Diad:	2 char	access to High Speed Memory.
Cell:	900 char	location for record in Data Record File.
Band:	10 cells	Data Record File.
Data Record:	4 bands	Data Record File.
Sector:	160 char	location for record in Data Disc File.
Band:	10 sectors	Data Disc File.
Zone:	group of 128 bands readable by one head	Data Disc File.
Stratum:	group of 108-432 bands readable by all heads without yoke movement	Data Disc File (1 File of 1-4 modules).
Data Disc:	2,304 bands	Data Disc File.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeric:	1 char.
Alphabetic:	1 char.
Instruction:	10 char.
Numbers:	1 to 44 char.
Items:	1 to 44 char.
Block:	any number of char.
Number referenced by automatic arithmetic operations in 354/355 Processor	
Fixed point:	8 char (digits).
Floating point:	8 char (digits) mantissa and 2 char (digits) exponent.

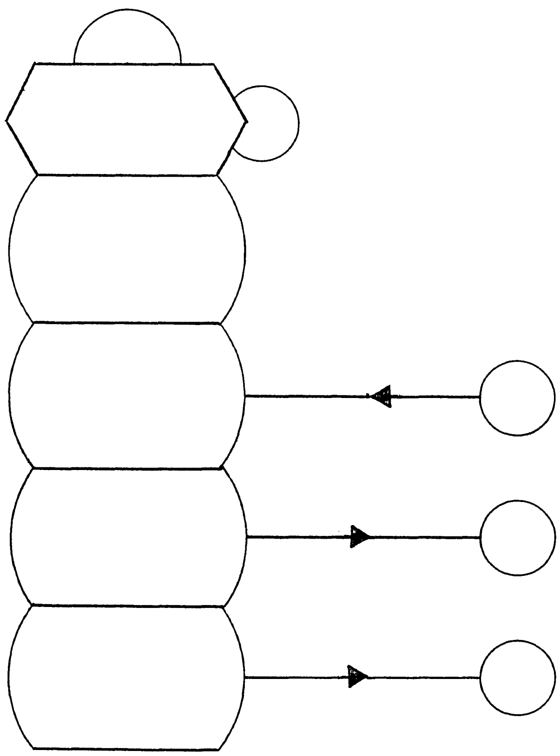
SYSTEM CONFIGURATION

§ 031.

.1 TYPICAL CARD SYSTEM (CONFIGURATION I)

Deviations from Standard Configuration: . . . . Multiply-Divide not available.

Rental: . . . . $4,271 per month.



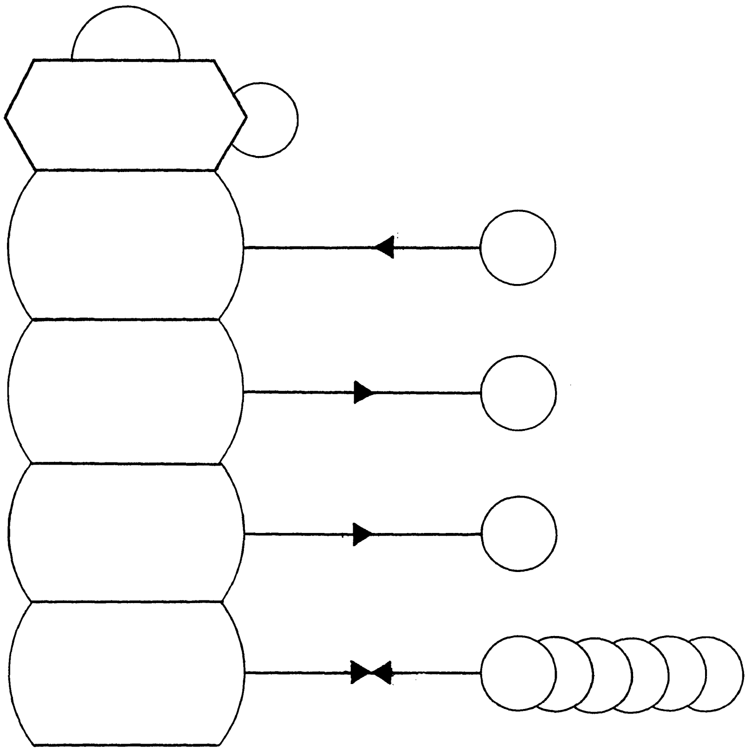
Equipment	Rental
Core Storage: 10,000 characters; 303 Processor and Console	1,803
392 Simultaneous Mode Control	608
314-1R Controller	134
323 Card Reader 600 cards/min.	361
315 Controller	283
334 Card Punch 100 cards/min.	206
316-1 Controller	155
333 Printer 1,000 lines/min.	721
Total	$4,271

§ 031.

.2 4-TAPE BUSINESS SYSTEM (CONFIGURATION II)

Deviations from Standard Configuration: . . . . none.

Rental: . . . . $5,084 per month.



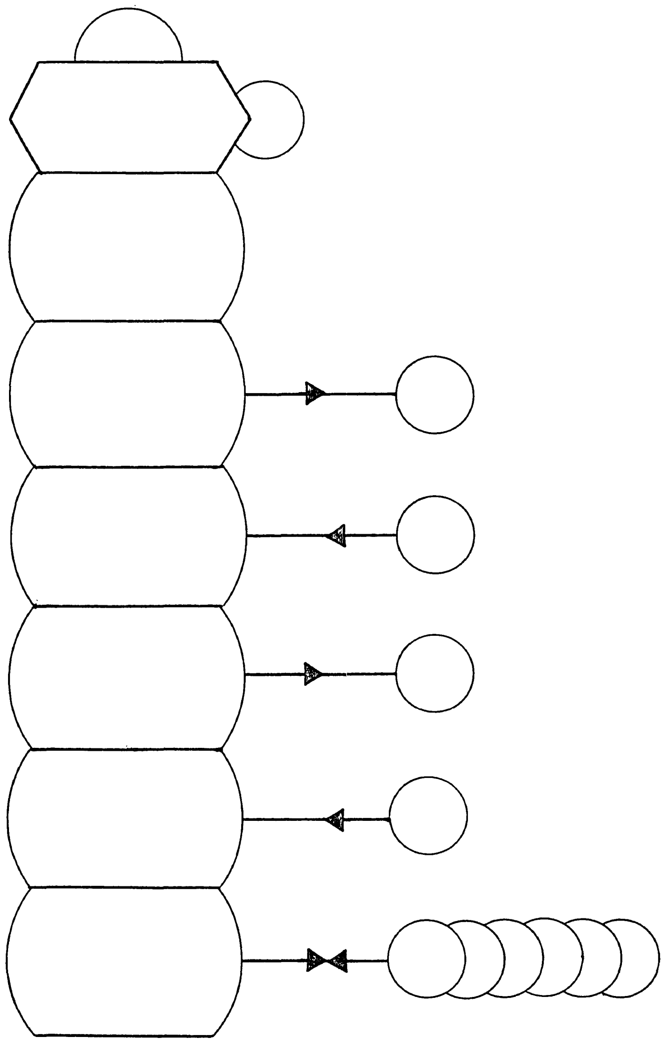
Equipment	Rental
Core Storage: 10,000 characters; 303 Processor and Console	1,803
314-1R Controller	134
323 Card reader 600 cards/min.	361
315 Controller	283
334 Card Punch 100 cards/min.	206
316-1 Controller	155
333 Printer 1,000 lines/min.	721
318 Controller	386
381-4 Hi-Data Tape Group (4 magnetic tape units)	1,040
Total	$5,084

§ 031.

.3 6-TAPE BUSINESS SYSTEM (CONFIGURATION III)

Deviations from Standard Configuration: . . . . Multiply-Divide not available.

Rental: . . . . $9,687 per month.



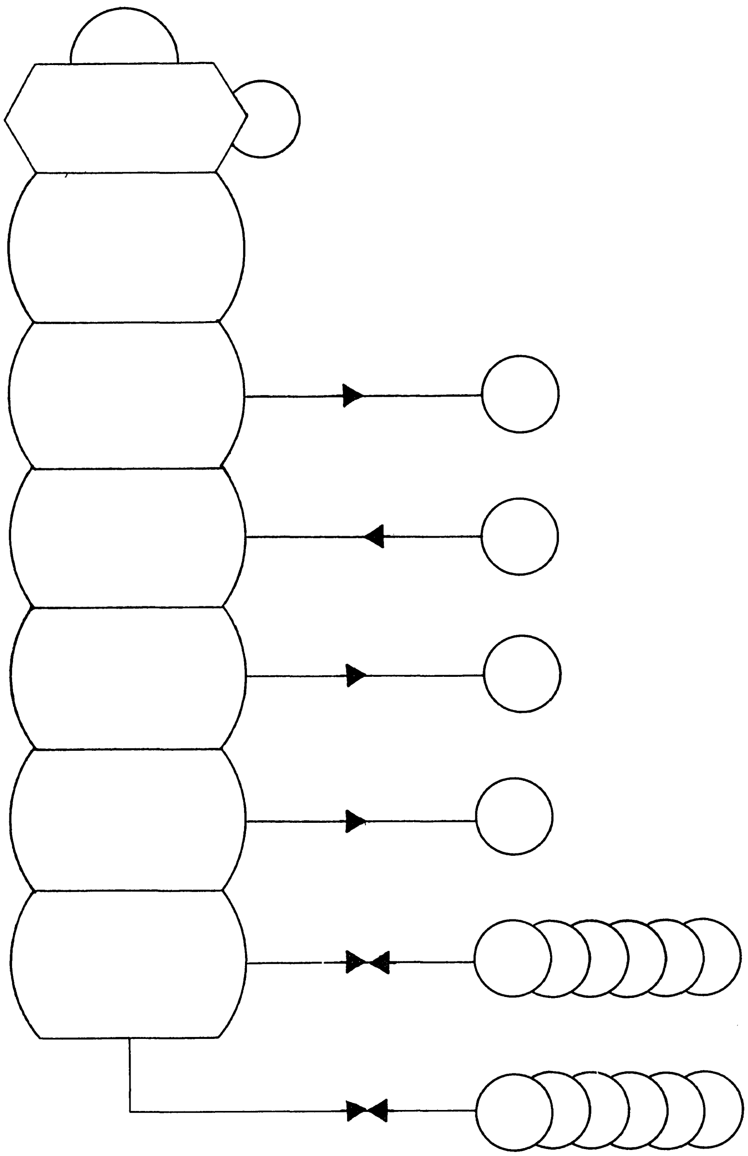
Equipment	Rental
Core Storage: 20,000 characters. 304 Processor and Console	2,421
392 Simultaneous Mode Control	608
308 Controller	170
338 Monitor Printer 10 char/sec.	196
314-1R Controller	134
323 Card Reader 600 cards/min.	361
315 Controller	283
334 Card Punch 100 cards/min.	206
316-1 Controller	155
333 Printer 1,000 lines/min.	721
341 Controller	1,030
581 Magnetic Tape Units (6) 33,333 char/sec.	3,402
Total	$9,687

§ 031.

.4 12-TAPE BUSINESS SYSTEM (CONFIGURATION IV)

Deviations from Standard Configuration: . . . . Multiply-Divide not available. Simultaneous Read, Write, and Compute is not available.

Rental: . . . . $20,290 per month.



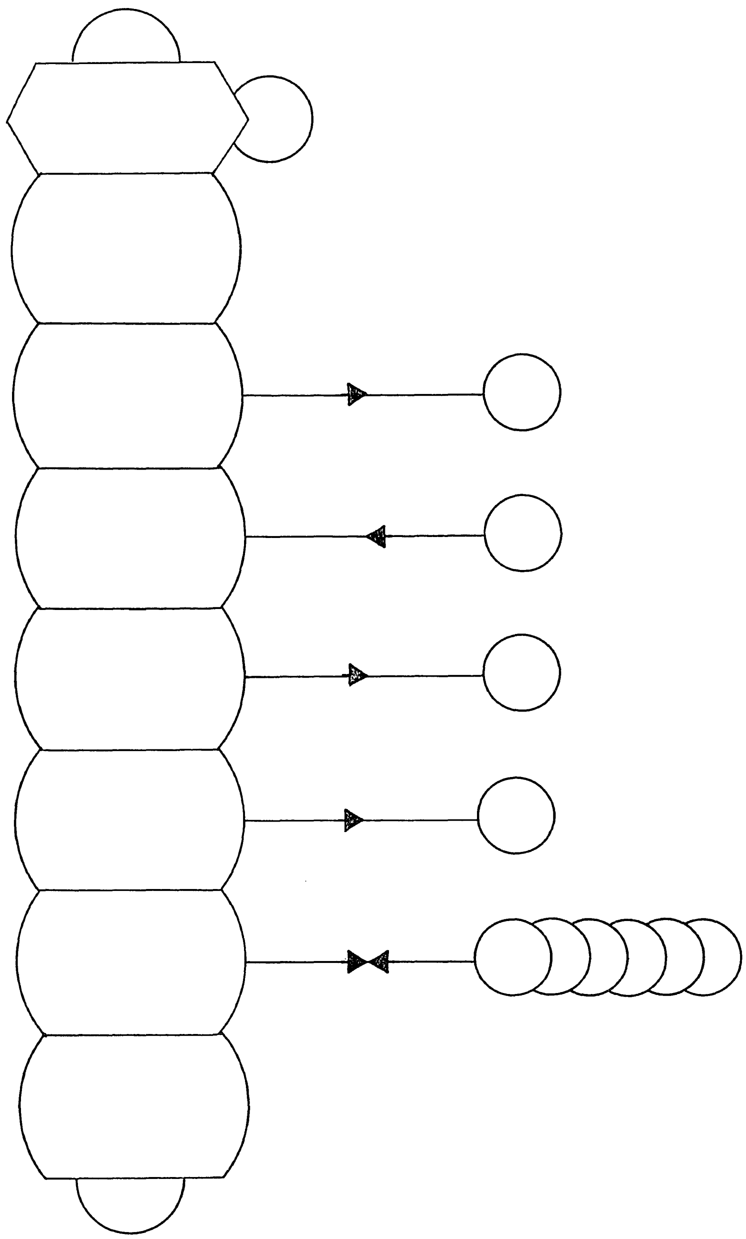
Equipment	Rental
Core Storage: 40,000 characters; 305 Processor and Console	4,069
392 Simultaneous Mode Control	608
308 Controller	170
338 Monitor Printer 10 char/sec.	196
314-1R Controller	134
323 Card Reader 600 cards/min.	361
315 Controller	283
334 Card Punch 100 cards/min.	206
316-1 Controller	155
333 Printer 1,000 lines/min.	721
352 Controller	2,575
582 Magnetic Tape Units (12) 66,667 char/sec.	10,812
Total	$20,290

§031.

.5 AUXILIARY STORAGE SYSTEM (CONFIGURATION V)

Deviations from Standard Configuration: . . . . Multiply-Divide not available.

Rental: . . . . $12,777 per month.



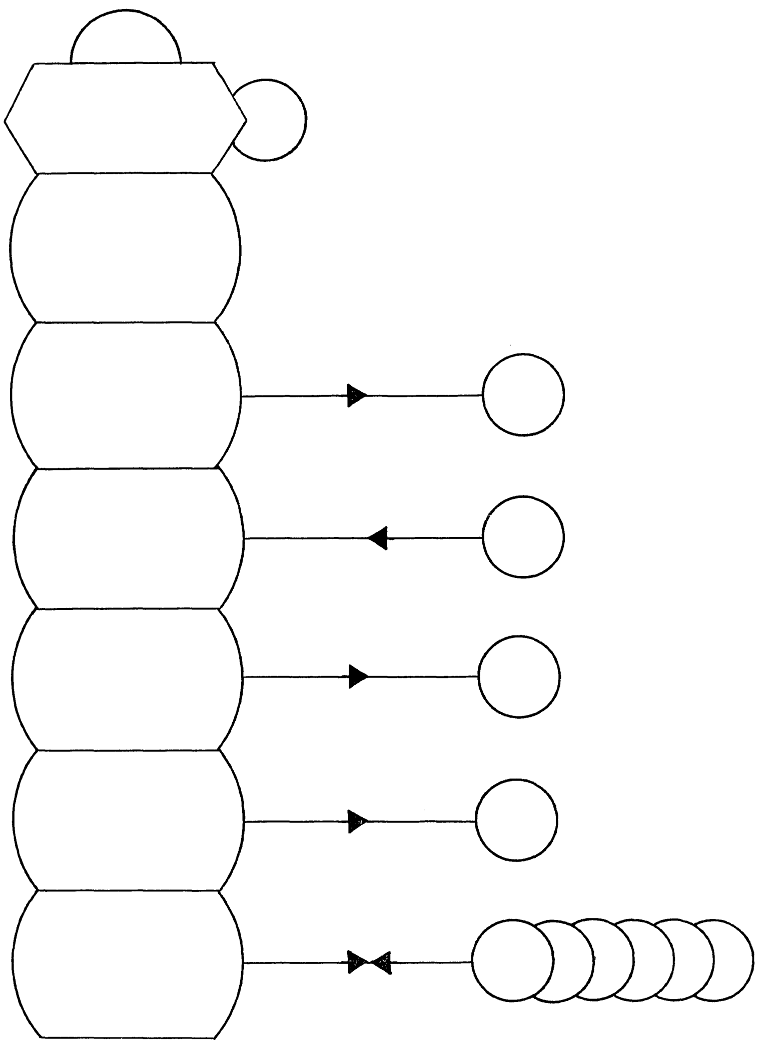
Equipment	Rental
Core Storage: 20,000 characters. / 304 Processor and Console	2,421
392 Simultaneous Mode Control	608
308 Controller	170
338 Monitor Printer 10 char/sec.	196
314-1R Controller	134
323 Card Reader 600 cards/min.	361
315 Controller	283
334 Card Punch 100 card/min.	206
316-1 Controller	155
333 Printer 1,000 lines/min.	721
341 Controller	1,030
581 Magnetic Tape Units (6) 33,333 char/sec.	3,402
3661-1 Disc Storage and Controller: 22,000,000 characters.	3,090
Total	$12,777

§ 031.

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

Deviations from Standard Configuration: . . . .
1. Core storage is 40,000 char rather than 85,000.
2. 2 index registers rather than 3.
3. 1 simultaneous transfer with processing rather than 2.
4. Printer 100% faster

Rental: . . . . $12,880 per month.



Equipment	Rental
Core Storage: 40,000 characters. 355 Processor and Console.	5,614
392 Simultaneous Mode Control.	608
308 Controller	170
338 Monitor Printer 10 char/sec.	196
314-1R Controller	134
323 Card Reader 600 cards/min.	361
315 Controller	283
334 Card Punch 100 cards/min.	206
316-1 Controller	155
333 Printer 1,000 lines/min.	721
341 Controller	1,030
581 Magnetic Tape Units (6) 33,333 char/sec.	3,402
Total	$12,880

INTERNAL STORAGE: HIGH SPEED MEMORY

§ 041.

.1 GENERAL

.11 Identity: . . . . High Speed Memory.
Part of Model 303, 304, or 305 Processor.
HSM.

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

.13 Description:

Magnetic core storage, addressed by single characters, is a part of the Processor. Models 303, 304, and 305 Processors contain 10,000, 20,000, and 40,000 alphameric characters of storage, respectively. Cycle time is 7.0 microseconds for each memory access. One access to storage obtains a two-character diad, but only the single addressed character is used in data processing operations. Each character consists of seven bits: six data bits and one odd parity bit. Core storage is used for all input-output areas, working storage, and restricted-access special Processor tables.

.14 Availability: . . . . February, 1961

.15 First Delivery: . . . . . February, 1961

.16 Reserved Storage

Purpose	Number of locations	Locks
Arith registers:	200.	
Logic registers:	12.	
I-O control:	4.	
Arithmetic control:	4.	
Print table:	64.	
Service Engineering:	22.	
Total:	306	switch on console.

.2 PHYSICAL FORM

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

.22 Physical Dimensions

.221 Magnetic core storage
Core size: . . . . 0.050 inches O.D.
0.030 inches I.D.
Array size (10,000 characters): . . . . . 100 bits by 50 bits by 14 bits. 8 inches by 4 inches.
Array size (20,000 characters): . . . . . 100 bits by 100 bits by 14 bits. 8 inches by 8 inches.
Array size (40,000 characters): . . . . . 200 bits by 100 bits by 14 bits. 17 inches by 8 inches.

.23 Storage phenomenon: . . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by program: . . . . 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: . . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Unit of data: . . . . . . 2 characters (1 diad).
Cycling rate: . . . . . 142,857 cycles per second.
Conversion factor: . . 14 bits per diad.
Data rate: . . . . . . 285,714 char/sec.
Compound data rate: . 285,714 char/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
Identity:	303 Processor	304 Processor	305 Processor
Characters:	10,000	20,000	40,000
Instructions:	1,000	2,000	4,000
Modules:	1	1	1

.32 Rules for Combining Modules: . . . . choice of 303, 304, or 305 Processor.

.4 CONTROLLER . . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads: . 1 access device per system.

.52 Simultaneous Operations: . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 3.5 μ sec.
Cycle time: . . . . . 7.0 μ sec.
For data unit of: . . . 1 char (6 bits plus parity bit).

.6 CHANGEABLE STORAGE: . . . . none

§ 041.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . yes.

.72 Transfer Load Size

With self: . . . . 1 to 44 char.

.73 Effective Transfer Rate

With self: . . . . 67,600 char per sec max. (44 char).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	stop computer, alarm.
Receipt of data:	parity check on memory register	stop computer, alarm.
Dispatch of data:	transmits parity bit.	
Conflicting commands:	none.	
Physical record missing:	none.	
Attempt to write in arithmetic table area of memory:	check	stop computer, alarm.
Recording of data:	none.	
Recovery of data:	parity check on memory register	stop computer, alarm.

INTERNAL STORAGE: DATA RECORD FILE

§ 042.

.1 GENERAL

.11 Identity: Data Record File.
Model 361.
DRF.

.12 Basic Use: auxiliary storage.

.13 Description

This store consists of thin magnetic discs. They are automatically placed upon a turntable to be recorded or read. Up to 128 discs are held in a carrousel-type cage which rotates to bring any required disc into position to be placed on the turntable. Individual discs can be inserted and removed from the cage by an operator. Data is recorded on both sides of each disc. On each side there are two spiral bands, and the heads are able to follow the spirals -- as a disc turns -- by using a locating groove on the disc. Each Data Record File has a capacity of 4.6 million characters in 5,120 variable-length blocks. Access time varies from 0.01 to over six seconds. While the peak transfer rate is 2,500 characters per second bulk transfer is at 1,500 characters per second. There are checks to insure that positions accessed in the cage are occupied, but standard program procedures similar to tape labeling procedures are used to insure that the correct discs have been accessed. Tabs on the record cage can be used to prevent recording on discs. One type of instruction physically locates a disc, and another type provides data transfers.

.14 Availability: . . . . January, 1962

.15 First Delivery: . . . . . January, 1962

.16 Reserved Storage: none.

.2 PHYSICAL FORM

.21 Storage Medium: magnetic discs.

.22 Physical Dimensions

.222 Drum or Disc
Diameter: . . . . 6.815 inches.
Thickness or length:. . thin.
Number on shaft: . . . 128 in carrousel.

.23 Storage Phenomenon: . . 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: . . . yes.

.25 Data Volume per Band of 1 Track

Characters: . . . . 9,000 max.
Digits: . . . . 9,000 max.
Instructions: . . . . . . 900 max.
Revolutions: . . . . . . 20; spiral track.
Calls: . . . . 10.

.26 Bands per Physical Unit: 4 per disc (2 on each side).

.27 Interleaving levels: . . . 1.

.28 Access Techniques

.281 Recording method: . . . magnetic heads which follow tracks.

.283 Type of access

Description of stage	Possible starting stage
Remove unwanted disc from turntable:	if previous disc remains when band select (search) given.
Turn to selected disc:	no.
Place on turntable and position head: . .	no.
Wait for start of band:	always new instruction.
Wait for chosen cell:	no.
Read or record records in cells: . . .	no
Optional return of disc from turntable: .	no (option at end of data transfer).

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . . band traversed in 4 seconds.
Track/head speed:. . . approx. 50 inches/sec.
Bits/inch/track: . . . . approx. 280.
Bit rate per track: . . . 17,500 bits/sec/track.
.292 Peak data rates
Unit of data: . . . . . . character.
Conversion factor:. . . 7 bits per char.
Data rate: . . . . 2,500 char/sec/device (Normal Mode).
Compound data rate:. . 5,000 char/sec/system (Normal and Simultaneous Mode).
7,500 char/sec/system (Normal, Simultaneous and Data Record File Mode).

§ 042.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
Identity:	-	Model 361	Model 361.
Discs:	0	128	768.
Characters:	0	4,608,000	27,648,000.
Instructions:	0	460,800	2,746,800.
Bands:	0	512	3,072.
Cells:	0	5,120	30,720.
Cartridges:	0	128	768.
Modules:	0	1	6.

.32 Rules for Combining Modules: . . . . up to six modules in system.

.4 CONTROLLER

.41 Identity: . . . . Data Record File Control; Model 317-1, 317-2; DRFC.
Data Record File Mode Control; Model 391; DRFMC.

.42 Connection to System

.421 On-Line: . . . . maximum of one, each model control.
.422 Off-Line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . one to DRFC, Model 317-1; one to DRFC, Model 317-2; four to DRFMC, Model 391; total of six at one time in system.
.432 Restrictions: . . . . . . when using DRFC, first DRF requires DRFC 317-1.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 10 blocks, each of 1 to 900 char.
.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: . . Record File operable.
Record File operating.
disc on turntable.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks
Stacks per system: . . 12.
Stacks per module: . . 2.
Stacks per yoke: . . . . 2.
Yokes per module: . . . 1.
.512 Stack movement: . . . . to beginning of band on selected disc.
.513 Stacks that can access any particular location: 1.
.514 Accessible locations
By single stack
With no movement: . . 1 band (10 cells).
With all movement: 1 band (10 cells).
By all stacks
With no movement: . 1 band per module.
6 bands per system.
.515 Relationship between stacks and locations: odd-even address of band.

.52 Simultaneous Operations

A: . . . . waiting for access to specified location (searching).
B: . . . . searching for access by pattern matching.
C: . . . . reading.
D: . . . . recording.
a $\leq$ 1 per DRFC + 4 per DRFMC.
b = 0.
c + d $\leq$ 2 per 2 DRFCs.
c + d $\leq$ 1 per DRFMC.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, sec.	Example, sec.
Return of disc from table:	0.0 or 1.5	1.5.
Physical selection of unit; turn cage:	0.0 to 2.5	1.3.
Place disc on table:	1.5	1.5
Wait for start of band:	0.0 to 0.2 (0 to 1 rev).	0.1
Wait for chosen cell:	0.0 to 4.0	2.0
Read N cells:	0.4 N	0.0
Read M char in last chosen cell:	M/2500	0.2
Total		6.6 sec.

.6 CHANGEABLE STORAGE

.61 Cartridges

.611 Cartridge capacity: . . . 40 cells, each 1 to 900 char (36,000 char total).
.612 Cartridges per module: . 128
.613 Interchangeable: . . . . . yes.

.62 Loading Convenience

.621 Possible loading
While computing system in use: . . . . yes.
While storage system in use: . . . . no.
.622 Method of loading: . . . . operator.
.623 Approximate change time: . . . . 0.75 min.
.624 Bulk loading: . . . . no.

§ 042.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With Self: . . . . no.
With HSM: . . . . yes.

.72 Transfer Load Size: . . . with HSM in units of 1 to 10 cells, each 1 to 900 char.

.73 Effective Transfer Rate

With HSM: . . . . 1,540 char/sec. for 36,000 character transfer.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	parity check	stop computer, alarm.
Receipt of data:	parity	stop computer, alarm.
Dispatch of data:	transmits parity bit.	
Conflicting commands:	interlock	wait.
Physical record missing:	sensing	stop computer, alarm.
Inoperable device:	check	stop computer, alarm.
Recording of data:	check	stop computer, alarm.
Recovery of data:	parity check by Processor	stop computer, alarm.

INTERNAL STORAGE: DATA DISC FILE

§ 043.

.1 GENERAL

.11 Identity: . . . . Data Disc File.
Model 366.
DDF.

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

.13 Description

The Data Disc File offers up to 88 million characters of random-access bulk storage, with access times on the order of 130 milliseconds to locate and read a group of characters. Two such files may be used with a system. The Data Disc File is available in modules of 22 million characters resulting in the following models:

Model 366-1	22 million characters
Model 366-2	44 million characters
Model 366-3	66 million characters
Model 366-4	88 million characters

The 301 System Data Record Files also offer bulk storage but with slower access times and smaller storage capacities. The Data Disc File single module capacity is much greater than that of the Data Record File module and is employed for fast on-line data record-keeping applications.

Each module consists of six discs spinning on a common shaft. Access within a module is by multiple heads mounted on a common movable yoke, which has 128 possible positions. Each disc face has six two-inch zones for recorded data. Each zone contains 128 bands or tracks of data, read and recorded by one of the heads. Three of the six zones have double packing of data; hence, there are effectively nine zones per disc face. Each of the 128 physical locations of the yoke permits access to 1 band in each of the 108 zones in a 6-disc module, and there are 72 read-record heads total. Selection of the particular one of the 108 possible bands is by electrical switching of the heads, and each group of 108 bands is called a stratum. A stratum stores a maximum of 172,800 characters. There are additional bands in the file held in reserve.

Data is stored in a circular band in 10 sectors, all of which may be read or recorded in a single operation. One sector stores up to 160 characters. Each module stores 13,824 bands and 138,240 sectors. Information is stored in 301 internal code form, requiring no translation

Access time varies from 0 to 100 milliseconds to position the heads; rotation time of a disc is 50 milliseconds. The peak data transfer rate is 32,000 characters per second. The effective bulk transfer rate is claimed by the manufacturer to be 25,400 characters per second. At this data rate, data must be stored in the same band location of the zones used or in bands physically near each other.

.13 Description (Contd.)

The heads are positioned within a zone by one type of instruction, and the head and sector are selected by a second type of instruction. After head positioning is initiated, the computer is free to perform other instructions. Arrival of the heads at the specified position may be sensed by the program. The band address is automatically checked for validity of the address of the band being read.

The Disc File demand on the central processor, that is, the time the central processor is tied up by the transfer of data, is 100% since there can be no overlapped operations without the Simultaneous Mode Control. When the Simultaneous Mode Control is present, overlapped operation is possible and the central processor is delayed for only 11.2% of the total data transfer time.

.14 Availability: . . . . . approximately 6 months.

.15 First Delivery: . . . February, 1963.

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . multiple discs.

.22 Physical Dimensions

.222 Disc
Diameter: . . . . . . 39 inches.
Thickness or length: . thin.
Number on shaft: . . . 6 in 1 module, recorded on both sides.

.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.

.25 Data volume per band of 1 track

Characters: . . . . . . 1,600.
Digits: . . . . 1,600.
Instructions: . . . . . . 160.
Sectors: . . . . 10.

.26 Bands per Physical Unit: 1,152 per disc side, of which 768 are packed 2 to a track.

.27 Bands per Physical Unit: 1 on 384 tracks per disc side; 2 on 384 tracks per disc side.

§ 043.

.28 Access Techniques

.281 Recording method: . . moving head.

.283 Type of access

Description of stage	Possible starting stage
Move yoke to selected band:	if new yoke position is selected.
Select head:	if same yoke position is selected.
Wait for start of selected sector of band:	no.
Wait for transfer of 1-10 sectors of data:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
- Cycling rates: . . . . 1, 200 rpm.
- Bit rate per track: . . 224, 000 bits/sec/track.
- Bits/track: . . . . . . 11, 200.

.292 Peak data rates
- Unit of data: . . . . . character.
- Conversion factor: . . 7 bits per char.
- Data rate: . . . . . . 32, 000 char/sec.
- Compound data rate: . 64, 000 char/sec. max; 2 files operating and SMC 392 in system.

.3 DATA CAPACITY

.31 Module and System Sizes (See table below)

.32 Rules for Combining Modules: . . . . 2 files may be used in a system. This brings maximum storage of Data Disc Files to 176, 947, 200 characters.

.4 CONTROLLER

.41 Identity: . . . . controller is built into Disc File.

.42 Connection to System

.421 On-line: . . . . 1 or 2 files.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: file consists of Model 366-1, -2, -3, or -4.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 10 sectors of 1 band, of max. of 160 characters per sector. Number of sectors specified by program.
.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: . . Disc File operable.
Disc File operating.
Yoke moving.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks
- Stacks per system: . . 576 (2 Model 366-4).
- Stacks per module: . . 72.
- Stacks per yoke: . . . 72 to 288 (1-4 modules).
- Yokes per module: . . 1.
- Yokes per file: . . . . 1.

.512 Stack movement: . . . . across group (zone) of 128 tracks to addressed band.

.513 Stacks that can access any particular location: 1.

.514 Accessible locations
- By single stack
  - With no movement: . 1 band.
  - With all movement: 128 bands.
- By all stacks
  - With no movement: . 108 bands per module (stratum). 864 bands per system (2 Model 366-4).

.52 Simultaneous Operations

A: . . . . waiting for access to specified location.
B: . . . . searching for access by pattern matching.
C: . . . . reading.
D: . . . . recording.

$a + c + d \leq 1$ for each file in use.
$b = 0$ in all operations.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation	Example
Move yoke to selected band:	0, or 10-100 msec.	80 msec.*
Select head:		negligible.
Wait for start of selected sector of band:	0-50 msec.	25 msec.
Wait for transfer of 1-10 sectors of data:	5-50 msec.	25 msec.
Total:		130 msec.

*yoke movement proceeds independently of computer after initiation (0.042 msec.).

	Minimum Storage				Maximum Storage (1 file)
Identity:		DDF 366-1	DDF 366-2	DDF 366-3	DDF 366-4.
Discs:	0	6	12	18	24.
Characters:	0	22, 118, 400	44, 236, 800	66, 355, 200	88, 473, 600.
Instructions:	0	2, 211, 840	4, 423, 680	6, 635, 520	8, 847, 360.
Sectors:	0	221, 184	442, 368	663, 552	884, 736.
Modules:	0	1	2	3	4.

§ 043.

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

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . no.
With HSM: . . . . yes.

.72 Transfer Load Size

With HSM: . . . . 1-10 sectors on one band, of max of 160 characters per sector.

.73 Effective Transfer Rate

With HSM: . . . . 25,400 char/sec (claimed).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	?	
Receipt of data:	parity check	stop computer, alarm.
Dispatch of data:	transmits parity bit.	
Conflicting commands:	interlock	wait.
Disc file inoperable:	check	stop computer, alarm.
Data File positioning:	check	stop computer, alarm.
Recording of data:	?	
Recovery of data:	?	
Bit counter check:	check	stop computer, alarm.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . Processor.
Models 303, 304, and 305.

Processor.
Models 354 and 355.

.12 Description

All models of the 301 processor are identical except for their core storage capacity and provisions for built-in fixed and floating point operations. The central processor is a sequential, two-address, add-to-storage unit. The instruction uses four-character operand addresses, with alphamerics in the most significant position to indicate the segment of core storage to be referenced. A program written for one processor will run on any other model processor containing the same or greater amount of core storage, assuming the program does not call for use of floating point arithmetic hardware facilities (which applies to programs written for Models 354 and 355 only).

The Model 303 processor contains 10, 000 positions of core storage. Each character position contains six information bits plus a parity bit and is individually addressable. Models 304 and 354 contain 20, 000 positions of core storage, and Models 305 and 355 contain 40, 000 positions.

Models 354 and 355 contain additional high speed arithmetic circuits, not present in any form in Models 303, 304, and 305 (they use sum and difference tables which are always present in core storage) for fixed and floating point arithmetic. The high speed arithmetic unit is located in some of the space previously assigned to input-output controllers (cabinets next to the processor cabinets). The manufacturer's recommended procedure for changing from a 303/304/305 processor to a 354/355 processor is to replace the existing cabinets with new cabinets. Use of a 354/355 processor may limit the system to less than the maximum number of input-output devices previously available.

Standard Processor

The standard unit processes data serially by character with operands of up to 44 characters; the operand length is specified by the 6-bit alphameric N-character of the instruction.

The standard processor does not include index registers or automatic multiply or divide instructions. However, with the Models 354 and 355 high speed processors, a set of 10 instructions exists that can be indexed through 3 index registers.

.12 Description (Contd.)

Indirect addressing is provided in all five processor models; also, instructions for comparison, Boolean operations, data movement, and repeating instruction groups. A translate instruction exists which converts the code of each six-bit character of an operand to any other desired (preset) code.

A conditional transfer instruction can test the position of a console spring-return switch (Interrupt Button) which permits a console-initiated program interrupt. Another conditional branch instruction provides a jump based on the input-output operation proceeding in the Simultaneous Mode; i.e., a write, a read, or no operation. Program sequencing utilizes direct or indirect operand addresses. Addition and subtraction are performed in the Models 303, 304, and 305 with the use of restricted-access sum and difference tables rather than conventional adder circuits. The tables always occupy 200 positions of core storage.

Input-output operations performed independently of the central processor are: advance paper on printer; seek a record on the Data Record File; rewind magnetic tape; and seek a band on the Data Disc File. Although the processor is basically a decimally addressed machine which can be programmed simply, a number of instructions require the use of special characters: for special cases, control of bits within a character, referencing core storage beyond 10, 000 locations, or specifying operand length.

Although the central processor has provision for processing variable length data fields (through use of item separator symbols), the arithmetic and logical instructions must use field lengths specified by the N-character of the instruction. Therefore, to use the processor for dynamically variable length fields or variable length records would increase the programming complexity.

Simultaneous operations are provided by optional hardware. Two data transfers or one data transfer and internal processing can occur simultaneously. Use of one additional option, the Data Record File Mode Control, permits one additional data transfer, to the Data Record File only.

Fast Processor Additions

Models 354 and 355 each provide facilities for operating on fixed or floating point eight-digit numeric operands. These facilities are provided by the introduction of special accumulators, 10 new instruction operations, and an extension to the TALLY instruction to step indexes. Only the 10 new instructions are indexable.

The 10 new operations provide addition, subtraction, multiplication, division, and shifting of fixed and

§ 051.

.12 Description (Contd.)

floating point numbers. These new operations require fixed sized operands in contrast to the variable length operations available in the basic operation repertoire. Floating point decimal operations are carried out on eight-character fixed point parts (mantissas) and two-character exponents and are normalized and rounded.

Models 354 and 355 have an 8-digit parallel adder circuit and a 16-digit accumulator. The accumulator contents can be stored and can be shifted. For convenience, either operand can be obtained from the accumulator, and the result can be left in the accumulator after the operation, or can be placed in storage. Increase in time to obtain or store each operand is shown in the table below. Operations which can use an operand in the accumulator or can leave the results in the accumulator (summing, for example) require less time than the full two-address add-to-storage operation.

The times for individual instructions can be computed from the following components:

	Fixed point, μsec	Floating point, μsec
Addition or subtraction	42	42
Multiplication	350	357
Division	357	364
Fetch each operand from HSM	28	35
Place result in HSM	28	35
Shift for alignment or normalizing	28	7
Index an address	21	21
Step an index	21	21
Addition range	70 to 126	77 to 210

These facilities increase the arithmetic speeds by a factor of 2.5 to 3.0 for addition and a factor of 10 to 20 for multiplication and floating point.

Three index locations, A, B, and C, are held in the high speed memory. It is possible to specify:

- no indexing.
- index address A by index A.
- index address B by index B.
- index addresses A and B, by indexes A and B, respectively.
- index addresses A and B, each by index C.

.13 Availability

303/304/305: . . . . . 6 months following receipt of order.
354/355: . . . . 6 months following receipt of order.

.14 First Delivery

303/304/305: . . . . . February, 1961.
354/355: . . . . scheduled Sept. 1963.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and variation	Provision	Radix	Size
.211	Fixed point			
	Add-subtract			
	303/304/305:	automatic	decimal	1 to 44 digits.
	354/355:	automatic	decimal	8 digits, or 1 to 44 digits.
	Multiply			
	Short:	none.		
	Long			
	303/304/305:	subroutine	decimal	8, 13, or 18 digits.
	354/355:	automatic	decimal	8 digits.
	Divide			
	No remainder:	none.		
	Remainder			
	303/304/305:	subroutine	decimal	8, 13, or 18 digits.
	354/355:	automatic	decimal	8 digits.
.212	Floating point			
	Add-subtract			
	303/304/305:	subroutine	decimal	8, 13, or 18 and 2.
	354/355:	automatic	decimal	8 and 2.
	Multiply			
	303/304/305:	subroutine	decimal	8, 13, or 18 and 2.
	354/355:	automatic	decimal	8 and 2.
	Divide			
	303/304/305:	subroutine	decimal	8, 13, or 18 and 2.
	354/355:	automatic	decimal	8 and 2.
.213	Boolean			
	AND: / Inclusive OR: / Exclusive OR:	automatic	binary	1 to 44 6-bit groups.
.214	Comparison			
	Numbers:	automatic	high, low, equal	1 to 44 char.
	Absolute:	none.	high, low, equal	1 to 44 char.
	Letters:	automatic	high, low, equal	1 to 44 char.
	Mixed:	automatic	high, low, equal	1 to 44 char.
	Collating sequence:	numerals, letters, specials interspersed.		

.215 Code translation
- Provision: . . . . . . automatic, using table.
- Between: . . . . any 6-bit codes.
- Size: . . . . 1 to 44 char.

.216 Radix conversion: . . . none; decimal machine.

.217 Edit format: . . . . . . subroutine only.

.218 Table lookup
- Equality: . . . . no provision.
- Greater than: . . . . . no provision.
- Greatest: . . . . no provision.
- Least: . . . . no provision.
- Non-equality: . . . . . automatic; searches 1 to 44 char for absence of 1 specified char.

.219 Other

Repeat
- Provision: . . . . . . automatic.
- Comment: . . . . . . repeats any group of instructions up to 14 times. Applies to arithmetic, data transfer, translate, Boolean, tape and card read instructions.

Tally
- Provision: . . . . . . automatic.
- Comment: . . . . . . provides loop control by automatic counting; 100 times maximum.

§ 051.

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value with sign bit in one of the digits.
.222 Zero: . . . . minus zero is exceptional case; it cannot arise in arithmetic; it is different from plus zero in comparison.
.223 Operand size determination
303/304/305: . . . . . count in instruction.
354/355: . . . . automatic; 8 digits.

.23 Instruction Formats

.231 Instruction structure: . 10 char.
.232 Instruction layout

Part	O	N	A	B
Size (char.)	1	1	4	4

.233 Instruction parts

Name	Purpose
O:	operation code.
N:	operand size delimiter code, device addressing, count specification, register/indicator selection, device control, I/O data transfer control, index register selection (354/355), or index register incrementing control (354/355).
A:	HSM location or instruction control.
B:	HSM location, instruction control, or device control.

.234 Basic address structure: . . . . . . 2 + 0.
.235 Literals
Arithmetic: . . . . . . none.
Comparisons and tests: . . . . single character.
Incrementing modifiers: . . . . . none.
.236 Directly addressed operands

	Minimum size	Maximum size	Volume accessible
Core Storage:	1 char	44 char	total capacity.
Data Record File:	1 block	10 blocks	total capacity.
Data Disc File:	1 sector	10 sectors	total capacity.

.237 Address indexing
.2371 Number of methods: . 1; in 354/355 Processor only.
.2373 Indexing rule: . . . . . algebraic addition of field to operand address. If negative address or overflow address occurs, halt and alarm results. Entire store is available.
.2374 Index specification: . . within the modified instruction which must be 1 of the 10 new instructions associated with the 354/355 Processor.
.2375 Number of potential indexers: . . . . . . A address, B address, both A and B address by the same value, or both A and B addresses by different values; specified by N-character of instruction. 3 index registers.
.2376 Addresses which can be indexed: . . . . . all.
.2377 Cumulative indexing: . not possible.
.2378 Combined index and step: . . . . yes; indirect addressing followed by indexing.
.238 Indirect addressing
.2381 Recursive: . . . . . . yes.
.2382 Designation: . . . . . bit in least significant address character.
.2383 Control: . . . . executed address has no indirect bit.
.239 Stepping: . . . . using Tally instruction; 100 steps max.
.2391 Specification of increment
303/304/305: . . . . always -1 (implicit).
354/355: . . . . arbitrary value, held in index increment register.
.2392 Increment sign
303/304/305: . . . . always -1 (implicit).
354/355: . . . . + or - .
.2393 Size of increment
303/304/305: . . . . 1, as above.
354/355: . . . . arbitrary within maximum size of storage.
.2394 End value
303/304/305: . . . . implied as zero.
354/355: . . . . none as such; either indexing is controlled by N char in Tally instruction, or is done one time.
.2395 Combined step and test: . . . . automatic, using Tally instruction.

.24 Special Processor Storage

.241 Category of storage

Category of storage	Number of locations	Program usage
Core storage in all processors:	200	tables.
	4	card punch.
	4	arithmetic unit.
	12	program control.
	22	other reserved areas.
Additional core storage in 354/355:	12	3 index registers.
	12	3 index increment registers.

.242 Category: . . . . core storage.
Access time: . . . . . . 3.5 μsec.
Cycle time: . . . . . . 7.0 μsec.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1.

§ 051.

.314 Special sub-sequence counters

Number	Purpose
1:	repeat instruction counter.
1:	operand size counter.

.315 Sequence control step size: . . . . instruction.

.316 Accessibility to program: . . . . yes; stored if jump takes place.

.317 Permanent or optional modifier: . . . . none.

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

.33 Interruption: . . . . . . none; operator can depress sense switch (Interrupt Button) on console, and program can contain test instructions for this condition.

.34 Multi-running: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μsec

	303/304/305 Processor	354/355 Processor
.411 Fixed point		
Add-subtract:	49 + 28D	130 (8 digits; includes obtaining and storing operands).
Multiply:	5,000 (8-digit operands)	406 (8 digits; includes obtaining operands).
Divide:	18,000 (8-digit operands)	413 (8 digits; includes obtaining operands).
.412 Floating point		
Add-subtract:	3,500 (8-digit subroutine)	150 (8 digits; includes obtaining and storing operands).
Multiply:	5,800 (8-digit subroutine)	430 (8 digits; includes obtaining operands).
Divide:	18,800 (8-digit subroutine)	440 (8 digits; includes obtaining operands).

.413 Additional allowance for
- Indirect addressing: . 14.
- Recomplementing
  - 303/304/305: . . . . 14 + 11D.
  - 354/355: . . . . . . 7.

.414 Control
- Compare: . . . . 35 + 21D.
- Branch: . . . . 49.

.415 Counter control
- Step: . . . . none.
- Step and test: . . . . . 70 (Tally Instruction).

.416 Edit: . . . . subroutine only.

.417 Convert: . . . . 0 (decimal machine).

.418 Shift
- 303/304/305: . . . . . no shifting.
- 354/355: . . . . 7D.

.419 Other
- Translate: . . . . . . 35 + 21C.
- Boolean instructions: . 35 + 21C, where C includes all 6 bits.

.42 Processor Performance in μsec

	303/304/305 Processor	354/355 Processor
.421 For random addresses		
Fixed point		
c = a + b:	84 + 42D	166 (8 digits).
b = a + b:	49 + 28D	126 (8 digits).
Sum N items:	49 + 28D	70 (8 digits).
c = ab:	8,400 (8-digit subroutine)	434 (8 digits).
c = a/b:	18,000 (8-digit subroutine)	441 (8 digits).
Floating point		
c = a + b:	3,500 (8-digit subroutine)	196 (8 digits).
b = a + b:	3,500 (8-digit subroutine)	161 (8 digits).
Sum N items:	3,500 (8-digit subroutine)	91 (8 digits).
c = ab:	9,200 (8-digit subroutine)	476 (8 digits).
c = a/b:	18,800 (8-digit subroutine)	483 (8 digits).
.422 For arrays of data		
Fixed point		
$c_i = a_i + b_j$:	442 + 42D	500 (8 digits).
$b_j = a_i + b_j$:	311 + 28D	448 (8 digits).
Sum N items:	215 + 28D	329 (8 digits).
$c = c + a_ib_j$:	9,400 (8-digit subroutine)	826 (8 digits).
Floating point		
$c_i = a_i + b_j$:	3,800 (8-digit subroutine)	539 (8 digits).
$b_j = a_i + b_j$:	3,750 (8-digit subroutine)	483 (8 digits).
Sum N items:	3,650 (8-digit subroutine)	336 (8 digits).
$c = c + a_ib_j$:	19,000 (8-digit subroutine)	882 (8 digits).

.423 Branch based on comparison
- Numeric data: . . . . 240 + 25C.
- Alphabetic data: . . . 240 + 25C.
- Alphameric data: . . . 276 + 46C.

.424 Switching
- Unchecked: . . . . . . 305.
- Checked: . . . . 375 + 21C.
- List search: . . . . . 14 + (70 + 21C)N.

.425 Format control per character
- Unpack: . . . . 18.
- Compose: . . . . 34.

.426 Table look up per comparison
- For a match: . . . . . 266 + 21C.
- For least or greatest: 357 + 21C.
- For interpolation point: . . . . 266 + 21C.

.427 Bit indicators
- Set bit in separate location: . . . . . . 49.
- Test bit in separate location: . . . . . . 105.

.428 Moving: . . . . 35 + 14C.

§ 051.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Fixed point overflow (303/304/305):	check	indicator, and bit in result.
Fixed point overflow (354/355):	check	indicator; alarm and halt on next arithmetic operation.
Address indexing (354/355):	check	stop computer; alarm.
Floating point exponent overflow check (354/355):	check	indicator; alarm and halt on next arithmetic operation.
Floating point mantissa overflow check (354/355):	none.	
Invalid data:	parity check	stop computer; alarm.
Invalid operation:	check	stop computer; alarm.
Arithmetic error:	none.	
Invalid address:	check	stop computer; alarm.
Receipt of data:	parity check	stop computer; alarm.
Control registers:	parity	stop computer; alarm.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . Console Panel; a sub-unit of Processor. Console is built into center area of Processor cabinet and consists of sloping panel and horizontal work space.

.12 Associated Units: . . . none.

.13 Description

The Console Panel contains the controls and visible indicators used in the operation and maintenance of the computer. These are contained in three banks of pushbuttons and indicators. The pushbuttons light when depressed.

The right-hand bank displays and allows insertion of bits into the four (or two)-character-size computer registers. Core storage locations themselves are not directly addressable. The system must be stopped for register display.

The center bank allows selection of the computer register to be displayed or filled. Also, it includes some alternate action selection switches and switches to select one of the five instruction-staticizing levels.

The left-hand bank contains the balance of the alternate action selection switches, error indicators, and miscellaneous indicators.

The panel also contains a Start button, a General Reset button, and a Power Off button. Power can be turned on only at the System Power Supply.

.2 CONTROLS

.21 Power

Name	Form	Comment
Power Off:	button	turns off power to power supply and Processor.

.22 Connections: . . . . . . none.

.23 Stops and Restarts

Name	Form	Comment
Start:	button	initiates execution of selected status level of instruction.
Stop:	none.	
One Cycle Stop (OCSP):	button	stops computer at end of execution of each status level.
Instruction Complete Stop (ICSP):	button	stops computer prior to staticizing of next instruction.
First Processing Level Stop (FPLS):	button	stops computer after staticizing an instruction.

.24 Stepping: . . . . The OCSP, ICSP, and FPLS buttons in section 23 provide stepping.

.25 Resets

Name	Form	Comment
General Reset:	button	resets all registers, counters and most flip-flops (error indicators). It sets up initial status level of instruction staticizing.
Status Level Reset:	button	clears push buttons which specify status level.
Clear Register	buttons	clears register selection.
Clear Error		clears error indicators.
C_o	button	clears binary coded data entry push buttons.

.26 Loading: . . . . Must use bit filling of registers or core storage locations.

.27 Special

Name	Form	Comment
High Speed Memory Inhibit (HSMI):	button	inhibits information from going to or coming from HSM.
Bus Adder Inhibit (BAI):	button	output of Bus Adder same as input.
Status Level Repeat (STLR):	button	inhibits changing the current status level.
Inhibit Simultaneity (ISIM):	button	all instructions executed serially but in mode control specified by instruction.
Simultaneous Mode Inhibit (SMDI):	button	all instructions performed in Normal Mode (Processor only).
Bypass Card Translation (BCT):	button	characters from cards read as binary data.
Interrupt (INT):	button	single sense switch becomes set.
Alarm Inhibit (ALI):	button	computer does not stop on an error. Error indicator lights and remains lit.
Write to Table (WTAB):	button	allows access to HSM arithmetic tables.
Specify a status level:	binary coded buttons	set up binary value to specify one of the five status levels.

§ 061.

.3 DISPLAY

.31 Alarms

Name	Form	Conditions Indicated
Parity Errors		
Simultaneous Operation or M Register (SORM):	static lamp	parity error in register(s).
Normal Operation or N Register (NORN):	static lamp	parity error in register(s).
V or L Register (FORL):	static lamp	parity error in register(s).
Repeat Register (NRPE):	static lamp	parity error in register(s).
Memory Address Register (MAPE):	static lamp	parity error in register(s).
Memory Register (MRPE):	static lamp	parity error in register(s).
D Register (DPE):	static lamp	parity error in register(s).
Status Level (STLE):	static lamp	parity error in register(s).
Other Errors		
COME:	static lamp	comparator error.
ARIE:	static lamp	arithmetic error.
WTT:	static lamp	illegal attempt to write to sum or difference table.
DDF:	static lamp	device inoperable.
RE:	static lamp	error during a read instruction.
WE:	static lamp	error during a write instruction.
TAE:	static lamp	parity error in tape address.
CCE:	static lamp	hole count error on card reader or card punch.
MCP:	static lamp	missing clock pulse on 581/582 tape stations.
SAL:	static lamp	peripheral error while instruction using SMC.
MPE:	static lamp	invalid card character.
CIG:	static lamp	character in paper tape or magnetic tape gap.
RAE:	static lamp	parity error in Data Record File or Data Disc File. Address Register.
FAL:	static lamp	error during Record File Mode instruction operation.

.32 Conditions

Name	Form	Condition Indicated
SB:	lamp while condition present	Simultaneous Mode occupied.
FB:	lamp while condition present	Record File Mode occupied.

.33 Control Registers

Name	Form	Comment
P, A, B, S, T, U, V:	binary coded indicating push buttons	desired register selected for display by appropriate push button. Contents shown as four 7-bit characters.
NOR/N, SOR/M, FOR/L, MR:	same binary coded indicating push buttons as above	as registers above, except are two 7-bit characters.

.34 Storage: . . . . One HSM location displayed by using RDM (Read Memory) push button, and register selection and data entry push buttons.

.4 ENTRY OF DATA

.41 Into Control Registers

(1) desired register selected by depressing appropriate push button.
(2) depress binary coded indicating push buttons.

.42 Into Storage: . . . . . . One HSM location may be written into by using WRM (Write Memory) push button, and register selection and data entry push buttons.

.5 CONVENIENCES

.51 Communication: . . . . none.

.52 Clock: . . . . none.

.53 Desk Space: . . . . . . approximately 12 by 48 inches.

.54 View: . . . . operator sits at console directly in front of Processor cabinet. All equipment is to side or rear of operator.

INPUT-OUTPUT: PAPER TAPE READER/PUNCH

§ 071.

.1 GENERAL

.11 Identity: . . . . Paper Tape Reader/Punch.
Model 321.
PTRP.

.12 Description:

This is a pair of separate units housed in a single cabinet. Both the reader and the punch operate at one hundred rows per second on standard one-inch seven-level paper tape. Optional features permit five- or seven-level punch and/or five- or seven-level reader operation. The external code is the same as the internal code, but a convenient code translation instruction can be used to translate any code. The system normally requires that blocks be separated by gaps of three rows, but the reader can be set to read gapless tape by ignoring gap detection.

.13 Availability: . . . . July, 1961.

.14 First Delivery: . . . . . July, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . sprocket drive for punch. clutch controlled rollers for reader.
.212 Reservoirs
Number: . . . . 4; 2 per unit.
Form: . . . . swinging arm.
Capacity: . . . . 8 inches maximum.
.213 Feed drive: . . . . electric motor.
.214 Take-up drive: . . . . . electric motor

.22 Sensing and Recording System

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . . photoelectric.
.223 Common system: . . . . no.

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

.24 Arrangement of Heads

Use of station: . . . . . . reading
Stacks: . . . . 1.
Heads/stack: . . . . . . 8.
Method of use: . . . . . reads one row at a time.

Use of station: . . . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8.
Method of use: . . . . . punches one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

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

.32 Positional Arrangement

.321 Serial by: . . . . N rows at 10 per inch.
.322 Parallel by: 7 tracks at standard spacing (5- or 7-tracks in modified units).

.324 Track use

	7-level	5-level
Data:	6	5.
Redundancy check:	1	0.
Timing:	1 (sprocket track)	1 (sprocket track).
Control signals:	0	0.
Unused:	0	0.
Total:	7 plus sprocket track	5 plus sprocket track.

.325 Row use
Data: . . . . all.
Redundancy check: . . . 0.
Timing: . . . . 0.
Control signals: . . . . 0.
Gap: . . . . 3, in block format.

.33 Coding: . . . . as in Data Code Table No. 1, with holes representing zero bits and no holes representing one bits.

.34 Format Compatibility: . any paper tape device accepting standard 11/16-inch 5-level or 1-inch 7-level tape.

.35 Physical Dimensions

.351 Overall width: . . . . . . 11/16-inch or 1-inch.
.352 Length: . . . . 1,000 ft max, punch and reader; also short lengths (reader).

.4 CONTROLLER

.41 Identity: . . . . Paper Tape Reader/Punch Control.
Model 311.
PTRPC.

.42 Connection to System

.421 On-line: . . . . one PTRPC max.
.422 Off-line: . . . . none.

§ 071.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions:. . . . . . . the PTRP Control 311 can control either one PTRP 321, or one PTR 322 and one PTP 331.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N char, 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 char; depends on available core storage.

.512 Block demarcation
Input: . . . . block gap for input.
Output: . . . . limit counter for output.

.52 Input-Output Operations

.521 Input: . . . . 1 block forward with limit cut off; block gap or HSM location.
.522 Output: . . . . 1 block forward.
.523 Stepping:. . . . . none.
.524 Skipping:. . . . . none.
.525 Marking:. . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . matched codes; parity bit generated when reading 5-level codes.

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

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . . . no.
Rewind: . . . . no.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . yes.
End of medium marks: . no.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . without SMC.
II: . . . . with SMC.

.62 Speeds

.621 Nominal or peak speed: . . . . 100 rows/sec for reading and punching.

.622 Important parameters
Speed: . . . . 10 in/sec.
Stopping distance: . . . ready to read or punch next character at nominal spacing.

.623 Overhead: . . . . 3 rows per block gap; no gap required when reading.

.624 Effective speeds: 100 N/(N + 3G) char/sec
where N = char in block
G = no. of gaps in data.

.63 Demands on System

Component	Condition	m. sec per char	or	Percentage
Processor	I	10,000	or	100.00.
Processor	II	0.007	or	0.07

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Tape width guide for modified 5- or 7-level reader and/or punch:	knob	by operator.

.72 Other Controls

Function	Form	Comment
Stop mode:	button	gap detection made inoperative for reading gapless tape.
Tape feed:	button	feeds tape, punching sprocket holes.
Punch delete codes:	button	feeds tape punching holes in each track.

.73 Loading and Unloading

.731 Volumes handled: spools of 1,000 feet.
.732 Replenishment time: 1 to 2 mins.
device needs to be stopped.
.733 Adjustment time: 5- or 7-level option; 0.5 min to adjust tape width guide.
.734 Optimum reloading period: 20 mins.

§ 071.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording	parity check on punch	stop computer, alarm.
Reading:	parity check	stop computer, alarm.
Input area overflow:	limit counter interlock	cut-off and indicator.
Invalid code:	all codes valid.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Punch, reader inoperable:	check	stop computer, alarm.
Character found in gap:	check	stop computer, alarm.
Output block size:	limit counter interlock	cut-off and indicator.

INPUT-OUTPUT: PAPER TAPE READER

§ 072.

.1 GENERAL

.11 Identity: . . . . Paper Tape Reader. Model 322. PTR.

.12 Description:

This is a high-speed paper tape reader which will read 5, 6, or 7 level chad (fully perforated) punched paper tape at rates up to 1,000 rows per second. The normal external code is the same as the internal code, but a convenient translation instruction can be used to translate any code. The reader can be set to read gapless tape, at 500 rows/second. The system requires that blocks be separated by gaps of three rows when reading at the rate of 1,000 rows per second.

.13 Availability: . . . . December, 1961.

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

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . clutch controlled rollers.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . 60 inches maximum.
.213 Feed drive: . . . . electric motor.
.214 Take-up drive: . . . . . electric 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: . . . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8.
Method of use: . . . . . . reads one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

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

.32 Positional Arrangement

.321 Serial by: . . . . N rows at 10 per inch.
.322 Parallel by: . . . . 5, 6, or 7 tracks at standard spacing.

.324 Track use
Data: . . . . 5 or 6.
Redundancy check: . . . 1 (if 7 level).
Timing: . . . . 1 (sprocket track).
Control signals: . . . . 0.
Unused: . . . . 0.
Total: . . . . 5, 6 or 7 plus sprocket track.

.325 Row use
Data: . . . . all.
Redundancy check: . . . 0.
Timing: . . . . 0.
Control signals: . . . . 0.
Gap: . . . . 3, in block format.

.33 Coding: . . . . as in Data Code Table No. 1, with holes representing zero bits and no holes representing one bits.

.34 Format Compatibility: . . any paper tape device accepting standard 11/16 inch 5-level to 1-inch 7-level tape.

.35 Physical Dimensions

.351 Overall width: . . . . . . 11/16 to 1 inch by 1/16 inch increments.

.352 Length: . . . . 1,000 ft. max.; also short lengths.

.4 CONTROLLER

.41 Identity: . . . . Paper Tape Reader Punch Control. Model 311. PTRPC.

.42 Connection to System

.421 On-line: . . . . one PTRPC max.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . . the 311 PTRP Control can control either one 321 PTRP, or one 322 PTR and one 331 PTP.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N char, limited by available core storage.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . each character.
.444 Input-output area lockout: . . . . none.

§ 072.

.445 Table control: . . . . . . none.
.446 Synchronization: . . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . . 1 to N char, depends on available core storage.
.512 Block demarcation
Input: . . . . block gap.

.52 Input-Output Operations

.521 Input: . . . . 1 block forward with limit cut off; block gap or HSM location.
.522 Output: . . . . none.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . . matched codes; parity bit generated when reading 5- or 6-level codes.

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

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . no.
Rewind: . . . . no.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . yes.
End of medium marks: . no.
Code level (5, 6 or 7) . . no.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . without SMC.
II: . . . . with SMC.

.62 Speeds

.621 Nominal or peak speed: . 1000 rows/sec normal; 500 row/sec with gapless tape (telegraph codes).

.622 Important parameters
Speed: . . . . 50 or 100 in/sec.
Stopping distance: . . . approximately 0.3 inches at 100 in/sec; stops on a single character at 50 in/sec (no gap).
.623 Overhead: . . . . 3 rows per block gap in block format.
.624 Effective speeds: 500 N/(N + 3G) char/sec or 1,000 N/(N +3G) char/sec.
N = number of characters read.
G = number of gaps in data.

.63 Demands on System

Component	Condition	m.sec. per char	or	Percentage
Processor:	I	2 or 1	or	100.
Processor:	II	0.007	or	0.35 or 0.7.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Tape width guide	knob	by operator.

.72 Other Controls

Function	Form	Comment
Rewind:	button	
Stop:	button	stops tape motion.
Start:	button	starts tape motion.
Stop mode:	button	gap detection made inoperative for reading gapless tape; speed set to 500 char/sec.
Parity select:	button	selects odd or even parity.
Servo control:	buttons	control servo power.
Tape type select:	button	permits reading of short strips of tape.
Code select:	switch	selects 5-, 6-, 7-, 8-level tape.
Remoting:	button	puts reader under computer control.

.73 Loading and Unloading

.731 Volumes handled: . . . reel of 1,000 feet.
.732 Replenishment time: . . . 0.75 min. to 1 min; reader needs to be stopped.
.733 Adjustment time: . . . . 1/2 min. to adjust tape width guide.
.734 Optimum reloading period: . . . . 2 minutes at 1,000 char/sec.
4 minutes at 500 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity	stop computer, alarm.
Input area overflow:	limit counter interlock	cut off and indicator.
Invalid code:	all good.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts	interlock	wait.
Reader inoperable:	check	stop computer, alarm.
Character found in gap:	check	stop computer, alarm.

INPUT-OUTPUT: PAPER TAPE PUNCH

§ 073.

.1 GENERAL

.11 Identity: . . . . Paper Tape Punch.
Model 331.
PTP.

.12 Description

This is the same punch unit used in the Paper Tape Reader/Punch, Model 321. The Model 331 PTP is used when a paper tape punch is required with the high-speed Paper Tape Reader, Model 322. Its peak speed is 100 rows per second. The standard unit punches 7-level tape. An optional feature provides for punching either 5- or 7-level tapes.

.13 Availability: . . . . . . April, 1961.

.14 First Delivery: . . . . February, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . swinging arm.
Capacity: . . . . 8 inches maximum.
.213 Feed drive: . . . . . . electric motor.
.214 Take-up drive: . . . . . electric motor.

.22 Sensing and Recording Systems

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

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . 1.
Heads/stack: . . . . . . 8.
Method of use: . . . . . one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper tape.
.213 Phenomenon: . . . . . . standard punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . N rows at 10 per inch.
.322 Parallel by: . . . . . . 8 tracks at standard spacing (6 or 8 tracks in modified units).

.324 Track use:

	7-level	5-level
Data:	6	5.
Redundancy check:	1	0.
Timing:	1 (sprocket track)	1 (sprocket track).
Control signals:	0	0.
Unused:	0	0.
Total:	7 plus sprocket track	5 plus sprocket track.

.325 Row use
Data: . . . . all.
Redundancy check: . . 0.
Timing: . . . . 0.
Control signals: . . . 0.
Gap: . . . . 3.

.33 Coding: . . . . as in Data Code Table No. 1, with holes representing zero bits and no holes representing one bits.

.34 Format Compatibility: any paper tape device accepting standard 11/16 inch 5-level or 1-inch 7-level tape.

.35 Physical Dimensions

.351 Overall width: . . . . . 11/16 inch or 1 inch.
.352 Length: . . . . 1,000 ft. max.

.4 CONTROLLER

.41 Identity: . . . . Paper Tape Reader/Punch Control.
Model 311.
PTRPC.

.42 Connection to System

.421 On-line: . . . . one PTRPC max.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . the PTRP Control 311 can control either one PTRP 321 or one PTR 322 and one PTP 331.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to N char, 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.

§ 073.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N char, depends on available core storage.

.512 Block demarcation
Output: . . . . limit counter for output.

.52 Input-Output Operations

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

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . . no.
Rewind: . . . . no.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . without SMC.
II: . . . . with SMC.

.62 Speeds

.621 Nominal or peak speed: 100 rows/sec.

.622 Important parameters
Speed: . . . . 10 in/sec.
Stopping distance: . . ready to punch next character at nominal spacing.

.623 Overhead: . . . . 3 rows per block gap.
.624 Effective speeds: . . . 100 N/(N + 3) char./sec., where N = char. in block.

.63 Demands on System

Component	Condition	m.sec per char.	or	Percentage
Processor:	I	10.000	or	100.00.
Processor:	II	0.007	or	0.07.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Tape width guide for modified 5- or 7-level punch:	knob	by operator.

.72 Other Controls

Function	Form	Comment
Punch feed:	button	feeds tape, punching sprocket holes.
Punch delete codes:	button	feeds tape, punching holes in each track.

.73 Loading and Unloading

.731 Volumes handled: . . . spools of 1,000 feet.
.732 Replenishment time: . . 1 to 2 mins. punch needs to be stopped.
.733 Adjustment time: . . . 5- 7-level option: 1/2 min. to adjust tape width guide.
.734 Optimum reloading period: . . . . 20 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	parity check at punch	stop computer, alarm.
Output block size:	limit counter interlock	cut off & indicator.
Invalid code:	all codes valid.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Punch inoperable:	check	stop computer, alarm.

INPUT-OUTPUT: CARD READER

§ 074.

.1 GENERAL

.11 Identity: . . . . Card Reader.
Model 323.
CR.

.12 Description

The Card Reader has a maximum speed of six hundred cards per minute and reads 80-column punched cards. Each instruction causes one card to be read. Card timing can be reduced to three hundred cards per minute under program control, or cards may be fed on demand at a maximum rate of approximately two hundred cards per minute. The Card Reader Control automatically translates from standard card code to 301 internal code. Automatic translation may be by-passed, in which case the card image will be read into core storage and translation will be performed by a subroutine. The reader employs two sensing stations and a hole count check for reliability. The input hopper and output stacker have capacities of 2,000 cards each and can be loaded and unloaded while the reader is operating. The reject stacker has a capacity of 100 cards.

.13 Availability: . . . . . . September, 1961.

.14 First Delivery: . . . . September, 1961.

.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: . . . . . one row ata time.

Use of station: . . . . . checking.
Distance: . . . . one row.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . one 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.
.322 Parallel by: . . . . . . 80 columns.
.324 Track use: . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding: . . . . as in Data Code Table No. 2.

.34 Format Compatibility: . all devices using standard 80-column cards.

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

.4 CONTROLLER

.41 Identity: . . . . Card Reader Control.
Models 314-1R, 314-2R.

.42 Connection to System

.421 On-line: . . . . one 314-1R controls first card reader.
one 314-2R controls second card reader.
.422 Off-line: . . . . none.

.43 Connection to Device

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

.44 Data Transfer Control

.441 Size of load: . . . . . . one card, punched in any format.
.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 card.
.512 Block demarcation
Input: . . . . at end of each card.

.52 Input-Output Operations

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

§ 074.

.53 Code Translation: . . . automatic translation unless manually by-passed.

.54 Format Control: . . . . none.

.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: . . . . yes.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Hopper empty: . . . . . no.
Stacker full: . . . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . without SMC.
II: . . . . with SMC.

.62 Speeds

.621 Nominal or peak speed: 600 ± 10 cards/min.
.623 Overhead: . . . . single-point clutch.
.624 Effective speeds: . . .
1. at 600 cards per minute; available processing time is 20 m. sec.
2. at 300 cards per minute; available processing time is 120 m. sec.
3. single card reading: maximum speed is approximately 200 cards per minute.

.63 Demands on System

Component	Condition	m. sec per card	or	Percentage*
Processor:	I	80.00	or	80.00
Processor:	II	13.44	or	13.44

* at 600 cards/minute.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls: . . . . none.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	2, 000 cards.
Stacker:	2, 000 cards.

.732 Replenishment time: 1 min max.; reader does not need to be stopped.

.734 Optimum reloading period: . . . . 3.3 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Receipt of data from translator:	parity check	stop computer, alarm.
Reading:	double reading and hole count	stop computer, alarm.
Input area overflow:	fixed size.	
Invalid code:	check for non-301 character	stop computer, alarm.
Read instruction too late for continuous feeding:	check	stop computer, alarm, at next read instruction.
Exhausted medium:	disabled check	stop computer, alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Full stacker:	disabled check	stop computer, alarm.
Reader inoperable:	disabled check	stop computer, alarm.

INPUT-OUTPUT: CARD PUNCH

§ 075.

.1 GENERAL

.11 Identity: . . . . Card Punch.
Model 334.
CP 334.

.12 Description

This card punch has a maximum speed of 100 cards per minute, and punches standard 80-column cards. Internal codes are punched in standard RCA card code after automatic translation by the card punch controller. The punch unit has a reading station after the punching station for hole-count accuracy control purposes. Stacker and hopper capacity is 800 cards. A card punch instruction causes one card to be punched.

.13 Availability: . . . . . . September, 1961.

.14 First Delivery: . . . . September, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch-controlled 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: . . . . . one row at a time.

Use of station: . . . . . reading.
Distance: . . . . one card.
Stacks: . . . . 1.
Heads/stack: . . . . . . 80.
Method of use: . . . . . one 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.
.322 Parallel by: . . . . . . 80 columns.
.323 Bands: . . . . 1.
.324 Track use: . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding: . . . . as in Data Code Table No. 2.

.34 Format Compatibility: . all devices using standard 80-column punched cards.

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

.4 CONTROLLER

.41 Identity: . . . . Card Punch Control.
Model 315.
CPC 315.

.42 Connection to System

.421 On-line: . . . . one CPC 315.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: one per control.
.432 Restrictions: . . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to 80 char of one card.
.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 card of 1 - 80 columns.
.512 Block demarcation: . . limit counter.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . 1 card forward controlled by column count.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . internal code to card code by CPC 315.

.54 Format Control: . . . . none.

§ 075.

.55 Control Operations

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

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . not applicable.

.6 PERFORMANCE

.61 Conditions

I: . . . . normal mode.
II: . . . . simultaneous mode.

.62 Speeds

.621 Nominal or peak speed: 100 $\pm$ 5 cards/min.
.622 Important parameters: none.
.623 Overhead: . . . . single point clutch.
.624 Effective speeds: . . . maximum speed depends on cycles missed.

.63 Demands on System

Component	Condition	m.sec per card	or	Percentage
Processor:	I	600	or	100.0.
Processor:	II	6.72	or	1.1.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls: . . . . load, unload.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	800.
Stacker:	800.

.732 Replenishment time: 1 min max. no need to be stopped.

.734 Optimum reloading period: . . . . 8 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-punch; hole count	stop computer, alarm.
Output block size:	limit counter interlock	cut off and indicator.
Invalid code:	301 code check	stop computer, alarm.
Exhausted medium:	disabled check	stop computer, alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Full stacker:	disabled check	stop computer, alarm.
Punch inoperable:	disabled check	stop computer, alarm.

INPUT-OUTPUT: PRINTER (MODEL 333)

§ 081.

.1 GENERAL

.11 Identity: . . . . On-Line Printer. Model 333. O-LP 333.

.12 Description:

Model 333 printer provides high-speed line printing capability for the 301 system up to one thousand single-spaced lines per minute. Output format is 120 characters per line, and six lines per inch vertically. As an option, vertical pitch may be specified as eight or ten lines per inch. When a restricted set of 47 characters is specified, printing can be done at one thousand lines per minute, and when the full set of 64 is used, Model 333 can print eight hundred lines per minute. At one-inch line spacing, printing speed drops to about 565 lines per minute. Two Model 333 printers may be used in the system.

The printer uses the standard rotating drum printing technique and prints one line from one computer instruction. Paper skipping speed is 25 inches (150 single-spaced lines) per second. The printer controller requires sixty computer memory cycles for each character in the printed character set (47-64 characters) for each line printed. All paper movement is performed independent of the computer.

Under manual selection, the rotational speed of the engraved printing drum may be lowered, giving maximum printing speeds of 667 and 570 lines per minute.

There is another printer, Model 335, which can print 160 characters per line at approximately the same speeds as Model 333.

.13 Availability: . . . . September, 1961.

.14 First Delivery: . . . . . September, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . sprocket drive push and pull.

.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: . . 1 + 5.
Carbon creep: . . . . . no.

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

.24 Arrangement of Heads

Use of station: . . . . . . printing.
Stacks: . . . . 1.
Heads/stack: . . . . . . 120.
Method of use: . . . . . prints one line at a time.

.25 Range of Symbols

Numerals:	10	0 to 9.
Letters:	26	A to Z.
Special:	28, including space	see below*
Alternatives:		by special request.
FORTRAN set:		yes.
Basic COBOL set:		yes, with all electives.
Total:	64	

* In restricted set	Balance of full set	
- minus	(open parenthesis	÷ divide
+ plus	) closed parenthesis	↑ up arrow
, comma	" quote	= equal
. period	10 subscript 10	@ at the rate of
space	[open bracket	% percent
' apostrophe	] close bracket	: colon
* asterisk	; semicolon	# number
& ampersand	< less than	$ dollar
/ slant	> greater than	
□ lozenge		
CR credit		

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper fanfold, multi-set.
.312 Phenomenon: . . . . . . printing of engraved characters.

.32 Positional Arrangement

.321 Serial by: . . . . one line at 6 lines per inch; 6 or 8 and 6 or 10 lines per inch options available.
.322 Parallel by: . . . . 120 columns at 10 per inch.
.323 Bands: . . . . 1.
.324 Track use: . . . . all for data.
.325 Row use: . . . . all for data.

.33 Coding: . . . . as in Data Code Table No. 1.

.35 Physical Dimensions

.351 Overall width: . . . . . . 4 to 19 inches.
.352 Length: . . . . 0.5 to 17 inches.

§ 081.

.353 Maximum margins
Left: . . . . 3.5 inches
Right: . . . . 3.5 inches.

.4 CONTROLLER

.41 Identity: . . . . On-Line Printer Control; Model 316-1 and Model 316-2.

.42 Connection to System

.421 On-line: . . . . 2 controllers maximum; one Model 316-1 and one Model 316-2. If Model 316-1, 2 used, Model 396, for Model 335 Printer, may not be used.

.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . . first printer connected to Model 316-1; second printer connected to Model 316-2. Both printers must be same model (333).

.44 Data Transfer Control

.441 Size of load: . . . . 120 characters.
.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: . . . . . . one line of 120 characters
.512 Block demarcation
Output: . . . . counter.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . one block.
.523 Stepping: . . . . combined as "output then step forward" 0 to 14 lines.
.524 Skipping: . . . . combined as "output then skip forward" choice of two paper tape loop tracks as alternative to step. Up to 44 lines.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . automatic variable output using a table set up in HSM.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . . yes, any code.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . yes.
Paper advancing: . . . . yes.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . synchronous.
II: . . . . asynchronous.
III: . . . . high speed.
IV: . . . . low speed.
V: . . . . with SMC.
VI: . . . . without SMC.

.62 Speeds

.621 Nominal or peak speed
I & III: . . . . 1,000 lines/min.
II & III: . . . . 800 lines/min.
I & IV: . . . . 667 lines/min.
II & IV: . . . . 570 lines/min.

.622 Important parameters
Printing timing tolerances: . . . . . + 3%, - 5.5%.
Skipping speed: . . . 150 lines per second.

.623 Overhead: paper advance time.
.624 Effective speeds
II & III: . . . . 36,000/ (41 + 4N) lines/min.
II & IV: . . . . 36,000/ (59 + 4N) lines/min.
N = No. of lines advanced.

.63 Demands on System

Component	Condition	m. sec per line	or	Percentage
Processor:	I & III & VI	44		73.
Processor:	I & III & V	20		33.
Processor:	II & III & VI	59		79.
Processor:	II & III & V	27		36.
Processor:	I & IV & VI	74		82.
Processor:	I & IV & V	20		22.
Processor:	II & IV & VI	89		85.
Processor:	II & IV & V	27		26.

Notes:

1. Single space printing.
2. Includes print table access time.

§ 081.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	knob.	
Horizontal alignment:	knob.	
Width:	knob	tractor adjustment.
New paper loop:	operator.	

.72 Other Controls

Function	Form	Comment
Select print drum speed:	switch	selects high or low speed.
Paper tension adj.:		fine adj. of paper stock.
Fine adj. of tractors:	vernier.	
Phasing:		synchronization pulse timing adj.
Penetration:		print hammer/print roll fine adj.
Top of form positioning:		align paper at form stop.

.73 Loading and Unloading

.731 Volumes handled: . . . . paper stack 12-14 inches high.

.732 Replenishment time: . . 1 minute. printer must be stopped.

.733 Adjustment time: . . . . 1 minute.

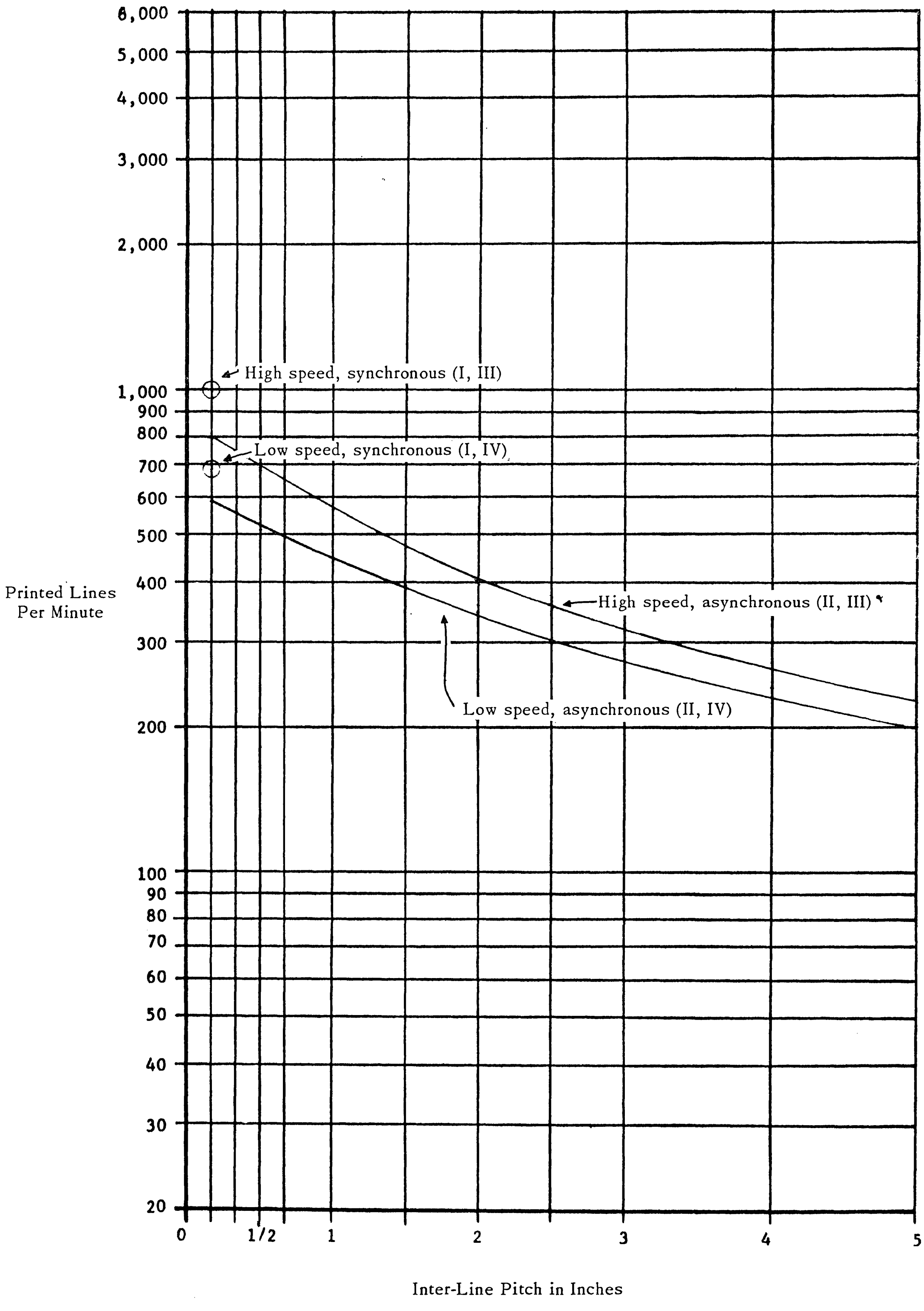
.734 Optimum reloading period: . . . . 27 mins.
Basis: 2-part sets, 17 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Errors	Check or Interlock	Action
Recording:	none.	
Output block size:	1 full line	stop computer, alarm.
Invalid code:	all valid.	
Exhausted medium:	advance sensing	stop computer, alarm.
Imperfect medium:	none.	
Time conflicts	interlock	wait.
Exhausted ribbon:	none.	
Low paper:	check	stop computer at end of present page, alarm.
Printer inoperable:	check	stop computer, alarm.

§ 081.

EFFECTIVE SPEED
(Model 333)



INPUT-OUTPUT: PRINTER (MODEL 335)

§ 082.

.1 GENERAL

.11 Identity: . . . . On-Line Printer.
Model 335.
O-LP 335.

.12 Description

Model 335 printer provides high speed line printing capability for the 301 system up to 1,075 single-spaced lines per minute. Output format is 160 characters per line, and six lines per inch vertically. As an option, vertical pitch may be specified as 8 or 10 lines per inch. When a restricted set of 47 characters is specified, printing can be done at 1,075 lines per minute, and when the full set of 63 characters is used, Model 335 can print 835 lines per minute. At one-inch line spacing, printing speed drops to about 570 lines per minute.

Two Model 335 printers may be used in the system. If two are operated in the system, however, maximum printing speed is limited to 715 lines per minute on each one.

The printer uses the standard rotating drum printing technique and prints one line from one computer instruction. Paper skipping speed is 25 inches (150 single-spaced lines) per second. The printer controller requires 80 computer memory cycles for each character in the printed character set (47-64 characters) for each line printed. All paper movement is performed independent of the computer.

Under manual selection, the rotational speed of the engraved printing drum may be lowered, giving maximum printing speeds of 715 and 600 lines per minute.

There is another printer, Model 333, which can print 120 characters per line at approximately the same speeds as Model 335.

.13 Availability: . . . . . . March, 1962.

.14 First Delivery: . . . . March, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive push and pull.
.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: . 1 + 5.
Carbon creep: . . . . no.
.233 Types of master
Multilith: . . . . yes.
Xerox: . . . . yes.
Spirit: . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . 1.
Heads/stack: . . . . . . 160.
Method of use: . . . . . prints one line at a time.

.25 Range of Symbols

Numerals:	10	0 to 9.
Letters:	26	A to Z.
Special:	28 (including space)	see below.*
Alternatives:		by special request.
FORTRAN set:		yes.
Basic COBOL set: . . .		yes, with all electives.
Total:	64.	

* In restricted set	Balance of full set	
- minus	(open parenthesis	÷ divide
+ plus	) closed parenthesis	↑ up arrow
, comma	" quote	= equal
' apostrophe	$_{10}$ subscript 10	@ at the rate of
. period		
* asterisk	[open bracket	% percent
& ampersand	] close bracket	: colon
/ slant	; semicolon	# number
□ lozenge	< less than	$ dollar
CR credit	> greater than	
space		

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . paper fanfold, multi-set.
.312 Phenomenon: . . . . . . printing of engraved characters.

.32 Positional Arrangement

.321 Serial by: . . . . one line at 6 lines per inch; 6 or 8 and 6 or 10 lines per inch options available.
.322 Parallel by: . . . . . . 160 columns at 10 per inch.
.323 Bands: . . . . 1.
.324 Track use: . . . . all for data.
.325 Row use: . . . . all for data.

§ 082.

.33 Coding: . . . . as in Data Code Table No. 1.

.35 Physical Dimensions

.351 Overall width: . . . . . 4 to 19 inches.
.352 Length: . . . . 0.5 to 17 inches.
.353 Maximum margins:
Left: . . . . 1.5 inch.
Right: . . . . 1.5 inch.

.4 CONTROLLER

.41 Identity: . . . . On-Line Printer Control. Model 396-1 and Model 396-2.

.42 Connection to System

.421 On-line: . . . . 2 controllers maximum; one Model 396-1 and one Model 396-2. If Model 396-1, 2 used, Model 316, for Model 333 Printer, may not be used.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . . first printer connected to Model 396-1; second printer connected to Model 396-2. Both printers must be same model (335).

.44 Data Transfer Control

.441 Size of load: . . . . . . 160 characters per line.
.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: . . . . . one line of 160 characters.
.512 Block demarcation
Output: . . . . counter.

.52 Input-Output Operations

.521 Input: . . . . none.
.522 Output: . . . . one block.
.523 Stepping: . . . . combined as "output then step forward" 0 to 14 lines.
.524 Skipping: . . . . combined as "output then step forward", choice of two paper tape loop tracks as alternate to step. Up to 44 lines.
.525 Marking: . . . . none.
.526 Searching: . . . . none.

.53 Code Translation: . . . automatic variable output using a table set up in HSM.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . . . yes, any code.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
Paper advancing: . . . . yes.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . synchronous.
II: . . . . asynchronous.
III: . . . . high speed.
IV: . . . . low speed.
V: . . . . with SMC.
VI: . . . . without SMC.

.62 Speeds

.621 Nominal or peak speed:
I & III: 1,075 lines/min.*
II & III: 835 lines/min.
I & IV: 715 lines/min.
II & IV: 600 lines/min.

* Printing in Normal Mode, and no punched card instruction in Simultaneous Mode.

.622 Important parameters
Printing timing tolerances: . . . . . . + 3%, - 5.5%.
Skipping speed: . . . . 150 lines per second.
.623 Overhead: . . . . paper advance time.
.624 Effective speeds: . . . II & III; 36,000/(39 + 4N) lines/min.
II & IV; 36,000/(56 + 4N) lines/min.
N = No. lines advanced.

§ 082.

.63 Demands on System

Component	Condition	m. sec. per line	or	Percentage
Processor:	I & III & VI	40		71.
Processor:	I & III & V	see Note 2.		
Processor:	II & III & VI	56		73.
Processor:	II & III & V	36		51.
Processor:	I & IV & VI	68		81.
Processor:	I & IV & V	27		32.
Processor:	II & IV & VI	84		84.0.
Processor:	II & IV & V	36		36.

Notes
1. Single-space printing.
2. I & III not possible with SMC (V).
3. If two Model 335 printers used, operation must be at low speed (715 or 600 l. p. m.).
4. Includes print table access time.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	knob.	
Horizontal alignment:	knob.	
Width:	knob	tractor adjustment.
New paper loop:	operator.	

.72 Other Controls

Function	Form	Comment
Paper tension adj.:		fine adjustment of paper stock.
Select print drum speed:	switch	selects high or low speed.
Fine adjustments of tractors:	vernier.	
Phasing:		synchronization pulse timing adjustment.
Penetration:		print hammer/print roll fine adjustment.
Top of form positioning:		align paper at form stop.

.73 Loading and Unloading

.731 Volumes handled: . . . paper stack 12 - 14 inches high.

.732 Replenishment time: . . 1 minute; printer must be be stopped.

.733 Adjustment time: . . . 1 minute.

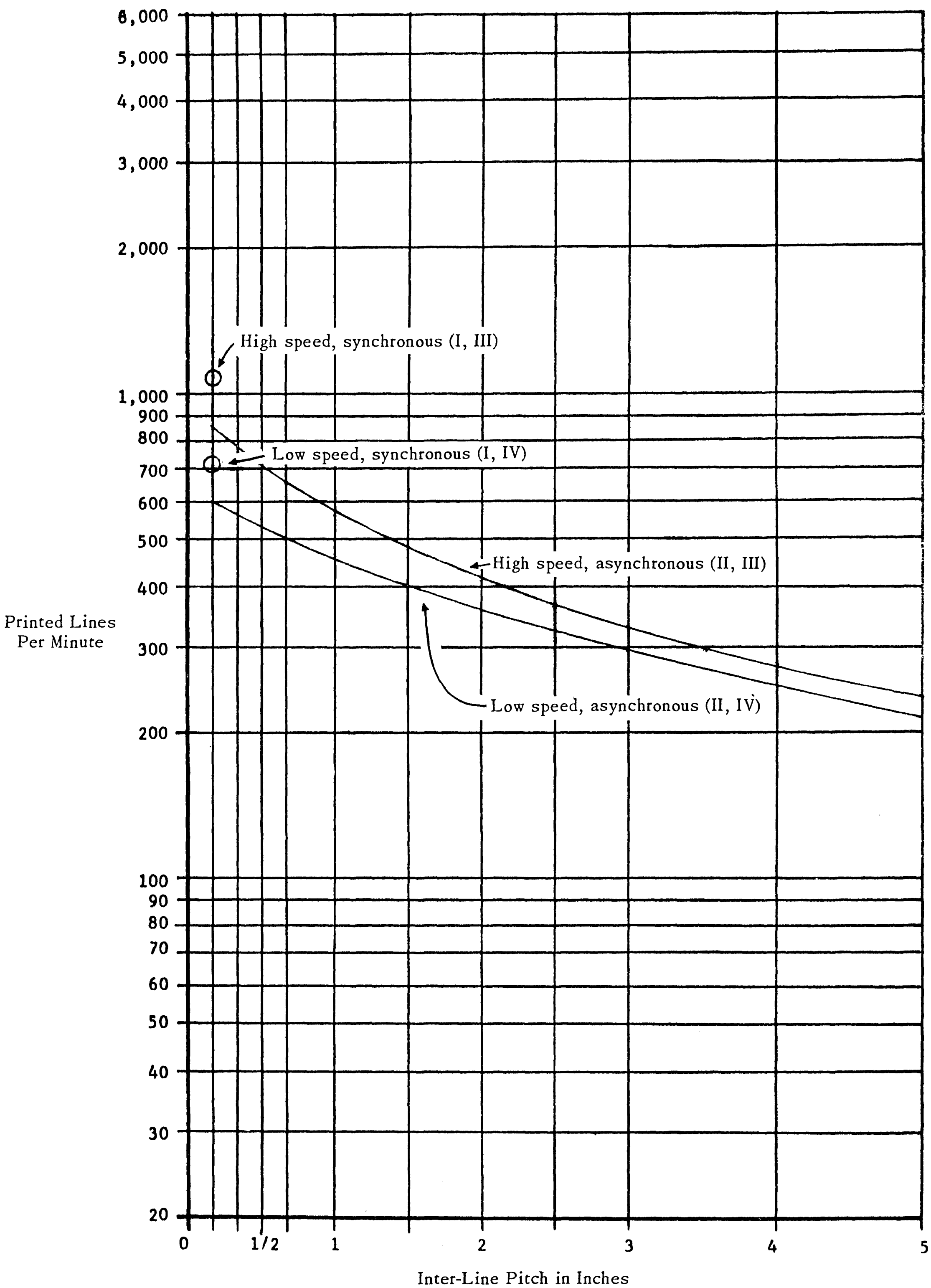
.734 Optimum reloading period: . . . . 26 mins.
Basis: . . . . 2-part sets, 17 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Output block size:	1 full line	stop computer, alarm.
Invalid code:	all valid.	
Exhausted medium:	advance sensing	stop computer, alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Exhausted ribbon:	none.	
Low paper:	check	stop computer at end of present page, alarm.
Printer inoperable:	check	stop computer, alarm.

§ 082.

EFFECTIVE SPEED
(Model 335)



INPUT-OUTPUT: HI-DATA TAPE GROUP

§091.

.1 GENERAL

.11 Identity: . . . . Hi-Data Tape Group.
Model 381.
H-DTG.

.12 Description:

This is a group of three, four, or six magnetic tape units in one cabinet, sharing common control and switching circuits. Provision is made for sets of three facing out from its front and back, respectively. Two of these cabinets may be connected to a 301 system. Although only one tape unit in each group of six may be reading or recording at one time, all of the other five in each cabinet may be rewinding. Rewinding takes place independently of the computer after initiation. Records are stored in variable-length blocks. Recording is performed in the forward direction, while reading takes place in either the forward or backward direction. Reading and recording take place at the peak rate of 10,000 characters per second.

A single reel of tape when being used to store blocks of 1,000 characters has a capacity of 4,320 blocks. The reading rate may be as high as 9,000 characters per second under these conditions, if consecutive read instructions are given by the end of each block. In this case, tape will continue moving at full speed.

.13 Availability: . . . . September, 1961.

.14 First Delivery: . . . . . September, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2 per drive.
Form: . . . . swinging arm.
Capacity: . . . . 26 inches.
.213 Feed drive: . . . . electric motor.
.214 Take-up drive: . . . . . electric 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: . . . . . read or write (6 separate tape units in Group).
Stacks: . . . . 1.
Heads/stack: . . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable coating.
.312 Phenomenon: . . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 333.3 rows/inch: N limited by size of High Speed Memory.
.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: . . . . all.
Redundancy check: . . . 0.
Timing: . . . . 0.
Control signals: . . . . 0.
Unused: . . . . 0.

.33 Coding: . . . . as in Data Code Table No. 1.

.34 Format Compatibility: . RCA 301 only.

.35 Physical Dimensions

.351 Overall width: . . . . . $\frac{1}{2}$ inch.
.352 Length: . . . . 1,230 feet on 8-inch diameter reel.

.4 CONTROLLER

.41 Identity: . . . . Hi-Data Tape Group Control, Models 318 and 319.

.42 Connection to System

.421 On-line: . . . . 2 max; Model 318 controls first Group, Model 319 controls second Group.
Model 319 cannot be used if Model 341 or 351 Control is used.
Models 318 and 319 cannot be used if Models 342 or 352 Control is used.
.422 Off-line: . . . . none.

.43 Connection to Device

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

§ 091.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N characters, limited by size of 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 size of available core storage.
.512 Block demarcation
Input: . . . . gap for input.
Output: . . . . variable counter for output.

.52 Input-Output Operations

.521 Input: . . . . 1 block forward or backward; input stopped by gap or limit cut-off. Characters in High Speed Memory are in "forward" order regardless of direction of read.
.522 Output: . . . . 1 block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . End File, End Data, End Block, End Information symbols.
.526 Searching: . . . . none.

.53 Code Translation: . . . . matched codes.
.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . no.
Rewind: . . . . yes.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Output lock: . . . . . . no.
Nearly exhausted: . . . yes, 80 inches min.
Busy controller: . . . . yes.
End of medium marks: . yes, at beginning.
Tape moving backward: . yes.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . without Simultaneous Mode Control.
II: . . . . with Simultaneous Mode Control.

.62 Speeds

.621 Nominal or peak speed: . 10,000 char/sec.
.622 Important parameters
Switching between units: . . . . 10 msec ± 20%.
Up to speed: . . . . . . 7 msec ± 10%
Density: . . . . 333.3 rows/inch.
Running speed: . . . . . 30 inches/sec.
Read mode to write mode: . . . . . 25 msec.
Interblock gap: . . . . . 0.34 inches (avg).
Full rewind time: . . . 3 minutes.
.623 Overhead: . . . . 11 msec per block.
.624 Effective speeds: . . . . 10,000 N(N + 110) char/sec, where N = char/block (see graph).

.63 Demands on System

Component	Condition	msec. per block	or	Percentage of transfer time
Processor:	I	11 + 0.100C	or	100.
HSM:	II	0.007C	or	7.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.72 Other Controls

Function	Form	Comment
Write-enable:	ring on spool	ring permits recording.
Manual erase:	button	erases tape when moving forward.
Energize motors and servo system:	button.	
Manual wind:	button	forward or backward.
Manual rewind:	button	positions tape at start of reel.

.73 Loading and Unloading

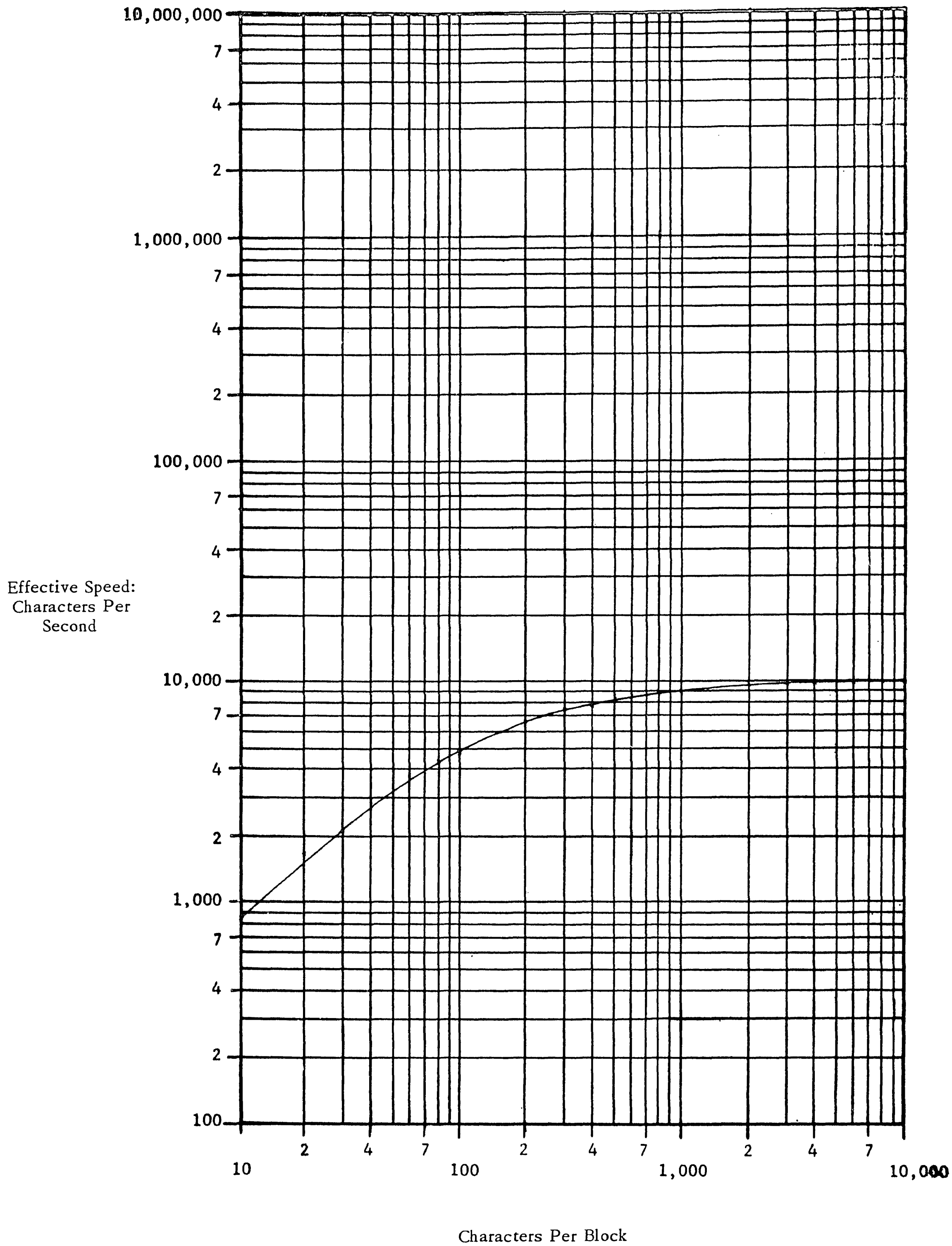
.731 Volumes handled: . . . . reel of 1,200 feet minimum usable, or 4,800,000 char less 113 per block gap.
.732 Replenishment time: . . 1 minute max. device needs to be stopped.
.734 Optimum reloading period: . . . . 8.2 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo parity	stop processor, alarm.
Reading:	row parity	stop processor, alarm.
Input area overflow:	limit counter interlock	cut-off and indicator.
Output block size:	limit counter interlock	cut-off and indicator.
Invalid code:	all codes good.	
Exhausted medium:	photo sensing stations	stop processor, alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Inoperable device:	check	stop processor, alarm.

§ 091.

EFFECTIVE SPEED
(Model 381)



N. B. These speeds take full advantage of "hot starts" in which there is no deceleration between blocks.

INPUT-OUTPUT: TAPE STATION (581)

§092.

.1 GENERAL

.11 Identity: . . . . Tape Station.
Model 581.
MT 581.

.12 Description

581 Tape Stations provide high-speed data transfer to and from the Processor, either adding to or replacing the capabilities of the Hi-Data Tape Group. Not only does the 581 Tape Station provide greater storage per reel than the Hi-Data Tape Group, but 581 tapes provide a compatibility medium with the RCA 501 and 601 EDP Systems. This compatibility allows tapes from one system to be read on another, although programmed code translation is required. One or two of the tape stations may be added to the 301 system and, in addition, the Hi-Data Tape Groups may be replaced by up to twelve 581 Tape Stations. Although only one station in each group of six may be reading or writing, any number of stations may be rewinding simultaneously.

Recording takes place in the forward direction, while reading may be in either direction. The peak transfer rate is 33,333 characters per second. The recording system makes a parity check on the record head current ("echo" check). Data is recorded in two separate bands simultaneously to lessen the effect of possible tape surface imperfections. Read-back senses data in both bands; a "one" need be sensed in only one band to be accepted as a "one". Data is transferred into the Processor one character at a time.

Information is recorded in variable length blocks. A single reel of tape, when being used to store blocks of 1,000 characters, has a capacity of 8,430 blocks. The reading rate may be as high as 30,000 characters per second under these conditions, if consecutive read instructions are given at the end of each block. In this case, tape will continue moving at full speed.

No computing can be done during a tape input or output operation unless the Simultaneous Mode Control, Model 392, is added to the system.

.13 Availability: . . . . September, 1959

.14 First Delivery: . . . . . September, 1959

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . pinch roller friction.

.212 Reservoirs
Number: . . . . 2.
Form: . . . . bin which senses tape weight.
Capacity: . . . . 25 feet.

.213 Feed drive: . . . . electric motor.

.214 Take-up drive: . . . . . electric motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.

.222 Sensing system: . . . . magnetic head.

.223 Common system: . . . . combined.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading or recording.
Stacks: . . . . 1.
Heads/stack: . . . . . . 16 (8 dual).
Method of use: . . . . . one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable coating.

.312 Phenomenon: . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 333.3 rows per inch.
N limited by available core storage.

.322 Parallel by: . . . . 16 tracks.

.323 Bands: . . . . 2; duplicate patterns.

.324 Track use
Data: . . . . 6.
Redundancy check: . . 1.
Timing: . . . . 1.
Control signals: . . . . 0.
Unused: . . . . 0.
Total: . . . . 8.

.325 Row use
Data: . . . . all.

.33 Coding: . . . . as in Data Code Table No. 1.

.34 Format Compatibility

Other device or system — Code translation
RCA 501 EDP System: . . by program.
RCA 601 EDP System: . . by program.

.35 Physical Dimensions

.351 Overall width: . . . . . . 0.75 inch.

.352 Length: . . . . 2,400 feet on a 10.5 inch diameter reel.

§092.

.4 CONTROLLER

.41 Identity: . . . . Adapter, 393-1.
Adapter, 393-2.
Dual Tape Channel (2 x 6), 341.
Dual Tape Channel (2 x 12), 342.

.42 Connection to System

.421 On-line: . . . . A. 393-1 for 1 MT 581; or 394-1 for 1 MT 582.
B. 393-1 and 393-2 for 2 MT 581; or 394-1 and 394-2 for 2 MT 582.
C. 341 or 342 for 6 or 12 MT 581.
D. 351 or 352 for 6 or 12 MT 582.

Rules: Either group A or B may be connected to system at the same time as either group C or D.
If C is connected to system, only one H-DTG Control, Model 318, may be connected to system.
If D is connected to system, neither H-DTG may be used.

.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: 1 MT 581 on Adapter 393-1.
1 MT 582 on Adapter 394-1.
1 MT 581 on Adapter 393-2 if 2 MT 581 used in group.
1 MT 582 on Adapter 394-2 if 2 MT 582 used in group.
3 to 6 MT 581 on Dual Tape Channel 341.
8 to 12 MT 581 on Dual Tape Channel 342.
3 to 6 MT 582 on Dual Channel 351.
8 to 12 MT 582 on Dual Tape Channel 352.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N char, 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 char, limited by available core storage.
.512 Block demarcation
Input: . . . . gap on tape.
Output: . . . . limit counter.

.52 Input-Output Operations

.521 Input: . . . . one block forward or backward; input stopped by gap or limit cut-off.
Characters in HSM are in forward order regardless of direction of read.
.522 Output: . . . . one block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . End file, End Data, End Block codes.
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . . . no.
Rewind: . . . . yes.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Output lock: . . . . no.
Nearly exhausted: . . . yes.
Busy controller: . . . . . yes.
End of medium marks: . yes (at beginning).
Tape moving backward: . yes.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . without SMC.
II: . . . . with SMC.

.62 Speeds

.621 Nominal or peak speed: . 33,333 char/sec.
.622 Important parameters
Switching between units (with Dual Tape Channels): . . . . . . 10 μ sec.
Up to speed: . . . . . 2.5 m.sec.
Start distance: . . . . . 0.075 $\pm$ 0.050 in.
Start-write delay: . . . 3.5 m.sec. (includes up to speed time).
Read-stop distance: . . 0.115 to 0.190 in.
Write-stop distance: . . 0.215 to 0.358 in.
Write-to-read switching time: . . . 4.5 $\pm$ 0.9 m.sec.
Read-to-write switching time: . . . 10 μ sec.
Density: . . . . 333.3 rows/inch.
Running speed: . . . . 100 in/sec.
Interlock gap: . . . . 0.34 in min.
0.46 in avg.
Full rewind time: . . . 5 minutes.

§092.

.623 Overhead: . . . . 3.5 m.sec per block (tape moving at full speed).

.624 Effective speeds: . . . 33,333 N/(N + 113) char/sec.

.63 Demands on System

Component	Condition	m.sec per block	or	Percentage of transfer time
Processor:	I	3.5 + 0.030C	or	100.
Processor:	II	0.007C	or	23.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.72 Other Controls

Function	Form	Comment
Write enable:	ring on spool	ring permits recording.
Energize motors and servo system:	button.	
Stabilize:	button	allows proper loading of tape bins.
Manual wind:	button	forward or backward.
Manual rewind:	button	positions tape at start of reel.
Manual erase:	button	while winding tape forward.
Switch station to computer control:	buttons	local or remote (computer control).

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel of 2,350 feet minimum usable: . .	9,400,000 characters, less 113 char per block gap.

.732 Replenishment time: . . 1 minute. tape station must be stopped.

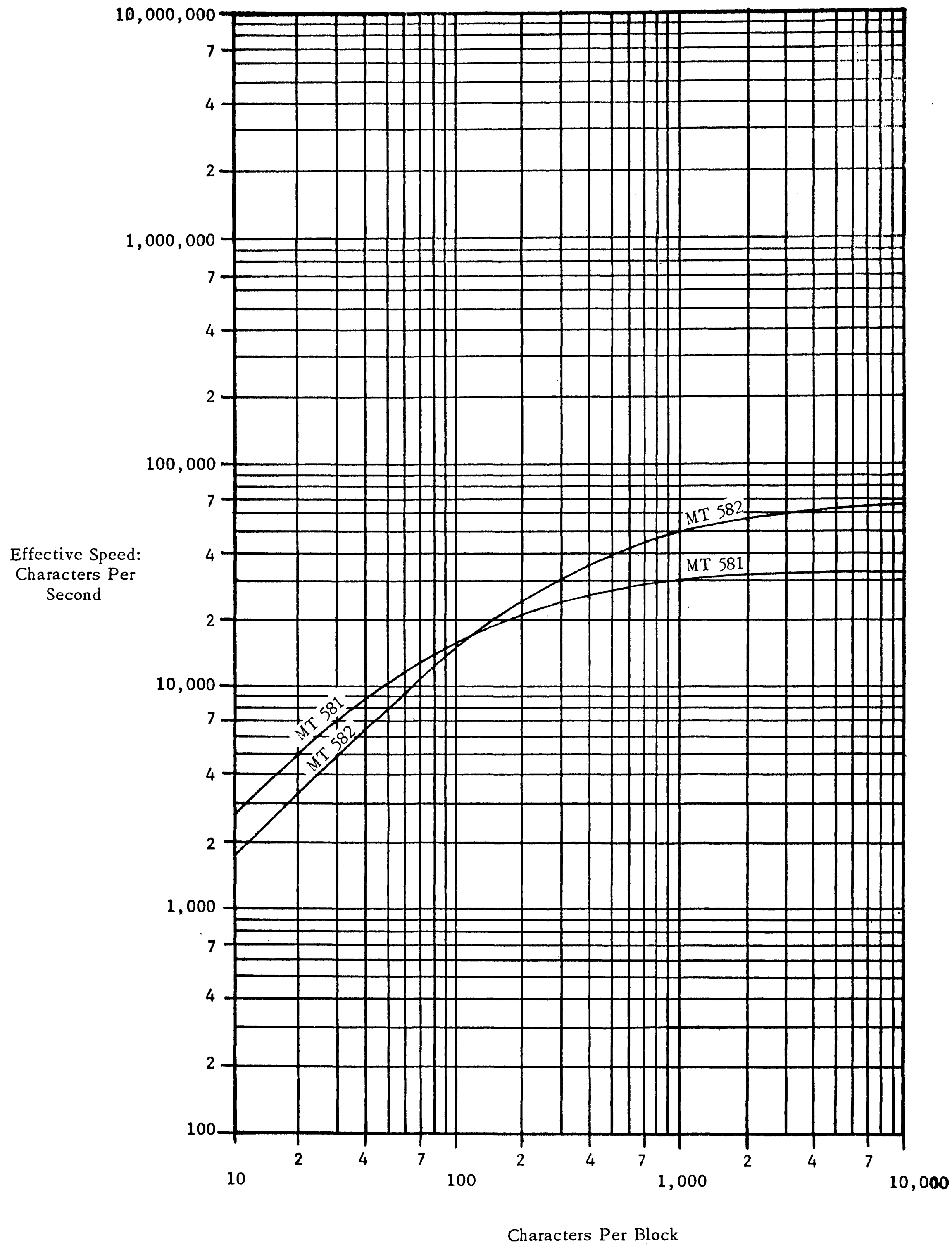
.734 Optimum reloading period: . . . . 4.7 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo parity	stop computer, alarm.
Reading:	row parity	stop computer, alarm.
Input area overflow:	limit counter interlock	cut-off and indicator.
Output block size:	limit counter interlock	cut-off and indicator.
Invalid code:	all codes valid.	
Exhausted medium:	interlock	stop computer, alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Inoperable device:	check	stop computer, alarm.

§ 092.

EFFECTIVE SPEEDS
(Model 581)



N. B. These speeds take full advantage of "hot starts" in which there is no deceleration between blocks.

INPUT-OUTPUT: TAPE STATION (582)

§ 093.

.1 GENERAL

.11 Identity: . . . . Tape Station.
Model 582.
MT 582.

.12 Description

582 Tape Stations provide high-speed data transfer to and from the Processor, either adding to or replacing the capabilities of the Hi-Data Tape Group. Not only does the 582 Tape Station provide greater storage per reel than the Hi-Data Tape Group, but 582 tapes provide a compatibility medium with the RCA 501 and 601 EDP Systems. This compatibility allows tapes from one system to be read on another, although programmed code translation is required. One or two of the tape stations may be added to the 301 system, and in addition, the Hi-Data Tape Groups may be replaced by up to twelve 582 Tape Stations. Although only one tape station in each group of six may be reading or writing, any number of tape stations may be rewinding simultaneously.

Recording takes place in the forward direction, while reading may be in either direction. The peak transfer rate is 66,667 characters per second. The recording system incorporates a read-after-write row parity check. Data is recorded in two separate bands simultaneously to lessen the effect of possible tape surface imperfections. Read-back senses data in both bands; a "one" need be sensed in only one band to be accepted as a "one". Data is transferred into the Processor one diad (two characters) at a time.

Information is recorded in variable length blocks. A single reel of tape, when being used to store blocks of 1,000 characters, has a capacity of 13,800 blocks. The reading rate may be as high as 49,000 characters per second under these condi tions, if consecutive read instructions are given at the end of each block. In this case, tape will continue moving at full speed.

No computing can be done during a tape input or output operation unless the Simultaneous Mode Control, Model 392, is added to the system.

.13 Availability: . . . . . . January, 1962.

.14 First Delivery: . . . . January, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . 2.
Form: . . . . bin which senses tape weight.
Capacity: . . . . 25 feet.
.213 Feed drive: . . . . . . electric motor.
.214 Take-up drive: . . . . . electric motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . two-gap head.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . . 16 (8 dual).
Method of use: . . . . . one row at a time.

Use of station: . . . . . recording.
Distance: . . . . 0.2 inch ahead of read head.
Stacks: . . . . 1.
Heads/stack: . . . . . . 16 (8 dual).
Method of use: . . . . . one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable coating.
.312 Phenomenon: . . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows of 666.7 rows per inch; N limited by available core storage.
.322 Parallel by: . . . . . . 16 tracks.
.323 Bands: . . . . 2; duplicate patterns.
.324 Track use
Data: . . . . 6.
Redundancy check: . . 1.
Timing: . . . . 1.
Control signals: . . . 0.
Unused: . . . . 0.
Total: . . . . 8.
.325 Row use
Data: . . . . all.

.33 Coding: . . . . as in Data Code Table No. 1.

.34 Format Compatibility

Other device or system	Code translation
RCA 501 EDP System (MT 582):	by program.
RCA 601 EDP System (MT 582, MT 681):	by program.
Tape Station Model 681:	by program.

§ 093.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.75 inch.
.352 Length: . . . . 2,400 feet on a 10.5 inch diameter reel.

.4 CONTROLLER

.41 Identity: . . . . Adapter, 394-1.
Adapter, 394-2.
Dual Tape Channel (2 x 6), 351.
Dual Tape Channel (2 x 12), 352.

.42 Connection to System

.421 On-line: . . . .
A. 393-1 for 1 MT 581; or 394-1 for 1 MT 582.
B. 393-1 and 393-2 for 2 MT 581; or 394-1 and 394-2 for 2 MT 582.
C. 341 or 342 for 6 or 12 MT 581.
D. 351 or 352 for 6 or 12 MT 582.
Rules:
Either group A or B may be connected to system at the same time as either group C or D.
If C is connected to system only one H-DTG Control, Model 318, may be connected to system.
If D is connected to system, neither H-DTG may be used.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller:
1 MT 581 on Adapter 393-1.
1 MT 582 on Adapter 394-1.
1 MT 581 on Adapter 393-2 if 2 MT 581 used in group.
1 MT 582 on Adapter 394-2 if 2 MT 582 used in group.
3 to 6 MT 581 on Dual Tape Channel 341.
8 to 12 MT 581 on Dual Tape Channel 342.
3 to 6 MT 582 on Dual Tape Channel 351.
8 to 12 MT 582 on Dual Tape Channel 352.

.44 Data Transfer Control

.441 Size of load: . . . . . . 1 to N char, 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 char, limited by available core storage.
.512 Block demarcation
Input: . . . . gap on tape.
Output: . . . . limit counter.

.52 Input-Output Operations

.521 Input: . . . . one block forward or backward; input stopped by gap or limit cut-off. Characters in HSM are in forward order regardless of direction of read.
.522 Output: . . . . one block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . End File, End Data, End Block codes.
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . . no.
Rewind: . . . . yes.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . . . yes.
Output lock: . . . . . . no.
Nearly exhausted: . . . yes.
Busy controller: . . . . yes.
End of medium marks: yes (at beginning).
Tape moving backward: yes.
Exhausted: . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . without SMC.
II: . . . . with SMC.

.62 Speeds

.621 Nominal or peak speed: 66,667 char/sec.
.622 Important parameters
Switching between units (with Dual Tape Channels): . . . . . 10 μ sec.
Up to speed: . . . . . 2.5 m.sec.
Start distance: . . . . 0.075 ± 0.050 in.
Start-write delay: . . 3.5 m.sec. (includes up to speed time).
Read-stop distance: . 0.115 to 0.190 in.
Write-stop distance: . 0.415 to 0.558 in.
Write-to-read switching time: . . . . . . 7.0 m.sec.

(Continued)

§ 093.

.622 Important parameters (Contd.)

Read-to-write switching time:	10 μ sec.
Density:	666.7 rows/inch.
Running speed:	100 in./sec.
Interblock gap:	0.54 in. min. 0.66 in. avg.
Full rewind time:	3.2 minutes.
Read-after-write data delay:	2.0 m.sec.
Read-after-write stop delay:	2.0 m.sec.

.623 Overhead: . . . . 5.5 m.sec per block (tape moving at full speed).

.624 Effective speeds: . . . 66,667 N/(N + 367) char/sec.

.63 Demands on System

Component	Condition	m.sec per block	or	Percentage* of transfer time
Processor:	I	3.5 + 0.015C	or	100.
Processor:	II	0.0035C	or	23.

* transfer takes place by diad (2 characters).

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Write enable:	ring on spool	ring permits recording.
Energize motors and servo system:	button.	
Stabilize:	button	allows proper loading of tape bins.
Manual wind:	button	forward or backward.
Manual rewind:	button	positions tape at start of reel.
Manual erase:	button	while winding tape forward.

.72 Other Controls (Contd.)

Function	Form	Comment
Switch station to computer control:	buttons	local or remote (computer control).
Long gap:	button	signal to generate proper gap for MT 581-MT 681 compatibility.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel of 2,350 feet minimum usable:	18,800,000 characters, less average of 367 characters per block gap.

.732 Replenishment time: 1 minute.
tape station needs to be stopped.

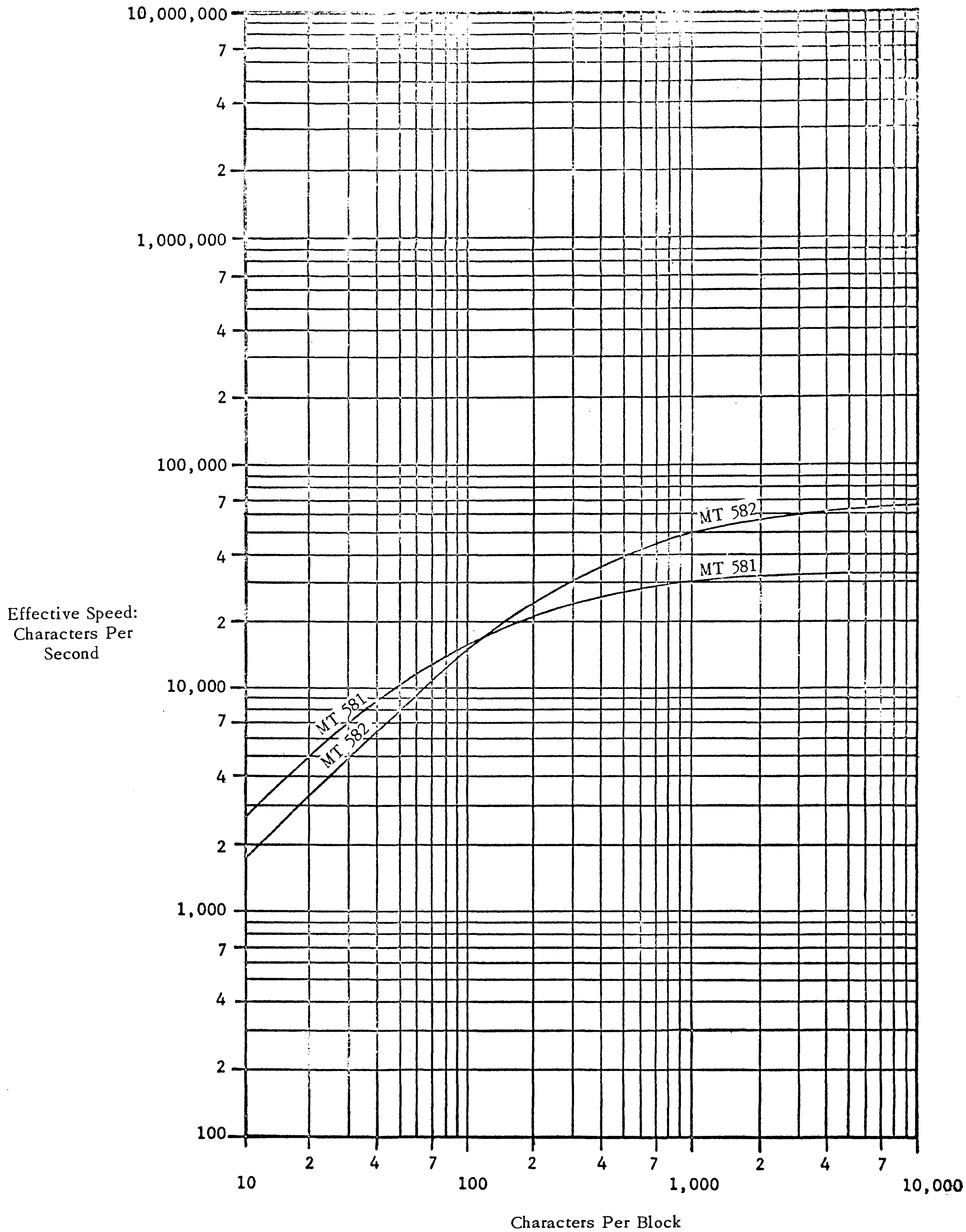
.734 Optimum reloading period: . . . . 4.7 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write row parity	stop computer, alarm.
Reading:	row parity	stop computer, alarm.
Input area overflow:	limit counter interlock	cut-off and indicator.
Output block size:	limit counter interlock	cut-off and indicator.
Invalid code:	all codes valid.	
Exhausted medium:	interlock	stop computer, alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Inoperable device:	check	stop computer, alarm.

§ 093.

EFFECTIVE SPEED
(Model 582)



N. B. These speeds take full advantage of "hot starts" in which there is no deceleration between blocks.

INPUT-OUTPUT: INTERROGATING TYPEWRITER

§ 101.

.1 GENERAL

.11 Identity: . . . . Interrogating Typewriter.
Model 328.
IT 328.

.12 Description:

The Interrogating Typewriter is an input-output inquiry station, operated under control of the Interrogating Typewriter Control unit, ITC 398-1. Inquiry messages may be entered into the Processor by an operator. The program must periodically sense whether the Interrogating Typewriter is ready to transmit a message.

The inquiry is processed by the computer program, and the answer may be typed at normal typewriter speeds on the Interrogating Typewriter. Its output capabilities are similar to those of the Monitor Printer.

The Interrogating Typewriter may be operated as a remote inquiry station up to 2,000 feet from the Processor, as an optional feature. Normally it is used near the Processor. Its control unit, ITC 398-1, is located in the Processor cabinet.

.13 Availability: . . . . . . April, 1962.

.14 First Delivery: . . . . Scheduled April, 1962.

INPUT-OUTPUT: MONITOR PRINTER

§ 102.

.1 GENERAL

.11 Identity: . . . . Monitor Printer.
Model 338.
MP 338.

12. Description

The Monitor Printer is a typewriter-like output device which operates under program control. It may be used for such functions as program testing, listing of intermediate or final figures accumulated by the computer program, and the printing of short reports. It operates at a speed of ten characters per second and is capable of printing all of the RCA 301 characters.

The Monitor Printer is operated by the Monitor Printer Control unit, MPC 308, located in the Processor along with other device control units.

.13 Availability: . . . . . . March, 1962.

.14 First Delivery: . . . . . March, 1962.

INPUT-OUTPUT: OPTICAL CHARACTER READER

§103.

.1 GENERAL

.11 Identity: . . . . . . VIDEOSCAN Document Reader.
Model 5820.
VIDEOSCAN.

.12 Description

The VIDEOSCAN Document Reader is an optical character reader, which can read documents at a maximum speed of 1,500 documents per minute. This device was announced and demonstrated in early 1963. VIDEOSCAN reads up to 79 characters (spaced 10 per inch) on a single printed line on the document, and can read mark sensing fields with an optional Special Feature #102. A special RCA type font set available with the Model 333 and 335 line printers includes the digits 0 through 9 and four special symbols (dash, asterisk, dollar sign, and decimal point). With the mark-reading feature, pencil or pen marks indicate locations interpreted as the digits 0 to 9.

The VIDEOSCAN unit includes a Document Handler, an Optical Character Reader Scanning Station, an electronics rack, and a VIDEOSCAN Control Unit in the central processor input-output area. Single characters are converted to the 301 code in the electronics unit and transferred through the input-output control unit to core storage. Any character which is unreadable is replaced by an octal 57 code.

Document sizes range from 2.5 by 2.5 inch to 4 by 8.5 inch, and thickness ranges from 0.003 to 0.010 inch. Document handling rates are restricted to 750 documents per minute for document widths greater than 4.0 inches. During any one run, all documents must be the same size and thickness. The unreadable rate can be reduced by running the On-Line Printer at the 600 lines per minute rate.

The input hopper can hold a 12-inch stack of documents. There are two program selectable output accept stackers, and one rerun stacker for unreadable documents. The stackers each have a 6-inch capacity. Loading and unloading is possible during operation. The horizontal line of print can be at any location within the margins specified: 0.300 inch minimum at the right and left edges of the document, and 0.5 inch at the top and bottom.

Optional Features

Mark-Reading Station; Special Feature #102: With this Special Feature, mark-reading and character-reading can be accomplished in one pass of the documents. The mark-reading station is 3.5 inches ahead of the character-reading station. Mark-read data is transferred to core storage followed by character data.

The mark-reading area is composed of columns and rows of identification digits. One mark is made in each column to indicate the digit, and columns are spaced at six per inch. The number of columns available is limited only by the document size, except that there are restrictions on the width of the mark-read field when characters are to be read in the same pass.

Off-Line Use

The standard model 5820 can be used off-line for sorting on one special character, the asterisk with a vertical mark through it. This mark is put on normally for the purpose of automatically selecting documents requiring clerical attention after the reading operation is completed.

.13 Availability: . . . . . 9 months, following receipt of order.

.14 First Delivery: . . . . scheduled for September, 1963.

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . . Data Record File Mode Control.
Model 391.

Simultaneous Mode Control.
Model 392.

.12 Description

Without the optional Mode Controls, capability of the system to perform simultaneous operations is limited to rewinding magnetic tapes, advancing paper on the printer, and selecting bands on the Data Disc and Data Record Files. The Processor is fully occupied in controlling all input-output and auxiliary storage transfers except for short periods at the end of each transfer load.

The optional Simultaneous Mode Control provides the control for one independent data transfer and can use any input-output device. Thus operation of any device can be overlapped; selection of the overlapped (simultaneous) mode or the Normal (processor) Mode is effected by the instruction operation code used.

The optional Data Record File Mode Control can have 1 to 4 Data Record Files connected to it in addition to the Data Record Files connected to the Processor. The units connected to the Data Record File Mode Control are addressable only in the Data Record File Mode; the others (one or two) connected directly to the Processor are addressable in the Normal or in the Simultaneous Mode.

Optional Features

Data Record File Mode Control: Each data transfer between the High Speed Memory and a Data Record File connected to the Data Record File Mode Control is controlled by this Mode Control. The data transfer is overlapped by interrupting central processor operation for only 7 microseconds for each character transferred into or out of core store. The Mode Control can control only one transfer at a time.

Simultaneous Mode Control: Each data transfer between the High Speed Memory and a device addressed in the Simultaneous Mode is controlled by this Mode Control. The data transfer is overlapped by interrupting central processor operation for only 7 microseconds for each character transferred into or out of core store. The Simultaneous Mode Control can control only one transfer at a time.

When both Mode Controls are present in the system, the Processor and both Mode Controls can all operate by overlapping their operations.

.12 Description (Contd.)

With the Simultaneous Mode Control one input or output unit may operate in conjunction with the Central Processor or two peripheral units may interleave transfer of data into and out of the core store. The programmer must therefore stagger his I/O control by alternating reading, writing, and processing operations. There are also special switches to inhibit operation of the Simultaneous Mode Control and Data Record File Mode Control.

.2 CONFIGURATION CONDITIONS

I: . . . . system includes neither Simultaneous Mode Control nor Data Record File Mode.
II: . . . . system includes SMC but not Data Record File Mode Control.
III: . . . . system includes both Data Record File Mode Control and Simultaneous Mode Control.

.4 RULES

General

Each controller can control only one transfer at a time, and each controller interrupts the computer for a memory access for each character. (Exceptions are the printer and the 66KC magnetic tape. Refer to sections describing these units for the time demand on the processor storage.) Processing can continue except for these storage interruptions.

The Simultaneous Mode and Data Record File Mode commands, when used, should be given before processing of the previous record is started or before a Normal Mode input-output operation is started to enable maximum utilization of the Simultaneous Mode Control features.

Condition I; no Simultaneous Mode Control and no Data Record File Mode Control.

One of the following operations:

Process instructions
Read or write magnetic tape
Read or punch a card
Print a line
Read or write Data Record File
Read or write Data Disc File

and any number of the following operations, limited only by the system configuration:

Rewind magnetic tapes
Advance paper on line printer
Seek on Data Record and Data Disc Files.

§ 111.

.4 RULES (Contd.)

Condition II; Simultaneous Mode Control Included

Any two of the following operations, depending on the system configuration:

Process instructions
Read a card
Punch a card
Read magnetic tape using Processor
Read magnetic tape using Simultaneous Mode Control
Write magnetic tape using Processor
Write magnetic tape using Simultaneous Mode Control
Print a line
Read Data Record File using Processor
Read Data Record File using Simultaneous Mode Control
Write Data Record File using Processor
Write Data Record File using Simultaneous Mode Control
Read Data Disc File using Processor
Read Data Disc File using Simultaneous Mode Control
Write Data Disc File using Processor
Write Data Disc File using Simultaneous Mode Control

and any number of the following operations, limited only by the system configuration:

Rewind magnetic tapes
Advance paper on line printer
Seek on Data Record and Data Disc Files.

.4 RULES (Contd.)

Condition III; both Simultaneous Mode Control and Data Record File Mode Control Included

Any two of the following operations, depending on the system configuration:

Process instructions
Read a card
Punch a card
Read magnetic tape using Processor
Read magnetic tape using Simultaneous Mode Control
Write magnetic tape using Processor
Write magnetic tape using Simultaneous Mode Control
Print a line
Read Data Record File using Processor
Read Data Record File using Simultaneous Mode Control
Write Data Record File using Processor
Write Data Record File using Simultaneous Mode Control
Read Data Disc File using Processor
Read Data Disc File using Simultaneous Mode Control
Write Data Disc File using Processor
Write Data Disc File using Simultaneous Mode Control

and read or write on Data Record File, and any number of the following operations, limited only by system configuration:

Rewind magnetic tapes
Advance paper on line printer
Seek on Data Record and Data Disc Files

INSTRUCTION LIST

§ 121.

INSTRUCTION					OPERATION
Mnemonic	OP	N	A	B	
					Arithmetic
ADD	+	N	A	B	(A) + (B) → A.
SUB	-	N	A	B	(A) - (B) → A.
OR	Q	N	A	B	(A) OR (B) → A.
AND	T	N	A	B	(A) AND (B) → A.
EXO	U	N	A	B	(A) Exclusive OR (B) → A.
					Arithmetic, using 354/355 Processor
					Fixed point
FXA	@	N	A	B	(A) + (B) → A.
FXS	(	N	A	B	(A) - (B) → A.
FXM	)	N	A	B	(A) x (B) → A.
FXD	&	N	A	B	(A) ÷ (B) → A.
					Floating point
FLA	$	N	A	B	(A) + (B) → A.
FLS	:	N	A	B	(A) - (B) → A.
FLM	"	N	A	B	(A) x (B) → A.
FLD	/	N	A	B	(A) ÷ (B) → A.
					Other
SAC	Z	N	-	B	(Accumulator and/or Product Register) → B.
SHA	=	N	-	B	(Accumulator and/or Product Register) shifted, under control of N, B characters.
					Logic
REG	V	1	A	B	(P) → A, Jump to B.
		2	A		(A) of previous instruction → STA.
		4	A		(B register) → A.
		8	A		(S register) → A.
		&	A		(U register) → A.
CTC	W	1	A	B	Jump to A if PRP set, to B if PRN is set, to next instruction if PRZ is set.
		2	A	B	Jump to A if first overflow set, to B if neither overflow is set, to next instruction if second overflow is set.
		4	A	B	Jump to A if there is a read in Simultaneous Mode, to B if there is a write in Simultaneous Mode, to next instruction if Simultaneous Mode is unoccupied.
		8	A	B	Jump to A if EF/ED Normal set, otherwise to B.
		&	A	B	Jump to A if interrupt set, otherwise to B.
		-	A	B	Jump to A if EF/ED Simultaneous set, otherwise to B.
TA	X	N	A	B	Jump to B if (A) not zero; (A)-1 → A. If N not zero, increment index registers as specified by N.
COM	Y	N	A	B	Compare (A) against (B) from the left and set PRI.
RPT	R	N	0000	0000	Repeat next instruction N times, resetting A and B.
		N	0000	0001	Repeat next instruction N times, resetting A chaining B.
		N	0001	0000	Repeat next instruction N times, resetting A resetting B.
		N	0001	0001	Repeat next instruction N times, chaining A and B.

§ 121.

INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic	OP	N	A	B	
					Logic (Contd.)
IOS	S	N	A	B	Jump to B if device selected by N satisfies condition A.
		X	1		Tape station: . . . . . non-operable
			2		tape in motion
			4		at end of tape
			8		at front of tape
			16		tape in reverse motion
		X	1		Paper Tape: . . . . . non-operable
			2		operating
		X	1		Cards: . . . . non-operable
			2		operating
		X	1		Printer: . . . . non-operable
			2		printing a line
			4		advancing paper
		X	1		Data Record File: . . . non-operable
			2		operating (reading or writing)
			4		turntable occupied
		X	1		Data Disc File: . . . . non-operable
			2		operating
			4		arm movement terminated
		X	1		MICR Sorter-Reader: . non-operable
			2		jam
			4		transporting problem
			8		feeder hopper empty
			16		pocket selection ignored
HLT	(period)	ignored	ignored	ignored	Stop computer, after completion of any instruction in Simultaneous Mode.
					Data Transfer
LSL	K	N	A	B	Search left from A to B to find first symbol different from N.
LSR	L	N	A	B	Search right from A to B to find first symbol different from N.
DL	M	N	A	B	Copy N characters from A to B left.
DR	N	N	A	B	Copy N characters from A to B right.
DSL	#	N	A	B	Copy characters from A to B left, delimited by symbol N.
DSR	P	N	A	B	Copy characters from A to B right, delimited by symbol N.
SF	J	N	A	B	Fill area A to B with symbol N.
TRA	A	N	A	B	Translate starting at A using table starting at B, for N entries.
					Internal Storage; Data Record Files
BSN	D	N	0000	B	Get record and ready arm to band B of Processor-controlled File. N specifies initial return of record to cage.
BSM	E	N		B	Get record and ready arm to band B of file N using Record File Mode Control; N also specifies initial return of record to cage.
BRN	F	N	A	XBCD	Read N cells into A starting from cell D using Processor. If C even stop on block delimiter, if B odd return record to cage.
BRS	G	N	A	XBCD	Read N cells into A, using SMC. Control as in OP F.
BWN	H	N	A	XBCD	Write N cells from A, using Processor. Control as in OP F.
BWS	I	N	A	XBCD	Write N cells from A, using SMC. Control as in OP F.

§ 121.

INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic	OP	N	A	B	
RMR	*	N	A	XBCD	Read N cells into A, using DRFMC. Control as in OP F.
RMW	%	N	A	XBCD	Write N cells from A, using DRFMC. Control as in OP F.
					Internal Storage; Data Disc File
TS	D	N	0000	B	N selects File; yoke position from B.
SRN	F		A		Read sectors using Processor into A.
SRS	G		A		Read sectors using SMC into A.
SWN	H		A		Write sectors using Processor from A.
SWS	I		A		Write sectors using SMC from A.
					Input-Output; Paper Tape, Magnetic Tape
RFN	4	N	A	B	Read tape N forward into area from A to B using Processor.
RFS	5	N	A	B	Read tape N forward into area from A to B using SMC.
RRN	6	N	A	B	Read tape N backward into area from A to B using Processor.
RRS	7	N	A	B	Read tape N backward into area from A to B using SMC.
TWN	8	N	A	B	Write tape N forward from area from A to B using Processor.
TWS	9	N	A	B	Write tape N forward from area from A to B using SMC.
RWD	;	N			Rewind tape N.
					Input-Output; Punched Cards
CRN	0	X	A	0000	Read card into area starting at A using Processor.
CRS	1	X	A	0000	Read card into area starting at A using SMC.
CPN	2		A	B	Punch card from area from A to B using Processor.
CPS	3		A	B	Punch card from area from A to B using SMC.
					Input-Output; Printer
PAN	B		0000	BBB0	Print one line starting at BBB0 using Processor; no paper advance.
		N	0000	BBB1	Print one line starting at BBB0 using Processor; advance N lines.
			0000	BBB2	Print one line starting at BBB0 using Processor; advance using tape loop (tab).
			0000	BBB3	Print one line starting at BBB0 using Processor; advance and change page.
PAS	C	N		B	Print as in B Operation, using SMC.
					Input-Output: MICR Sorter-Reader
	;	0	0000	B	Start feeding documents on MICR device if B = 1. Stop feeding documents on MICR device if B = 0.
	6	0	A	B	Read one MICR document into area from A to B using Processor.
	7	0	A	B	Read one MICR document into area from A to B using SMC.
	8	0	A	A	Selects pocket in MICR device based on character in A.

RCA 301 AUTOMATIC ASSEMBLY SYSTEM FILE DESCRIPTOR

TITLE FCP EXAMPLE

PROGRAMMER John Doe | DATE 2/27/62

COLUMNS	INFORMATION	USE OF ENTRY
1-6	FILEA,	Select a unique character for each file from 0-9 and A-I.
7-8	T,	Indicate the input-output media: C = card, T = tape.
9-11	DD,	Assign a device character: for tape, assign two device characters. Repeat the first device character if only one tape station is assigned to the file. For input card files, indicate the appropriate device character.
12-20	MASTER,	Label identification item for label procedures: enter NONE____if not appropriate.
21-24	000,	Active time value expressed in days; 000 must appear if entry is not appropriate.
25-26	C,	Label-Type Indicator; B = beginning label only, C = both beginning and ending, N = no labels.
27-32	NONE,	Tag of own coding to be executed for beginning label. Enter NONE_if not appropriate.
33-38	NONE,	Tag of own coding to be executed for ending label. Enter NONE_if not appropriate.
39-40	Y,	Is this file always present when the program is run? Y = yes, N = no.
41-42	N,	Is this file batched? Y = yes, N = no. (Always N for card files.)
43-46	000,	Enter numbers of records per batch or total number of read or punch areas for card files; 000 must appear for non-batched tape files.
47-51	0000,	Enter maximum size of a batch. This total includes each E/I symbol associated with each data record and the terminal E/F of the batch. 0000 must appear if the file is not batched.
52-56	100,	Enter size of largest record in the file including terminating E/I. (0080 for cards.)
57-58	N,	Execute I-O commands in the simultaneous mode? Y = yes, N = no.
59-60	B,	Type of file: I = input, O = output, B = both input and output.
61	N	Is rerun controlled by this file? Y=yes, N=no.
62-71		Punched blanks in these columns.
72-74		Program IDEN.
75-80	000050	Sequence Number.

28-00-089

RCA 301 AUTOMATIC ASSEMBLY SYSTEM FILE DESCRIPTOR

TITLE FCP EXAMPLE

PROGRAMMER John Doe — DATE 2/27/62

COLUMNS	INFORMATION	USE OF ENTRY
1-6	FILEB ,	Select a unique character for each file from 0-9 and A-I.
7-8	T ,	Indicate the input-output media: C = card, T = tape.
9-11	EE ,	Assign a device character: for tape, assign two device characters. Repeat the first device character if only one tape station is assigned to the file. For input card files, indicate the appropriate device character.
12-20	MASTER ,	Label identification item for label procedures: enter NONE____if not appropriate.
21-24	000 ,	Active time value expressed in days; 000 must appear if entry is not appropriate.
25-26	C ,	Label-Type Indicator; B = beginning label only, C = both beginning and ending, N = no labels.
27-32	NONE ,	Tag of own coding to be executed for beginning label. Enter NONE_if not appropriate.
33-38	NONE ,	Tag of own coding to be executed for ending label. Enter NONE_if not appropriate.
39-40	Y ,	Is this file always present when the program is run? Y = yes, N = no.
41-42	N ,	Is this file batched? Y = yes, N = no. (Always N for card files.)
43-46	000 ,	Enter numbers of records per batch or total number of read or punch areas for card files; 000 must appear for non-batched tape files.
47-51	0000 ,	Enter maximum size of a batch. This total includes each E/I symbol associated with each data record and the terminal E/F of the batch. 0000 must appear if the file is not batched.
52-56	400 ,	Enter size of largest record in the file including terminating E/I. (0080 for cards.)
57-58	N ,	Execute I-O commands in the simultaneous mode? Y = yes, N = no.
59-60	B ,	Type of file: I = input, O = output, B = both input and output.
61	N	Is rerun controlled by this file? Y = yes, N = no.
62-71		Punch blanks in these columns.
72-74		Program IDEN.
75-80	000080	Sequence Number.

28-00-089

RCA 301 AUTOMATIC ASSEMBLY PROGRAM SHEET

TITLE FCP EXAMPLE

HEADER

PROGRAMMER John Doe

DATE 2/27/62

18 TAG 22	23 OP 25	26 N 32	33 ADDRESS FIELD 71	72 IDEN 74	75 NUMERIC SEQUENCING 80
	RMK		301 FCP EXAMPLE-REMOVE OBSOLETE RECORDS		000010
	LBL	BEGIN	29, STANDARD BEGIN INCLUDES IDEN, REEL#,		000020
	LBL	END	10, STANDARD & BOTH WRITEN & PURGE DATE		000030
	SHR		FILEA, FILEB EFFICIENT MEMORY UTILIZAT		000040
	(SEE FILE DESCRIPTOR)				000050
	RCD		400 SIZE OF LARGEST MESSAGES		000060
DECID	BST		8 PREVIOUSLY SET SENTINAL,		000070
	(SEE FILE DESCRIPTOR)		SAME MESSAGE SIZE IN BOTH		000080
	RCD		400 INPUT & OUTPUT		000090
	BST		8		000100
	SEG	7	START OF ACTUAL PROGRAM		000110
START	OPN		FILEA, INPUT INCLUDES INIT OF PARAMET,		000120
	OPN		FILEB, OUTPUT LABEL CHECKS & POSITIONING		000130
NOTSO	RED		FILEA, OUT READ MESSAGE, SENSE EF		000140
	COM	8	NGOOD, DECID MESSAGE ACCEPTABLE?		000150
	TPN		GOOD, GOOD YES, WRITE		000160
	TRS		STP, NOTSO NO, DELETE		000170
GOOD	WRT		FILEB, VARIABLE		000180
OUT	CLO	RWD	FILEA, INPUT-FILE CLOSE INCLUDES END		000190
	CLO	RWD	FILEB, OUTPUT-FILE LABEL EXECUTION AND		000200
	HLT	0	/,/ REWOUND AT BTL IF SPECIFIED		000210
NGOOD	CON	8	E/B REJECT SENTINEL CONSTANT		000220

28-00-033

PAGE 1 OF 2

RCA 301 AUTOMATIC ASSEMBLY PROGRAM SHEET

TITLE	HEADER
PROGRAMMER	DATE

18 TAG 22	23 OP 25	26 N 32	33 ADDRESS FIELD 71	72 IDEN 74	75 NUMERIC SEQUENCING 80
	END		START TO BEGINNING AFTER AUTO INS		000230

28-00-033

PAGE 2 OF 2

CODING SPECIMEN: COBOL

§ 132.

.1 SOURCE PROGRAM EXCERPT

301 COBOL NARRATOR PROGRAM SHEET

TITLE INVENTORY UPDATING RUN

PROGRAMMER | DATE

```
SEQUENCE
NUMBER
1    6 7 8   12                                                            IDENT 73-80
001000   CONSTANT SECTION.
         77 ERROR-1; SIZE IS 33; CLASS ALPHABETIC; VALUE "AGENCY COUNTERS
       -     "DO NOT BALANCE -".
         77 ERROR-2; PICTURE A(32); VALUE "AGENCY AMOUNTS DO NOT BALANCE -
       -     " ".
         77 ERROR-3; SIZE 29; CLASS ALPHABETIC; VALUE "RECORD COUNTS DO NO
       -     "T AGREE -".

001100   PROCEDURE DIVISION.
         DECLARATIVES.
         ABLE SECTION 00. USE AFTER ENDING REEL LABEL PROCEDURE
             ERROR-FILE.
         ERROR-LABEL. ADD BLOCK-COUNT TO ERROR-OUT.
001110   END DECLARATIVES.
001200   HOUSEKEEPING SECTION 01.
001300   INITIALIZE-FILES. OPEN INPUT MASTER-FILE; OUTPUT NEW-MASTER-FILE,
             ERROR-FILE, PROCUREMENT-FILE. ACCEPT TODAYS-DATE FROM SPECIAL
       -     -INPUT. MOVE "P" TO P-CODE.
001400   LOAD-TABLES. MOVE ZEROS TO AGENCY-COUNTER (ENTRY), AGENCY-AMT (EN
       -     TRY). ADD 1 TO ENTRY.
001500   EXECUTE-LOAD. PERFORM LOAD-TABLES 7 TIMES.
001700   MAIN-PROCESSING SECTION 00.
001710   MAST-IN. READ MASTER-FILE; AT END GO TO CLOSE-RUN. ADD 1 TO MASTE
       -     R-IN. IF ID-CODE IN MASTER-FILE IS NOT EQUAL TO "R" MOVE "A"
             TO ID-CODE IN MASTER-FILE THEN GO TO ERR-OUT.
```

PAGE 5 OF 7

RCA 301 UMAC PROGRAM SHEET

TITLE SAMPLE PROGRAM 1

PROGRAMMER R. Dash DATE 7/4/62

C (1)	STATEMENT NUMBER (2–5)	6	UMAC STATEMENTS (7–76)	CARD NUMBER (80)
C			SAMPLE PROGRAM 1 R. DASH	
			FIX ALL I,N	
			FUNCTION SQRT : LBJ, ATAN : LBI	
C			READ PARAMETER	
			READ, N	
			PRINT AND LABEL, N	
			SPACE 4	
			DO 5 I = 1, N	
			READ, X1, Y1, X2, Y2, X3, Y3	
			PRINT AND LABEL, X1, Y1, X2, Y2, X3, Y3	
C			COMPUTE LENGTH OF SIDES	
			AB = SQRT F ((X2 - X1) ** 2 + (Y2 - Y1) ** 2)	
			AC = SQRT F ((X3 - X1) ** 2 + (Y3 - Y1) ** 2)	
			BC = SQRT F ((X3 - X2) ** 2 + (Y3 - Y2) ** 2)	
C			COMPUTE AREA	
			S = (BC + AC + AB)/2	
			AREA = SQRT F (S * (S - BC) * (S - AC) * (S - AB))	
C			COMPUTE RADIUS OF INSCRIBED	
C			AND CIRCUMSCRIBED CIRCLES	
			RINSC = AREA/S	
			FOURA = 4. * AREA	
			RCIRC = BC * AC * AB/FOURA	

28-00-094

PAGE 1 OF

DATA CODE TABLE NO. 1

§141.

.1 USE OF CODE: . . . . . Internal Code, Magnetic Tape 1/, Paper Tape 1/, Printer, Data Disc File, Record File.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . 6 bits plus odd parity bit, except tape codes which are even parity.

.22 Character Structure

.221 More significant pattern: . . . . 2 bits: 16, 32.

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

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	&"	minus -	"
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	0	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10	Note 2/	+	EI	EB
11	#	.	$	,
12	@	;	*	%
13	(	:	ED	●
14	)	'	EF	=
15				

Notes: 1/ Tape code is complement of 301 internal code. On tape, gap is denoted by no punches (paper tape) or no characters (magnetic tape).
2/ This code is interpreted as space or underscore.
3/ EB = End of Block.
ED = End Data.
EF = End File.
EI = End Information.
● = ISS = Item Separator.

DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . . Punched card input-output.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH None	12	11	0
None	Note 1	&	minus -	
12				
11				
0	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		+	EI	EB
8-3	#	.	$	,
8-4	@	;	*	%
8-5	(	:	ED	• 2/
8-6	)	'	EF	=
8-7				

Notes: 1/ A blank column is interpreted as a blank or underscore.
2/ ISS (item separator) symbol.

DATA CODE TABLE No. 3

§ 143.

.1 USE OF CODE: . . . . internal coding sequence.

.2 STRUCTURE OF CODE

In ascending sequence:

0	minus (-)
1	J
2	K
3	L
4	M
5	N
6	O
7	P
8	Q
9	R
Note †	EI
#	$
@	*
(	ED ‡
)	EF ‡
&	"
A	/
B	S
C	T
E	U
F	V
G	W
H	X
I	Y
+	Z
.	EB ‡
;	,
:	%
'	• ‡
	=

† This code is interpreted as space or underscore.

‡ EB = End of Block.
ED = End Data.
EF = End File.
EI = End Information.
• = ISS = Item Separator.

PROBLEM ORIENTED FACILITIES

§151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers: . . . . . . none.

.12 Simulation by Other Computers: . . . . none.

.13 Data Sorting and Merging

Tape Merge 30
- Record size: . . . . . . preset for each run.
- Block size: . . . . . . accepts any, chooses own optimum.
- Key size: . . . . preset for each run.
- File size: . . . . 10 reels.
- Number of tapes: . . . 4 or 6.
- Date available: . . . ?
- Description: . . . . . . 1 to 10 way merge of sequenced files.

Tape Sort 31
- Record size: . . . . . . preset for each run.
- Block size: . . . . . . accepts any, chooses own optimum.
- Key size: . . . . preset for each run.
- File size: . . . . 99 reels.
- Number of tapes: . . . up to 12.
- Date available: . . . . ?
- Description: . . . . . . 2 to 10 way, one pass merge, or "1-way" sequence check; uses re-run tape; can use alternators; requires 20K HSM.

.14 Report Writing: . . . . . none.

.15 Data Transcription

Magnetic Tape to Printer
- Reference: . . . . . . TAPE TO PRINTER.
- Date available: . . . . September 1961.
- Description: . . . . . transcribe 501 type tapes to printed output.

Magnetic Tape to Card
Card to Magnetic Tape
- Reference: . . . . TAPE TO CARD; CARD TO TAPE.
- Date available: . . . . September 1961
- Description: . . . . . uses 501 tapes with either 501 or 301 code, provides column splitting, rearrangements and editing.

.16 File Maintenance: . . . . none.

.17 Other

ABSTRACT
- Date available: . . . . . September, 1961
- Description: . . . . . . lists for a magnetic tape the names of files, numbers of blocks, and fixed sample from each block.

ASSEMBLER CARD CONDENSER
- Date available: . . . . September, 1961.
- Description: . . . . . combined instruction cards produced by the Automatic Assembly System Program into six (6) instructions per card format. This routine would consolidate cards, thereby decreasing loading time.

CARD PRINT
- Date available: . . . . . December 15, 1961
- Description: . . . . . . prints information from punched cards to the printer. This routine could be used for checking the contents of card test data.

LOADER PRINT
- Date available: . . . . September, 1961.
- Description: . . . . . . prints the contents of program instruction cards. For programs that are coded in machine language, this routine could be used to check the contents of program instruction cards.

.2 PROBLEM ORIENTED LANGUAGES: . . . . . none.

PROCESS ORIENTED LANGUAGE: COBOL 61

§ 161.

.1 GENERAL

.11 Identity: . . . . RCA 301 COBOL Narrator. COBOL 61.

.12 Origin: . . . . CODASYL committee.

.13 Reference: . . . . 301 COBOL Narrator, Users' Reference 93-05-002.

.14 Description

The RCA 301 COBOL Narrator covers all of the Required COBOL facilities and many electives. (A general description of COBOL and a detailed list of all possible electives is included in The Users' Guide, 4:161.) In addition, there are special extensions to improve object program performance on low activity file processing. Both fixed and variable sized items can be used freely.

Deficiencies

None.

Electives

# 2:	"=" sign only.
# 3, 5, 6, 8, 9, 10:	
# 11, 13:	accepted but only as a comment, no "DEPENDING" elective.
# 14:	"L" but not "DEPENDING."
# 17:	
# 19:	not "DEPENDING."
# 20:	
# 21:	in one program all labels must be standard or all non-standard.
# 24:	ENTER AASP language.
# 25:	except "REPLACING" (Parameter names) facility.
# 26:	only option 2.
# 27, 28, 30:	
# 33:	up to size 18 digits.
# 34, 35, 36 37, 38, 39:	
# 40, 41:	all except option to specify standard "SUPERVISOR."
# 42, 43, 45:	
# 46:	re-start only at end of reel, no multi-file reels.
# 47:	
# 48:	see 25.
# 49:	

Extensions

Facilities to increase the object program efficiency for low activity files will be available later in 1962. First, there are read and write verbs (RELEASE) for complete blocks instead of only records and second, there is a verb to access the identities of the first and last records in a block.

.15 Publication Date: . . . . Initial, June, 1961. Extended, February, 1962. Further extension expected late 1962.

.2 PROGRAM STRUCTURE

.21 Divisions

IDENTIFICATION: . . . name of author; name and data of program.
ENVIRONMENT: . . . . describes translating and target computers and relates I/O units to files, names to units.
DATA: . . . . describes the data items and shows the structure of records, files, working storage and constants.
PROCEDURE: . . . . . describes the procedures in an imperative form.

.22 Procedure Entities

PROCEDURE DIVISION: sections and/or paragraphs.
SECTION: . . . . paragraphs.
PARAGRAPH: . . . . . sentences.
SENTENCE: . . . . . . imperative, conditional and compiler directing statements.
STATEMENT: . . . . . COBOL words.

.23 Data Entities

FILE: . . . . records.
RECORD: . . . . elementary items or group items.
GROUP ITEM: . . . . . elementary items or group items; up to 48 levels of group items are possible.
ELEMENTARY ITEM: . characters.

.24 Names

.241 Simple name formation
Alphabet: . . . . A to Z, 0 to 9, and hyphen.
Size: . . . . 30 characters maximum.
Avoid key words: . . . yes.
Formation rule: . . . at least one letter; no hyphen as first or last character.

§ 161.

.242 Designators

Procedures	
PROCEDURE DIVISION:	labeled with name.
SECTION:	SECTION is part of header.
PARAGRAPH:	none.
SENTENCE:	no name allowed.
Data:	none.
Equipment:	standard names, e.g., PAPER-TAPE-READER.
Comments:	begin with key word NOTE.
Translator control:	none.

.25 Structure of Data Names

.251 Qualified names	
Example:	TOTAL IN MASTER.
Multiple qualifiers:	yes.
Complete sequence:	optional.
Broken sequence:	yes.
.252 Subscripts	
Number per item:	0 to 3.
Applicable to:	group item or elementary items.
Class may be	
Special index variable:	no.
Any variable:	yes.
Literal:	yes.
Expression:	no.
Form may be	
Integer only:	yes.
Signed:	only positive.
.253 Synonyms	
Preset:	yes.
Dynamically set:	no.

.26 Number of Names:	unlimited.

.27 Region of Meaning of Names

.271 Universal names:	all.
.272 Local names:	none.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture:	yes.
.312 List by kind:	no.
.313 Qualify by adjective:	NUMERIC.
.314 Qualify by phrase:	CLASS IS NUMERIC.
.315 Qualify by code:	no.
.316 Hierarchy by list:	yes.
.317 Level by indenting:	optional.
.318 Level by coding:	mandatory.

.32 Files and Reels

.321 File labels	
Variable layout:	card files only, description and/or own coding or library, or standard throughout or none.
Control totals:	use own coding.
Identity control:	description, or library, or USE.
Multi-reel:	description, or library, or USE.
.322 Reel labels	
Variable layout:	tape files only, description or library or standard or none.
Block count:	description, or USE.
Multi-files:	none directly, but can be arranged in program.

.33 Records and Blocks

.331 Variable record size:	preset, or dynamic.
.332 Variable block size:	preset, or dynamic.
.335 Choice of record size:	description.
.336 Choice of block size:	description.
.337 Sequence control:	SEQUENCED ON, recognized but no action taken.
.338 In-out error control:	automatic.
.339 Blocking control:	automatic.

.34 Data Items

.341 Designation of class:	description.
.342 Possible classes	
Integer:	yes.
Fixed point:	yes.
Floating point:	no.
Alphabetic:	yes.
Alphameric:	yes.
.343 Choice of external radix:	none.
.344 Possible radices:	only decimal.
.345 Justification:	description, or automatic left for alpha and point alignment for numeric.
.346 Choice of code:	description.
.347 Possible codes:	standard only.
.348 Item size	
Variable size:	preset or dynamic.
Designation:	picture or phrase. variable by delimiter in data.
Range	
Fixed point numeric:	1 to 18 characters in arithmetic.
Alphameric:	no limit.
.349 Sign provision:	optional.

§ 161.

.35 Data Values

.351 Constants
Possible sizes
Integer: . . . . 1 to 18 characters in arithmetic.
Fixed point: . . . . . 1 to 18 characters in arithmetic.
Alphabetic: . . . . . 1 to 120 characters.
Alphameric: . . . . 1 to 120 characters.
Subscriptible: . . . . by redefining.
Sign provision: . . . . optional.
.352 Literals: . . . . same as constants.
.353 Figuratives
Examples: . . . . . . ZERO, ZEROES, ZEROS, SPACE, SPACES, ALL "literal."
.354 Conditional variables: . yes.

.36 Special Description Facilities

.361 Duplicate format: . . . COPY.
.362 Re-definition: . . . . . REDEFINES.
.363 Table description
Subscription: . . . . . mandatory.
Multi-subscripts: . . by hierarchy of levels.
Level of item: . . . . group item or elementary item.
Implied subscript at lower level: . . . . . yes.
.364 Other subscriptable entities: . . . . none.

.4 OPERATION REPERTOIRE

.41 Formulae: . . . . none.

.42 Operations on Arrays: . none.

.43 Other Computation

.431 Operator list
ADD: . . . . unrounded addition, to.
SUBTRACT: . . . . . unrounded subtraction, from.
MULTIPLY: . . . . . unrounded multiplication, by.
DIVIDE: . . . . unrounded division, into.
.432 Operands allowed
Mixed scaling: . . . . yes.
Mixed radices: . . . . no.
Literals: . . . . yes.
Restrictions: . . . . . must be pure numeric, no decimal points allowed in data.

.433 Statement
Mixed verbs: . . . . . no.
Multi-results: . . . . yes.
Size limits: . . . . . . none.
Multi-operand: . . . . yes.
Implied results: . . . last named operand.
.434 Rounding of results: . . optional ROUNDED in procedures, else truncated.
.435 Special cases
x = -x: . . . . SUBTRACT X FROM 0 GIVING X.
x = x + 1: . . . . ADD 1 TO X.
x = x + y: . . . . ADD Y TO X.
x = x ÷ y: . . . . DIVIDE Y INTO X.
x = xy: . . . . MULTIPLY Y BY X.
x = remainder ÷ y: . . DIVIDE Y INTO X GIVING Z; MULTIPLY Y BY Z; SUBTRACT Z FROM X.
.436 Typical cases
x = y + z: . . . . ADD Y, Z GIVING X.

.44 Data Movement and Format

.441 Data copy example: . . MOVE X TO Y.
.442 Levels possible: . . . . group items. elementary items.
.443 Multiple results: . . . . MOVE X TO Y, Z.
.444 Missing operands
Excess sources: . . . MOVE CORRESPONDING.
Excess destinations: . MOVE CORRESPONDING.
.445 Size of operands
Exact match: . . . . . only group items.
Alignment rule
Numbers: . . . . . . decimal point.
Alpha: . . . . left justified.
Fuller rule
Numbers: . . . . . . zeroes.
Alpha: . . . . blanks.
Truncating rule
Numbers: . . . . . . at each end.
Alpha: . . . . at right.
Variable size destination: . . . . yes.
.446 Editing possible
Change class: . . . . description.
Change radix: . . . . no.
Delete editing symbols: no.
Insert editing symbols
Actual point: . . . . description.
Suppress zeroes: . . description.
Insert: . . . . $, . *+- CR DB blank, 0
Float: . . . . $+- *
.447 Special moves: . . . . . MOVE ZEROES TO X. moves between fixed and variable sized items.
.448 Code translation: . . . none.

.449 Character manipulation: EXAMINE; to replace and/or count the number of occurrences of a given character in a data item.

.45 File Manipulation

Open: . . . . OPEN.
Close: . . . . CLOSE.
Advance to next record: READ; WRITE; including paper ADVANCING.
Step back a record: . . none.
Set restart point: . . . library or description.
Restart: . . . . none.
Start new reel: . . . . . CLOSE REEL.
Start new block: . . . . none.
Search on key: . . . . . none.
Rewind: . . . . automatic for CLOSE file but can say NO REWIND.
Unload: . . . . REWIND, LOCK.

§ 161.

.46 Operating Communication

.461 Log of progress: . . . . STOP literal, shows literal to operator.
DISPLAY; to display low volume data on typewriter or on-line printer.
.462 Messages to operator: . same as log.
.463 Offer options: . . . . . own COBOL coding using DISPLAY and ACCEPT.
.464 Accept option: . . . . . ACCEPT; to receive low volume data from magnetic or paper tapes or cards.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	ON SIZE ERROR	own COBOL coding.
In-out:	automatic	automatic.
Invalid data:	none	none.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . sections.
paragraphs.
.512 Unconditional jump: . . GO TO X.
.513 Switch: . . . . separate paragraph, named Y containing only a GO TO X statement.
.514 Setting a switch: . . . . ALTER Y TO PROCEED TO Z.
.515 Switch on data: . . . . . GO TO X, Y, Z DEPENDING ON W.

.52 Conditional Procedures

.521 Designators
Condition: . . . . . . IF.
Procedure: . . . . . . implied.
.522 Simple conditions
Expression v Expression: . . . no.
Expression v Variable: . . . . no.
Expression v Literal: . . . . . no.
Expression v Figurative: . . . no.
Expression v Condition: . . . . no.
Variable v Variable: . . . . yes.
Variable v Literal: . . . . . yes and reverse.
Variable v Figurative: . . . yes and reverse.
Variable v Condition: . . . . yes.
Conditional value: . . . . yes.
.523 Conditional relations
Equal: . . . . IS UNEQUAL TO.
IS (NOT) EQUAL TO.
EQUALS.
Greater than: . . . . . IS (NOT) GREATER THAN.
EXCEEDS.
Less than: . . . . . . IS (NOT) LESS THAN.
Greater than or equal: none.
Less than or equal: . none.
.524 Variable conditions: . . NOT POSITIVE; does include zero.
POSITIVE; does not include zero.
NOT NEGATIVE; does include zero.
NEGATIVE; does not include zero.
(NOT) NUMERIC.
(NOT) ALPHABETIC.
(NOT) ZERO.
.525 Compound conditionals
IF x AND y: . . . . . many times, not mixed with OR.
IF x OR y: . . . . . . many times, not mixed with AND.
IF x DO a AND y DO b: yes.
IF x DO a OR y DO b: yes.
.526 Alternative designator: ELSE, or OTHERWISE.
.527 Condition or alternative: yes.
.528 Typical examples: . . . IF X IS POSITIVE AND Y IS POSITIVE ADD X TO Y, ELSE IF Z IS POSITIVE MOVE Z TO Y.

.53 Sub-routines

.531 Designation
Single statement: . . . name of paragraph or section, in a cue.
Set of statements
First: . . . . name of first.
Last: . . . . name of last.
.532 Possible sub-routines: . series of paragraphs or sections.
.533 Use in-line program: . yes.
.534 Mechanism
Cue with parameters: none.
Cue without parameter: . . . . . PERFORM A THRU B.
Formal return: . . . . implied.
Alternative return: . . EXIT.
.535 Names: . . . . all univeral.
.536 Nesting limit: . . . . . none.
.537 Automatic recursion allowed: . . . . none.

.54 Function Definition by Procedure: . . . . . . none.

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

.56 Loop Control

.561 Designation of loop
Single procedure: . . PERFORM A.
USE . . .
First and last procedures: . . . . . PERFORM A THRU B.
.562 Control by count
Literal: . . . . yes.
Data: . . . . yes.
Example: . . . . PERFORM A AGE TIMES.

§ 161.

.563 Control by step
  Parameter
    Special index: . . . . none.
    Any variable: . . . . VARYING AGE FROM 1 BY 1 UNTIL.
  Step: . . . . any variable.
  Criteria: . . . . any conditional expression.
  Multiple parameters: no.
.564 Control by condition
  Example: . . . . UNTIL B IS NEGATIVE.
  Combined with step: . optional.
.565 Control by list: . . . . no.
.566 Nesting limit: . . . . . none.
.567 Jump out allowed: . . . yes.
.568 Control variable exit status: . . . . available always.

.6 EXTENSION OF THE LANGUAGE: . . . . . none.

.7 LIBRARY FACILITIES

.71 Identity: . . . . 301 COBOL library.

.72 Kinds of Libraries

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

.73 Storage Form: . . . . . magnetic tape.

.74 Varieties of Contents: . data descriptions/divisions; environment divisions; identification divisions.
file and reel labels.
routines.
data descriptions.
input-output control and assignments.
re-start procedure.
own coded routines.

.75 Mechanism

.751 Insertion of new item: . library maintenance routine.
.752 Language of new item: . COBOL or AASP.
.753 Method of call: . . . . . COPY statement.
INCLUDE statement.

.76 Types of Routine

.761 Open routines exist: . . yes.
.762 Closed routines exist: . yes.
.763 Open-closed is variable: . . . . yes.

.8 TRANSLATER CONTROL

.81 Transfer to Another Language: . . . . . . ENTER AASP language.

.82 Optimizing Information Statements: . . . . . . special verbs for low activity files.
size of file.
range of size of item.
specify segments for overlays.

.83 Translater Environ ment: . . . . library call.
description.

.84 Target Computer Environment: . . . . . library call.
description.

.85 Program Documentation Control: . . . . yes, by non-COBOL statements.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: . . . . priority of segments.
SAME AREA description.

.92 Address Allocation: . . RENAMES, overlapping groups.
REDEFINES.

.93 Arrangement of Items in Words in Unpacked Form: . . . . not applicable.

.94 Assignment of Input-Output Devices: . . . environment division.
library description.

.95 Input-Output Areas: . . environment division.
library description.

PROCESS ORIENTED LANGUAGE: UMAC

§ 162.

.1 GENERAL

.11 Identity: . . . . . . UMAC, University of Miami Algebraic Compiler.

.12 Origin: . . . . . . Jay F. W. Pearson, Jr. Data Processing Center University of Miami, Fla.

.13 Reference: . . . . . RCA 301 Programs Application Library #97-20-031 Supplemental Information for the RCA 301 UMAC System (July, 1962).

.14 Description

UMAC is a language derived from basic FORTRAN, but has so many changes that, for practical purposes, it would be necessary to re-write all except the mathematical part of a program before running it on the RCA 301. A full FORTRAN compiler for the Scientific RCA 301 is being written.

The input-output facilities are particularly different from those of FORTRAN, because no equivalent to the FORMAT facility of FORTRAN exists in UMAC. All input-output is treated alike, packed into cards, card images, or lines of seven numeric values. A single statement can specify an array in all I/O transfers.

The rigid conventions in FORTRAN of dividing the integers from the floating point variables is somewhat relaxed, allowing free specification of initial letters of the name for use in determining which mode is to be used.

Most of the arithmetical and trigonometric functions are available but the logical function, such as MAXimum value x, y, etc., must be programmed. The subroutine mode has not been used; two functions, JUMP TO n, and JUMP BACK have been provided instead, and partially fill the gap. No compiler-directing statements are available.

.2 PROGRAM STRUCTURE

.21 Divisions

Arithmetic Statements: . . . . variable = expression.

Control Statements: . GO TO and IF to provide conditional jumps on data.
DO to provide loops.
PAUSE and STOP to allow operator action.

.21 Divisons (Contd.)

Control Statements (Contd.)
TEST to provide conditional jumps on environment.
CHANGE PAGE, SPACE, VERTICAL TAB, to provide format control.

Input-output Statements: . . . . READ, PUNCH, PRINT, READ TAPE, WRITE TAPE, each followed by either a list of variables or arrays.
END FILE, BACKSPACE, or REWIND for physical control.

Specification Statements: . . . . FIX ALL to define which names will belong to fixed point variables.
DIMENSION, to define array sizes.
FUNCTION to define all functions.

.22 Procedure Entities

Program: . . . . . statements.
functions.

Statements: . . . . character blanks are ignored.

Functions: . . . . . in machine code included at run time.

.23 Data Entities

Arrays: . . . . . . all variables.

Items: . . . . floating point variables or constants.
integer (fixed point) variables or constants.

Labels: . . . . . . item names which can be only used for printing immediately above the item.

.24 Names

.241 Simple name formation
- Alphabet: . . . . . A to Z, 0 to 9.
- Size: . . . . 1 to 5 characters.
- Avoid key words: . no.
- Formation rule: . . first character must be alphabetic.

.242 Designators
- Procedures
  - Statements: . . . 1 to 9999.
  - Function: . . . . no special restriction.

§ 162.

.242 Designators (Contd.)

Data
- Integer variables: . . . must start with an alphabetic which has been quoted in a "FIX ALL" statement.
- Floating point: . . must start with alphabetic which has not been quoted in a "FIX ALL" statement.
- Arrays: . . . . . must not end with F.

Equipment
- Card: . . . . . . implied by verbs READ, PUNCH.
- Magnetic Tape: . implied by word TAPE.
- Printer: . . . . implied by verb PRINT.

Comments: . . . . C in column 1 of the card.

Translator control: . . . . key words; DIMENSION, FIX ALL.

.25 Structure of Data Names

.251 Qualified names: . . none.

.252 Subscripts
- Number per item: . 3.
- Applicable to: . . . any fixed point expression.
- Form may be: . . integer only.

.253 Synonyms: . . . . . no.

.26 Number of Names

.261 All entities: . . . . no limit.

.262 Procedures: . . . . no limit.

.263 Data
- Files: . . . . . . names not used.
- Record formats: . names not used, standard format only.
- Items: . . . . . . no limit.
- Data levels: . . . not used.

.264 Equipment
- Card readers: . . 1.
- Card punches: . . 1.
- Printers: . . . . . 1.
- Magnetic Tape Units: . . . . . 10 absolute addresses.

.27 Region of Meaning of Names: all universal.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: . . . . . no.

.312 List by kind: . . . . no.

.313 Qualify by adjective: . . . . . no.

.314 Qualify by phrase: . . . . . . no.

.315 Qualify by code: . . . yes, the code being given in FIX ALL.

.316 Hierarchy by list: . . no.

.317 Level by indenting: . no.

.318 Level by coding: . . . no.

.319 Others
- Qualify by use: . . arrays listed in DIMENSION statement.

.32 Files and Reels: . . own coding.

.33 Records and Blocks

.331 Record size: . . . . fixed at one digit number.

.332 Block size: . . . . . fixed at one card image, containing up to seven numbers.

.338 In-out error control: . . . . . . automatic.

.339 Blocking Control: . . always 7 numbers per card image.

.34 Data Items

.341 Designation of class: . . . . . . by name.

.342 Possible classes
- Integer: . . . . . yes (called fixed point variables).
- Fixed point: . . . . only integers.
- Floating point: . . . yes.
- Alphabetic: . . . . only variable names.
- Alphameric: . . . . only variable names.

.343 Choice of external radix: . . . . . . none.

.344 Possible radices: . . only decimal.

.345 Justification: . . . . right justified on output.

.346 Choice of code: . . . implied by choice of equipment.

.347 Possible codes
- Card: . . . . see Data Code Table No. 2.
- Paper Tape: . . . . see Data Code Table No. 1.
- Magnetic Tape: . . see Data Code Table No. 1.
- Printer: . . . . . . see Data Code Table No. 1.

.348 Item size
- Variable size: . . . fixed.
- Range
  - Fixed point numeric: . . . . -99, 999, 999 to+99, 999, 999
  - Floating point numeric: . . . 10^{-100} to 10^{+99}, or zero in magnitude.
- Alphameric: . . . . max 5 characters.

.349 Sign provision: . . . optional.

.35 Data Values

.351 Constants
- Possible sizes
  - Integer: . . . . . 1 to 8 digits.
  - Fixed point: . . . none except integers.
  - Floating point: . . 1 to 8 significant digits, with 2 digit exponent.
  - Alphabetic: . . . none.
  - Alphameric: . . . none.
- Subscriptable: . . . yes.
- Sign provision: . . optional on input.

.352 Literals
- Possible sizes
  - Integer: . . . . . 1 to 8 digits.
  - Fixed point: . . . none, except integers.
  - Floating point: . . 1 to 8 significant digits, with 2 digit exponent.
  - Alphabetic: . . . none.
  - Alphameric: . . . none.
- Sign provision: . . optional, on input.

.353 Figuratives: . . . . own coding.

.354 Conditional variables: . . . . computed GO TO.

§ 162.

.36 Special Description Facilities

.361 Duplicate format: . . none (all format fixed).
.363 Table description
Subscription: . . . mandatory.
Multi-subscripts: . up to three, maximum value set at compilation time in DIMENSION statement.
Level of item: . . variable only.

.364 Other subscriptable entities: . . . . . none.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator list
+ : . . . . addition, never unary.
- : . . . . subtraction, can be unary.
* : . . . . multiplication.
/ : . . . . division.
** : . . . . exponentiation.
= : . . . . is set equal to.
ABSF: . . . . . absolute value of a floating point variable.
† XABSF: . . . . absolute value of a fixed point variable.
† LOGF: . . . . natural log.
† EXPF: . . . . exponentiation.
† SINF: . . . . . sine.
† COSF: . . . . cosine.
† ATANF: . . . . arctangent.
† SQRTF: . . . . square root.
† LOGXF: . . . . log 10.
† EXPXF: . . . . 10^x.

† The name of these routines is left free in UMAC, and must be specified by the user in calling statements. The names quoted are the standard FORTRAN names for these functions.

.412 Operands allowed
Classes: . . . . . numeric only.
Mixed scaling: . . yes, in floating point.
Mixed classes: . . only in exponentiation and subscripts.
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: . . . $(a^b)^c$.
Size limit: . . . . 149 characters (spaces ignored) 125 operands, operators, and parentheses.
Multi-results: . . no.
.414 Rounding of results: . truncation of integers at each step of 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 = 47/10 * K	X = 4.7 * Y.
$x = 5 \times 10^7 \times y^2$:	K = 50000000 + L * L	X = 5. E 7 + Y * Y.
x = y integer part:	K = y	K = Y, X = K.
x = |y|:	K = XABSF (J)	X = ABSF (Y).

.416 Typical examples: . X = (0. - B + SQRTF (B * B - 4. * A * C)) / 2. / A.

.42 Operations on Arrays

.421 Matrix operations: . . . . none.
.422 Logical operations: . . . . none.
.423 Scanning: . . . . . none.
.424 Input-Output: . . . . yes, using key word ARRAY.

.43 Other Computation: . . . none.

.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: . . only one size available.
.446 Editing possible: . . only change of class.
.447 Special moves: . . . none.
.448 Code translation: . . not required.
.449 Character manipulation: . . . not available.

.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.
Start new page: . . CHANGE PAGE.
Advance n lines: . . VERTICAL TAB n.
Position paper as directed by paper loop: . . . . SPACE n.
Search on key: . . . none.
Rewind: . . . . REWIND.
Unload: . . . . none.

.46 Operating Communication

.461 Log of progress: . . none.
.462 Messages to operator: . . . . via display in "A" register.
.463 Offer options: . . . PAUSE, followed by manual setting of interrupt button on the console.
.464 Accept option: . . . TEST interrupt setting.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	TEST verb	as coded.
In-out:	?	?
Invalid data:	input routine	stops with print-out.

§ 162.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . . . . . statement.
.512 Unconditional jump: . . . . . . GO TO N.
.513 Switch: . . . . . . GO TO M (35, 47, 18).
.514 Setting a switch: . . not available.
.515 Switch on data: . . . not available.

.52 Conditional Procedures

.521 Designators
Condition: . . . . IF.
Procedure: . . . . implied.

.522 Simple conditions
Expression v Expression: . . . no.
Expression v Variable: . . . . no.
Expression v Literal: . . . . . no.
Expression v Figurative: . . . always zero.
Expression v Condition: . . . . no.
Variable v Variable: . . . . no.
Variable v Literal: . . . . . no.
Variable v Figurative: . . . always zero.
Variable v Condition: . . . . no.
Conditional value: . no.

.523 Conditional relations
Equal: . . . . . . } jointly in each
Greater than: . . . } IF statement against
Less than: . . . . } zero.
Greater than or equal to: . . . . no.
Less than: . . . . no.
.524 Variable conditions: . always zero.
.525 Compound conditionals: . . . no.
.526 Alternative designator: . . . . none.
.527 Condition on alternative: . . . . none.
.528 Typical examples: . . IF (X ** 2 - 3.) 29, 37, 18 means go to statement Nos. 29, 37, and 18 if $x^2 - 3$ is respectively less than, equal to, or greater than zero.

.53 Subroutines

.531 Designation
Single statement: . same as set.
Set of statements
First: . . . . . . named in a JUMP TO n statement.
Last: . . . . . . followed by a JUMP BACK statement.
.532 Possible subroutines: . . . only one level permitted.
.533 Use in-line in program: . . . . . one.
.534 Mechanism
Cue with parameters: . . . none.
Cue without parameter: . . . JUMP TO n.
Formal return: . . JUMP BACK.
Alternative return: . . . . . none.
.535 Names: . . . . not possible.
.536 Nesting limit: . . . . 1.
.537 Automatic recursion allowed: . . . . . . no.

.54 Function Definition by Procedure: . . . . . none.

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

.56 Loop Control

.561 Designation of loop
Single procedure: . . none.
First and last procedures: . . . . current place to specifically numbered statement; e.g., DO 173 I = 1, N, 2.
.562 Control by count: . . none.
.563 Control by step
Parameter
Special index: . . . no.
Any variable: . . . integer variables only.
Step: . . . . positive integers.
Criteria: . . . . . greater than.
Multiple parameters: . . . no.
.564 Control by condition: . none.
.565 Control by list: . . . no.
.566 Nesting limit: . . . . 8.
.567 Jump out allowed: . . yes.
.568 Control variable exit status: . . . . . . available.

.57 Diagnostics: . . . . . none.

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

.7 LIBRARY FACILITIES

.71 Identity: . . . . . . UMAC library.

.72 Kinds of Libraries

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

.73 Storage Form: . . . . cards or tape.

.74 Varieties of Contents: . . . . . functions.

§ 162.

.75 Mechanism

.751 Insertion of new item: . . . . manual.
.752 Language of new item: . . . . machine coding.
.753 Method of call: . . . FUNCTION statement.

.76 Types of Routine

.761 Open routines exist: . no.
.762 Closed routines exist: . . . . yes.
.763 Open-closed is variable: . . . . . no.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . no (functions may be written in machine code.)

.82 Optimizing Information Statements

.821 Process usage statements: . . . . no.
.822 Data usage statements: . . . . no.

.83 Translator Environment: . . . choice of cards, paper tape, or magnetic tape I/O.

.84 Target Computer Environment: . . . own coding

.85 Program Documentation Control: . . . . . printing of object program optional.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: . . . . . . no.

.92 Address Allocation: . no.

.93 Arrangement of Items in Words and Unpacked Form: . . . . . . predetermined.

.94 Assignment of Input-Output Devices: . . yes.

.95 Input-Output Areas: . predetermined, at
120 characters for printer
80 characters for card and tape input.
80 characters for card and tape output.

MACHINE ORIENTED LANGUAGE: ASSEMBLY LANGUAGE

§ 171.

.1 GENERAL

.11 Identity: . . . . RCA 301 Automatic Assembly System Language.

.12 Origin: . . . . RCA.

.13 Reference: . . . . 93-19-000.

.14 Description

This is a straightforward assembly language which incorporates suitable macro-operations to avoid the coding of multiplication, division, and input-output control. The addressing system is simple but flexible. Subroutine control is simple. Although program overlays must be written in each program, no special facilities are provided for this, nor is editing of input and output formats.

Macros are provided for Input-Output file control of punched tape, cards and magnetic tape.

The tape version of the Assembler has the RIS Macro instruction which reads in the next segment. Through this Macro program, overlays may be written. This version also includes as Macros the Floating Decimal Arithmetic Package.

.15 Publication Date: . . . May, 1961.

.2 LANGUAGE FORMAT

.21 Diagram

RCA 301 Automatic Assembly Program Sheet.

		Title		Header		
			Date			
18 22 TAG	23. 25 OP	26 32 N	33 70 Address Field	71 74 Iden.	75 80 Numeric Sequencing	

.22 Legend

TAG: . . . . procedure name.
OP: . . . . mnemonic op code.
N: . . . . extension of op code. length of operands. repeat counter, etc.
ADDRESS FIELD: . . . . A and B addresses.
IDEN: . . . . used to identify lines of code.
NUMERIC SEQUENCING: number used to sequence lines of code.

.23 Corrections: . . . . . . no automatic method for card version. The tape version provides three verbs for correction of pseudo-code.

.231 Insertions: . . . . INS (for insertion after a given line).
.232 Deletions: . . . . DLT (for deletion after a given line).
.233 Alterations: . . . . RPL (for replacement of single line).

.24 Special Conventions

.241 Compound addresses: . . (tag or integer) ± (tag or integer).
.242 Multi-addresses: . . . . no.
.243 Literals: . . . . no.
.244 Special coded addresses: . . . . " means this address.
.245 Other
#: . . . . indirect address.
/: . . . . address is computed.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . no limit.
.312 Common label formation rule: . . . . . . yes, all called tags.
.313 Reserved labels: . . . . STA, STP, only.
.315 Designators: . . . . . . none.
.316 Synonyms permitted: IDN pseudo.

.32 Universal Labels: . . . . only if program not divided by HED pseudos.

.321 Labels for procedures
Existence: . . . . optional.
Formation rule: . . . . 1 to 5 char. from A to Z, 0 to 9 but not all numeric.
Others: . . . . symbolic N must be 2 characters.

.322 Labels for library routines: . . . . none.

§171.

.323 Labels for constants: . . . same as procedures.
.325 Labels for records: . . . same as procedures.
.326 Labels for variables: . . same as procedures.

.33 Local Labels

.331 Region: . . . . started by each HED pseudo.
.332 Labels: . . . . same as universals.

.4 DATA

.41 Constants

.411 Maximum size constants
Integer
Decimal: . . . . 38 digits.
Octal:. . . . . none.
Fixed numeric
Decimal:. . . . . . . 38 digits.
Floating numeric
Decimal: . . . . 8 and 2 digits.
Alphabetic: . . . . . . 38 digits.
Alphameric: . . . . . . 38 digits.
.412 Maximum size literals: . none.

.42 Working Areas

.421 Data layout
Implied by use: . . . . yes.
Specified in program: no.
.422 Data type: . . . . not required.
.423 Redefinition: . . . . . . implied by use.

.43 Input-Output Areas

.431 Data layout: . . . . implied.
.432 Data type: . . . . not required.
.433 Copy layout: . . . . . . no.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . mandatory.
Number: . . . . 53.
Example: . . . . SKP.
Comment: . . . . 2 or 3 alpha.
.512 Absolute: . . . . none.

.52 Macro-Codes

.521 Number available
Input-output: . . . . . . 9.
Arithmetic: . . . . . . 2.
Math functions: . . . . 0.
Error control: . . . . 0.
Restarts: . . . . 0.
Floating point: . . . . 4.
.522 Examples
Simple: . . . . SF.
Elaborate: . . . . none.
.523 New macros: . . . . . . none.

.53 Interludes: . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . yes.
Label adjustment: . . . yes.
Annotation: . . . . . . yes.
.542 Allocation counter
Set to absolute: . . . . DST pseudo.
Set to label: . . . . . . DAC pseudo.
Step forward: . . . . . no.
Step backward: . . . . no.
Reserve area: . . . . BST, BEN pseudo.
.543 Label adjustment: . . . BST, BEN pseudo.
Set labels equal: . . . IDN pseudo.
Set absolute value:. . . no.
Clear label table: . . . HED pseudo.
.544 Annotation
Comment phrase: . . . RMK pseudo.
Title phrase: . . . . . no.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . . multiplication macros for 8 x 8, 10 x 10, 17 x 17 and division 10 x 10, 17 x 17; also floating add, subtract, divide and multiply.
.612 Method of call: . . . . . macro.

.62 Special Functions: none.

.63 Overlay Control: . . . . control of overlays is maintained through the use of the SEG and RIS verbs. Through the use of the SEG verb, the user is able to identify each of his segments, and through the use of the RIS verb, he is able to automatically call in these segments.

.64 Data Editing: . . . . . . none.

.65 Input-Output Control

.651 File labels: . . . . defined by description.
.652 Reel labels: . . . . automatic standard.
.653 Blocking: . . . . description.
.654 Error control: . . . . . automatic.
.655 Method of call: . . . . . macro.

.66 Sorting: . . . . none.

.67 Diagnostics: . . . . see "Consolidata".

§171.

.7 LIBRARY FACILITIES: . none.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Code	Description
MPY:	multiply.
DIV:	divide.
FAD:	floating add.
FSB:	floating subtract.
FMY:	floating multiply.
FDV:	floating divide.
OPN:	open file.
RED:	read a record
WRT:	write a record.
RLS:	release output batch.
CLO:	close reel, or file.
RIS:	read in next segment.

.82 Pseudos:

Code	Description
CON:	to set constant.
DST:	sets allocation counter.
NUM:	to set number.
BST:	define start location of a block.
BEN:	define last location of a block.
DAC:	used to set parameters for dynamically relocatable routines.
IDN:	set tags equal.
AFA:	assists in forming addresses dynamically from data such as sense bits.
RMK:	identifies comments, remarks.
HED:	introduces a new section of program with local names.
END:	last program card.
LBL:	in-out label description.
SHR:	in-out share storage areas.
RCD:	data record description.
SEG:	identify beginning of segment and set allocation counters.
RPL:	replace a line of pseudo-code.
INS:	insert after a line of pseudo-code.
DLT:	delete after a line of pseudo-code.

PROGRAM TRANSLATOR: COBOL 61

§181.

.1 GENERAL

.11 Identity: . . . . RCA 301 COBOL NARRATOR Translator.

.12 Description

This translator requires a 301 with six tapes and a 20,000 character store. Up to three additional tapes and a 40,000 character store may be utilized to decrease translation time. The target computer may include all mixtures and combinations of the various types of available units, such as 10,000, 20,000, or 40,000 characters stores, Record File, Simultaneous Mode, Cards, Magnetic or Paper Tape. The input can be on paper tape, punched cards or magnetic tape. The translator can accept 501 COBOL-60 as well as COBOL-61. The object program is efficient and the translation has low overheads. All listings are produced on-line.

.13 Originator: RCA

.14 Maintainer: RCA

.15 Availability: July, 1962

.2 INPUT

.21 Language

.211 Name: . . . . COBOL-61 plus electives see section 161.14.
501 COBOL-60.
.212 Exemptions: . . . . none.

.22 Form

.221 Input media: . . . . cards.
paper tape.
magnetic tape.
.222 Obligatory ordering: . . Not necessary if sequence nos. are included.
.223 Obligatory grouping: . . By DIVISIONS and certain SECTIONS.

.23 Size Limitations

.231 Maximum number of source statements: . . . unlimited
.232 Maximum size source statements: . . . . . . no limit.
.233 Maximum number of data items: . . . . 99,999/file.
.234 Others
Files: . . . . 18.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . 301 machine code.
.312 Language style: . . . . machine code.
.313 Output media: . . . . . paper or magnetic tape record file cards.

.32 Conventions

.321 Standard inclusions: . . . object program in 301 library format.
rerun provided.
I/O logging provided.
Input-Output controlled by FCP.
.322 Compatible with: . . . . . all 301 standards.
object program in 301 library format.
rerun provided.
I/O logging provided.
Input-Output controlled by FCP.

.33 Documentation

Subject	Provision
Source program:	updated listing of source program; listing 1.
Object program:	machine code listing; listing 3.
Storage map:	listing of file, constant & working storage; listing 3.
Restart point list:	compiler restart points listed; listing 2.
Language errors: . . .	list of language errors & error warning; listing 2.
Cross Reference: . . .	references to procedures; listing 3. references to data areas; listing 3.
Notes:	all listings on-line. all listings may be by-passed.

.4 TRANSLATING PROCEDURES

.41 Phases and Passes

Translation Phase: . . . one scan on entire source program.
three passes on the data division.
six passes on the procedure.
Generation Phase: . . . three passes on procedure.
Allocation Phase: . . . . multi-pass, depending on size.

.42 Optional Modes

§181.

.421 Translate: . . . . translate only.
.422 Translate and run: . . . no.
.423 Check only: . . . . . . possible stop at intermediate point.
.424 Patching: . . . . only in symbolic coding using FILE MAINTENANCE routine.
.425 Up-dating: yes, corrections can be submitted for recompilation.

.43 Special Features

.431 Alter to check only: . . . none.
.432 Fast unoptimized translate: . . . . no.
.433 Short translate on restricted program: . . no.

.44 Bulk Translating: . . . . none.

.45 Program Diagnostics: . . none included during translation.
output tape for SAMPLER.

.46 Translator Library

.461 Identity: . . . . 301 COBOL library
.462 User restriction: . . . . none.
.463 Form
Storage medium: . . . magnetic tape.
Organization: . . . . . by COBOL division.
.464 Contents
Routines: . . . . unrestricted.
Functions: . . . . . . any COBOL division and own-code.
Data description: . . . yes.
Record descriptions: . yes.
.465 Librarianship
Insertion: . . . . by separate library maintenance routine.
Amendment: . . . . . . by separate library maintenance routine.
Call procedure: . . . . COBOL options; COPY from library; INCLUDE from library.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space, char
Sum of difference tables:	200.
Standard areas:	30.
Loader routine:	370.
Loader work & print areas:	170
Standard data area: . .	10.
Standard exit:	10.

.512 Space required for each input-output file: . . . . as controlled by program description.
.513 Approximate expansion of procedures: . . 7 to 1 variable data.
3 to 1 fixed data.

.52 Translation Time: . . . $(5 + (7P + D)/70)$ mins approx.
P = simple procedure statements.
D = data entries.

.53 Optimizing Data: . . . . COBOL segmentation (segment-limit, priority numbers).
segmentation of Input-Output.
eliminate duplicates and nesting of literals.

.54 Object Program Performance: . . . . . manufacturer claims only slightly reduced performance except for times for editing and complex subscripts which are moderately reduced.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 20,000 character store.
6 tape units.
1 printer.
1 card reader or paper tape reader.
.612 Advantages of larger configurations: . . . . . decrease translation time with larger store and up to 3 additional tapes.

.62 Target Computer

.621 Minimum configuration: . . . . 10,000 character store.
1 tape unit or card reader, or record-file.
.622 Usable extra facilities: . any 301 hardware including all mixtures and combination of the various types of units available.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	error warning or stoppage.
Unsequenced entries:	check	entries sequenced.
Duplicate names:	check	error warning.
Improper format:	check	error warning or stoppage.
Incomplete entries:	check	error warning.
Target computer overflow:	check	error warning or stoppage.
Inconsistent program:	check	error warning.

.8 ALTERNATIVE TRANSLATORS: . . . . none.

PROGRAM TRANSLATOR

§182.

.1 GENERAL

.11 Identity . . . . RCA 301 Automatic Assembly System Processor

June, 1961.
Document 93-19-000.
AASP.

.12 Description:

This is straightforward assembler available in two versions: one is based on punched cards and requires two feeds of data; the other is based on magnetic tapes and requires but one. The output is in a form suitable for inclusion in either a card or tape library. The assembler itself may be part of the library and run under SRS control.

There are no special modes of operation for patching or updating a current program in the card version. In the magnetic tape version, there is a "User's Corrector", which corrects entries.

The operating speed is about 120 cards per minute, but the card system is only effectively sixty cards per minute because two passes are necessary through the cards. On magnetic tape, the second pass is very quick.

.13 Originator: . . . . RCA Commercial Systems Dept., EDP Division Camden 8, N. J.

.14 Maintainer: . . . . Originator.

.15 Availability: . . . . August, 1961, using card system, AASP-C.

February, 1962, using magnetic tape system, AASP-T.

.2 INPUT

.21 Language

.211 Name: . . . . RCA 301 AAS Language.
.212 Exemptions: . . . . none.

.22 Form

.221 Input media: . . . . paper tape, or punched card, or magnetic tape.
.222 Obligatory ordering: . . none.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . no limit.
.232 Maximum size source statements:. . . . . . limited by format.
.233 Maximum number of data items: . . . . . . none.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . . RCA 301.
.312 Language style: . . . . . computer relocatable code.
.313 Output media: . . . . . punched cards - AASP-C
magnetic tape - AASP-T.

.32 Conventions

.321 Standard inclusions: FCP (File Control Processor)
Fixed Point Multiply and Divide Floating Point Arithmetic } Subroutines
.322 Compatible with: . . . . Standard LOADER routines.

.33 Documentation

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

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Card system: . . . . . . two passes.
Tape system: . . . . . . one card, one tape pass.

.42 Optional Modes

•.421 Translate: . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . no.
.424 Patching: . . . . yes in tape version.
.425 Up-dating: . . . . no.

.43 Special Features

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

§182.

.44 Bulk Translating: . . . . no.

.45 Program Diagnostics: . . see Consolidata.

.46 Translator Library: . . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . . none.
.512 Space required for each input-output file: . . . . twice max block size + max record size.
.513 Approximate expansion of procedures: . . . . . unity.

.52 Translation Time

.521 Normal translating: . . . 1 + 0.0175 s mins AASP-Card.
2 + 0.0085 s mins AASP-Tape.

.53 Optimizing Data: . . . . none.

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

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 1 group HDTG; tape version only.
10,000 char HSM
1 printer.
1 paper tape or card reader.
1 paper tape or card punch.
.612 Larger configuration advantages: . . . . . . larger HSM, more tape units, more tags.

.62 Target Computer

.621 Minimum configuration: none.
.622 Usable extra facilities: all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	listings.
Unsequenced entries:	monotonic check	alarm.
Duplicate names:	check	take first, flag others.
Improper format:	check	flag on listing.
Incomplete entries:	check	flag on listing.
Target computer overflow:	check	flag, can continue.
Tag table overflow:	check	alarm.

.8 ALTERNATIVE TRANSLATORS: . . . . none.

PROGRAM TRANSLATOR: UMAC

§ 183.

.1 GENERAL

.11 Identity: . . . . . . University of Miami, Algebraic Compiler, UMAC. RCA Publication 97-20-031.

.12 Description

The UMAC Translator is primarily punched card oriented, and while magnetic tape and punched tape versions are available, these media are used to simulate card input and output.

Key points a programmer should watch while writing a UMAC program are the number of names he uses (this should not exceed 327 if at all possible) and the amount of storage available to him in the target computer. The latter is important, because a simple UMAC statement averages some 100 characters, and a heavy overhead of 9,000 characters of object space are pre-empted by the translator.

Translation time is strongly dependent upon configuration. Originally, UMAC was a card system, in which each generated machine instruction was punched twice, which costs approximately 2.0 seconds for each instruction.

However, if three magnetic tapes are available, this double punching is not needed and translation time can be reduced from some 10 seconds per UMAC statement to about 1 to 2 seconds per statement.

The translator makes no provision for diagnostics to be inserted in the object program, but does provide a good listing showing the machine and assembly languages and some part of each source statement side-by-side.

.13 Originator: . . . . . . Jay F. W. Pearson, Jr. University of Miami.

.14 Maintainer: . . . . . . RCA (Systems Development) Camden, N. J., September, 1962; after field test revision in May, 1962.

.2 INPUT

.21 Language

.211 Name: . . . . UMAC; Section 701:162.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched cards or punched paper tape.
.222 Obligatory ordering: . . all statements in logical sequence.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . indefinite.
.232 Maximum size source statements: . . . . . 149 characters excluding blanks.
.233 Maximum number of data items: . . . . . 329 for each translator cycle.
.234 Others
Maximum number of nested DO's: . . . 8.
Maximum number of operands, operators, or parentheses per statement: . . . . . 125.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . machine language.
.313 Output media: . . . . magnetic tape or punched card.

.32 Conventions

.321 Standard inclusions: . UMAC fixed subroutine deck.

.33 Documentation

Subject	Provision
Source program: . .	full print-out, Listing I. edited print-out, Listing II.
Assembly instruction:	Listing II.
Object program: . .	Listing II.
Storage map: . . .	none.
Restart point list: . .	none.
Language errors: . .	on-line print-outs for six specific and two general errors. a register display for 5 specific cases.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Phase I: . . . . translation of the source language into a one-to-one assembly language, which is stored on cards or on tape. The original source language program, without the assembly language, is printed (Listing 1).

§ 183.

.41 Phases and Passes (Cont'd)

Phase II: . . . . . . reading the output of Phase I, and producing a machine-language program in storage. This program can optionally be output on cards or paper tape.

documentation in Phase II consists of a full print-out of the machine instruction and assembly instruction, with a partial print-out of the source program.

.42 Optional Mode

.421 Translate: . . . . . . yes.
.422 Translate and run:. . . yes with magnetic tape version.
.423 Check only: . . . . . . yes.
.424 Patching: . . . . . . no.
.425 Updating: . . . . . . no.

.43 Special Features

.431 Alter to check only: . . . . yes, (mandatory after error located).
.432 Fast unoptimized translate: . . . . . . no.
.433 Short translate on restricted program: . . no.

.44 Bulk Translating: . . . no, the translator program is in two parts, which overwrite each other during translation.

.45 Program Diagnostics

.451 Tracers: . . . . no.
.452 Snapshots: . . . . . . no.
.453 Dumps: . . . . no.

.46 Translator Library: . . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed Overhead
Name: . . . . Fixed Subroutine Package.
Space: . . . . 9,000 characters.
Comment: . . . . . . includes floating point, I/O control, mathematical routines, etc.
.512 Space required for each input-output file: . . . 80 char.
.513 Approximate expansion of procedures: . . 10 to 1.

.52 Translation Time

.521 Normal translating: . . 100 + 2.5 S seconds. (Card version)
60 + 0.5 S seconds. (Tape version)
where S is the number of instructions generated.

.522 Checking only: . . . . not available.

.53 Optimizing Data: . . . none.

.54 Object Program Performance

Type	Time	Space
Elementary algebra	unaffected	unaffected.
Complex formulae:	unaffected	unaffected.
Deep nesting:	unaffected	unaffected.
Heavy branching:	unaffected	unaffected.
Single subscripts:	increased	50 char added.
Complex subscripts:	doubled	50 char added.
Data editing:	unaffected	unaffected.
Overlapping operations:	not available.	not available.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . RCA 301 with 20,000 position high speed memory.
Model 323 Card Reader.
Model 334 Card Punch.
Model 333 Printer.
.612 Larger configuration advantages: . . . . . faster compilation and output; particularly with 2 or 3 magnetic tapes.

.62 Target Computer

.621 Minimum configuration: . . . . RCA 301 with 10,000 position high speed storage.
Model 323 Card Reader.
.622 Usable extra facilities: . . . . paper tape units.
magnetic tape units.
additional storage.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	none.	
Duplicate names:	none.	
Improper format:	check	halt, with display or print-out.
Incomplete entries:	none.	
Target computer overflow:	check	print-out in Phase II.
Inconsistent program:	some checks	print-out.
Size limitations exceeded:	some checks	print-out.

.8 ALTERNATIVE TRANSLATORS: . . . . . . none.

OPERATING ENVIRONMENT: SRS CARD

§ 191.

.1 GENERAL

.11 Identity: . . . . RCA 301 Service Routine System (Card Library). SRS Card.

.12 Description

This is one of a set of Service Routine Systems. There are separate systems oriented toward punched card, paper tape, magnetic tape and magnetic record file operation. Many of the executive routines are available in several systems with only minor changes made necessary by different input-output units; e.g., a system for paper tape is similar to that for punched cards and one for magnetic records is similar to that for magnetic tape. Even in a card oriented system, magnetic tapes may be attached and some executive routines, such as program libraries, used with them.

Automatic run-to-run control is provided through the EXECUTE function of the system.

The LOADER routine allows programs to be relocated in HSM. All service routines are floatable.

In order to avoid extensive manual manipulations at the Console, a special service routine EXECUTE is available. It is always incorporated in service routines such as LOADER and can be incorporated in individual programs. It operates by using short sequences of instructions pre-punched on cards (or paper tape) with space for some parameters. Routines containing EXECUTE require a few instructions to recognize, jump into and return from the special control cards.

There is a sophisticated Input-Output File Control routine incorporated in most programs which handles punched tape and cards as well as magnetic tape.

.13 Availability . . . . . . September, 1961.

.2 PROGRAM LOADING . . punched cards or punched tape in sequence.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Segmenting of routines: incorporated in programs.
.312 Occupation of working storage: . . . . incorporated in programs.
.313 Choice of location: . . assignment by the programmer or operator and located by the LOADER routine.

.32 Input-Output Units

.321 Initial assignment: . . . incorporated in program.
.322 Alternation: . . . . . . incorporated in program using FCP.
.323 Reassignment: . . . . . by operator.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: none--must be incorporated in program.

.42 Multi-running: . . . . none.

.43 Multisequencing: . . . none.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	none.	
Allocation impossible:	none.	
In-out error - single:	check	stop, alarm.
Overflow:	indicator	program choice.
Invalid instructions:	check	stop, alarm.
Program conflicts:	interlock	wait.

.45 Restarts

.451 Establishing restart points: . . . . none - must be incorporated in program.
.452 Restarting process . . effected by operator's manual forcing of jump instruction.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . TRACER, up to 9,999 steps
.512 Snapshots: . . . . . . use HSM PRINT.

.52 Post Mortem: . . . . HSM PRINT routine can be loaded to print contents of HSM; it can be altered to cover any one area.
TAPE PRINT routine can be loaded into memory and can print the entire contents or selected contents of a tape.
MEMORY DUMP TO CARDS punches out on cards the contents of specified areas of HSM.

.6 OPERATOR CONTROL

.61 Signals to Operator . . stop instruction displayed on console.

§ 191.

.62 Operator's Decision: manual forcing of jump instruction or restart, or insertion of EXECUTE card.

.63 Operator's Signals

.631 Inquiry: . . . . none.

.632 Change of normal progress: . . . . . console manipulation, or insertion of EXECUTE card.

.7 LOGGING: . . . . . incorporated in program, or by insertion of EXECUTE cards.

.8 PERFORMANCE

.81 Program Loading Time: input limited.

.82 Reserved Equipment

Arithmetic tables: . . .	200
Loader routine:	370
Multiply-Divide parameters:	55
Standard area:.	18
Debugging area *. . .	1,120
Print table:	100
Total:	1,863

* Only if debugging facilities being used.

.83 Running Overhead: . . . negligible except for overlays.

OPERATING ENVIRONMENT: SRS CARD

§ 191.

.1 GENERAL

.11 Identity: . . . . RCA 301 Service Routine System (Card Library). SRS Card.

.12 Description

This is one of a set of Service Routine Systems. There are separate systems oriented toward punched card, paper tape, magnetic tape and magnetic record file operation. Many of the executive routines are available in several systems with only minor changes made necessary by different input-output units; e.g., a system for paper tape is similar to that for punched cards and one for magnetic records is similar to that for magnetic tape. Even in a card oriented system, magnetic tapes may be attached and some executive routines, such as program libraries, used with them.

Automatic run-to-run control is provided through the EXECUTE function of the system.

The LOADER routine allows programs to be relocated in HSM. All service routines are floatable.

In order to avoid extensive manual manipulations at the Console, a special service routine EXECUTE is available. It is always incorporated in service routines such as LOADER and can be incorporated in individual programs. It operates by using short sequences of instructions pre-punched on cards (or paper tape) with space for some parameters. Routines containing EXECUTE require a few instructions to recognize, jump into and return from the special control cards.

There is a sophisticated Input-Output File Control routine incorporated in most programs which handles punched tape and cards as well as magnetic tape.

.13 Availability . . . . . . September, 1961.

.2 PROGRAM LOADING . . punched cards or punched tape in sequence.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Segmenting of routines: incorporated in programs.
.312 Occupation of working storage: . . . . incorporated in programs.
.313 Choice of location: . . assignment by the programmer or operator and located by the LOADER routine.

.32 Input-Output Units

.321 Initial assignment: . . . incorporated in program.
.322 Alternation: . . . . . . incorporated in program using FCP.
.323 Reassignment: . . . . . by operator.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: none--must be incorporated in program.

.42 Multi-running: . . . . none.

.43 Multisequencing: . . . none.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	none.	
Allocation impossible:	none.	
In-out error - single:	check	stop, alarm.
Overflow:	indicator	program choice.
Invalid instructions:	check	stop, alarm.
Program conflicts:	interlock	wait.

.45 Restarts

.451 Establishing restart points: . . . . none - must be incorporated in program.
.452 Restarting process . . effected by operator's manual forcing of jump instruction.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . TRACER, up to 9,999 steps
.512 Snapshots: . . . . . . use HSM PRINT.

.52 Post Mortem: . . . . HSM PRINT routine can be loaded to print contents of HSM; it can be altered to cover any one area.
TAPE PRINT routine can be loaded into memory and can print the entire contents or selected contents of a tape.
MEMORY DUMP TO CARDS punches out on cards the contents of specified areas of HSM.

.6 OPERATOR CONTROL

.61 Signals to Operator . . stop instruction displayed on console.

§ 191.

.62 Operator's Decision: manual forcing of jump instruction or restart, or insertion of EXECUTE card.

.63 Operator's Signals

.631 Inquiry: . . . . none.

.632 Change of normal progress: . . . . . console manipulation, or insertion of EXECUTE card.

.7 LOGGING: . . . . . incorporated in program, or by insertion of EXECUTE cards.

.8 PERFORMANCE

.81 Program Loading Time: input limited.

.82 Reserved Equipment

Arithmetic tables: . . .	200
Loader routine:	370
Multiply-Divide parameters:	55
Standard area:.	18
Debugging area *. . .	1,120
Print table:	100
Total:	1,863

* Only if debugging facilities being used.

.83 Running Overhead: . . . negligible except for overlays.

OPERATING ENVIRONMENT: SRS TAPE

§ 192.

.1 GENERAL

.11 Identity: . . . . RCA 301 Service Routine System (Tape Library). SRS-Tape.

.12 Description

This is one of a set of Service Routine Systems. There are separate systems oriented toward punched card, paper tape, magnetic tape and magnetic record file operation. Many of the executive routines are available in several systems with only minor changes made necessary by different input-output units; e.g., a system for paper tape is similar to that for punched cards and one for magnetic records is similar to that for magnetic tape. Even in a card-oriented system, magnetic tapes may be attached and some executive routines used with these, such as program libraries.

This system provides a TAPE PROGRAM TRANSCRIBER routine for transcribing programs to a program library tape. Once stored on tape, program may be run automatically in tape sequence, or the library tape may be searched for running selected programs such as service routines.

In order to avoid extensive manual manipulations at the Console, a special service routine EXECUTE is available. It is always incorporated in service routines such as LOADER and can be incorporated in individual programs. It operates by using short sequences of instructions pre-punched on cards (or paper tape) with space for some parameters. Routines containing EXECUTE require a few instructions to recognize, jump into and return from the special control cards.

There is a sophisticated Input-Output File Control routine incorporated in most programs which handles punched tape and cards as well as magnetic tape.

This system of alternatives using card or DRF libraries can be used with output from AASP. There is a sophisticated Input-Output File Control routine incorporated in most programs which handles punched tape and cards as well as magnetic tape.

.13 Availability: . . . . October, 1961.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Libraries: . . . . are loaded from the master library tape which has programs stored in alphameric order; the programs are inserted by the search phase of the INSERTION routine.

.212 Independents: . . . . . . as loaded by operator from punched card files.

.22 Library Subroutines: . . none.

.23 Loading Sequence:

The INSERTION routine offers two options for inserting programs into memory--an automatic (run-to-run) phase and a search phase: the sequence of programs stored on tape is determined by the way a particular program library tape is to be used. If independent programs are to be transcribed to tape, they will be transcribed in alphameric order for insertion using the search phase. Programs constituting a run or related runs will be contained on the Program Library Tape (usually a special PLT) in the desired order of running. The sequence of the programs on tape can be varied by using the FILE MAINTENANCE routine. The alphameric storing of programs (such as on the Master PLT) allows programs to be run in any order indicated by the order of parameters which call the specific programs into memory. In the automatic insertion phase, there is a break sequence option which allows programs to be inserted and run in an order other than the order of their placement on tape.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Segmenting of routines: incorporated in programs.

.312 Occupation of working storage: . . . . incorporated in programs.

.313 Choice of location: . . . assigned when transcribing to tape.

.32 Input-Output Units

.321 Initial assignment: . . . incorporated in program.

.322 Alternation: . . . . incorporated in program using FCP.

.323 Reassignment: . . . . . by operator.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: . none -- must be incorporated in program.

.42 Multi-running: . . . . . . none.

.43 Multisequencing: . . . . none.

§ 192.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	none.	
Allocation impossible:	none.	
In-out error - single:	check	stop, alarm.
Overflow:	indicator	program choice.
Invalid instructions:	check	stop, alarm.
Program conflicts:	interlock	wait.

.45 Restarts

.451 Establishing restart points: . . . . none -- must be incorporated in program.

.452 Restarting process: . . . effected by operator's manual forcing of jump instruction.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . "TRACER" can be limited to N instructions executed, N=1(100) 9900.

.512 Snapshots: . . . . ADDRESS STOP allows the interruption of a program after a special instruction has been executed a designated number of times, and is used in conjunction with the HSM PRINT.
CONSOLIDATA is a program-testing system designed to consolidate on a tape the object program all test data and validation routines (SAMPLE, TRACER, MEMORY PRINT and TAPE PRINT). This system enables automatic selection of the mode of operation i.e., sampling or tracing of the program.

.52 Post Mortem: . . . . . . "DATA PRINT" parameters control HSM and output tapes.
HSM Print routine can be altered to cover any one area.
TAPE PRINT routine can print the entire or selected contents of a tape.

.6 OPERATOR CONTROL

.61 Signals to Operator: . . stop instruction displayed on console.
EXECUTE CARDS CAN BE USED.

.62 Operator's Decision: . . manual forcing of jump instruction or restart.

.63 Operator's Signals

.631 Inquiry: . . . . none.

.632 Change of normal progress: . . . . console manipulation.

.7 LOGGING: . . . . names of loaded programs.

.8 PERFORMANCE

.81 Program Loading Time: input limited.

.82 Reserved Equipment

Arithmetic Tables: .	200
Insertion Area: . . .	370
Multiply & Divide Parameters:	55
Standard Areas: . . .	54
Debugging Area: . .	1,120
Print Table:	100
Total	1,899

.83 Running Overhead . . . negligible except for overlays.

NOTES ON SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

General

The high-speed addition and subtraction facilities of the 354 and 355 Processors are not particularly useful in the File Processing problems on the RCA 301 system. For the fast arithmetic circuits to be useful, data fields must be a fixed length of digits. When they are not, move instructions are required for unpacking and packing the fields, and the time required for this offsets the faster arithmetic speeds. Where fields are longer than eight digits, the fast arithmetic circuits are not usable without greater than eight-digit precision subroutines (to use the fast arithmetic circuits); these are not yet available.

The multiplication and division facilities of the 354 and 355 Processors provide much faster speeds than the 303-305 Processors offer through subroutines. Data movement times become insignificant in view of the overall multiply-divide time saved. However, one must check the amount of time spent in such operations within the overall program to decide whether the additional cost of the 354/355 Processors is justified. The cost of the fast processors is about 50 per cent higher than that of the standard processors.

.11 Standard File Problem A

All configurations use the Model 323 Card Reader to read File 3, the detail file, at a speed of 600 cards per minute. The printer used in all configurations is the Model 333, printing at a maximum effective speed of about 500 lines per minute with 1-inch line spacing. Configuration I has Files 1 and 2, the master files, on punched cards, two cards per record or block. Card Reader Model 323 is used in Configuration I to read the Master File input, and the timing is based on an activity factor (F) of 1.0. Configurations II, III, and IV have magnetic tape Master Files input and output. Configuration II uses the Hi-Data Tape Group (10KC character rate), and Configurations III and IV use the 581 and 582 tape units operating at 33, 333 and 66, 667 characters per second, respectively.

All configurations except the minimum tape system (Configuration II) use the Simultaneous Mode Control, Model 392. This is used for overlapping printer and tape operations with internal processing.

Timing for configuration II, using the Simultaneous Mode Control (designated Configuration IIS) is also shown. In this Configuration, magnetic tape and/or the printer operations are calculated as overlapped with processing. The additional cost over the standard Configuration II is $608 per month.

.12 Standard File Problem B, C, and D

These problems are variations of Problem A, and are described fully in the Users' Guide, Section 4:200.12 to 4:200.14. Problem B doubles the number of master records per block (record size halved); Problem C halves the number of master records per block (record size doubled); and Problem D trebles the amount of computation per transaction.

NOTES ON SYSTEM PERFORMANCE (Contd.)

§ 201.

.2 SORTING

.21 Standard Problem

Times are presented (Standard EDP Reports estimates) for sorting 80-character records of a master file, based on tape passing time in Problem A with the activity factor (F) equal to zero. Configuration II uses a two-way merge technique and Configurations III and IV use a three-way merge technique. Details of the timing estimating procedure are given in the Users' Guide, Section 4:200.21.

.3 MATRIX INVERSION

.31 Standard Problem

The standard problem estimate of the Users' Guide is used. The estimate is based on the time for floating point cumulative multiplication. Times are shown for floating point subroutines, which would be used on the 303/304/305 Processors, and using the floating point arithmetic circuits of the 354/355 Processor.

.32 Standard Routine

Timing for the manufacturer's Matrix Inversion routine, using subroutines for floating point arithmetic, is shown. This routine finds the inverse of a matrix, and also multiplies a second matrix by the inverse.

.4 GENERALIZED MATHEMATICAL PROCESSING

Floating point times are shown, using Configuration VI, 6-Tape Business/Scientific. Results are shown for subroutines for floating point operations, used by the 303/304/305 Processor, and for the floating point unit of the 354/355 Processor. Input and output are on punched cards, with card punching performed through the Simultaneous Mode Control feature.

RCA 301
SYSTEM PERFORMANCE

SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration I		II		IIS		III		IV		IV with 354/355 Processor		Reference
1	Char/block	(File 1)	108		1,080		1,080		1,080		1,080		1,080		
	Records/block	K (File 1)	1		10		10		10		10		10		
	msec/block	File 1 = File 2	200/1,200		140		140		46		32		32		
		File 3	100		100		100		100		100		100		
		File 4	118		118		118		118		118		118		
Input-Output Times	msec/switch	File 1 = File 2	0		10		10		0		0		0		4:200.112
		File 3	0		0		0		0		0		0		
		File 4	0		0		0		0		0		0		
	msec/penalty	File 1 = File 2	26/14		7		7		7		7		7		
		File 3	13		13		13		13		13		13		
		File 4	59		59		59		59		59		59		
2	msec/block	a1	2.3		2.3		2.3		2.3		2.3		2.3		
	msec/record	a2	5.9		5.9		5.9		5.9		5.9		5.5		
Central Processor Times	msec/detail	b6	0.4		0.4		0.4		0.4		0.4		0.4		4:200.1132
	msec/work	b5 + b9	39.3		39.3		5.4		5.4		5.4		5.4		
	msec/report	b7 + b8	4.4		4.4		4.4		4.4		4.4		4.4		
3	msec/block for C. P. and dominant column.	a1	2		2		2		2		2		2		
		a2 K	6		59		59		59		59		55		
		a3 K	44		442		442		442		442		103		
Standard Problem A		File 1 Master In	200		140		7	140	7	46	7	32	7	32	4:200.114
F = 1.0		File 2 Master Out	14	1,200	140		7	140	7	46	7	32	7	32	
		File 3 Details	100		1,000		800	0	800	0	800	0	800		
		File 4 Reports	118		1,180	1,180	590	1,180	590	1,180	590	1,180	590	1,180	
		Total	484	1,200	2,963	1,180	1,907	1,460	1,907	1,272	1,907	1,244	1,564	1,244	
4	Unit of measure	(character)													
		Std. routines	5,250		5,250		5,250		5,250		5,250		5,250		
		Fixed	1,125		1,125		1,125		1,125		1,125		1,125		
Standard Problem A Space		3 (Blocks 1 to 23)	162		162		162		162		162		162		4:200.1151
		6 (Blocks 24 to 48)	301		301		301		301		301		301		
		Files	724		2,560		2,560		2,720		2,720		2,720		
		Working	108		108		108		108		108		108		
		Total	7,670		9,506		9,506		9,666		9,666		9,666		

SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration VI		Reference
5 Standard Mathematical Problem A	Fixed/Floating point			Floating point using subroutines and 303/304/305 Processor	Floating point using automatic features in 354/355 Processor	4:200.413
	Unit name	input		323 Card Reader	323 Card Reader	
		output		334 Card Punch	334 Card Punch	
	Size of record	input		2 cards	2 cards	
		output		2 cards	2 cards	
	msec/block	input	T_1	250	250	
		output	T_2	1,200	1,200	
	msec penalty	input	T_3	250	250	
		output	T_4	0	0	
	msec/record		T_5	-	0.2	
	msec/5 loops		T_6	384	34.4	
	msec/report		T_7	1	1	
7 Standard Statistical Problem A	Unit name					4:200.512
	Size of block					
	Records/block		B			
	msec/block		T_1			
	msec/penalty		T_3			
	C. P.	msec/block	T_5			
		msec/record	T_6			
		msec/table	T_7			

SYSTEM PERFORMANCE

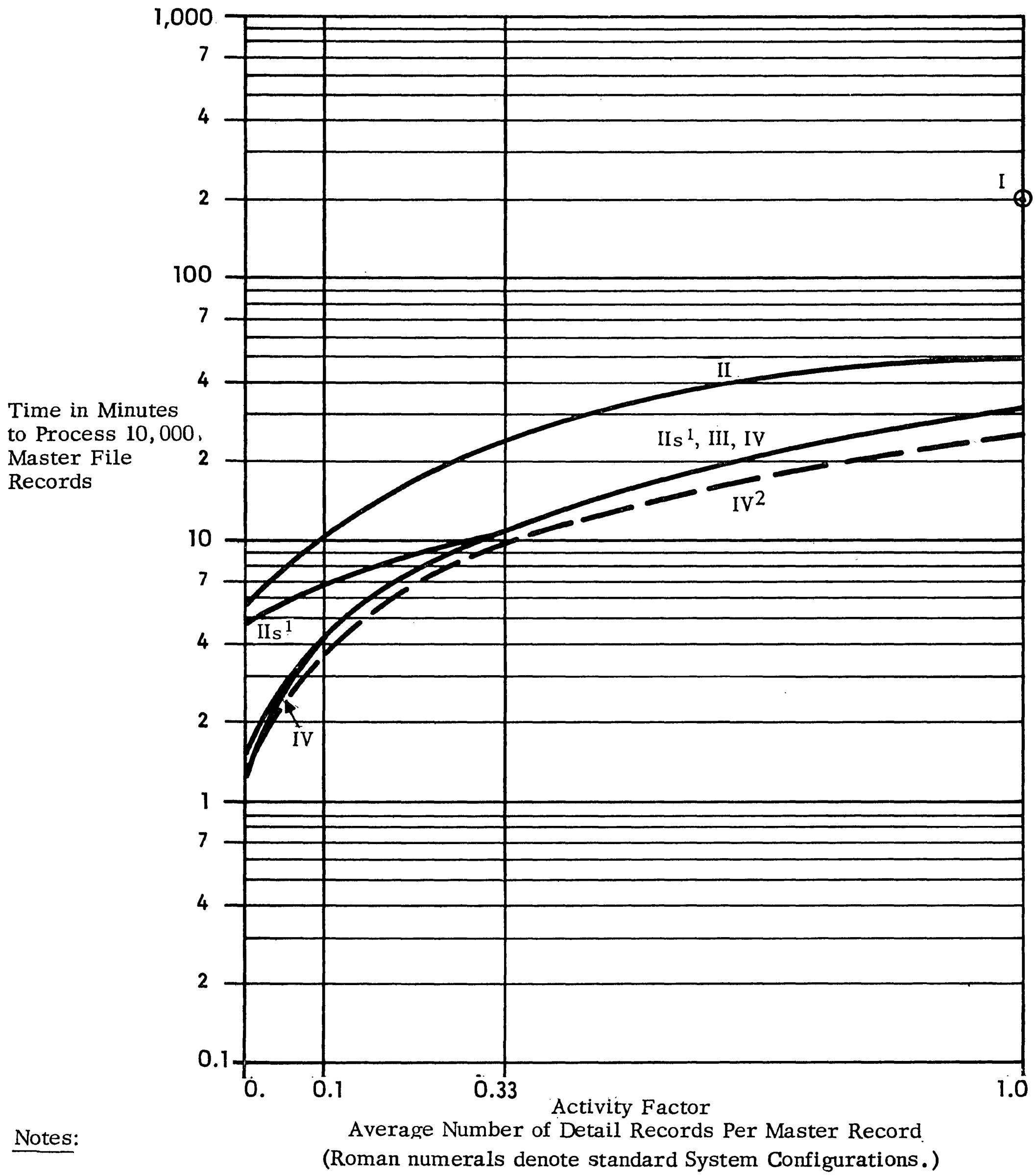
§ 201.

.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 I: . . . . 7,670.
Configuration II: . . . 9,506.
Configuration III: . . . 9,666.
Configuration IV: . . . 9,666.



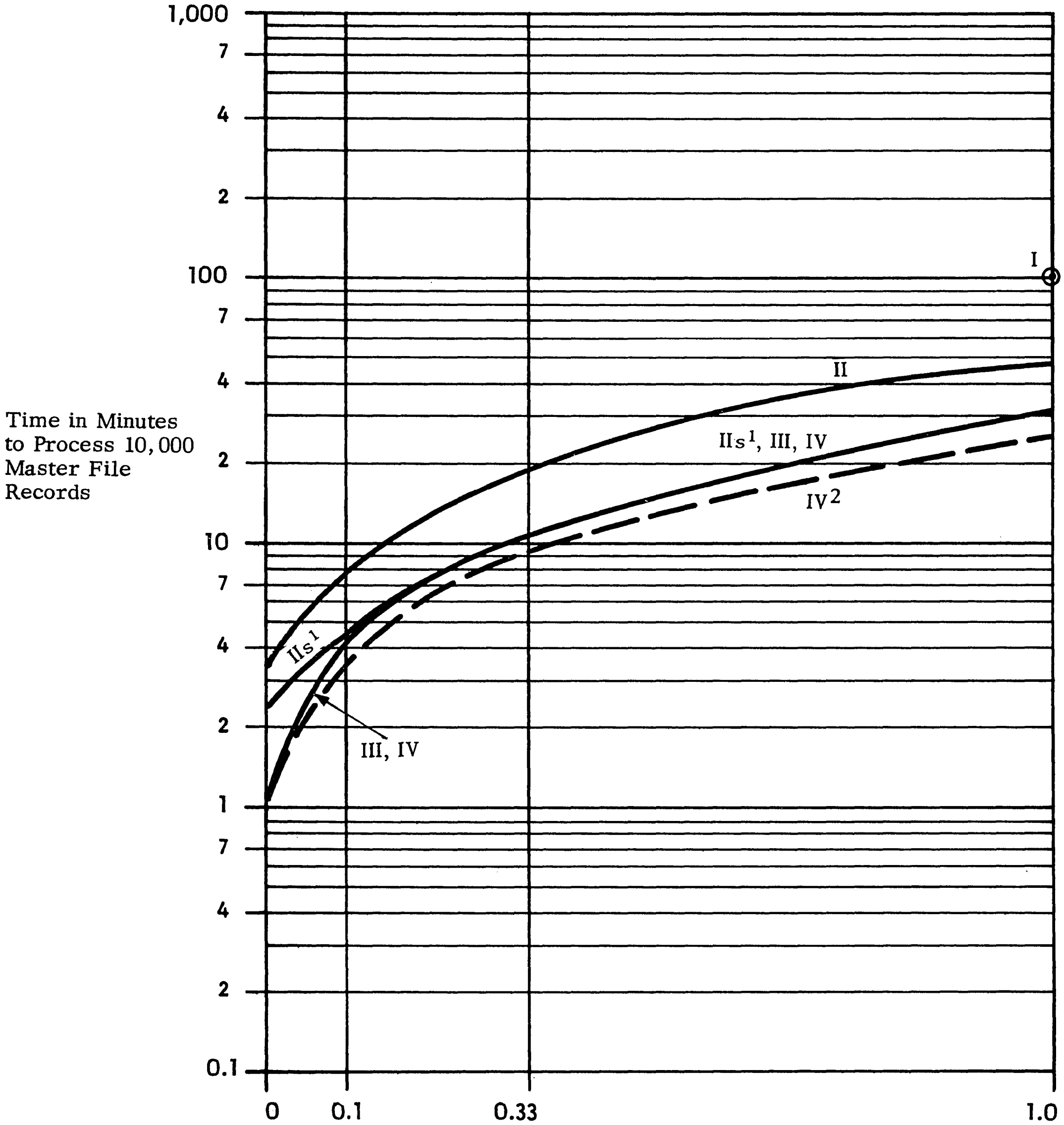
Notes:
1. with SMC unit.
2. using 354/355 Processor (i.e., with arithmetic unit).

§ 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

(Roman numerals denote standard System Configurations.)

Notes:

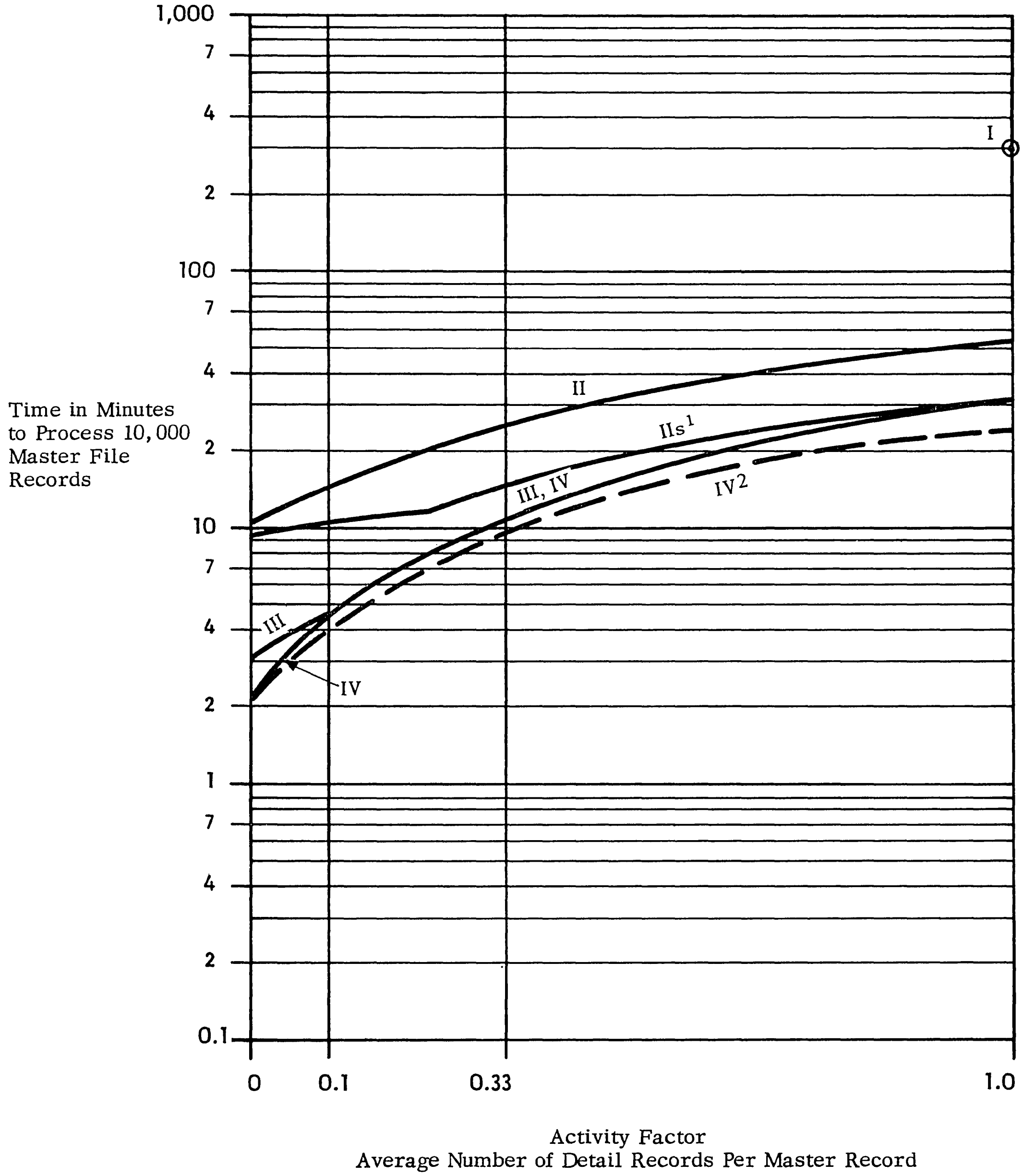
1. with SMC unit.
2. using 354/355 Processor (i.e., with arithmetic unit).

§ 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.



(Roman numerals denote standard System Configurations.)

Notes:

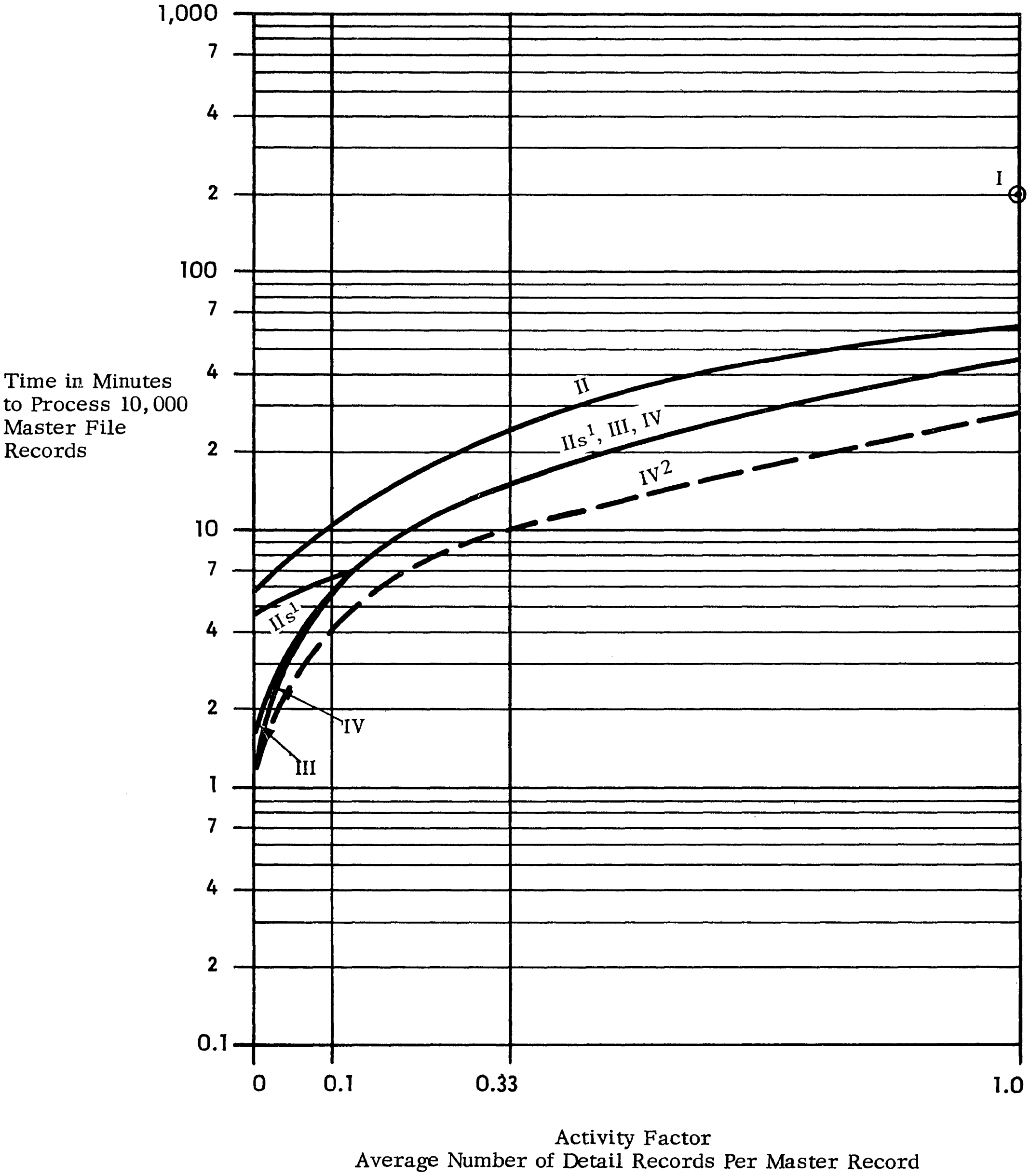
1. with SMC unit.
2. using 354/355 Processor (i.e., with arithmetic unit).

§ 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.)

Notes:

1. with SMC unit.
2. using 354/355 Processor (i.e., with arithmetic unit).

§ 201.

.2 SORTING

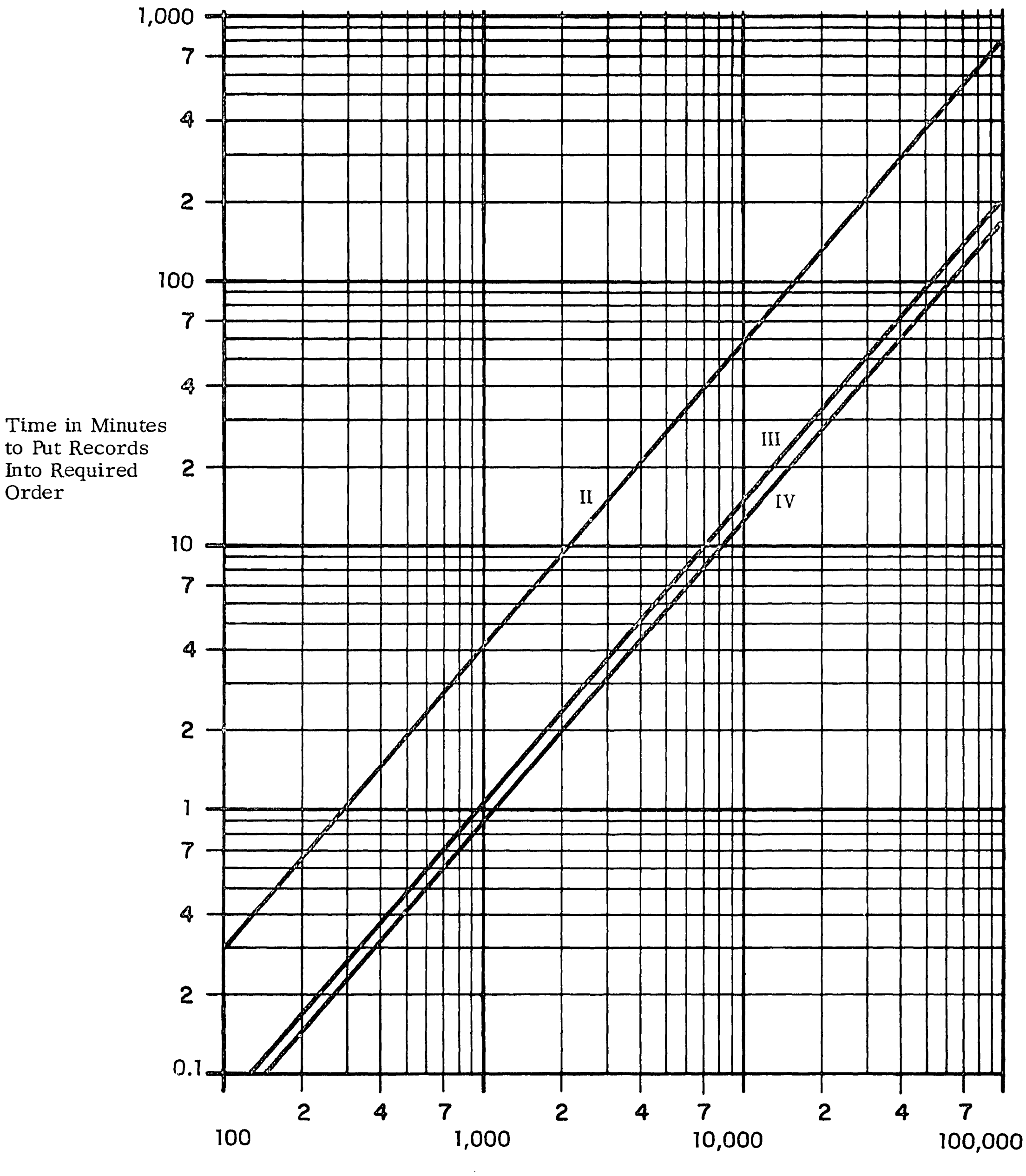
.21 Standard Problem Estimates

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

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

.213 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

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



(Roman numerals denote standard System Configurations.)

§ 201.

.3 MATRIX INVERSION

.31 Standard Problem Estimates

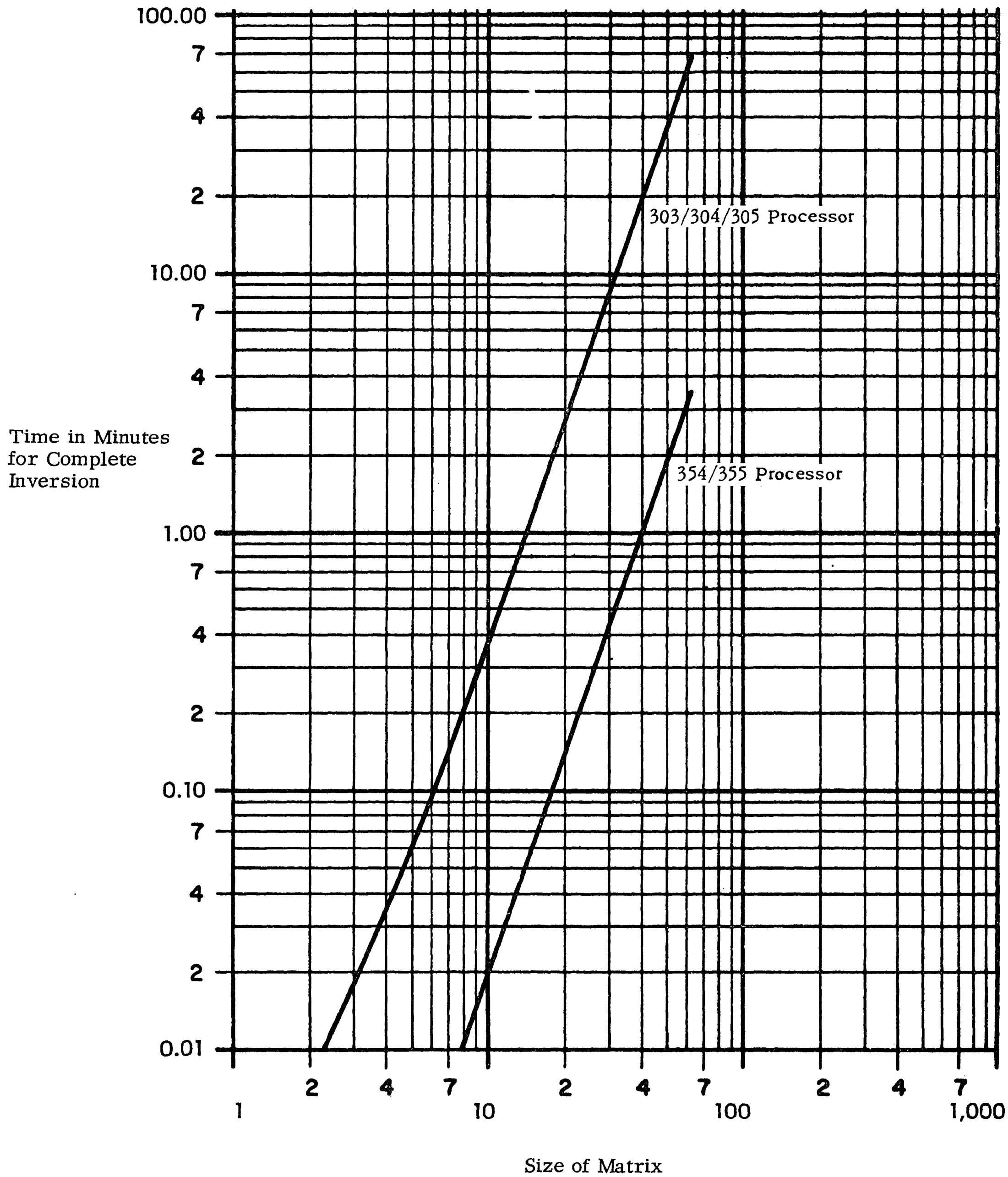
.311 Basic parameters: . . .general, non-symmetric matrices, using floating point to at least 8 decimal digits.

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

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

.314 Maximum size of matrix

Number of locations in core storage	Matrix size
10,000:	30 x 30
20,000:	44 x 44
40,000:	63 x 63



§ 201.

.32 Matrix Inversion Times

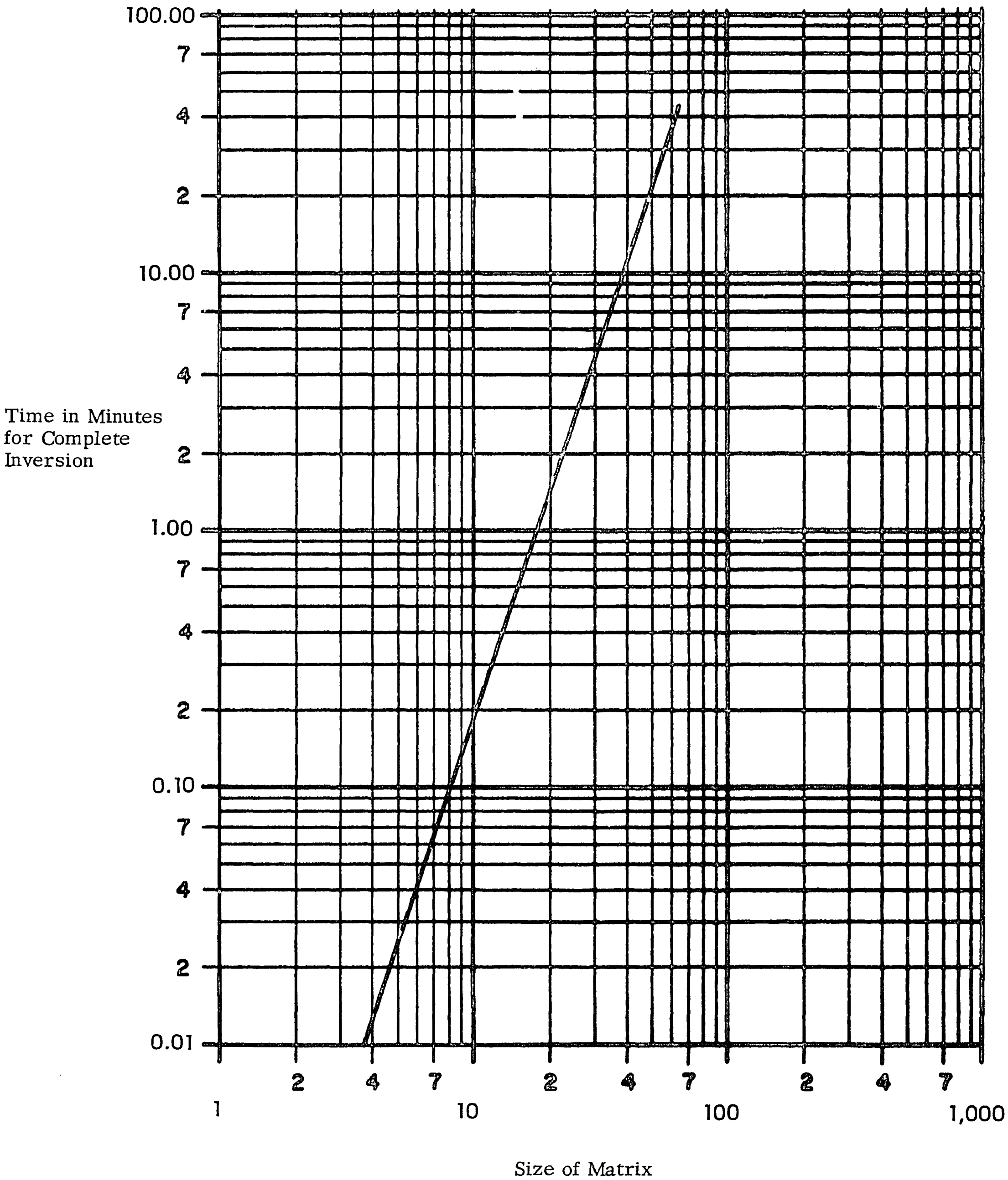
.321 Basic parameters: . . .general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.322 Timing basis: . . . . .Matrix Inversion subroutine description, using 303/304/305 Processor.

.323 Graph: . . . . see graph below.

.324 Maximum size of matrix

Number of locations in core storage	Matrix size
10,000:	26 x 26
20,000:	40 x 40
40,000:	60 x 60



§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

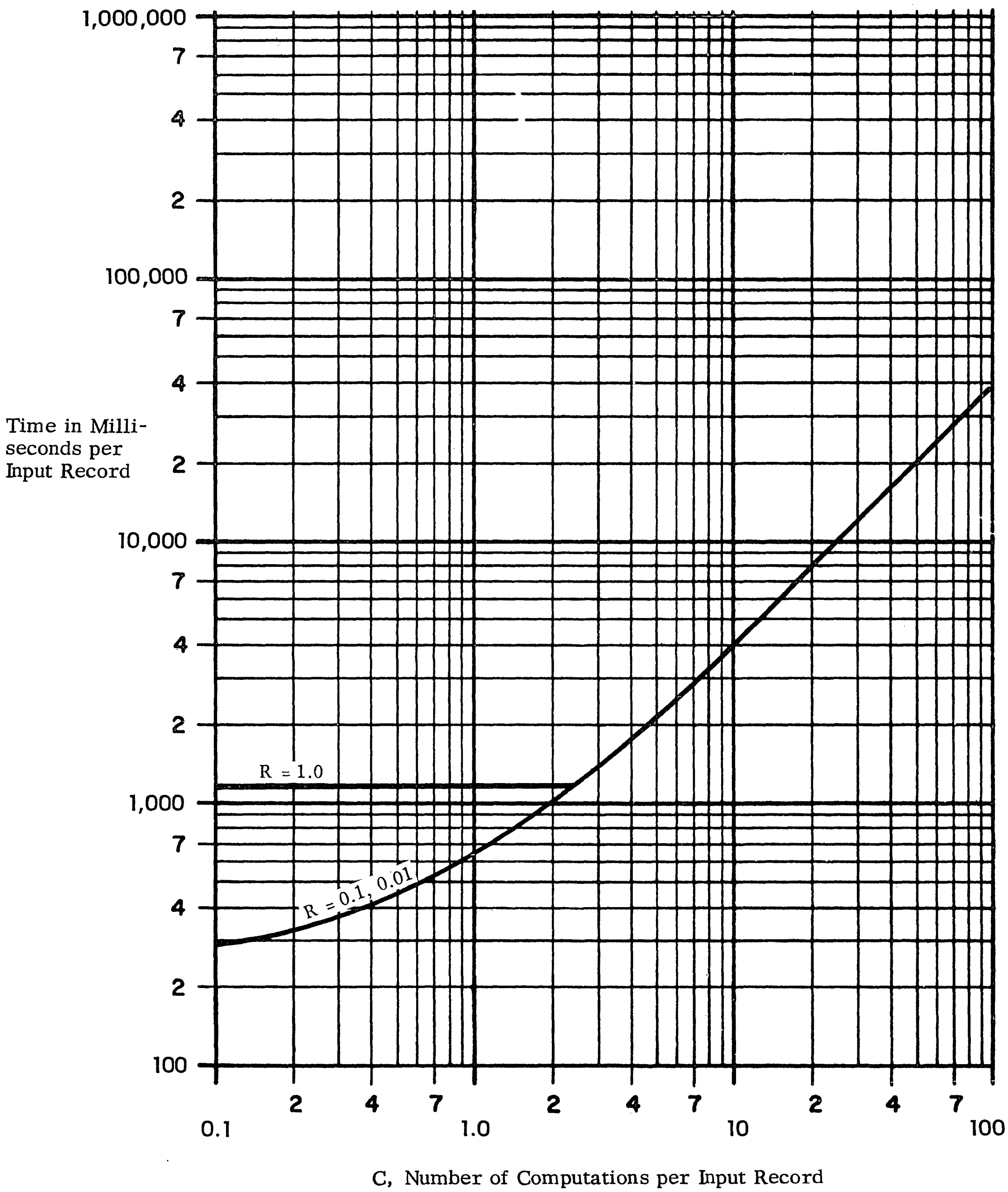
.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.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: . . . . see graph below, for 305 Processor using floating point subroutines.

CONFIGURATION VI; SINGLE LENGTH (8 DIGIT PRECISION); FLOATING POINT
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD

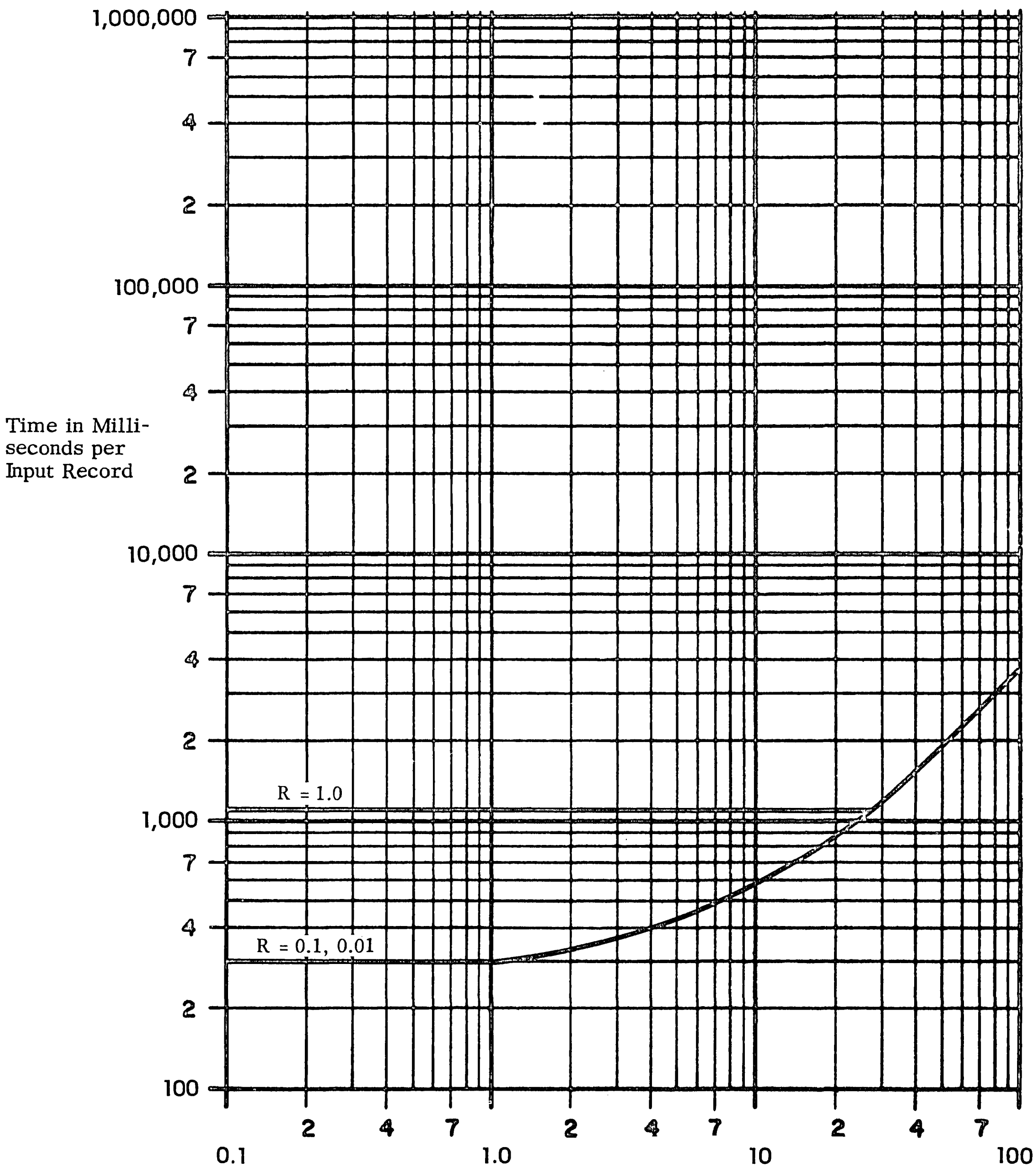


§ 201.

.415 Graph: . . . . see graph below, for 355 Processor with built-in floating point arithmetic.

CONFIGURATION VI; SINGLE LENGTH (8 DIGIT PRECISION); FLOATING POINT

R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



C, Number of Computations per Input Record

RCA 301
PHYSICAL CHARACTERISTICS

RCA 301 PHYSICAL CHARACTERISTICS

		Processor	PTRP Control	CR Control	CP Control	O-LP Control	O-LP Control	DRF Control	H-DTG Control	Paper Tape Reader Punch	Paper Tape Reader	Card Reader	Paper Tape Punch	Card Punch	On-Line Printer	On-Line Printer	Interrogating Typewriter	Monitor Printer	Data Record File	Data Disc File
IDENTITY	Unit Name	Processor	PTRP Control	CR Control	CP Control	O-LP Control	O-LP Control	DRF Control	H-DTG Control	Paper Tape Reader Punch	Paper Tape Reader	Card Reader	Paper Tape Punch	Card Punch	On-Line Printer	On-Line Printer	Interrogating Typewriter	Monitor Printer	Data Record File	Data Disc File
	Model Number	303; 304; 305	311	314-1R; 314-2R	315	316-1; 316-2	396-1; 396-2	317-1; 317-2	318; 319	321	322	323	331	334	333	335	328 & Console	338	361	366-1
PHYSICAL	Height × width × depth, in.	75 × 132 × 20[1]	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	60 × 34 × 24	60 × 34 × 24	56 × 46 × 27	60 × 34 × 24	48 × 48 × 30	56 × 71 × 31	56 × 71 × 31	38 × 36 × 38	38 × 36 × 38	48 × 36 × 27	58 × 82 × 45
	Weight, pounds	3,100[2]								250	250	600	200	1,000	1,150	1,150	250	250	600	4,000
	Maximum cable lengths	15' to Power Supply	15' to Reader 15' to Punch	75' to Reader	15' to Punch	25' to Printer	25' to Printer	75' to Data Record File	100' to H-DTG	25' Power 15' Control	25' Power 15' Control	75' Control	25' Power 15' Control	15' Control	25' Control	25' Control Cable	15' Control. 2,000' Control Optional.	15' Control	25' Power 75' Control	100' Processor
ATMOSPHERE	Storage Ranges: Temperature, °F.																			
	Storage Ranges: Humidity, %																			
	Working Ranges: Temperature, °F.	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85	65 - 85
	Working Ranges: Humidity, %	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65	20 - 65
	Heat dissipated, BTU/hr.	9,200	500	500	900	1,200	1,200	700	600	5,500	4,800	6,200	5,500	6,500	5,500	5,500	700	700	4,100	19,100
	Air flow, cfm.																			
	Internal filters	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ELECTRICAL	Voltage: Nominal	208/230*	d-c power furnished by System Power Supply	d-c power furnished by System Power Supply	d-c power furnished by System Power Supply	d-c power furnished by System Power Supply	d-c power from Processor Power Supply	d-c power furnished by System Power Supply	d-c power furnished by System Power Supply	d-c power furnished by System Power Supply	d-c power furnished by System Power Supply	208/230*	d-c power furnished by System Power Supply	208/230*	208/230*	208/230*	115	115	Furnished by System Power Supply	208/230
	Voltage: Tolerance	±10%										±10%		±10%	±10%	±10%	±10%	±10%		±10%
	Cycles: Nominal	60										60		60	60	60	60	60		60
	Cycles: Tolerance	±½ cycle										±½ cycle		±½ cycle		±½ cycle	±½ cycle	±½ cycle		±½ cycle
	Phases and lines	1φ, 3 wire										1φ, 3 wire		1φ, 3 wire	1φ, 3 wire	1φ, 3 wire	1φ, 3 wire	1φ, 3 wire		1φ, 3 wire
	Load KW @ p.f. of 0.8	2.7	0.14	0.15	0.27	0.35	0.35	0.2	0.16	1.6 total	1.4	1.8 total	1.6 total	1.9 total	1.6 total	1.6	0.2	0.2	1.2	5.6
NOTES		58°F max. dew point.	58°F. max. dew point. 3 rows of cards in Processor.	58°F. max. dew point. 4 rows of cards in Processor.	58°F. max. dew point. 5 rows of cards in Processor.	58°F. max. dew point. 5 rows of cards in Processor.	58°F. max. dew point. 5 rows of cards in Processor.	58°F. max. dew point. 4 rows of cards in Processor.	58°F. max. dew point. 4 rows of cards in Processor.	58°F. max. dew point.	58°F. max. dew point.	58°F. max. dew point. *Also 115 V. ±10%,60 cy. 1φ	58°F. max. dew point.	58°F. max. dew point. *Also 115 V. ±10%,60 cy. 1φ	58°F max. dew point. *Also 115 V. ±10%,60 cy. 1φ	*Also 115 V. ±10% 60 cy. 1φ			58°F max. dew point.	58°F max. dew point. *Additional 0.4 KW furnished by System Power Supply.

[1] Increase of 44" in width for each additional rack of 12 rows.
[2] Add 500 pounds for each additional rack of 12 rows.
*Also 120/115 V. ±10% 60 cy. 1φ.

RCA 301 PHYSICAL CHARACTERISTICS–Contd.

		Data Disc File	Data Disc File	Data Disc File	MICR Sorter-Reader Control	Hi-Data Tape Group	Data Record File Mode Control	Simultaneous Mode Control	581 Adaptor	582 Adaptor	581 Dual Tape Channel (2×6)
IDENTITY	Unit Name	Data Disc File	Data Disc File	Data Disc File	MICR Sorter-Reader Control	Hi-Data Tape Group	Data Record File Mode Control	Simul-taneous Mode Control	581 Adaptor	582 Adaptor	581 Dual Tape Channel (2×6)
	Model Number	366-2	366-3	366-4	371	381	391	392	393-1; 393-2	394-1; 394-2	341
PHYSICAL	Height × width × depth, in.	58×92×45	58×102×45	58×112×45	Note 1	74×44×20	Note 1	Note 1	Note 1	Note 1	Note 1
	Weight, pounds	4,400	4,700	5,000		1,200					
	Maximum cable lengths	100' Processor	100' Processor	100' Processor	50' to Sorter Reader	100' to Control	75' to Data Record File		100' to Tape Station	100' to Tape Station	100' to each Tape Station
ATMOSPHERE	Storage Ranges: Temperature, °F.										
	Storage Ranges: Humidity, %										
	Working Ranges: Temperature, °F.	65-85	65-85	65-85	65-85	65-85	65-85	65-85	65-85	65-85	65-85
	Working Ranges: Humidity, %	20-65	20-65	20-65	20-65	20-65	20-65	20-65	20-65	20-65	20-65
	Heat dissipated, BTU/hr.	19,100	19,100	19,100	700	14,000 max. 9,500 standby	1,700	800	700	900	2,500
	Air flow, cfm.										
	Internal filters	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ELECTRICAL	Voltage: Nominal	208/230	208/230	208/230	d-c power from Processor Power Supply	208/230	d-c power from Processor Power Supply	d-c power from Processor Power Supply	d-c power from Processor Power Supply	d-c power from Processor Power Supply	d-c power from Processor Power Supply
	Voltage: Tolerance	±10%	±10%	±10%		±10%					
	Cycles: Nominal	60	60	60		60					
	Cycles: Tolerance	±½ cycle	±½ cycle	±½ cycle		±½ cycle					
	Phases and lines	1φ, 3 wire	1φ, 3 wire	1φ, 3 wire		1φ, 3 wire					
	Load KW @ p.f. of 0.8	5.6*	5.6*	5.6*	0.2	4.1 max.	0.5	0.22	0.2	0.25	0.65
NOTES		58°F max. dew point. *Additional 0.4 KW furnished by System Power Supply	58°F max. dew point. *Additional 0.4 KW furnished by System Power Supply	*Additional 0.4 KW furnished by System Power Supply	58°F max. dew point. 5 rows of cards in Processor.	58°F max. dew point.	58°F max. dew point. 8 rows of cards in Processor.	58°F max. dew point. 5 rows of cards in Processor.	58°F max. dew point. 4 rows of cards in Processor.	58°F max. dew point. 6 rows of cards in Processor.	58°F max. dew point. 10 rows of cards in Processor.

		581 Dual Tape Channel (2×12)	582 Dual Tape Channel (2×6)	582 Dual Tape Channel (2×12)	72911 Adaptor	Tape Station	Monitor Printer Control	Interrogating Typewriter Control	Typewriter	Typewriter-Verifier	System Power Supply
IDENTITY	Unit Name	581 Dual Tape Channel (2×12)	582 Dual Tape Channel (2×6)	582 Dual Tape Channel (2×12)	72911 Adaptor	Tape Station	Monitor Printer Control	Interro-gating Typewriter Control	Type-writer	Type-writer-Verifier	System Power Supply
	Model Number	342	351	352	390-1; 390-2	581, 582	308	398-1	325	326	Sub-unit of Processor
PHYSICAL	Height × width × depth, in.	Note 1	Note 1	Note 1	Note 1	69×44×19	Note 1	Note 1	10×22×21	10×35×24	(*)
	Weight, pounds					900			90		(*)
	Maximum cable lengths	100' to each Tape Station	100' to each Tape Station	100' to each Tape Station	30' to Tape Unit	100' to Adapter or Tape Channel	15' Monitor Printer	15' to I.T., standard. 2,000' optional	Off-line	Off-line	15' to Processor
ATMOSPHERE	Storage Ranges: Temperature, °F.										
	Storage Ranges: Humidity, %										
	Working Ranges: Temperature, °F.	65-85	65-85	65-85	65-85	65-85	65-85	70-80	Limits of operator	Limits of operator	65-85
	Working Ranges: Humidity, %	20-65	20-65	20-65	20-65	20-65	20-65	20-65	Limits of operator	Limits of operator	20-65
	Heat dissipated, BTU/hr.	2,800	2,500	2,800	1,400	2,900 max. 1,400 standby	200	1,200	685	820	7,200
	Air flow, cfm.										
	Internal filters	Yes	Yes	Yes	Yes	Yes	Yes	Yes	---	---	Yes
ELECTRICAL	Voltage: Nominal	d-c power from Processor Power Supply	d-c power from Processor Power Supply	d-c power from Processor Power Supply	d-c power from Processor Power Supply	115/208/230	d-c power furnished by System Power Supply	d-c power furnished by System Power Supply	115	115	208/230
	Voltage: Tolerance					±10%			±10%	±10%	±10%
	Cycles: Nominal					60			60	60	60
	Cycles: Tolerance					±½ cycle					±½ cycle
	Phases and lines					1φ, 3 wire			1φ, 3 wire	1φ, 3 wire	1φ, 3 wire
	Load KW @ p.f. of 0.8	0.8	0.65	0.8	0.4	0.85/0.4	0.6	0.3	0.2	0.24	2.1
NOTES		58°F max. dew point. 12 rows of cards in Processor.	58°F max. dew point. 15 rows of cards in Processor.	58°F max. dew point. 17 rows of cards in Processor.	58°F max. dew point. 7 rows of cards in Processor.	58°F max. dew point.	58°F max. dew point. 2 rows of cards in Processor.	58°F max. dew point. 3 rows cards in Processor.			*Included in Processor specifications

PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental* $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	303	Processor and 10,000 char. store	1,803	86.50	89,400
	304	Processor and 20,000 char. store	2,421	109.00	112,900
	305	Processor and 40,000 char. store	4,069	236.00	193,600
	354	Processor and 20,000 char. store	3,966	177.00	192,100
	355	Processor and 40,000 char. store	5,614	327.00	271,400
		Optional Equipment			
	392	Simultaneous Mode Control	608	36.50	27,900
STORAGE	361	Data Record File	309	137.00	14,900
	317-1	DRF Control	129	9.00	6,250
	317-2	DRF Control	247	15.50	11,900
	391	DRF Mode Control	711	43.25	32,800
	366-1	Data Disc File, 22 million char.	3,090	589.00	141,000
	366-2	Data Disc File, 44 million char.	4,635	879.00	211,500
	366-3	Data Disc File, 66 million char.	6,695	1,267.00	305,500
	366-4	Data Disc File, 88 million char.	7,725	1,462.00	352,500
INPUT-OUTPUT	321	Paper Tape Reader-Punch (7-level)	175	24.50	7,800
		5-,7-level read modification for 321	108	—	4,400
		5-,7-level punch modification for 321, 331 (operator's choice)	82	—	3,360
	322	Paper Tape Reader	361	36.50	14,500
	331	Paper Tape Punch (7-level)	160	23.00	7,150
	311	Paper Tape Control	124	7.75	5,900
	330	Card Reader-Punch	567	45.00	30,000
	323	Card Reader	361	43.50	15,850
	314-1R	Card Reader Control	134	9.00	6,900
	334	Card Punch	206	23.00	8,900
	315	Card Punch Control	283	17.50	13,750
	369-1	Card Reader-Punch Control	597		30,200
	333	On-line Printer 120 col.	721	262.00	32,200
	335	On-line Printer 160 col.	1,154	419.00	51,500
	316-1	On-line Printer Control	155	10.25	7,850
	316-2	On-line Printer Control	350	20.50	15,500
	396-1	On-line Printer Control	264	18.00	13,400
	396-2	On-line Printer Control	597	36.00	26,500
	381	Hi-Data Tape Group (6 units)	1,566	515.00	74,900
	381-3	Hi-Data Tape Group (3 units)	839	276.00	40,200
	381-4	Hi-Data Tape Group (4 units)	1,040	343.00	49,900
	318	Hi-Data Tape Group Control (1x6)	386	23.50	17,900
	319	Hi-Data Tape Group Control (1x6)	386	23.50	17,900
	581	Tape Station 33 Kc.	567	193.00	29,700
	582	Tape Station 66 Kc.	901	207.00	43,260

§ 221.

PRICE DATA (Contd.)

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental* $	Monthly Maintenance $	Purchase $
INPUT-OUTPUT (Contd.)	393-1	Tape Station Adapter (581)	330	21.00	15,900
	393-2	Tape Station Adapter (581)	381	24.25	18,500
	394-1	Tape Station Adapter (582)	659	42.00	31,800
	394-2	Tape Station Adapter (582)	758	48.00	36,600
	341	581 Dual Tape Channel, 2x6	1,030	70.75	49,000
	342	581 Dual Tape Channel, 2x12	1,494	103.00	71,100
	351	582 Dual Tape Channel, 2x6	2,060	142.00	98,000
	352	582 Dual Tape Channel, 2x12	2,575	178.00	122,500
	390-1	729 II Adapter	850	53.50	37,100
	390-2	729 II Adapter	850	53.50	37,100
	5820	Videoscan Document Reader (optical character reader)	3,450	483.00	145,900
	102	Mark Reading Option	110	15.50	4,700
	371	MICR Sorter-Reader Control	536	33.50	25,500
	338	Monitor Printer	196	24.75	7,300
	308	Monitor Printer Control	170	10.75	8,100
	328	Interrogating Typewriter	352	29.00	9,960
	398-1	Interrogating Typewriter Control	242	15.25	11,500
	325	Tapewriter (Off-line)	113	19.00	3,300
	326	Tapewriter-Verifier (Off-line)	155	24.50	4,500

*Single Shift availability.

RCA 3301

Radio Corporation of America

STANDARD
EDP
REPORTS

AUERBACH INFO, INC.

PRINTED IN U. S. A.

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AUERBACH INFO, INC.

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CONTENTS

§ 001.

§ 001.

INTRODUCTION

§ 011.

The RCA 3301 REALCOM is a medium-scale general purpose computing system. It can be used as a data processor, as a real-time processor, or as a switching center in a message switching system, depending upon the equipment complement selected. Hardware and software facilities are being provided that enable these functions to be combined as needed, to allow for more economic operations. This flexibility will be particularly advantageous when functional processing requirements (such as real-time operations) are being phased in or phased out.

Monthly rentals for the RCA 3301, as a conventional data processor, range from about $11,000 to $30,000 per month, with a median rental of about $15,000. When real-time or communications facilities are added, the minimum system rental is about $14,000 per month and the median rental is around $20,000. Initial customer deliveries were made in July, 1964.

As a data processor, the 3301 has adequate input-output control capabilities to serve a complement of peripheral devices chosen from among the following:

- 1 or 2 high-speed printers, rated at 800 or 1,000 lines per minute, depending upon the size of the character set used.
- 1 or 2 80-column card readers, rated at 900 or 1,470 cards per minute.
- 1 or 2 card punches, rated at 300 cards per minute.
- 1 or 2 paper tape readers, rated at 100 or 1,000 characters per second.
- 1 or 2 paper tape punches, rated at 100 characters per second.
- Up to 24 magnetic tape stations, described on the next page.
- Up to 8 Model 3488 Random Access Computer Equipment units, each with a maximum capacity of 681 million characters and an average access time of about 300 milliseconds.
- 1 Model 3465 Data Drum Memory, with a maximum capacity of 2.6 million characters and an average access time of 8.6 milliseconds.

These peripheral devices are serviced by two (or at most three) data channels that provide for time-sharing of High Speed Memory (the main core storage). Except for the printers and card punches, which are buffered, each of these units monopolizes a data channel throughout an input or output operation.

In addition, the RCA 3301 has available hardware and software capabilities to accept and transmit information via up to 160 telegraph or telephone lines. It is expected that these facilities will be used to serve real-time processing requirements, while most of the peripheral units will remain available for conventional batched processing.

The CMC (Communications Mode Control) connects the RCA 3301 system to these communications lines, scanning and servicing them as often as required. Two models are available: the Single Scan CMC, which scans all lines with equal frequency; and the Dual Scan CMC, in which some of the lines are scanned more frequently than the others. Internally, the CMC transmits the data from each line to a separate 100-character block in High Speed Memory, called a "line slot".

Periodic peaks of activity occur in most real-time applications, and to satisfy them a certain volume of processing power must be instantly available. Since the peak loads are so much higher than the normal usage, it is often impossible to justify the exclusive use of the full equipment complement by the real-time process. In such cases, a system that can process a normal data processing installation workload, can be interrupted with small cost, and can operate both real-time programs and "production programs" (RCA's term) simultaneously is highly desirable.

§ 011.

The software for the RCA 3301, when used solely as a data processor, is organized exactly as if it were to be used as a combined data processing, real-time processing, and message switching system. There is only one comprehensive operating system, and individual installations (or occasions) use only those parts of the system which are applicable.

The needs of the full system are naturally complex, and these needs have been met by the introduction of a new concept of writing programs. The writing of the actual coding for different parts of programs has been separated from the interconnections between them, and the control of all input and output functions has been placed solely in the operating system.

In this new method, all coding, in the form of separate routines, is assembled and placed on tape. Input-output instructions in the form of macros are used in the routines. A series of "task descriptions" is prepared after assembly, which lays out the logical relationships between these routines (which together comprise all of the coding). When a program is executed, this complete subdivision of the program into logical units is used by the operating system to allocate the available storage space in the most advantageous way, considering the other tasks that are running in the system at the same time.

Under this system, several programs (tasks) can be independently run, with each task receiving storage space and processing ability according to the possibilities of the moment. It makes no difference (except in the allocation of priorities) whether the particular task is a real-time or batch process.

Three properties of this operating system are of particular interest:

(1) It appears to be practical. Using the special hardware facilities, the change-over from one program to another is expected to take between 0.1 and 1.0 millisecond, which is relatively fast.

(2) It appears to reduce the need for reprogramming due to changing circumstances. If a processing method is to be used which differs from the one originally implemented, then rewriting of the "task descriptions" is usually all that will be required. Changing over to real-time operations, for permanent or experimental purposes, would likewise require no more than reforming of the task descriptions.

(3) It appears to allow economical interruptions of normal batch processing to handle priority work.

The special software used for real-time and communication functions (scheduling, message compilation, etc.) is incorporated into the operating system, together with routine functions such as checking for errors.

No specialized functions, such as separate accounting or totally reliable inter-program protection, are included in the operating system. The clock, which works in units of one second, and the lack of stopper registers which positively prevent one program from overwriting another are hardware factors which would make it difficult to include such functions effectively. The current pricing structure, which is based on continuous full use of the equipment, does not reflect the potential use of the system on a demand basis (e.g., to handle infrequent real-time requests outside the normal business hours).

The question of compatibility between the RCA 3301 and its earlier, less powerful predecessor, the RCA 301, has two important facets:

(1) The operating programs of an RCA 301 user can be run on a 3301 in an interpretive mode. This means, however, that the greatly improved input-output facilities of the 3301 will not normally be employed. A number of specific hardware configurations are not directly compatible, but most 301 configurations which are in the field can be simulated in this manner. In particular, there is no compatibility between the 301 Scientific Processor and any RCA 3301 system.

(2) RCA 301 programs and programming systems are being used to back up the 3301 system. These include the 301 FORTRAN II and COBOL-61 compilers, which run under the 301 compatibility program for both compilation and execution. In this mode of operation, the compiler user may have to tolerate considerable inefficiencies in his object program input-output.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Character:	6 data bits + parity bit	basic addressable storage unit.
Diad:	2 characters	transferred in parallel to or from High Speed Memory.
Decade:	10 characters	transferred in parallel to or from High Speed Memory.
Row (magnetic tape):	7 or 8 bits (6 data bits)	holds 1 character.
Row (punched tape):	5 to 8 bits	holds 1 character.
Block (tape):	3 to N rows	holds 1 or more records on magnetic or punched tape.
Column:	12 positions	punched cards; holds 1 character (Hollerith mode) or 12 bits (Binary mode).
Line:	120 or 160 characters	High Speed Printer reports.
Block (Model 3488):	650 characters	data storage in Random Access Computer Equipment.
Band (Model 3488):	4 blocks	data storage in Random Access Computer Equipment.
Card (Model 3488):	166,400 characters	data storage in Random Access Computer Equipment.
Sector (Data Drum Memory):	320 characters	data storage.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	1 character.
Letter or special symbol:	1 character.
Instruction:	10 characters.
Number:	1 to 45 characters.*
Item:	1 to 45 characters, specifying a particular unit of information
Record:	1 or more related items.
File:	any number of related records.

* When the High Speed Arithmetic Unit in the Model 3304 Processor is used, operand lengths are fixed as follows:

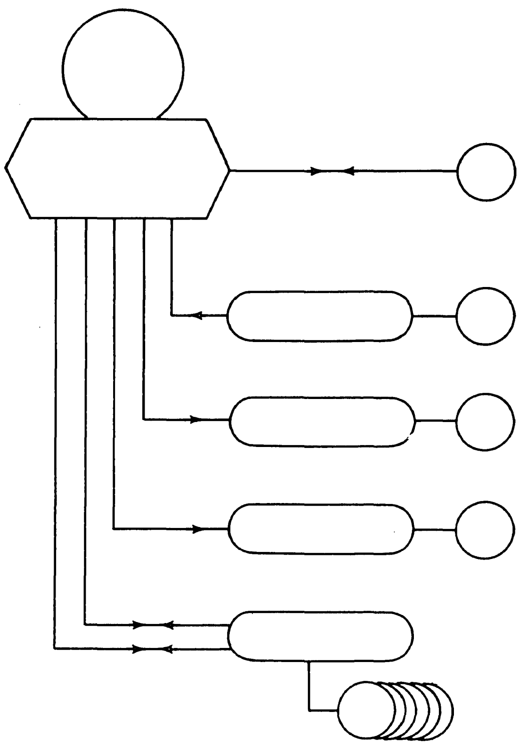
Fixed point:	8 characters.
Floating point:	8 character fraction and 2-character exponent.

SYSTEM CONFIGURATION

§ 031.

.1 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . core storage is 87% larger.
printer is up to 100% faster.
card reader is 80% faster.
card punch is 200% faster.



Equipment	Rental
High Speed Memory: 40,000 characters; 3303 Processor with Console and 2 data channels	$ 5,000
324 Card Reader: 900 cards/min.	340
3329 Card Reader Control	200
3436 Card Punch: 300 cards/min.	500
3336 Buffer and Control	475
333 On-Line Printer: 800/1,000 lines/min.	700
3333 Buffer and Control	475
3383-6 Dual Tape Channel	400
581 Magnetic Tape Stations (6): 33,333 char/sec.	3,300

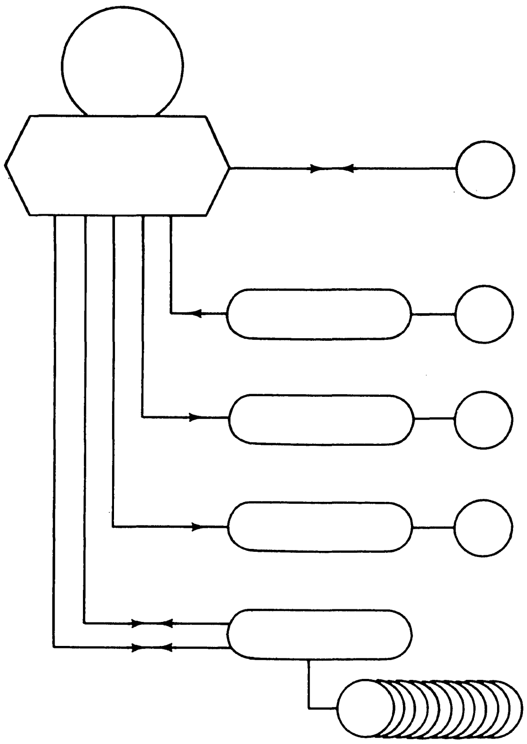
Optional Features Included: . . . . none.

TOTAL RENTAL: $11,390

§ 301.

.2 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card punch is 50% faster. seven fewer index registers.



Equipment	Rental
High Speed Memory: 40,000 characters; 3303 Processor with Console and 2 data channels	$ 5,000
324 Card Reader: 900 cards/min.	340
3329 Card Reader Control	200
3436 Card Punch: 300 cards/min.	500
3336 Buffer and Control	475
333 On-Line Printer: 800/1,000 lines/min.	700
3333 Buffer and Control	475
3383-12 Dual Tape Channel	450
582 Magnetic Tape Stations (12): 66,667 char/sec.	10,500
Optional Features Included: . . . . Simo 3 (additional data channel)	300
TOTAL RENTAL:	$18,940

.3 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Same as Standard Configuration III, shown on Page 703:031.100, except for the following additions:

Equipment	Rental
1 Model 3488 Random Access Computer Equipment (340 million characters)	$ 2,850
1 Model 3388 Channel	625
TOTAL RENTAL	$14,865

.4 6-TAPE BUSINESS/SCIENTIFIC SYSTEM; CONFIGURATION VI

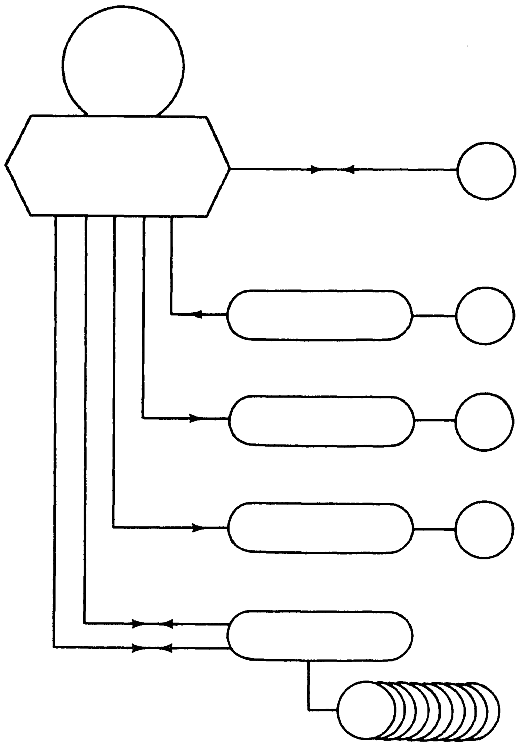
Same as Standard Configuration III, shown on Page 703:031.100, except that the Model 3303 Processor is replaced by the Model 3304 Processor with High Speed Arithmetic Unit and the Model 3361-3 Additional High Speed Memory Module, providing a total of 80,000 character positions of core storage.

TOTAL RENTAL: $14,265

§ 031.

.5 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VII A

Deviations from Standard Configuration: . . . . printer is up to 100% faster.
card reader is 80% faster.
card punch is 200% faster.



Equipment	Rental
High Speed Memory: 120,000 characters total; 3304 Processor with High Speed Arithmetic Unit, Console, and 2 data channels	$ 9,075
324 Card Reader: 900 cards/min.	340
3329 Card Reader Control	200
3436 Card Punch: 300 cards/min.	500
3336 Buffer and Control	475
333 On-Line Printer: 800/1,000 lines/min.	700
3333 Buffer and Control	475
3383-12 Dual Tape Channel	450
582 Magnetic Tape Stations (10): 66,667 char/sec.	8,750

Optional Features Included: . . . . Simo 3 (additional data channel) 300

TOTAL RENTAL: $21,265

§ 031.

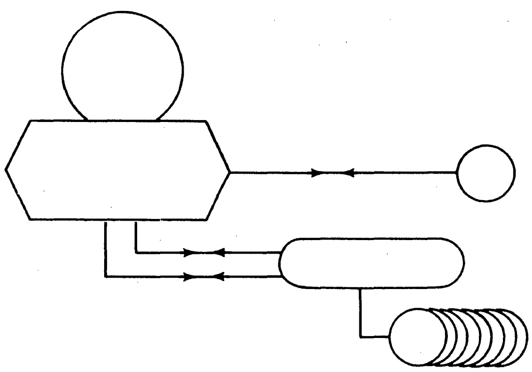
.6 10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VII B

Deviations from Standard Configuration:

On-Line Equipment: . . . . no on-line card reader is used.

Off-Line Equipment: . . . . core storage is 87% larger.
card reader is 60% faster.
card punch is 150% faster.
printer is up to 100% faster.

On-Line Equipment



Equipment	Rental
High Speed Memory: 80,000 characters total	$ 1,500
3304 Processor with High Speed Arithmetic Unit, Console, and 2 data channels	6,375
3383-12 Dual Tape Channel	450
582 Magnetic Tape Stations (8): 66,667 char/sec.	7,000

Optional Features Included: . . . . none.

Total On-Line Equipment:	$15,325

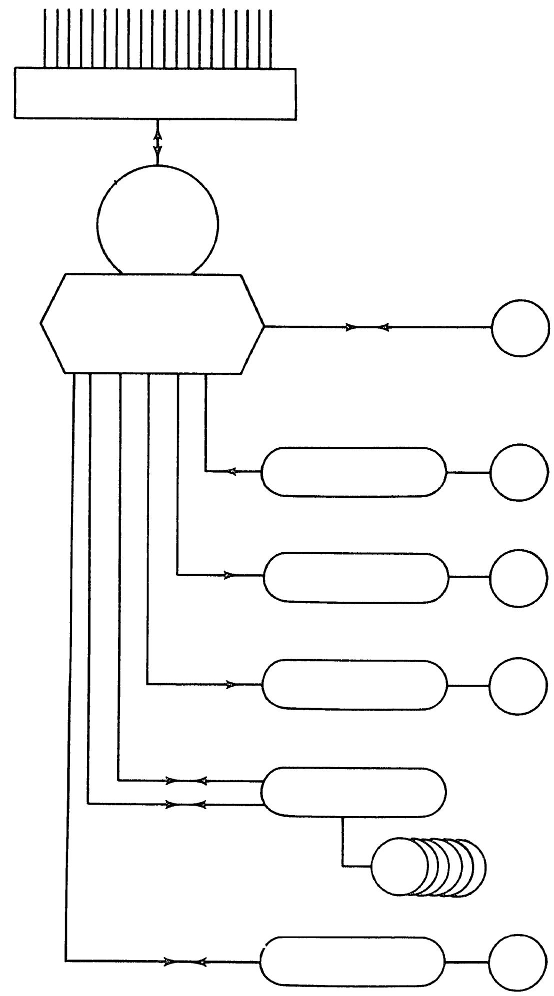
Off-Line Equipment (RCA 301 System)

	Rental
1 - 303 Processor with 10,000 characters of High Speed Memory	$ 1,803
1 - 330 Card Reader-Punch (IBM 1402) and Control	1,164
1 - 333 On-Line Printer and Control	876
2 - 581 Magnetic Tape Stations	1,134
1 - 341 Magnetic Tape Control	1,030
1 - 347 Tape Switch*	260
2 - 347 Extension Switches*	12
Total Off-Line Equipment:	$ 6,279
TOTAL RENTAL:	$21,604

*Permit the two 581 Tape Stations to be switched between the RCA 301 and 3301 systems.

§ 031.

.7 TYPICAL COMMUNICATIONS SYSTEM



Equipment	Rental
Communications Mode Control: Single Scan, 160 lines	$ 580
High Speed Memory: 100, 000 characters total	2, 100
3303 Processor with Console and 2 data channels	5, 000
324 Card Reader: 900 cards/min.	340
3329 Card Reader Control	200
3436 Card Punch: 300 cards/min.	500
3336 Buffer and Control	475
333 On-Line Printer: 800/1, 000 lines/min.	700
3333 Buffer Control	475
3383-6 Dual Tape Channel	400
581 Magnetic Tape Stations (6): 33, 000 char/sec.	3, 300
3488 Random Access Computer Equipment (340 million characters)	2, 850
3388-4 Channel	625
TOTAL RENTAL:	$17, 545*

*Costs of the necessary communication line buffers and interface units are not included.

INTERNAL STORAGE: HIGH SPEED MEMORY

§ 041.

.1 GENERAL

.11 Identity: . . . . High Speed Memory.
Models 3361-1 through 3361-7.
HSM.

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

.13 Description

High Speed Memory forms the basic working storage for the RCA 3301, and is independent of the Central Processor. It consists of from 40,000 to 160,000 character positions of core storage. Each position is composed of six data bits and one parity bit, and can hold one alphameric character. The High Speed Memory is 70 bits, or 10 characters, in depth, and its cycle time is 1.5 or 1.9 microseconds. Depending upon the instruction being executed, access can be had to 1, 2 or 10 characters in parallel, yielding a maximum potential data transfer rate of over 5.0 million characters per second. Access to each 10-character instruction is accomplished in one 1.9-microsecond cycle.

Each character position in High Speed Memory is directly addressable. A group of two consecutive character positions whose contents can be transferred in parallel is called a "diad," and always starts at an even-numbered core location. A group of ten consecutive character positions whose contents can be transferred in parallel is called a "decade," and begins at an address whose low-order character is zero.

Only four characters are used internally to specify each address. The zone bits of the two high-order characters are used to specify which one of up to 16 10,000-character groups is being referenced, a convention that leads to machine addresses like

.13 Description (Contd.)

JR97 and 1-00. To simplify references to High Speed Memory locations, six-digit decimal addresses are used in the assembly programs and in the checkout software package.

.14 Availability: . . . . 6 months.

.15 First Delivery: . . . . . July, 1964.

.16 Reserved Storage

Purpose	Number of locations
Index registers:	none.
Arithmetic registers:	4 characters.
I/O control:	none.
Repeat Instruction Control:	4 characters.
"A" address storage:	4 characters.
Sequence counter	4 characters.

Note: The 200-character Micro Magnetic Memory in the Central Processor contains most of the reserved storage (see Paragraph 702:042.16).

.2 PHYSICAL FORM

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

.23 Storage Phenomenon: . . . . direction of magnetization.

.24 Recording Permanence

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

.28 Access Technique: . . coincident current.

.29 Potential Transfer Rates

.292 Data rates

	1-char access	2-char access	10-char access
Cycling rate cps:	667,000	667,000	526,000.
Unit of data:	1 character	2 characters	10 characters.
Conversion factor:	7 bits	14 bits	70 bits.
Data rate, char/sec:	667,000	1,300,000	5,260,000.
Compound data rate, char/sec:	667,000	1,300,000	5,260,000.

§ 041.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Incre-ments	Maximum Storage
Model:	3361-1	- -	3361-7
Characters:	40,000	20,000	160,000
Instructions:	4,000	4,000	16,000
Modules:	1	- -	1

.32 Rules for Combining Modules: . . . . each specific size (i.e., 60,000; 80,000; 100,000; etc.) has its own model number.

.4 CONTROLLER: . . . . no separate controller required.

.5 ACCESS TIMING

.531 For uniform access
Access time: . . . . . 1.5 or 1.9 μsec.
Cycle time: . . . . . . 1.5 or 1.9 μsec.
For data unit of: . . . . 1, 2, or 10 characters, depending upon the instruction.
Each 2-character unit (diad) must start with an even address.
Each 10-character unit (decade) must start at XXX0 and extend to XXX9.

.532 Variation in access time: . . . . dependent on usage.

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

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	address check	interrupt.
Receipt of data:	parity	interrupt.
Recording of data:	record parity bit.	
Recovery of data:	parity	interrupt.
Dispatch of data:	parity	interrupt.

INTERNAL STORAGE: MICRO MAGNETIC MEMORY

§ 042.

.1 GENERAL

.11 Identity: . . . . Micro Magnetic Memory. MMM.

.12 Basic Use: . . . . . . control memory, addressable by the program, but mainly used without explicit specification in the execution of certain instructions.

.13 Description

The Micro Magnetic Memory (or MMM) consists of 200 character positions of high-speed core storage arranged in 50 four-character locations. Cycle time is 214 nanoseconds; i.e., 4 characters can be read from or written into any one MMM location within one 214-nanosecond Processor pulse.

Micro Magnetic Memory has the following functions:

(1) To assist in arithmetic operations.

(2) To control the interrupt systems.

(3) To store the three index registers and their incrementors.

(4) To record and control the Simultaneous Mode operations.

Instructions cannot be executed from the MMM, and in normal practice the programmer will directly address the MMM only to set the index registers and their increments. The other locations (such as the input-output control locations) are set during the execution of particular instructions.

The systems programmer dealing with an I/O package will, however, make extensive use of the addressable features of the MMM and will not need to duplicate in his own control program any of the quantities stored in the MMM. Certain specific requirements (such as those arising from simulating programs written for the RCA 301, with its different memory structure) are also eased by the use of MMM.

Physically, this memory is made up of ferrite cores.

.14 Availability: . . . . . 6 months.

.15 First Delivery: . . . July, 1964.

.16 Reserved Storage

The 4-character locations are listed by function below.

P Register
A Register
B Register
S Register
T Register
C Register
E Register
P (General Interrupt)
A (General Interrupt)
B (General Interrupt)
STA* (General Interrupt)
STP** (General Interrupt)
Control Register (General Interrupt)
STPR*** (General Interrupt)
Op and N (Simo 1 instruction)
A Address (Simo 1 instruction)
B Address (Simo 1 instruction)
Index Field 1
Index Field 2
Index Field 3
General Interrupt Routine Entry
Real-Time Interrupt Routine Entry
Stop P (Computer Stop Address)
Multiply/Divide (MD1)
Multiply/Divide (MD2)
Multiply/Divide (MD3)
Multiply/Divide (MD4)
P (Real-Time Interrupt)
A (Real-Time Interrupt)
B (Real-Time Interrupt)
STA* (Real-Time Interrupt)
STP** (Real-Time Interrupt)
Control Register (Real-Time Interrupt)
STPR*** (Real-Time Interrupt)
Op and N (Simo 2 instruction)
A Address (Simo 2 instruction)
B Address (Simo 2 instruction)
Op and N (Simo 3 instruction)
A Address (Simo 3 instruction)
B Address (Simo 3 instruction)
Increment Field 1
Increment Field 2
Increment Field 3

* STA stores the A Address Register setting.
** STP stores the previous setting of the P (sequence control) Register.
*** STPR stores the previous result.

.2 PHYSICAL FORM

.21 Storage Medium: . . . micro-ferrite cores.

.23 Storage Phenomenon: . direction of magnetization.

§ 042.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	instruction ignored; computation continues.
Receipt of data:	parity	interrupt.
Recording of data:	record parity bit.	
Recovery of data:	parity	interrupt.
Dispatch of data:	parity	interrupt.
Timing conflicts:	not possible.	

INTERNAL STORAGE: MODEL 3488 RANDOM ACCESS COMPUTER EQUIPMENT

§ 044.

.1 GENERAL

.11 Identity: . . . . Model 3488 Random Access Computer Equipment.

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

.13 Description

Model 3488 Random Access Computer Equipment (previously referred to as RACE) can read or write on magnetic cards, just as a magnetic tape unit reads or writes on magnetic tape. A maximum throughput rate of 200 cards per minute is possible. Each card can hold 256 blocks of 650 characters each; 256 cards are held in a magazine; which can be removed from the equipment in the same way as a magnetic tape reel can be unloaded. Up to sixteen of these magazines can be held in each 3488 Unit (see Figure 1).

An RCA 3301 Computer can control a maximum of eight Model 3488 units, four units being connected to a control module, and two control modules being connected to the system. A minimum system can hold from one to eight card magazines on-line and has a capacity of over 340 million characters; a fully expanded system (see Figure 2) provides positions for 128 card magazines, thus giving a capacity of 5,452 million characters.

Within the intermediate capacity ranges (i.e., between 8 and 128 card magazines), the arrangement is flexible. The second set of eight card magazines can be placed on the same Model 3488 Unit as the first set — which is the cheapest way available. It can alternatively be placed on a second Model 3488 Unit, and connected to either the same channel as the first Model 3488 or to a second channel unit.

A complete card cycle, including its selection, movement to the read/write station, and subsequent return to its position in the magazine, takes between 600 and 1100 milliseconds. The access itself normally takes between 290 and 465 milliseconds, although under worst-case conditions, obtaining access to a card may take 570 milliseconds for an

.13 Description (Contd.)

8-magazine unit or 900 milliseconds for a 16-magazine unit. The variation in access time is related to the position of the magazine concerned; Figure 1 clearly shows why this is so.

A considerable amount of this card cycle time can be overlapped, so that the throughput of the unit can reach slightly over three cards per second provided that all the data is held in the front magazines. The throughput is naturally reduced when data from the magazines at the back are used; throughput rate of less than two cards per second would be obtained if all the cards were taken from the 16th (back) magazine.

The cards are supported in the card magazine by rods that fit into notches on both sides of the cards and by selector rods that fit into other coded notches on the top of the card. The actual selection of a card involves the horizontal movement of some of the selector bars so that they will no longer support any appropriately-coded card. When, at the same time or at a later time, the side rods are momentarily displaced, the selected card is extracted into the raceway and is carried to the read-write station. There is no control at this level to check that only one card is selected at any one position of the selector bars. The selection of two cards at a time may cause serious damage to the unit, and it is important to assure that this never occurs. RCA is studying this problem, but no details are presently available regarding preventive methods which may be adopted.

Once in the raceway, the card is carried past any card magazines which are nearer the read/write station and is then loaded onto a drum which revolves under the read/write heads.

Subsequent to its use by the computer, the card is stripped from the drum and placed on another, slower raceway which carries it back to the magazine concerned (using a powered drive) and then lifts it and slips it into position.

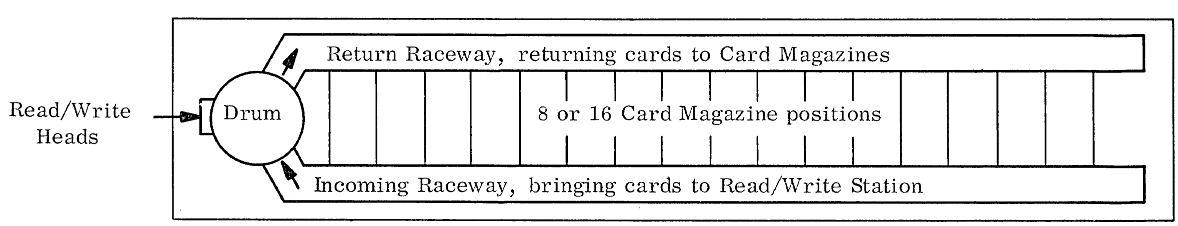


FIGURE 1: LOGICAL DIAGRAM OF A MODEL 3488 UNIT

§ 044.

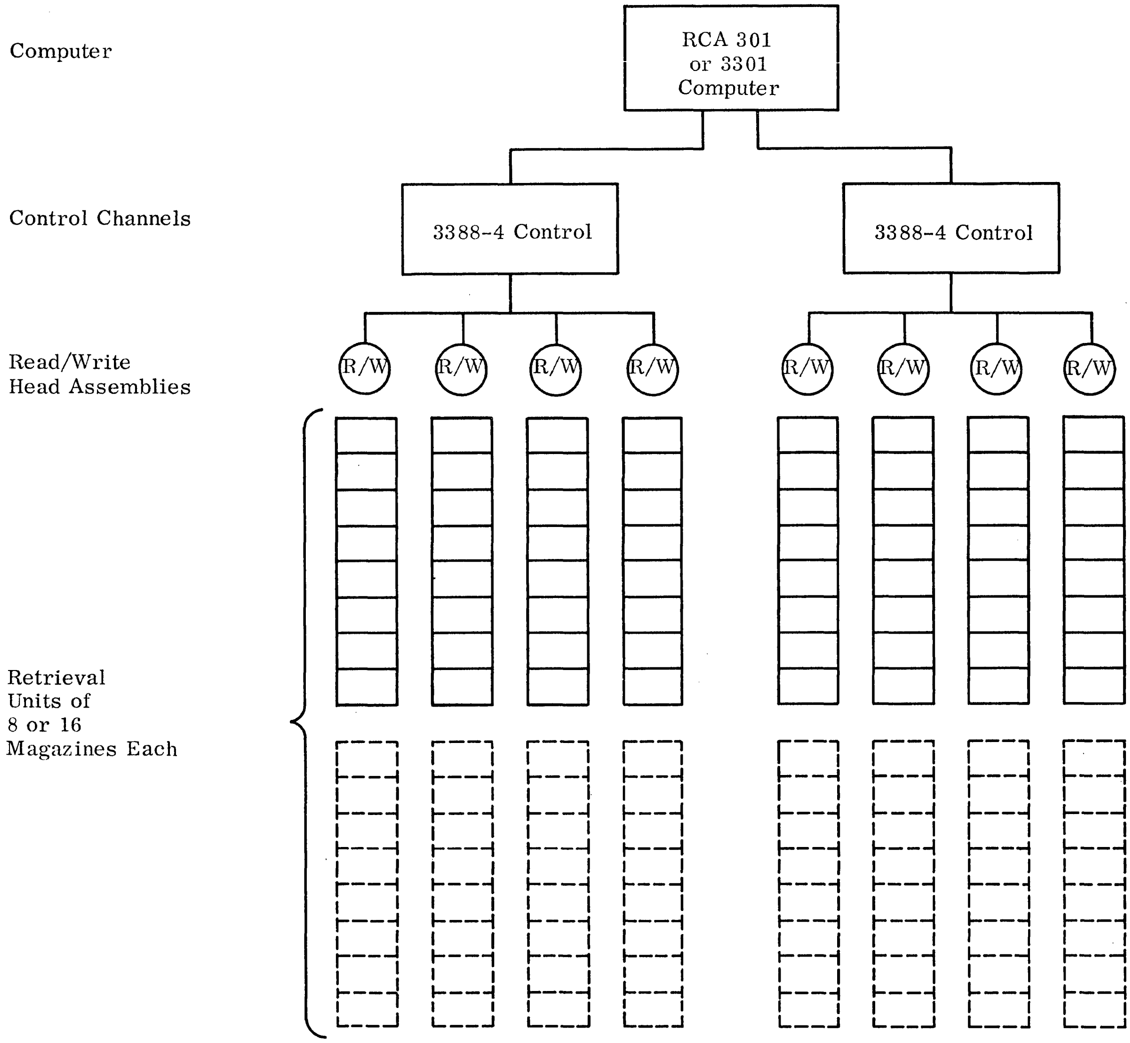


FIGURE 2: RCA 3301 COMPUTER WITH MAXIMUM COMPLEMENT OF MODEL 3488 UNITS

.13 Description (Contd.)

When the card is mounted on the drum and revolving around the read/write heads, the arrangement of the card itself is important. This is illustrated in Figure 3, which shows the arrangement of blocks on the card.

Each Model 3488 card has 64 bands, with four 650-character blocks on each band. Physically, each band consists of two tracks and uses two read/write heads. A total of four pairs of read/write heads are provided in each read/write station. These heads are moved, in unison, into one of 16 possible positions so that they can cover all the 64 bands on the card. This head movement, which takes 20 milliseconds, can be done between cards.

.13 Description (Contd.)

Actual reading or writing is done at an instantaneous data transfer rate of 80,000 characters per second. This rate only applies to each single block, which is read as a unit. The effective transfer rate for large amounts of data is reduced to 43,333 characters per second as a result of interblock gaps of 1 millisecond and intercard gaps of 25 milliseconds.

RCA recommends that the magnetic cards used by the Model 3488 Random Access Computer Equipment be replaced after 30,000 extractions or 100,000 revolutions on the drum, whichever occurs first.

§ 044.

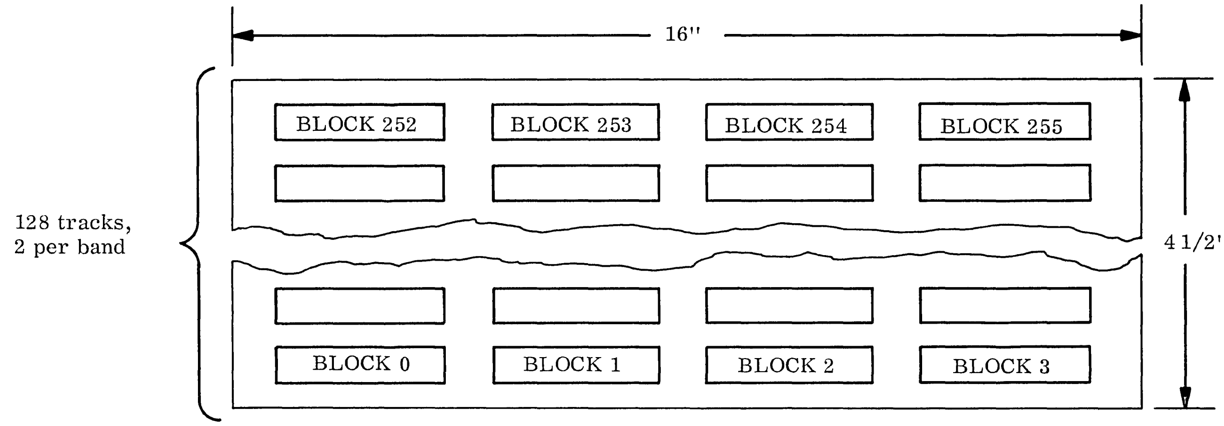


FIGURE 3: ARRANGEMENT OF THE 256 650-CHARACTER DATA BLOCKS ON EACH MAGNETIC CARD

.13 Description (Contd.)

Error checks are made during data transfer upon the accuracy of the block selection, card selection, and magazine selection. Each character is recorded in seven-bit form: six data bits plus a parity bit which is checked during transfers.

Specialized software is needed for operating the 3488, including randomizing routines, card maintenance utility routines, etc. The available software is described in the appropriate entries in the Problem Oriented Facilities section (703:151.100) and the Operating Environment section (703:191.100) of this report.

It is possible for a single random access unit to be used as a number of logically independent input-output units. Model 3488 is considered from this angle in Section 703:105.100 of this report.

.14 Availability: . . . . 9 months.

.15 First Delivery: . . . . . late 1964.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic cards.

.22 Physical Dimensions

.222 Drum (used to support the card at the read/write station; not for data storage) —
Diameter: . . . . . . 6 inches.
Thickness or length: . . . . 5 inches.
Number on shaft: . . 1.

.223 Card —
Length: . . . . 16 inches.
Width: . . . . 4.5 inches.
Number: . . . . 256 cards/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.

.25 Data Volume per Band of 2 Tracks

Words: . . . . 260.
Characters: . . . . . . 2,600.
Digits: . . . . 2,600.
Instructions: . . . . . . 260.

.26 Bands per Physical Unit: . . . . 64.

.27 Interleaving Levels: . no interleaving.

.28 Access Techniques

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

Description of stage	Possible starting stage?
Card access -	
Select card:	yes.
Extract card to raceway:	yes.
Move card and mount on drum: . .	no.
Data block on card access -	
Leading edge of block approaches the read/write heads:.	yes.

§ 044.

.29 Potential Transfer Rates

.291 Peak bit rates -
Track/head speed: . 400 inches/sec.
Bits/inch/track: . . 700.
Bit rate per track: . 280,000 bits/sec/track.

.292 Peak data rates -
Unit of data: . . . . . alphameric character.
Conversion factor: . . . . 6 data bits + 1 parity bit.
Gain factor: . . . . . 2.
Data rate: . . . . 80,000 characters/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	1 3488 Unit	8 3488 Units.
Words:	34,078,720	545,259,520.
Characters:	340,787,200	5,452,595,200.
Instructions:	34,078,720	545,259,520.
Magazines:	8	128.
Cards:	2,048	32,768.
Modules:	1	8.

.32 Rules for Combining Modules: . . . . 8 or 16 magazines per 3488 Unit.
1 to 4 3488 Units per Control Unit.
1 or 2 Control Units per 3301 computer system.

.4 CONTROLLER

.41 Identity: . . . . Model 3388-4 Channel.

.42 Connection to System

.421 On-Line: . . . . 2.
.422 Off-Line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . 4.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . from 650 characters up to the capacity of core storage, or 166,400 characters.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . by character.
.444 Input-output area lockout: . . . . none.
.445 Synchronization: . . . . . semi-automatic.
.446 Synchronizing aids: . . . interrupt when unit is ready.
.447 Table control: . . . . . none.
.448 Testable conditions: . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks -
Stacks per yoke: . . . 4.
Yokes per module: . . 1.
.512 Stack movement: . . . . to 1 of 16 positions.
.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations
By single stack -
With no movement: . 4 650-character blocks.
With all movement: . 64 650 character blocks.
By all stacks -
With no movement: . 16 650-character blocks per 3488 unit.
128 650-character blocks per system.

.52 Simultaneous Operations: . . . . . . Within one 3488 unit, the only types of simultaneity possible are the selection of a card in parallel with the use of another card, and the overlapping of the movement of one card towards the read/write station with the movement of one card from the read/write station back to the card magazine. A number of interlocks may prevent full use of this simultaneity.
Simultaneity at control unit and system level is discussed in the Simultaneous Operations section of this report (703:111.100).

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, msec	Example, msec
Card access -		
Card is selected: . .	0 or 170	170
Card moves to read/write station:	120 to 295*	130
Block access -		
Head assembly moves into position:	0 or 20	0
Leading edge of block comes under the heads: . .	0 to 60	30
Block of 650 characters is transferred: . . .	8	8
Total	128 to 573	338

*Depending on position of magazine.

§ 044.

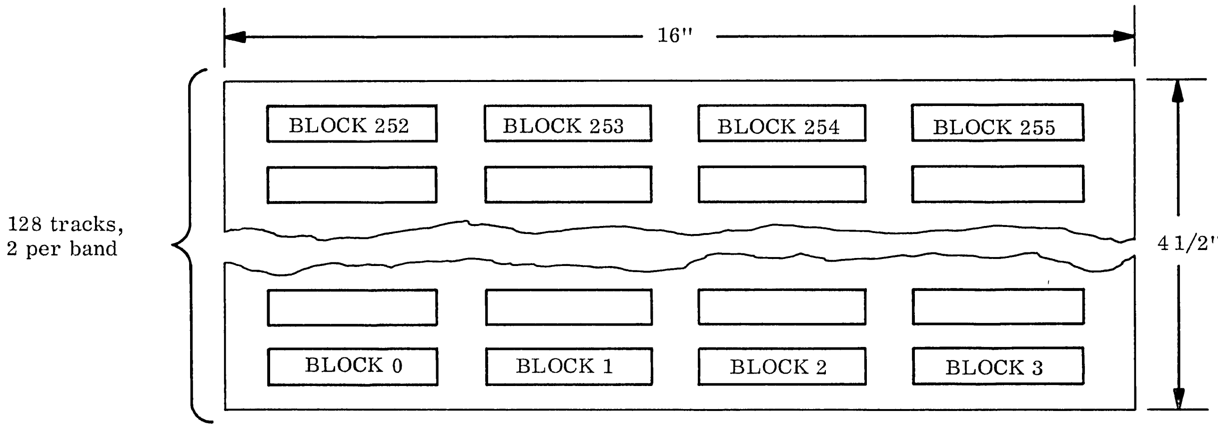


FIGURE 3: ARRANGEMENT OF THE 256 650-CHARACTER DATA BLOCKS ON EACH MAGNETIC CARD

.13 Description (Contd.)

Error checks are made during data transfer upon the accuracy of the block selection, card selection, and magazine selection. Each character is recorded in seven-bit form: six data bits plus a parity bit which is checked during transfers.

Specialized software is needed for operating the 3488, including randomizing routines, card maintenance utility routines, etc. The available software is described in the appropriate entries in the Problem Oriented Facilities section (703:151.100) and the Operating Environment section (703:191.100) of this report.

It is possible for a single random access unit to be used as a number of logically independent input-output units. Model 3488 is considered from this angle in Section 703:105.100 of this report.

.14 Availability: . . . . 9 months.

.15 First Delivery: . . . . . late 1964.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic cards.

.22 Physical Dimensions

.222 Drum (used to support the card at the read/write station; not for data storage) —
- Diameter: . . . . . . 6 inches.
- Thickness or length: . . . . 5 inches.
- Number on shaft: . . 1.

.223 Card —
- Length: . . . . 16 inches.
- Width: . . . . 4.5 inches.
- Number: . . . . 256 cards/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.

.25 Data Volume per Band of 2 Tracks

- Words: . . . . 260.
- Characters: . . . . . . 2,600.
- Digits: . . . . 2,600.
- Instructions: . . . . . . 260.

.26 Bands per Physical Unit: . . . . 64.

.27 Interleaving Levels: . no interleaving.

.28 Access Techniques

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

Description of stage	Possible starting stage?
Card access -	
Select card:	yes.
Extract card to raceway:	yes.
Move card and mount on drum: . .	no.
Data block on card access -	
Leading edge of block approaches the read/write heads:.	yes.

§ 044.

.29 Potential Transfer Rates

.291 Peak bit rates -
Track/head speed: . 400 inches/sec.
Bits/inch/track: . . 700.
Bit rate per track: . 280,000 bits/sec/track.

.292 Peak data rates -
Unit of data: . . . . . alphameric character.
Conversion factor: . . . . 6 data bits + 1 parity bit.
Gain factor: . . . . . 2.
Data rate: . . . . 80,000 characters/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	1 3488 Unit	8 3488 Units.
Words:	34,078,720	545,259,520.
Characters:	340,787,200	5,452,595,200.
Instructions:	34,078,720	545,259,520.
Magazines:	8	128.
Cards:	2,048	32,768.
Modules:	1	8.

.32 Rules for Combining Modules: . . . . 8 or 16 magazines per 3488 Unit.
1 to 4 3488 Units per Control Unit.
1 or 2 Control Units per 3301 computer system.

.4 CONTROLLER

.41 Identity: . . . . Model 3388-4 Channel.

.42 Connection to System

.421 On-Line: . . . . 2.
.422 Off-Line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . 4.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . from 650 characters up to the capacity of core storage, or 166,400 characters.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . by character.
.444 Input-output area lockout: . . . . none.
.445 Synchronization: . . . . . semi-automatic.
.446 Synchronizing aids: . . . interrupt when unit is ready.
.447 Table control: . . . . . none.
.448 Testable conditions: . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks -
Stacks per yoke: . . . 4.
Yokes per module: . . 1.
.512 Stack movement: . . . . to 1 of 16 positions.
.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations
By single stack -
With no movement: . 4 650-character blocks.
With all movement: . 64 650 character blocks.
By all stacks -
With no movement: . 16 650-character blocks per 3488 unit.
128 650-character blocks per system.

.52 Simultaneous Operations: . . . . . . Within one 3488 unit, the only types of simultaneity possible are the selection of a card in parallel with the use of another card, and the overlapping of the movement of one card towards the read/write station with the movement of one card from the read/write station back to the card magazine. A number of interlocks may prevent full use of this simultaneity.
Simultaneity at control unit and system level is discussed in the Simultaneous Operations section of this report (703:111.100).

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, msec	Example, msec
Card access -		
Card is selected: . .	0 or 170	170
Card moves to read/write station:	120 to 295*	130
Block access -		
Head assembly moves into position:	0 or 20	0
Leading edge of block comes under the heads: . .	0 to 60	30
Block of 650 characters is transferred: . . .	8	8
Total	128 to 573	338

*Depending on position of magazine.

§ 044.

.6 CHANGEABLE STORAGE

.61 Magazines

.611 Capacity: . . . . 256 cards.
.612 Cartridges per module: . . . . 8 or 16.
.613 Interchangeable: . . . yes.

.62 Loading Convenience

.621 Possible loading —
While computing system is in use: . yes.
While storage system is in use: . no.
.622 Method of loading: . . operator.
.623 Approximate change time: . . . . . 0.5 to 1.0 minute.
.624 Bulk loading: . . . . . 1 cartridge per module at a time.

.7 PERFORMANCE

.72 Transfer Load Size

With core store:. . . . 1 to 16,640 words.

.73 Effective Transfer Rate

With 40,000-character store: . . 35,000 char/sec.
With 160,000-character store: . . 42,000 char/sec.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	ignore instruction and set future interrupt.
Recording of data:	read-after-write parity check	interrupt.
Recovery of data:	row parity check	interrupt.
Physical record missing:	check	interrupt.
Wrong card:	hardware check on correct physical location;	interrupt.
	optional software check on correct actual data	own coding.
Select 2 or more cards:	none as of 8/64.	

INTERNAL STORAGE: 3465 DATA DRUM MEMORY

§ 045.

.1 GENERAL

.11 Identity: . . . . 3465 Data Drum Memory.

.12 Basic Use: . . . . . . random access auxiliary storage.

.13 Description

The Model 3465 Data Drum Memory provides storage for between 327,680 and 2,621,440 characters, with an average access time of 8.6 milliseconds and an actual data transfer rate of 149,000 characters per second. RCA states that these performance characteristics will be maintained, although the physical implementation of the Data Drum Memory may be modified at some time in the future.

The unit currently consists of a single module containing one or two magnetic drums. Logically, this operates as a single drum irrespective of the number of physical units present, with automatic electronic switching to handle the reading or writing of records which overlap from the first drum onto the second one.

The data is arranged in 320-character sectors, and there are 8 sectors in each track. As many sectors as are required can be transferred by a single input or output instruction.

The data is safeguarded both by error controls which check the accuracy of the individual data transfers and by operational checks which are used to confirm that the unit is in proper operating condition. These operational checks include an "echo check" during the recording of data, which verifies that current is physically flowing through the read/write heads. A further measure to ensure that the unit is in proper operating condition is the provision of spare tracks on the drum. Additional tracks are provided on all drums, to be used in case some of the operational tracks develop bad spots which cause recording errors.

The operational checks, which are used whenever any record is read or written, include character parity on all characters transferred in or out. The character parity bit is recorded with the data on the drum. In addition, a count of the bits in each 320-character sector is made when the sector is recorded. This count is held and recorded with the sector in modulo-256 form. When the sector is read, the bit-count recorded with the sector is automatically checked.

The Data Drum Memory is manufactured by Bryant Computer Products Corporation for RCA, and is expected to become operational late in 1964.

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

.15 First Delivery: . . . late 1964.

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic drum.

.22 Physical Dimensions

.222 Drum —
Diameter: . . . . . . 10 inches.
Length: . . . . 16-3/8, 17-7/8, or 30-13/16 inches.
Number on shaft: . . 1 drum.

.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 One Track

Characters: . . . . . 2,560.
Digits: . . . . 2,560.
Instructions: . . . . . 256.
Sectors: . . . . 8.

.26 Bands per Physical Unit: . . . . 128, 256, or 512 per drum; 1 or 2 drums per module.

.27 Interleaving Levels: . no interleaving.

.28 Access Techniques

.281 Recording method: . . fixed heads.
.283 Type of access —

Description of stage	Possible starting stage?
Wait for drum revolution to place sector under read/write heads: . . .	yes.
Read or write: . .	no.

.29 Potential Transfer Rates

.291 Peak bit rates —
Cycling rate: . . . . 3,500 rpm.
Track/head speed: . 1,830 inches/sec.
Bits/inch/track: . . . 574.
Bit rate per track: . 1,050,000 bits/sec/track.

§ 045.

.292 Peak data rates —

Cycling rate:	3,500 rpm.
Unit of data:	character.
Conversion factor: .	6 data bits/character.
Data rate:	150,000 char/sec, approximately.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	Model 1	Model 6.
Drums:	1	2.
Words:	32,768	262,144.
Characters:	327,680	2,621,440.
Instructions:	32,768	262,144.
Sectors:	1,024	8,192.
Modules:	1	1.

.32 Rules for Combining Modules: . . . . . . only one module per RCA 3301 computer.

.4 CONTROLLER: . . . required control circuitry is built into the 3301 I/O Rack.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks —

Stacks per system: .	128, 256, 512, 640, 768, or 1024.
Stacks per module: .	128, 256, 512, 640, 768, or 1024.
Stacks per yoke: . .	128, 256, or 512.
Yokes per module: .	1 or 2 drums per module.

.512 Stack movement: . . . . none; fixed heads.

.513 Stacks that can access any particular location: . . . . . . 1.

.514 Accessible locations —

By single stack: . .	2,560 characters.
By all stacks:	1,310,720 characters per drum.
	2,621,440 characters per module.
	2,621,440 characters per system.

.52 Simultaneous Operations: . . . . . . only one drum operation at a time. (Overlapped operation with other peripheral devices is possible.)

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, msec	Example, msec
Wait for sector to approach read/write heads:	0.6 to 17.2	8.9
Read N sectors: . . .	2.15N	2.15
Total.		11.05

.6 CHANGEABLE STORAGE: . . . . . None

.7 PERFORMANCE

.71 Data Transfer: . . . . between drum and core storage only.

.72 Transfer Load Size: . 1 to N sectors of 320 characters each.

.73 Effective Transfer Rate: . . . . 146,000 to 149,000 characters per second, depending upon size of core storage.

.8 ERRORS, CHECKS, AND ACTION

Error	Check of Interlock	Action
Invalid address:	address check	interrupt.
Receipt of data:	parity check	interrupt.
Recording of data:	echo check	interrupt.
	parity bit recorded, with modulo-256 bit count on each segment.	
Recovery of data:	parity check	interrupt.
	bit count check	interrupt.
Dispatch of data:	parity bit forwarded.	

CENTRAL PROCESSORS

§ 051.

.1 GENERAL

.11 Identity: . . . . Model 3303 Processor.
Model 3304 Processor with High Speed Arithmetic Unit.

.12 Description

Specifications for the central processors of the RCA 3301 system were modified in 1964 to improve their performance. The major modifications consisted of: (1) reducing the basic cycle times of the High Speed Memory and the control Micro Magnetic Memory by 14%, and (2) speeding up the cycle pulse of the High Speed Arithmetic Unit used in the Model 3304 Processor by some 40%. The latter modification mainly affects the multiplication and division instructions. All performance figures throughout this report are based upon the new, faster processor and memory speeds.

The basic Model 3303 Processor is a character-oriented processor; i.e., it treats operands one character at a time in executing most instructions. This naturally slows up some operations which could be treated in parallel (such as addition and data transfers), but also allows a number of special operations upon individual characters (Edit, Search for Symbol, Translate Symbol, etc.) and eliminates the need for others (such as shifting). However, in the mass-transfer operation, a 10-character "decade" format is used, and all 10 characters are handled in parallel. Character operations also allow core storage to be fully utilized without leaving unused parts of words. The optional Model 3304 Processor has all the basic facilities of the 3303, but in addition it has a high-speed parallel arithmetic unit that is used for fixed and floating point arithmetic operations. These arithmetic operations, which are additional to and much faster than the basic ones, use fixed-length operands stored in 10-character "decade" positions in High Speed Memory, so the optimum layouts of data (in internal storage and on tape) will often be very different for the two Processor models.

Both processors have three index registers, three levels of interrupts, and a variety of logical operations. A number of indicators are available to the programmer; these include the sign of the previous result, the contents of the A address register at the end of the instruction, and (a particularly useful one) the address from which a transfer of control has been made.

The Boolean operations AND, Inclusive OR, and Exclusive OR are provided. They are carried out on each of the 6 data bits in up to 44 consecutive character positions.

Specialized operating modes provide compatibility with the RCA 301 and assist in testing programs.

.12 Description (Contd.)

Overall speeds of the two processors are largely controlled by the time required to access the operands in High Speed Memory. In most cases this is one long memory cycle (1.9 microseconds) per character or per decade (10-character field). Typical fixed-point arithmetic times for the basic Model 3303 Processor are 40.16 microseconds for an 8-digit add-to-storage and 5.62 microseconds for multiplication with 5 significant digits. Any of the basic arithmetic instructions included in the 3303 repertoire will be executed at the same speed on either processor. Corresponding times utilizing the High Speed Arithmetic Unit of the Model 3304 Processor are 10.29 and 25.2 microseconds, respectively. Floating point times (on Model 3304 only) average 10.9 microseconds for add-to-storage and 28.8 microseconds for multiplication.

The "Translate by Table" instruction enables the Processors to translate any 6-bit code to any other 6-bit code at a cost of only 4.5 microseconds per character. The number of codes that can be accommodated is limited only by the High Speed Memory space required to hold the tables: 64 positions for each full 64-character code.

Editing operations are designed primarily to produce edited output. A mask including all symbols to be inserted is set up. Then individual characters from the data field are transferred sequentially into the "blank" positions in the edit mask. Other instructions search designated fields until specific characters are found (or not found) and, in the meantime, alter all leading characters to zero, space, dollar sign, asterisk, etc., thereby facilitating zero suppression, check protection, and floating dollar signs. The editing time is 4.5 microseconds per character scanned, so that producing a card image takes about half a millisecond and editing a full 120-character line of print takes from about 0.5 to 1.0 milliseconds, depending upon the amount of editing needed.

The same editing instructions can be used to change the format of an input item so that it meets the needs of its particular processor (placing it in word format, perhaps). Fields can only be expanded — not compressed — by the editing instructions.

In addition to its computing facilities, the processor must control the operation of the various input-output devices and switching between real-time, communications, and batch programs. This is handled by the executive routines, which in turn utilize the hardware interrupt systems. These provide for interrupts to occur at the end of input-output operations, receipt of communication requests, etc. Each interrupt type is connected to an indicator, and when interruptions take place, control is transferred to one of two specific locations by the hardware. The software routine then interrogates the indicators in order to enter the appropriate routine.

§ 051.

.12 Description (Contd.)

Switching between programs is initiated by interrupts and performed under the control of the Operating System (Section 703:191). When switching from one program to another, it will frequently be necessary to transfer the contents of all the operational registers from the Micro Magnetic Memory into special locations in the High Speed Memory. No instructions are available to do this en masse, so individual instructions must be used to store each four-character register. Because two sets of certain registers are provided in the Micro Magnetic Memory, the operating system will, in certain specific, routine cases, be able to avoid this storing and restoring of the operational registers. When only one real-time program and one production program are operating concurrently, there should be relatively few occasions which require all the operational registers to be stored.

Real-Time Interrupts can occur whenever an outside agency wants to initiate a data transfer to or from the computer, upon completion of a data transfer operation, or when Processor servicing is required during the transmission. The outside agencies can be nearby or remote; e.g., Console Typewriter, telephone or telegraph lines via either the Communications Control of the Communications Mode Control, or adjacent RCA 301 or 3301 computers.

.13 Availability: . . . . . . 6 months from date of order (but not before dates listed below).

.14 First Delivery

Model 3303 Processor: . . . . . . July, 1964.
Model 3304 Processor: . . . . . . October, 1964.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-subtract:	automatic	decimal	1 thru 44 char.
	automatic*	decimal	8 char.
Multiply			
Short:	none.		
Long:	automatic	decimal	8 char.
Divide			
Remainder:	automatic	decimal	8 char.
No remainder:	none.		
.212 Floating point			
Add-subtract:	automatic*	decimal	8 & 2 char.
Multiply:	automatic*	decimal	8 & 2 char.
Divide:	automatic*	decimal	8 & 2 char.

* With optional High Speed Arithmetic Unit (Model 3304 Processor).

.213 Boolean

AND:	automatic	binary	1 thru 44 6-bit groups.
Inclusive OR:	automatic	binary	1 thru 44 6-bit groups.
Exclusive OR:	automatic	binary	1 thru 44 6-bit groups.

.214 Comparison

Numbers:	automatic	high, low, or equal compare.
Letters:	automatic	high, low, or equal compare.
Mixed:	automatic	high, low, or equal compare.

Collating sequence: 0 through 9,], #, @ , (,), e, &,
A through I, +, ., ;, :, ', CR, -,
J through R, [, $, *, >, <, $_{10}$, ", /,
S through Z, ÷, , , %, ↑ , =, ¤.

.215 Code translation
Provision: . . . . automatic.
From: . . . . any 6-bit code.
To: . . . . any 6-bit code.
Size: . . . . 1 through 44 chars.

.216 Radix conversion: . . none; decimal machine.

.217 Edit format (numeric characters only)

	Provision	Comment	Size
Alter size:	automatic	fills blanks in provided mask	1 thru 44 char.
Suppress zero:	automatic	combined with insert of 1 character, such as "$"	1 thru 44 char.
Round off:	automatic*		8 char.
Insert point:	automatic		1 thru 44 char.
Insert spaces:	automatic		1 thru 44 char.
Insert any char:	automatic		1 thru 44 char.
Float dollar:	automatic		1 thru 44 char.
Protection:	none.		
Absolute:	automatic*		8 char.

* With optional High Speed Arithmetic Unit (Model 3304 Processor).

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

.219 Others –

Address arithmetic:	automatic.	
Repeat:	automatic	repeats specific instruction up to 14 times.
Tally:	automatic	provides loop control, jump, and index modification in single instruction.

.22 Special Cases of Operands

.221 Negative numbers: . . zone bit in least significant character.

.222 Zero: . . . . positive, negative, and unsigned zero characters are treated differently in compare operations. Only positive zero can be created by arithmetic operations.

.223 Operand size determination: . . . . number of characters is specified in instruction.

§ 051.

.23 Instruction Formats

.231 Instruction structure: 10 characters.

.232 Instruction layout

Part:	O	N	A	B
Size (char):	1	1	4	4

.233 Instruction parts

Name	Purpose
O:	operation code.
N:	operand size, or specialized functions depending upon instruction.
A & B:	storage addresses, including indication of indirect addressing and use of index register.

.234 Basic address structure: . . . . . . 2 + 0.

.235 Literals: . . . . none.

.236 Directly addressed operands

Internal storage type	Minimum size	Maximum size	Volume accessible
MMM:	4 char	4 char	200 char.
Core storage (HSM):	1 char	total capacity	all.

.237 Address indexing

.2371 Number of methods: 1.

.2373 Indexing rule: . . . . addition, with overflow to allow for decrementing.

.2374 Index specification: use of zone bits in one 6-bit character of address to be modified.

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

.2376 Addresses which can be indexed: . . . . . any in High Speed Memory.

.2377 Cumulative indexing: none.

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

.238 Indirect addressing

.2381 Recursive: . . . . . . yes.

.2382 Designation: . . . . . bit in zone position of low-order 6-bit address character.

.2383 Control: . . . . executed address has no indirect address bit.

.2384 Indexing with indirect addressing: . . . . . the address is first modified by the contents of the appropriate index register, and then used as an indirect address.

.239 Stepping

The RCA 3301 provides three methods of stepping:

(1) The "Tally" instruction decrements the designated 2-digit counter (anywhere in High Speed Memory) by one and loops back to a given address unless the new count is zero.

(2) The "Repeat" instruction repeats any one repeatable instruction the number of times specified. Should any "unrepeatable" instructions be placed between a Repeat instruction and the related repeatable instruction, these "unrepeatable" instructions will also be repeated.

(3) The three Index Registers can be used in the normal way for loop control. However, because the index registers are incremented by the Tally instruction, which provides a more direct means of loop control, it is not likely that the index registers will often be used for this purpose.

Details of each of these stepping operations follow.

		Tally	Repeat	Index Register
.2391	Specification of increment:	implied	implied	implied as content of MMM location.
.2392	Increment sign:	always negative	always negative	always positive; negative by complementation.
.2393	Size of increment:	one	one	actual content of register.
.2394	End value:	zero	zero	tally instruction used to end.
.2395	Combined step and test:	yes	yes, can only apply to 1 single instruction	no.
.2396	Maximum cycles:	99	14	159,999 (using address structure).

§ 051.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in characters	Program usage
MMM:	50	4	arithmetic, I/O and sequence control, index registers & increments, etc. #
HSM:	1	4	arithmetic operations.
HSM:	3	4	program control.

.242

Category of storage	Total number of locations	Physical form	Access time, μsec	Cycle time, μsec
MMM:	50#	micro-ferrite cores	0.214	0.214
HSM:	4	cores	- -	1.5 or 1.9

See Paragraph 703:042.16 for a tabulation of the 50 Micro Magnetic Memory locations and their uses.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing: . . . . . . sequential.

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

.33 Interruption

(See table at top of following page)

.331 Possible causes

In-out units: . . . . . normal and abnormal end of operation. The precise conditions are specified for each unit.

Processor errors: . end of off-line time operations.
single error in Processor. (Double error causes enforced halt.)
overflow, invalid operation code, illegal address.
invalid "N" codes (which amplify the operation code).

Other: . . . . communication request.
external equipment request.
console request.
program set interrupt.
Program Test Mode.
301 incompatible instruction.
real-time clock.

.332 Control by routine

Individual control: . general interrupts (see table) can be inhibited by program. All interrupts can be inhibited by Program Test Mode. 301 Compatibility can be inhibited.

Restriction: . . . . . interrupt inhibition is normally undertaken only in the executive routine. Any operating program, including real-time programs, will be interrupted whenever an occasion arises.

.333 Operator control: . . . via console interrupt and special routine.

.334 Interruption conditions: unless inhibited, interruption occurs when present instruction (or independent part of instruction) ends.

.335 Interruption process

Disabling interruption: . . . . all subsequent interrupts except those of higher priority are automatically inhibited.

Registers saved: . . 7 General Registers and 7 Real-Time Registers.

Destination: . . . . . fixed location.

.336 Control methods

Determine cause: . . recursive use of "Scan Interrupt" instruction, which scans 6 of the 18 Interrupt Indicators through a mask and locates the most significant indicator set and not masked. Transfers must be programmed. In the case of the I/O devices, each can be tested through up to 12 tests to establish present operating conditions.

.34 Multi-running

.341 Method of control: . . by interruption and software (see Section 703:191).

.342 Maximum number of programs: . . . . . . 8.

.343 Precedence rules: . . priority level of each program can be dynamically altered.

§ 051.

Real Time Interrupts		General Interrupts
System Errors:	Parity error in Processor Illegal operation codes Addressing outside range of HSM	Arithmetic error Overflow Input-output on-line operation complete (normal or abnormal completion signaled separately, one pair of indicators per input-output channel connected) Input-output off-line operation complete (one indicator per system; present off-line operations include Random Access, Select Complete, Buffer Available for buffered printers and card punches) 301 Compatibility Program Test Mode Unit busy or inoperable; this actually performs as a test, causing entry to the interrupt routine wherever these instructions cannot be carried out for any reason.
Requests from:	Communications Mode Control Interrogating Typewriter Data Exchange Control Communications Control Operator's Console	

INTERRUPTS AVAILABLE WITH THE RCA 3301

.344 Program protection

Storage: . . . . no positive locks are provided.
control registers for 2 programs are held separately in MMM.
data and instructions are allocated during program loading under control of operating system.

In-out units: . . . . . no hardware protection.

.35 Multi-sequencing: . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μsec (Model 3303 Processor)

.411 Fixed point

Add-subtract: . . . . 4.89 + 4.46C, where C is operand length in characters.
Multiply: . . . . 59.5 + 94.4d, where d is no. of non-zero digits in multiplier.
Divide: 1,541

.412 Floating point

Add-subtract: . . . . not available.
Multiply: . . . . not available.
Divide: . . . . not available.

.413 Additional allowance for

Indexing: . . . . 1.9 per modification.
Indirect addressing: 1.9 per level.
Re-complementing: 2.99

.414 Control

Compare: . . . . 1.9 + 3.4C
Branch: 1.9
Compare and branch: 3.83

.415 Counter control (see Paragraph .239)

	Tally	Repeat	Index
Step:	9.78	4.46	1.9
Step and test:	9.78	4.46	-
Test:	-	-	-

.416 Edit: . . . . 4.89 + 4.89C + 3.4E, where C is no. of characters to be edited and E is no. of edit symbols encountered.

.417 Translate: . . . . 1.9 + 4.46C

.418 Shift: . . . . not used.

.41 Instruction Times in μsec (Model 3304 Processor with High Speed Arithmetic Unit)

.411 Fixed point

Add-subtract: 3.43
Multiply: 16.48
Divide: 31.92

.412 Floating point

Add-subtract: 3.43
Multiply: 16.48
Divide: 31.92

.413 Additional allowance for

Indexing: . . . . 1.93 per modification.
Indirect addressing: . . . . 3.0 per level.
Re-complementing: 2.9

.414 Control

Compare: . . . . 1.9 + 3.4C
Branch: 1.9
Compare and branch: 3.83

.415 Counter control (see Paragraph .239)

	Tally	Repeat	Index
Step:	9.78	4.46	1.9
Step and test:	9.78	4.46	-
Test:	-	-	

§ 051.

.416 Edit: . . . . 4.9 + 4.9C + 3.4E where C is no. of characters to be edited and E is no. of edit symbols encountered.

.417 Translate: . . . . 1.9 + 4.5C

.418 Shift: . . . . 0.96 per character.

.42 Processor Performance in μsec (Model 3303 Processor)

.421 For random addresses

	Fixed point
c = a + b:	44.84
b = a + b:	40.16
Sum N items:	40.16N
c = ab:	562
c = a/b:	1,649

.422 For arrays of data

$c_i = a_i + b_j$:	66.09
$b_j = a_i + b_j$:	57.79
Sum N items:	53.76
$c = c + a_i b_j$:	618.44

.423 Branch based on comparison

Numeric data:	53.37
Alphabetic data:	53.37

.424 Switching

Unchecked:	21.7 (or 8.25 using index register).
Checked:	31.75 (using index register).
List search:	40.5N

.425 Format control, per character

Unpack:	3.0
Compose:	6.0

.426 Table look-up, per comparison

For a match:	28.70
For least or greatest:	28.70 or 54.4, depending on find.
For interpolation point:	28.70

.428 Moving: . . . . 0.30 per character (decade move).
2.975 per character (otherwise).

.42 Processor Performance in μsec (Model 3304 Processor with High Speed Arithmetic Unit)

The Model 3304 Processor includes all the facilities of the Model 3303 Processor. The times shown here, however, assume full use of the special instructions of the Model 3304, some of which parallel logically identical facilities in the Model 3303.

.421 For random addresses

	Fixed point	Floating point*
c = a + b:	12.22	12.8
b = a + b:	10.29	10.9
Sum N items:	5.36	5.9
c = ab:	25.20	25.8
c = a/b:	40.72	41.3

.422 For arrays of data

$c_i = a_i + b_j$:	33.5	34.1
$b_j = a_i + b_j$:	27.3	27.9
Sum N items:	20.3	20.9
$c = c + a_i b_j$:	31.5	32.1

* Including allowances for normalization.

.423 Branch based on comparison

Numeric data:	19.76

.424 Switching

Unchecked:	21.68 (or 8.29 using index register)
Checked:	31.66 (using index register).
List search:	40.38N

.425 Format control, per character

Unpack:	3.0
Compose:	6.0

.426 Table look-up, per comparison

For a match:	28.7
For least or greatest:	28.7 or 54.4 depending on find.
For interpolation point:	28.7

.428 Moving: . . . . 0.30 per character (decade move).
2.99 percharacter (otherwise).

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	hardware check	interrupt.
Underflow (float-pt):	none.	
Zero divisor:	hardware check	interrupt.
Invalid data:	none.	
Invalid operation (including N character):	check	interrupt.
Arithmetic error:	parity only	interrupt.
Invalid address:	check on physical presence	interrupt.
Receipt of data:	parity	interrupt.
Dispatch of data:	send parity bit.	
Input area protect:	check first and last location	interrupt.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . Operator Console and Maintenance Console (both included with 3303 or 3304 Processor).

.12 Associated Units: . . . . . Console Typewriter.

.13 Description

The Control Console consists of a desk with a minimum complement of control switches, buttons, and display lights built into the top. The Console Typewriter, which is also located on the desk top, permits direct communication under program control between the operator and the Processor.

The switches and lights located on the Operator's panel permit the operator to:

- Set four independent Alteration Switches, whose settings can be interrogated by the stored program.
- Terminate data entry and indicate cancellation of erroneous information.
- Cause a program interrupt.
- Note that a double systems error or read instruction parity error (during the program load function) has caused the Processor to halt.
- Enable the program load function to be executed from Magnetic Tape Station #6 or the Console Typewriter.

.13 Description (Contd.)

- Bring the Processor to an orderly halt or note when a Halt instruction has been executed.
- Clear all registers not in Micro Magnetic Memory, clear interrupt inhibits, clear the Interrupt Register, and reset error indicators.
- Start execution of the stored program.

The Console Typewriter is a keyboard printing device with 44 keys and 64 printable characters. A printed line may consist of up to 85 pica characters (10 characters per inch). Single or multiple sheet stock up to 11 inches wide can be used. Characters can be printed at a rate of up to 924 characters per minute. A light in the Control Console indicates when the Typewriter is available to the operator. The operator signals the end of transmission by depressing a Release button on the Control Console. Instructions for reading, writing, and testing the status of the Console Typewriter are provided. Either of the standard data channels (Simo 1 or Simo 2) can be used.

The Maintenance Console is normally concealed under the Operator's panel and is used by engineering personnel to diagnose computer malfunctions and provide checkouts. The lights and switches on this panel which are accessible to the operator enable him to:

- Turn off DC power without disturbing the main power for the system.
- Turn the main power supply on and off.
- Note marginal check, overheating, and D.C. ready.

INPUT-OUTPUT: 324 CARD READER

§ 071.

.1 GENERAL

.11 Identity: . . . . Card Reader. Model 324.

.12 Description

This is a fast, British-designed 80-column card reader which completes the reading and translating of a card within 67 milliseconds after the "read" instruction has been issued. Rated speed is 900 cards per minute, and the effective speed after allowing for processing of the appropriate interrupts is virtually the same. (Provided that no errors have occurred, this interrupt processing takes about 50 microseconds per card.) The reader has an infinite clutch (i.e., there is no delay while waiting for a clutch point to come around). Thus, any delay caused by the interactions of the other units (which may not be directly controllable by a programmer) has a minimum effect on the card reading rate.

Reading is done by a set of 12 photoelectric cells, which read one column at a time. Either 80-column or 51-column cards can be read. Each column can either be translated from Hollerith code to the RCA 3301 character set or treated as a 2-character, 12-bit binary image. Accuracy controls on the reading consist of two tests of the photocells during each card cycle. The Leading Edge lamp check notes that all cells correctly register the absence of the card material. The Trailing Edge lamp check assures that all cells correctly register the presence of the card. An additional check (on the legality of the punched character) takes place in the controller when operating in the Translate Mode. There are no hole-count or other checks on the sensing of the card image itself.

After reading, cards are placed into either a 500-card reject stacker or the 2,400-card main stacker. The

.12 Description (Contd.)

main stacker stacks the cards in batches of 400 cards, which can be removed while the reader is operating, and requires attention at least once every 2.6 minutes (6 batches) when working at full capacity. The 2,000-card input hopper similarly requires attention at least once every 2.2 minutes.

A maximum of two card readers can be connected to a 3301 system at any one time via the 3329 Card Reader Control (1 for each card reader). The Simultaneous Mode channel concerned (Simo 1 or Simo 2) is fully engaged throughout each 67-millisecond card cycle. Completion of each card reader operation causes interruption of the main processor program on a "Normal" or "Abnormal" end of operation condition, unless the interrupt has been inhibited.

Parity checks are made upon all data transfers, and the data read from each card can be stored in any 80-character area in High Speed Memory (160 characters are used for each column binary card). Protection of the input area during the read-in operation is a program responsibility; there is no automatic lock-out during the gradual filling up of the input area.

The theoretical load on the central processor consists simply of the core cycles required for the actual transfer of data into High Speed Memory. This amounts to a maximum of 0.10% (translated) or 0.20% (untranslated). Allowing for an additional 50 microseconds of central processor time per card for servicing a routine interrupt condition, the total processor load would be approximately 0.17% or 0.27%, respectively.

This card reader was designed by International Computers and Tabulators Company, Ltd. Where and by whom the units delivered with the RCA 3301 will be manufactured has not been announced to date.

INPUT-OUTPUT: 329 CARD READER

§ 072.

.1 GENERAL

.11 Identity: . . . . Card Reader.
Model 329.

.12 Description

This is a high-speed 80-column card reader which completes reading and translating a card within 40.6 milliseconds after the "read" instruction has been given. A maximum of 1,470 cards can be read each minute if a new read command is given immediately after the completion of each card read operation. In fact, this peak rate usually will not be fully achieved because servicing of the appropriate interrupt will probably take between 50 and 100 microseconds. The reader has an infinite clutch (i.e., it is always ready to execute a read command without delay), so the effect of these interrupt delays on the reading rate is minimized. The effective rate is 1,460 cards per minute with a 100-microsecond delay and 1,430 cards per minute with a 1-millisecond delay.

The reading is done by a set of 12 photoelectric cells, which read one column at a time. Either 80-column or 51-column cards can be read. Each column can either be translated from Hollerith coding into the RCA 3301 character set or treated as a 2-character, 12-bit binary image. Accuracy controls on the reading consist of two tests of the photocells during each card cycle: the LIGHT test, which tests that all cells are working; and the DARK test, which ascertains that a card effectively cuts them all off. There is no re-reading or hole count check on the actual image. A test on the legality of Hollerith characters is made during reading in the Translate Mode.

After reading, cards are placed in either the main or reject stacker. Stacker selection is not under program control and depends solely upon the results of the checks during reading. The main output stacker holds 2,000 cards, and therefore requires unloading at least once every 80 seconds during maximum speed operations. In practice, the quantity normally unloaded is about 500 cards, so the reader requires unloading about every 20 seconds. The input hopper holds 3,000 cards, which keep the reader supplied for at least 2 minutes. It is not necessary to stop the reader while loading or unloading cards.

A maximum of two card readers can be connected to a 3301 system at any one time via the 3329 Card Reader Control (1 per card reader). The Simultaneous Mode channel concerned (Simo 1 or Simo 2) is engaged throughout the 40.6 milliseconds subsequent to the card read instruction. Completion of each card reader operation causes interruption of the main processor program on a "Normal" or "Abnormal" end of operation condition.

Parity checks are made upon all transfers, and the data read from each card can be stored in any area in High Speed Memory. Protection of this input area during the read operation is a program responsibility; there is no automatic lockout during the gradual filling up of the input area.

The basic theoretical load on the central processor consists simply of the core cycles required for the actual transfer of data into High Speed Memory. This amounts to a maximum of 0.17% (translated) or 0.34% (untranslated) per card. Allowing for a further 50 microseconds of central processor time per card to handle the interrupt, the total processor load would be approximately 0.28% or 0.45%, respectively.

The Model 329 Card Reader was designed by Uptime Corporation. It was initially delivered to RCA in Spring, 1963, for testing purposes.

INPUT–OUTPUT: 3436 CARD PUNCH

§ 073.

.1 GENERAL

.11 Identity: . . . . Card Punch.
Model 3436.

.12 Description

The Model 3436 Card Punch punches standard 80-column cards at a rated speed of 300 cards per minute. The rated speed can be maintained if each punch instruction is issued within a 26-millisecond period near the end of the 200-millisecond cycle of the previous punch instruction. The unit has a single clutch point, so that a speed of 200 cards per minute can be expected under random timing conditions. Use of the "Buffer Available" interrupt facility allows the programmer to maintain close control of his punching instructions and should permit full rated speed to be reached.

Punching is done on a row by row basis by a yoke of 80 die punches. Automatic translation into Hollerith code is optional; otherwise, column binary cards are punched. Column binary format is two characters per column, with the more significant character at the bottom of the card column. This format is compatible with the column binary card read instruction.

.12 Description (Contd.)

Accuracy controls include a parity check on each character transmitted to the control unit and a hole count check after punching on each card. Any failure of these checks automatically directs the card into a special Reject Stacker and causes an interrupt when the next punch instruction is issued. Programming can also direct cards into the 450-card Reject Stacker or a 730-card Auxiliary Stacker, as well as into the standard 3,000-card Normal Stacker. These stackers and the 3,000-card Input Hopper are sufficient to keep the unit operating for ten minutes without attention.

One or two card punches, each with its own control and buffer unit, can be connected to the RCA 3301. The Simultaneous Mode channel concerned (Simo 1 or Simo 2) is occupied only until the buffer is loaded; this takes 2.9 milliseconds per card. Central Processor loading is only 0.05 or 0.10 per cent, depending upon whether Hollerith or column binary data is being punched.

This card punch was designed by Bull in France. Manufacturing details have not been announced to date.

INPUT-OUTPUT: PAPER TAPE READERS

§ 074.

.1 GENERAL

.11 Identity: . . . . Paper Tape Reader (1,000 char/sec). Model 322.

Paper Tape Reader/Punch (100 char/sec). Model 321.

.12 Description

The Model 322 Paper Tape Reader operates at 1,000 characters per second when gaps of at least 3 rows are included between data messages; otherwise, its peak speed is 500 characters per second. Model 321 is a joint Paper Tape Reader/Punch that operates at 100 characters per second. Operationally, the two readers are identical, and any two can be connected via their respective controls to an RCA 3301 system.

Five-, six-, seven-, or eight-channel punched tape can be read. A special feature permits "advance sprocket" tapes (used with some typesetting systems) to be read as well as the standard tapes. All holes must be fully punched. Each row read from the tape is converted to a single six-bit character code. Five-channel tape, therefore, always has a zero bit placed in the most significant (2^5) position. (There is no equivalent of the Communications Mode Control's facility to note whether a letter shift or a figure shift has preceded the character, and to insert a 1 or 0 bit accordingly). Six-channel code is stored unchanged, while seven-channel code has its parity bit stripped off. Each eight-channel code is treated as two characters, with the contents of six channels being placed in one High Speed Memory position and the other two channels in the next higher position.

In all cases, a hole is considered as a zero bit in High Speed Memory — not a one as in most EDP equipment.

.12 Description (Contd.)

Translation to RCA 3301 internal code is accomplished simply in the case of six- or seven-channel codes, using the translate tables. The load on the central processor due to the code translation is 4.5 microseconds per character, in addition to the 1.9 microseconds used to store the character itself in High Speed Memory. The total cost is, therefore, under 0.75% of the total processor capacity when reading at 1,000 characters per second, and proportionately less at lower reading rates.

In the case of five- and eight-channel tape, code translation is less straightforward. The cost of translating these codes is not presently defined, but in both cases it will have to be done on a character-by-character basis by the computer program. A figure of 50 microseconds per character appears reasonable for such a routine, making the total cost 5.6% of the processor capacity at 1,000 characters per second, and proportionately less at the lower speeds.

Instructions are available which read a block of data from punched tape into High Speed Memory. Reading can be forward or backward along the tape, and the data is stored in the same sequence regardless of the direction of tape movement.

The reading is performed by photoelectric cells. Checking of odd or even parity can be done by plugboard control. The action of the photo-diodes is not tested. Operational checks of the equipment are made by the central processor, and an abnormal interrupt occurs if the device has no power or is otherwise interlocked.

The Model 3321 Paper Tape Control is used with both paper tape readers. This control handles one paper tape reader and one paper tape punch. Two paper tape controls can be connected to any RCA 3301 system.

Both the Model 321 Reader/Punch and the Model 322 Reader are manufactured by RCA and have been used in RCA 301 EDP Systems.

INPUT-OUTPUT: PAPER TAPE PUNCHES

§ 075.

.1 GENERAL

.11 Identity: . . . . Paper Tape Punch (100 char/sec). Model 331.

Paper Tape Reader/ Punch (100 char/sec). Model 321.

.12 Description

Both of the paper tape punches available with the RCA 3301 operate at 100 characters per second. The Model 331 is solely a punch, while the Model 321 is a combination paper tape reader/punch unit. Both punches use the same instructions, and any two can be connected to an RCA 3301 system.

Seven-channel punched tape can be produced. With optional features, five-or eight-channel tapes can also be punched. By means of another special feature, tapes with "advance sproket" holes can be punched. Punching of conventional tapes is precluded, however, when the advanced sprocket feature is installed. Switches for the selection of number of channels and parity mode (odd, even, of no parity) are provided. The Paper Tape Reader/Punch has a switch that permits punching gapless tape. Each "zero" bit in HSM becomes a hole on punched tape, and each "one" bit becomes a "no hole."

.12 Description (Contd.)

The punched tape output instruction specifies the punch and the data channel to be used (Simo 1 or Simo 2), and the High Speed Memory locations of the first and last character to be punched. A three-character gap is automatically generated after each block of data unless gapless tape has been specified. One 2.25-microsecond cycle is used to transfer each character code from High Speed Memory. Non-standard codes of up to 6 data levels can readily be handled by means of the 3301's "Translate by Table" instruction, which takes only 4.5 microseconds per character translated. Five-channel Baudot tape and eight-channel tape present special problems, as discussed in the Paper Tape Readers section (703:074).

Accuracy control consists of parity checks on each transmitted character code in the processor, the control unit, and the punch itself; and an "echo" check which determines whether the proper die punches have been actuated. Detection of an error causes an interrupt indicator to be set.

The Model 3321 Paper Tape Control is used with both paper tape punches. This control handles one paper tape reader and one paper tape punch. Two paper tape controls can be connected to an RCA 3301 system.

The Model 331 Paper Tape Punch and the Model 321 Paper Tape Reader/Punch are currently operating in RCA 301 systems. They are scheduled for delivery with the RCA 3301 during 1964.

INPUT–OUTPUT: HIGH SPEED PRINTERS

§ 081.

.1 GENERAL

.11 Identity: . . . . On-Line Printer.
Model 333 (120 print positions).
Model 335 (160 print positions).

.12 Description

The Model 333 and 335 Printers can print at a maximum rate of 1,000 single-spaced lines per minute, using 47 characters, or at a maximum rate of 800 lines per minute when the full set of 64 characters is used. The highest speed with the restricted character set is obtained by advancing the paper while the seventeen unused characters (positions 16 through 32 in the table below) are passing through the printing positions; this is called the "Synchronous Mode," because it is synchronized with the revolving print drum and has effectively one clutch point per cycle. By contrast, the full character set mode provides 64 clutch points during the cycle and is called "Asynchronous Printing." In general, Asynchronous Printing gives better results in almost all cases except at single line spacing (see graph).

The printing is done by an on-the-fly hammer stroke which presses the ribbon and paper against the engraved drum. Up to 6 copies can be printed at once. The two models differ only in line length: Model 333 has 120 printing positions and Model 335 has 160.

Standard vertical spacing is 6 lines to the inch. An optional switch permits manual selection of either 6 or 8 lines to the inch or 6 or 10 lines to the inch. Skipping can be done under program control, with

.12 Description (Contd.)

the number of lines to be skipped after printing stipulated in the instruction. Alternatively, skipping can be defined in connection with two channels of a paper tape loop. One of these channels is normally used to define the heading position on the page. Skipping speed (after the first line, which always takes 15 milliseconds) is 25 inches per second. This is equivalent to 150 lines per second at 6 lines to the inch.

There are checks on the overall operation of the printer (e.g., paper present, power turned on) and on the parity of the data supplied. There are, however, no checks on the actual printing itself, or (which is applicable in the Synchronous Mode only) on the validity of the characters supplied.

A maximum of two printers (each with its own Printer Control Unit) can be connected to an RCA 3301 system. The Printer Control Unit is buffered and occupies the Simultaneous Mode output channel (Simo 1 or Simo 2) only while the buffer is being loaded. This takes less than 0.03% of the Central Processor time during each print cycle, and can be done while the paper is being advanced after printing the preceding line.

The Buffer Available interrupt, which occurs when the line has been printed and before the paper has advanced, allows the programmer to maintain a close control on the printing operation, and should permit the maximum possible speed to be obtained operationally.

The Model 333 and 335 On-Line Printers are manufactured by Anelex Corporation to RCA's specifications, and are currently operating with the RCA 301 computer.

§ 081. STANDARD CHARACTER SET

(Models 333 and 335 On-Line Printers)

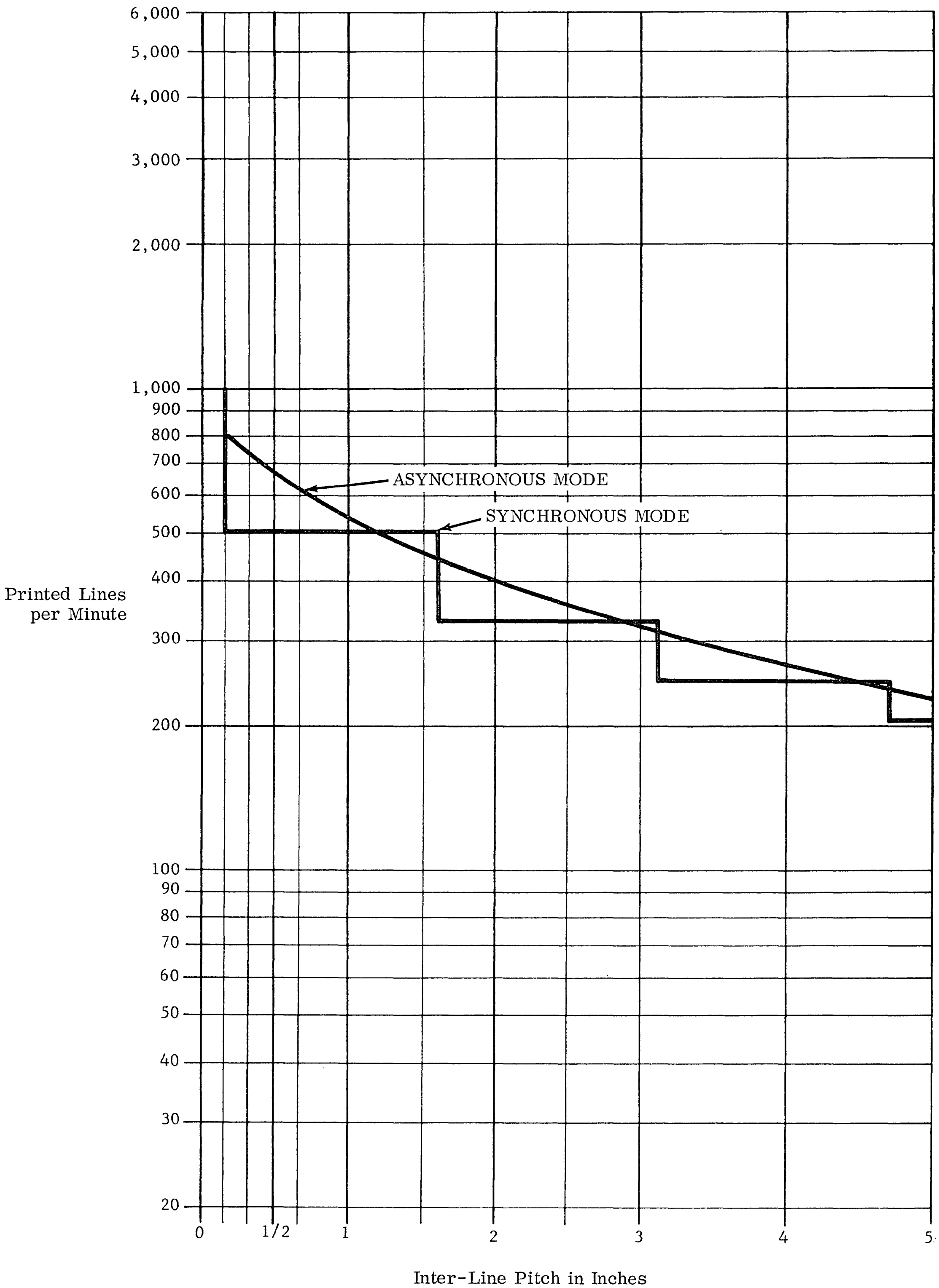
Table* Position	Character	Printed Symbol	Table* Position	Character	Printed Symbol
1	Minus	-	33	A	A
2	Plus	+	34	B	B
3	Space		35	C	C
4	Zero	0	36	D	D
5	One	1	37	E	E
6	Two	2	38	F	F
7	Three	3	39	G	G
8	Four	4	40	H	H
9	Five	5	41	I	I
10	Six	6	42	J	J
11	Seven	7	43	K	K
12	Eight	8	44	L	L
13	Nine	9	45	M	M
14	Comma	,	46	N	N
15	Period	.	47	O	O
16	At the Rate Of	@	48	P	P
17	Percent	%	49	Q	Q
18	Colon	:	50	R	R
19	Number	#	51	S	S
20	Dollar Sign	$	52	T	T
21	Close Parenthesis	)	53	U	U
22	Quotation Mark	"	54	V	V
23	Subscript $_{10}$	$_{10}$	55	W	W
24	Open Parenthesis	(	56	X	X
25	Close Bracket	]	57	Y	Y
26	Semicolon	;	58	Z	Z
27	Greater	>	59	Credit	C_R
28	Divide	÷	60	Apostrophe	'
29	Up Arrow	↑	61	Asterisk	*
30	Open Bracket	[	62	Ampersand	&
31	Less	<	63	Virgule	/
32	Equal	=	64	Lozenge	⌑

*Table positions correspond to print positions on the drum.

§ 081.

EFFECTIVE SPEED

Models 333 and 335 On-Line Printers



INPUT-OUTPUT: 581 TAPE STATION

§ 091.

.1 GENERAL

.11 Identity: . . . . Tape Station. Model 581.

.12 Description

The Model 581 Tape Station is one of five magnetic tape stations available for the RCA 3301 system. It has also been used with the RCA 301, 501, and 601 systems, and can provide a basis for tape compatibility among these systems. The peak data transfer rate is 33,333 characters per second, and reading can be either forward or backward. (The control unit makes reading in both directions appear the same to the user.)

Information is recorded in variable length blocks on 2,450-foot reels. When used to store blocks of 1,000 characters, the capacity of each reel is 8.4 million characters. The inter-block gap length is only 0.34 inch, so that for blocks of less than 120 characters this unit is faster than the other tape stations, even though its peak transfer rate is the slowest. Any combination of Model 581, 582, and 681 Tape Stations can be connected to the same control unit, so this factor may be worth noting in specific applications.

The data recorded on tape is safeguarded in two ways:

(1) An "echo" parity check is made upon the record head current during recording.

(2) Each character code, with the appropriate parity bit added, is recorded twice, in two duplicate bands located side by side on the 3/4-inch-wide tape.

When data is read back, only one of the two recorded bands is read initially. If a parity error is noted in a character code, then the corresponding code in the other band is read. If its parity is correct, it is used in place of the incorrect code. If the second character code also has incorrect parity, then a special error character is inserted into High Speed Memory in its place, and an interrupt indicator is set.

It should be noted that there is no read-after-write or similar positive check to detect recording errors at the time of occurrence.

The control unit is called a Dual Tape Channel and incorporates a 2 x 6 or 2 x 12 internal switch, allowing a maximum of 6 or 12 tape stations to be connected. Two controls can be connected to an RCA 3301 system, allowing a maximum total of 24 tape stations. Simultaneous READ/READ, READ/WRITE, or WRITE/WRITE operations can be performed as instructed by any two of the tape stations connected to a single Dual Tape Channel.

The Simo Mode (data channel) concerned with a magnetic tape transmission is fully utilized from the time it is first allocated until the data transmission ceases. No other use can be made of the data channel, for instance, while a tape station is getting up to speed or while a gap is being passed over. Either of the two standard data channels (Simo Mode 1 or 2) or the optional Simo Mode 3 can be utilized.

.13 Availability: . . . . stock.

.14 First Delivery: . . . . . . September, 1959 (with RCA 301).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . . pinch roller friction.
.212 Reservoirs —
Number: . . . . 2.
Form: . . . . bin which senses tape weight.
Capacity: . . . . 25 feet.
.213 Feed drive: . . . . electric motor.
.214 Take-up drive: . . . . electric motor.

.22 Sensing and Recording Systems

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

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

.24 Arrangement of Heads

Use of station: . . . . reading or recording.
Stacks: . . . . 1.
Heads/stack: . . . . 16 (8 dual).
Method of use: . . . . one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable coating.
.312 Phenomenon: . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 333.3 rows per inch; N limited by available core storage.
.322 Parallel by: . . . . 16 tracks.
.323 Bands: . . . . 2; duplicate patterns.

§ 091.

.324 Track use (duplicated on each band) —
- Data: . . . . 6.
- Redundancy check: . . . 1.
- Timing: . . . . 1.
- Control signals: . . . . . 0.
- Unused: . . . . 0.
- Total: . . . . 8.

.325 Row use: . . . . all for data.

.33 Coding: . . . . as in Data Code Table, Section 703:141.

.34 Format Compatibility

Other device or System	Code translation
RCA 301 EDP System:	none required.
RCA 301 EDP System:	by program.
RCA 301 EDP System:	by program.

.35 Physical Dimensions

.351 Overall width: . . . . 0.75 inch.
.352 Length: . . . . 2,450 feet on a 10.5-inch diameter reel.

.4 CONTROLLER

.41 Identity: . . . . 3383-6 Dual Tape Channel. 3383-12 Dual Tape Channel.

.42 Connection to System

.421 On-line: . . . . 1 or 2 controllers.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . 6 Magnetic Tape Stations can be connected to each Model 3383-6; 12 to each Model 3383-12. Any combination of Model 581, 582, and 681 Tape Stations can be utilized. Model 3485 Tape Stations cannot be connected to this controller.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N char, 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 char, limited by available core storage.
.512 Block demarcation —
- Input: . . . . gap on tape.
- Output: . . . . limit counter.

.52 Input-Output Operations

.521 Input: . . . . one block forward or backward; input stopped by gap or limit cut-off. Characters in HSM are in forward order regardless of direction of read.
.522 Output: . . . . one block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . End File, End Data, End Block codes.
.526 Searching: . . . . none.

.53 Code Translation: . . . . matched codes.

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

.55 Control Operations

- Disable: . . . . no.
- Request interrupt: . . . . no.
- Select format: . . . . no.
- Select code: . . . . no.
- Rewind: . . . . yes.
- Unload: . . . . no.

.56 Testable Conditions

- Disabled: . . . . yes.
- Busy device: . . . . yes.
- Output lock: . . . . no.
- Nearly exhausted: . . . . yes.
- Busy controller: . . . . . yes.
- End of medium marks: . . . . yes (at beginning).
- Tape moving backward: . . . . yes.
- Exhausted: . . . . no (station becomes inoperable).

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: . . . . 33,333 char/sec.
.622 Important parameters —
- Up to speed: . . . . 2.5 msec.
- Start distance: . . . . . . 0.075 ± 0.050 in.
- Start-write delay: . . . . 3.5 msec.
- Read-stop distance: . . . 0.115 to 0.190 in.
- Write-stop distance: . . 0.215 to 0.358 in.
- Write-to-read switching time: . . . . 4.5 ± 0.9 msec.
- Density: . . . . 333.3 rows/inch.
- Running speed: . . . . . 100 in/sec.
- Inter-block gap: . . . . . 0.34 in. minimum; 0.46 in. when stopping between blocks.
- Full rewind time: . . . . 5 minutes.

.623 Overhead: . . . . 3.4 msec per block (tape moving at full speed).
.624 Effective speeds: . . . . . 33,333N/ (N + 113) char/sec (See graph 703:091.800).

§ 091.

.63 Demands on System

Component	msec per block	or	Percentage of transfer time
Processor:	0.0008N		3.25
Simo Mode:	3.5 + 0.03N		100

N = Number of characters per block.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . none.

.72 Other Controls

Function	Form	Comment
Write enable:	ring on spool	ring permits recording.
Energize motors and servo system:	button.	
Stabilize:	button	allows proper loading of tape bins.
Manual wind:	button	forward or backward.
Manual erase:	button	while winding tape forward.
Switch station to computer control:	buttons	local or remote (computer control).

.73 Loading and Unloading

.731 Volumes handled —

Storage	Capacity
Reel of 2,400 feet minimum usable:	. 9,600,000 characters, less 113 characters per block gap.

.732 Replenishment time: . . 1 minute; tape station must be stopped.

.734 Optimum reloading period: . . . . 4.7 minutes

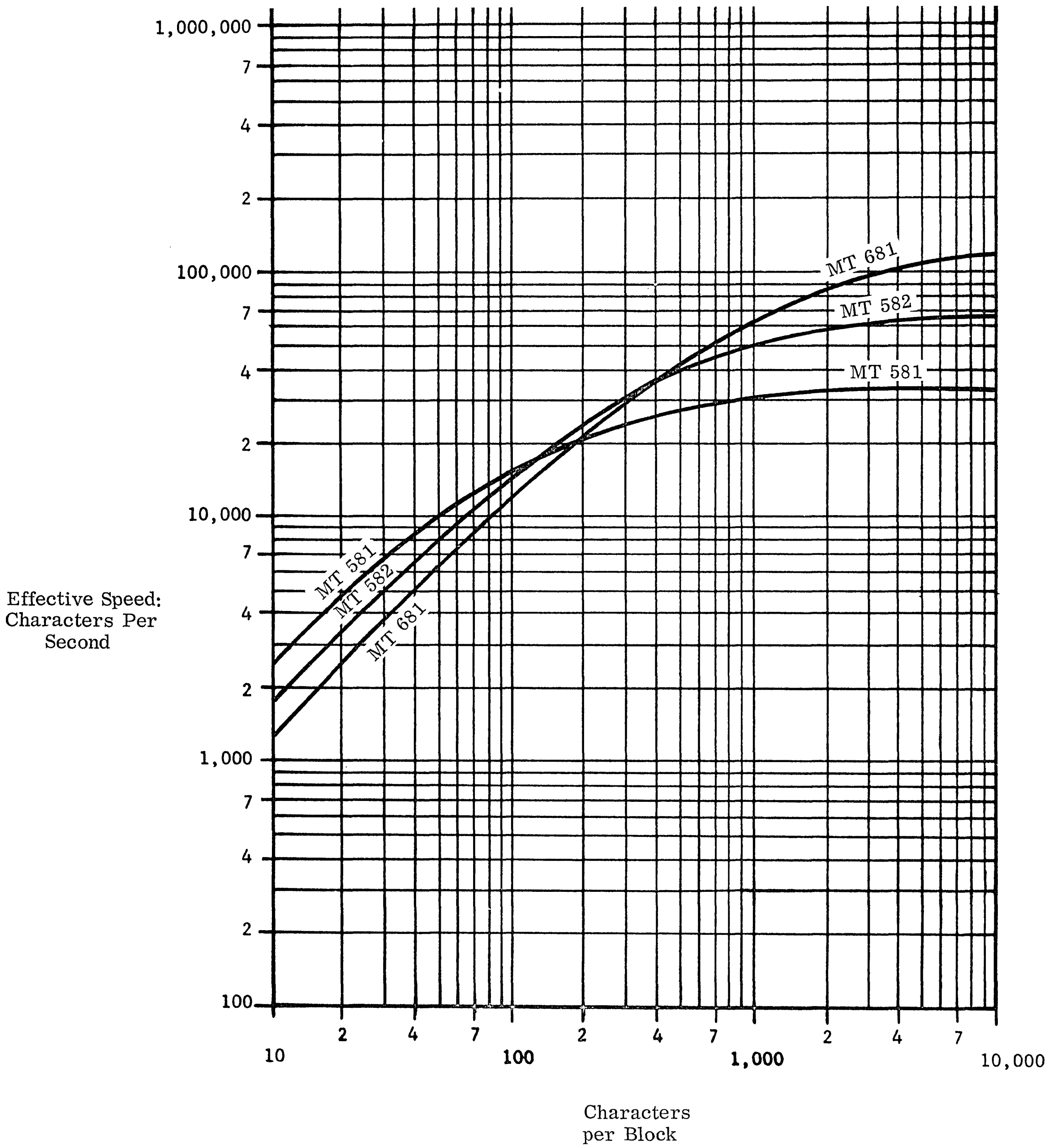
.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo parity	set indicator, interrupt.
Reading:	row parity	set indicator, interrupt.
Input area overflow:	limit counter interlock	cut-off indicator, interrupt.
Output block size:	limit counter interlock	cut-off indicator, interrupt.
Invalid code:	all codes valid.	
Exhausted medium:	interlock	set indicator, interrupt.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Inoperable device:	check	set indicator, interrupt.

§ 091.

EFFECTIVE SPEEDS

Model 581, 582, and 681 Tape Stations



N.B. These speeds take full advantage of "hot starts" in which there is no deceleration between blocks.

INPUT-OUTPUT: 582 TAPE STATION

§ 092.

.1 GENERAL

.11 Identity: . . . . Tape Station. Model 582.

.12 Description

The Model 582 Tape Station is one of five magnetic tape stations available for the RCA 3301 system. It has also been used with the RCA 301, 501, and 601 systems, and can provide a basis for tape compatibility among these systems. The peak data transfer rate is 66,667 characters per second, and reading can be either forward or backward. (The control unit makes reading in both directions appear the same to the user.)

Information is recorded in variable length blocks on 2,450-foot reels. When used to store blocks of 1,000 characters, the capacity of each reel is 14.5 million characters. The inter-block gap length is 0.54 inches, so that for blocks of less than 120 characters, this unit has a lower effective speed than the Model 581 Tape Station, whose peak data transfer rate is only half as high.

Data is safeguarded in three ways:

(1) As the data is recorded on tape, a read-after-write parity check is made upon each character.

(2) Guard characters are placed in front of and behind each block on tape, providing a safeguard against the misinterpretation of noise in the inter-block gaps without placing any restrictions on the allowable block lengths.

(3) Each character code, with the appropriate parity bit added, is recorded twice, in two duplicate bands located side by side on the 3/4-inch-wide tape.

When data is read back, only one of the two recorded bands is read initially. If a parity error is noted in a character code, then the corresponding code in the other band is read. If its parity is correct, it is used in place of the incorrect code. If the second character code also has incorrect parity, then a special error character is inserted into High Speed Memory in its place, and an interrupt indicator is set.

The control unit is called a Dual Tape Channel and incorporates a 2 x 6 or 2 x 12 internal switch, allowing a maximum of 6 or 12 tape stations to be connected. Two controls can be connected to an RCA 3301 system, allowing a maximum total of 24 tape stations. Any combination of Model 581, 582, and 681 Tape Stations can be connected to the same control unit. Simultaneous READ/READ, READ/WRITE, or WRITE/WRITE operations can be performed as

.12 Description (Contd.)

instructed by any two of the tape stations connected to a single Dual Tape Channel.

The Simo Mode (data channel) concerned with a magnetic tape transmission is fully utilized from the time it is first allocated until the data transmission ceases. No other use can be made of the data channel, for instance, while a tape station is getting up to speed or while a gap is being passed over. Either of the two standard data channels (Simo Mode 1 or 2) or the optional Simo Mode 3 can be utilized.

.13 Availability: . . . . stock.

.14 First Delivery: . . . . . . January, 1962 (with RCA 501).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . pinch roller friction.
.212 Reservoirs —
Number: . . . . 2.
Form: . . . . bin which senses tape weight.
Capacity: . . . . 25 feet.
.213 Feed drive: . . . . electric motor.
.214 Take-up drive: . . . . electric motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . . magnetic head.
.222 Sensing system: . . . . . . magnetic head.
.223 Common system: . . . . . two-gap head.

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

.24 Arrangement of Heads

Use of station: . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . 16 (8 dual).
Method of use: . . . . one row at a time.

Use of station: . . . . recording.
Distance: . . . . 0.2 inch ahead of read head.
Stacks: . . . . 1.
Heads/stack: . . . . 16 (8 dual).
Method of use: . . . . one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable coating.
.312 Phenomenon: . . . . magnetization.

§ 092.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 666.7 rows per inch; N limited by available core storage.
.322 Parallel by: . . . . 16 tracks.
.323 Bands: . . . . 2; duplicate patterns.
.324 Track use (duplicated on each band) —
Data: . . . . 6.
Redundancy check: . . . 1.
Timing: . . . . 1.
Control signals: . . . . . 0.
Unused: . . . . 0.
Total: . . . . 8.
.325 Row use: . . . . all for data.

.33 Coding: . . . . as in Data Code Table, Section 703:141.

.34 Format Compatibility

Other device or system	Code translation
RCA 301 EDP System:	none required.
RCA 501 EDP System:	by program.
RCA 601 EDP System:	by program.
Tape Station, Model 681:	none required; 582 must be set for "Long Gap" and 681 for 666.7 rows/inch density.

.35 Physical Dimensions

.351 Overall width: . . . . 0.75 inch.
.352 Length: . . . . 2,450 feet on a 10.5-inch diameter reel.

.4 CONTROLLER

.41 Identity: . . . . 3383-6 Dual Tape Channel. 3383-12 Dual Tape Channel.

.42 Connection to System

.421 On-line: . . . . 1 or 2 controllers.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . 6 Magnetic Tape Stations can be connected to each Model 3383-6; 12 to each Model 3383-12. Any combination of Model 581, 582, and 681 Tape Stations can be utilized. Model 3485 Tape Stations cannot be connected to this controller.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N char, 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 char, limited by available core storage.
.512 Block demarcation —
Input: . . . . gap on tape.
Output: . . . . limit counter.

.52 Input-Output Operations

.521 Input: . . . . one block forward or backward; input stopped by gap or limit cut-off. Characters in HSM are in forward order regardless of direction of read.
.522 Output: . . . . one block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . End File, End Data, End Block codes.
.526 Searching: . . . . none.

.53 Code Translation: . . . . matched codes.

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

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . . no.
Select format: . . . . no.
Select code: . . . . no.
Rewind: . . . . yes.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Output lock: . . . . no.
Nearly exhausted: . . . . . yes (75 feet from physical end of tape).
Busy controller: . . . . . yes.
End of medium marks: . . yes (at beginning).
Tape moving backward: . yes.
Exhausted: . . . . no (station becomes inoperable).

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: . 66,667 char/sec.
.622 Important parameters —
Up to speed: . . . . 2.5 msec.
Start-write delay: . . . . . 5.5 msec.
Write-stop distance: . . . 0.415 to 0.558 in.
Density: . . . . 666.7 rows/inch.
Running speed: . . . . 100 in/sec.
Inter-block gap: . . . . . . 0.54 in., minimum; 0.66 in. when stopping between blocks.
Full rewind time: . . . . . 3.2 minutes.
.623 Overhead: . . . . 5.5 msec per block (tape moving at full speed).
.624 Effective speeds: . . . . . 66,667N/ (N + 367) char/sec. (See graph 703:091.800).

§ 092.

.63 Demands on System

Component	msec per block	or	Percentage of transfer time
Processor:	0.0008N	or	6.5
Simo Mode:	5.5 + 0.015N	or	100.0

N = No. of characters per block.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . . none.

.73 Loading and Unloading

.731 Volumes handled —

Storage	Capacity
Reel of 2,400 feet minimum usable: . .	19,200,000 characters, less average of 367 characters per inter-block gap.

.732 Replenishment time: . . . 1 minute; tape station must be stopped.

.734 Optimum reloading period: . . . . 4.7 minutes.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write row parity	set indicator, interrupt.
Reading:	row parity	set indicator, interrupt.
Input area overflow:	limit counter interlock	set indicator, interrupt.
Output block size:	limit counter interlock	set indicator, interrupt.
Invalid code:	all codes valid.	
Exhausted medium:	interlock	set indicator, interrupt.
Imperfect medium:	none.	
Timing conflict:	interlock	wait:
Inoperable device:	check	set indicator, interrupt.

INPUT-OUTPUT: 681 TAPE STATION

§ 093.

.1 GENERAL

.11 Identity: . . . . Tape Station.
Model 681.

.12 Description

The Model 681 Tape Station is the fastest of the five available magnetic tape stations for the RCA 3301 system. It has also been used with the RCA 601 system. Tape compatibility with the RCA 301 and 501 can be achieved by using the same tapes on Model 582 Tape Stations connected to these systems. Peak data transfer rate for the Model 681 is 120,000 characters per second, and reading can be either forward or backward. (The control unit causes the character codes to be arranged in forward order in High Speed Memory regardless of the direction of reading.)

Information is recorded at a density of 800 characters per inch in variable length blocks on 2,450-foot reels. When used to store blocks of 1,000 characters, the capacity of each reel is 11.7 million characters. The inter-block gap length is 1.1 inches, so that for blocks of less than 160 characters this unit is slower than the other tape stations, even though its peak transfer rate is the fastest. Any combination of Model 581, 582, and 681 Tape Stations can be connected to the same control unit, so this factor may be worth noting in specific applications.

Data is safeguarded in three ways:

(1) As the data is recorded on tape, a read-after-write parity check is made upon each character.

(2) Guard characters are placed in front of and behind each block on tape, providing a safeguard against the misinterpretation of noise in the inter-block gaps without placing any restrictions on the allowable block lengths.

(3) Each character code, with the appropriate parity bit added, is recorded twice, in two duplicate bands located side by side on the 3/4-inch-wide tape.

When data is read back, only one of the two recorded bands is read initially. If a parity error is noted in a character code, then the corresponding code in the other band is read. If its parity is correct, it is used in place of the incorrect code. If the second character code also has incorrect parity, then a special error character is inserted into High Speed Memory in its place, and an interrupt indicator is set.

.12 Description (Contd.)

The control unit is called a Dual Tape Channel and incorporates a 2 x 6 or 2 x 12 internal switch, allowing a maximum of 6 or 12 tape stations to be connected. Two controls can be connected to an RCA 3301 system, allowing a maximum total of 24 tape stations. Simultaneous READ/READ, READ/WRITE, or WRITE/WRITE operations can be performed as instructed by any two of the tape stations connected to a single Dual Tape Channel.

The Simo Mode (data channel) concerned with a magnetic tape transmission is fully utilized from the time it is first allocated until the data transmission ceases. No other use can be made of the data channel, for instance, while a tape station is getting up to speed, or while a gap is being passed over. Either of the two standard data channels (Simo Mode 1 or 2) or the optional Simo Mode 3 can be utilized for magnetic tape operations.

.13 Availability: . . . . stock.

.14 First Delivery: . . . . . April, 1963 (with RCA 601 system).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.

.212 Reservoirs —
Number: . . . . 2.
Form: . . . . bin which senses tape weight.
Capacity: . . . . 25 feet.

.213 Feed drive: . . . . electric motor.

.214 Take-up drive: . . . . electric motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . . magnetic head.
.223 Common system: . . . . two-gap head.

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

.24 Arrangement of Heads

Use of station: . . . . . . reading.
Stacks: . . . . 1.
Heads/stack: . . . . . . 16 (8 dual).
Method of use: . . . . . . one row at a time.

Use of station: . . . . . . recording.
Distance: . . . . 0.2 inch ahead of read head.
Stacks: . . . . 1.
Heads/stack: . . . . . . 16 (8 dual).
Method of use: . . . . . . one row at a time.

§ 093.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . plastic tape with magnetizable coating.
.312 Phenomenon: . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 800 rows per inch; N limited by available core storage.
.322 Parallel by: . . . . 16 tracks.
.323 Bands: . . . . 2; duplicate patterns.
.324 Track use (duplicated on each band) —
Data: . . . . 6.
Redundancy check: . . 1.
Timing: . . . . 1.
Control signals: . . . . 0.
Unused: . . . . 0.
Total: . . . . 8.
.325 Row use: . . . . all for data.

.33 Coding: . . . . as in Data Code Table, Section 703:141.

.34 Format Compatibility

Other device or system	Code translation
RCA 501 EDP System:	by program.
Tape Station, Model 582:	none required; 681 must be set for 666.7 rows/inch density and 582 for "Long Gap."

.35 Physical Dimensions

.351 Overall width: . . . . . . 0.75 inch.
.352 Length: . . . . 2,450 feet on a 10.5-inch diameter reel.

.4 CONTROLLER

.41 Identity: . . . . 3383-6 Dual Tape Channel. 3383-12 Dual Tape Channel.

.42 Connection to System

.421 On-line: . . . . 1 or 2 controllers.
.422 Off-line: . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . 6 Magnetic Tape Stations can be connected to each Model 3383-6; 12 to each Model 3383-12. Any combination of Model 581, 582, and 681 Tape Stations can be utilized. Model 3485 Tape Stations cannot be connected to this controller.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N char, 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 char, limited by available core storage.
.512 Block demarcation
Input: . . . . gap on tape.
Output: . . . . limit counter.

.52 Input-Output Operations

.521 Input: . . . . one block forward or backward; input stopped by gap or limit cut-off. Characters in HSM are in forward order regardless of direction of read.
.522 Output: . . . . one block forward.
.523 Stepping: . . . . none.
.524 Skipping: . . . . none.
.525 Marking: . . . . End File, End Data, End Block codes.
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes.

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

.55 Control Operations

Disable: . . . . no.
Request interrupt: . . . no.
Select format: . . . . . . no.
Select code: . . . . no.
Rewind: . . . . yes.
Unload: . . . . no.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Output lock: . . . . no.
Nearly exhausted: . . . . yes (75 feet from physical end of tape).
Busy controller: . . . . . yes.
End of medium marks: . . . . yes (at beginning).
Tape moving backward: . . . . yes.
Exhausted: . . . . no (station becomes inoperable).

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: . . . . 120,000 char/sec.

§ 093.

.622 Important parameters —
- Start-write delay: . . . 6.0 msec (includes up-to-speed time).
- Density: . . . . 800 rows/inch.
- Running speed: . . . . 150 in/sec.
- Interblock gap: . . . . 1.1 in. minimum; ? when stopping between blocks.
- Full rewind time: . . . 2.4 minutes.
- Read-after-write data delay: . . . . . . 1.3 msec.

.623 Overhead: . . . . 7.3 msec per block (tape moving at full speed).

.624 Effective speeds: . . . . 120,000N/ (N + 880) char/sec. (See graph 703:091.800).

.63 Demands on System

Component	msec per block	or	Percentage of transfer time
Processor:	0.0008N	or	11.5
Simo Mode:	7.3 + 0.0083N	or	100.0

N = No. of characters per block.

.7 EXTERNAL FACILITIES

.71 Adustments: . . . . . . none.

.72 Other Controls

Function	Form	Comment
Write enable:	ring on spool	ring permits recording.
Energize motors and servo system:	button.	
Stablize:	button	allows proper loading of tape bins.
Manual wind:	button	forward or backward.
Manual rewind:	button	positions tape at start of reel.
Manual erase:	button	while winding tape forward.
Switch station to computer control:	buttons	local or remote (computer control).

.73 Loading and Unloading

.731 Volumes handled —

Storage	Capacity
Reel of 2,400 feet minimum usable:	22,560,000 characters, less average of 880 characters per inter-block gap.

.732 Replenishment time: . . 1 minute; tape station must be stopped.

.734 Optimum reloading period: . . . . 3.2 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write row parity	set indicator, interrupt.
Reading:	row parity	set indicator, interrupt.
Input area overflow:	limit counter interlock	set indicator, interrupt.
Output block size:	limit counter interlock	set indicator, interrupt.
Invalid code:	all codes valid.	
Exhausted medium:	interlock	set indicator, interrupt.
Imperfect medium:	none.	
Timing conflict:	interlock	wait.
Inoperable device:	check	set indicator, interrupt.

INPUT-OUTPUT: 3485 TAPE STATION

§ 094.

.1 GENERAL

.11 Identity: . . . . Tape Station Model 3485.

.12 Description

The Model 3485 Tape Station provides magnetic tape compatibility with IBM 727, 729, and 7330 Magnetic Tape Units. The tape transport speed is 150 inches per second, giving a peak data rate of 120,000 characters per second at a density of 800 characters per inch. Densities of 200 and 556 characters per inch can also be used for both reading or writing. Peak and effective data transfer rates at each density are shown in the table below.

Data can be read and recorded on 2,400-foot reels of 1/2-inch wide, 7-channel tape in any of three modes: IBM-compatible BCD (even parity) Mode, IBM-compatible Binary (odd parity) Mode, or "RCA Mode", in which each block on tape is preceded and followed by a guard character. Code compatibility can readily be achieved by means of the RCA 3301's efficient "Translate by Table" instruction.

Recording density can be 200, 556, or 800 characters per inch. Interblock gap length is 0.75 inch, start time is 3 milliseconds, and read-after-write stop delay is 2 milliseconds. Peak and effective data transfer rates are as follows; the effective rates are based upon 1,000-character blocks, with no deceleration between blocks.

Density char/inch	Peak Rate, char/sec.	Effective Rate, char/sec.
200	30,000	26,100
556	83,400	58,900
800	120,000	75,000

Reading can be either forward or backward, although the "Read Reverse" instructions are applicable only to tapes written in the RCA Mode. Recording mode and density are program-selected. Rewinding speed is 300 inches per second; backspace operations occur at the normal speed of 150 inches per second. The "Erase" instruction erases a portion of tape equivalent to the length of tape required to hold any specified number of characters. The current status of any specified Tape Station can be determined by using the "Test Device" instruction to interrogate one or more of twelve condition indicators.

.12 Description (Contd.)

Either of the two standard data channels (Simo Mode 1 or 2) or the optional Simo Mode 3 can be used for a magnetic tape input-output operation. The selected data channel is fully occupied from the time it is allocated until the data transmission ceases. Data transfers to and from High Speed Memory are by diad, so one 1.9-microsecond cycle is required for each pair of characters read or written.

There are three major controls upon read/write accuracy:

(1) As the data is recorded on tape, a read-after-write parity check is made upon each character. Detection of a write error causes termination of the write operation and setting of an interrupt indicator.

(2) Lateral and longitudinal parity bits are generated during recording and checked during reading. When a read error is detected, an interrupt indicator is set and all characters with incorrect parity are replaced by "error characters" in High Speed Memory.

(3) In the RCA Mode only, guard characters are written in front of and behind each block on tape, providing a safeguard against misinterpretation of noise in the inter-block gaps. In the IBM-compatible modes, the program is responsible for detecting "noise blocks" less than 12 or 13 characters in length and discarding them.

A maximum of 6 or 12 tape stations can be controlled by a Dual Tape Channel. Each control permits simultaneous read/read, read/write, or write/write operations by any two of the tape stations connected to it. Two Dual Tape Channels can be connected to an RCA 3301 system, allowing a maximum total of 24 tape stations.

There are specific controllers for each tape station model, and each controller can only handle tape stations of that one model; i.e., there can be no intermixing of tape stations of different models on any one controller.

First customer deliveries of the Model 3485 Tape Station are scheduled for October, 1964.

INPUT–OUTPUT: 3487 MAGNETIC TAPE GROUP

§ 095.

.1 GENERAL

.11 Identity: . . . . Magnetic Tape Group Model 3487

.12 Description

The Model 3487 Magnetic Tape Group consists of two, four, or six tape decks which are tape and reel compatible with the RCA Model 3485 Tape Station (Section 703:094) and with IBM 727, 729, and 7330 Magnetic Tape Units. The tape transport speed is 75 inches per second, giving a peak data transfer rate of 60,000 characters per second at a density of 800 characters per inch. Densities of 200 and 556 characters per inch can alternatively be used. Peak and effective data transfer rates at each density are shown in the table below.

Data can be read and recorded on 2,400-foot reels of 1/2-inch wide, 7-channel tape in any of three modes: IBM-compatible BCD (even parity) Mode, IBM-compatible Binary (odd parity) Mode, or "RCA Mode", in which each block on tape is preceded and followed by a guard character. Code compatibility can readily be achieved by means of the RCA 3301's efficient "Translate by Table" instruction.

Recording density can be 200, 556, or 800 characters per inch. Inter-block gap length is 0.75 inch, start time is 6 milliseconds, and read-after-write stop delay is 4 milliseconds. Peak and effective data transfer rates are as follows; the effective rates are based upon 1,000-character blocks, with no deceleration between blocks.

Density, char/inch	Peak Rate, char/sec.	Effective Rate, char/sec.
200	15,000	13,000
556	41,700	29,400
800	60,000	37,500

Reading can be either forward or backward, although the "Read Reverse" instructions are applicable only to tapes written in the RCA Mode. Recording mode and density are program-selected. Rewinding speed is 300 inches per second; backspace operations occur at the normal speed of 150 inches per second. The "Erase" instruction erases a portion of tape equivalent to the length of tape required to hold any specified number of characters. The current status of any specified tape station can be determined by using the "Test

.12 Description (Contd.)

Device" instruction to interrogate one or more of twelve condition indicators.

Either of the two standard data channels (Simo Mode 1 or 2) or the optional Simo Mode 3 can be used for a magnetic tape input-output operation. The selected data channel is fully occupied from the time it is allocated until the data transmission ceases. Data transfers to and from High Speed Memory are by diad, so one 1.9-microsecond cycle is required for each pair of characters read or written.

There are three major controls upon read/write accuracy:

(1) As the data is recorded on tape, a read-after-write parity check is made upon each character. Detection of a write error causes termination of the write operation and setting of an interrupt indicator.

(2) Lateral and longitudinal parity bits are generated during recording and checked during reading. When a read error is detected, an interrupt indicator is set and all characters with incorrect parity are replaced by "error characters" in High Speed Memory.

(3) In the RCA Mode only, guard characters are written in front of and behind each block on tape, providing a safeguard against misinterpretation of noise in the inter-block gaps. In the IBM-compatible modes, the program is responsible for detecting "noise blocks" less than 12 or 13 characters in length and discarding them.

A maximum of 6 or 12 tape stations can be controlled by a Dual Tape Channel. Each control permits simultaneous read/read, read/write, or write/write operations by any two of the tape stations connected to it. Two Dual Tape Channels can be connected to an RCA 3301 system, allowing a maximum total of 24 tape stations.

There are specific controllers for each tape station model, and each controller can only handle tape stations of that one model; i.e., there can be no intermixing of tape stations of different models on any one controller.

First customer deliveries of the Model 3487 Magnetic Tape Group are scheduled for 1965.

INPUT-OUTPUT: COMMUNICATIONS MODE CONTROL

§ 101.

.1 GENERAL

.11 Identity: . . . . Communications Mode Control.
Model 3378.
CMC.

Communications Buffers.
Models 6010 and 6020.

Code Translator
Model 6042.

.12 Description

The Communications Mode Control (or CMC) permits remote devices such as card transceivers, teletypewriters, paper tape readers, and printers to communicate with an RCA 3301 via up to 160 buffered lines. Each line can operate at speeds of up to 300 characters per second, and all reception and transmission of data between the central processor and the buffers is handled in parallel without involving any program. This "CMC Mode" represents a further degree of simultaneity that is available in 3301 systems.

The Communications Mode Control is available with capacities of 20 to 160 lines, in increments of 20 lines. Each size is available in either a Single Scan or Dual Scan model. The Single Scan model scans all lines in an unbroken sequence. The Dual Scan model permits up to 20 of the lines to be selected by plugboard wiring for more frequent servicing, allowing faster response to the needs of the lines with higher data transfer rates.

Each line connected to a CMC has an associated 100-character storage area in High Speed Memory called a "line slot." The line slot serves as a temporary buffer, and also as a point of communication and control for both the program and the CMC. Four control characters within each line slot indicate what tests should be made on the input, inform the program (and the Communications Mode Control) of the results of the tests, and keep a record of which of the 96 data character positions within the line slot is to be used for storing the next character.

When a message is completed or a line requires attention for some other reason (e.g., line slot nearly full), a real-time interrupt is generated and the address of the line requiring attention is placed in a special area. This area is called the Service Table and is 100 characters long (or 200 characters long when more than 100 lines are connected to a system). The Service Table holds the 2-digit addresses of all lines that require servicing by the central processor at any given time.

.12 Description (Contd.)

Output of data is initiated by setting an "Output Permitted" bit in the control area of the line slot. The overheads involved in the operation of the CMC are:

(1) The areas reserved in High Speed Memory for the Service Table and the line slots: 100 characters per line connected, plus 100 or 200 characters for the Service Table.

(2) The time utilized in transferring the data between the communication lines and High Speed Memory. Three 1.93-microsecond cycles are required to transfer a single character. A cycle is made available to the CMC only every sixth machine cycle, so under no circumstances can the load exceed 16 per cent of the system's capacity.

(3) The time involved in the interrupt routine, in changing over from a production program to the real-time program, and later in changing back again. No firm estimate is available for this, but it is expected to be less than 500 microseconds per change-over.

(4) The "turn-around" time. An acknowledgement is sent by a receiving station to a transmitting station immediately after a message has been received. This is primarily to ensure that the reception has been properly accomplished, or to arrange for the message to be transmitted again. In the majority of cases, this involves switching the communication line status from transmit to receive, and then from receive to transmit. The turn-around process frequently takes half a second to complete and may seriously reduce the capacity of the line. In general, long block lengths are advised by the manufacturer to reduce the effect of the delays due to turn-around times.

The following tests are used to control the operation of the CMC:

(1) Test for Nth Position. Any one position out of the 96 available positions in a line slot can be chosen, by plugboard, as the Nth character for all lines. When data is stored in this position, a real-time interrupt is initiated. Typically, the Nth position is chosen to minimize line slot servicing while providing an adequate "overflow" area to insure that no incoming data is lost. The last data position of the slot also acts as an Nth position test to insure detection of line slot overflows.

§ 101.

.12 Description (Contd.)

(2) Test for Data Delimiters. Any two symbols, chosen by plugboard wiring and uniform for all lines, can cause separate interrupts upon being received in the data.

(3) Test for Shift Status. Two shift characters can be selected by plugboard and are uniform for all the lines. They are usually used with 5-level (Baudot) code. A zero or one bit is added to each incoming code before it is stored in High Speed Memory, depending upon whether the last shift character detected was a "letters" or "figures" shift. The shift characters themselves are never stored. During output of 5-level codes, the CMC can automatically insert a "letters" or "figures" shift character wherever necessary. A special option permits operation in the "unshift on space or letters" mode.

(4) Test Parity. All parity-protected characters are checked for correct parity. Any character with incorrect parity is suppressed and an error character is inserted in its place. No salvage or reconstruction of the incorrect character is possible.

.12 Description (Contd.)

A number of buffers are available to act as intermediaries between the CMC and various communication units such as A.T. & T. Data-Phone Sets, working at up to 300 characters per second. Other buffers can connect the CMC to certain Western Union automatic switching control equipment for multi-station lines. The CMC and its buffers are currently working with the RCA 301, where they came into use in 1963.

Some of the communications buffers and their characteristics are described in Table I below.

Where 7- or 8-bit codes are to be transmitted, the Model 6042 Code Translator is necessary. This will convert the codes into the 7-bit (6 data bits plus parity) characters of the RCA 3301, handling the parity as either odd or even, as required.

For handling codes such as the ASCII 128-character code, which use seven information bits per character, an "Escape" character is used. This character selects which of two 64-character sub-codes is to be used. Its action is similar to the "Letter Shift" and "Figure Shift" codes in 5-row paper tape systems, or the upper and lower case facilities on a typewriter.

TABLE I: COMMUNICATIONS BUFFER CHARACTERISTICS

Communications Buffer Model No.	Connection to Devices	Speeds, char/sec	Codes Available
6010	A. T. & T. 202 Data-Phone subset.	up to 120 or 180	5, 6, 7 or 8 bits; transmission line code uses 10 bits.
	Data-Speed Tape Terminal, Model 1 or 2	up to 105	5, 6, 7, or 8 bits; transmission line code uses 10 bits.
6020	Bell 103A or 103F to leased line or TWX facilities.	up to 18	5, 6, 7, or 8 bits; transmission line code uses 10 bits.
	Direct connection (without subsets) to local telegraph lines.	up to 18	5, 6, 7, or 8 bits; transmission line code uses 10 bits.

INPUT-OUTPUT: DATA EXCHANGE CONTROL

§ 102.

.1 GENERAL

.11 Identity: . . . . Data Exchange Control.
Model 3377.
DXC.

.12 Description

The Data Exchange Control (or DXC) allows direct interchange of core storage contents between two DXC-equipped computers, either of which may be an RCA 3301 or 301, at speeds of 268,000 to 311,000 characters per second. Data transmission can be in either direction (but only in one direction at a time), and can be initiated by either computer. Standard input-output instructions and the Simultaneous Mode channels (Simo 1 or Simo 2) are used for communication between two DXC-equipped computers.

.12 Description (Contd.)

Whenever a character with incorrect parity is detected by the receiving Data Exchange Control, a special error character is stored in its place and an indicator is set. No count of the number of parity errors is kept.

Up to two Data Exchange Controls can be connected to any RCA 3301, allowing the possibility of a "daisy ring" computer system composed of any desired number of interconnected computing elements.

All DXC-connected computers must be physically close together — maximum cable length between the processors is 100 feet.

The Data Exchange Control is currently operating with the RCA 301. It can be field-installed on any RCA 3301 system.

INPUT-OUTPUT: COMMUNICATIONS CONTROL

§ 103.

.1 GENERAL

.11 Identity: . . . . Communications Control. Model 3376.

.12 Description

The Communications Control allows direct communication with an RCA 3301 system, via a single telephone line. The maximum speed of existing telephone lines is about 300 characters per second, although leased lines with a capacity of 5,100 characters per second are available and can be used with the Communications Control.

A number of different version of the Model 3376 Communications Control are available, depending on the line characteristics. These are listed in Table I below. Two Communications Controls can be connected to a single RCA 3301. Transmission can be via dialed telephone lines or leased lines, using A. T. & T. or Western Union subsets as interfaces. Grouped lines (such as the TELPAK facilities) may be used.

Transmission takes place as a normal input-output operation under the control of Simo Mode 1 or 2. Interrupts occur at the end of transmission, upon receipt of a request to initiate transmission, or when an error condition arises during transmission. The errors checked for are:

Transmit Mode

(1) Character parity error.

(2) "Time-out" (acknowledgment not received within 0.5 second after transmitting End of Message and Block Parity).

(3) Detection of loss of subset carrier.

(4) Specific response not received from the remote location within 20 seconds after transmission of a request to the remote location.

.12 Description (Contd.)

Transmit Mode (Contd.)

(5) Detection of "Error" signal on Abandon Call and Retry circuit when using Automatic Dialing unit.

(6) Subset inoperable.

Receive Mode

(1) Character parity error. Upon detection of a character parity error, a special error character is substituted for all erroneous characters before transfer to High Speed Memory.

(2) Detection of Block Parity error.

(3) Detection of "No-data" time out (more than one character time between the completion of one character and the start of the next character).

(4) Detection of loss of subset carrier.

(5) No response from remote terminal within 0.5 second after read instruction is accessed and request has been transmitted to the remote terminal.

(6) Subset inoperable.

(7) Termination of read upon reaching limit of input area with no "terminate" code received.

TABLE I: CHARACTERISTICS OF COMMUNICATIONS CONTROL MODELS

Model No.	Type of Communications Facility	Transmission Speed	
		Bits/sec	Char/sec
3376-11	Manually-dialed public network	2,000	250
3376-11	Leased line	2,400	300
3376-12	Automatically-dialed public network	2,000	250
3376-21	Manually-dialed public network	1,200	150
3376-21	Leased line	1,800	225
3376-22	Automatically-dialed public network	1,200	150
3376-34	Leased line	40,800	5,100

INPUT-OUTPUT: MODEL 3488 RANDOM ACCESS COMPUTER EQUIPMENT

§ 105.

.1 GENERAL

.11 Identity: . . . . Model 3488 Random Access Computer Equipment.

.12 Description

Model 3488 Random Access Computer Equipment (previously referred to as RACE) allows random access references to be made to data recorded on magnetic cards. One Model 3488 Unit can hold, on-line, 8 or 16 card magazines at a time. These magazines, which are removable like magnetic tape reels, hold 256 cards or 42 million characters each. Up to eight Model 3488 units can be on line at a time in an RCA 3301 computer system. A detailed physical description of the Model 3488 unit is presented in the Internal Storage section (703:044.100) of this report, because in normal use this equipment is more truly a storage medium for on-line access by the computer than an input-output unit.

However, a single Model 3488 Unit can serve the logical functions of one or a number of input-output units. It has an instantaneous data rate of 80,000 characters per second and an effective peak data transfer rate of 43,000 characters per second. The main advantages of using a Model 3488 random access system as an input-output device are that:

- Only the active parts of a file need to be processed. Inactive parts do not need to be copied over into a new file; they can simply be left alone.
- A card magazine can represent any number of logically different files, each of which can be referred to at any time, whereas a magnetic tape unit normally holds only one file.

The disadvantage is, of course, the 300 milliseconds or more required to process a card, which sets the upper limit on the capacity of each Model 3488 unit at 200 references per minute.

.12 Description (Contd.)

Higher rates can be obtained by having more than one Model 3488 Unit connected at a time. The systems considerations in the addressing and randomizing of the file to provide equal loads on the various units may become complex, but such multi-unit arrangements can yield a theoretical overall system capacity of up to 1,600 references per minute. A discussion of possible systems approaches to the organization of the files and the accessing methods is included in the explanation of the special random access system performance calculations in the System Performance section of this report (page 703:201.001).

.13 Availability: . . . . 9 months.

.14 First Delivery: . . . . . late 1964.

.6 PERFORMANCE

.61 Conditions

.62 Speeds

.621 Nominal or peak speed: 80,000 characters/second.
.622 Important parameters
Interblock gap: . . . . . 1 millisecond.
Intercard gap: . . . . . 25 milliseconds.
Block transfer time: . 8 milliseconds.
Block length: . . . . . . 650 characters.
Number of blocks per card length: . . . 4.
.624 Effective speeds: . . . . see Graph 703:105.900.

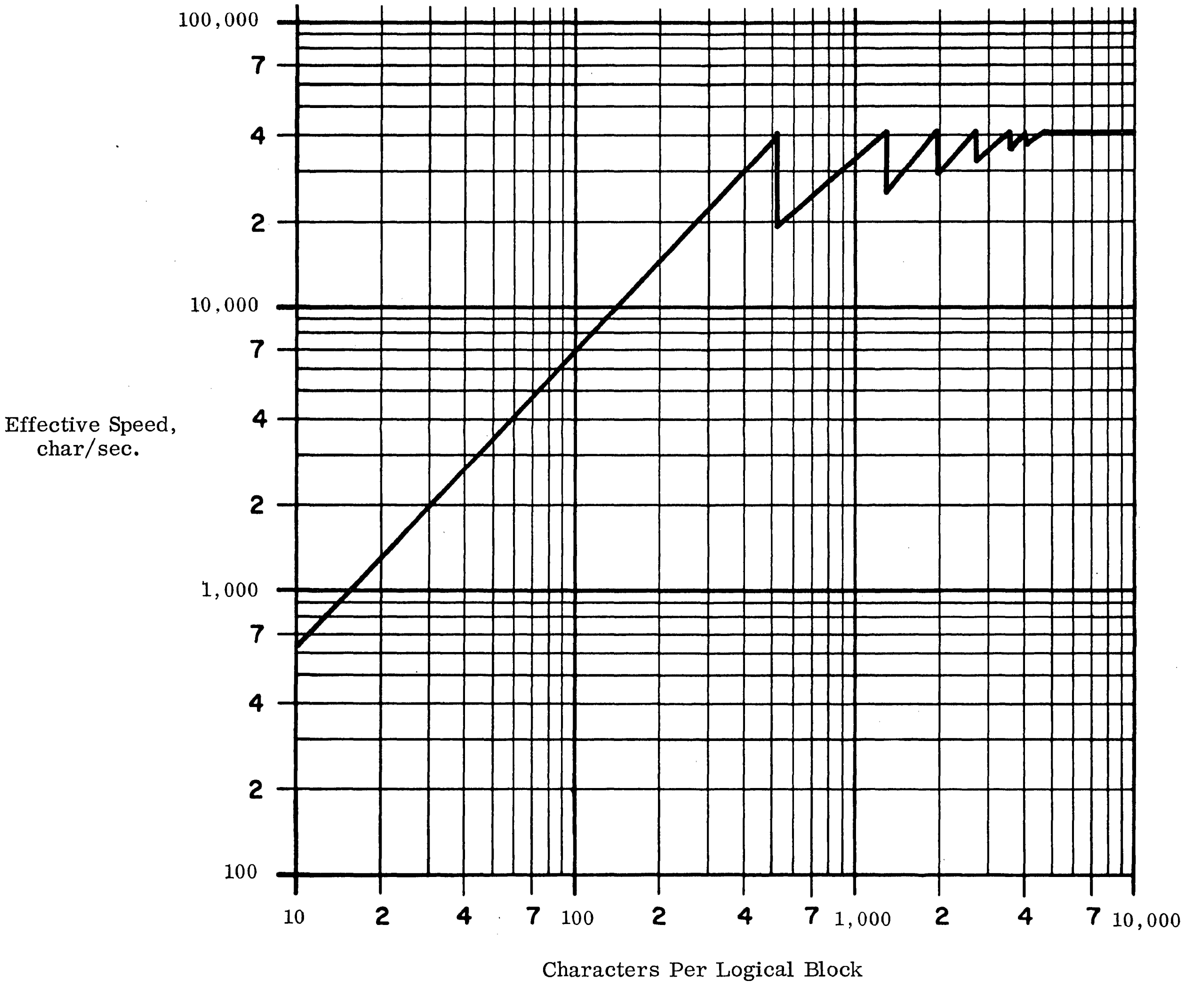
.63 Demands on System

Component	msec per block	Percentage of data transfer time
Processor:	0.0009N	3.8
Simo Mode:	4.0 + 0.0125N	100.0

N = number of characters per block.

§ 105.

EFFECTIVE SPEED: MODEL 3488



N. B. It is assumed that:

(1) Each logical block is stored separately in one or more physical blocks.

(2) All 256 physical blocks on each card are accessed sequentially.

INPUT–OUTPUT: VIDEO DISPLAY DEVICES

§ 106.

.1 GENERAL

.11 Identity: . . . . Video Data Terminal, Model 6050.
Video Data Interrogator, Model 6051.

.12 Description

Both the Model 6050 Video Data Terminal and the Model 6051 Video Data Interrogator are designed for operation at a remote location, away from the RCA 3301 Computer. The operator types an inquiry message on his keyboard, checks its accuracy on a cathode ray display, and then transmits the inquiry to the computer over telegraph or telephone lines. Subsequently the display unit receives and displays on the 14-inch cathode ray tube the response originated by the computer. A maximum of 480 characters can be displayed at one time. These devices are suitable only for alphanumeric messages — not for graphical displays.

The one-way message transmission time is dependent on the line characteristics and on message length. It will usually be less than two seconds for telephone lines, but may be up to fifty seconds for telegraph lines.

The Model 6050 is a stand-alone unit that transmits and receives data directly to and from the data communications link. By contrast, the Model 6051 is connected to a controller which handles the actual transmission and reception, and which also provides formatting services which effectively reduce the amount of data that needs to be transmitted. Each controller can handle up to eight Model 6051 Video Data Interrogators.

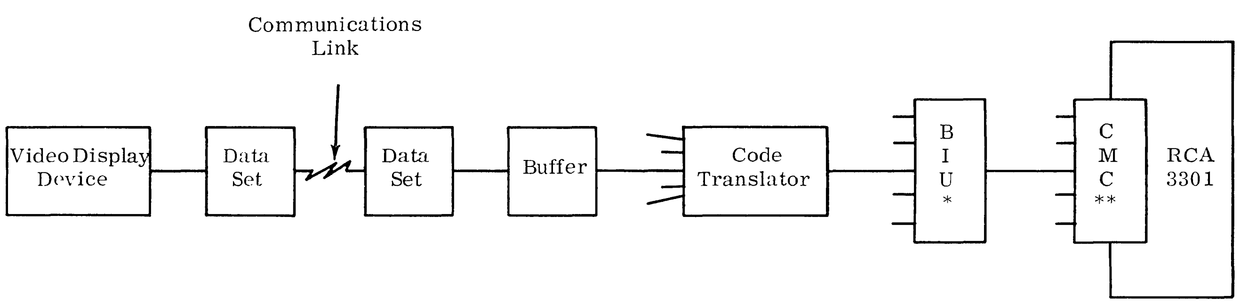
An RCA 3301 can handle, through its Communications Mode Control, up to 160 communication lines. This permits a maximum network size, at any one instant in time, of either 160 Model 6050 Video Data Terminals or 2,560 Model 6051 Video Data Interrogators connected via 160 controllers. Because dial facilities can be used on the communication lines, these restrictions apply only to the number of devices actually connected with the computer at the same time; the actual size of the network has no real physical limit.

The operator uses a conventional typewriter keyboard to type the inquiry. Because the typed message is simultaneously being displayed on the cathode ray tube in front of him, he can check the accuracy of form and content while he is typing it. The 14-inch tube can display a maximum of 480 characters, arranged in 15 lines of 32 characters each.

After typing and checking the inquiry, the operator initiates its transmission to the computer by means of a simple control panel. During transmission the query remains displayed, being erased only upon receipt of the response from the computer. This response is then displayed until the operator erases it, although the computer is disengaged as soon as the message is successfully received at the remote location. Accuracy control is handled by the Communications Mode Control, as described in Section 703:101.

The terminal includes a character generator, which works on ASCII codes. The set of 61 characters used consists of A through Z (upper case only), 0 through 9, and 25 special characters.

The translation between ASCII and RCA 3301 codes is handled by the Model 6042 Code Translator. The translator is connected to the main computer system, between the buffer unit connected to the computer-system data set and the buffer interface unit, which in turn is connected to the Communications Mode Control (see Figure 1).



* Buffer Interface Unit, Model 6010 or 6020
** Communications Mode Control

FIGURE 1: CONNECTION OF VIDEO DISPLAY DEVICE TO AN RCA 3301 SYSTEM

§ 106.

.12 Description (Contd.)

A maximum-length message would consist of 480 data characters. This can be reduced by using the equivalent of the Carriage Return symbol, which advances the printing on a typewriter to the start of the next line. No facility equivalent to the Tabulate key on a typewriter is available, so that within any one line, any blanks which occur before or between data fields must themselves be transmitted as data characters.

The controller for the Model 6051 Video Data Interrogator has not been firmly specified to date. Preliminary information indicates that it will contain a data drum on which sixteen 480-character masks can be stored. These masks can be used to improve the appearance of the displays by providing standard display material, while reducing the amount of data that needs to be transmitted. The appropriate mask is called for by the station originating the particular display, either the Interrogator operator or the computer.

The Video Data units were announced for the RCA 3301 in May, 1964. The Model 6051 Video Data Terminal is expected to become operational in October, 1964. No information regarding the delivery of the Model 6051 Video Data Interrogator is available to date.

SIMULTANEOUS OPERATIONS

§ 111.

The RCA 3301 can have capabilities for a number of different types of simultaneous operations, as described below. Except in one case, * each type can be considered separately, and the full potential simultaneity for a specific operation or configuration can be arrived at by adding the different sets of simultaneity.

(1) Computation within the central processor continues at all times, except during the individual 1.9-microsecond cycles required for each unit of data transferred between High Speed Memory and a peripheral unit.

(2) The following operations are carried out in an essentially off-line manner once initiated. The number of these operations that can proceed simultaneously with any other operations is limited only by the number of devices attached.

- Printing (subsequent to buffer loading) and paper advance.
- Card punching (subsequent to buffer loading).
- Magnetic tape advancing (without transmission of data) or rewinding.
- Preparing a Model 3488 Unit for data transmission, either by bringing a selected magnetic card to the read/write heads or by positioning the read/write heads over the appropriate tracks.

(3) In addition, in every RCA 3301 system any two of the operations listed in Table I can proceed at one time (one on each Simultaneous Mode 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 Simultaneous Mode (Simo) channel.

(4) If the optional Simo 3 is added, one further simultaneous data transfer operation, which can only be to or from magnetic tape or a random access storage device, can occur.

(5) If a Communications Mode Control (CMC) is connected, data transmission operations to or from communications devices on each of up to 160 lines can occur simultaneously. One 1.9-microsecond cycle is required for each character transferred between the single-character buffer serving an individual line and the associated 100-character "line slot" in High Speed Memory.

*Some buffered units (notably the Card Punch and Line Printer) require very little actual Simo (data channel) time, but initiation of these operations may have to be delayed until a Simo channel becomes available.

§ 111.

TABLE I — SIMULTANEOUS MODE OPERATIONS

OPERATION	Cycle Time, msec	Start Time			Data Transmission			Stop Time		
		Time, msec	CP Use	Simo Use	Time, msec	CP Use	Simo Use	Time, msec	CP Use	Simo Use
Card Reader, 1470 cpm	41	0	-	-	41	0.19%	Yes	0	-	-
Card Reader, 900 cpm	67	0	-	-	67	0.11%	Yes	0	-	-
Card Punch, 300 cpm	200	17 to 217*	2.5 msec	2.5 msec	157	0	No	26.0	0	No
Magnetic Tape, 33KC	-	3.5	0	Yes	Indefinite	3.19%	Yes	2.0	0	No
Magnetic Tape, 66KC	-	5.5	0	Yes	Indefinite	6.38%	Yes	3.0	0	2.0
Magnetic Tape, 120KC	-	7.3	0	Yes	Indefinite	11.5%	Yes	4.0	0	1.3
Paper Tape Reader, 1,000 cps	1	3.0	0	Yes	Indefinite	0.20%	Yes	2 msec	0	No
Paper Tape Reader, 500 cps	2	3.0	0	Yes	Indefinite	0.10%	Yes	2 msec	0	No
Paper Tape Punch, 300 cps	3.3	3.3	0	Yes	Indefinite	0.05%	Yes	3 msec	0	No
Paper Tape Punch, 100 cps	10	10.0	0	Yes	Indefinite	0.02%	Yes	5 msec	0	No
Paper Tape Reader/ Punch, 100 cps	10	10.0	0	Yes	Indefinite	0.02%	Yes	5 msec	0	No
Printer, 120 columns	75#	0.5*	0.16 msec	Yes	60	0	No	15 msec	0	No
Data Drum Memory	16.6	0.6 to 17.2	0	Yes	Indefinite	14.2%	Yes	0	0	No
Model 3488 - First reference to a card	60	225 to ?	0	8	Indefinite	5.0%	Yes	0	0	No
Subsequent references	60	8 to 68	0	8	Indefinite	5.0%	Yes	0	0	No
Data Exchange with another RCA 3301 or RCA 301	0.002	0	0	-	Indefinite	21.3%	Yes	0	0	No
Communication Control via telephone lines	3	0	0	-	Indefinite	0.1%	Yes	0	0	No

* Buffer loading time.
\# Asynchronous Mode; can be reduced to 60 msec per cycle by using restricted 47-character set.
s Number of sectors read.

INSTRUCTION LIST

§ 121.

DATA HANDLING INSTRUCTIONS

MNEM-ONIC	OP CODE	INSTRUCTION NAME	N CHARACTER	A ADDRESS	B ADDRESS	SPECIAL CONDITIONS
FDN	(Comma)	Float Dollar Sign to Non-Zero Numeric	$	Leftmost HSM location to be searched	Rightmost HSM location to be searched	STA PRI
LAL	K	Locate Absence of Symbol Left	Specified Symbol	Leftmost HSM location to be searched	Rightmost HSM location to be searched	STA PRI
LAR	L	Locate Absence of Symbol Right	Specified Symbol	Rightmost HSM location to be searched	Leftmost HSM location to be searched	STA PRI
SFS	J	Symbol Fill Sector	Specified Symbol	Leftmost HSM location to be filled	Rightmost HSM location to be filled	
SFN	(Comma)	Symbol Fill to Non-Zero Numeric	Specified Symbol (except $)	Leftmost HSM location to be searched	Rightmost HSM location to be searched	STA PRI
TCL	M	Transfer by Count Left	No. of characters (0-44)	HSM location of leftmost char. in sending area	HSM location of leftmost char. in receiving area	REP
TCR	N	Transfer by Count Right	No. of characters (0-44)	HSM location of rightmost char. in sending area	HSM location of rightmost char. in receiving area	REP
TCE	÷	Transfer by Count to Edit Field	No. of characters (0-44)	HSM location of rightmost char. of the edit (receiving) field	HSM location of rightmost char. of the non-edited (sending) field	STA PRI
TSL	#	Transfer by Symbol Left	Symbol after which to stop transferring	HSM location of leftmost char. in sending area	HSM location of leftmost char. in receiving area	STA REP
TSR	P	Transfer by Symbol Right	Symbol after which to stop transferring	HSM location of rightmost char. in sending area	HSM location of rightmost char. in receiving area	STA REP
TDC	10 (Sub 10)	Transfer Decade by Count	No. of decades (0-44)	HSM location of leftmost decade in sending area	HSM location of leftmost decade in receiving area	REP
TBT	A	Translate by Table	No. of characters (0-44)	HSM location of leftmost char. to be translated and the result area	HSM location of leftmost char. of translate table (must end in 00)	REP

ARITHMETIC AND LOGICAL INSTRUCTIONS

MNEM-ONIC	OP CODE	INSTRUCTION NAME	N CHARACTER	A ADDRESS	B ADDRESS	SPECIAL CONDITIONS
AAD	+	Add Address	+ (Plus)	HSM location of LSD of augend and sum	HSM location of LSD of addend	REP PRI
ADT	+	Add Data	No. of characters (0-44)	HSM location of LSD of augend and sum	HSM location of LSD of addend	REP PRI
DVD	+	Divide	#	HSM location of LSD of dividend and quotient	HSM location of LSD of divisor	PRI
LAN	T	Logical "And"	No. of characters (0-44)	HSM location of right-most char. of original operand and result	HSM location of right-most char. of modifier	REP PRI
LEO	U	Logical Exclusive "Or"	No. of characters (0-44)	HSM location of right-most char. of original operand and result	HSM location of right-most char. of modifier	REP
LIO	Q	Logical Inclusive "Or"	No. of characters (0-44)	HSM location of right-most char. of original operand and result	HSM location of right-most char. of modifier	REP
MPY	+	Multiply	$	HSM location of LSD of multiplicand	HSM location of LSD of multiplier and LSD of the 8 most significant digits of the product	PRI
SAD	– (Minus)	Subtract Address	+ (Plus)	HSM location of LSD of the minuend and difference	HSM location of LSD of subtrahend	REP PRI
SDT	– (Minus)	Subtract Data	No. of characters (0-44)	HSM location of LSD of minuend and difference	HSM location of LSD of subtrahend	REP PRI

§ 121.

DECISION AND CONTROL INSTRUCTIONS

MNEMONIC	OP CODE	INSTRUCTION NAME	N CHARACTER	A ADDRESS	B ADDRESS	SPECIAL CONDITIONS
CAD	– (Minus)	Compare Address	. (Period)	HSM location of rightmost char. of minuend	HSM location of rightmost char. of subtrahend	PRI
CDT	Y	Compare Data	No. of characters (0-44)	HSM location of leftmost char. of first (minuend) operand	HSM location of leftmost char. of second (subtrahend) operand	PRI
CTC	W	Conditional Transfer of Control	Indicator or switch to be sensed	Address of next instruction when condition exists	Address of next instruction when condition exists	STP
CIL	[(Open Bracket)	Control Interrupt Logic	Specifies function	0000 (Not to be used)	0000 (Not to be used)	
HLT	. (Period)	Halt	. (Period)	Unused	Unused	
LDR	C_R (Credit)	Load Register	MMM location symbol	Rightmost HSM diad containing contents to be stored	0000 (Not to be used)	
PIN	. (Period)	Programmed Interrupt	Any symbol except a period	Unused	Unused	
RPT	R	Repeat	No. of repeats (0-14)	Even=No instruction access of A Addr. when instruction is repeated Odd=Instruction access of A Addr.	Even=No instruction access of B Addr. when instruction is repeated Odd=Instruction access of B Addr.	
SIN	< (Less)	Scan Interrupt	Designates Interrupt Indicators	A_0A_3 To be set initially by programmer A_1A_2 00	HSM location of leftmost char. of inhibit mask	STA
STR	V	Store Register	MMM location symbol	Rightmost HSM diad to receive contents	Address of next instruction if P is stored; otherwise 0000.	
TLY	X	Tally	0 (Zero)	HSM Location of diad containing quantity to be tested	Address of next instruction if quantity has not been exhausted	STP
UTC	W	Unconditional Transfer of Control	. (Period)	0000 (Not to be used)	HSM location of next instruction to be executed	

INPUT-OUTPUT INSTRUCTIONS

MNEMONIC	OP CODE	INSTRUCTION NAME	N CHARACTER	A ADDRESS	B ADDRESS	SPECIAL CONDITIONS
CD1 CD2	2 3	Control Device Simo 1 Control Device Simo 2	Device Symbol	0000 (Not to be used)	$B_0B_1B_2$ = 000 (Not to be used) <u>Card Reader</u> B_3 = 1 Translate Mode B_3 = 2 Binary Mode <u>Card Punch</u> B_3 = 1 Reject Stacker B_3 = 2 Auxiliary Stacker <u>Magnetic Tape</u> B_3 = 1 Rewind to BTC B_3 = 2 Rewind to Load Point and disconnect B_3 = 4 Rewind 1 gap	
ER1 ER2	* > (Greater)	Erase Simo 1 Erase Simo 2	Magnetic Tape Station Symbol	Beginning HSM location used for counting the no. of chars. to be erased	Ending HSM location used for counting the no. of characters to be erased	
RF1 RF2	4 5	Read Forward Simo 1 Read Forward Simo 2	Device Symbol	HSM location to receive first char. Must be even for Card Reader.	<u>Paper Tape, Magnetic Tape and Console Typewriter</u> HSM location to receive last character <u>Card Reader</u> 0000 (Not to be used)	
RR1 RR2	6 7	Read Reverse Simo 1 Read Reverse Simo 2	Paper Tape or Magnetic Tape Station Symbol	HSM location to receive first char.	HSM location to receive last character	
TDV	S	Test Device	Device Symbol	Specifies the test, set or reset function to be performed	Address of next instruction to be executed if the condition(s) being tested are present	STP

§ 121. INPUT-OUTPUT INSTRUCTIONS (Cont'd.)

MNEM-ONIC	OP CODE	INSTRUCTION NAME	N CHARACTER	A ADDRESS	B ADDRESS	SPECIAL CONDITIONS
WR1 WR2	8 9	Write Simo 1 Write Simo 2	Device Symbol	HSM location of first character to be written, typed or punched. Must be even for card punching and printer buffer loading Paper Advancing – 0000 (Not to be used)	Paper Tape, Magnetic Tape & Console Typewriter HSM location of last character to be written. Card Punch $B_0 B_1 B_2$ = 000 (Not to be used) B_3 = 1 Translate Mode B_3 = 2 Binary Mode On-Line Printer B_0 = 0 Paper advance via count in B_2 B_0 = 1 Loop-controlled vertical tabulation B_0 = 2 Loop-controlled page change B_1 = 0 Asynchronous mode printing B_1 = 1 No printing B_1 = 2 Synchronous mode printing B_2 = Number of lines (0-14) to advance B_3 = 0 No HSM to Buffer Transfer B_3 = 1 Print 120 characters B_3 = 2 Print 160 characters B_3 = 4 Print Table to Buffer	

HIGH SPEED ARITHMETIC UNIT INSTRUCTIONS

MNE-MONIC	OP CODE	INSTRUCTION NAME	N CHARACTER	A ADDRESS	B ADDRESS	SPECIAL CONDITIONS
FXA	@	Fixed Point Add	Location of arithmetic operands: • Store result in Accumulator OR both Accumulator and location specified by A address • B operand located in Accumulator OR at address in B address • A operand located in Accumulator OR at address in A address	HSM address of augend and/or sum	HSM address of addend	3304 only, PRI
FXS	(	Fixed Point Subtract	Same as FXA	HSM address of minuend and/or difference	HSM address of subtradend	3304 only, PRI
FXM	)	Fixed Point Multiply	Same as FXA	HSM address of multiplicand and/or product	HSM address of multiplier	3304 only, PRI
FXD	&	Fixed Point Divide	Same as FXA	HSM address of dividend and/or quotient	HSM address of divisor	3304 only, PRI
FLA	$	Floating Point Add	Same as FXA	HSM address of augend and/or sum	HSM address of addend	3304 only, PRI
FLS	:	Floating Point Subtract	Same as FXA	HSM address of minuend and/or difference	HSM address of subtradend	3304 only, PRI
FLM	"	Floating Point Multiply	Same as FXA	HSM address of multiplicand and/or product	HSM address of multiplier	3304 only, PRI
FLD	/	Floating Point Divide	Same as FXA	HSM address of dividend and/or quotient	HSM address of divisor	3304 only, PRI
SAC	Z	Store Accumulator	Indicates whether Accumulator only, Accumulator and PR Register, PR Register only, or Accumulator and Exponent Register are to be stored	0000 (not to be used)	HSM address where designated portion is to be stored	3304 only
SHA	=	Shift Accumulator	Indicates whether Accumulator and PR Register are to be shifted as one unit or separately, the direction of shift, and which is to be shifted (Accumulator or PR Register)	0000 (not to be used)	$B_0 B_1 B_2$ = 000 (not to be used) B_3 = number of shifts	3304 only

Special Conditions

STA: Stores final contents of "A" Register.
STP: Stores address of previous instruction + 10.
REP: Repeatable instruction.
PRI: Previous Result Indicators are set.
3304 only: Included only in Model 3304 Processor.

Reproduced from RCA 3301 System Reference Manual, Appendix VII (except "High Speed Arithmetic Unit Instructions").

STANDARD EDP REPORTS

DATA CODE TABLE

§ 141.

CHARACTER		PRINTED SYMBOL	MACHINE CODE							CARD CODE PUNCHED ROWS
			P	ZONE		NUMERIC				
DESCRIPTION	CODE		2^6	2^5	2^4	2^3	2^2	2^1	2^0	
Zero	0	0	1	0	0	0	0	0	0	0
One	1	1	0	0	0	0	0	0	1	1
Two	2	2	0	0	0	0	0	1	0	2
Three	3	3	1	0	0	0	0	1	1	3
Four	4	4	0	0	0	0	1	0	0	4
Five	5	5	1	0	0	0	1	0	1	5
Six	6	6	1	0	0	0	1	1	0	6
Seven	7	7	0	0	0	0	1	1	1	7
Eight	8	8	0	0	0	1	0	0	0	8
Nine	9	9	1	0	0	1	0	0	1	9
Space	Sp	]	1	0	0	1	0	1	0	
Number	#	#	0	0	0	1	0	1	1	3,8
At The Rate Of	@	@	1	0	0	1	1	0	0	4,8
Open Parenthesis	(	(	0	0	0	1	1	0	1	5,8
Close Parenthesis	)	)	0	0	0	1	1	1	0	6,8
Error	e	e*	1	0	0	1	1	1	1	7,8
Ampersand	&	&	0	0	1	0	0	0	0	Y
A	A	A	1	0	1	0	0	0	1	Y,1
B	B	B	1	0	1	0	0	1	0	Y,2
C	C	C	0	0	1	0	0	1	1	Y,3
D	D	D	1	0	1	0	1	0	0	Y,4
E	E	E	0	0	1	0	1	0	1	Y,5
F	F	F	0	0	1	0	1	1	0	Y,6
G	G	G	1	0	1	0	1	1	1	Y,7
H	H	H	1	0	1	1	0	0	0	Y,8
I	I	I	0	0	1	1	0	0	1	Y,9
Plus	+	+	0	0	1	1	0	1	0	Y,2,8
Period	.	.	1	0	1	1	0	1	1	Y,3,8
Semicolon	;	;	0	0	1	1	1	0	0	Y,4,8
Colon	:	:	1	0	1	1	1	0	1	Y,5,8
Apostrophe	'	'	1	0	1	1	1	1	0	Y,6,8
Plus zero	+0	C_R	0	0	1	1	1	1	1	Y,0

(Continued on back)

* Printed only by typewriter.

§ 141.

DATA CODE TABLE – Contd.

CHARACTER: DESCRIPTION	CHARACTER: CODE	PRINTED SYMBOL	MACHINE CODE: P 2^6	ZONE 2^5	ZONE 2^4	NUMERIC 2^3	NUMERIC 2^2	NUMERIC 2^1	NUMERIC 2^0	CARD CODE PUNCHED ROWS
Minus	–	–	0	1	0	0	0	0	0	X
J	J	J	1	1	0	0	0	0	1	X,1
K	K	K	1	1	0	0	0	1	0	X,2
L	L	L	0	1	0	0	0	1	1	X,3
M	M	M	1	1	0	0	1	0	0	X,4
N	N	N	0	1	0	0	1	0	1	X,5
O	O	O	0	1	0	0	1	1	0	X,6
P	P	P	1	1	0	0	1	1	1	X,7
Q	Q	Q	1	1	0	1	0	0	0	X,8
R	R	R	0	1	0	1	0	0	1	X,9
End Information	EI	[	0	1	0	1	0	1	0	X,2,8
Dollar	$	$	1	1	0	1	0	1	1	X,3,8
Asterisk	*	*	0	1	0	1	1	0	0	X,4,8
End Data	ED	>	1	1	0	1	1	0	1	X,5,8
End File	EF	<	1	1	0	1	1	1	0	X,6,8
Subscript 10	10	10	0	1	0	1	1	1	1	X,7,8
Quotation Mark	"	"	1	1	1	0	0	0	0	X,0
Virgule	/	/	0	1	1	0	0	0	1	0,1
S	S	S	0	1	1	0	0	1	0	0,2
T	T	T	1	1	1	0	0	1	1	0,3
U	U	U	0	1	1	0	1	0	0	0,4
V	V	V	1	1	1	0	1	0	1	0,5
W	W	W	1	1	1	0	1	1	0	0,6
X	X	X	0	1	1	0	1	1	1	0,7
Y	Y	Y	0	1	1	1	0	0	0	0,8
Z	Z	Z	1	1	1	1	0	0	1	0,9
End Block	EB	÷	1	1	1	1	0	1	0	0,2,8
Comma	,	,	0	1	1	1	0	1	1	0,3,8
Percent	%	%	1	1	1	1	1	0	0	0,4,8
Item Separator	●	†	0	1	1	1	1	0	1	0,5,8
Equal	=	=	0	1	1	1	1	1	0	0,6,8
Lozenge	⌑	⌑	1	1	1	1	1	1	1	0,7,8

Reproduced from RCA 3301 System Reference Manual, Appendix VIII.

PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

The RCA 3301 System is designed for a number of different types of use, each of which requires a different complement of utility routines, as summarized in the following table. The individual programs are described in the paragraphs below in the context of their actual functions (Report Writing, File Maintenance, etc.).

USE OF 3301 SYSTEM	UTILITY ROUTINE	WHERE DESCRIBED
General Data Processing	Sort/Merge System	Paragraph .13
	Report Program Generator	Paragraph .14
	Peripheral Conversion Programs	Paragraph .15
General Installation Maintenance	Program Library Tape Maintenance Service	Paragraph .16
	Magnetic Tape Service Programs	Paragraph .17
RCA 301 Simulation	301 Compatibility Package	Paragraph .11
Model 3488 Random Access Support Programs	3488 Sort System	Paragraph .13
	3488 Program Maintenance System	Paragraph .16
	3488 File Maintenance System (Data Files only)	Paragraph .16
	3488 Peripheral Conversion Programs	Paragraph .15
Model 3465 Data Drum	No special programs	

.11 Simulators of Other Computers

RCA 301 Compatibility Program

Date available: . . . . July, 1964.

Description:

Program compatibility between RCA 301 and 3301 Systems is achieved by a combined hardware-software approach. The principal hardware differences between the two systems are in the areas of input-output operations, console operations, and address computation. When an RCA 3301 is conditioned to operate in the 301 Compatibility Mode, instructions which are not identical between the two systems are "trapped" by the hardware and simulated by the Compatibility Program. RCA 301 programs cannot normally take advantage of the greatly improved input-output facilities of the 3301. Most of the existing RCA 301 installations can be simulated on a 3301 with a similar (or more extensive) hardware complement, but 301 programs that utilize any of the following devices cannot be accommodated:

.11 Simulators of Other Computers (Contd.)

Model 361 Data Record File
Model 377 Data Exchange Control
Model 378 Communications Mode Control
Model 5820 Videoscan Document Reader
IBM 729 Magnetic Tape Unit
Burroughs B 101 MICR Sorter Reader

RCA 301 programs that utilize the Model 354 or 355 Scientific Processor will have to be recompiled on either a 301 or 3301 system, using specially modified versions of the COBOL, FORTRAN, or Assembly System translators, and then run in the 301 Compatibility Mode.

A number of other minor restrictions and incompatibilities must be considered when running RCA 301 programs on a 3301; these are described in detail in the RCA 3301 System Reference Manual, Section XV.

.12 Simulation by Other Computers: . . . . . . none.

§ 151.

.13 Data Sorting and Merging

RCA 3301 Sort/Merge System

Reference:	RCA Publication 94-10-000, July, 1963.
Date available:	July, 1964.
Record size:	13 to 4,500 alphameric characters.
Block size:	variable by character; maximum is determined by the available storage; minimum is equal to the minimum record size.
Key size:	1 to 45 characters; the Sort/Merge will handle up to 10 keys, or an unlimited number with the "own coding" option.
File size:	N-3 full (output) reels, where N is the total number of tapes available to the Sort/Merge System, including a Program Library Tape. Reel changes, if necessary, are monitored by the Sort/Merge System.

Description:

The RCA 3301 Sort/Merge System is comprised of a generalized tape sort and tape merge program. The system can be used for independent sort and merge operations or included as an integral part of another run. "Own coding" is optional and includes facilities for pre-sort and post-sort record processing, control of all data comparisons, and handling of records found to have equal keys during intermediate merging passes.

The Sort/Merge System generator will make dynamic (object time) adjustments and allocation of coding, working storage, and tape stations to minimize total processing time. A volume specification, if provided, will be used to make further dynamic adjustments for maximum efficiency. An oscillating sort technique is utilized by the system to maintain a merging power of N-3, where N is the total number of tape stations available, including a Program Library Tape . The user can control the amount of core storage and the number of tapes made available to the Sort/Merge System. Sort/Merge programs will operate under control of the RCA 3301 Operating System, making them capable of parallel operation with other user programs.

3488 Sort System for 3301

Date available: ..... late 1964.

Description:

The 3488 Sort System for the RCA 3301 is a generalized sort routine which exists as a segmented program within the REALCOM Software Library on magnetic tape or a 3488 unit. The sort may be used as an independent program or employed as a subroutine by a user program via appropriate macros available in the RCA 3301 Assembly System.

.13 Data Sorting and Merging (Contd.)

The 3488 Sort will operate within a 3488 configuration ranging from a minimum of one 3488 unit on a single channel to a maximum of four 3488 units on each of two channels. Two modes of operation are available within the 3488 Sort: a "tag" mode and a "record" mode. The "tag" mode directs the sort to extract and process only the keys of each record and the related 3488 addresses. The "record" mode directs the sort to process the entire record with the sort key assembled at the beginning of each record.

Fixed or variable length records ranging from 13 to 4,500 characters are acceptable. The sorting keys may be contained in 1 to 10 fields, any field of which may contain 1 to 45 characters. Any field may be defined as ascending or descending. Each key must be fixed in length and distance from the beginning (lefthand end) of the record. User parameters are accepted from cards, paper tape, or core storage. In the "tag" mode, the user may specify that fields other than the keys be carried along with the tag-keys during the sort.

The 3488 sort is composed of three main sections: a Generation Routine, a First Pass (string-generation phase) and a Merge Pass (string-merge phase).

The Generation Routine verifies and analyzes the user's parameters, determines memory input, output, and work areas for First Pass and Merge Pass, and computes the way of merge for the Merge Pass.

The First Pass accepts the input and produces sorted memory-load strings by means of an internal sort technique which, as a first step, quickly determines the number of sub-strings already present in the input due to natural ordering. Each set of these sub-strings is then sorted by successive 2-way merges and written onto the work-area cards as one string. The First Pass is completed when the entire file has been divided into sorted strings and written out in the work area.

The Merge Pass first merges all strings on each output card from the First Pass, resulting in as many strings as there are cards. The cards are then merged to form the final sorted file.

.14 Report Writing

RCA 301 Report Program Generator

Reference:	RCA 301 Report Program Generator Manual.
Date available:	Spring, 1963.

Description:

This program is now running on the RCA 301 and will provide report writing capabilities for the 3301 until the RCA 3301 Report Program Generator is available. It will be run via the RCA 301 Compatibility Program.

RCA 3301 Report Program Generator: . no detailed specifications are available to date.

§ 151.

.15 Data Transcription

Peripheral Conversion Programs

Description:

The data transcription routines listed below will be available to RCA 3301 users. They will be able to run in parallel with each other and with at least one main "production" program. Details as to how they will fit into the Operating System have not been released.

- Punched cards to magnetic tape
- Punched tape to magnetic tape
- Magnetic tape to punched cards
- Magnetic tape to punched tape
- Magnetic tape to on-line printer
- Loading and unloading of mass storage devices.
- Magnetic tape, punched cards, or punched tape to a 3488 unit.
- 3488 unit to magnetic tape or to an on-line printer.

.16 File Maintenance

PLT Maintenance System

Reference: . . . . RCA Publication 94-10-000, July, 1963.
Date available: . . . . July, 1964.

Description:

The PLT Maintenance System is a group of service routines used to create, update, list, and edit the program Library Tape, or PLT. The system can also form new tasks by collecting and reorganizing various segments stored on the PLT in accordance with task descriptions supplied by the user. In addition, small, special-purpose Program Library Tapes can be created for more efficient system operations.

3488 Program Maintenance System

Date available:. . . . . . ?

Description:

A series of service programs, similar in scope to those provided for the PLT Maintenance System, will be provided for the maintenance of programs on the 3488 unit. Functions included will be 3488 program library construction, task definition, task collection, and program library correction and editing.

3488 File Maintenance System

Date available:. . . . . . ?
Description:

The File Maintenance package of routines provides facilities for maintaining an effective file organization through the use of special file loading, dumping, and status functions as described below.

.16 File Maintenance (Contd.)

Loading

There are basically three different considerations for file loading: initial load, reload and file reallocation.

The initial load is concerned with the initial establishment of a data file in 3488 storage. In this operation, the input data may be contained on magnetic tape, punched cards, paper tape, or the 3488 unit itself. The user provides descriptions of how the information is to be stored on the 3488 with such parameters as record size, bucket size, number of data records or data characters to a bucket (i.e., density for initial load), file size, etc.

Reload copies a previously dumped file back into 3488 memory for recovery procedures.

File reallocation occurs after a file has been in production use for a period of time and it is determined that the original file characteristics have changed sufficiently to justify a reorganization. File reallocation will permit the user to redefine file storage characteristics such as bucket size, density, and random code generation scheme.

In addition, the load function will condition new and replacement magazines to receive data files.

Dumping

Facilities are provided in this function to:

(1) make a "mirror" image (copy) of the contents of 3488 storage in another portion of the 3488 or on magnetic tape for back-up purposes, or

(2) make a dump of a selected data file (or files) for subsequent file reallocation.

Status

This function is provided to supply analytical information to the user that will assist him in determining the degree of change of a data file from a previous or initial ordering and indicate to the user what area is available.

Based on this analysis, the user may decide to:

(1) Reallocate an entire file or a portion of a file, or

(2) Utilize the load option to establish a new data file in 3488 storage.

3488 File Maintenance System (Card Replacement)

This system, an extension of the one described above, will include provisions for updating the usage record of each card during operation and for noting reading or writing errors encountered. Also incorporated will be some analysis, based on the installation's own standards, as to which cards are in need of replacement. No reference is yet available.

§ 151.

.17 Other

The following utility programs will be available to RCA 3301 users:

- Tape Copy Program: duplicates magnetic tape files recorded in accordance with RCA 301 or 3301 Data Standards.

.17 Other (Contd.)

- Tape Compare Program: compares two magnetic tape files, listing all unlike records on the on-line printer or magnetic tape.
- Test Data Distribution Program: generates magnetic tape data files for program testing, in accordance with user-supplied descriptors.

Most of the available library routines for the RCA 301 can be run on the 3301 via the RCA 301 Compatibility Program.

PROCESS ORIENTED LANGUAGE: FORTRAN IV

§ 161.

.1 GENERAL

.11 Identity: . . . . RCA 3301 FORTRAN IV.

.12 Origin: . . . . RCA EDP Division.

.13 Reference: . . . . REALCOM FORTRAN IV Programmer's Reference Manual, April 1964.

.14 Description

No formal standard for the FORTRAN IV language currently exists. This report uses as a basis for its comparison the specifications for IBM 7090/7094 FORTRAN IV, as contained in IBM publication C28-6274 and described in detail in our report on the IBM 7090, Section 408:162.100. The FORTRAN IV compiler program for the 3301 is described in Section 703:182.100.

The RCA 3301 FORTRAN IV language includes most of the basic parts of FORTRAN IV in the same manner as the IBM 7090/7094 version. However, it does not have facilities for double precision or complex arithmetic, and the lack of these facilities affects the statement lists and the available subroutines and functions. Eight-digit-precision arithmetic is used for normal floating point operations.

RCA has included facilities for operating FORTRAN II programs after modification by providing subroutines to handle eliminated functions. RCA also intends to provide a SIFT-type program which will convert RCA FORTRAN II programs to FORTRAN IV. This program will take advantage of the fact that the RCA FORTRAN II compiler uses FORTRAN IV methods to allocate its COMMON areas, so it will not be suitable to convert non-RCA FORTRAN II programs if they assumed use of the earlier FORTRAN II methods of allocating COMMON areas. No availability date has yet been announced for this conversion program.

.14 Description (Contd.)

The 3301 FORTRAN IV source program can include dumping instructions which allow partial or complete dumps to be made at object time. These instructions are useful both during debugging and during normal execution. Specific dumps can be eliminated by use of simulated sense switches.

The restrictions and extensions of RCA 3301 FORTRAN IV as compared with IBM 7090/7094 FORTRAN IV are listed below.

.141 Availability

Language: . . . . April, 1964.
Compiler: . . . . 1st quarter, 1965 (see Section 703:182.100).

.142 Restrictions (Relative to IBM 7090/7094 FORTRAN IV)

(1) DOUBLE PRECISION and COMPLEX variables are not permitted.

(2) The various complex and double precision functions are not available.

(3) Octal digits cannot be defined in a DATA statement.

.143 Extensions (Relative to IBM 7090/7094 FORTRAN IV)

(1) The magnitude of a real variable may be anywhere between 10^{-100} and 10^{91}, as compared to limits of 10^{-38} and 10^{38} in 7090/7094 FORTRAN IV.

PROCESS ORIENTED LANGUAGE: COBOL

§ 162.

.1 GENERAL

.11 Identity: . . . . RCA 3301 COBOL.

.12 Origin: . . . . RCA EDP Division.

.13 Reference: . . . . REALCOM COBOL Narrator, RCA Publication 94-05-000, December, 1963.

.14 Description

RCA 3301 COBOL is a version of COBOL-61, the most widely implemented pseudo-English common language for business applications. It is a complete implementation of Required COBOL-61, along with 41 of the original electives. The Mass Storage, Table Handling, Sorting, and Report Writing extensions of COBOL-61 Extended have been included.

Probably the most important electives which are included are the libraries for procedures and the segmentation facilities. Both of these are fully implemented, and their use can be very helpful.

Tabulated at the end of this report are lists of the electives implemented and not implemented, the official extensions implemented and not implemented, and the private extensions which have been implemented.

The first 3301 COBOL compiler, which will include most of the language facilities, is expected to be operational in January 1965. Details of this and subsequent versions of the compiler are included in the Program Translator section on RCA 3301 COBOL (Section 703:182.100).

A 3301 COBOL Library can be maintained by an installation to make available pre-stored COBOL program material that is to be referenced by different programs. The COBOL Library is developed by the user and stored on magnetic tape. The information in the library is retrieved through the use of COPY or INCLUDE verbs during the compilation of a source program. The COPY verb allows for exact copies of the stored material from the Environment or Data Divisions. This can include such entities as computer descriptions, input-output control techniques, file descriptions (for normal files or the special Sort Files), and Report Descriptions and Record Descriptions for the Report Writer.

The INCLUDE verb, which is used in the Procedure Division, allows the copied material to be amended during its insertion into the program. This is handled by means of the REPLACING clause, which inserts a field name given in the source program wherever some specific field name is used in the library procedure.

.14 Description (Contd.)

Typical examples of cases where the library function might be of use would be: (1) where some files are common to more than one program in an overall system, (2) where computer descriptions are common to different programs, or (3) where specialized label-handling procedures are to be incorporated in a number of programs — perhaps to help set up installation standards.

The sorting facility provided in the 3301 COBOL compiler includes a generalized tape sort of two phases. It is an oscillating sort, as described in the Problem Oriented Facilities section, Paragraph 703:151.13. The input to the sort is from magnetic tape; up to 10 files or 99 reels are allowed. The record size can range from 13 to 4,500 characters. Up to 10 key fields can be used, and sorting in either ascending or descending sequence can be stipulated.

"Own coding" sections can be incorporated into the first and last pass of the sort. The first-pass own coding can be used to modify or delete records, but not to add new records or increase the size of a record. The last-pass own coding can add records, delete records, or modify them without restriction.

Whereas the sorting facility is used in the form of an independent COBOL program, with the only verb in the procedure division being the SORT verb itself, The Report Writing facility is part of a larger COBOL program. A description of the desired report is given in standardized form, including details of the page layout, the control breaks, the editing rules, etc. When, during the processing, all the new information which is to be printed on the report is ready, a GENERATE instruction is given, together with the name of the desired line type. In addition to preparing this line, the object program will also: (1) step and test the line counter and/or page counter and produce the necessary page and/or line overflow footings or headings; (2) increment all accumulated totals related to the specific report type for summary reporting; (3) recognize any specific control breaks and produce appropriate control footings and control headings; and (4) execute any routines specified by the USE verb generating the report line itself.

.141 Availability

Language: . . . . December, 1963.
Compiler -
Initial version: . . . . January, 1965.
Full version: . . . . . . July, 1965.

.142 Deficiencies with Respect to Required COBOL-61: . . . . none.

.143 COBOL-61 Extended Facilities Implemented: . . . . . . Mass Storage.
Sorting.
Report Writing.

§ 162.

.144 COBOL-61 Electives Implemented (See Users' Guide, 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
1	Formula characters	Formulas are allowed.
2	Relationship characters	The symbols <, >, = are allowed.
3	Semicolon	A semicolon is in the character set.
5	Figurative constants	HIGH or LOW BOUND(S) are available.
6	Figurative constants	HIGH or LOW VALUE(S) are available.
7	Computer-name	Alternative object computers exist.
	File Description	
8	BLOCK CONTAINS	A range of block sizes can be given.
9	FILE CONTAINS	The approximate size of the file can be shown.
10	Label formats	Special labels are allowed.
11	SEQUENCED ON	Key fields can be given for sequencing.
	Record Description	
13	Table-length	Lengths of tables and arrays may vary.
17	RENAMES	Alternative groupings of elementary items can be specified.
19	SIZE clause	Variable items can be specified.
20	Conditional ranges	VALUES can be ascribed to conditionals.
21	Label handling	Special label procedures may be used.
	Verbs	
22	COMPUTE	Algebraic formulas may be used.
24	ENTER	Non-COBOL languages can be used in a program.
25	INCLUDE	Library routines are available automatically.
26	USE	Non-standard auxiliary I/O error handling or label handling routines can be inserted.
	Verb Options	
27	LOCK	A rewound tape can optionally be locked.
28	MOVE CORRESPONDING	Commonly-named items in a group can be handled together.
29	OPEN REVERSED	Tapes can be read backward.
30	ADVANCING	Specific paper advance instructions can be given.
32	Formulas	Algebraic formulas can be used.
33	Operand size	Operands are not restricted to 10 digits.
34	Relationship	IS EQUAL TO, EQUALS, EXCEEDS relationships are allowed.
35	Tests	IF x IS NOT ZERO test is allowed.
36	Conditionals	Implied subjects with implied objects are allowed.
37	Complex conditionals	ANDs and ORs may be intermixed.
38	Complex conditionals	Nested conditionals are permitted.
39	Conditional statements	IF, SIZE ERROR, AT END, ELSE (OTHERWISE) may follow an imperative statement.
	Environment Division	
40	SOURCE-COMPUTER	Computer description can be given.
41	OBJECT-COMPUTER	Computer description can be given.
42	SPECIAL-NAMES	Hardware devices, and their status conditions, can be given special names by the program.
43	FILE-CONTROL	File naming and description of desired control method can be taken from the library.
44	PRIORITY IS	Priorities can be given.
45	I-O-CONTROL	Input-output control can be taken from the library.
46	I-O-CONTROL	A full range of rerun techniques is available.
	Identification Division	
47	DATE-COMPILED	The current date is inserted automatically.
	Special Features	
48	Library	Library facilities for the procedure division are available.
49	Segmentation	Segmentation of programs is allowed.

§ 162.

.145 COBOL-61 Electives Not Implemented (See Users' Guide, 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
4	Long literals	The maximum size is 120 characters.
	File Description	
12	HASHED	Hash totals cannot be created.
	Record Description	
14	Item-length	Variable-length items cannot be specified.
15	BITS option	Items cannot be specified in binary.
16	RANGE IS	Value range of items cannot be shown.
18	SIGN IS	No separate signs are allowed.
	Verbs	
23	DEFINE	The user cannot define new verbs.
	Verb Options	
31	STOP provisions	No special numeric-coded alphabetic displays.

MACHINE ORIENTED LANGUAGE: REALCOM

§ 171.

.1 GENERAL

.11 Identity: . . . . REALCOM Assembly System.

.12 Origin: . . . . RCA.

.13 Reference: . . . . Reference Manual, RCA Publication 94-19-00, December 1963.

.14 Description

The REALCOM Assembly System Language permits the programmer to write RCA 3301 coding in symbolic or absolute form. The language is, in general, a one-to-one assembly language that represents the RCA 3301 machine instructions mnemonically and permits a considerable amount of address arithmetic in defining operands.

The coding is organized into units of logical manipulation called "sequences," which have arbitrarily numbered exits and entrances. A number of "sequences" are grouped for assembly purposes as a "segment," the basic unit of program loading and execution. Each source program must begin with a "catalog" that lists all its component segments and sequences and specifies which sequences are to be included in each segment. The arrangement of segments to produce a 3301 "task" is not part of the assembly process (see the RCA 3301 Operating System, Section 703:191), so the assembled object program will refer to numbered entrances and exits from each segment.

Each sequence is, in effect, independent and may be a block of procedural coding, a file description, a set of constants, or any combination thereof. Symbols can be restricted in meaning to the sequences in which they are defined if desired. Non-unique symbols appearing in other sequences can be referenced by qualifying the name of the operand by the name of the appropriate sequence.

A number of macro codes in the assembly language (READ, WRITE, OPEN, CLOSE, etc.) generate linkages to the input-output control routines of the File Control Processor. User-defined macro instructions, as such, are not part of the REALCOM Assembly System.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . see Assembly Program Sheet, page 703:171.820.

.22 Legend

Name	Contents
Location:	optional label of line; 1-6 numeric and/or alphabetic characters.
Operation:	1-digit absolute machine code; or 3-character mnemonic machine code; or 3- to 6-character control code.
Size:	number of characters, words, etc. to be used; also used for control names.
Unit:	type of data unit to be used for storage allocation control; i.e., single characters, 2-character diads, 10-character words, next available hundreds or thousands position.
Address/Value/ Comments:	two addresses, and any comments; symbolic, relocatable, or absolute addresses may be used. Specification of indirect addressing and index register modification is included with the addresses, as well as sequence qualification if required.
Ident.:	optional identification of program.
Reference Key:	optional line identification number, used in corrections.

.23 Corrections: . . . . insertions, deletions, and alterations are permitted. The first and last reference keys are quoted and the new contents of the affected area are then listed.

.24 Special Conventions

.241 Compound addresses: . only as much of the full form as is needed is used. The full form of an address is: Q@S ± T#Mn where Q is a sequence qualifier; S is a symbolic or absolute address; T is an augmenting address to be applied to S; n is an index register number (1, 2, or 3); # indicates indirect addressing; @, +, and M are delimiters.

§ 171.

.242 Multi-addresses: . . . . 2 addresses are standard for most 3301 instructions.
.243 Literals: . . . . not available.
.244 Special coded addresses: . . . . the quote symbol (") indicates "this address."

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . Any overflow of the internal symbol tables is stored on magnetic tape or in mass storage, so there is no definite upper limit. For any particular size of High Speed Memory, a specific limit (which is not yet known) will be stated which will avoid unnecessary tape movement. No differentiation is made between labels for procedures, constants, files, records, etc.
.312 Common label formation rule: . . . . any 1 to 6 numeric or alphabetic characters.
.313 Reserved labels: . . . . no symbolic labels are reserved.
various parts of the hardware can be referred to in mnemonic form after a special symbol ($).
.314 Other restrictions: . . . none.
.315 Designators
Hardware references, including absolute addresses: . . . . mnemonic, preceded by $
.316 Synonyms permitted: . yes.

.32 Universal Labels

.321 Labels for procedures: optional.
.322 Labels for library routines: . . . . used as parameters in "CALL" procedure.
.323 Labels for constants: . no restriction.
.324 Labels for files: . . . . mandatory; integrated with File Control Processor.
.325 Labels for records: . . optional; integrated with File Control Processor.
.326 Labels for variables: . . . . no restriction.

.33 Local Labels: . . . . . . labels can be made to apply only within the one program sequence in which they are defined. Formation is exactly the same as for universal labels.

.4 DATA

.41 Constants

.411 Maximum size constants
Integer
Decimal: . . . . 50 digits.
Fixed point numeric
Decimal: . . . . 50 digits.
Floating point numeric
Decimal: . . . . 8-digit fraction; 2-digit exponent.
Alphabetic: . . . . 50 characters.
Alphameric: . . . . . . 50 characters.
.412 Maximum size literals: no literals are utilized.

.42 Working Areas

.421 Data layout
Implied by use: . . . . optional.
Specified in program: via applicable pseudo-operation in conjunction with ALOC pseudo-operation (see Paragraph .82).
.422 Data type: . . . . specified in each instruction.
.423 Redefinition: . . . . yes, via redefining pseudo-operations.

.43 Input-Output Areas: . . controlled by File Control Processor (Section 703:191).

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . alternative.
Number: . . . . 67.
Example: . . . . CTC (Conditional Transfer of Control).
.512 Absolute
Existence: . . . . alternative.
Number: . . . . 47.
Example: . . . . W (Conditional Transfer of Control).

.52 Macro-Codes

.521 Number available
Input-output: . . . . . . 15.
Arithmetic: . . . . . . 0.
Math functions: . . . . 0.
.522 Examples
Simple: . . . . READ.
Elaborate: . . . . none.
.523 New macros: . . . . . . will be provided for any new input-output operations.

.53 Interludes: . . . . none.

§ 171.

.54 Translator Control

.541 Method of control
Allocation counter: . . DEFSEQ and ALOC control operations.
Label adjustment: . . within each address (see Paragraph .24).

.542 Allocation counter
Set to absolute: . . . . yes.
Set to label: . . . . . . yes.
Step forward: . . . . . by definition of filler fields.
Step backward: . . . . by redefining and renaming.
Reserve area: . . . . yes.

.543 Label adjustment
Set labels equal: . . . yes.
Set absolute value: . . only in non-relocatable program.

Clear label table: . . . automatic, when required.

.544 Annotation
Comment phrase: . . with each instruction, in address field (optional); or REMARK pseudo-op.
Title phrase: . . . . . from NAME entry.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic: . . none to date.

.62 Special Functions: . . . none to date.

.63 Overlay Control: . . . . by division into defined program segments which can be overlaid by use of the Operating System (see Section 703:191).

.64 Data Editing: . . . . . . by machine instructions only.

.65 Input-Output Control: . . by File Control Processor via macro-codes (see Paragraph .81).

.66 Sorting: . . . . none to date.

.67 Diagnostics: . . . . functions of the Operating System (see Section 703:191.5).

.7 LIBRARY FACILITIES

.71 Identity: . . . . general library (Program Library Tape).

.72 Kinds of Libraries

.721 Fixed master: . . . . . . no.

.722 Expandable master: . . yes.

.723 Private: . . . . yes.

.73 Storage Form: . . . . . magnetic tape or mass storage.

.74 Varieties of Contents: program sequences.

.75 Mechanism

.751 Insertion of new item: via PLT Maintenance System.

.752 Language of new item: REALCOM Assembly System Language.

.753 Method of call: . . . . . CALL pseudo-op.

.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: . . . . optional.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Code	Description
READ:	obtain a logical record from an input file.
WRITE:	cause a logical record to be included in an output file.
OPEN:	prepare a file for processing.
CLOSE:	terminate the processing of a file.
CLOSER:	terminate the processing of a tape reel.
RELS:	terminate the processing of the current batch of logical records.
EXIT:	linkage to Operating System.
ACCEPT:	accept Console input.
TYPE:	write on Console Typewriter.
ISSUE:	instruct the operating system to issue a specific order to a specific device.
FREEDV:	instruct the operating system to retain control until a previous input-output operation is completed.
TESTDV:	test device and branch on the result.
TYPE:	type a message of between 1 and 79 characters on the console typewriter.
TYPERED:	type a message of between 1 and 79 characters on the console typewriter, and then receive a message of between 1 and 84 characters from the console typewriter.
CKPNT:	dump part of the contents of core memory on a previously-opened diagnostic tape unit.

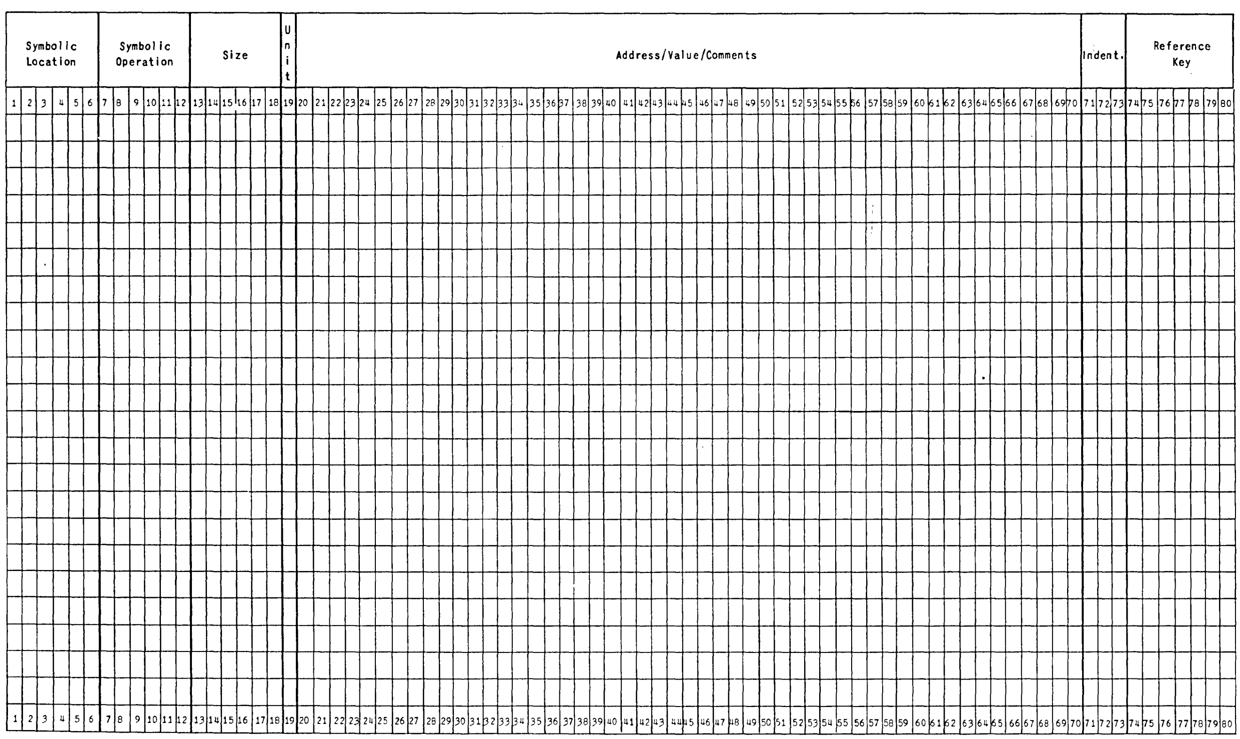
§ 171.

.82 Pseudos

Code	Description
STARTF:	start relocatable ("floatable") program.
STARTN:	start non-relocatable program.
NAME:	name of program.
REMARK:	descriptive remarks, for listing only.
SGMT:	segment name.
SEQ:	sequence name (used to identify sequences which comprise a segment).
DEFSEQ:	sequence leader (used to define contents of a sequence).
END:	end of program.

.82 Pseudos (Contd.)

Code	Description
ALOC:	control allocation of High Speed Memory.
RENAME:	set labels equivalent.
REDEF:	assign new label to a previously allocated storage area.
FIXCON:	fixed alphameric constant.
FIXNUM:	fixed numeric constant.
FLTNUM:	floating numeric constant.
ADRCON:	address constant.
CALL:	calls a program sequence from the library.
STARTC:	indicates the start of a correction patch for the source program.
ENDC:	indicates the end of a correction patch for the source program.


RCA 3301
Real Com
ASSEMBLY PROGRAM SHEET

PROGRAM ______ PAGE NO. ____ OF ____

PROGRAMMER ______ DATE ______

Symbolic Location	Symbolic Operation	Size	Unit	Address/Value/Comments	Indent.	Reference Key
1–6	7–12	13–18	19	20–70	71–73	74–80

REMARKS:

AUERBACH ®

PROGRAM TRANSLATOR: FORTRAN IV

§ 182.

.1 GENERAL

.11 Identity: . . . . REALCOM FORTRAN IV.

.12 Description

The REALCOM FORTRAN IV compiler translates RCA 3301 FORTRAN IV source programs into relocatable machine code. (See Section 703:161.100 for a description of the 3301 FORTRAN IV language.) The compiler requires 60,000 locations in core storage for its own purposes during compilation, in addition to the space required by the Executive Control System (ECS). A minimum system consisting of a 3304 Central Processor, 80,000 core storage locations and 6 input-output devices is required.

The compiler is due to be available in the first quarter of 1965.

.2 INPUT

The FORTRAN source program can be on punched cards or magnetic tape. At present there is no provision for paper tape or random access input to the compiler. There will be some limitations on the size of the source program, due to the maximum sizes of various tables. No details are currently available regarding these limitations.

.3 OUTPUT

The output program will be in relocatable machine code, suitable for operating in conjunction with the RCA FORTRAN Monitor, which is a subsystem of the 3301 Operating System. FORMAT definitions will be interpreted at object time, making it possible to vary the formats used in a compiled program without having to recompile.

The output documentation includes:

- A listing of the control cards, which control the compilation.
- A listing of the source program.

.3 OUTPUT (Contd.)

- An optional listing, in memory order, of the assembly language version of the object coding. This shows the contents of each of the 60,000 contiguous memory locations.
- A list showing the size of the compiled program, without COMMON areas.
- A list showing the size of each COMMON area.
- A list of subprograms used, and their position in memory.
- A list of the statement numbers used in the source program, showing them in numerical order and indicating their locations in memory.
- A list of the variable names used in each segment, and their locations in memory.
- A list of the variable names used in COMMON statements.

Error diagnostics are produced immediately after the listing of the source program. Each diagnostic consists of a one-line printed message, keyed to the statement in error. Approximately 100 error messages are included in the system.

.4 TRANSLATING PROCEDURE

The compiler can run in a translate-and-execute, translate-only, or execute mode, under the control of the FORTRAN Monitor. Complete and partial dumps, which can be written into the FORTRAN source program, allow for object-time diagnostics. Their removal requires a recompilation.

The translator has its own library on-line. The FORTRAN library consists of functions supplied by the system or by the installation; it does not have access to a Program Library Tape.

PROGRAM TRANSLATOR: COBOL

§ 183.

.1 GENERAL

.11 Identity: . . . . RCA 3301 COBOL Translator.

.12 Description

The RCA 3301 COBOL Translator is a seven-phase system that produces 3301 machine-language object programs from source programs coded in the RCA 3301 COBOL language, as described in Section 703:162.100. The object programs run under control of the 3301 Operating System, as described in Section 703:191.100 of this report. Preliminary release will be in January 1965, and the full compiler will be released in July 1965. The first version will include all of Required COBOL-61. The full version will also include mass storage facilities, table handling, sorting, report writing, library facilities, and a number of elective provisions.

The main design objective of the translator is to provide fast compilations. RCA expects to accomplish this by selecting which parts of the language should be covered, and by making parts of the compilation process optional — such as sorting of the input prior to compilation, provision of a subsequent cross-reference listing, etc. The input can be sorted either in terms of the statement numbers or in terms of the priority ascribed to each group of procedures.

.2 INPUT

Input, which must be in RCA 3301 COBOL language, can be provided on punched cards, punched tape, or magnetic tape. It cannot currently be supplied from a mass storage device. The input must make up a complete, self-contained COBOL program. There are no facilities for entering into machine language or into any other high-level language, such as FORTRAN.

Size limitations on the input are not yet completely defined; however, the most important limitations will probably be the maximum of 4,000 symbolic names and the maximum of 18 files.

.3 OUTPUT

The object program is a relocatable, machine-language program in the form of one instruction per card (or per card image in the case of magnetic tape output). The object program assumes the use of the File Processing Package of the RCA 3301 Operating System (see Section 703:201.100) and observes all the standard 3301 conventions.

Documentation of the program consists of an object program listing, a cross-reference analysis, a memory usage map, and a diagnostic listing.

.4 TRANSLATING PROCEDURE

The basic translating procedure consists of seven phases. Optionally, the translation may include other processing such as obtaining input from the library, sorting the input, or providing a correction facility; all these occur before compilation. Subsequent to the main compilation is an optional special run which provides the cross-reference listing. No object-time diagnostic facilities are directly available in the COBOL language, but diagnostics can be written in full by the programmer or called in by him from the installation library.

The library consists of stored procedures, file descriptions, configuration descriptions, etc. These can be called in and used exactly as they stand in the library, or they can be stored in a parameterized form with the particular fields to be used specified in each individual program.

The contents of the library will be under the control of the individual installation. No library maintenance programs have as yet been announced by RCA.

.6 COMPUTER CONFIGURATIONS

The compiling RCA 3301 computer must have 40,000 positions of core storage and at least six magnetic tape units. Additional core storage and peripheral devices can increase compilation speed by allowing larger tables to be held in core storage, by eliminating the need for overwriting or removing the original source program, etc.

The object programs produced by the COBOL compiler can be executed on any standard RCA 3301 system with the required facilities.

.8 ALTERNATIVE TRANSLATORS

The RCA 301 COBOL Translator, which handles most of Required COBOL-61, can be run on an RCA 3301 system via the RCA 301 Compatibility Program described in Paragraph 703:151.11. This translator produces RCA 301 object coding, which in turn requires the use of the 301 Compatibility Program for execution on a 3301.

OPERATING ENVIRONMENT: RCA 3301 OPERATING SYSTEM

§ 191.

.1 GENERAL

.11 Identity: . . . . RCA 3301 Operating System: Executive Control System (ECS), File Control Processor (FCP).

.12 Description

The RCA 3301 Operating System coordinates and controls the execution of all programs. The same comprehensive system maintains overall control no matter how many independent programs are running or waiting to run. In the extended version, at least one main or "production" program, two or more real-time programs, and two or more peripheral programs can be handled simultaneously. The Operating System exercises control over the entire physical environment of the RCA 3301 system, including allocation of storage and input-output units, handling of interrupts, and communication with the operator. In these areas, the programmer has no responsibility.

The Operating System has two major components: The Executive Control System (ECS) and the File Control Processor (FCP). The main functions of the Executive Control System are:

- To initiate system operations via the Console LOAD facility.
- To initiate user-defined tasks in accordance with either programmed or operator requests.
- To control the execution of individual segments of the user-defined tasks and permit inter-segment communications.
- To determine the cause of program interrupts and take the appropriate actions.
- To coordinate communications between the operator and the 3301.

The File Control Processor is an integrated input-output control system whose principal functions are:

- To handle reading and writing of fixed or variable length records in either blocked or unblocked form. (The programmer can work at the logical record level, and need not concern himself with the physical reading, writing, blocking, or unblocking operations.)
- To monitor and schedule all input-output operations that are initiated by the user's program when the programmer elects to work at the "physical" level rather than the logical record level.

.12 Description (Contd.)

- To create and check file labels in standard or non-standard formats. (Data Standards for the RCA 301 are a subset of those for the 3301.)
- To handle the servicing of all real-time devices in such a way that the user need not be concerned with the physical conditions involved.
- To position multi-file tape reels to the appropriate file.
- To create restart points that enable a running program to be interrupted and later restarted without excessive duplication of work.
- To utilize alternate input-output areas, when specified, to achieve maximum overlapping of internal processing with input-output operations.

Different parts of the Operating System are used for different functions, and the system is therefore designed to handle the most complex cases. The system is itself modular, and the amount of the Operating System held in storage at any time will vary with the number of types of input-output devices active at the time, to avoid penalizing a user who does not have (or is not currently using) the fully expanded system. This is done by breaking the operating system into functional units, and allocating space only to those needed.

The Operating System will take advantage of the two-level interrupt system of the RCA 3301 and the partially duplicated registers held in Micro Magnetic Memory to achieve relatively low operating overheads. The central processor time required to control a complete input-output operation (allocation of Simo Mode, queuing as needed, initiation of the operation, checking for its completion and for any recognized errors) is estimated to be 50 to 100 microseconds. A request that requires the transfer of control to another program and subsequent restarting of the original program is expected to take less than one millisecond under all circumstances.

Allowance for several levels of external priorities is planned. This effectively means that a number of separate tasks can be active at one time, and transfer of control between them will be handled automatically whenever the operating task cannot continue to utilize the computing facilities or when a higher priority task is able to start utilizing the central processor. (This priority facility is not available in the initial version.)

§ 191.

.12 Description (Contd.)

The need for reprogramming due to changes in the running installation has been reduced. Basically, a programmer writes (or obtains from the library) a group of routines (called "sequences"), which are translated and organized into segments during assembly. The assembled segments are stored on a Program Library Tape, and formed into units of execution (called "tasks") by the Operating System.

Task descriptions, provided by the user prior to execution, are used to form these segments into tasks and to control their flow on any particular day. For instance, it would be appropriate in one segment to test whether the day's input had been in sequence, and if not, to bring in a sort run. This would require no intervention by the operator or the original programmer.

RCA 301 programs can be run under the Compatibility section of the Operating System (see 703:151.11). Details of how programs written for the 301 will run in parallel with other programs on RCA 3301 systems have not been released to date.

The Operating System (using the File Control Processor) has complete control of all input-output functions. The programmer can consider all input-output devices to be functionally identical, so many change-overs between different units can be handled

.13 Availability: . . . . initial version: July 1964. extended version: no date announced.

.14 Originator: . . . . RCA.

.15 Maintainer: . . . . RCA.

.16 First Use: . . . . February 1964 at RCA; July 1964 in customer installations.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . Program Library Tape (PLT) or random access device. More than one can be used to ensure easy reference to both production and real-time program segments.

.212 Independent programs: . . none.

.213 Data: . . . . as called for by program or as listed on the Program Library Tape.

.214 Master routines: . . . . . Executive Control System and File Control Processor are held at many positions on the PLT. At least one segment of these routines is always held in High Speed Memory.

.22 Library Subroutines: . . . incorporated as segments at "task definition" time.

.23 Loading Sequence: segments can have more than one exit, and each exit can be separately described in the Task Description, thereby determining the specific segment to follow. While normally the Task Description is expected to be static, it can be altered during the execution of a task.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . the Task Definition arranges recall of segments from storage, which is handled by the Executive Control System. Each sequence can be allocated independently.

.32 Input-Output Units

.321 Initial assignment: . . . . handled by File Control Processor.

.322 Alternation: . . . . handled by File Control Processor.

.323 Reassignment: . . . . handled by File Control Processor.

§ 191.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: organized by File Control Processor on basis of requests from operating program.

.42 Multi-running: . . . . . 1 main program, 2 or more real-time programs, and 2 or more peripheral programs can be active within the system. The allocation of central processor time, data channel usage, etc., is determined by the Operating System in accordance with the priorities stated in the Task Description. These priorities can be amended dynamically at the start of execution of a specific task.

.43 Multi-sequencing: . . . none within a single central processor, but planned for multi-processor installations in which the processors are connected via Data Exchange Controls.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	check in hardware	error routine.
Allocation impossible:	check in Operating System*	dump task and restart later.
In-out error - single:	check	interrupt to error routine.
In-out error- persistent:	check	error routine includes facility to accept or ignore records.
Storage overflow:	none	wrap-around on max. storage size (160,000 chars).

.44 Errors, Checks, and Action (con't)

Error	Check or Interlock	Action
Invalid instructions:	check	interrupt.
Program conflicts:	check	interrupt to error routine, with optional user control.
Arithmetic overflow:	check	interrupt to error routine, with optional user control.
Underflow:	check	interrupt.
Invalid operation:	check	interrupt.
Improper format:	no check.	
Invalid address:	check on stopper address	interrupt to error routine.
Reference to forbidden area:	check in Operating System on mass storage address; load time check for valid and allowable memory address	flag interrupt instruction in its place to avoid execution.

* Note: Data channel, High Speed Memory, and input-output device requirements are stated flexibly; e.g., "must have 3, can use 5."

.45 Restarts

.451 Establishing restart point: . . . . automatic; points selected by programmer.

.452 Restarting process: . . . automatically set up by Operating System when a high priority task preempts storage allocated to lower priority tasks; automatic or at request of operator (latter applies only to programmer-requested restarts).

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . none.

.512 Snapshots: . . . . pre-planned test mode provides print-out (or tape record) of specified areas(s) and pertinent registers when a specific instruction is executed.

§ 191.

.52 Post-Mortem: .... yes; print-outs in data and/ or instruction format of areas defined by task and segment (i.e., not necessarily absolute) references supplied at print-out time. Operator may establish such trap points from the console at the initiation (or restart) of a task. The number of trap points is limited by the available memory at time of task initiation.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: .... own coding via the Operating System or, for all standard cases, Operating System printouts in clear and/or coded form. Uniform coding is supplied for all tasks.

.612 Action required by operator: .... own coding via the Operating System or, for all standard cases, Operating System printouts in clear and/or coded form. Uniform coding is supplied for all tasks.

.613 Reporting progress of run: .... initiation, termination of task, diagnostic traps, restart points initiated or used. File and reel assignments and utilization are automatically supplied.

.62 Operator's Decisions: standard approve/disapprove action from the console, related to recommended action.

.63 Operator's Signals

.631 Inquiry: .... console interrupt, with standard action codes or own coded routine.

.632 Change of normal progress: .... console interrupt, with standard action codes or own coded routine.

.7 LOGGING

.71 Operator: .... signals reported on console typewriter.

.72 Operator Decisions: . . . "disapprove" decisions recorded on console typewriter.

.73 Run Progress: .... console typewriter (automatic print-outs).

.74 Errors: .... irrecoverable errors are noted on console typewriter.

.75 Running Times: ...... provided if clock is available; otherwise, times must be recorded manually.

.76 Multi-running Status: . . upon operator request.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: .... RCA 3301 with 5 tape stations.* (This is required by the REALCOM translator).

.812 Usable extra facilities: .... any.

.813 Reserved equipment: . . . 1 or 2 tape stations for Program Library Tape.*
1 tape station (if required) for dumps.*
5,000 to 10,000 characters of High Speed Memory.

* Tape stations can be replaced by a mass storage device.

§ 191.

.82 System Overhead

.821 Loading time: . . . . less than 1 minute.

.822 Reloading frequency:. . . segments of the Operating System are called in from disc storage or tape as required. A number of copies of the system are maintained along the PLT to minimize access time.

.83 Program Space Available: . . . . all except the 5,000 to 10,000 positions required by the Operating System and 100 positions for each connected communication line.

.84 Program Loading time: . . . . dependent upon the program medium (tape or disc storage) and the placement of the required task on the medium. Segments within a task are loaded (unless the PLT has moved) in less than 1 second. Average loading time is about 1 second.

.85 Program Performance: probably less than 2% of the total Processor time will be spent in the Operating System, except in the following two cases:

(1) In all systems, while a new segment is being obtained from the Program Library Tape, no other activity or instruction is initiated.

(2) In communications systems with from 1 to 160 lines, servicing the interrupts will take approximately 1 msec. per message received or sent.

In addition, a logical transfer to a user program (not those routine tasks incorporated in the Operating System) will take less than 1 msec.

SYSTEM PERFORMANCE

§ 201.

GENERALIZED FILE PROCESSING (703:201.100)

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 typical of commercial data processing jobs, and it is fully described in Section 4:200.1 of the Users' Guide.

The RCA 3301 is basically a character-oriented, decimal processor. No problems, therefore, arise in arranging the master file data on magnetic tape. The master record, which has a nominal length of 108 characters, is assigned an actual length of 110 characters. This enables the major computational fields to be held in decade positions, suitable for efficient operation of the Model 3304 High Speed Processor.

In System Configurations III, IV, VI, and VIIA, the master file is on magnetic tape, the detail file is on punched cards, and the report file is produced by the on-line printer. Under these conditions the printer becomes the controlling element as soon as the activity is significantly greater than 0.05. At lower activities, the master file input-output time controls the overall timing. At no point does the central processor usage exceed the input-output time and become the controlling factor.

In System Configuration VIIB, the detail input file and report output file are on magnetic tape, as is the master file. The graphs show two separate treatments of this situation. In the first case (shown by the solid lines), there is no blocking of the detail and report file records. This means that the effective tape speeds are considerably lower than would be the case if blocked files were used. The graphs show the timing for blocked detail and report files by means of dashed lines, clearly demonstrating the differences between the two modes.

For tape-oriented Configuration VIIB, the unblocked report file becomes the controlling factor at some point between 0.05 and 0.25 activity, replacing the tape passing time of the master file. The exact transition point differs for each of the standard problems. In no case with the standard computation does the operation become processor-limited; but with triple the standard amount of processing, and using the slower Model 3303 processor, the processor speed becomes the limiting factor at activities above about 0.10. (See Graph 703:201.140, for Standard File Problem D.)

When the tape files are blocked, however, processor speed is the limiting factor in all cases where the Model 3303 Processor is used and the activity is above 0.20.

For a discussion of file processing by random access methods on the RCA 3301, see the following special section.

FILE PROCESSING BY RANDOM ACCESS METHODS (703:201.150)

There are a number of relatively standardized programming approaches to random access file processing. These involve three major factors:

- Response Time: How long does it take to reply to an input?
- Addressing Method: File records are normally either arranged in sequential order by their identification fields or "randomized" so as to spread them out evenly over the available storage space. This randomization is usually based on a mathematical treatment of the normal identification fields, allowing a good guess to be made as to the location of any desired record in the random access store.

§ 201.

- Processing Method: When a record has to be processed, there are a number of ways of handling the task. Each individual record may be treated separately, without reference to any other record. Alternatively, a number of inputs may be grouped together so as to shorten average access time. This may be done either by avoiding accessing the same area of random access storage twice for two different inputs, both of which require some of the data in the area; or by avoiding some of the mechanical movement involved when random accesses to any area in the store are made. This grouping of inputs reaches its extreme when the inputs are arranged in strict sequential order, as in normal magnetic tape processing.

In order to provide a comparative measure of the performance of random access devices (such as RCA's Model 3488 Random Access Computer Equipment) which can be useful to those interested in comparing their performance with that of magnetic tape equipment for file updating applications, a modification of Standard File Problem A is used.

In this modification, the actual processing of each transaction is handled exactly as in the standard problem, without any alteration. The input, output, and master file records also remain unchanged; and the performance continues to be presented in terms of minutes required to process 10,000 master file records.

One significant change is in the activity rates. For normal sequential processing, calculations are made at activities of 1.0 (i.e., an input record for every master file record), 0.3, 0.1, and 0. For the purpose of random access file processing, however, activities of 1.0, 0.1, 0.01, and 0.001 are shown, on a log-log graph. This effectively covers the same range, but places more emphasis on the lower end of the activity range where random access devices can be expected to find their most important application.

The other significant change is in the method of describing the size of the master file. For sequential processing, the master file size has been standardized at 10,000 records, because simple multiplication can provide the correct answer for larger or smaller master files. This is not so for random access devices. Random access to a file which contains only 1,000,000 characters may take far less time than random access to a file which contains 1,000,000,000 characters because of the characteristics of the storage devices. The resulting differences in timing are therefore shown in Graph 703:201.150 by providing a different line for each of three different master file sizes: 10 million, 100 million, and 500 million characters. This allows the performance for a specific activity and a specific file size to be read directly from the graph, rather than derived indirectly as in the sequential cases.

In preparing the timing for random access file processing using the RCA Model 3488, a randomized master file was assumed. This randomizing could be obtained by using a standard package supplied by RCA. The randomizing is handled only to the level of one Model 3488 card, or a unit of nearly one thousand records. Provided that the card is initially set up with some spare space for expansion problems — say 20% — the probability of a record not being found on the selected card is low, and was ignored in these calculations.

This randomized master file approach was preferred to the alternative approach of arranging the file sequentially and holding an index on the first card of a magazine. In this approach, it is frequently necessary to access more than one card in locating a particular record, either to find the appropriate index or to handle overflow situations.

Calculations indicated that the time involved is related only to the number of Model 3488 units connected to the system, and not to the other configuration parameters of the RCA 3301. Three cases are shown on the graph on page 703:201.150, representing the times required to process 10,000-record segments of files containing 10 million, 100 million, and 500 million characters, respectively. It is assumed that these files will be held on a single Model 3488 unit. If two or more Model 3488 units are used at peak efficiency, the times required will be in a linear proportion to the times shown (e.g., with two Model 3488 units, processing times will be only half as long as the indicated times if peak efficiency is maintained).

A line showing the time required for tape-oriented Configuration VIIB to perform Standard File Problem A is included in Graph 703:201.150 to facilitate comparisons between the random access and sequential file processing techniques.

SORTING (703:201.200)

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. Sorting times for two-way and three-way merges were calculated, and the results are shown in Graphs 703:201.214 and .215.

§ 201.

MATRIX INVERSION (703:201.300)

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 to perform cumulative multiplication ($c = c + a_i b_j$) of eight-digit floating-point operands. Only one line is shown on the graph — that for the Model 3304 Processor, in which the floating-point operations are carried out by the hardware. No times are currently available for floating-point arithmetic operations using subroutines on the Model 3303 Processor.

GENERALIZED MATHEMATICAL PROCESSING (703:201.400)

Standard Mathematical Problem A is an application in which there is one stream of input data, a fixed computation to be performed, and one stream of output data to be produced. Two variables are introduced to demonstrate how the time for a job varies with different proportions of input, output, and computation. The factor C is used to vary the amount of computation per input record. The factor R is used to vary the ratio of input records to output records. The procedure followed is described in Section 4:200.2 of the Users' Guide.

Computations are performed in single-length floating-point on the Model 3304 High Speed Processor.

Graph 703:201.400 shows two curves: one for Configurations VI and VIIA, which use on-line card and printing equipment, and one for Configuration VIIB, which uses magnetic tape for both input and output.

No appreciable delay is caused by writing the output records in either case, so the same curves are applicable for all values of R.

The graph shows that the process becomes computer-bound when the processing load is 5 times or 30 times the standard load, depending upon which configuration is being considered. The standard processing load consists of five fifth-order polynomials, five divisions, and one square root.

§ 201.

WORKSHEET DATA TABLE

	ITEM		CONFIGURATION						REFERENCE
			III	IV	VI	VII A	VII B		
							Files 3 & 4 Unblocked	Files 3 & 4 Blocked	
1	Char/block	(File 1)	990	990	990	990	990	990	
	Records/block	K (File 1)	9	9	9	9	9	9	
	msec/block	File 1 - File 2	33.2	20.4	33.2	15.6	15.6	15.6	
Standard File Problem A Input-Output Times		File 3	67.0	67.0	67.0	67.0	8.0	0.5	
		File 4	109.0	109.0	109.0	109.0	6.0	0.7	
	msec/switch	File 1 = File 2							
		File 3							4:200.112
		File 4							
	msec/penalty	File 1 File 2	1.5	1.5	1.5	1.5	1.5	1.5	
		File 3	0.1	0.1	0.1	0.1	0.1	0.2	
		File 4	0.1	0.1	0.1	0.1	0.2	0.3	
2	msec/block	a_1	0.1	0.1	0.1	0.1	0.1	0.1	
Central Processor Times	msec/record	a_2	0.3	0.3	0.2	0.2	0.2	0.2	
	msec/detail	b6	0.05	0.05	0.05	0.05	0.05	0.05	4:200.1132
	msec/work	b5 + b9	3.1	3.1	0.4	0.4	0.4	0.4	
	msec/report	b7 + b8	0.5	0.5	0.5	0.5	0.5	0.5	
3	msec/block for C. P.	a_1K	0.1	0.1	0.1	0.1	0.1	0.1	
		a_2K	2.5	2.5	1.3	1.3	1.3	1.3	
Standard File Problem A		a_3	33.0	33.0	8.0	8.0	8.0	8.0	
		File 1 Master In	1.5	1.5	1.5	1.5	1.5	1.5	4:200.114
F = 1.0		File 2 Master Out	1.5	1.5	1.5	1.5	1.5	1.5	
		File 3 Details	0.8	0.8	0.8	0.8	0.8	0.8	
		File 4 Reports	0.8	0.8	0.8	0.8	0.8	0.8	
		Total	40.5	40.5	14.0	14.0	14.0	14.0	
4	Unit of measure (characters)								
		Std. routines							
		Fixed	5-10,000	5-10,000	5-10,000	5-10,000	5-10,000	5-10,000	
Standard File Problem A Space		3 (Blocks 1 to 23)	750	750	750	750	750	750	
		6 (Blocks 24 to 48)	3,000	3,000	3,000	3,000	3,000	3,000	4:200.1151
		Files	4,360	4,360	4,360	4,360	4,360	4,360	
		Working	500	500	500	500	500	500	
		Total	13,730 to 18,730	13,730 to 18,730	13,730 to 18,730	13,730 to 18,730	13,730 to 18,730	13,730 to 18,730	
5	Fixed/Floating point				Floating	Floating	Floating		
	Unit name	input			324 Card Reader	324 Card Reader	681 Tape		
		output			333 Printer	333 Printer	681 Tape		
	Size of record	input			80	80	100		
		output			120	120	120		
Standard Mathematical Problem A	msec/block	input T_1			67	67	8.2		4:200.413
		output T_2			60	60	8.2		
	msec/penalty	input T_3			0.	0.2	0.1		
		output T_4			0.3	0.3	0.2		
	msec/record	T_5			-	-	-		
	msec/5 loops	T_6			2.1	2.1	2.1		
	msec/report	T_7			-	-	-		

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A*

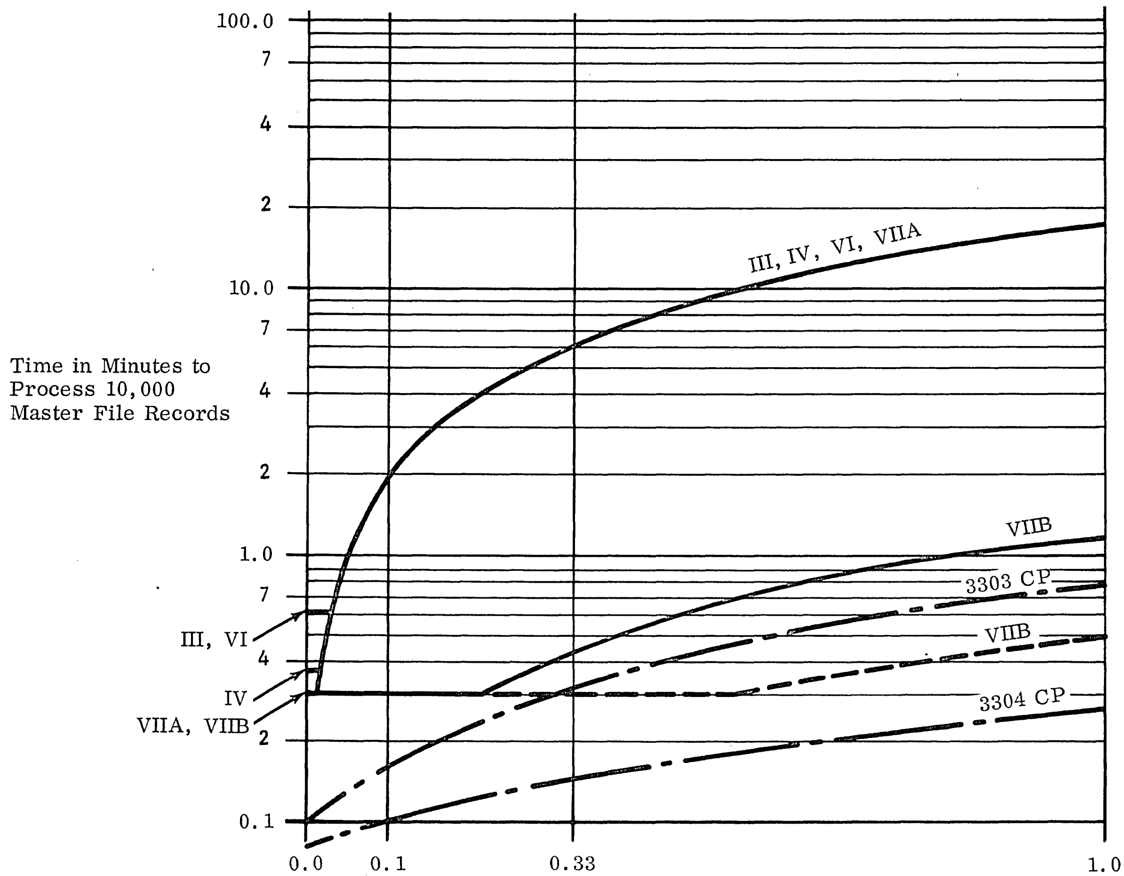
.111 Record sizes
- Master file: . . . . . . 108 characters.
- Detail file: . . . . 1 card.
- Report file: . . . . . . 1 line.

.112 Computation: . . . . . . standard.

.113 Timing basis: . . . . . . using estimating procedure outlined in User's Guide, 4:200.113.

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

.115 Storage space required: . . . . 13,730 to 18,730 characters.



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote Standard System Configurations)

LEGEND

- Elapsed time (unblocked detail and report files)
- Elapsed time (blocked detail and report files)
- Central Processor (CP) time

*See Graph 703:201.150 for performance of Model 3488 Random Access Computer Equipment on Standard File Problem A.

§ 201.

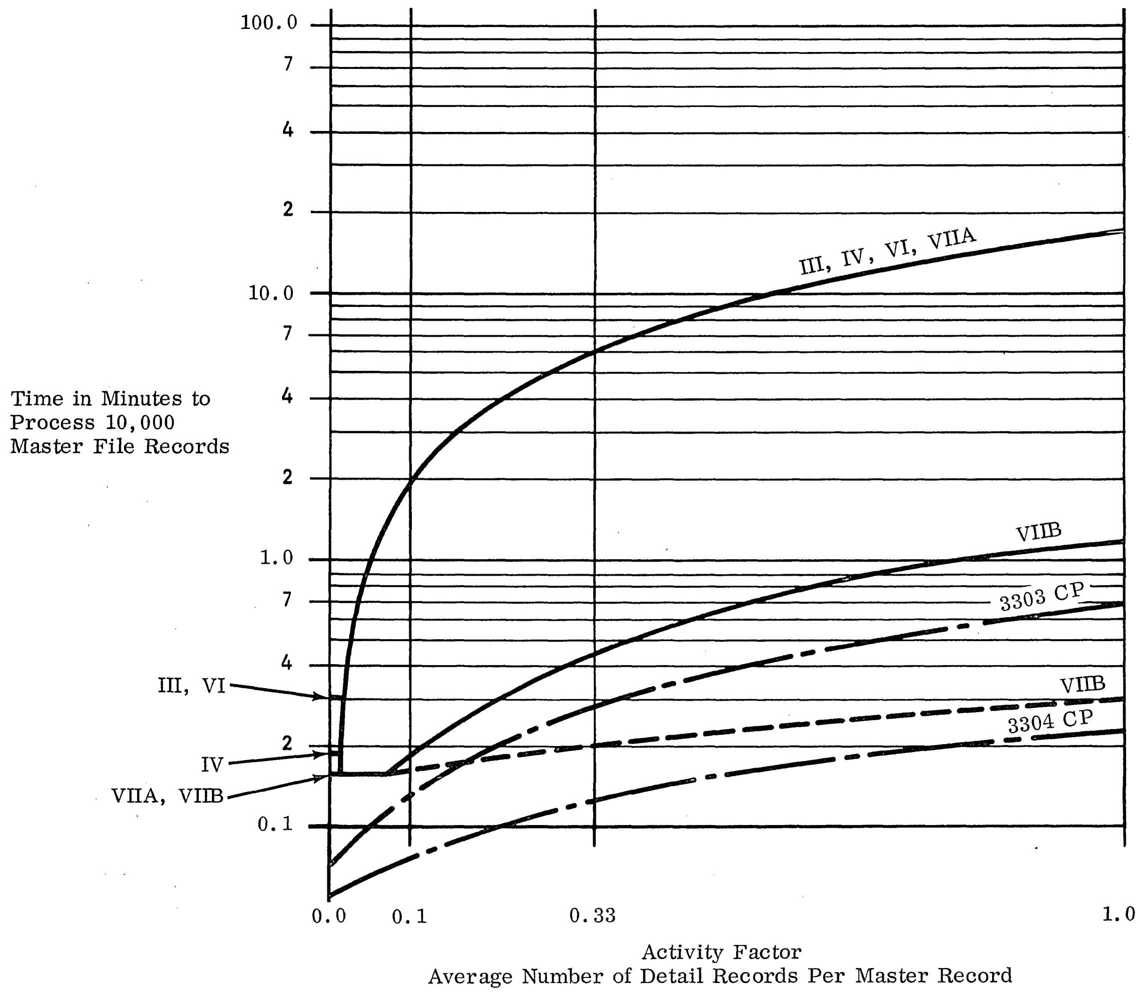
.12 Standard File Problem B

.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 User's Guide, 4:200.12.

.124 Graph: . . . . see graph below.



(Roman numerals denote Standard System Configurations)

LEGEND

- (solid line) Elapsed time (unblocked detail and report files)
- (dashed line) Elapsed time (blocked detail and report files)
- (dash-dot line) Central Processor (CP) time

§ 201.

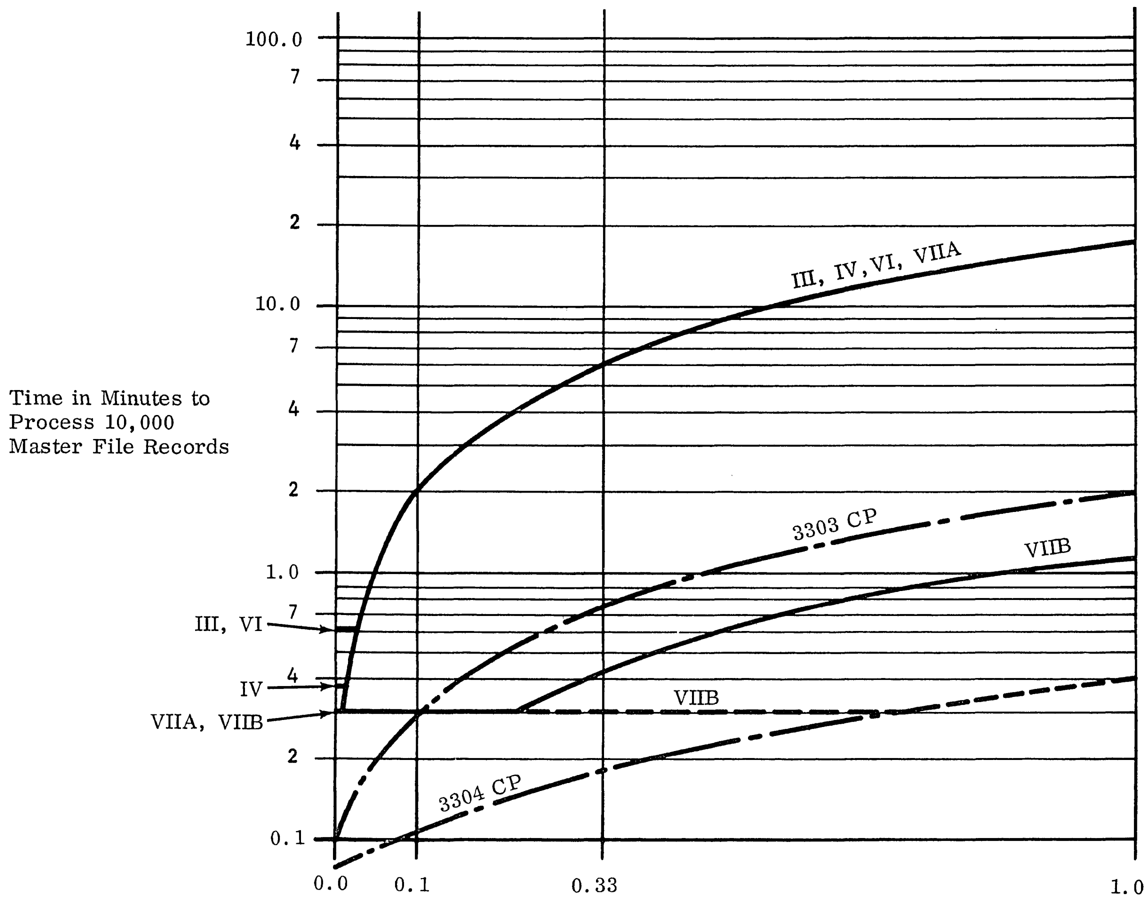
.14 Standard File Problem D

.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 User's 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 detail and report files)
— — — — — Elapsed time (blocked detail and report files)
—— - —— - —— Central Processor (CP) time

§ 201.

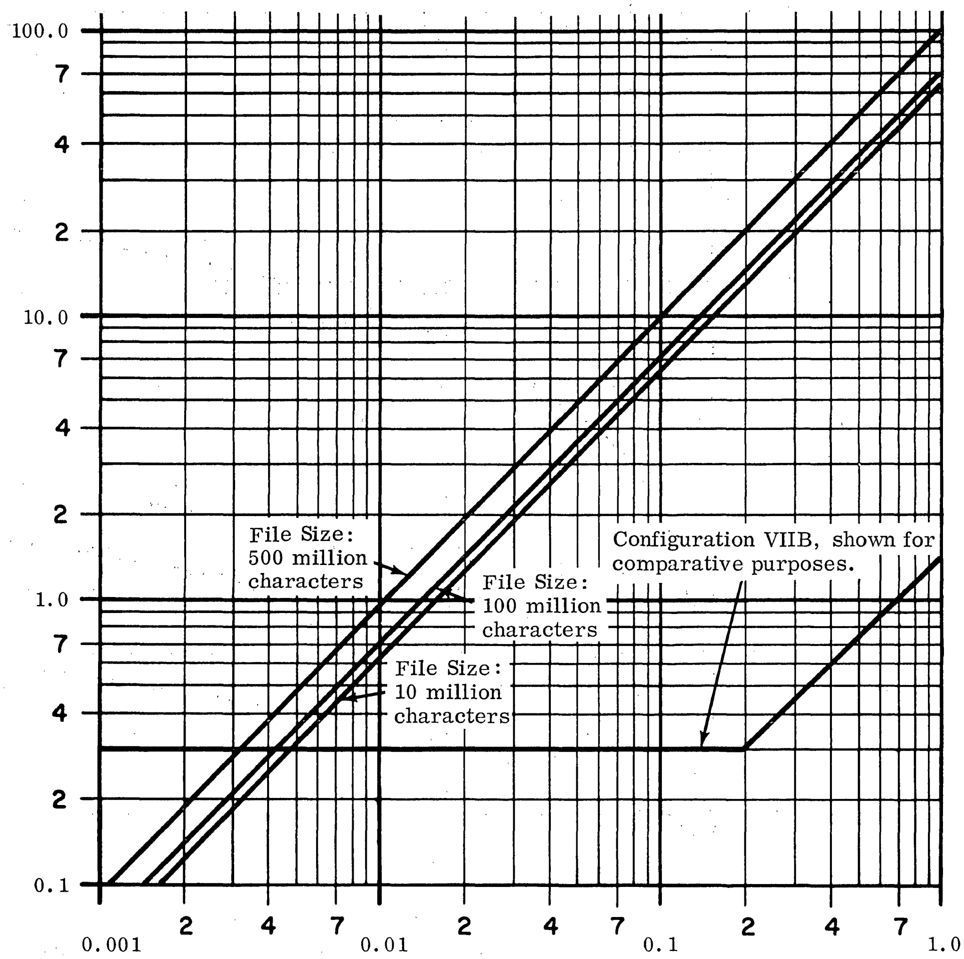
.15 Standard File Problem A (using Model 3488 Random Access Computer Equipment)

.151 Record sizes
Master file: . . . . . . 108 characters.
Detail file: . . . . 1 card.
Report file: . . . . 1 line.

.152 Computation: . . . . standard.

.153 Timing basis: . . . . . . using estimating procedure outlined on page 703:201.001 under "File Processing by Random Access Methods."

.154 Graph: . . . . see graph below.



Activity Factor
Average Number of Detail Records per Master Record

§ 201.

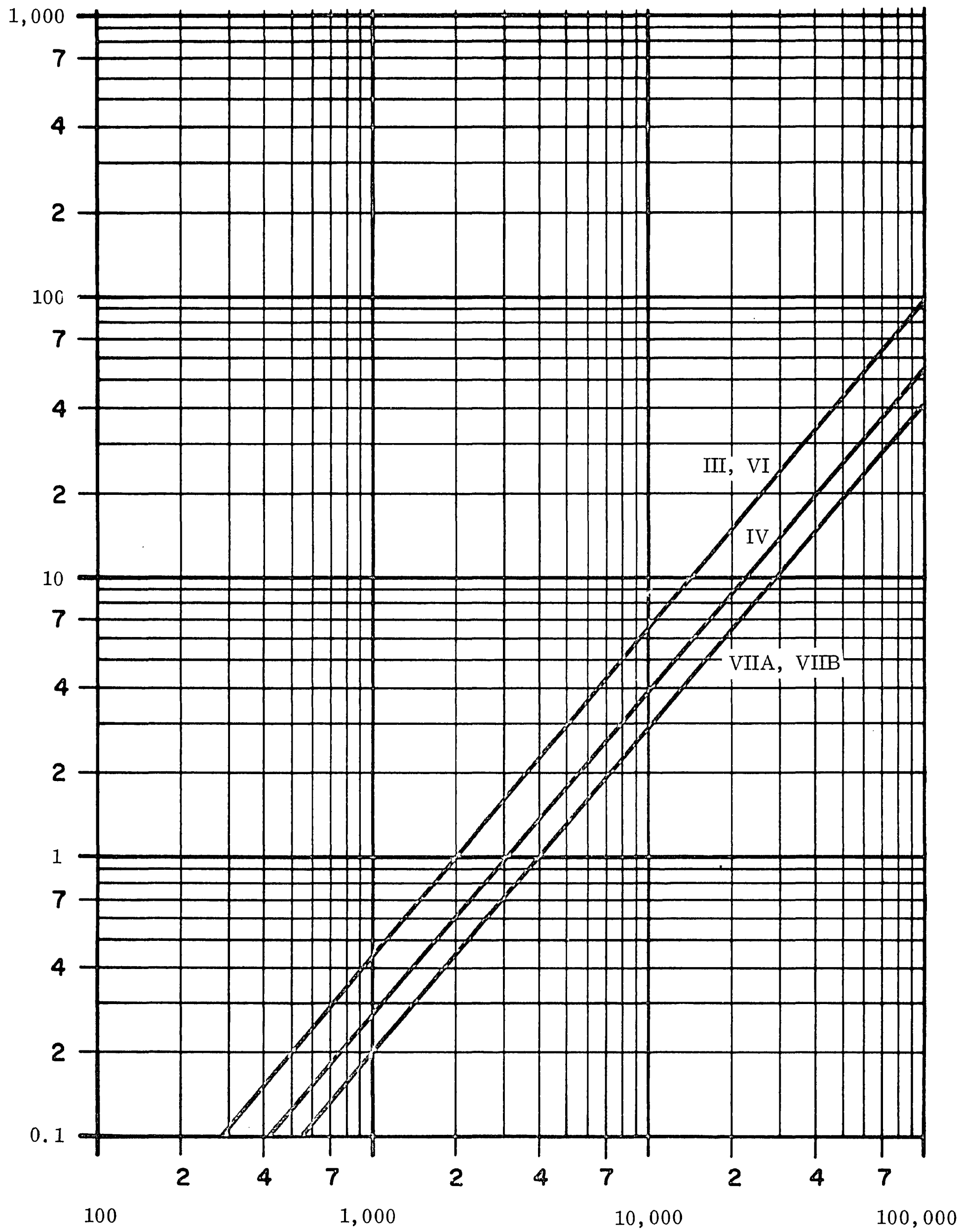
.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.
.212 Key size: . . . . 8 characters.
.213 Timing basis: . . . . . . using estimating procedure outlined in User's Guide, 4:200.213.

.214 Graph: . . . . see graph below, based on a simple 2-way merge.

Time in Minutes to Put Records Into Required Order

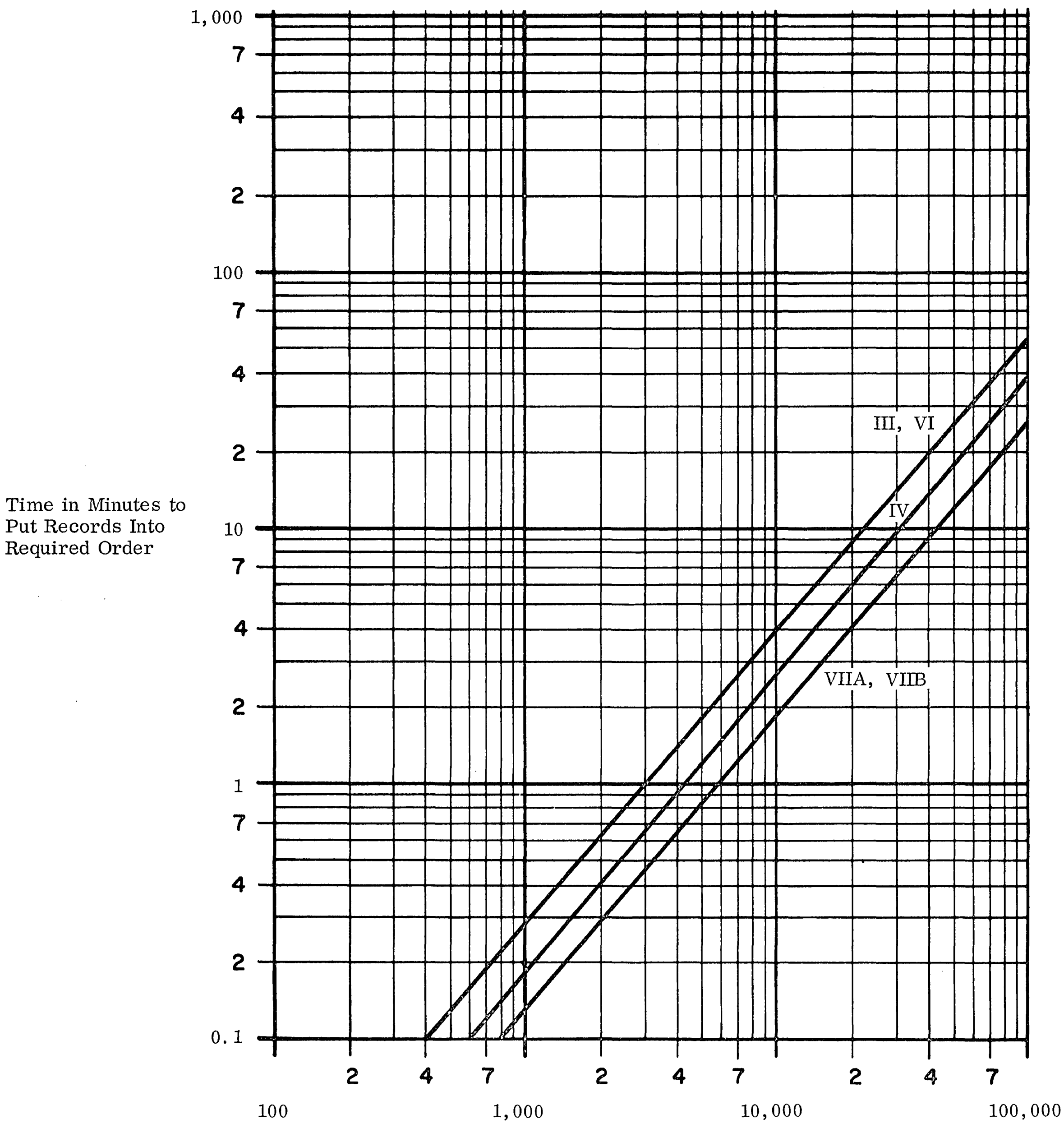


Number of records to be sorted, using a simple 2-way merge

(Roman numerals denote Standard System Configurations.)

§ 201.

.215 Graph: . . . . see graph below, based on a simple 3-way merge.



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

(Roman numerals denote Standard System Configurations)

§ 201.

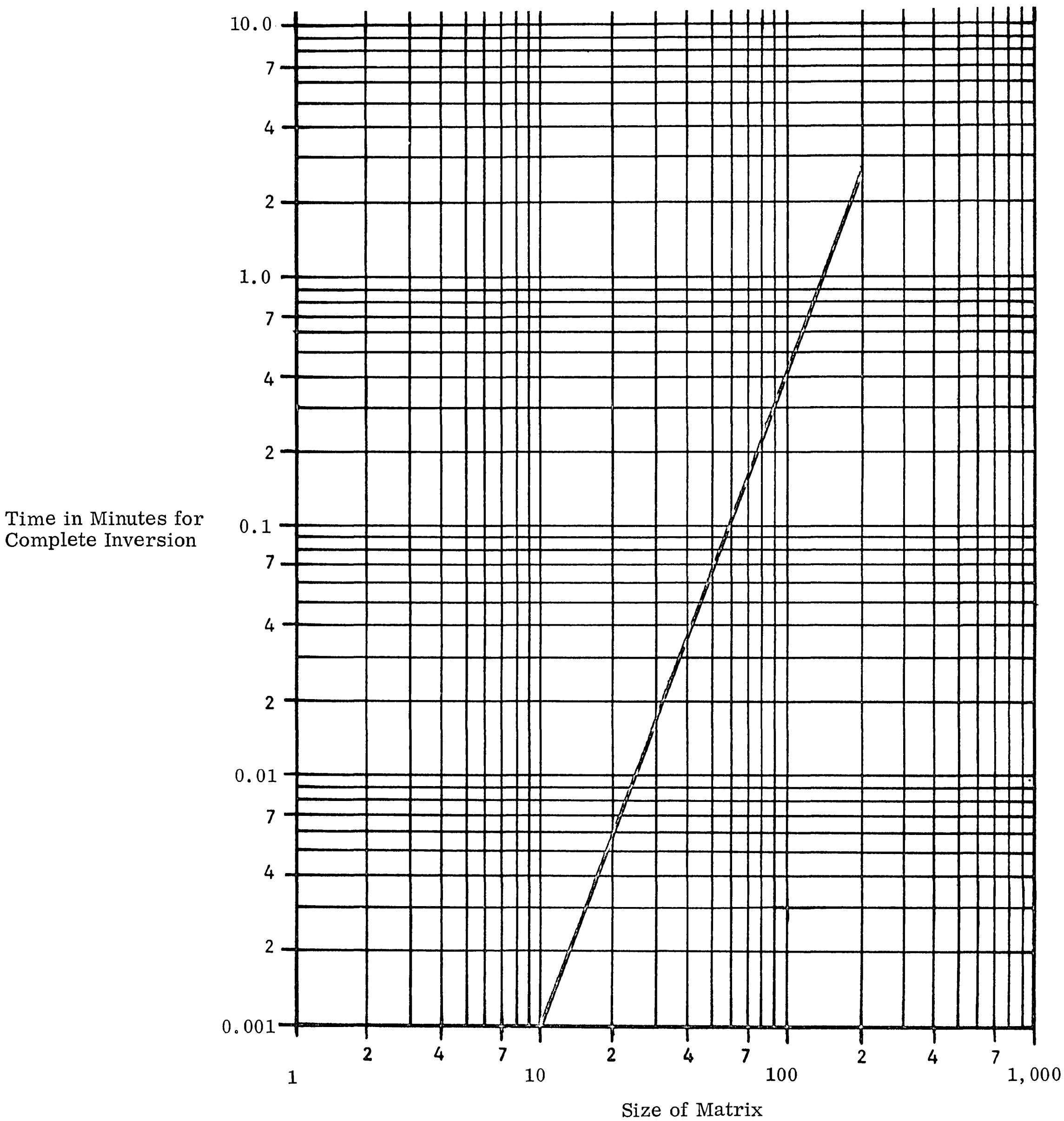
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits, on Model 3304 Processor with High Speed Arithmetic Unit.

.312 Timing basis: . . . . . . using estimating procedure outlined in User's 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.

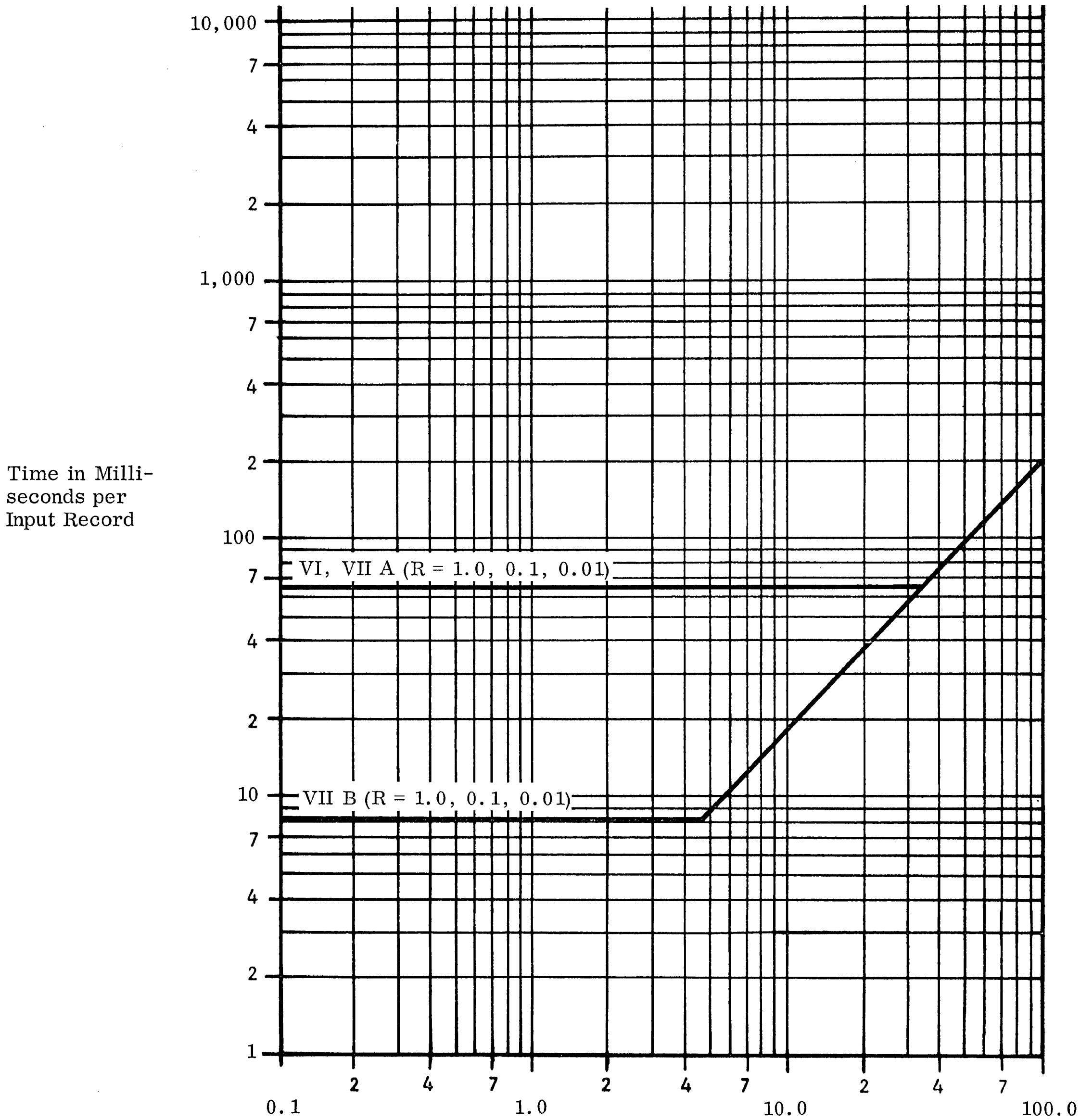
.412 Computation: . . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . . using estimating procedure outlined in User's Guide, 4:200.413.

.414 Graph: . . . . see graph below.

CONFIGURATIONS VI, VIIA, VIIB; 8-DIGIT PRECISION FLOATING POINT

R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



C, Number of Computations per Input Record

(Roman numerals denote Standard System Configurations)

PHYSICAL CHARACTERISTICS

§ 211.

Model No.	Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
3303	Processor - Logic	66	25	75	1500	1.4	3800
	High Speed Memory (40K)	44	25	75	1200	2.3	6300
	Console	60	29	34	300	0.2	550
	Power Supply	88	25	75	2900	5.0	13650
	I/O Control Rack	44	25	75	750	0.5	1350
3304	Processor - same as 3303 plus Additional Arithmetic Unit:	44	25	75	600	1.0	2750
3313-2	Power Supply	44	25	75	1500	2.4	6550
	High Speed Memory:						
3361-2	60K	44	25	75	1200	2.3	6300
3361-3	80K	44	25	75	1200	2.3	6300
3361-4	100K	66	25	75	1600	3.6	9850
3361-5	120K	66	25	75	1600	3.6	9850
3361-6	140K	66	25	75	1600	3.6	9850
3361-7	160K	66	25	75	1600	3.6	9850
321	Paper Tape Reader/Punch	34	24	60	425	N.A.	5500
322	Paper Tape Reader	34	24	60	425	N.A.	4450
324	Card Reader	64	30	55	425	3.0	7100
329	Card Reader	39	33	40	550	2.5	6300
331	Paper Tape Punch	34	24	60	425	N.A.	5100
333	Printer	58	31	55	1350	1.3	3100
335	Printer	58	31	55	1350	1.3	3100
581	Tape Station	49	19	69	900	1.1	3100
582	Tape Station	49	19	69	900	.1.5	3400
681	Tape Station	49	19	69	900	2.5	6550
3485	Tape Station	30	29	70	450	5.3	14900
3436	Card Punch	47	24	52	770	†	3290
3488-1	Random Access Computer Equipment	72	29	59	2600	7.7	21000

† Included in 3336 Card Punch Buffer power.

§ 211.

Model No.	Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
3321	Paper Tape Reader/Punch Control	*	*	*	100	0.16	450
3329	Card Reader Control	*	*	*	80	0.19	500
3333	Printer Buffer &	22	25	75	500	1.2	3300
	Control (for 333)	*	*	*	80	0.25	700
3335	Printer Buffer &	22	25	75	500	1.2	3300
	Control (for 335)	*	*	*	80	0.25	700
3336	Card Punch Buffer &	22	25	75	640	2.8	1710
	Control	*	*	*	80	0.23	650
3376	Communication Control	*	*	*	140	0.7	1900
3377	Data Exchange Control	*	*	*	100	0.31	850
	Communications Mode Control:						
3378-21	20-line single	*	*	*	240	0.87	2400
3378-22	20-line dual	*	*	*	240	0.87	2400
3378-41	40-line single	*	*	*	240	0.87	2400
3378-42	40-line dual	*	*	*	240	0.87	2400
3378-61	60-line single	*	*	*	260	0.94	2550
3378-62	60-line dual	*	*	*	260	0.94	2550
3378-81	80-line single	*	*	*	260	0.94	2550
3378-82	80-line dual	*	*	*	260	0.94	2550
3378-101	100-line single	*	*	*	280	1.07	2900
3378-102	100-line dual	*	*	*	280	1.07	2900
3378-121	120-line single	*	*	*	280	1.07	2900
3378-122	120-line dual	*	*	*	280	1.07	2900
3378-141	140-line single	*	*	*	300	1.26	3450
3378-142	140-line dual	*	*	*	300	1.26	3450
3378-161	160-line single	*	*	*	320	1.48	4050
3378-162	160-line dual	*	*	*	320	1.48	4050
3383-6	Dual Tape Channel (2x6)	*	*	*	280	0.96	2600
3383-12	Dual Tape Channel (2x12)	*	*	*	320	1.18	3200
3385-6	Dual Tape Channel (2x6)	*	*	*	340	1.14	3100
3385-12	Dual Tape Channel (2x12)	*	*	*	380	1.35	3700
3388-4	3488 Channel	*	*	*	130	0.92	2030

* Housed in Processor I/O Control Rack.

General Requirements

Temperature: . . . . 65 to 85° F, held reasonably stable.
Relative Humidity: . . . . 20 to 65%, held reasonably stable.
Power: . . . . 208V, 60 cycle, single phase, 4-wire cable.

PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	Model No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	3303	Processor - with 40,000 characters of High Speed Memory	5,000	465	250,000
	3304	Processor - with 40,000 characters of High Speed Memory and High Speed Arithmetic Unit	6,375	526	320,000
		Optional Features			
	Special Feature 164	Simultaneous Mode #3 (Simo 3) - Processor modification for add'l. level of simultaneity with Tape Stations	300	12.75	15,600
	3416	Digital Clock (Includes Special Feature 168, Console Typewriter Control modification, at no extra charge)	55	5.00	2,750
INTERNAL STORAGE		High Speed Memory -			
	3361-2	20,000 additional characters	1,000	84.00	50,000
	3361-3	40,000 additional characters	1,500	124.00	75,000
	3361-4	60,000 additional characters	2,100	172.00	105,000
	3361-5	80,000 additional characters	2,700	220.00	135,000
	3361-6	100,000 additional characters	3,300	268.00	165,000
	3361-7	120,000 additional characters	4,000	324.00	200,000
		Data Drum Memory -			
	3465-1	327,680 characters	1,365	191.00	64,700
	3465-2	655,360 characters	1,680	235.00	79,500
	3465-3	1,310,720 characters	2,310	323.00	109,100
	3465-4	1,638,400 characters	2,865	401.00	135,200
	3465-5	1,966,080 characters	3,145	440.00	148,400
	3465-6	2,621,440 characters	3,705	519.00	174,800
	3488-1	Random Access Computer Equipment File	2,850	650.00	135,000
	3488-2	File Expansion Unit	1,425	275.00	65,000
INPUT-OUTPUT		Paper Tape Units -			
	321	Reader/Punch (100 char/sec.)	170	24.50	7,800
	322	Reader (1,000 char./sec.)	350	36.50	14,500
	331	Punch (100 char/sec.)	155	23.00	7,150
		Card Readers -			
	324	900 cards/minute	340	64.50	17,000
	329	1,470 cards/minute	695	97.25	29,800
	3436	Card Punch (300 cards/minute)	500	109.00	24,000

§ 221.

PRICE DATA (Contd.)

CLASS	IDENTITY OF UNIT		PRICES		
	Model No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
INPUT-OUTPUT (Contd.)		On-Line Printers -			
	333	120 columns	700	262.00	32,200
	335	160 columns	1,120	419.00	51,500
		Magnetic Tape Stations -			
	581	33KC	550	193.00	29,700
	582	66KC	875	207.00	36,750
	681	120KC	950	228.00	39,850
	3485	30/83/120KC (IBM-compatible)	775	186.00	37,200
	3487	15/41/60KC (IBM-compatible):			
	3487-2	Group of 2 tape drives	1,200	206.00	60,000
	3487-4	Group of 4 tape drives	1,925	384.00	96,300
	3487-6	Group of 6 tape drives	2,650	562.00	132,500
	6050-1	Video Data Terminal	275	38.50	11,600
	6050-2	Video Data Terminal	250	35.00	10,600
	6051	Video Data Interrogator	45	6.25	1,900
CONTROL-LERS	3313-2	Supplemental Power Supply	400	26.00	20,000
	3321	Paper Tape Control	190	16.00	9,500
	3329	Card Reader Control	200	11.75	10,000
		Printer Buffer and Control:			
	3333	For 120-column Printer	475	46.75	23,750
	3335	For 160-column Printer	780	60.25	39,780
	3336	Card Punch Buffer and Control	475	49.00	23,750
	3376	Communications Control (Single Channel)	400	25.00	20,000
	3377	Data Exchange Control	390	25.25	17,900
		Communications Mode Control:			
	3378-21	Single Scan (20 line)	430	36.50	21,500
	3378-41	Single Scan (40 line)	450	37.75	22,500
	3378-61	Single Scan (60 line)	470	39.25	23,500
	3378-81	Single Scan (80 line)	490	40.75	24,500
	3378-101	Single Scan (100 line)	520	44.00	26,000
	3378-121	Single Scan (120 line)	540	45.50	27,000
	3378-141	Single Scan (140 line)	560	46.75	28,000
	3378-161	Single Scan (160 line)	580	48.25	29,000
	3378-22	Dual Scan (20 line)	455	38.50	22,750
	3378-42	Dual Scan (40 line)	470	39.50	23,500
	3378-62	Dual Scan (60 line)	485	40.50	24,250
	3378-82	Dual Scan (80 line)	500	41.50	25,000
	3378-102	Dual Scan (100 line)	540	45.75	27,000
	3378-122	Dual Scan (120 line)	555	46.75	27,750
	3378-143	Dual Scan (140 line)	570	47.50	28,500
	3378-162	Dual Scan (160 line)	585	48.50	29,250
		Dual Magnetic Tape Channel:			
	3383-6	For up to 6 581, 582, or 681 Stations	400	26.00	24,000
	3383-12	For up to 12 581, 582, or 681 Stations	450	29.25	27,000

§ 221. PRICE DATA (Contd.)

CLASS	IDENTITY OF UNIT		PRICES		
	Model No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CONTROL-LERS (Contd.)	3385-6	For up to 6 Model 3485 Stations	790	72.75	39,500
	3385-12	For up to 12 Model 3485 Stations	850	79.75	42,500
	3387-6	For up to 6 Model 3487 Stations	950	61.00	47,500
	3387-12	For up to 12 Model 3487 Stations	1,050	68.00	52,500
	3388-4	Channel for Random Access Computer Equipment	625	40.75	32,500
COMMUNICA-TIONS BUF-FERS AND AUXILIARIES	6002-11	Telegraph Buffer	15.	1.00	700
	6002-12	Telegraph Buffer	20.	1.25	900
	6002-21	Telegraph Buffer	15.	1.00	700
	6003	Telegraph Buffer	80.	5.00	3,650
	6010-21	Communication Buffer	115.	16.00	4,900
	6010-22	Communication Buffer	165.	23.00	7,000
	6012-11	Communication Buffer	175.	11.25	8,100
	6012-12	Communication Buffer	175.	11.25	8,100
	6012-21	Communication Buffer	175.	11.25	8,100
	6012-22	Communication Buffer	175.	11.25	8,100
	6013	Telegraph Buffer	80.	5.00	3,650
	6015	Telegraph Buffer	80.	5.00	3,650
	6016	Parallel Buffer	60.	3.75	3,800
	6020-11	Communication Buffer	115.	16.00	4,900
	6020-12	Communication Buffer	160.	22.50	6,800
	6025-100	Buffer Interface Unit	60.	3.75	2,800
	6025-101	Buffer Interface Unit	70.	4.50	3,200
	6025-210	Buffer Interface Unit	60.	3.75	2,800
	6025-211	Buffer Interface Unit	70.	4.50	3,200
	6025-220	Buffer Interface Unit	70.	5.00	3,200
	6025-221	Buffer Interface Unit	80.	5.00	3,700
	6025-400	Buffer Interface Unit	60.	3.75	2,800
	6025-401	Buffer Interface Unit	70.	4.50	3,200
	6025-411	Buffer Interface Unit	80.	4.50	3,700
	6025-421	Buffer Interface Unit	80.	5.00	3,700
	6025-431	Buffer Interface Unit	80.	5.00	3,700
	6027	Line Termination Assembly	45.	3.00	2,100
	6041	Time Generator	80.	5.00	3,700
	6042	Code Translator	105.	14.75	4,500
	6076	Video Data Interrogator Control Terminal	840.	118.00	35,300
	6077	Video Data Interrogator Control	1,160	162.00	48,700

RCA SPECTRA 70

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CONTENTS

Report 710: RCA Spectra 70 — General

Report 712: RCA Spectra 70/15

Report 713: RCA Spectra 70/25

Report 714: RCA Spectra 70/35

Report 715: RCA Spectra 70/45

Report 716: RCA Spectra 70/55

INTRODUCTION

.1 SUMMARY

Spectra 70 is the "brand name" for RCA's third-generation family of central processors, peripheral devices, and supporting software. Noteworthy characteristics of the Spectra 70 include:

- The high degree of program compatibility, both upward and downward, among three of the five Spectra 70 processor models. Compatibility is also achieved with the IBM System/360 processors through similar hardware design and compatible source languages.
- The wide range of input-output and storage devices.
- The numerous arithmetic modes and data forms, and the resulting complexity of machine-language coding.
- The emphasis upon software support through several levels of integrated operating systems.
- The use of true monolithic integrated circuits in the 70/35, 70/45, and 70/55 Processors.
- The availability of optional features that enable certain Spectra 70 processor models to emulate a number of second-generation RCA and IBM computers.

The format of this report is designed to present and analyze all the facts about the Spectra 70 line in a way that will make it easy to locate and study the material desired, while placing proper emphasis upon the similarities and differences among the various Spectra 70 models. The format of this report closely parallels that of our IBM System/360 report to facilitate comparisons with the third-generation offerings of the leading computer manufacturer. The Spectra 70 coverage consists of a general Computer System Report (behind Tab 710) which analyzes the concepts, hardware, and software that are common to all Spectra 70 models, and individual subreports (behind Tabs 712 through 716) which report the characteristics, performance, and pricing of computer systems using each of the Spectra 70 processor models. (Spectra 70/15 has its own specialized software, which is therefore described within the individual subreport for this model.)

This Introduction is divided into five independent sections, each of which describes and (where pertinent) analyzes some particular facet of the Spectra 70 Series. Each section is independent and can be read as your needs and interests warrant. The five sections are:

.1 Summary
.2 Data Structure
.3 Hardware
.4 Software
.5 Compatibility

.2 DATA STRUCTURE

Spectra 70's data structure is identical in all respects with that of the IBM System/360. The basic unit of data storage is the "byte," which consists of eight data bits plus (in most system components) one parity bit. The eight data bits in a byte can represent one alphameric character, two decimal digits, or a portion of a binary field.

Bytes can be handled individually or grouped together into fields. A "halfword" is defined as a group of two consecutive bytes, or 16 bits. A "word" in the Spectra 70 is a group of four consecutive bytes, or 32 bits. A "double word" consists of two consecutive words, or 64 bits. The location of any field or group of bytes is specified by the address of its leftmost byte.

Every fixed-length field (halfword, word, or double word) must be located in main storage on an "integral boundary"; i.e., the storage address of the field must be a multiple of the length of the field in bytes. This restriction is particularly important for efficient operation of the Spectra 70/55 Processor, which accesses up to four bytes in parallel, and the same restriction has been applied to the smaller processors in order to maintain compatibility. Variable-length (decimal) fields are processed serially by byte in all models, so they may start at any byte location.

.2 DATA STRUCTURE (Contd.)

At the low end of the Spectra 70 line of processors, the 70/15 and 70/25 Processors can perform arithmetic operations on two basic types of operands: fixed-point binary and variable-length decimal. The larger Spectra 70 processor models can perform arithmetic operations on four basic types of operands. In addition to fixed-point binary and variable-length decimal, these models can also perform arithmetic operations on two sizes of floating-point binary operands. The basic arithmetic operand size is the 32-bit fixed-point binary word. Most fixed-point instructions can alternatively specify the use of 16-bit halfword operands.

Floating-point numbers can be represented in either a "short" (32-bit) or "long" (64-bit) format. The fractional part occupies 24 bits in the short format and 56 bits in the long format. The hexadecimal character occupies 7 bits in both formats and permits representation of numbers ranging from 10^{-78} to 10^{75}.

Decimal arithmetic is performed upon 4-bit BCD digits packed two to a byte, with a sign in the rightmost four bits of the low-order byte. Decimal operands can be up to 16 bytes (31 digits and sign) in length.

The 8-bit byte structure has certain basic advantages over the 6-bit data format: decimal digits can be packed more conveniently, the new standard 7-bit ASCII code and the Extended BCD Interchange Code can be used, and today's familiar character sets can be conveniently expanded.

.3 HARDWARE

.31 Central Processors

Five processor models currently form the nucleus of the Spectra 70 Series. Three of the processor models are program-compatible and suitable for a broad range of business and scientific applications: 70/35, 70/45, and 70/55. The 70/15, with its restricted instruction repertoire, may be of primary interest as a satellite or remote terminal system for the larger Spectra 70 processors. The 70/25 also has a limited instruction repertoire, but its expanded throughput capability for magnetic tape-oriented applications makes it suitable for certain single-processor installations.

Comparative arithmetic execution times for the various Spectra 70 processors are illustrated in Table I. Table II shows the various core storage capacities that can be obtained with each of the basic processor models.

TABLE I: ARITHMETIC EXECUTION TIMES FOR THE RCA SPECTRA 70 PROCESSORS

Task	Processor Model				
	70/15	70/25	70/35	70/45	70/55
Fixed Point Binary					
c = a + b	62	36.8	51.2	25.2	7.8
c = ab	#	#	163.2	81.9	17.9
c = a/b	#	#	243.2	111.2	25.0
Fixed Point Decimal					
c = a + b	56	33.0	53.1	22.0	9.7
c = ab	#	454.0	247.5	98.0	40.1
c = a/b	#	660.0	454.1	189.8	24.9
Floating Point — Short					
c = a + b	#	#	80.9	37.4	13.2
c = ab	#	#	202.6	67.6	23.0
c = a/b	#	#	445.5	101.2	28.4
Floating Point — Long					
c = a + b	#	#	115.9	52.6	18.5
c = ab	#	#	536.4	211.5	50.0
c = a/b	#	#	1282.1	305.2	83.8

NOTE: All times are expressed in microseconds. The fixed-point decimal times are based on 5-digit (3-byte) decimal operands. The floating-point times are based on both the short-form (32 bits) and the long-form (64 bits) binary operands. The 70/15 and 70/25 do not require programmer-initiated operand movement to a fixed accumulator register.

Facility not available.

(Contd.)

.31 Central Processors (Contd.)

The Spectra 70 processors which are larger than the 70/25 Processor are designed to facilitate achieving program compatibility with the IBM System/360 computers. The remainder of this discussion of Central Processors concerns itself exclusively with the processors associated with the Spectra 70/35, 70/45, and 70/55 systems. These processors offer the full System/360 instruction repertoire except for the "privileged" instructions, which are normally reserved for operating system use and are not permitted in users' programs. Thus, RCA expects to achieve two-way program compatibility — to a limited extent at the machine-language level and to a much greater extent at the assembly, COBOL, and FORTRAN language levels.

The Spectra 70 processors contain facilities for addressing main storage, for fetching and storing information, for executing stored-program instructions in the desired order, for arithmetic and logical processing of data, and for initiating all communication between main storage and peripheral devices. Each program uses sixteen 32-bit general registers and four 64-bit floating-point registers. The general registers can be used as fixed-point accumulators or as index registers. These registers are contained in a 128-word scratchpad memory in the Spectra 70/45 and 70/55 Processors. Scratchpad memory has a cycle time of 300 nanoseconds per 4-byte word. In lieu of scratchpad memory, the Spectra 70/35 Processor provides 128 words of additional core storage for use as general registers. Different parts of these memory units are used as the operational registers depending upon which processor state is being used.

Instructions can be two, four, or six bytes in length. A 2-byte instruction causes no reference to main core storage. A 4-byte instruction causes one reference to main storage, while a 6-byte instruction causes two storage references.

Main storage addresses are formed by adding a 12-bit "displacement" contained in the instruction to a 24-bit "base address" contained in one of the 16 general registers. The addresses in many instructions (including most binary arithmetic and logical instructions) can be further modified by adding a 24-bit "index" contained in another general register; this effectively provides a double indexing capability. The base-register technique of address formation facilitates program relocation and segmentation, at the expense of increased programming complexity.

The basic arithmetic mode of these processors is fixed-point binary, using 32-bit operands and two's-complement notation. Most instructions can alternatively specify the use of 16-bit "halfword" operands to improve storage utilization. Most products and all dividends are 64 bits long. Fixed-point arithmetic and comparison instructions specify one operand in a general register and a second operand in either main storage or a general register; these instructions are 4 bytes long when they specify an operand address in main storage and 2 bytes long when both operands are in registers.

The System/360-compatible instruction set includes instructions which perform fixed-point arithmetic, comparison, branching, moving, loading, storing, shifting, radix conversion, code translation, packing, unpacking, and Boolean operations. The radix conversion operations perform automatic conversions between signed, packed decimal fields up to 15 digits in length and 32-bit signed binary integers. The code translation instruction uses a table to translate any 8-bit data code to any other 8-bit code. The packing and unpacking instructions convert numeric BCD data between the one-character-per-byte format used in most input-output devices and the two-digits-per-byte format used for decimal arithmetic.

The decimal arithmetic facility provides additional instructions for addition, subtraction, multiplication, division, comparison, and editing of decimal numbers. Decimal arithmetic is performed upon 4-bit BCD digits packed two to a byte, with a sign in the rightmost four bits of the low-order byte. Decimal operands may be up to 16 bytes (31 digits and sign) in length. The length of each decimal field is specified in the instruction referencing it. Two-address (6-byte) instructions of the storage-to-storage type are used for all decimal operations; the general and floating-point registers are not utilized.

Decimal arithmetic in the Spectra 70 processors can be faster than binary arithmetic. This is particularly true when the times to perform radix conversions and to load and store processor registers are added to the basic binary arithmetic times.

The floating-point arithmetic facility provides additional instructions for addition, subtraction, multiplication, division, loading, storing, and comparison of both "short" (32-bit) and "long" (64-bit) floating-point numbers. Floating-point instructions specify one operand in a floating-point register and a second operand in either main storage or a floating-point register.

.32 Internal Storage

Table II indicates the range of core storage sizes and speeds available with the various Spectra 70 processor models.

TABLE II: SPECTRA 70 MAIN CORE STORAGE CHARACTERISTICS

Core Storage Capacity, Bytes	70/15	70/25	70/35	70/45	70/55
4,096	15-A				
8,192	15-B				
16,384		25-C	35-C	45-C	
32,768		25-D	35-D	45-D	
65,536		25-E	35-E	45-E	55-E
131,072				45-F	55-F
262,144				45-G	55-G
524,288					55-H
Cycle Time, μsec	2.0	1.5	1.44	1.44	0.84
Bytes Accessed per Cycle	1	4	2	2	4
Cycle Time per Byte, μsec	2.0	0.38	0.72	0.72	0.21

.32 Internal Storage (Contd.)

The optional Storage Protection feature can protect the contents of specified 2,048-byte blocks of core storage from being altered as a result of program errors or misguided input data. This feature prevents overwriting by unauthorized programs, but it does not guarantee privacy since any program can still read the contents of any desired portion of core storage.

Three different types of auxiliary storage devices are available in the form of magnetic drums, discs, and cards. The storage capacity of these devices ranges from less than 0.8 million bytes for the drum unit to over 561 million bytes for the magnetic card mass storage unit. Similarly, average access times can range from 8.6 milliseconds to 385 milliseconds for the same two devices, respectively. The single controller used for all three storage devices allows an installation to tailor its complement of storage devices according to specific capacity and access time requirements. Table III lists the various Spectra 70 auxiliary storage devices with their principal functional characteristics. None of these devices can be used with the small-scale 70/15 or 70/25 Processors.

TABLE III: SPECTRA 70 AUXILIARY STORAGE UNITS

Device	Capacity Range (Millions of Bytes per Control Unit)	Average Access Time (msec)	Data Transfer Rate (bytes/sec)	Report Reference
70/564 Disc Storage Unit*	7.25 to 58.0	98	156,000	710:042
70/568 Mass Storage Unit	561.5 to 4,492.0	385	70,000	710:043
70/565 Drum Memory Unit	0.8 to 3.2	8.6	210,000	710:044

* This is RCA's designation for the IBM 2311 Disk Storage Drive, which RCA is marketing for use with Spectra 70 systems.

.33 Sequential Input-Output Units

RCA has announced a wide range of input-output units for the Spectra 70 computer family. Some of the more significant units are:

- 9-track System/360-compatible magnetic tape units with transfer rates of up to 120,000 bytes per second.
- A fast card reader (1,435 cards per minute) with optional mark-sensing capabilities at a slower rate.
- A triple-purpose optical scanner with optional mark-sensing and punched-hole reading capabilities.

The paper tape, punched card, and printing equipment is conventional and differs only in minor details from previous RCA offerings. Table IV summarizes the capabilities of the available sequential input-output units.

(Contd.)

TABLE IV: SPECTRA 70 SEQUENTIAL INPUT-OUTPUT UNITS

Unit	Models Available	Peak Speed	Report Reference
70/237 Card Reader		1,435 cpm	710:071
70/234 Card Punch		100 cpm	710:072
70/236 Card Punch		300 cpm	710:072
70/221 Paper Tape Reader-Punch		200 cps (reader 100 cps (punch)	710:073
70/242 Printer	132 or 160 columns	625 lpm	710:081
70/243 Printer	132 or 160 columns	1,250 lpm	710:082
70/248 Bill Feed Printer		600 lpm 400 cpm	710:083
9-track Magnetic Tape Units	30, 60, or 120 KB versions; seven-track adapters	120,000 bytes/sec	710:091
70/251 Videoscan Document Reader		1,800 doc/min.	710:106

.34 Display Equipment

Display devices are a means for presenting information either to a camera or directly to man. They generally hold only a small amount of data for only a short time; their value is in the variety and speed at which they can display the appropriate information.

RCA provides a display device called the 6050 Video Data Terminal. This combination entry and display device can be used for both local and remote operations. Up to 480 characters can be displayed on a 14-inch rectangular cathode-ray-tube screen.

.35 Data Communications Equipment

The RCA 70/668 Communications Controller — Multichannel (CCM) operates on the 70/35, 70/45, and 70/55 Processors and terminates from 16 to 48 communications lines serving a wide variety of remote terminals. Each of the 16 to 48 scan positions requires a communications buffer, and in some cases a data set, to interface with the communications line. The CCM is connected to a Spectra 70/35, 70/45, or 70/55 computer by one trunk of the Multiplexor Channel. Each scan position of a CCM uses one Multiplexor subchannel. The maximum total communications data rate that one 70/668 CCM can handle is 6,000 characters per second.

The RCA Communication Controls (Single Channel) permit remote half-duplex communications between an RCA Spectra 70 computer system and an RCA 301, 3301, or Spectra 70 computer system that is equipped with the appropriate communications equipment. Different models of these Controls permit communication over the public switched telephone network, a common-carrier leased voice-band line, or a common-carrier leased broadband line. Some models offer facilities for programmed automatic dialing over the public telephone network through use of a Bell System Automatic Calling Unit.

.36 System Configuration

The Spectra 70 peripheral devices and their controllers are connected to the 70/25 and larger systems through input-output channels of various types and capacities. A single Multiplexor Channel is provided as standard equipment for the 70/35, 70/45, and 70/55 systems and as optional equipment for the 70/25 system. The 70/55 Multiplexor Channel can control up to 256 low-speed devices. Selector Channels are provided as standard equipment for the 70/15 and 70/25, and as optional equipment for the larger systems of

.36 System Configuration (Contd.)

the Spectra 70 series. A Selector Channel provides direct control of one high-speed input-output operation at a time. Table V shows the various combinations and capacities of Multiplexor and Selector Channels possible for all Spectra 70 systems, together with the maximum number of simultaneous I/O operations per system.

.37 Simultaneous Operations

An RCA Spectra 70 Central Processor (except for the small-scale Model 70/15) can concurrently execute:

- One machine instruction; and
- Up to eight high-speed input-output operations (one per Selector Channel); and
- Multiple slower input-output operations via a Multiplexor Channel.

Detailed information concerning the number of Selector and Multiplexor Channels that can be connected, together with their data capacities, is presented in Report Section 710:111. Table V summarizes the mix possibilities and simultaneous operations capabilities of the various Spectra 70 input-output channels.

In general, the relationships between RCA Spectra 70 peripheral devices and input-output data channels are determined at installation time and cannot be altered under program control except by the inclusion of special optional features. Since it is not normally possible to assign by program any free channel to any available peripheral device, the number of input-output operations that can actually occur simultaneously can in many cases be considerably fewer than the theoretical maximum. However, special features are available to switch a limited number of devices to free data channels under program control.

.4 SOFTWARE

RCA's software systems for the Spectra 70 series, in general, closely parallel the structure and contents of the software supplied by IBM for its System/360 series. However, RCA has either omitted or delayed for implementation at a later time most of the sophisticated, "third-generation" software facilities such as disc-oriented control systems, disc file language facilities, automatic on-line file management techniques, comprehensive data communications control routines, and time-sharing processing support. Multiprogramming control for a fixed number of jobs is provided for Spectra 70 systems that have

TABLE V: SPECTRA 70 INPUT-OUTPUT CHANNEL COMBINATIONS

	Processor Model				
Standard Channel Complement	70/15	70/25	70/35	70/45	70/55
Selector Channels —	1	4	0	0	0
Trunks per channel	6	1	-	-	-
Number of simultaneous operations	3	4	-	-	-
Multiplexor Channels —	0	0	1	1	1
Number of devices	-	-	192	256	256
Number of simultaneous operations	-	-	7	8	8
Fully Expanded Channel Complement	70/15	70/25	70/35	70/45	70/55
Selector Channels —	1	8	2	3	6
Trunks per channel	6	1	2	2	4
Number of simultaneous operations	3	8	2	3	6
Multiplexor Channels —	0	1	1	1	1
Number of devices	-	115	192	256	256
Number of simultaneous operations	-	8	7	8	8
Combined total of possible simultaneous operations	3	16	9	11	14

(Contd.)

.4 SOFTWARE (Contd.)

a minimum of 65K bytes of core storage. RCA emphasizes that the development of its individual software elements has been and is expected to remain on schedule (or in some cases, ahead of schedule). Table VI lists the principal control, language, and utility programs offered at the several levels of Spectra 70 software support, together with the scheduled delivery date for each program.

The principal levels of RCA Spectra 70 software are designated Primary Operating System, Tape or Tape/Disc Operating System, and Disc Operating System, in order of increasing complexity and capability. Software for the small-scale Spectra 70/15 system, however, is a specially-designed, card-oriented set of routines that provides assembly language, Report Program Generator, I/O control, and service routine facilities at 4K- and 8K-byte core storage design levels. The more powerful Spectra 70/25 system can function either with a basic set of independent software programs (Assembler, RPG, Sort/Merge, etc.) or with the integrated Primary Operating System (POS). Virtually all software announced for both the Spectra 70/15 and 70/25 systems is already in use.

POS for the Spectra 70/25 system offers basically the same supervised facilities as POS for the larger Spectra 70 systems (described below) and functions with a minimum hardware configuration of 16K bytes of core storage, four magnetic tape units, console typewriter, printer, and card reader and punch. The principal limitations of 70/25 POS facilities in comparison to the POS facilities for the 70/35, 70/45, and 70/55 systems are the omission of a COBOL language processor and the lack of assembly-language-level control of random-access devices. The method of implementation of POS programs for use with the Spectra 70/25 differs from that used with the larger Spectra 70 systems due to the fact that the 70/25 Processor has a somewhat restricted instruction set.

TABLE VI: SOFTWARE SCHEDULE FOR THE RCA SPECTRA 70/35, 70/45, AND 70/55

PROGRAMS TO BE SUPPLIED	TAPE/DISC OPERATING SYSTEM	TAPE OPERATING SYSTEM	PRIMARY OPERATING SYSTEM
	Minimum Core Storage: 65K bytes	Minimum Core Storage: 65K bytes	Minimum Core Storage: 16K bytes
Supervisory Control —			
Non-Random Access	11/66	8/66	6/66
Random Access	11/66	10/66	9/66
FORTRAN IV	12/66	12/66	-
COBOL	12/66	12/66	8/67
With Random Access	6/67	6/67	-
PL/I	-	-	-
Assembler	1/67	8/66	6/66
Sort/Merge	1/67	10/66	7/66
Report Writer	1/67	9/66	7/66
With Random Access	1/67	11/66	-
AIDS (debugging package)	1/67	10/66	-
Peripheral Routines —			
Sequential	12/66	8/66	6/66
Random Access	12/66	10/66	-
Communications —			
Phase I	2/67	-	-
Phase II	3/67	-	-

.41 Primary Operating System

The Primary Operating System for use with the Spectra 70/35, 70/45, and 70/55 systems is a magnetic tape-oriented software system that provides basic supervisory control for the sequential execution of programs, interrupt control, and input-output control, as well as a COBOL compiler, assembler, report program generator, and standard utility routines. POS COBOL is a subset language of full COBOL 65 and requires a minimum of 32K bytes of core storage for compilations. All other POS facilities are designed to permit operation in a minimum environment that includes 16K bytes of core storage and four magnetic tape units. No FORTRAN or PL/I processors are provided under POS, nor are any routines supplied for the automatic control of random-access devices, although the operation of these devices can be programmed at the assembly-language level. The only form of multiprogramming supported by POS occurs with the RCA-provided Peripheral Control Routine, which permits concurrent operation of up to three data transcription routines.

.42 Tape Operating System

The second major level of Spectra 70 software support designed for use with the 70/35, 70/45, and 70/55 systems is designated the Tape Operating System (TOS). TOS is a magnetic tape-oriented integrated software package that provides supervisory control programs, language processors, and utility programs for installations that have a minimum hardware configuration of 65K bytes of core storage, five magnetic tape units, console typewriter, card reader, and line printer. The facility to control multiprogrammed operation of up to six programs concurrently is the primary feature of TOS software. The basic TOS Executive program requires a minimum of 16K bytes of core storage. The Monitor program that coordinates the operations of stacked-job processing requires an additional 4K bytes, and the File Control Processor for input-output device and file control requires another 4K to 8K bytes of core storage. Although the theoretical maximum number of problem and control programs that can be processed concurrently is six, the actual limit will frequently be fewer than six, limited by the amount of available core storage and number of available peripheral devices. As many as five magnetic tape units can be dedicated to system control and library functions when processing in a stacked-job, multiprogramming environment.

In addition to a comprehensive assembly system, TOS offers a COBOL language similar to IBM's Operating System/360 COBOL F, as well as a full-scale FORTRAN IV language that includes all Operating System/360 FORTRAN IV facilities except random-access device control statements. No PL/I language processor has been scheduled for implementation to date.

.43 Tape/Disc Operating System

RCA's Tape/Disc Operating System (TDOS) is simply an extension of its Tape Operating System. TDOS offers all TOS software facilities, plus additional options that permit both system control routines and problem programs to reside on either the 70/564 Disc or 70/565 Drum units in order to improve the Spectra 70's throughput capabilities. The Tape/Disc Operating System is still basically a magnetic tape-oriented software system that makes limited use of random-access devices for program storage and retrieval. However, another significant addition to the TDOS software package is a set of input-output routines for control of data communications devices. The TDOS Executive routine consumes from about 20K to 22K bytes of core storage, but the minimum Spectra 70 core storage requirement for use of TDOS remains at 65K bytes. The principal software elements of the Tape and Tape/Disc Operating Systems are listed in Table VI, where the scheduled availability date for each element is also shown.

.44 Disc Operating System

RCA plans to supply, at an undisclosed date, a large-scale, disc-oriented integrated software package called the Disc Operating System (DOS). DOS will encompass all the facilities of POS and TOS/TDOS, and will additionally provide completely automatic control of all system operations. Among the planned features of DOS are a comprehensive Data Management system, dynamic scheduling of job processing, input-output device reassignment at execution time, and multiprogramming that is limited only by the availability of core storage and peripheral devices.

.5 COMPATIBILITY

.51 Program Compatibility Within the Spectra 70 Line

RCA emphasizes the high degree of program compatibility, in both the upward and downward directions, among the following models of Spectra 70: 70/35, 70/45, and 70/55.

(Contd.)

.51 Program Compatibility Within the Spectra 70 Line (Contd.)

Among these three models, any valid program that runs on configuration A will run on configuration B and produce the same results if:

- Configuration B includes the required amount of main storage, the same or compatible input-output devices, and all required special features; and
- The program is independent of the relationships between instruction execution times and input-output rates.

These limitations seem to mean that there will be a high degree of effective upward compatibility, making it easy to expand an installation, but that the concept of downward compatibility will be useful mainly in making possible the common use of subroutines and software, rather than in making it feasible to "shrink" an installation as its workload decreases or to back up a large computer with a smaller one.

A Spectra 70/15 object program can be run on a 70/25 if the following rules are adhered to:

- The 70/15-70/25 Program Loader must be used to preset 70/25 Processor conditions;
- The 70/15 program must provide for only legal 70/15 interrupt conditions; and
- The 70/15 software must be used in the manner in which it was designed.

A Spectra 70/25 program can be run on a 70/35, 70/45, or 70/55 system after reassembly or recompilation if:

- The 70/25 program abides by the Addressing, Data, and Specification restrictions placed on 70/35, 70/45, and 70/55 programs; and
- The general requirements mentioned above in regard to configuration similarity and time-dependent I/O devices are observed.

.52 Program Compatibility with the IBM System/360

RCA provides, through its Spectra 70 source languages, program compatibility with the IBM System/360. The Spectra 70 COBOL and FORTRAN languages are in many cases identical to their System/360 counterparts. Furthermore, since the instruction repertoire of the larger Spectra 70 processors is virtually identical with that of the similar-sized IBM processors, RCA has been able to develop System/360 program compatibility at the assembly-language level as well. The differences in the "privileged" instructions, however, make it impossible to run machine-language System/360 programs on a Spectra 70 system without alteration. Therefore, to execute programs written for an IBM System/360 on a Spectra 70 system, program recompilation or reassembly is always required. In many situations, the System/360 operational control cards can be retained and used directly in the Spectra 70 program input stream.

At present there are two primary areas of incompatibility with IBM System/360 programming languages. IBM is currently developing three levels of PL/I compilers, but RCA has not announced one to date, although it is still considering the advisability of providing one. Also, despite the extensive software support for random-access devices that is being provided in the System/360 programming languages, RCA has to date provided only assembly-language-level support of such devices.

RCA's adoption of many of the System/360 concepts and facilities in the areas of source languages, operational methods, and basic instruction sets marked the first such acceptance of the IBM System/360 by another major computer manufacturer, and reinforced the widespread feeling that the System/360 may become a de facto standard for the design of data processing systems for the next few years.

.53 Program Compatibility With Second-Generation RCA and IBM Computers

RCA offers a series of Emulator Features that will enable certain models of the Spectra 70 to run object programs written for certain second-generation RCA and IBM computer systems. The earlier computers whose programs can be run by the various Spectra 70 systems (when properly equipped) are as follows:

Spectra 70 System	Systems Emulated	Release Dates
70/35	IBM 1401/1460	2/67
	RCA 301	4/67
70/45	IBM 1401/1460	10/66
	IBM 1410/7010	10/66
	RCA 301	12/66
	RCA 501	2/67

.53 Program Compatibility With Second-Generation RCA and IBM Computers (Contd.)

Emulation, in general, requires a Spectra 70 system with an equivalent array of peripheral equipment, more processing power, and more core storage than the second-generation system to be emulated. The functions of most of the common peripheral devices (e.g., card readers and punches, printers, magnetic tape units, and console typewriters) can be emulated, but the less common devices (e.g., optical and magnetic character readers, paper tape units, data communications devices, and random-access storage devices) cannot be emulated. Time-dependent programs and programs not written in accordance with RCA and IBM programming manuals, when emulated, may yield results which differ from those obtained in the original system; the handling of many console operations and error conditions will differ; and a variety of specific program restrictions and limitations apply to each Emulator Feature. Nevertheless, it is likely that most users of second-generation RCA and IBM computers will be able to run most of their programs on a Spectra 70 system with little or no need for immediate reprogramming. For details on the capabilities, performance, and limitations of each Emulator Feature, please refer to Sections 710:131, 710:132, 710:134, and 710:135 of this report.

The principal value of the Emulator Features is that they enable users of second-generation RCA and IBM computers to spread the task of reprogramming for the Spectra 70 system over an extended period of time. In nearly every case, the emulation mode will involve additional equipment costs and will fall short of fully utilizing the performance capabilities of the Spectra 70 system. Therefore, for maximum efficiency, most users will want to recode all of their principal applications for the Spectra 70 system as soon as possible. The cost of the additional core storage and of the optional features required for emulation must be borne until all of the user's programs have been recoded.

DATA STRUCTURE

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Byte:	8 data bits + 1 parity bit	basic addressable storage unit; holds 1 character or 2 "packed" decimal digits.
Word:	4 bytes	basic fixed-point binary operand length.
Halfword:	2 bytes	
Double word:	8 bytes	
General registers (16):	32 bits each	fixed-point accumulators, base-address registers, or index registers.
Floating-point registers (4:)	64 bits each	floating-point accumulators.
Row (magnetic tape):	8 data bits + 1 parity bit	holds 1 byte.
Column (punched cards):	12 positions	holds 1 character.
Track (random access equipment):	variable with unit	holds one or more logical records.

.2 INFORMATION FORMATS

Type of Information	Representation
Alphameric character:	1 byte.
Decimal digit:	4 bits; packed 2 digits per byte.
Fixed-point binary operand:	1 word (or 1 halfword in most instructions).
Floating-point operand (short):	1 word; 24-bit fraction* and 7-bit hexadecimal exponent.
Floating-point operand (long):	2 words; 56-bit fraction* and 7-bit hexadecimal exponent.
Decimal operand:	1 to 16 bytes (i.e., 1 to 31 digits plus sign).
Instruction:	2, 4, or 6 bytes (specifying 0, 1, or 2 core storage addresses, respectively).

Note: Every fixed-length field (halfword, word or double word) must be located in main storage on an "integral boundary", i.e., the storage address of the field must be a multiple of the length of the field in bytes. This restriction is essential for efficient operation of the larger processing units, which access two or four bytes in parallel. Variable-length (decimal) fields are processed serially by byte in all models, so they may start at any byte location.

* The unusual floating-point representation (hexadecimal rather than binary exponents) makes the effective precision three bits shorter than the actual length of the fractional part.

SYSTEM CONFIGURATION

The configuration rules for the Spectra 70 computer systems vary among the different models, although the variation is not complex. Each system has a single Processor which includes a core storage bank and one or more input-output channels. The maximum number of input-output channels that can be connected to each processor can be summarized as follows:

	Multiplexor Channels	Selector Channels
Spectra 70/15:	0	1*
Spectra 70/25:	1	8
Spectra 70/35:	1	2
Spectra 70/45:	1	3
Spectra 70/55:	1	6

*Spectra 70/15 can also use an unsupervised Auxiliary Channel for input or output operations.

The number of peripheral devices or control units that can be directly connected to each channel is somewhat restricted, particularly in the case of the Selector Channels on the Spectra 70/25, 70/35, and 70/45. The number of devices or controllers that can be directly connected to each type of channel used with the various processors is as follows:

	Trunks** Per Selector Channel	Trunks** Per Multiplexor Channel
Spectra 70/15:	-	6
Spectra 70/25:	8	1
Spectra 70/35:	7 + console typewriter	2
Spectra 70/45:	8 + console typewriter	2
Spectra 70/55:	8 + console typewriter	4

** Each trunk can be connected to one peripheral device or controller.

Any of the peripheral units supplied with the Spectra 70 computer family can be connected to any processor, with one major exception: the random access storage units are currently offered only for the 70/35, 70/45, and 70/55 systems.

For diagrams and prices of Spectra 70 systems in representative standard configurations (as defined in Section 4:030 of the Users' Guide), see the System Configuration sections of the sub-reports on the individual models:

Spectra 70/15: .... Section 712:031.
Spectra 70/25: .... Section 713:031.
Spectra 70/35: .... Section 714:031.
Spectra 70/45: .... Section 715:031.
Spectra 70/55: .... Section 716:031.

INTERNAL STORAGE: CORE STORAGE

.1 GENERAL

.11 Identity: . . . . contained in the Spectra 70 Processors.

.12 Basic Usage: . . . . working storage and (in some cases) register storage.

.13 Description

The 17 currently available models of the Spectra 70 computer family differ in their core storage capacity, speed, and the number of bytes accessed per cycle, as well as in their processing capabilities and system functions. Main storage characteristics of the available models are summarized in Table I. Differences in processing capabilities, system functions, and special features are described in Paragraphs .131 through .135.

Each byte consists of eight data bits and one parity bit, and each byte is directly addressable. Internal storage addressing is binary (though decimal or symbolic addresses are used in the assembly programs to facilitate coding). The eight data bits of a byte may represent binary, alphameric, or packed decimal (two decimal digits per byte) data.

The Memory Protect feature (optional in Models 70/35, 70/45, and 70/55; not available in the 70/15 or 70/25) prevents the contents of specified 2,048-byte blocks of core storage from being altered as a result of program errors or misguided input data. A 4-bit "storage key" is associated with each 2,048-byte block, and a 4-bit "protection key" is supplied with the data to be stored. Detection of a mismatch between the two keys — when neither key is zero — results in a program interrupt. As many as 15 independent programs can be protected at any one time. Each protected program can occupy any number of blocks, and the blocks do not need to be contiguous. Memory Protect is an essential safeguard wherever more than one program is to be loaded and run at the same time.

The Shared Storage feature (currently available only for Model 70/55) permits main storage units of two processors to be shared and addressed by either processor as a single main storage. The first 131,072 bytes of each processor's core storage cannot be shared.

.131 Spectra 70/15 Core Storage

The Main Memory unit of the Spectra 70/15 Processor is the only internal storage unit used in the 70/15 system; it incorporates arithmetic registers, input-output control, and equivalent functions which are provided in separate memory units in the Spectra 70/35 and larger processors. There are no facilities for the incorporatio of scratchpad memory units or read-only control memories in the 70/15 system.

The size of the 70/15's Main Memory unit can be 4,096 or 8,192 eight-bit bytes. The complete cycle time is 2.0 microseconds per byte. The memory is addressable only in single-byte units. The time required to access a particular data field will be constant whether or not its addresses are aligned with the 4-byte "integral word boundaries."

No provision is made in the Spectra 70/15 system for General-Purpose Registers in core storage or other special storage units. As a result, instructions that require registers for their normal operation (types RR, RS, and RI) cannot be executed by a 70/15 Processor. The available instructions are tabulated in the Instruction List section on page 710:121.101.

Only two sets of input-output registers are provided, and they must be shared by the six I/O channels. The I/O registers are built into the 70/15 Processor. Peripheral device simultaneity (described in detail in Report Section 712:111) is achieved either through the use of buffered I/O units or the special Read and Write Auxiliary instructions.

The first 50 bytes of Main Memory are reserved for use by the 70/15 Processor; they contain utility registers and intermediate storage areas used in the handling of input-output operations and interrupt processing.

.132 Spectra 70/25 Core Storage

Like the Main Memory of the Spectra 70/15, the 70/25's Main Memory is a homogeneous core storage unit, 150 bytes of which provide the arithmetic and control registers for the system. There are no provisions for the inclusion of scratchpad or read-only memory units, which are standard features in the larger Spectra 70 computer systems.

The size of the 70/25's Main Memory can be 16,384, 32,768, or 65,536 eight-bit bytes. The complete cycle time is 1.5 microseconds per four bytes. The memory is byte-addressable and can be addressed in units of between one and four bytes. The time required to move a particular data field will vary depending on whether or not its addresses are aligned with the 4-byte "integral word boundaries."

The first 50 bytes of the Main Memory are reserved for use by the 70/25 Processor; they contain utility registers and intermediate storage areas used in the handling of Selector Channel input-output operations and interrupt processing.

The last 100 bytes of the Main Memory are also reserved for use by the Processor; they are used to provide 15 General-Purpose Registers, a Timer Register, and other utility registers.

The area immediately preceding the last 100 bytes of the Main Memory is used for control registers by the optional Multiplexor Channel. The amount of memory required for this purpose is dependent upon the number of peripheral devices connected to the Multiplexor Channel; eight Main Memory bytes are used for each device.

.133 Spectra 70/35 Core Storage

The Spectra 70/35's internal core storage consists of three distinct memory units:

- A Main Memory of 16K, 32K, or 65K bytes, with a memory cycle time of 1.44 microseconds per two bytes. The first 128 bytes of Main Memory are reserved for hardware requirements.
- A Read-Only Control Memory, with a memory cycle time of 480 nanoseconds per 54-bit access. The Read-Only Control Memory consists of 1,024 54-bit words of factory-programmed logic used to control the execution of central processor instructions and to permit direct execution of object programs written for an RCA 301, IBM 1401, or other ostensibly non-compatible computers through "emulation." The functions of the Read-Only Control Memory are described in the Central Processor report section, page 710:051.100.
- A Non-Addressable Memory, with a memory cycle time of 1.44 microseconds per two bytes. Non-Addressable Memory is a physical extension of the Main Memory unit; it provides a set of three 32-bit control registers for each input-output device connected to the system's standard Multiplexor Channel. Control registers can be provided for up to 192 such devices in 32K and 65K 70/35 systems, and for up to 64 such devices in 16K systems.

An additional 128 four-byte words of Non-Addressable Memory are provided in lieu of the Scratchpad Memory used in the 70/45 and 70/55. These reserved bytes provide the General-Purpose Registers, Floating-Point Registers, and various other processor, program, and Selector Channel control registers. This area of so-called Non-Addressable Memory can actually be addressed through use of the privileged instructions Load Scratch Pad and Store Scratch Pad.

Because both Multiplexor and Selector Channel input-output data transmission flow are controlled by the Non-Addressable Memory registers, and because Non-Addressable Memory is an extension of Main Memory, the use of Main Memory cycles by the central processor is inhibited in direct proportion to the volume of traffic over the I/O channels. The amount of processor delay caused by the operation of various types of I/O units is included in the Spectra 70/35 Simultaneous Operations report section, page 714:111.101.

.134 Spectra 70/45 Core Storage

Four distinct memory units make up the Spectra 70/45's internal core storage:

- A Main Memory of 16K, 32K, 65K, 131K, or 262K bytes of core storage, with a memory cycle time of 1.44 microseconds per two bytes. The first 128 bytes of lower Main Memory are reserved for hardware requirements.
- A Scratchpad Memory of 128 four-byte words, with a cycle time of 300 nanoseconds per word. Scratchpad Memory provides the General-Purpose Registers, Floating-Point Registers, and various other processor, program, and Selector Channel control registers.
- A Read-Only Control Memory, with a memory cycle time of 480 nanoseconds per 54-bit access. The Read-Only Control Memory consists of 2,048 54-bit words of core storage that is microprogrammed at the factory to control the execution of central processor instructions and to permit the "emulation" of RCA 301, 501, and IBM 1401, 1410, 1460, and 7010 object programs. Logic for emulating the instruction execution processes of other non-Spectra 70 systems can also be built into the Read-Only Control Memory. (The functions of both the Scratchpad and Read-Only Control Memory units are described in the Central Processor report section, page 710:051.100).
- A Non-Addressable Memory, with a memory cycle time of 1.44 microseconds per two bytes. Non-Addressable Memory is a physical extension of the Main Memory unit; it provides a set of three 32-bit control registers for each input-output device connected to the system's standard Multiplexor Channel. Control registers can be provided for up to 256 such devices in 65K, 131K, and 262K Spectra 70/45 systems.

Accesses to Scratchpad and Non-Addressable Memory units are required for control of the Selector and Multiplexor Channels, respectively. Both types of accesses cause delays in the operations of the central processor. Both sets of processor delay timings for various types of input-output operations are included in the Simultaneous Operations report section, page 715:111.101.

.135 Spectra 70/55 Core Storage

The Spectra 70/55's internal core storage consists of three distinct memory units:

- A Main Memory of 65K, 131K, 262K, or 524K bytes, with a memory cycle time of 0.84 microsecond per four bytes. The first 128 bytes of lower Main Memory are reserved for hardware requirements.
- A Scratchpad Memory of 128 four-byte words, with a cycle time of 300 nanoseconds per word. Scratchpad Memory provides the General-Purpose Registers, Floating-Point Registers, and various other processor, program, and Selector Channel control registers. The functions of the Scratchpad Memory are described in the Central Processor report section, page 710:051.100.
- A Non-Addressable Memory, with a memory cycle time of 0.84 microsecond per four bytes. Non-Addressable Memory is a physical extension of the Main Memory unit; it provides a set of three 32-bit control registers for each input-output device connected to the system's standard Multiplexor Channel. Control registers are provided for 256 such I/O devices.

I/O channel usage of both the Scratchpad and Non-Addressable Memory units delays the memory access operations of the central processor. The amount of this delay, for various types of peripheral devices operating on both Multiplexor and Selector Channels, is listed in the Simultaneous Operations report section, page 716:111.101.

(Contd.)

.14 Availability

70/15: . . . . 6 to 9 months.
70/25: . . . . 6 to 9 months.
70/35: . . . . 12 to 15 months.
70/45: . . . . 12 to 15 months.
70/55: . . . . 15 months.

.15 First Delivery

70/15: . . . . 4th quarter 1965.
70/25: . . . . 4th quarter 1965.
70/35: . . . . 1st quarter 1967.
70/45: . . . . 1st quarter 1966.
70/55: . . . . 3rd quarter 1966.

.16 Reserved Storage: . . . see Description, Paragraphs .131 through .135.

.2 PHYSICAL FORM

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

.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 below.

.3 DATA CAPACITY

.31 Module and System Sizes: . . . . see Table I.

.32 Rules for Combining Modules: . . . . each processor module is self-contained. Any 70/55 processor can share its memory with another 70/55 processor, provided the optional Shared Storage feature is installed. The first 131,072 bytes of 70/55 core storage can never be shared.

.4 CONTROLLER: . . . . . no separate controller.

.5 ACCESS TIMING

.52 Simultaneous Operations: . . . . none; i.e., only one access to core storage per cycle is possible, by either the processor or a peripheral device.

.53 Access Time Parameters and Variations: . . . . see Table I.

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE

.72 Transfer Load Size

With self: . . . . 1 to 255 bytes using Move instruction. Variable amount using multiple register instructions in a loop.

.73 Effective Transfer Rate: . . . . see table below.

.29 Potential Transfer Rates

.292 Peak data rates —

Spectra 70 model:	70/15	70/25	70/35	70/45	70/55
Unit of data, bytes/access:	1	4	2	2	4
Cycling rate, cycles/second:	500,000	666,666	695,000	695,000	1,192,000
Conversion factor, data bits/byte:	8	8	8	8	8
Data rate, bytes/second:	0.5 million	2.7 million	1.4 million	1.4 million	4.8 million

.73 Effective Transfer Rate (With Self)

(All transfer rates are in bytes per second.)

Spectra 70 Model	Using Move Instruction	Using Multiple Register Instructions in a Loop
70/15	250,000	not available
70/25	1,333,333	636,000
70/35	695,000	695,000
70/45	695,000	695,000
70/55	1,236,000	2,380,000

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	program interrupt.
Invalid code:	all 8-bit codes valid.	
Receipt of data:	parity check	program interrupt.
Recording of data:	record parity bit.	
Recovery of data:	parity check	program interrupt.
Dispatch of data:	transmit parity bit.	
Reference to protected area:	check, if Memory Protect feature is present	program interrupt.

TABLE I: CORE STORAGE CHARACTERISTICS

	SYSTEM MODEL				
	70/15	70/25	70/35	70/45	70/55
Capacity, bytes					
4,096	15-A	—	—	—	—
8,192	15-B	—	—	—	—
16,384	—	25-C	35-C	45-C	—
32,768	—	25-D	35-D	45-D	—
65,536	—	25-E	35-E	45-E	55-E
131,072	—	—	—	45-F	55-F
262,144	—	—	—	45-G	55-G
524,288	—	—	—	—	55-H
Cycle Time, μsec	2.0	1.5	1.44	1.44	0.84
Bytes Accessed per Cycle:					
During processing	1	4	2	2	4
For Selector Channels	1	1	1	1	4
For Multiplexor Channel	1	1	1	1	1
Cycle Time per Byte, μsec:	2.0	0.38	0.72	0.72	0.21

INTERNAL STORAGE: 70/564 DISC STORAGE UNIT

.1 GENERAL

.11 Identity: .... 70/564 Disc Storage Unit (IBM 2311 Disk Storage Drive).

70/563 Disc Pack (IBM 1316 Disk Pack).

70/551 Random Access Controller.

.12 Basic Use: .... random access auxiliary storage, or input-output medium.

.13 Description

RCA is marketing the IBM 2311 Disk Storage Drives (relabeled 70/564 Disc Storage Units) for use with the Spectra 70/35, 70/45, and 70/55 computer systems. RCA plans to maintain compatibility between Disk Packs written on Spectra 70 computers and those written on IBM System/360 computers, so that data can be exchanged between the two systems as required, using discs as the exchange medium.

The main characteristics of the IBM 2311 Disk Storage Drive are summarized below, and are more completely described on page 420:044.100 of the IBM System/360 Computer System Report.

Storage capacity of 1 Disk Pack: ...... 7.25 million 8-bit bytes (1 record per track).
Discs per pack: ..... 6.
Recording surfaces per pack: .... 10.
Tracks per disc surface: .... 200.
Data transfer rate:... 156,000 bytes/sec.
Rotation time: ...... 25 msec.
Average positioning time: .... 85 msec.

Control of the Disc Storage Unit will be handled by the 70/551, a general-purpose random access controller that can handle up to eight Spectra 70 random access devices in any intermix. The 70/551 controller permits read, write, write-with-check, and seek (either for a specific address or a specific data record) operations. Optional features allow the data to be scanned for the presence or absence of a condition or identifier in a record, and allow data records to be packed without regard to the capacity of the physical tracks on the random access storage device.

The software provided for the 70/551 Random Access Controller regards all random access devices as being essentially the same. The addressing structure in each case includes references to track and cylinder. (A "cylinder", in the general case, is defined as a group of 100 tracks.)

Interrupts can be set by the program to occur whenever an operation is completed and the random access unit becomes available to receive further instructions. The condition of the device at the time (whether it is in fact available, or has terminated the prior operation because it has become inoperable) and the success or failure of the previous operation are signalled to the processor through transmission of a Standard Device Byte.

The demands on the central processor, core storage, and I/O channels which result from Disc Storage Unit operations vary with each of the processor models. These demands are listed for each of the processors in the Simultaneous Operations sections of the individual subreports.

.14 Availability: .... 20 months.

.15 First Delivery: ..... third quarter, 1966.

INTERNAL STORAGE: 70/568-11 MASS STORAGE UNIT

.1 GENERAL

.11 Identity: . . . . 70/568-11 Mass Storage Unit.
70/551 Random Access Controller.

.13 Description

The 70/568-11 Mass Storage Unit is RCA's latest version of a mass storage device that was originally announced for use with the RCA 301 and 3301 computer systems (see RCA Model 3488 Random Access Computer Equipment, Report Section 703:044). More than half a billion bytes of data can be stored on-line in each 70/568-11.

Packing density in the 70/568-11 has been increased to 1,400 bits per inch, double the 700 bits-per-inch density of the Model 70/568-1 unit that was announced with the Spectra 70 Series in December 1964. The new unit can be used with the Spectra 70/35, 70/45, and 70/55 computer systems.

The 70/568 Mass Storage Unit reads or writes on magnetic cards, just as a magnetic tape unit reads or writes on magnetic tape. A maximum throughput rate of 150 cards per minute is possible. A total of 256 cards are held in a magazine, and each magazine can be removed from the equipment in the same way as a magnetic tape reel can be unloaded. Up to eight of these magazines can be kept on-line in each unit (see Figure 1). A former option allowing sixteen magazines per unit has been dropped because of the slow access (less than two cards per second) when the sixteenth magazine was accessed.

A complete card cycle, including its selection, movement to the read/write station, and subsequent return to the magazine, takes between 600 and 800 milliseconds. The access operation itself normally takes between 395 and 498 milliseconds.

The variation in access time is related to the position of the magazine containing the selected card. Table I indicates the various stages in the card cycle and shows the timing variations according to the position of the accessed magazine. A considerable amount of this card cycle time can be overlapped, so that the throughput of the unit can reach slightly over 2.5 cards per second. (And, by batching the transactions, it may be practical to process more than one record per card.)

The cards are supported in the card magazine by rods that fit into notches on the top of the card. The actual selection of a card involves horizontal movement of some of the selector bars so that they will no longer support the appropriately-coded card. When, at the same time or at a later time, the side rods are momentarily displaced, the selected card is extracted into the raceway and is carried to the read-write station. Card jam detection is provided, as well as a number of interlocks to ensure that no more than two cards will be in motion at any one time.

Once in the raceway, the card is carried past any card magazines which are nearer the read/write station and then loaded onto a drum which revolves under the read/write heads. The drum revolves at 1,000 revolutions per minute.

Subsequent to its use by the computer, the card is stripped from the drum and placed on another, slower raceway which carries it back to the magazine from which it came (using a powered drive) and then lifts and slips it into position.

The maximum data storage capacity of each 70/568-11 Mass Storage Unit is 560,726,016 bytes. Up to eight Mass Storage Units can be connected to a 70/551 Random Access Controller, providing more than 4.4 billion bytes of on-line data per Controller.

Each of the Mass Storage Unit's 8 interchangeable magazines can store up to 70.0 million bytes of data, and each of the 256 magnetic cards within each magazine can store up to 273,792 bytes. Data is recorded on each card in 2,139-byte tracks, and each of the 128 tracks per card is individually addressable. The read/write head assembly consists of eight read/write heads which can be moved in unison to any of 16 discrete positions along the card, providing access to all 128 card tracks. The eight tracks that can be accessed by electronic switching at each position of the head assembly are referred to as a "cylinder." Each track of data is addressed by its cylinder number and its read/write head number (track number) within that cylinder.

Data is read and recorded starting at the physical beginning of each track. Eight data bits per byte are recorded; the ninth (parity) bit is stripped out by the 70/551 Controller prior to data recording. A 7-byte Home Address record is automatically recorded with each 2,139-byte (or smaller) block of data. The Home Address consists of a flag or control byte, four bytes for cylinder and track addressing, and two bytes for a cyclic check code. This check code is generated and recorded automatically for each data record and is subsequently checked against a regenerated cyclic check character each time the record is read. Unequal code comparisons result in the setting of a testable error indicator.

For preventive maintenance purposes, the 70/568-11 maintains, on each card, a count of the total number of times that card has been accessed. The user can elect to replace each card as soon as it has been accessed a certain number of times, and before excessive card wear leads to reliability problems.

The controller for the 70/568-11 Mass Storage Unit (and for all random access devices used with the Spectra 70 series) is the 70/551 Random Access Controller. Feature 5502-1, a special attachment

.13 Description

to the 70/551 Controller, is also required for control of the 70/568-11 Mass Storage Unit.

Interrupts can be set by the program to occur whenever an operation is completed and the random access unit becomes available to accept further instructions. The condition of the device and the success or failure of the previous operation are signalled to the processor through transmission of a Standard Device Byte.

The demands on the central processor, core storage, and I/O channels resulting from Mass Storage Unit operations vary with each of the Spectra 70 processor models. These demands are listed for each of the processors in the Simultaneous Operations sections of the individual subreports.

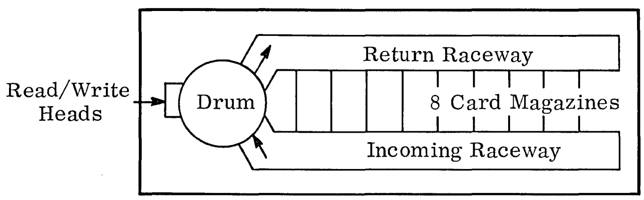


Figure 1: Logical Diagram of a 70/568-11 Mass Storage Unit.

.14 Availability: . . . . 9 months.

.15 First Delivery: . . . . . not specified; original Model 3488 unit was delivered in late 1964.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic cards.

.22 Physical Dimensions

.223 Card —
Length: . . . . 16 inches.
Width: . . . . 4.5 inches.
Number:. . . . . 256 cards/magazine.

.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 256-card magazines.

.25 Data Volume per Band of 1 Track

Words:. . . . . 534 4-byte words.
Bytes —
One record per track: . . . . 2,139 bytes.
Multiple records per track:. . . . . . . $N = \frac{1 + 2,222\text{-}LR}{R}$, where N = number of records per track, R = number of bytes per record, as computed below, and LR = number of bytes in last record of track.

R = 210-C + 1.049(KL + DL), where R = number of bytes per record, KL = bytes per record key, DL = bytes per data record, and C = 0 if KL $\neq$ 0, or C = 66 if KL = 0.

Digits: . . . . 2,139 in zoned byte format. 4,278 in packed format.

.26 Bands per Physical Unit: . . . . 128 per card.

.27 Interleaving Levels: . . no interleaving.

.28 Access Techniques

.281 Reading/recording method: . . . . card on revolving drum passes under movable read/write heads.

.283 Type of access —

Description of stage	Possible starting stage
Card access —	
Select card:	yes.
Extract card to raceway:	yes.
Move card and mount on drum: . . .	no.
Data block on card access —	
Leading edge of block approaches the read/write head:	yes.

.29 Potential Transfer Rates

.291 Peak bit rates —
Track/head speed: . . 400 inches/sec.
Bits/inch/track: . . . 1,400.
Bit rate per track: . . 560,000 bits/sec/track.
.292 Peak data rates —
Unit of data: . . . . . . byte.
Conversion factor: . . 8 bits per byte.
Gain factor (tracks per band):. . . . . . . 1.
Loss factor (degree of interleaving):. . . none.
Data rate:. . . . . 70,000 bytes per second.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	1 70/568 Unit	8 70/568 Units.
Bytes:	560,726,016	4,485,808,128.
Packed digits:	1,121,452,032	8,971,616,256.
Magazines:	8	128.
Cards:	2,048	32,768.
Modules:	1	8.

.32 Rules for Combining Modules: . . . . up to 8 Spectra 70 random-access devices can be connected to a 70/551 Controller. The 70/551 requires a special attachment, Feature 5502-1, to interface with the 70/568-11 Mass Storage Unit.

(Contd.)

.4 CONTROLLER

.41 Identity: . . . . RCA 70/551 Random Access Controller.

.42 Connection to System: . see Section 710:031, System Configuration, for number of controllers that can be connected to various types of I/O channels.

.43 Connection to Device

.431 Devices per controller: 1 to 8.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . one track, containing a maximum of 2,139 bytes.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . each byte.
.444 Input-output area lockout: . . . . blocks of 2,048 bytes can be protected by optional Memory Protect feature.
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . . yes; scatter-read and gather-write facilities are available at programmer's option. See Section 710:111, Simultaneous Operations, for further considerations.
.448 Testable conditions: . . available; busy; not operational; performing operation with interruption pending.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks —
Stacks per yoke: . . . 8.
Yokes per module: . . 1.
.512 Stack movement: . . . . to 1 of 16 positions.
.513 Stacks that can access any particular location: . . . . 1.
.514 Accessible locations:
By single stack —
With no movement: . 1 2,139-byte block.
With all movement: 16 2,139-byte blocks.
By all stacks —
With no movement: . 8 2,139-byte blocks per 70/568-11 Mass Storage Unit.
64 2,139-byte blocks per system.

.52 Simultaneous Operations: . . . . within each 70/568 Unit, a card can be selected while another card is being read. Only one read or write operation can occur at a time over each 70/551 Controller.

.53 Access Time Parameters and Variations: . . . . see Table I.

.6 CHANGEABLE STORAGE

.61 Magazines

.611 Magazine capacity: . . . 256 cards.
.612 Magazines per module: 8.
.613 Interchangeable: . . . . yes.

.62 Loading Convenience

.621 Possible loading —
While computing system is in use: . . . . yes.
While storage system is in use: . . . . no.
.622 Method of loading: . . . operator.
.623 Approximate change time: . . . . 0.5 to 1.0 minute.
.624 Bulk loading: . . . . only 1 magazine per module can be reloaded at a time.

TABLE I: CARD CYCLE TIMING VARIATIONS

Magazine Position*	Card Cycle Times, Milliseconds					
	Card Select†	Card Feed	Card Read	Card Return	Reload	Total
1A	235	121	60	158	70	644
1B/2A	235	128	60	186	70	679
2B/3A	235	138	60	186	70	689
3B/4A	235	148	60	213	70	726
4B/5A	235	158	60	213	70	736
5B/6A	235	168	60	240	70	773
6B/7A	235	178	60	240	70	783
7B/8A	235	188	60	268	70	821
8B	235	198	60	268	70	831

* Each numbered magazine has two parts, designated A and B, and each part contains 128 cards.

† The Card Select time expressed here is an average figure; the actual Card Select time will vary from 210 to 260 milliseconds. Card Select time can be overlapped with Card Read and Card Return time.

.7 PERFORMANCE

.72 Transfer Load Size

With core storage: . . . 2,139 bytes.

.73 Effective Transfer Rate

With core storage,
one-way transfer: . 24,650 bytes per second, based on random selection of card and transfer of one cylinder (17,112 bytes) of data.

.74 Update Cycle Rate

Reference to card already on drum: . . . 5.3 references/second.
Reference to new card: . . . . 1.8 references/second.

Note: Based on random accessing of one 2,139-byte record; reading, updating, and re-writing that record; and rereading for verification of recording accuracy.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	ignore instruction and set future interrupts.
Invalid code:	?	
Receipt of data:	parity check	interrupt.
Recording of data:	read-after-write cyclic code check	interrupt.
Recovery of data:	row parity check	interrupt.
Dispatch of data:	parity check	interrupt.
Timing conflicts:	interlock.	
Physical record missing:	check	interrupt.
Reference to locked area:	check	interrupt.
Wrong card:	hardware check on correct physical location	interrupt.
Select 2 more cards:	check	set unit in-operable.
Card jam:	check	set unit in-operable.
Card wear:	card access count	interrupt.

INTERNAL STORAGE: 70/565 DRUM MEMORY UNIT

.1 GENERAL

.11 Identity: . . . . 70/565-12 and 70/565-13 Drum Memory Units.
70/551 Random Access Controller (with Input-Output Attachment Feature 5503-11, -12, or -13).

.12 Basic Use: . . . . random-access auxiliary storage.

.13 Description

The 70/565 Drum Memory Unit is an auxiliary storage device that provides rapid random access to programs and data in RCA Spectra 70/35, 70/45, and 70/55 systems. Each drum has either 256 (Model 565-12) or 512 (Model 565-13) fixed read/write heads, with each head serving one track. The data capacity per track is 3,053 bytes when recording in the one-record-per-track mode. Average access time is 8.6 milliseconds, and the peak data transfer rate is 210,000 bytes per second. Up to four 70/565 drums can be connected to a 70/551 Random Access Controller, providing data storage capacities that range from 782,000 to 6,263,000 bytes.

Record length and number of records per track are variable and user-defined, and each record may contain a key portion. A separate "count" byte in each record is used to specify the key length, which can be as long as 255 bytes. The number of bytes in the data portion of the record is specified by a two-byte count code. Thus each record can have a count area, a key (optional), and a data area. An additional area is included at the beginning of each track to specify the track address, and a one-byte code is used to indicate unusable portions of the track.

When multiple records are present on a track, the amount of data which can be recorded is decreased markedly. For example, a track which stores records consisting of a 10-byte key and 150 data bytes holds 11 records, or only 1,650 data bytes. A series of file commands permits any or all of the three areas (count, key, and data) of a record in a random-access file to be searched, read, or written.

Selection of a track is initiated by transferring a 6-byte address from the Spectra 70 Processor to the 70/551 Random Access Controller. The optional File Scan feature permits an automatic search for a specific identifier or key. The Record Overflow feature permits a single record to overflow from one track to another within a cylinder. The Multichannel Switch feature enables a 70/551 Random Access Controller to be switched from one Selector Channel to another under program control.

The 70/551 Random Access Controller is used to control the 70/564 Disc Unit and the 70/568-11 Mass Storage Unit, as well as the 70/565 Drum Memory Unit. The 70/551 interprets and executes file commands, performs the required conversions between serial-by-bit and parallel-by-bit data modes, checks the validity of the data being transferred, and furnishes status information about the random-access file units to the Spectra 70 Processor.

The 70/551 strips the parity bit off each byte to be recorded in random-access storage. The validity of the recorded information is checked by generating a string of 16 "cyclic check bits" and appending it to the end of each disc record. When the data is read, the check bits are regenerated and compared; an unequal comparison results in a data error signal. Parity bits are restored as the data is transferred back into core storage.

.14 Availability: . . . . not specified.

.15 First Delivery: . . . . . not specified.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic drum.

.22 Physical Dimensions

.222 Drum —
Diameter: . . . . 12 inches.
Length: . . . . ?
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: . . . . 764 4-byte words.
Characters: . . . . see "Bytes."
Digits: . . . . 3,053 in zoned byte format; 6,112 in packed format.
Bytes —
One record per track: . . . . 3,053.
Multiple records per track: . . . . $N = \frac{1 + 3093 - LR}{R}$ where N = number of records per track, R = number of bytes per record, as computed below, and LR = number of bytes in last record of track.
R = 90-C+ (KL+DL) where R = number of bytes per

.25 Data Volume per Band of 1 Track (Contd.)

record, KL = number of bytes in record key, DL = number of data bytes in record, and C = 0 if KL ≠ 0, or C = 26 if KL = 0.

.26 Tracks per Physical Unit: . . . . 256 (Model 565-12) or 512 (Model 565-13).

.27 Interleaving Levels: . . no interleaving.

.28 Access Techniques: . . fixed heads, one per track.

.29 Potential Transfer Rates

.291 Peak bit rates —
Cycling rates: . . . . . 3,600 rpm.
Track/head speed: . . 2,256 inches/sec.
Bits/inch/track: . . . 750.
Bit rate per track: . . 1,285,920 bits/sec/track.

.292 Peak data rates —
Unit of data: . . . . . . byte.
Conversion factor: . . 8 bits per byte.
Data rate: . . . . 210,000 bytes per second.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
Identity:	70/565-12	70/565-13	70/565-13
Drums:	1	1	4
Tracks:	253	506	2,024
Words:	195,392	390,784	1,563,136
Bytes:	781,568	1,563,136	6,252,544
Packed digits:	1,563,136	3,126,272	12,505,088

.32 Rules for Combining Modules: . . . . up to 4 drums per 70/551 Random Access Controller. Addressing through the 70/551 is done by logical cylinders of eight consecutive tracks. These cylinders are sequentially numbered from 0 to 255.

.4 CONTROLLER

.41 Identity: . . . . RCA 70/551 Random Access Controller.

.42 Connection to System: . see Section 710:031, System Configuration, for number of controllers that can be connected to various types of I/O channels.

.43 Connection to Device

.431 Devices per controller: . . . . 1 to 4 drums.

.432 Restrictions: . . . . a combination of random-access devices can be handled by the same 70/551 Controller when the adapters for the specific random-access devices are attached.

.5 ACCESS TIMING

.51 Arrangement of Heads: one fixed read/write head per track.

.52 Simultaneous Operations: . . . . one 70/565 Drum operation at a time over each 70/551 Controller.

.53 Access Time Parameters and Variations

.532 Variation in access time —

Stage	Variation, msec	Average, msec
Wait for start of desired track:	0 to 17.2	8.6
Transfer data:	17.2 per track	17.2

.6 CHANGEABLE STORAGE: . . . . none.

.7 PERFORMANCE

.72 Transfer Load Size

With core storage —
Single track: . . . . . . 1 to 3,053 bytes.
Cylinder: . . . . 24,424 bytes.

.73 Effective Transfer Rate

With core storage: . . . 198,000 bytes/second, based on transfer of 30,530 bytes (10 tracks); includes rotational delay time.

.74 Update Cycle Rate: . . . 22.7 references/second, based on random accessing of one 80-byte record, reading, updating, and rewriting that record; and rereading for verification of recording accuracy.

.75 Read-Only Reference Cycle Rate: . . . . 116 references/second, based on random accessing of one 80-byte record, with no updating or re-writing.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Invalid address:	via 551 control	channel interrupt.
Invalid code:	via 551 control	channel interrupt.
Receipt of data:	via 551 control	channel interrupt.
Recording of data:	via 551 control	channel interrupt.
Recovery of data:	via 551 control	channel interrupt.
Dispatch of data:	via 551 control	channel interrupt.
Timing conflicts:	via 551 control	channel interrupt.
Physical record missing:	via 551 control	channel interrupt.
Reference to locked area:	via 551 control	channel interrupt.

CENTRAL PROCESSORS (70/35, 70/45, & 70/55)

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70/35, Spectra 70/45, and Spectra 70/55 Processors. (For Spectra 70/15 and 70/25 Processor descriptions, see Report Sections 712:051 and 713:051, respectively.)

.12 Description

The RCA Spectra 70 Series currently includes three central processor models — 70/35, 70/45, and 70/55 — that are fully program-compatible among themselves and are also program-compatible with the IBM System/360 Processors, Models 30 through 75. (Please consult Report Section 710:133 for detailed information on the question of compatibility between the RCA Spectra 70 and the IBM System/360.) Two additional Spectra 70 Processors, the 70/15 and 70/25, differ considerably in design and processing facilities from the three larger Spectra 70 models; consequently, the two smaller Processors are described in detail in their individual subreport sections: the 70/15 in Section 712:051, and the 70/25 in Section 713:051.

Because of the number of different aspects under which the 70/35, 70/45, and 70/55 Processors can be considered, the description of these Processors has been segmented into a number of sections, each of which can be read independently. The sections are:

- Summary (Paragraph .121)
- Basic Design and Performance (Paragraph .122)
- The Instruction Repertoire as a Programming Tool (Paragraph .123)
- Interrupt System (Paragraph .124)
- Multiprogramming Facilities (Paragraph .125)
- Errors and Special Cases (Paragraph .126)
- The Compatibility Question (Paragraph .127)
- Special Features (Paragraph .128).

.121 Summary

The instruction repertoire of the Spectra 70/35, 70/45, and 70/55 Processors is identical and includes both decimal and binary arithmetic, with floating point operations possible in either 32-bit or 64-bit form. Automatic binary-to-decimal and decimal-to-binary radix conversion instructions are included, as is a translate instruction that can convert any 8-bit code to any other 8-bit code. As in the System/360, there are no large-scale mass transfer or storage search instructions.

The instruction length varies from two bytes to six bytes, depending upon whether registers, literals, or main storage locations are being used for operand addresses. In any case, the form is basically a two-address, add-to-storage instruction. No indirect addressing is possible.

Spectra 70, like the IBM System/360, provides various registers for the programmer's use and reserves others for its own use. In Spectra 70/45 and 70/55 Processors, these registers are held in a scratchpad memory, which also contains most of the input-output control data. In the Spectra 70/35 Processor, these processor and control registers are provided in Non-Addressable Memory, a physical extension of Main Memory (see Paragraph 710:041.33). Spectra 70 is designed so that different parts of the scratchpad or non-addressable memory are used as registers in each of the four programming states, thus avoiding the necessity of repeated storing and reloading of the register contents. This is a major difference between the Spectra 70 and System/360 processors.

The same scratchpad memory (or Non-Addressable Memory in the 70/35) is used to hold most of the input-output control words which are held in the first 128 words of core storage in the System/360.

There is a sophisticated interrupt system, involving four processor conditions. This is described in detail in Paragraph .124 of this report section. Multiprogramming is possible through software, and multi-processor installations are feasible.

The actual performance of the Spectra 70/35, 70/45, and 70/55 Processors falls between the performance of the IBM System/360 Models 30 and 40, Models 40 and 50, and Models 50 and 65, respectively — as the model numbers might lead one to expect. Because the Spectra 70 design structure is not the same as that of the System/360, the results of comparisons between the systems will vary depending on the type of processing tasks involved.

Error control includes parity checks upon all transferred data and some unspecified checks on machine functioning. Checks on program execution include checks for overflow and underflow, correct alignment of operands, illegal use of machine instructions, and use of instructions not included in the processor's repertoire. Error recovery is assisted by a special "machine condition" processing state, which is entered when power fails or when some other apparent machine failure has been detected. In the Machine Condition State, a routine may be entered which allows the system either to recover or to close down in an orderly condition, thus simplifying successful restarting of the operating programs.

.122 Basic Design and Performance

The Spectra 70/35, 70/45, and 70/55 Processors contain facilities for addressing main storage, for fetching and storing information, for executing

.122 Basic Design and Performance (Contd.)

stored program instructions in the desired order, for arithmetic and logical processing of data, and for initiating all communication between main storage and peripheral devices.

The Spectra 70/35 and 70/45 Processors use stored logic, in a special read-only memory section, to define the functions to be performed in executing each instruction. The Spectra 70/55 uses conventional wired circuits for the same purpose.

The performance of each Spectra 70 Processor, in terms of both basic instruction times and speeds on our standard measures of processor performance, is shown in the Central Processor section of the appropriate subreport:

70/15 Processor — Section 712:051.
70/25 Processor — Section 713:051.
70/35 Processor — Section 714:051.
70/45 Processor — Section 715:051.
70/55 Processor — Section 716:051.

Processor Registers

In both the Spectra 70/45 and 70/55, the processor registers are held in a scratchpad memory. Different parts of this memory are used for the registers, depending on which of the four processing modes is currently in use (see Paragraph .124, Interrupt System). It is therefore not necessary to load and unload the registers each time an interruption takes place.

The programmer has the use of sixteen 32-bit general registers and four 64-bit floating point registers when operating in either the normal processing mode or the interrupt response mode. The general-purpose registers can be used as fixed-point accumulators or as index registers. They are specified by the 4-bit R, B, or X fields in many Spectra 70 instructions. Some operations use two adjacent registers coupled together to provide a 64-bit capacity.

Addressing

Main storage addresses are formed by adding a 12-bit "displacement" (contained in the D field of every Spectra 70 instruction that references main storage) to a 24-bit "base address" (contained in a general register specified by the 4-bit B field in the same instruction). The addresses in many instructions (including most binary arithmetic and logical instructions) can be further modified by adding a 24-bit "index" contained in a general register specified by the 4-bit X field in the instruction; this effectively provides a double indexing capability.

All three parts of an address (base, displacement, and index) are treated as unsigned, positive binary integers and are added together with overflows ignored. Since every address includes a base, the sum is always 24 bits long; this provides a logical capability for addressing up to 16,777,216 bytes, although the direct part of the address (the 12-bit displacement) permits direct addressing of only 4,096 bytes. The base-register technique of address formation facilitates program relocation and segmentation.

Instruction Format

Instructions can be two, four, or six bytes in length. A 2-byte instruction causes no reference to main storage. A 4-byte instruction causes one reference to main storage, while a 6-byte instruction causes two storage references. There are five basic instruction formats, as shown below.

- Type RR — Register to Register (2 bytes)

Op	R_1	R_2

- Type RX — Register to Indexed Storage (4 bytes)

Op	R_1	X_2	B_2	D_2

- Type RS — Register to Storage (4 bytes)

Op	R_1	R_3	B_2	D_2

- Type SI — Storage and Immediate Operand (4 bytes)

Op	I	B_1	D_1

- Type SS — Storage to Storage (6 bytes)

Op	L_1	L_2	B_1	D_1	B_2	D_2

B = 4-bit base register specification
D = 12-bit displacement
I = 8-bit literal operand
L = 8-bit operand length specification
Op = 8-bit operation code
R = 4-bit operand register specification
X = 4-bit index register specification

(Contd.)

.122 Basic Design and Performance (Contd.)

Fixed-Point Arithmetic

The basic arithmetic mode of the processor is fixed-point binary, using 32-bit operands and two's-complement notation. Most operations can alternatively specify the use of 16-bit halfword operands to improve storage utilization. Most products and all dividends are 64 bits long. Fixed-point arithmetic and comparison instructions specify one operand in a general register and a second operand in either main storage or a general register; these instructions are 4 bytes long when they specify an operand address in main storage (type RS or RX) and 2 bytes long when both operands are in registers (type RR).

The standard instruction set includes instructions which perform fixed-point arithmetic, comparison, branching, moving, loading, storing, shifting, radix conversion, code translation, packing, unpacking, and Boolean operations. The radix conversion operations perform automatic conversions between signed, packed decimal fields up to 15 digits in length and 32-bit signed binary integers. The code translation instruction uses a table to translate any 8-bit data code to any other 8-bit code. The packing and unpacking instructions convert numeric BCD data between the one-character-per-byte format used by most input-output devices and the two-digits-per-byte format used for decimal arithmetic.

The other instructions in the standard set are quite conventional in form and function, as shown in the Instruction List (Section 710:121). However, in addition to performing their explicit functions, many instructions take action to ensure that valid operations are being performed upon acceptable operands, and also to set a condition indicator that can subsequently be tested to control conditional branching. These additional processor functions occur on most, but not all, instructions. Where a check fails (e.g., an invalid operand, result, or instruction is noted), the program is interrupted and a forced transfer is made to an appropriate routine, with proper linkages being set up to effect a return to the original program.

Floating-Point Arithmetic

The Floating-Point Arithmetic feature is standard equipment in the 70/35, 70/45, and 70/55 Processors. It provides additional instructions for addition, subtraction, multiplication, division, loading, storing, and comparison of both "short" (32-bit) and "long" (64-bit) floating point numbers. The fractional part occupies 24 bits in the short format and 56 bits in the long format. The characteristic occupies 7 bits in either format, represents the power of 16 by which the fractional part is to be multiplied, and permits representation of numbers ranging from 10^{-78} to 10^{75}. In this type of floating-point representation, a "normalized" fraction may contain up to three leading zeros: the resulting precision is either 6 or 16 decimal digits.

There are four 64-bit floating-point registers in each processor. Floating-point instructions specify one operand in a floating-point register and a second operand in either main storage or a floating-point register; the instructions are of type RX (4 bytes) or RR (2 bytes). Addition and subtraction may be either normalized or unnormalized.

Decimal Arithmetic

Decimal arithmetic is also standard in the Spectra 70/35, 70/45, and 70/55 Processors. It is performed upon 4-bit BCD digits packed two to a byte, with a sign in the rightmost four bits of the low-order byte. Decimal operands may be up to 16 bytes (31 digits and sign) in length. The length of each decimal field is specified in the L fields of the instructions that reference it. Two-address instructions of the storage-to-storage (SS) type are used for all decimal operations; the general and floating-point registers are not utilized.

Decimal arithmetic in these processors is considerably slower than binary arithmetic, which is also standard. The decimal mode is most suitable for processes which require relatively few computational steps between input and output, so that radix conversions and the use of fast-access registers for temporary storage of the results are not justified; or where some parts of the decimal numbers being used have some operational significance in their own right (i.e., are part of some code) as well as indicating magnitude.

.123 The Instruction Repertoire as a Programming Tool

The instruction repertoire of the Spectra 70/35, 70/45, and 70/55 computer systems, as far as the programmer is concerned, is identical with the instruction repertoire of the IBM System/360 computers. This will allow Spectra 70 programmers to use programs and routines written for System/360 computers, and allow programmers to learn on one manufacturer's computers and apply their training on another manufacturer's systems. From both of these viewpoints — common usage and common training — the instructions used in the Spectra 70 Processors can in certain circumstances reduce program writing time.

However, the IBM System/360 code itself is not without its drawbacks as a programming tool. It is complex, making program writing and checking less than straightforward if efficient operation is required. It does not include a number of facilities which could increase coding and operating efficiency — such as effective storage search operations — and must therefore be considered capable of improvement. The comments on the instruction repertoire included in the main Central Processor section of the IBM System/360 report, Paragraph 420:051.122, are equally valid when applied to the Spectra 70 implementation.

.124 Interrupt System

A program interrupt can be initiated by a machine malfunction, use of an illegal operation code, improper data, improper addressing, the occurrence of unexpected results (overflows, etc.), overflowing of the elapsed-time clock, or a request from any connected peripheral device (up to 256 devices can be connected to a channel). The interrupts are arranged in 32 classes (listed in Paragraph 710:051.313), and any class can be

.124 Interrupt System (Contd.)

inhibited by the program. (Interrupts which are inhibited are not lost, but are retained as necessary.)

For normal interrupt causes (data transmissions completed successfully, units becoming available, etc.), a single 8-bit byte, the Standard Device Byte, which is transmitted with the interrupt signal, is sufficient to identify the precise cause of the interrupt. However, a second byte, the Secondary Device Byte, identifies the precise present conditions within the unit itself. The meaning of some of the bits of this byte are standard (unit busy, unit being serviced by the operator, etc.); others are defined for the specific unit (e.g., card jam). This Secondary Device Byte can be read at any time by the computer to provide an up-to-date view of its environment, but in general it is used only when an interrupt has occurred which requires special treatment or analysis.

The specific meanings of the bits of the Secondary Device Byte are described in the reports on the individual peripheral units.

When the interrupt has been analyzed, a jump is made to the Interrupt Response State. (In the 70/15 and 70/25 Processors, where there is no such processor state, the jump goes to a routine which operates in the Normal Processing State.) In the Interrupt Response State, the necessary operations take place to service the interrupt condition. At the end of these operations, control is passed back to the operational program in the Normal Processing State.

All the other interrupt causes (elapsed-time clock, invalid addresses or data, overflows, etc.), except parity errors or machine malfunctions, are treated similarly: the interrupt triggers entry into the Interrupt Control State, where the cause is located, and then the interrupt condition is serviced in the Interrupt Response State. Machine malfunction bypass the Interrupt Control State in the 70/35, 70/45, and 70/55 Processors, and instead enter the Machine Control State, for diagnosis and recovery if possible, or an orderly shutdown if not.

Each of the four machine states (Normal Processing, Interrupt Response, Interrupt Control, and Machine Condition) has its own set of arithmetic and logic registers, including its own interrupt control register, which specifies the interrupt conditions that can and cannot be accepted.

.125 Multiprogramming Facilities

The capability to run more than one program at a time requires effective solutions to two major hardware problems. These are the sequencing problem (i.e., providing automatic switching between programs to maximize overall throughput) and the safety problem (i.e., safeguarding each program from all the others). In the Spectra 70 the necessary functions are performed by a supervisory routine in conjunction with the interrupt system (described in the preceding section) and two special sets of instructions.

Whenever an interrupt occurs, the running program is safeguarded, and a special routine is entered which determines the cause of the interrupt and then transfers control to the supervisory routine. The Supervisor Call instruction, which deliberately causes a further interrupt, switches the mode of operation of the computer to permit the use of a small group of "privileged" instructions. These instructions permit changing memory protection, altering the channel controls, and initiating input-output instructions. Thus, the partnership between hardware and software provides organized sequence control and a safeguard for programs. This safeguard, the Memory Protect feature, is designed to prevent one program from overwriting another.

The Memory Protect feature cannot prevent one program from referring to another; any program can read data from any area of core storage, so the protection is against destruction rather than in favor of privacy. A 4-bit "storage key" is assigned to each 2,048-byte block of core storage, and a 4-bit "protection key" is associated with each program and with each input and output operation. In the case of input operations, the key can be read in with the data itself. Whenever an attempt is made to write data into core storage, the storage key associated with the block concerned is compared with the protection key associated with the data to be written. If the two keys match, or if either key is zero, the data is written into storage. If not, the operation is aborted and a special interrupt occurs.

A significant loophole in the Memory Protect facility is the inability of the programmer to be sure that no other programmer has used a protection key of zero on some data (in which case he could not positively safeguard his program against overwriting).

.126 Errors and Special Cases

Errors in the Spectra 70 are handled through the interrupt system in the following ways:

- Illegal operation codes and addresses — handled by the supervisory routine, usually leading to abortion of the program.
- Input-output errors — handled by the supervisory routine, usually leading to attempts to repeat the input or output operation successfully.
- Parity failures and machine malfunctions — handled by the machine condition routines, which attempt to repeat the instruction and check on the ability of the system to proceed.
- Power failure — handled by the machine condition routines, leading to an orderly shut-down with the data in the registers, core storage locations, input-output buffers, etc. safeguarded and ready for automatic restart procedures.

(Contd.)

.127 The Compatibility Question

Compatibility within the Spectra 70 Family.

The five Spectra 70 processors all use similar machine codes based on the IBM System/360 machine code, and all of them "trap" instruction codes which are invalid; i.e., where the processor does not have hardware facilities to implement a particular instruction code, control can be transferred to a subroutine that performs the appropriate functions. It would therefore appear that a high degree of compatibility would be possible among systems using the various Spectra 70 processors.

In fact, however, RCA is not promising that the systems will have a great deal of compatibility beyond the fact that programs will be interchangeable between the Spectra 70/35, 70/45, and 70/55, and that there will be a degree of upward compatibility between the 70/15 and 70/25 Processors.

Because of the possibilities of various types of complications, it appears probable that RCA is correct in restricting downward compatibility between the processors, and that an installation would be well advised to keep its Spectra 70/15 or Spectra 70/25 programs separate from its Spectra 70/35, 70/45, or 70/55 programs.

Compatibility with the IBM System/360

The Spectra 70/35, 70/45, and 70/55 Processors use the same internal codes and instruction repertoire (except for certain "privileged" instructions) as Models 30 through 75 of the IBM System/360, and RCA expects to achieve full program compatibility, at the assembly-language level, between similarly-equipped systems. Report Section 710:133 treats the System/360 compatibility question in greater detail.

Compatibility with the IBM 1400 Series and the RCA 301 and 501

Program compatibility with the IBM 1400 Series and the RCA 301 and 501 computer systems is achieved in the Spectra 70/35 and 70/45 systems by means of optional "emulators," a combination hardware-software technique that permits direct execution of object programs written for ostensibly non-compatible computer systems. The RCA Spectra 70 emulators and other system conversion aids are described in detail in the following sections:

- Compatibility with IBM 1401/1460: Section 710:131.
- Compatibility with IBM 1410/7010: Section 710:132.
- Compatibility with RCA 301: Section 710:134.
- Compatibility with RCA 501: Section 710:135.

.128 Special Features

The optional Memory Protect feature prevents accidental alteration of the contents of specified 2,048-byte blocks of main storage (see Paragraph .125 above).

The Elapsed Time Clock (also optional in the 70/35, 70/45, and 70/55 Processors) occupies a full word of main storage which holds a signed binary integer. This integer is counted down at the rate of 50 cycles or 60 cycles per second, depending upon the line frequency. The count-down constant (6 in the case of 50 cycle lines, 5 in the case of 60 cycle lines) is adjusted so that counting effectively occurs at a constant rate, independent of the line frequency. An interrupt condition arises when the clock's value goes from positive to negative.

The optional Direct Control feature provides six external interrupt lines and instructions that transfer a single byte of information at a time between main storage and another computer or special external device.

.13 Availability

70/15: . . . . 6 to 9 months.
70/25: . . . . 6 to 9 months.
70/35: . . . . 12 to 15 months.
70/45: . . . . 12 to 15 months.
70/55: . . . . 15 months.

.14 First Delivery

70/15: . . . . 4th quarter 1965.
70/25: . . . . 4th quarter 1965.
70/35: . . . . 1st quarter 1967.
70/45: . . . . 1st quarter 1966.
70/55: . . . . 3rd quarter 1966.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add-subtract:	automatic	binary	full or halfword.
		automatic	decimal	variable: 1 to 31 digits.
	Multiply —			
	Short:	automatic	binary	halfword (32-bit product).
	Long:	automatic	binary	full word (64-bit product).
		automatic	decimal	variable: 1 to 15 digits.
	Divide —			
	No remainder:	none.		
	Remainder:	automatic	binary	full word (64-bit dividend).
		automatic	decimal	variable: 3 to 31 digits.

	Provision	Radix	Size
.212 Floating point —			
Add-subtract:*	automatic	binary	24 and 7 bits (short). 56 and 7 bits (long).
Multiply:	automatic	binary	24 and 7 bits (short). 56 and 7 bits (long).
Divide:	automatic	binary	24 and 7 bits (short). 56 and 7 bits (long).

* Both normalized and unnormalized.

	Provision	Radix	Size
.213 Boolean —			
AND:	automatic	binary	1 word.
Inclusive OR:	automatic	binary	1 word.
Exclusive OR:	automatic	binary	1 word.
.214 Comparison —			
Numbers:	automatic	fixed point binary:	32 or 16 bits.
		fixed point decimal:	up to 32 digits.
		floating point binary:	32 or 64 bits.
Absolute:	automatic		32 bits or up to 256 bytes.
Letters:	automatic		32 bits or up to 256 bytes.
Mixed:	automatic		32 bits or up to 256 bytes.

Collating sequence —
ASCII code: . . . . specials, numbers, letters.
Extended BCD code: . . . . specials, letters, numbers.
(See Data Code Tables, Section 710:141.)

	Provision	From	To	Size
.215 Code translation:	automatic**	any 8-bit code	any 8-bit code	1 to 256 bytes.
.216 Radix conversion:	automatic	decimal	binary	15 digits + sign.
	automatic	binary	decimal	31 bits + sign.

** Special code tables must be provided to use the translate instructions.

	Provision	Comment	Size
.217 Edit format —			
Alter size:	generally make larger	can edit multiple fields with one instruction	2 to 256 bytes.
Suppress zero:	automatic		
Round off:	none		
Insert point:	automatic		
Insert spaces:	automatic		
Insert fill character:	automatic		
Protection:	automatic		
Float dollar sign:	semi-automatic	must use instruction first to indicate position at which symbol is to be inserted.	
.218 Table look-up:	none.		
.219 Others —			
Binary shift:	automatic	binary.	
Decimal shift:	semi-automatic	must use Move with Offset and Logical Move instructions.	

.22 Special Cases of Operands

.221 Negative numbers —
Binary: . . . . 2's complement and sign bit.
Decimal: . . . . sign in least significant byte.

.222 Zero —
Binary: . . . . only positive zero.
Decimal: . . . . positive or negative zero; treated as equal in comparisons.

.223 Operand size determination —
Binary: . . . . fixed size: halfword (16 bits), full word (32 bits), or double word (64 bits), implied by instruction used.
Decimal (and certain logical operations): . variable size, indicated by operand length fields in instruction.

(Contd.)

.23 Instruction Formats

.231 Instruction structure: . 1, 2, or 3 halfwords (16, 32, or 48 bits), depending on number of main storage addresses necessary.

.232 Instruction layout and parts: . . . . see "Instruction Format" in Paragraph 710:051.122.

.234 Basic address structure: . . . . 2 + 0; variations in instruction length are due to the fact that either operand address may be either a main storage address or a register address.

.235 Literals —
Arithmetic (logical): 1 byte.
Comparisons and tests (logical): . . . . 1 byte.
Incrementing modifiers: . . . . none; increment is either -1 or contained in a register.

.236 Directly addressed operands —

Internal storage type	Minimum size	Maximum size	Volume accessible
Core storage:	1 byte	256 bytes	all of core storage. *
General registers:	1 register	16 registers	16 one-word registers per processor mode.

* If base registers are used for relative addressing, a maximum of 4,096 bytes are accessible via each register so allocated.

.237 Address indexing —
.2371 Number of methods: . 2.
.2372 Names: . . . . (1) indexing using the base register addresses.
(2) indexing using the X field (in instruction format RX only); permits double indexing if used with method (1).
.2373 Indexing rule: . . . . . base address and index field are treated as 24-bit positive binary integers; displacement is treated as a 12-bit positive binary integer. All these are added to form a 24-bit binary integer, ignoring overflows.
.2374 Index specification: . . base address (B) field and index (X) field both specify the number of a register.
.2375 Number of potential indexers: . . . . 16.
.2376 Addresses which can be indexed

Type of address	Application
Storage reference: .	all can be indexed by base register contents.
Storage address in RX instruction format:	can have double indexing (by base register and index register).

.2377 Cumulative indexing: . . via double indexing and Execute instruction.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . . none.
Note: The Execute instruction permits one instruction which is not in the direct sequence of instructions to be modified and executed, followed by an automatic return to the next instruction in the original sequence.
.239 Stepping
.2391 Specification of increment: . . . . always minus one for Branch on Count; for Branch on Index, the increment is found in a register.
.2392 Increment sign: . . . . minus for Branch on Count; minus or plus for Branch on Index.
.2393 Size of increment: . . always one for Branch on Count; 32 bits for Branch on Index.
.2394 End value: . . . . implied as zero for Branch on Count; for Branch on Index, the value is in a storage location specified by the instruction.
.2395 Combined step and test: . . . . yes.

.24 Special Processor Storage

Category of Storage	Number of Locations	Size in Bits	Program Usage
General Registers:	16	32	Indexing, base addresses, and accumulators in normal Processing Mode.
General Registers:	16	32	Indexing, base addresses, and accumulators in Interrupt Response Mode.
General Registers:	6	32	Indexing, base addresses, and accumulators in Interrupt Control Mode.
General Registers:	5	32	Indexing, base addresses, and accumulators in Machine Condition Mode.

.24 Special Processor Storage (Contd.)

Category of Storage	Number of Locations	Size in Bits	Program Usage
Floating-Point Registers:	4	64	Floating-point operations in any mode.
P Counter:	1 for each processing mode	32	Holds Next Instruction Address, Condition Code, Instruction Length Code, and Program Mask for the specific processing mode.
Interrupt Status Register:	1 for each processing mode	32	Identifies processor state interrupted, key to be used for Memory Protect feature, whether ASCII or EBCDIC code is to be used internally, and data to allow simulation of trapped instruction codes.
Interrupt Mask:	1 for each processing mode	32	Identifies which of the 32 possible interrupt conditions are to be inhibited while the processor operates in the specific processing mode.
Interrupt Flag Register:	1	32	Identifies which of the 32 possible interrupt conditions are waiting to be serviced.

Note: The physical characteristics of the above registers in each of the available Spectra 70 Processors are summarized in Report Section 710:041 — Internal Storage.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 4.

.312 Arrangement: . . . . . 1 P-Counter for Processing Mode.
1 P-Counter for Interrupt Response Mode.
1 P-Counter for Interrupt Control Mode.
1 P-Counter for Machine Condition Mode.

.313 Precedence of interrupt conditions: Power failure.
Machine check.
External signals 1 through 6, associated with Direct Control feature.
Termination of data transmission from Selector Trunks 1 through 6.
Termination of data transmission from any device connected to the Multiplexor Channel.
Elapsed Time Clock interrupt.
Console request.
Supervisor Call Instruction executed.
Privileged operation illegally attempted.
Operation code trapped (not implemented on specific processor).
Addressing error, operand length error, and memory protection attempted but not installed.
Data error — signs of digits incorrect; illegal operand overlapping.
Exponent overflow.
Division by zero error.
Significance error.
Exponent underflow.
Decimal overflow.
Fixed-point overflow.
Debugging mode in force.

.314 Special subsequence counters: . . . . the length of variable-size operands used in the previously executed instruction in each specific processing state.

.315 Sequence control step size: . . . . half-word.

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

.33 Interruption

.331 Possible causes within the computer installation —

Input-output Units: . unit becomes available.
data transmission ceases.
unit malfunction before data transmission starts.

Input-output controllers: . . . . . controller becomes available.
data transmission ceases, under either normal or abnormal circumstances.
controller malfunction before data transmission starts.

(Contd.)

.331 Prossible causes within the computer installation (Contd.)

Selector Channels: . parity transmission error discovered.
data lost during transmission.
Selector Channel throughput capacity exceeded.

Multiplexor Channel: . . . . connected unit becomes available.
data transmission to any connected unit ceases.
malfunction occurs in any connected unit prior to data transmission.
parity transmission error discovered.
data lost during transmission.
Multiplexor Channel throughput capacity exceeded.

Program events: . . illegal operation code.
operation code and operands incompatible.
overflow, underflow, or divide errors.
all-zero floating-point results.

Program failures: . violation of memory protection.
violation of supervisory routines.

System failures: . . . machine check failure.
power failure.

Other: . . . . console, Data Exchange Control, or Communications Control request.

Possible causes outside the computer installation —

Any remote terminal: . . . . . . request interrupt signal transmitted via one of the six external signals associated with the Direct Control feature.

.332 Control by routine —

Individual programmers' routines: . . . control of any specific single interrupt cause (except for violation of storage protection and violation of privileged instruction) can be inhibited. For the list of specific interrupts, see Paragraph 710:051.313.
length checks are controlled by specific instruction.

Method: . . . . set or clear appropriate bit in the interrupt mask associated with the processing state in use.

.333 Operator control: . . . . operator may initiate an interrupt request from the console. He can also place an input-output device in Local condition, thus preventing interrupts during service operations.

.334 Conditions for interrupt: . . . . (1) Interrupt condition signalled.
(2) Instruction in progress completed.
(3) Interruption condition attains the necessary priority (on a Multiplexor Channel) to be forwarded to the computer interface.
(4) Interrupt condition not masked out by the interrupt mask in use with the operational processing state.

.335 Interruption process —

Interruption action: . . present operational mode P-Counter is stored. Interrupt Control State P-Counter is picked up for all non-machine error interrupts; Machine Check P-Counter is picked up for all machine error interrupts. Analysis of interrupt cause follows, using 6 or 5 General-Purpose Registers associated with the Interrupt Control and Machine Check States. Control is then transferred to the Interrupt Response State, using the Interrupt Response P-Counter. The interrupt is serviced using the 16 General-Purpose Registers unique to the Interrupt Response State. When the interrupt has been serviced, control is returned to the program originally interrupted.

Registers saved: . . each processor state has its own unique General-Purpose Registers, which therefore do not require storing and saving under normal circumstances.

Destination: . . . . . address defined in the P-Counter of the processing state to which control is transferred.

.336 Control methods: . . . as programmed, using privileged instructions and diagnostic instructions as necessary.

.34 Multiprogramming: . . available in systems with a minimum of 65K bytes of core storage; see Sections 710:191, 710:192, and 710:193 — Operating Environment.

.35 Multi-sequencing: . . . theoretically possible; no software provisions announced to date.

.4 PROCESSOR SPEEDS

See the following subreport sections for detailed processor speeds:

Spectra 70/15:. . . . Section 712:051.
Spectra 70/25:. . . . Section 713:051.
Spectra 70/35:. . . . Section 714:051.
Spectra 70/45:. . . . Section 715:051.
Spectra 70/55:. . . . Section 716:051.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	optional interrupt.
Underflow (floating point):	check	optional interrupt.
Zero divisor:	check	optional interrupt.
Illegal data:	check	optional interrupt.
Forbidden operation:	check	optional interrupt.
Unavailable operation:	check	optional interrupt.
Illegal storage address:	check	interrupt.
Receipt of data:	parity check	optional interrupt.
Dispatch of data:	send parity bit.	

CONSOLE: 70/97 CONSOLE AND TYPEWRITER

.1 GENERAL

.11 Identity: . . . . 70/97 Console and Typewriter.

.12 Description

The Operator's Console for the larger Spectra 70 systems (not the Spectra 70/15 or 70/25) is a free-standing table with a centrally-placed, built-in console typewriter, display lights, and control panel. It is designed to allow the operation of the Spectra 70 system in conjunction with one of the standard Operating Systems. (For system operation without the use of an Operating System, the Control Panel on the side of the Central Processor provides additional facilities.)

Beyond loading keys and stopping keys, the console contains only a Console Request Key, which causes the Console Interrupt Flag to be set and the Operating System to respond accordingly. Actual communication between the system and the operator is normally by means of the console typewriter (see below).

The display lights on the Operator's Console are also very restricted. They consist of a light showing when the processor is idling, a set of Program State Display Lights that show which of the four operating modes the processor was in when processing halted, and warning lights for processor errors and excessive temperature.

The console typewriter, which is an integral part of the 70/97 Console, operates at a maximum of 10 characters per second. It can type 25 special characters in addition to the 26 upper-case alphabetic symbols and the 10 numeric digits. Only a single carbon copy can be obtained on the typewriter.

The typewriter is connected to the processor by way of the Multiplexor Channel, where it utilizes a special trunk which is reserved for this purpose. When a type-in is required, a bell rings and a wait of up to ten seconds follows, during which the operator can type any message into the processor. Should typing not commence within ten seconds after the bell, a flag is set internally, and the processor will then act as directed by the particular program presently in operation.

When the processor responds, it can use any of the 25 special symbols as well as the 36 alphanumeric characters; the shift operation is automatically inserted by the control electronics. There is no Tabulate function, so the program must pad out material by inserting blanks in the appropriate places before transmission.

CONSOLE: INPUT-OUTPUT TYPEWRITER

.1 GENERAL

.11 Identity: . . . . 70/216 Input-Output Typewriter.

.12 Description

Operational control of most Spectra 70/15 systems and all Spectra 70/25 systems is handled through the Model 70/216 Input-Output Typewriter. The 70/216 performs the same console-device functions when it is connected to either a Spectra 70/15 or 70/25 system.

The typewriter can send or receive at a maximum speed of 10 characters per second. It can type 25 special characters in addition to the 26 upper-case alphabetic symbols and the 10 numeric digits. Maximum line length is 72 characters. Only a single carbon copy can be obtained. A Pin-Feed Platen provides for non-slip feeding of continuous forms.

Manual interruption of the processor can be initiated from the typewriter. When the processor requires a type-in, a bell rings and a wait of fifteen seconds follows, after which an internal flag is set if typing has not commenced.

When the processor transmits data, it can use any of the 25 special symbols as well as the 36 alphanumeric characters; the shift operation is automatically inserted by the control electronics. There is no Tabulate function, so the program must pad out the material to be typed by inserting blanks in the appropriate places before transmission.

Accuracy control is provided by generating a parity bit for each character sent to and from the processor, and also by performing a bit-by-bit echo check on the characters sent to the typewriter by the processor.

INPUT-OUTPUT: CARD READER

.1 GENERAL

.11 Identity: . . . . 70/237 Card Reader (1435 cpm), Models 70/237-10, 70/237-21, and 70/237-22.

.12 Description

The 70/237 Card Reader is a serial (column-by-column) card reader that can in certain models read pencil-marked data optically. As a serial card reader, the 70/237 operates at 1,435 cards per minute. This rate is reduced to a presently-undetermined speed when either mixed data (punched holes and pencil marks) or pencil marks only are being read. In both reading modes, translation from the standard 80-column punched card code to unique internal 8-bit characters is available for all the 256 codes of the Extended BCD Interchange Code. (For code translation purposes, a pencil mark is equivalent to a punched hole.)

The reader, which reads a column at a time, is not buffered. It will normally be used on the Multiplexor Channels of the larger Spectra 70 systems and may well be used on the Auxiliary Channel of the Spectra 70/15. Because the maximum length of a card image is fixed, card reading on the 70/15's unsupervised Auxiliary Channel is less likely to accidentally overwrite part of the program than, for example, magnetic tape reading.

Particular emphasis is placed by RCA on the ability of the card readers to read most types of cards in commercial use. These include heavily-scored cards designed for machine use either before or after the stubs have been detached, round-corner cards, standard 80-column cards, and 51-column cards.

Card Reader Models 70/237-21 and 70/237-22 permit reading pencil-marked data, or mixed punched-hole and pencil-marked data, in a single pass. Card reading speed is reduced while any optical mark reading is in progress, but the speed can be reset to 1,435 cards per minute by the operator when optical reading is not required.

The 70/237 Card Reader is manufactured by RCA and was first delivered in late 1965. Its current availability status is 12 months after order.

Optional Features

Feature 5202 — 51-Column Card Feature: Permits 51-column cards to be read. (The shorter stub of scored cards, i.e., the 29-column portion, cannot be read.)

Feature 5204 — Column Binary Feature: Permits the program to select reading either with automatic translation from punched-card code to internal machine code, or in column binary form. In column binary form, each 12-bit card column is read into the six low-order bit positions of two adjacent bytes.

.2 PHYSICAL FORM

The cards are picked, one at a time, from the input hopper and moved, at a track speed of 300 inches per second, under the Punched Hole Read Station, onto the Optical Mark Reading Station, and over a Pocket Selection track area before being diverted into either the normal or reject stacker. The Punched Hole Read Station uses 12 photoelectric cells, one cell to sense the holes in each card row. The Optical Mark Reading Station, 2.5 inches farther along the card track, uses 13 sensing diodes. The extra Optical Mark Reading Station diode is used to read the Optical Read Time Marks which are printed on the reverse side of the card.

.3 EXTERNAL STORAGE

Standard 80-column punched cards are used. If optical mark reading is to be performed, the reverse side of the card is printed with appropriate Mark Positions, using normal punched card notation but with the relative positions reversed; i.e., Mark Position 12 is next to the Row 9 edge and Mark Position 9 is next to the Row 12 edge. Optical Read Time Marks are printed on the Row 12 edge for each column of the mark-sense data sector. The mark-sense data sector always follows the punched-hole data sector, but the point at which it starts is arbitrary and can vary from card to card.

The coding used in both the punched-hole data sector and the mark-sense data sector is normally the Extended BCD Interchange Code. Any combination not included among the 256 defined characters of this code is automatically rejected. (See Data Code Table, page 710:141.100.) Alternatively, column binary codes can be read with the appropriate special feature.

.4 CONTROLLER

The 70/237 Card Reader is a self-contained unit which includes the required control circuitry and which connects directly to the Selector or Multiplexor Channels of the processor.

.5 PROGRAM FACILITIES AVAILABLE

Each Card Read instruction causes part or all of a single card to be read, and the data (up to 80 or 160 characters, depending on whether it has been translated or is in column binary form) is stored in ascending order in any part of the main core memory. No program facilities exist in the reader for varying the automatic translation used; it is not possible, for instance, to instruct that leading or trailing blanks be read as if they were zeros. Subsequent to completion of the data transfer into main memory, the program can select either stacker. Selection by the program of a specific stacker overrides the stacker selection which occurs automatically in the card reader internal logic. The card reader can be set by instruction to read in either the Translate Mode or Column Binary Mode.

.5 PROGRAM FACILITIES AVAILABLE (Contd.)

Information about the operation and status of the card reader can be obtained by the processor at any time, and such information is automatically transmitted to the processor by the card reader at the end of each card cycle. Two bytes are used for this purpose: the Standard Device Byte and the Device Sense Byte.

The Standard Device Byte is available to the processor on request and is automatically transmitted to the processor at the end of each input operation. It indicates:

- Whether the device is operable or not.
- Whether any bits of the Device Sense Byte are set.
- Whether the device is available.
- Whether the controller is busy executing an instruction or waiting for an interruption to be serviced.
- Whether the device is busy.
- Whether there is an interruption pending.

The Device Sense Byte is available to the processor on request. Its bits are set only if some condition exists which may require program attention. These bits indicate:

- Whether an invalid punch code has been detected.
- Whether a failure in the reading circuitry has been detected.
- Whether data has been lost in reading through being overwritten before it could be stored.
- Whether the operator has inhibited data transmissions between the reader and the processor (probably to provide for servicing without total disconnection of the device).
- Whether a Stacker Select Instruction has been received too late to be obeyed. (N.B., this occurs whether or not the selected stacker was, in fact, the right one.)
- Illegal operation.

.6 PERFORMANCE

The 70/237 Card Reader operates at a peak speed of 1,435 cards per minute when punched holes only are being read. The timing details when reading punched holes only can be summarized as follows:

Operation	Time
Time from receipt of instruction until card reading starts: .	16.0 msec
Time during which data is being read and transmitted: . . .	25.8 msec
Time subsequent to completion of data transmission during which a stacker select instruction can be accepted:	20.0 msec

The demand placed on the central processor during card input operations will vary for each of the processor models in the Spectra 70 computer family. These figures are listed in the Simultaneous Operations sections of the sub-reports on the individual processor models.

.7 EXTERNAL FACILITIES

The Control Panel switches allow the operator to adjust and monitor the status of the reader. The adjustments control whether 80-column or 51-column cards are to be read and whether the Mark Reading station is to be used. These controls consist of illuminated light switches, which allow the present settings to be read easily at a distance.

The capacity of the input hopper and each of the two output stackers is 2,000 cards. They can be replenished and emptied during operation. Replenishment will be needed approximately every 80 seconds when the 70/237 Card Reader is operating at its top rated speed of 1,435 cards per minute.

.8 ERRORS, CHECKS, AND ACTIONS

Each card column read in the Translate mode is checked to ascertain that it is one of the 256 legitimate punched hole combinations allowed in the Extended BCD Interchange Code, and the sensing mechanisms and sensing circuits are checked for correct operation during each card cycle. If any of these checks fails, data transmission is halted, and the processor is notified of the reason for the end of the operation. This end-of-operation condition can also be used by the program to initiate an automatic interruption.

Accurate transmission of data to the processor is safeguarded by the automatic generation of a parity bit for each 8-bit byte. The parity bit is generated in the card reader control section and transferred to the processor with the data. A failure detected later is reported in the Selector Channel Status byte, and can, optionally, give rise to an interrupt. Placement of the data in storage is controlled by a byte count, which is included in the read instruction.

Because any one instruction can involve only a single card, no specific checks are considered necessary to prevent input area overflow. A specific check is made, however, to insure that all the data is actually transferred into the processor. This checks that no bytes held temporarily in the card reader are overwritten by new information until after they have been transmitted to the processor. Any failure here automatically ends the read operation, signals the occurrence of the failure, and optionally causes the end-of-operation interrupt.

Physical conditions of the card readers are checked by card-operated switches on the input hopper and output stackers, and by checking circuits which can detect malfunctions of the picker or improper positioning of the card as it moves under the reading heads. In all cases, these faults cause the end-of-operation interrupt and some signal, either internally or by lights on the console, indicating what condition has been detected.

INPUT-OUTPUT: CARD PUNCHES

.1 GENERAL

.11 Identity: . . . . 70/234 Card Punch (100 cpm).
70/236 Card Punch (300 cpm).

.12 Description

The 70/234 and 70/236 Card Punches are both 80-column, row-by-row punches which contain their own controller circuitry and a 640-bit single-card buffer. They can punch in either the Extended BCD Interchange Code or (optionally) in column binary, and they check the accuracy of the punched data by means of a modulo-16 hole count. They differ in their peak operating speeds (100 or 300 cards per minute); in the number of output stackers (Model 70/236 has two stackers while Model 70/234 has only a single stacker); and in the availability of a Read/Punch option on the 300 card-per-minute Model 70/236 only.

.13 Availability: . . . . not specified.

.14 First Delivery

70/234: . . . . 2nd quarter, 1966.
70/236: . . . . 4th quarter, 1965.

.2 PHYSICAL FORM

The cards are fed by the picking mechanism from the hopper to Wait Station 1, then under the punching dies, where each row is punched in turn while the card moves along to the Post-Punch Station. During the next card cycle, the card is moved to the Post-Punch Read Station, where the punched holes are counted, and subsequently forwarded to a stacker. Each move is initiated by a Card Cycle instruction, and a total of four card cycles are used during the processing of each card.

.3 EXTERNAL STORAGE

Standard 80-column punched cards, with or without scoring for later separation, can be used. Particular emphasis is placed upon the ability to punch pre-scored cards. The extended BCD Interchange Code is the standard card code, but column binary punching is available as an optional feature. This feature uses the standard 640-bit buffer to "turn around" the card image from column form to the row-at-a-time form used in the punching process.

.4 CONTROLLER

Both card punches are self-contained units which include the required control circuitry and which connect directly to the Selector or Multiplexor Channels of the computer.

.5 PROGRAM FACILITIES AVAILABLE

Each Card Cycle instruction causes the buffer to be loaded from the area of core storage stipulated in the instruction. The buffer contents are then punched into the card presently at Wait Station 1, while at the same time a new card is fed into the Wait Station; the card presently at the Post-Punch Station is advanced to the Post-Punch Read Station; and the card at the Post-Punch Read Station has its modulo-16 hole count read and is directed to a stacker.

.6 PERFORMANCE

Model:	70/234	70/236
Peak punching speed: .	100 cpm	300 cpm
Data transmission time to buffer (per card):	from 0.64 to 10 msec	from 0.64 to 10 msec
Punching time:	590 msec	155 msec
Maximum time during which next punch instruction must be given to maintain peak speed:	10 msec	10 msec

The demand placed on the central processor during output operations will vary for each of the processor models in the Spectra 70 computer family. The appropriate figures are listed in the Simultaneous Operations sections of the sub-reports on the individual processor models.

.7 EXTERNAL FACILITIES

The control panel switches allow the operator to set up the equipment, and (in elementary fashion only) to monitor its status.

The capacity of the input hopper is 800 cards in Model 70/234 and 1000 cards in Model 70/236; the output stacker capacity is 800 cards in Model 70/234 and 850 cards in Model 70/236.

.8 ERRORS, CHECKS, AND ACTION

A hole count, modulo-16, is formed as the data to be punched is loaded into the buffer. This is checked against a physical hole count which takes place at the Post-Punch Read Station, and any failure of this check causes the processor to be notified through the setting of a bit in the Standard Device Byte and in the Device Sense Byte.

Checks are made on the correct action of the picking mechanism, and on card position inside the punch unit. Any failure detected here is indicated to the processor through an automatic termination of the card punch instruction in progress and the setting of appropriate bits in the Standard Device and Device Sense Bytes.

INPUT-OUTPUT: PAPER TAPE READER/PUNCH

.1 GENERAL

.11 Identity: . . . . 70/221 Paper Tape Reader/Punch.

.12 Description

The 70/221 Paper Tape Reader/Punch consists of a 200-character-per-second reader and a logically separate 100-character-per-second punch, mounted together in a single free-standing unit. The equipment can use paper tape with five, six, seven, or eight channels and either gap or gapless coding. Fully-punched holes are used in this equipment; chadless tape is not acceptable.

Translation of eight-channel tape codes is much simpler in the Spectra 70 than in previous RCA systems because of the eight-bit byte concept and the automatic Translate instruction included in the machine repertoire of all models except the small Spectra 70/15.

Parity checking is performed by the reader and the punch to control the accuracy of data. The paper tape reader has a switch that can be set to select odd, even, or no parity checking. A character on the paper tape that has incorrect parity will be replaced in Main Memory with the system error byte.

A 70/221 Paper Tape Reader/Punch can be connected to an input-output trunk of a Spectra 70/15 Processor, or to a Selector or Multiplexor Channel of any of the larger Spectra 70 systems. When the Reader/Punch is connected to a Multiplexor Channel, reading and punching operations can be performed concurrently by utilizing different Multiplexor subchannels.

The reader/punch handles 11/16-inch, 7/8-inch, or 1-inch paper tape reels and provides spooling facilities for reels up to 1,000 feet in length.

The 6-level Advanced Sprocket option (Feature 5219-1) provides the ability to read and punch 6-level tape with advanced sprocket holes. This feature can be installed in the field.

RCA offers the 70/221 Reader/Punch in four different models. Model 70/221-10 is supplied with no special features. Model 70/221-11 includes a feature that permits optional reading and punching in EBCDIC mode, with code translation performed automatically. The Advanced Sprocket option described above is supplied for the punch unit as a standard feature in Model 70/221-20. Model 70/221-21 is basically the same as Model 70/221-20, but it includes in addition the facility to read in EBCDIC mode.

The 70/221 Paper Tape Reader/Punch is manufactured by RCA and is currently available on a twelve-month delivery basis. First delivery occurred during the fourth quarter of 1965. The demands it places on the central processor during its operation are normally negligible.

INPUT-OUTPUT: 70/242 PRINTER

.1 GENERAL

.11 Identity: . . . . 70/242 Printer.

.12 Description

The Model 70/242 Printer operates at 625 lines per minute at single-line spacing when a 48-character set is used. When the full 64-character set is required, the operational speed is reduced to 555 lines per minute. Effective operational speeds are shown in the table below. The 70/242 Printer can have either 132 or, optionally, 160 printing positions. Printing occurs by hammer strokes which bring the paper against a revolving print drum; the timing of the hammer strokes is synchronized with the character position required.

The operational speeds of the printer are governed by the rotational speed of the print drum and the paper advance speeds. The rotational speed is 625 rpm, which sets an upper limit on the practical printing rate. The first line space takes 12 milliseconds; subsequent line spacing proceeds at 5 milliseconds per line. An optional high-speed paper advance feature allows a 2.5-millisecond line advance after eight lines have been skipped.

Printing is performed on continuous card or paper forms. Forms width can extend from 4 to 18.75 inches. As many as five carbons plus the original form will function properly in the printers. Output format spacing is 10 characters per inch horizontally and 6 or 8 lines per inch vertically.

A model 70/242 Printer can be connected to any one of the input-output trunks of a Spectra 70 processor.

Interrupts can be set to occur when the printer becomes available, when an operation is successfully completed, or when for some reason an operation ends without being successfully completed. The program can inhibit any or all of these three separate and distinct interrupt conditions.

The alphabetic characters are arranged around the drum in order of their frequency of usage in the English language. This may help to increase the effective speed of the unit on some occasions.

The 70/242 Printer is manufactured by RCA, using an Anelex printing mechanism.

.13 Availability: . . . . . . 20 months.

.14 First Delivery: . . . . 4th quarter, 1965.

TABLE I: EFFECTIVE SPEEDS OF THE RCA 70/242 PRINTER

Lines Advanced per Line Printed	Printed Lines per Minute*	
	48-Char. Set	64-Char. Set
1	625	555
2	555	530
3	555	508
4	530	487
5	530	468
6 (1 inch)	508	451
12 (2 inches)	468	390
18 (3 inches)	451	357
24 (4 inches)	357	327
30 (5 inches)	327	303

* Optional high-speed paper advance feature is utilized for skips of more than 1 inch.

INPUT-OUTPUT: 70/243 PRINTER

.1 GENERAL

.11 Identity: . . . . 70/243 Printer.

.12 Description

The Model 70/243 Printer operates at 1,250 lines per minute at single-line spacing when a 48-character set is used. When the full 64-character set is required, the operational speed is reduced to 1,000 lines per minute. Effective operational speeds are shown in the table below. The 70/243 Printer can have either 132 or, optionally, 160 printing positions.

Printing occurs by hammer strokes which bring the paper against a revolving print drum; the timing of the hammer strokes is synchronized with the character position required.

The operational speeds of the printer are governed by the rotational speed of the print drum and the paper advance speeds. The rotational speed is 1,250 rpm, which sets an upper limit on the practical printing rate. The first line space takes 12 milliseconds; subsequent line spacing proceeds at 5 milliseconds for the next 7 lines, and at 2.5 milliseconds per line thereafter. (A line spacing of 6 lines per inch is assumed.)

Printing is performed on continuous card or paper forms. Forms width can extend from 4 to 18.75 inches. As many as five carbons plus the original form will function properly in the printers. Output format spacing is 10 characters per inch horizontally and 6 or 8 lines per inch vertically.

A Model 70/243 Printer can be connected to any one of the input-output trunks of a Spectra 70 system.

Interrupts can be set to occur when the printer becomes available, when an operation is successfully completed, or when for some reason an operation ends without being successfully completed. The program can inhibit any or all of these three separate and distinct interrupt conditions.

The alphabetic characters are arranged around the drum in order of their frequency of usage in the English language. This may help to increase the effective speed of the unit on some occasions.

The 70/243 Printer is manufactured by RCA, using an Anelex printing mechanism.

.13 Availability: . . . . 20 months.

.14 First Delivery: . . . . . 4th quarter, 1965.

TABLE I: EFFECTIVE SPEEDS OF THE RCA 70/243 PRINTER

Lines Advanced per Line Printed	Printed Lines per Minute	
	48-Char. Set	64-Char. Set
1	1250	1,000
2	940	923
3	940	857
4	830	800
5	830	750
6 (1 inch)	750	705
12 (2 inches)	625	571
18 (3 inches)	500	500
24 (4 inches)	450	444
30 (5 inches)	420	400

INPUT-OUTPUT: BILL FEED PRINTER

.1 GENERAL

.11 Identity: . . . . 70/248 Bill Feed Printer.

.12 Description

The 70/248 Bill Feed Printer is RCA's name for the IBM 1404 Printer, which uses a horizontal-chain printing mechanism, tape-controlled carriage, and continuous form feeding and stacking system. It has 132 printing positions and a peak speed of 600 lines per minute. In addition, the 70/248 has a feeding and stacking system for card forms. By unlocking a single knob, the entire printing assembly can be moved laterally to print on either continuous forms or cards (but not on both during the same run).

The Bill Feed Printer can process cards ranging from a single 51-column card to an 80-column card with an 80-column stub. It can also process simultaneously any two cards, fed side by side, that range in size from 51 to 80 columns each. Peak speed, when feeding two cards at a time ("two up") and printing one line per card, is 800 cards per minute. Up to 25 lines can be printed on a standard IBM card. The standard character set contains 48 printable characters.

Section 401:082 of the IBM 1401 report contains a more complete description of the 70/248 Bill Feed Printer (i.e., the IBM 1404 Printer).

The Model 70/249 Bill Feed Printer Control provides the interface to connect a Bill Feed Printer to a Spectra 70/25, 70/35, 70/45, or 70/55 Selector or Multiplexor Channel, or to a Spectra 70/15 input-output trunk.

INPUT-OUTPUT: 9-TRACK MAGNETIC TAPE UNITS

.1 GENERAL

.11 Identity: . . . . RCA 70/432 Magnetic Tape Unit (a combination unit with two tape drives).
RCA 70/442 Magnetic Tape Unit (a combination unit with two tape drives).
RCA 70/445 Magnetic Tape Station (a conventional unit with a single tape drive).

.12 Description

The peak speeds of the three 9-track magnetic tape units available for Spectra 70 systems are 30,000, 60,000, and 120,000 bytes per second for the 70/432, 70/442, and 70/445, respectively. The performance characteristics of these units are summarized in Table I.

Single or dual channel controllers are available, and up to 8 or 16 tape drives can be connected to a controller. In the slower tape systems (the 70/432 and 70/442), two independent tape drives are housed in each cabinet, and each dual-drive cabinet is referred to by RCA as a "Magnetic Tape Unit." In the fastest system (the 70/445), a single drive is housed in a somewhat smaller cabinet and called a "Magnetic Tape Station."

These 9-track magnetic tape units are required for use of most of the operating systems implemented for the RCA Spectra 70 computers.

The magnetic tape used in all three of the 9-track tape units can be freely interchanged between IBM System/360 installations and RCA Spectra 70 installations, as the recording and reading characteristics of the RCA and IBM tape units used with these computers are identical.

It is also possible to interchange 7-track magnetic tape reels between Spectra 70 computers and installations using IBM 729 Magnetic Tape Units and other equivalent magnetic tape systems. This involves the use of 7-track read/write heads in the tape units instead of the standard 9-track heads. RCA supplies these 7-track heads without charge, and changing over from one type of read/write head to another takes about a day. It is possible to interchange magnetic tape with other RCA computer systems only if these systems are using IBM-compatible 7-track tape units such as the RCA 3485 and 3484 units. Use of the 7-track read/write heads permits reading and writing data that is packed 200, 556, or 800 bits per inch.

Reading operations can take place in either the forward or backward direction, but writing is restricted to the forward direction only. A block of data read from tape will be stored in Main Memory in the same order irrespective of the direction in which it is read.

The accuracy of data recording and reading is safeguarded by a combination of three separate checks which are recorded on the magnetic tape along with the data. These checks are:

- The horizontal check bit — a parity bit carried along with each data character and recorded in the parity track.
- The longitudinal check character — a 9-bit character recorded at the end of each block. Each bit of this character denotes the parity of one of the tracks of the block.
- The diagonal parity check character — a 9-bit character recorded along with the longitudinal check character at the end of each block.

When data is written, a read-after-write check is made upon the parity of each individual character, but not upon the accuracy of the data or check characters themselves. When the tape block is read, all three checks are used to tell whether the data has apparently been correctly read — or, if there has been a fault, whether it was restricted to a single tape track.

TABLE I: CHARACTERISTICS OF RCA 9-TRACK MAGNETIC TAPE UNITS

Model No.	Tape Speed, inches per sec	Recording Density, bytes per inch	Peak Speed, bytes per sec	Interblock Gap Lengths			Efficiency, % (3)		Demand on Core Storage, % (4)	Rewind Speed, inches per sec	Total Rewind Time (minutes)
				inches	msec (1)	chars (2)	100-char blocks	1,000-char blocks			
70/432	37.5	800	30,000	0.6	16.0	480	17%	67%	(4)	100	4.8
70/442	75.0	800	60,000	0.6	8.0	480	17%	67%	(4)	150	3.2
70/445	150.0	800	120,000	0.65 (5)	4.3	520	16%	66%	(4)	400	1.2

(1) Time in milliseconds to traverse each interblock gap when reading or writing consecutive blocks.
(2) Number of character positions occupied by each interblock gap.
(3) Effective speed at the indicated block size, expressed as a percentage of peak speed.
(4) Range varies depending on processor model and on type of channel used; details are included in Simultaneous Operations sections of the appropriate subreports.
(5) Tape recorded with 0.6-inch gaps can be read, providing compatibility with the 70/432 and 70/442 Tape Units.

.12 Description (Contd.)

If the read errors were restricted to a single track, then the read controls are set so that this track is ignored while the same block is automatically reread, and the parity track is used to reconstitute the original data. The accuracy of this error recovery technique is then checked by means of the longitudinal and diagonal check characters.

If the errors were not restricted to a single track, it is necessary to "rock" the tape backward and forward until the block is successfully read or until the attempt to read is abandoned. This technique can also be used in preference to relying on the automatic error recovery methods outlined above, but special routines will be needed to reset the tape units.

.13 Availability: . . . . 12 months after order.

.14 First Delivery: . . . . . . 4th quarter, 1965.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . vacuum capstan.
.212 Reservoirs —
Number:. . . . . 2.
Capacity: . . . . 6 feet of tape.
.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: . . . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station:. . . . . . recording.
Stacks:. . . . . 1.
Heads/stack:. . . . . . . 9.
Method of use:. . . . . . 1 row at a time.

Use of station:. . . . . . sensing.
Distance: . . . . 0.15 to 0.20 inch after recording head.
Stacks:. . . . . 1.
Heads/stack:. . . . . . . 9.
Method of use:. . . . . . 1 row at a time.

Use of station:. . . . . . 2-stack unit, as above, for recording and sensing 7-track tapes (optional feature).
Stacks:. . . . . 1 for recording, 1 for sensing.
Heads/stack:. . . . . . . 7, as special compatibility feature, in place of standard 9-head stack.
Method of use:. . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium:. . . . . plastic tape with magnetizable coating.

.312 Phenomenon:. . . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . 1 to N rows at 800 rows per inch; N limited by available core storage.

.322 Parallel by: . . . . 9 tracks, standard.
7 tracks, using special feature.

.324 Track use —
Data: . . . . 8.
Redundancy check: . . 1.
Timing: . . . . 0 (self-clocking).
Control signals: . . . . 0.
Unused: . . . . 0.
Total: . . . . 9.
With optional seven-track tape feature —
Data: . . . . 6.
Redundancy check: . . 1.
Timing: . . . . 0 (self-clocking).
Control signals: . . . . 0.
Unused: . . . . 0.
Total: . . . . 7.

.325 Row use —
Data: . . . . 1 to N.
Longitudinal parity: . 1.
Diagonal parity: . . . . 1.
Timing: . . . . 0.
Control signals: . . . . 0.
Unused: . . . . 0.
Gap: . . . . 0.6 inch (0.65 inch in Model 70/445).

.33 Coding: . . . . one 8-bit byte per tape row. See Data Code Tables, page 710:141.100.

.34 Format Compatibility: with IBM System/360 2400 Series Magnetic Tape Units.
with IBM 729 and 7330 Magnetic Tape Units when optional seven-track tape feature is used.

.35 Physical Dimensions

Overall width: . . . . . . 0.5 inch.
Length: . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . Model 70/472-108, -116 Single-Channel Tape Controllers.
Model 70/473-108, -116 Single Channel Tape Controllers (permit use of Pack/Unpack Feature).
Model 70/472-208, -216 Dual Channel Tape Controllers.
Model 70/473-208, -216 Dual Channel Tape Controllers (permit use of Pack/Unpack Feature).

.42 Connection to System:. each tape controller requires 1 control unit position on 1 or 2 Spectra 70 Selector or Multiplexor Channels.

.43 Connection to Device: . 1 to 8 tape drives can be connected to a 70/472-108 or 70/472-208 Controller.
1 to 16 tape drives can be connected to a 70/472-116 or 70/472-216 Controller.

(Contd.)

.43 Connection to Device (Contd.)

1 to 8 tape drives in combinations of 7- and 9-track units can be connected to a 70/473-108 or 70/473-208 Controller.

1 to 16 tape drives in combinations of 7- and 9-track units can be connected to a 70/473-116 or 70/473-216 Controller.

Tape units of different speeds can be connected to the same Controller.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N bytes.
.442 Input-output areas: . . . main core storage.
.443 Input-output area access: . . . . each byte.
.444 Input-output area lockout: . . . . blocks of 2,048 bytes can be protected (optional).
.445 Table control: . . . . . . yes, using data chaining in Channel Command Words.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . . 1 to N bytes, limited by available core storage.
.512 Block demarcation —
Input: . . . . gap on tape.
Output: . . . . count in command.

.52 Input-Output Operations

.521 Input: . . . . read data from tape, forward or backward, into core storage, with input stopped by count or gap. Data read backward is placed in descending order in main storage.
.522 Output: . . . . write one block forward from main storage.
.523 Stepping: . . . . none.
.524 Skipping: . . . . skip forward and erase defective tape areas.
skip one block forward or backward during a read operation, with data transfer inhibited.
.525 Marking: . . . . inter-block gap.
end-of-file mark (tape mark).
.526 Searching: . . . . none.

.53 Code Translation: . . . matched codes, except when using the optional seven-track tape feature. In that case, translation between internal 8-bit bytes and 6-bit BCD tape codes is automatic. With 7-track recording, the optional Pack-Unpack feature permits three 8-bit bytes to be recorded as four 6-bit tape characters.

.54 Format Control: . . . . none.

.55 Control Operations

Request interrupt: . . . automatic.
Select format: . . . . . . yes (using optional Pack-Unpack feature with 7-track recording).
Select code: . . . . see "format" above.
Rewind: . . . . yes.
Unload: . . . . yes.

.56 Testable Conditions

Disabled: . . . . yes.
Busy device: . . . . yes.
Output lock: . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: yes.
File protect condition: yes.

Information about the operation and status of the tape unit and tape controller can be obtained by the processor at any time; it is automatically transmitted to the processor via the controller at the end of each operation, whether the operation has ended normally or not. Three or four bytes are used for this purpose: the Channel Status Byte, the Standard Device Byte, and the Device Sense Byte(s).

The Channel Status Byte indicates whether or not a transmission parity error has been detected.

The Device Sense Bytes are available to the processor on request only. Specific bits are set if some condition exists which may require program attention.

The First Device Sense Byte indicates:

- A read or read-after-write error, including lateral parity or cyclical redundancy check errors.
- A data loss, through data being overwritten by new data before it could be stored.
- A read operation has been automatically terminated because the input area became filled prior to the end of the tape block itself.
- A Tape Mark has been read.
- A BT or ET signal has been received from the tape station.
- A transmission error has been detected in the channel, and the operation in progress has accordingly been halted.
- A too-short message (under 12 data characters) has been read.

The Second Device Sense Byte is used only for 9-track operation. The least significant four bits of this byte contain a binary count that indicates which track contained a read error or errors. If this count is zero, then errors have occurred in more than one track, and automatic recovery is impossible.

.6 PERFORMANCE

.61 Conditions: . . . . standard operation of tape drives, except where use of the optional seven-track tape feature is indicated.

.62 Speeds: . . . . see Table I and graph on page 710:091.900.

.63 Demands on System: . . varies with the Spectra 70 processor model and type of I/O channel used; see Simultaneous Operations sections in the individual system subreports.

.7 EXTERNAL FACILITIES

.73 Loading and Unloading

.731 Volumes handled —
Reel: . . . . 2,400 feet; holds 15,600,000 bytes when recorded in 1,000-byte blocks.

.732 Replenishment time: . . 1.0 minute; tape unit must be stopped and rewound to beginning.

.734 Optimum reloading period —
70/432: . . . . 12.8 minutes.
70/442: . . . . 6.4 minutes.
70/445: . . . . 2.4 minutes.

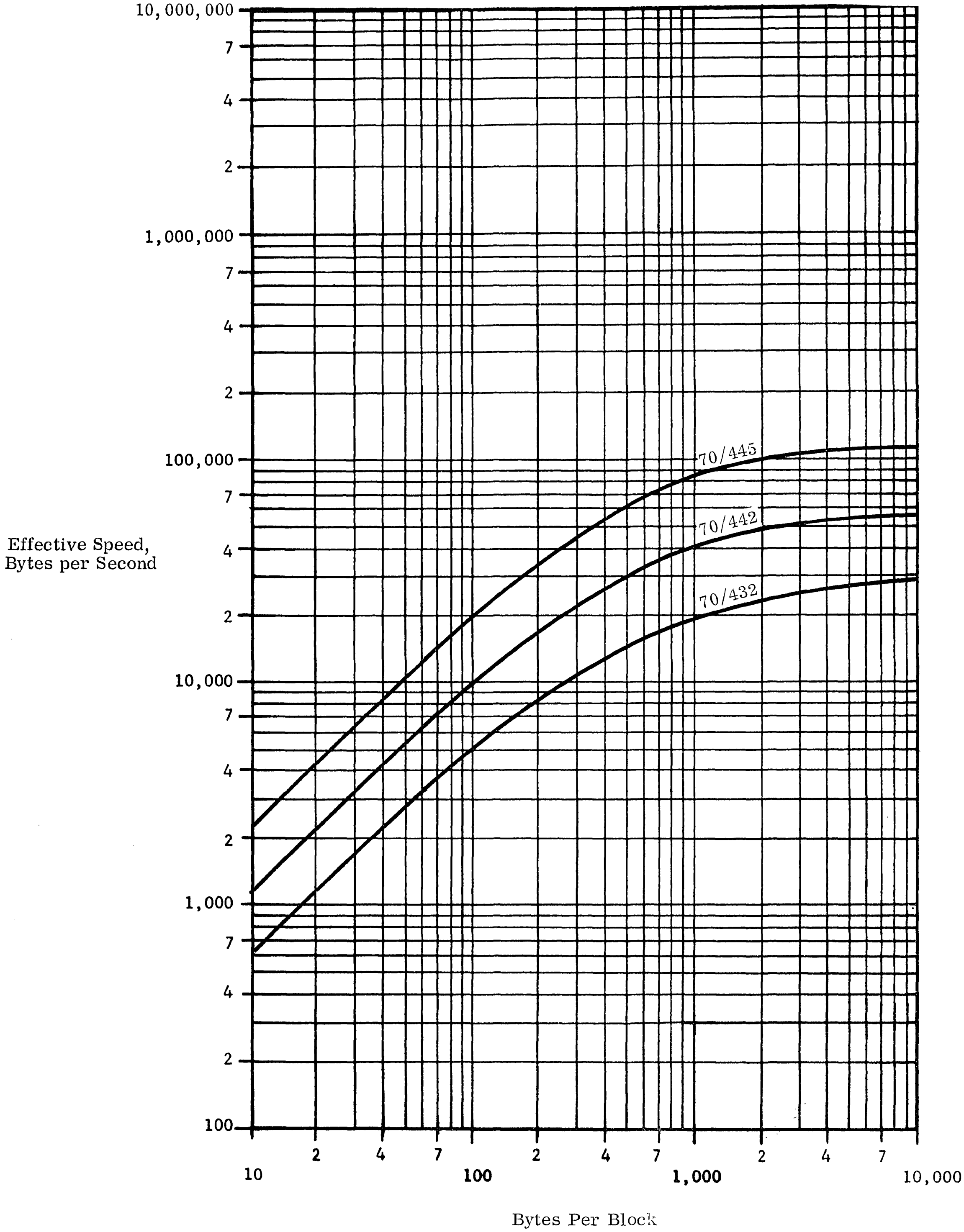
.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write parity check	set indicator.
Reading:	lateral, longitudinal and diagonal parity checks	set indicator.
Input area overflow:	byte count check	set indicator.
	Memory Protect	program interrupt.
Output block size:	byte count check	set indicator.
Invalid code:	all 8-bit codes are valid.	
Imperfect medium:	see recording check, above.	
Timing conflicts:	interlock	wait, or set indicator.
Invalid command:	check by channel	program-check or interruption condition set.
Invalid data address:	check	terminate operation; set indicator; interrupt.
Data or command chaining error:	check	set indicator.
Channel control signal parity error:	check	set indicator.
I/O interface invalid signal (timing, parity, wrong bit combinations, format):	check	terminate operation, set indicator.
Input rate too high for address resolution:	check	terminate operation, set indicator.

Note: These error indications and other status information are transmitted from the Tape Control to core storage in response to a Sense Command, or at the end of an operation in the Sense Byte.

(Contd.)

EFFECTIVE SPEED:
RCA 9-TRACK MAGNETIC TAPE UNITS



INPUT-OUTPUT: COMMUNICATION CONTROLS (SINGLE CHANNEL)

.1 GENERAL

.11 Identity: . . . . 70/652 Communication Control.
70/653 Communication Control.

.12 Description

The single-channel RCA Communication Controls permit remote half-duplex communications between an RCA Spectra 70 computer system and an RCA 301, 3301, or Spectra 70 computer system equipped with the appropriate communications equipment. The 70/652 Control can be used only with the Spectra 70/15, and the 70/563 Control can be used with the Spectra 70/15, 70/25, 70/35, 70/45, and 70/55. Different models of these Controls allow communication over the public switched telephone network, a common-carrier leased voice-band line, or (70/653-34 only) a common-carrier leased broad-band line. Some models include provisions for programmed automatic dialing over the public telephone network in conjunction with a Bell System Automatic Calling Unit. Checking provisions in all models include character parity and block or longitudinal parity.

.121 70/652 Communication Control (Spectra 70/15)

Two models of the 70/652 Communication Control are available. The 70/652-25 permits communications at 2,000 bits per second over the public telephone network or at 2,400 bits per second over a common-carrier leased voice-band line. The 70/562-26 is restricted to transmission at 2,000 bits per second over the public telephone network and includes provisions for programmed automatic dialing in conjunction with a Bell System Automatic Calling Unit. Both models can use either an 8-level transmission code which contains 6 data bits, 1 parity bit, and 1 control bit or a 9-level code which contains 8 data bits and 1 parity bit. The 9-level code cannot be used in communications between a Spectra 70/15 and a 301 or 3301 computer system. The selected code option is permanently wired at installation time. Character transmission speeds for the different code options are listed in Table I.

The 70/652 Communication Control transmits data in bit-serial, synchronous fashion. Data sets are required at each end of the line. Typical data sets would be the Bell System Data-Phone Data Set 201A with the public telephone network and the Bell System Data Set 201B with a leased voice-band line.

Each 70/652 Communication Control requires one of the six available trunks of the Spectra 70/15's Input-Output Channel.

TABLE I: CHARACTER TRANSMISSION SPEEDS

Bit Rate, bits/sec	Character Rate, char/sec	
	8-level code	9-level code
2,000	250	222
2,400	300	267
40,800*	5,100	4,533

.122 70/653 Communication Control (Spectra 70/15, 70/25, 70/35, 70/45, and 70/55)

Three models of the 70/653 Communication Control are available. The 70/653-25 and 70/653-26 are similar to and compatible with the corresponding models of the 70/652 Communication Control for the Spectra 70/15; see Paragraph .121. The 70/653-34 operates at 40,800 bits per second over a leased broad-band line such as a Telpak A channel with a Type A2 termination arrangement. Data sets are normally provided with the Telpak service. The 70/652-34 also operates in half-duplex, synchronous fashion and can be wired to operate with either the 8-level or 9-level transmission code. Character transmission speeds for the various bit rates are listed in Table I for both the 8-level and 9-level codes.

A 70/653 Communication Control (any model) can be connected via one trunk of any type of Input-Output Channel in a Spectra 70/25, 70/35, 70/45, or 70/55 computer system. Models 70/653-25 and 70/653-26 can also be connected to any trunk of a Spectra 70/15 system. A general discussion of the factors affecting input and output over the various channels is presented in Section 710:111, Simultaneous Operations.

.123 Programming

All models of the 70/652 and 70/653 Communication Controls are functionally similar; they differ in transmission speeds and in the communications facilities with which they can be used, as described in Paragraphs .121 and .122. In general, communications between an RCA Spectra 70 computer equipped with a 70/652 or 70/653 Communication Control and a remote computer equipped with compatible equipment take place as an interchange of data and acknowledgement messages.

Only the 70/652-26 and 70/653-26 can automatically initiate calls under program control; the other models require that a machine operator initiate the calls except when two computers are continuously linked by a dedicated communications line. This case is logically equivalent to the placing of one extremely long call.

Errors or other conditions (such as no more data to transmit) are generally indicated by failure to respond to a data or acknowledgement message within a specified time. Upon expiration of this time, the computer is interrupted and the message can be retransmitted or the call can be terminated, depending on the program and the conditions.

* This rate can be attained only with the Model 70/653-34 Communication Control.

INPUT-OUTPUT: COMMUNICATION CONTROLLER—MULTICHANNEL

.1 GENERAL

.11 Identity: . . . . 70/668 Communication Controller — Multichannel (CCM).

.12 Description

The 70/668 Communications Controller — Multichannel (CCM) permits communications between a Spectra 70/35, 70/45, or 70/55 computer system and a wide range of remote devices. A CCM can handle up to 48 half-duplex narrow-band or voice-band communications lines.

The Model 70/672 Communication Multiplexor Channel and the 70/664 Communication Buffer Control, which were previously announced for use with the Spectra 70/45, have been discontinued.

.121 Configuration

Three models of the 70/668 CCM are available:

- 70/668-11 — contains 16 scan positions.
- 70/668-21 — contains 32 scan positions.
- 70/668-31 — contains 48 scan positions.

A connection between the CCM and a communications line is made via a communications buffer and, in some cases, a data set. The currently-available buffers are described in Paragraph .124. Each buffer, with the exception of the 70/723 Autodin Buffer, requires one scan position and can handle one half-duplex communication line. Full-duplex facilities can be accommodated by a pair of buffers, each requiring one scan position. The 70/723 Autodin Mode 1 Buffer requires four scan positions.

A 70/668 CCM is connected to a Spectra 70/35, 70/45, or 70/55 computer by one trunk of the Multiplexor Channel. The 70/35 Multiplexor Channel has seven trunks, while the 70/45 and 70/55 Multiplexor Channels have eight. Although a CCM could theoretically be connected to each Multiplexor Channel trunk, the maximum number of communications lines that can be handled is determined by the number of Multiplexor Channel subchannels. Each scan position of a CCM uses one subchannel. The 70/35 Multiplexor Channel has 192 subchannels while the 70/45 and 70/55 Multiplexor Channels each have 256 subchannels. The amount of core storage available and the number of other peripheral devices connected to the Multiplexor Channel may also limit the number of communications lines that can be handled.

.122 Programming

The 70/668 CCM executes the input-output commands initiated by the processor program. The program designates the rules under which each communications line and remote device will operate. These rules include definition of control characters and sequences, the actions to be taken when the specified control characters and sequences are recognized, character parity checking, block or message parity checking, and code structure. The CCM contains a core memory that is used to store the communications status information and the rules of operation. The CCM also provides character framing of incoming data, bit serializing of outgoing data, and timing signals to the communications buffers. Once an input-output operation has been initiated by the processor program, the flow of data is essentially independent of the processor.

All data transferred between the CCM and the processor is in the 8-bit byte format. The CCM automatically transforms incoming data to the 8-bit byte format and outgoing data to the appropriate format for the receiving device by adding or deleting bits.

.123 Remote Terminals

A Spectra 70/35, 70/45, or 70/55 equipped with a 70/668 CCM and the appropriate communications buffers can communicate with the following remote terminals:

- Teletype Model 28, 32, 33, and 35 equipment operating at 6, 7.5, or 10 characters per second. Various common-carrier leased narrow-band systems which utilize this equipment can be accommodated, including Bell System 83B Series and 81D1 systems.
- Teletype Model 20 Teletypesetter equipment operating at 5.3 or 6.6 characters per second.
- RCA Model 6050 Video Data Terminals operating at 120 or 180 characters per second.
- RCA Model 6051 Video Data Interrogators and Model 6077 Interrogator Control Terminals operating at 120 or 180 characters per second.
- Bell System Dataspeed Type 2 Service operating at 105 characters/second.
- IBM 1050 or 1060 Data Communication Systems operating at 14.8 characters per second.
- IBM 1070 Process Communication Systems operating at 66.6 characters per second.
- IBM Synchronous Transmit-Receive (STR) Terminals (including the 1009 Data Transmission Unit, 1013 Card Transmission Terminal, and 7702 Magnetic Tape Transmission Terminal) operating at from 70 to 300 characters per second.
- IBM System/360 Computers equipped with an IBM 2701 Data Adapter Unit and the appropriate adapter.
- IBM 7740 Communication Control Systems equipped with the appropriate adapter.
- Friden Collectadata 30 data gathering systems.
- Teleregister Series 750 On-Line Banking Systems.

(Contd.)

.123 Remote Terminals (Contd.)

- UNIVAC 1004 Card Processors equipped with a Data Line Terminal, Type 1.
- RCA Model 6220 EDGE Input Stations and Model 6228 EDGE Auxiliary Card Readers operating at 27.7 characters per second.
- RCA Spectra 70 Computers equipped with a 70/652 or 70/653 Communication Control or a 70/668 CCM and a 70/721 Buffer.
- RCA 301 Computers equipped with a 376 Communication Control or a 378 Communications Mode Control and a Model 6012 Buffer.
- RCA 3301 Computers equipped with a 3376 Communication Control or a 3378 Communications Mode Control and the Model 6012 Buffer.
- Autodin Mode-1 Terminals operating at 150 or 300 characters per second.

.124 Communications Buffers

The following buffers are currently available for use with 70/668 CCM.

Model 70/710 Telegraph Buffer: The Telegraph Buffer is designed for communications with remote teleprinter devices over a narrow-band line. Single-station and multiple-station circuits can be accommodated. The Telegraph Buffer operates with 5- or 8-level, 7.5- to 10-unit codes at transmission speeds of 6, 7.5, or 10 characters per second. It can also operate with a 6-level, 8.5-unit code at 5.3 or 6.6 characters per second. The code levels and transmission rates are selected at the time of installation.

Model 70/715 Parallel Buffer: The Parallel Buffer operates in conjunction with a Bell System Date-Phone Data Set 403A to accommodate Touch-Tone input and voice output. Touch-Tone is the Bell System name applied to push-button telephone sets used in the public telephone network.

Model 70/720 Asynchronous Data Set Buffer (ADSB): The ADSB can operate over a narrow-band or voice-band line at a transmission rate of from 56.9 to 1,800 bits per second, depending on the options selected. The ADSB is compatible with the Bell System 103 and 202 Series Data Sets or equivalent; it operates asynchronously, using start and stop bits contained in the transmitted codes. Options include provisions for utilizing the reverse channel of a data set and for automatic call initiation over the Bell System TWX network or over the public telephone network in conjunction with a Bell System 801A1 Automatic Calling Unit or its equivalent.

Model 70/721 Synchronous Data Set Buffer (SDSB): The SDSB provides synchronous transmission and reception over the public switched telephone network or over a common-carrier leased voice-band line at a transmission rate of 2,000 or 2,400 bits per second. Options include provisions for utilizing the reverse channel of a data set and for automatic call initiation on the public telephone network in conjunction with a Bell System 801A Automatic Calling Unit or its equivalent.

Model 70/722 Synchronous Transmitter-Receiver Buffer (STRB): The STRB provides synchronous transmission and reception over the public telephone network or a common-carrier leased voice-band line at a transmission rate of from 600 to 2,400 bits per second, depending on the options selected. This buffer accommodates the IBM 4-of-8 constant-ratio code and has the capability for automatic call initiation on the public telephone network in conjunction with a Bell System 801A1 Automatic Calling Unit or its equivalent.

Model 70/723 Autodin Buffer: The Autodin Buffer enables an RCA 70/35, 70/45 or 70/55 computer to send and receive data via the Autodin Communication Network to any standard Mode-1 Autodin Terminal. This buffer operates in the full-duplex, continuous-transmission mode of the Autodin Network, utilizing the full Autodin channel co-ordination procedures. The ASCII Autodin Network synchronous transmission line code is used. Transmission rates are 1,200 or 2,400 bits per second (150 or 300 characters per second, respectively).

Model 70/724 EDGE Demodulator/Buffer (EDB): The EDGE Demodulator/Buffer provides communications with an RCA Model 6220 EDGE Input Station or a Model 6228 EDGE Auxiliary card reader at a transmission rate of 27.7 characters per second (250 bits per second) over a voice-band line, either privately-owned or leased from a common-carrier. The EDB also acts as the data set. The transmission code used is a 7-level, 9-unit code.

Model 70/780 Time Generator/Buffer (TGB): The Time Generator/Buffer consists of an electronic clock and a buffer for transferring the time of day to the CCM and to a control panel. Each time record transferred consists of four 9-bit, odd-parity characters in Spectra 70 internal code. The time of day is represented in terms of hours and hundredths of hours.

.125 Performance

The scan positions are divided into "high-speed" positions and "low-speed" positions according to the frequency with which they are scanned. Each scan of four low-speed positions is followed by a scan of all of the high-speed positions. The numbers of low-speed and high-speed positions in the various CCM models are shown in Table I.

The maximum communications data rate that one 70/668 CCM can handle is 6,000 characters per second. Table I also shows the maximum data rates per line for the worst case, i.e., for a fully-expanded CCM.

Demands on the Spectra 70 processors due to communications activity are listed in the individual Simultaneous Operations Sections for the Spectra 70/35, 70/45, and 70/55; see Sections 714:111, 715:111, and 716:111, respectively.

TABLE I: RCA 70/668 CCM PERFORMANCE

CCM Model	High-Speed Scan Positions	Low-Speed Scan Positions	Worst-Case Maximum Data Rate Per Line, char/sec	
			High-Speed	Low-Speed
70/668-11	16	0	375	—
70/668-21	16	16	300	75
70/668-31	16	32	300	37.5

INPUT-OUTPUT: VIDEO DATA EQUIPMENT

.1 GENERAL

.11 Identity: . . . . Video Data Terminal, Models 6050-11, 6050-12, 6050-13, 6050-21, 6050-22, and 6050-23.
Video Data Interrogator Models 6051-1, 6051-2, and 6051-3.

.12 Description

Both the Model 6050 Video Data Terminal and the Model 6051 Video Data Interrogator are designed for operation at a remote location, away from the RCA Spectra 70 Processor. Both units can be used with a Spectra 70/35, 70/45, or 70/55 system. The operator types an inquiry message on his keyboard, checks its accuracy on a cathode-ray display, and then transmits the inquiry to the computer over telephone lines. Subsequently the display unit receives and displays on the 14-inch cathode ray tube the response originated by the computer. A maximum of 480 characters can be displayed at one time. These devices are suitable only for alphanumeric messages — not for graphical displays. The character set includes 61 graphic characters. Only upper case alphabetics can be used.

Two versions of the 6050 Terminal are available. Model 6050-11 has a transmission rate of 120 or 180 characters per second. Its transmission line code contains 10 bits per character (1 start bit, 8 information bits including even parity, and 1 stop bit). Model 6050-21 has a transmission rate of only 10 characters per second. Its transmission line code contains 11 bits per character (1 start bit, 8 information bits, and 2 stop bits). The Model 6051 Video Data Interrogator transmits at the same rate as the Model 6050-11.

The one-way message transmission time is dependent on the line characteristics and on message length. It will usually be less than two seconds for telephone lines,

The Model 6050 is a stand-alone unit that transmits and receives data directly to and from the data communications link. By contrast, the Model 6051 is connected to the 6077 Interrogator Control Terminal, which handles the actual transmission and reception, and which also provides formatting services which effectively reduce the amount of data that needs to be transmitted. Each controller can handle up to eight Model 6051 Video Data Interrogators.

An RCA Spectra 70/35 can handle, through its optional Communication Controller — Multichannel, up to 176 communication lines. Similarly, a 70/45 or 70/55 system can handle up to 240 communications lines. In the latter case a maximum network size of either 240 Model 6050 Video Data Terminals or 1,820 Model 6051 Video Data Interrogators can be connected at any one time via 240 controllers. Because dial facilities can be used on the communication lines, these restrictions apply only to the number of devices actually connected with the computer at the same time; the total size of the network has no real physical limit.

The operator uses a conventional 4-row typewriter keyboard to type the inquiry. Because the typed message is simultaneously being displayed on the cathode ray tube in front of him, he can check the accuracy of form and content while he is typing it. The 14-inch tube can display a maximum of 480 characters, arranged in 15 lines of 32 characters each. The displayed characters are 0.22 inch high and 0.18 inch wide, with 0.4 inch vertical and 0.25 inch horizontal spacing. Other character sizes can also be obtained.

After typing and checking the inquiry, the operator initiates its transmission to the computer by means of a simple control panel. During transmission the query remains displayed, being erased only upon receipt of the response from the computer. This response is then displayed until the operator erases it, although the computer is disengaged as soon as the message is successfully received at the remote location. All characters are checked for even parity upon receipt by the terminal. All transmitted characters have even parity.

Both video display devices are connected to the Communication Controller — Multichannel of a Spectra 70 system via leased or switched common carrier facilities. Appropriate data subsets are required at the ends of the communications link.

A maximum-length message would consist of 480 data characters. This can be reduced by using the equivalent of the Carriage Return symbol, which advances the printing on a typewriter to the start of the next line. The 6050 Terminal has no facility equivalent to the Tabulate key on a typewriter, so that within any one line, any blanks which occur before or between data fields must themselves be transmitted as data characters. The 6051 Interrogator can perform tabulating operations through its SKIP function.

The Model 6077 Interrogator Control Terminal operates in the half-duplex mode and provides display memory and control for up to eight Model 6051 Video Data Interrogators. It provides storage capacity of 480 displayable character locations for each of the eight Video Data Interrogators it services. In addition, it can store up to sixteen 480-character prerecorded message formats which are accessible by any of the interrogator units. These masks can be used to help in accuracy control, as well as to improve the appearance of the displays by providing standard display material, while reducing the amount of data that needs to be transmitted. Different masks can be used for transmitting the query and receiving the response.

The Video Data units were announced for the RCA 3301 in May, 1964. The Model 6051 Video Data Terminal became operational in October, 1964.

INPUT-OUTPUT: DATA EXCHANGE CONTROL

.1 GENERAL

.11 Identity: . . . . 70/627 Data Exchange Control.
DXC.

.12 Description

The Model 70/627 Data Exchange Control (DXC) allows two Spectra 70 processors to interchange data. Connection between two processors is established by connecting one input-output channel on each of the processors to a Data Exchange Control, so it is possible to interconnect a number of processors either in a ring or as a network.

Transmission of data between two processors proceeds in one direction at a time and can normally overlap processing. The speed of the data transfer is related to the data throughput capacities of the processors and input-output channels involved. In general, it will proceed at the maximum data rate of the slower interconnected channel, provided that other simultaneous input-output operations on either processor do not prevent this channel from working at full capacity. The data transfer capacity of the 70/627 itself is 320,000 bytes per second.

The parity of each byte transferred is checked during the transfer.

INPUT-OUTPUT: VIDEOSCAN DOCUMENT READER

.1 GENERAL

.11 Identity: . . . . 70/251 Document Reader.

.12 Description

The 70/251 Videoscan Document Reader can optically read the ten numeric digits and five special characters of the RCA N-2 type font (see Table I), as produced by an electric typewriter, a drum-type on-line printer, or by offset or letterpress methods.

The smallest documents that can be read are 2.5 inches square, while the largest are 8.5 by 4.0 inches. The scan line can extend across an entire horizontal line, excluding a 0.3-inch margin at the leading edge and a 0.2-inch margin at the trailing edge of the document. Character spacing is 10 to the inch, permitting a maximum of 80 characters to be read from the largest allowable document. The line of characters to be scanned can be located as close as 0.5 inch from the top or bottom edge of the document. The thickness of the document can range from 0.003 to 0.010 inch. A document with a thickness of less than 0.006 inch can be scanned only if its vertical dimension is equal to or less than its horizontal dimension.

The document reader can handle 1,300 documents per minute when working in the demand mode or 1,800 per minute when the continuous feeding mode is used. RCA does not recommend use of the latter mode when the processor is engaged in multiprogrammed operation. Only one line on each document can be read in a single pass. Characters are actually read at the rate of 1,500 characters per second, and the document feed rate which can be maintained is related to the document size and the position of the characters to be read, as follows:

Distance between start of document and most distant character to be optically read	Document feeding rate when 70/251 is operating in Demand Mode
2 inches	1,300
4 inches	1,060
6 inches	930
8 inches	765

Optionally, the 70/251 Videoscan Document Reader can be equipped to read 80-column punched cards (in binary or EBCDIC mode) at up to 750 cards per minute and mark-sensed documents with vertical or slanted marks. Mark-sense reading and optical character reading can be performed during the same pass of the document. However, when the Videoscan unit operates as a punched card reader, neither optical nor mark-sense reading can be performed during the card-passing cycle.

The single input hopper can hold a 15.5-inch stack of documents. There are two output stackers (Accept and Reject), each with a capacity of 15 inches. Both the hopper and stackers can be loaded or unloaded while the reader is operating.

Positioning the document read-head is an operator function; he uses the Elevator Adjustment gauge, hand-wheel, and pointer to indicate the center of the line to be read, and the Read Start and Read Stop control dials to indicate the start and end of the line to be read. If a character is found to be unreadable, a special character code is forwarded to the computer in its place.

The 70/251 can be operated independently of the computer if required. This is sometimes done to weed out any unreadable documents before the computer run itself.

.13 Availability: . . . . 24 months.

.14 First Delivery: . . . . . 4th quarter, 1966.

TABLE I: RCA N-2 CHARACTER FONT

Name	N-2 Character	Encoded as
Zero	0	0
One	1	1
Two	2	2
Three	3	3
Four	4	4
Five	5	5
Six	6	6
Seven	7	7
Eight	8	8
Nine	9	9
Period	.	.
Dash	-	-
Dollars	$	$
Asterisk	*	*
Long Vertical Mark	|	@
Blank	(Blank)	
Unreadable	(Unreadable)	¤

SIMULTANEOUS OPERATIONS

An RCA Spectra 70 Computer System* can concurrently execute:

- One machine instruction; and
- As many fast input-output operations as there are Selector Channels; and
- Up to eight slower input-output operations via a Multiplexor Channel, where one is installed; and
- As many previously-initiated buffered input-output operations as have not yet been completed.

The number of simultaneous operations should not be confused with the number of concurrent programs. Only one program can be executed by a Spectra 70 processor at any one instant, although up to five other programs can be concurrently residing in main storage and utilizing input-output equipment. This multiprogramming mode of operation is made possible by the built-in interrupt system, in conjunction with the appropriate software operating system. In general, the Spectra 70 operating systems which require 65K bytes or more of core storage allow multiprogrammed operation. Full details are presented in the Operating Environment section on page 710:192.100.

The Spectra 70 input-output operations are handled through input-output channels. These channels contain all the common facilities required to control input-output operations and to provide a standard interface to the outside world so that many different types of input-output devices can utilize the same processor instructions.

The important characteristics of a channel are:

- The channel capacity, normally expressed in bytes per second.
- The demand on the processor, or "interference," normally expressed in terms of the percentage reduction in internal processing capacity while data transmission is taking place.

<u>Channel Capacity</u>

The measurement of channel capacity is based upon the highest instantaneous gross data transmission rate that can be safely maintained. For this purpose, it is necessary to consider the peak rates of all the peripheral units that can simultaneously transmit data through the channel. In the separate subreports on each of the Spectra 70 models, the capacity of each channel is listed, along with the overall system data capacity and the peak data rate of each of the individual peripheral units where known.

A channel may have more than one capacity listed in its specifications. In this case, the different capacities will correspond to different servicing requirements during data transmission. There are two major considerations that can affect channel capacities in the Spectra 70 computer family: one depends upon how the program is written, and the other upon how the data channel is being used.

Programming considerations are related to the concept of "chaining." Between the transmission of one byte and the next, it is possible that the channel control system will have to change the input-output area in use. This will involve obtaining the address of the new area to be used, performing various operations on it, and bringing it into use. All of these operations must be safely completed before the next byte can be accepted by the channel, and therefore the rate at which bytes can be accepted when the data is chained is considerably slower than the rate at which they can be accepted if it is known that chaining does not occur in the program.

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* Except for the Spectra 70/15, whose input-output operations are handled differently from those of the other Spectra 70 models, as described on page 712:111.100.

Hardware considerations are related to the Multiplexor Channel. On this channel, it is possible either to control a number of simultaneous operations or to operate in "burst" mode, in which case the channel can control only a single operation at a time. Operation in the burst mode eliminates the need to scan and service the other connected devices after each byte is transmitted on the single operating subchannel, and this greatly increases the safe operational speed of the channel.

Processor Demands

The measurements of processor demands, or "interference," are based on the average data transmission rates during specific peripheral operations, rather than upon the peak rates. The difference between these two rates can most easily be seen by considering the operation of a buffered printer. When the print order is issued, a complete line of 132 characters will be sent from Main Memory to the printer buffer, which may, for example, be able to accept the entire line within 1.1 milliseconds. This defines the peak data transmission rate: around 120,000 bytes per second in this example. Subsequently, the data in the buffer will be printed, the forms will be advanced one line, and the printer will be ready for another operation. The entire print cycle takes 48 milliseconds in a 1,250-line-per-minute printer; and it is this period which is used to define the average data transmission rate as 2,750 bytes per second, as compared with the peak rate of around 120,000 bytes per second.

In the Simultaneous Operations sections of the subreports on each of the Spectra 70 models, the average and peak data transmission rates of each of the peripheral units, and the resulting processor demand, are listed where known.

The Spectra 70 uses two basic types of input-output channels: Multiplexor Channels and Selector Channels. A discussion of each type follows.

Multiplexor Channels

A single Multiplexor Channel is available as an option on the Spectra 70/25 and as standard equipment on the larger processors. The Multiplexor Channel can operate in either of two modes: "multiplex" or "burst." (The burst mode is not available in Spectra 70/25 systems.)

In the multiplex mode, the channel can be time-shared by a number of simultaneously-operating low-speed input-output devices such as printers, card readers, card punches, and communication terminals. The channel is effectively divided into a number of "subchannels." Each subchannel consists of a group of storage locations holding the addresses, count, and status information associated with one input-output operation. Thus, the number of simultaneous input-output operations that the Multiplexor Channel can accommodate in the multiplex mode is limited only by the number of subchannels and by the channel's maximum gross data rate. Internal processing can always be overlapped with multiplexed input-output operations through automatic interleaving of accesses to main storage.

In the burst mode, a single input-output device monopolizes all the channel controls throughout the data transfer operation. The advantage of the burst mode is that it can handle significantly higher data transfer rates than the multiplex mode.

Selector Channels

Selector Channels can be used in all models of the Spectra 70 except the 70/15. The maximum number of Selector Channels per system varies with the processor model (and not always in the direction one would expect; see Table I). Some Selector Channels are able to handle more than a single controller: the Selector Channels connected to the 70/35 and 70/45 Processor can handle two controllers or peripheral devices each, and those on the 70/55 can handle up to four controllers. Each controller is connected to a "trunk," which is scanned during operation to see if a "Request for Interrupt" has been transmitted via the controller from one of the peripheral devices. The presence of such a request is transmitted to the processor when it occurs. Otherwise, each Selector Channel can handle only one data transmission operation at a time.

Input-output operations can occur simultaneously on all Selector Channels and can be overlapped with internal processing, provided that the maximum data-handling rate of the processor is not exceeded. Selector Channels are designed primarily for high-speed input-output devices such as magnetic tape units and disc files, but certain low-speed devices can also be connected.

The input-output channel capabilities of the Spectra 70 models are summarized in Table I.

(Contd.)

TABLE I: SPECTRA 70 INPUT-OUTPUT CAPABILITIES

SPECTRA 70 MODEL	70/25	70/35	70/45	70/55
SYSTEM DETAILS				
Estimated throughput, KB/sec*	200/500 †	694	465	640
Maximum number of simultaneous data transmissions	16	9	11	14
Maximum number of addressable devices	115	192	256	256
MULTIPLEXOR CHANNELS				
Minimum number	0	1	1	1
Maximum number	1	1	1	1
Number of subchannels per channel	8	7	8	8
Multiplexed Mode				
Maximum number of simultaneous data transmissions	8	7	8	8
Maximum total data rate, KB/sec*:				
No data chaining	111	31 ††	62	160
With data chaining	not appl.	?	?	?
Processor demand, per KB/sec**	0.9%	3.2%	1.6%	0.62%
Burst Mode				
Maximum number of transmissions	0	1	1	1
Maximum total data rate, KB/sec*:				
No data chaining	-	417	465	640
With data chaining	-	?	?	?
Processor demand, per KB/sec**	-	0.24%	0.22%	0.16%
SELECTOR CHANNELS				
Minimum number	4	0	0	0
Maximum number	8	2	3	6
Number of trunks per channel	1	2	2	4
Maximum total data rate, KB/sec*:				
No data chaining	200/500 †	694	465	640
With data chaining	not appl.	?	?	?
Processor demand, per KB/sec**	0.15%	0.144%	0.144%	0.021%

* Kilobytes (thousands of bytes) per second. Note that this is a peak rate, not an average rate.

** Processor demand for each kilobyte per second of data being input or output. Note that this is an average rate.

† The higher throughput is obtained by the use of a High Speed Selector Channel in place of the standard Selector Channel.

†† This is the maximum rate if the combined data rate is lower than 61 KB. If no Selector Channels are in use and the combined data rate is over 61 KB, a 63.1 KB rate is possible.

Control Units

A control unit, which may be a separate unit or an integral part of an input-output device, adapts the characteristics of each type of input-output device to the requirements of the standard channel interface. Each Selector Channel can handle a specific number of control units, which varies from one in the case of the Spectra 70/25 to four in the case of the 70/55.

Input-Output Control

The larger Spectra 70 computers use only four input-output instructions. These are privileged instructions, and are only executed when the processor is in the Executive Control State. The four I/O instructions are:

- Start Device, which initiates the data transmission and specifies the channel and I/O device to be used.
- Test Channel, which tests the channel's status (available, busy, not operational, or interrupt pending).
- Test Device, which places an indication of the status of the individual unit and of the channel into the scratchpad memory.
- Halt Device, which causes an immediate termination of data transmission.

When a Start Device instruction is executed, the specified channel fetches a 32-bit Channel Address Word (CAW) from Main Memory location 72. The CAW specifies the Main Memory address where the channel program for the desired input-output operation begins. The channel program consists of one or more 64-bit Channel Command Words (CCW), which are executed by the channel itself. The channel's operation is logically independent of the operation of the central processor. Depending upon which physical facilities are shared by the channel concerned and the central processor, the execution of the channel program will cause varying delays in the execution of the central processor program in progress.

There are six channel commands: Read, Write, Read Backward, Control, Sense, Write Erase, and Transfer in Channel. The Read, Write, and Read Backward commands initiate the corresponding data transfer operation. Control commands initiate functions peculiar to certain I/O devices, such as rewinding a tape unit, advancing forms on a printer, or seeking a particular disc record. Sense commands provide the program with detailed status information peculiar to a particular I/O device. The Transfer in Channel command provides chaining of Channel Command Words which are not located in adjacent memory locations.

An input-output area is described in each Channel Command Word, along with the channel command itself. Where more than one input-output area is required to complete the input-output operation, additional Channel Command Words are "chained" to the original CCW simply by placing them in the next sequential storage location. This facility allows scatter-read and gather-write operations, and is called "data chaining" to distinguish it from "command chaining." Command chaining occurs where more than one channel command is required to complete the input-output operation — perhaps a Write followed by a Rewind. Command chaining, like data chaining, is accomplished through the use of a series of Channel Command Words in successive locations. Flags are provided in each CCW to indicate which type of chaining, if any, is to take place.

Input-output interruptions are caused by termination of an I/O operation or by operator intervention at an I/O device. See Paragraph 710:051.124 for a description of the interruption process.

When a Selector Channel is used for a data transfer operation (Read, Write, or Read Backward), the selected channel is monopolized from the time the command is issued until the data transfer is completed. Control and Sense commands cause small-scale data transfers and tie up the channel for only a short period of time (on the order of 100 microseconds).

INSTRUCTION LIST

All of the following instructions are included in the larger Spectra 70/35, 70/45, and 70/55 Processors. Instructions that are also present (sometimes in slightly modified forms) in the small Spectra 70 processors are designated by the number "15" (for the Spectra 70/15) and/or "25" (for the Spectra 70/25) preceding the instruction name.

Instruction	Mnemonic Code	Hexadecimal Code
Add	A	5A
Add Normalized, Long	AD	6A
Add Normalized, Long	ADR	2A
Add Normalized, Short	AE	7A
Add Normalized, Short	AER	3A
Add Half-Word	AH	4A
Add Logical	AL	5E
Add Logical	ALR	1E
15, 25-Add Decimal	AP	FA
Add	AR	1A
Add Unnormalized, Short	AU	7E
Add Unnormalized, Short	AUR	3E
Add Unnormalized, Long	AW	6E
Add Unnormalized, Long	AWR	2E
25-Branch and Link	BAL	45
25-Branch and Link	BALR	05
15, 25-Branch on Condition	BC	47
Branch on Condition	BCR	07
25-Branch on Count	BCT	46
Branch on Count	BCTR	06
Branch on Index High	BXH	86
Branch on Index Low or Equal	BXLE	87
Compare Algebraic	C	59
Compare, Long	CD	69
Compare, Long	CDR	29
Compare, Short	CE	79
Compare, Short	CER	39
Compare Half-Word	CH	49
Check Channel	CKC	9F
Compare Logical	CL	55
15, 25-Compare Logical	CLC	D5
Compare Logical Immediate	CLI	95
Compare Logical	CLR	15
15, 25-Compare Decimal	CP	F9
Compare Algebraic	CR	19
Convert to Binary	CVB	4F
Convert to Decimal	CVD	4E
Diagnose	DIG	83
Divide	D	5D
Divide, Long	DD	6D
Divide, Long	DDR	2D
Divide, Short	DE	7D
Divide, Short	DER	3D
25-Divide Decimal	DP	FD
Divide	DR	1D
15, 25-Edit	ED	DE
Edit and Mark	EDMK	DF
Execute	EX	44
Halve, Long	HDR	24
Halt Device	HDV	9E
Halve, Short	HER	34

Instruction	Mnemonic Code	Hexadecimal Code
Idle	IDLE	80
Insert Character	IC	43
Insert Storage Key	ISK	09
Load	L	58
Load Address	LA	41
Load Complement, Long	LCDR	23
Load Complement, Short	LCER	33
Load Complement	LCR	13
Load, Long	LD	68
Load, Long	LDR	28
Load, Short	LE	78
Load, Short	LER	38
Load Half-Word	LH	48
25-Load Multiple	LM	98
Load Negative, Long	LNDR	21
Load Negative, Short	LNER	31
Load Negative	LNR	11
Load Positive, Long	LPDR	20
Load Positive, Short	LPER	30
Load Positive	LPR	10
Load	LR	18
Load Scratch Pad	LSP	D8
Load and Test, Long	LTDR	22
Load and Test, Short	LTER	32
Load and Test	LTR	12
Multiply	M	5C
Multiply, Long	MD	6C
Multiply, Long	MDR	2C
Multiply, Short	ME	7C
Multiply, Short	MER	3C
Multiply Half-Word	MH	4C
25-Multiply Decimal	MP	FC
Multiply	MR	1C
15, 25-Move Characters	MVC	D2
Move Immediate	MVI	92
Move Numerics	MVN	D1
Move with Offset	MVO	F1
Move Zones	MVZ	D3
AND Logical	N	54
15, 25-AND Logical	NC	D4
AND Logical Immediate	NI	94
AND Logical	NR	14
OR Logical	O	56
15, 25-OR Logical	OC	D6
OR Logical Immediate	OI	96
OR Logical	OR	16
15, 25-Pack	PACK	F2
Program Control	PCTL	82
Read Direct	RDD	85
Subtract	S	5B
Subtract Normalized, Long	SD	6B
Subtract Normalized, Long	SDR	2B
Start Device	SDV	9C

Instruction	Mnemonic Code	Hexadecimal Code
Subtract Normalized, Short	SE	7B
Subtract Normalized, Short	SER	3B
Subtract Half-Word	SH	4B
Subtract Logical	SL	5F
Shift Left Single Algebraic	SLA	8B
Shift Left Double Algebraic	SLDA	8F
Shift Left Double Logical	SLDL	8D
Shift Left Single Logical	SLL	89
Subtract Logical	SLR	1F
15, 25-Subtract Decimal	SP	FB
Set Program Mask	SPM	04
Subtract	SR	1B
Shift Right Single Algebraic	SRA	8A
Shift Right Double Algebraic	SRDA	8E
Shift Right Double Logical	SRDL	8C
Shift Right Single Logical	SRL	88
Set Storage Key	SSK	08
Store Scratch Pad	SSP	D0
Store	ST	50
Store Character	STC	42
Store, Long	STD	60
Store, Short	STE	70
Store Half-Word	STH	40
25-Store Multiple	STM	90
Subtract Unnormalized Short	SU	7F
Subtract Unnormalized	SUR	3F
Supervisor Call	SVC	0A
Subtract Unnormalized Long	SW	6F
Subtract Unnormalized Long	SWR	2F
Test Device	TDV	9D
15, 25-Test Under Mask	TM	91
25-Translate	TR	DC
Translate and Test	TRT	DD
15, 25-Unpack	UNPK	F3
Write Direct	WRD	84
Exclusive OR	X	57
15, 25-Exclusive OR	XC	D7
Exclusive OR, Immediate	XI	97
Exclusive OR	XR	17
Zero and Add Decimal	ZAP	F8

INSTRUCTIONS PRESENT ONLY IN THE 70/15 AND 70/25 PROCESSORS

Instruction	Mnemonic Code
Add Binary	AB
Subtract Binary	SB
Read Forward	RF
Read Reverse	RDR
Write	WR
Write Control	WRC
Halt and Branch	
Erase	
Post Status	
Sense	
Erase	
Set P2 Register	STP2

INSTRUCTIONS PRESENT ONLY IN THE 70/15 PROCESSOR

Instruction	Mnemonic Code
Read Auxiliary	RDA
Write Auxiliary	WDA

COMPATIBILITY WITH RCA 301

.1 GENERAL

Spectra 70/35 and 70/45 computer systems can be equipped with optional features that enable them to execute machine-code programs written for RCA 301 computer systems. This "emulation" of the 301 is accomplished by a combination of special hardware and software. The ability to run RCA 301 programs on a Spectra 70 without manual re-coding or machine translation can greatly facilitate the conversion process for 301 users who are installing a Spectra 70 system.

The 301 was actively marketed by RCA from its announcement in 1960 through mid-1965. During a portion of this time span, the 301 was the only computer actively marketed by RCA. Configuration combinations that were proposed to prospective users ranged in monthly rental from $3,500 to $25,000. This wide pricing range and comparatively long marketing life were made possible by the ease with which widely diverse configuration combinations could be effected. The success of this effort (more than 600 RCA 301's, many of which are distinctively configured, have been sold to date in the United States) has resulted in an extensive list of RCA 301 peripheral units that cannot be emulated by a Spectra 70 system. These exclusions, however, will not be important to the majority of 301 users.

The basic purpose served by the ability of the Spectra 70/35 and 70/45 to run object programs originally written for older RCA and IBM computers is to allow an installation more time to convert its programs into one of the Spectra 70 programming languages. An immediate gain in internal processing speed of about 1.5 to 1 will be realized during the emulation of RCA 301 programs on either a 70/35 or 70/45 system. The overall throughput during emulation can be increased still further by combining this increased internal processing speed with the 70/35 and 70/45's ability to perform several simultaneous input-output operations.

An RCA 301 has the equivalent of a single Selector Channel when the optional Simultaneous Mode Control, Model 392, is included in its configuration. For the average small RCA 301 magnetic tape installation that uses the Simultaneous Mode Control, the total increase in job processing speed can be as high as 3 to 1 when emulating with a Spectra 70/35 system that uses a single Selector Channel. This gain will to some extent be due to the faster performance of the Spectra 70's magnetic tape units (30KC minimum data transfer rate as compared to the 301's 10KC rate when using the Model 381 Tape Group).

The emulation method used by RCA is a combined hardware/software approach. All internal processing is handled through hardware, with micro-instructions in Read-Only Memory duplicating the functions of the RCA 301 instructions. Input-output operations, however, require the use of software. After an input-output instruction has been staticized, emulation control is transferred to the Emulator Control Program (ECP) contained in the 70/35 or 70/45's core memory. The purpose of the ECP is to translate the required 301 function into an equivalent Spectra 70 operation. The provision of alternate input-output areas can improve performance by permitting as many simultaneous operations as can be handled by the particular 70/35 or 70/45 configuration, rather than being limited by the characteristics of the emulated system. The memory requirements of the ECP, when added to the area containing the 301 program being executed, necessitate use of a larger core memory than that of the computer being emulated.

One of the interesting extensions of the ECP is the inclusion of a concurrent peripheral transcription facility. A combination of up to four of the following data transcription operations can be executed during the emulation of a main program: card-to-tape, card-to-printer, tape-to-printer, or tape-to-card. This extension, as well as the degree of increased simultaneity within the object program, is limited by the amount of additional core memory available for dual input-output areas and by the minimum memory requirement of the Emulation Control Program. A user, in defining the 301 system being emulated, can stipulate the minimum 301 memory requirement for the specific program to be run, rather than the full 20K or 40K physical size of the 301's memory. This will often free an additional 10K or 20K character area, providing increased simultaneous I/O operations.

Table I lists the Spectra 70 equipment required to emulate RCA 301 object programs that utilize various memory sizes and peripheral devices.

The RCA 301 emulators are scheduled for delivery beginning in December 1966 for the 70/45 and in April 1967 for the 70/35.

.2 CONVERSION OF DATA

.21 Punched Card Files

Punched card data is handled the same way in the Spectra 70 as it was in the RCA 301, with internal translations to 301 code taking place automatically. The Punch-Feed Read feature can be emulated by a Spectra 70/236 Card Punch on which the same feature is installed.

.22 Magnetic Tape Files

A special Model 385 adapter is required to use the RCA 3484 and 3485 Magnetic Tape Units on an RCA 301. Similarly, a Model 390 adapter is required to use IBM 729 Tape Units. These adapters are replaced by the Seven-Channel Tape feature on the Spectra 70 Tape Units. RCA 301 magnetic tape units can be connected to a Spectra 70/35 or 70/45 system by means of a Spectra 70 compatibility option.

.3 CONVERSION OF PROGRAMS

RCA expects a properly-equipped Spectra 70 to be able to handle all RCA 301 programs, excluding those with critical timing factors. An examination of the devices and features which are excluded from emulation, listed in Paragraphs .81 and .82, shows that these limitations might be very significant to certain RCA 301 users. All RCA 301 software can be utilized when emulating, excluding those scientific routines that make use of the optional Fixed and Floating Point Arithmetic registers (Features 354 and 355). Emulated RCA 301 software includes an assembler, COBOL and FORTRAN compilers, a scientific interpreter, and a full complement of service routines.

.4 CONVERSION OF PERSONNEL

The machine language of the Spectra 70 Series is completely different from that of the RCA 301, and all programming personnel who will be required to use the Spectra 70 will need extensive retraining. RCA 301 console operations will be replaced by nearly equivalent Spectra 70 operations.

.5 OPERATION OF EMULATED PROGRAMS

An Emulator Control Program is provided as an integral part of the 301 Emulator for Spectra 70/35 and 70/45 systems. This control program is written and executed in Spectra 70 language and performs the following basic functions:

- Loading of necessary tables and initialization of main memory, scratch-pad memory (Non-Addressable Memory in the 70/35), and processor registers.
- Handling of special functions, such as I/O interrupt control and console operations, that cannot be handled effectively by the Read-Only Memory's microprogrammed logic.
- Handling of external interrupts and error routines for which there are no provisions in the 301 program.
- Establishing peripheral device identification and density settings as required.
- Providing an interface between the operator and the 301 program being emulated.

.7 OPERATIONAL EFFICIENCY: . . . . . see Paragraph .1, GENERAL.

.8 LIMITATIONS

.81 RCA 301 Equipment Which Cannot be Emulated

363 and 366 Data Disc Files.
3488 Random Access Card Equipment.
MICR Sorter-Reader.
361 Data Record File.
376 Communications Control.
377 Data Exchange Control.
340 Multiple Tape Lister.
354 and 355 High-Speed Arithmetic Units.
5820 Videoscan Document Reader.

.82 RCA 301 Equipment Features Which Cannot be Emulated

Card Stacker Select of more than two pockets.
Row Binary Read and Punch.
Milli-sadic Non-Stop Paper Tape Reading.
Printer Spacing at 10 Lines Per Inch.
Over-printing through duplication of entries in the 301 printer table.
Special characters on printer.

TABLE I: CONFIGURATION REQUIREMENTS FOR EMULATION OF RCA 301 SYSTEMS

RCA 301	Device	RCA Spectra 70/35 or 70/45
303 (10K characters) 304 (20K characters) 305 (40K characters)	Processor Processor Processor	32K bytes 32K bytes* 65K bytes
323 (600 cpm) 324 (900 cpm) 329 (1470 cpm) 330 (800 cpm)	Card Reader	70/237 (1,435 cpm)
330 (250 cpm) 334 (100 cpm)	Card Punch	70/236 (300 cpm), or 70/234 (100 cpm)
321 (100 char/sec) 332 (1000 char/sec)	Paper Tape Reader	70/221 (200 char/sec)
331 (100 char/sec) 332 (300 char/sec)	Paper Tape Punch	70/221 (100 char/sec)
3484 (30KC) 3485 (60KC) IBM 729 (41.6KC)	Industry-Compatible Magnetic Tape Units	70/432 (30KC), 70/442 (60KC), or 70/445 (120KC)
581 (33KC), 582 (66KC)	RCA-Compatible Magnetic Tape Units	581 Magnetic Tape Unit
381 (10KC), 382 (30KC)	301 Magnetic Tape Units	70/441 Magnetic Tape Unit
333, 335 (1000 lpm)	Printer	70/242 (625 lpm), or 70/243 (1,250 lpm)
338 328	Monitor Printer Interrogating Typewriter	70/97 Console 70/97 Console

* Full emulation of input-output control facilities requires use of a 65K-byte Spectra 70 system.

COMPATIBILITY WITH RCA 501

.1 GENERAL

Spectra 70/45 systems have the optional facility to execute, without prior translation, machine-code programs written for RCA 501 computer systems. This is accomplished by means of the 501 Emulator Feature, a combined hardware/software technique that permits execution of 501 instructions in a factory-programmed "read-only" memory of the 70/45.

The 501 is a medium-scale, business-oriented system introduced by RCA in 1958; its solid-state design qualified it as one of the first second-generation computers. The 501's successful market penetration committed RCA to a major investment in electronic data processing. Over 100 RCA 501's have been sold, most of these between the years 1958 and 1961.

One of the most significant characteristics of the 501 is its ability to handle variable-length data, not only in data movement, but also in item interrelationships, such as in Add and Compare instructions. This facility helped to overcome the 501's slow internal speed (a five-digit add operation takes 350 microseconds). Faster competitive equipment of that period had limited capabilities for handling variable-length data fields.

The 501 was marketed as a magnetic tape-oriented data processor for business applications. Paper tape was the most common data input medium. The Model 581 Magnetic Tape Station was the most common intermediate storage device, although the Model 582 was also used. No time-dependent peripheral devices were used. Therefore, all RCA 501 peripheral devices can be emulated by a suitably-equipped Spectra 70/45 system.

The basic purpose of the ability to run object programs originally written for older RCA and IBM computer systems on an RCA Spectra 70/45 is simply to allow an installation more time for program conversion to a new Spectra language. No comparative speed estimates are available for determining time gain during emulation of 501 programs on a Spectra 70/45 system. The overall throughput during emulation will be enhanced by the 70/45's ability to perform several simultaneous input-output operations. The basic RCA 501 permits only one simultaneous I/O operation during processing. A field-installed "speed pack" option was provided in 1963 to permit one additional simultaneous I/O operation.

No buffered printing facility was provided with the RCA 501. Users with extensive printing requirements commonly expanded their installation to include either an off-line printer or an RCA 301 computer system as satellite equipment. As a conversion aid for these users, a combination 501/301 Emulator Feature for the Spectra 70/45 can be provided. RCA 501 installations that use an RCA 301 computer system primarily to perform editing and printing operations may find that the increased performance gained by emulation on the Spectra 70/45 will be offset by the loss of the multiprocessing facility inherent in the dual 501/301 configuration. RCA states that the use of all of the 70/45's registers during a single emulation precludes the concurrent use of 301/501 emulators at present.

The emulation method used by RCA is a combined hardware/software approach. All internal (non-input-output) instructions are handled through hardware, with micro-instructions in Read-Only Memory duplicating the functions of the RCA 501 instructions. Input-output instructions require the additional use of specialized emulator software. After staticizing an input-output instruction in Read-Only Memory, emulation control is transferred to the Emulator I/O Control Program contained in 70/45 core memory. The I/O Control Program then initiates and controls each specific input-output operation.

The 501 Emulator I/O Control Program requires a minimum of 16,384 bytes of core storage. When the Control Program is allotted additional core storage, more input-output buffer areas can be utilized, providing effective simultaneous input-output operations. A block of core storage at least equal to that of the minimum amount of 501 core storage originally required to run the object program must also be provided.

In addition to providing the facilities to control input-output operations, the Emulator Control Program performs the following basic functions:

- Communicating with the operator.
- Loading of necessary tables.
- Initializing main memory, scratchpad memory, and processor registers.
- Handling of external interrupts and error routines for which there are no provisions in the 501 program.
- Establishing peripheral identification and density settings as required.

An interesting extension of the I/O Control Program is the Concurrent Peripheral Transcription option. A combination of three of the following peripheral operations can be executed during emulation of the main 501 program: card-to-tape, card-to-printer, tape-to-printer, or tape-to-card. RCA 501 installations that perform a large amount of "off-line" printing can realize significant savings and increased performance by emulating the 501 on a Spectra 70/45 and performing data transcriptions concurrently.

The 501 Emulator feature for use with the RCA Spectra 70/45 system is scheduled for delivery in March 1967.

.2 CONVERSION OF DATA

.21 Punched Card Files

During the 501 emulation process, punched card data is handled by the 70/45 in the same format used by the 501. A code translation table within the Spectra 70/45 resolves any discrepancies between the 501 standard card format and the 70/45 EBCDIC card code. (Very few 501 systems were supplied with on-line card equipment.)

.22 Magnetic Tape Files

The 581 Magnetic Tape Station used with the RCA 501 is also available for the Spectra 70/45. This allows the present 501 user to upgrade his equipment to a Spectra 70 system without an accompanying magnetic tape inventory loss. The Model 581 Tape Station uses a seven-track data format. A detailed description of the RCA 581 Magnetic Tape Station can be found in Section 703:191. A disadvantage associated with using the 581 Tape Unit on the Spectra 70 lies in the fact that the 581's data recording format is not IBM-compatible.

The 66KC 582 Magnetic Tape Station used with some RCA 501 computer systems cannot be used with the Spectra 70 series. Therefore, 501 users with these units must first transcribe their tapes to a 581 unit to halve the recording density for acceptance by the Spectra 70/45.

.3 CONVERSION OF PROGRAMS

RCA expects a properly-equipped Spectra 70/45 to be able to run most RCA 501 programs with little or no hand editing. It will be possible to use, in the emulation mode, the normal 501 programming support software (which includes a recently-revised assembler and COBOL compiler).

.4 CONVERSION OF PERSONNEL

The machine language of the Spectra 70 series is totally different from that of the RCA 501, and all RCA 501-oriented personnel who will be programming the Spectra 70 will need extensive retraining. Operators trained on the 501 will require familiarization courses before running emulated programs on the Spectra 70.

.5 OPERATION OF EMULATED PROGRAMS

.51 Console Operation

Console Breakpoint Switch operations performed during 501 program operation are simulated in the emulation mode by the 70/97 Console Typewriter and the Emulator Control Program. Parameters to indicate the switch or condition settings must be entered to the Emulator Control Program. These settings are then stored for testing by the emulator. The switch and condition settings can be modified as required.

.52 Utilization of Program Libraries

An installation presently using a Program Library Tape in standard RCA format can use the same tape during emulation-mode processing by a Spectra 70/45.

.6 SPECIAL TECHNIQUES: . . . . . see Paragraph .1, GENERAL.

.7 OPERATIONAL EFFICIENCY: . . . . . see Paragraph .1, GENERAL.

.8 LIMITATIONS

The RCA 501 was actively marketed during a period when no time-dependent peripheral devices were offered by RCA. Therefore, all peripheral devices used with the 501 can be emulated.

TABLE I: COMPATIBLE HARDWARE DEVICES USED DURING EMULATION

RCA 501	Device	RCA Spectra 70/45
16K characters	Processor	32K bytes
32K characters	Processor	65K bytes
48K characters	Processor	65K bytes
64K characters	Processor	131K bytes
80K characters	Processor	131K bytes
503, 512, 513	Paper Tape Units	70/221
529	Card Reader	70/237
539	Card Punch	70/234 or 70/236
533	Printer	70/242 or 70/243
581, 582	Magnetic Tape Units	581
503	Monitor Printer	70/97 Console Typewriter

DATA CODES

The data code structure for the Spectra 70 line is based upon the Extended Binary-Coded Decimal Interchange Code (EBCDIC). Spectra 70 systems also offer facilities for generating and using an 8-bit representation of the 7-bit American Standard Code for Information Interchange (ASCII). See page 420:141.100 of the IBM System/360 Computer System Report for tables showing both the EBCDIC and ASCII codes. RCA plans to maintain direct compatibility with the System/360 implementations of both of these codes.

The 8-bit byte data structure, coupled with the efficient code translation instructions in most of the Spectra 70 processors, should enable Spectra 70 systems to accept and manipulate most present and future character codes of up to 8 bits.

PROBLEM ORIENTED FACILITIES: PRIMARY OPERATING SYSTEM

Software for the RCA Spectra 70 is presently classified in two principal groups, according to the operating system with which it is available and under whose control it functions. The Problem Oriented Facilities associated with the Primary Operating System are described in this section. Similar routines related to the Tape Operating System are described in Report Section 710:152. The Primary Operating System (POS) is the only operating system available for use with the Spectra 70/25 computer system, regardless of memory size, and for all Spectra 70/35 and 70/45 systems that have less than 65, 536 bytes of storage.

.1 UTILITY ROUTINES

.11 Simulation of Other Computers: . . . . a simulator of the IBM 1401 for use with the Spectra 70/25 is currently under development in the field. *

Simulation by Other Computers: . . . . . . none.

Data Sorting and Merging

Spectra 70 POS Sort/Merge

Reference:	RCA Publication 70-00-502.
Record size:	1, 500 bytes for 16K systems using 3 tape units. 4, 150 bytes for 32K systems using 3 tape units.
Block size:	same as record size.
Key size:	up to 12 control fields using a total of up to 256 bytes.
File size:	a single reel of tape at optimum record blocking.
Number of tapes: . . .	from three to nine magnetic tape units.
Date available:	POS Sort/Merge for the Spectra 70/25 — currently available; for the Spectra 70/35, 70/45, and 70/55 — July 1966.

Description:

The POS Sort/Merge program is divided into five processing phases:

- Assignment phase — reads and validates control statements.
- Internal Sort phase — reads and generates data strings to work tapes.
- External Sort phase — performs successive reverse-reading, polyphase merges.
- Final External Sort phase — merges the data into one sequenced string.
- File Merge phase — merges two or more sequenced tapes as specified by control card.

Features of the Sort/Merge include from two-way to eight-way merging, standard Spectra 70 label processing (as well as provision for handling non-standard labels), and exit points in all phases for entry to own-coding routines to perform file alterations. Other features provide for program restart prior to both External Sort phases, and for automatic alternation of tape units during input and output file passing.

The Sort/Merge routine is provided in the form of an object program card deck. This deck can be used directly or transcribed to magnetic tape. The object code of the sort program can be relocated at the programmer's option.

Table I includes actual sort times obtained by using the POS Sort/Merge program with a Spectra 70/25 computer system that has available 32, 768 bytes of core storage and three or six 60KB magnetic tape units.

.14 Report Writing

Reference:	RCA Publications 70-00-502 and 70-25.603.
Date available:	for the 70/25 — currently available. for the 70/35, 70/45, and 70/55 — July 1966.

Description:

Two versions of the Report Program Generator (RPG) are offered for use with the Primary Operating System. The Spectra 70/25's RPS lacks many of the facilities supplied with the RPG designed for use with the 70/35, 70/45, and 70/55 computer systems. The RPG used with the larger systems provides increased flexibility in the use of arithmetic, testing, and move operations.

Further extensions of the RPG supplied for the Spectra 70/35, 70/45, and 70/55 over that supplied for the 70/25 are facilities for performing table lookup and tape update operations, and for incorporating programmer-supplied source-language subroutines. Both RPG's require the following minimum equipment configuration:

- 1 Spectra 70 processor with a minimum of 16, 384 bytes of core storage.
- 4 magnetic tape drives.
- 1 card reader.
- 1 printer.
- 1 card punch.

Additional magnetic tape units can be substituted for the card reader, punch, and printer.

Performance times for the RPG for the 70/35, 70/45 and 70/55 RPG are not available at this time.

* See Sections 710:131, 710:132, 710:134, and 710:135 for detailed descriptions of the Spectra 70 "emulators" used to execute machine-language programs written for certain non-compatible, second-generation computer systems.

TABLE I: SELECTED SPECTRA 70/25 SORT TIMES, IN MINUTES

Number of Records, in Thousands	20	40	60	80	100
Record Size, in Bytes, During Three-Tape Sort					
50	3.06	7.10	11.4	15.3	19.9
100	6.17	13.5	21.2	30.4	38.4
200	13.3	30.3	45.8	64.5	81.0
400	30.6	64.9	102.0	147.0	183.0
Record Size, in Bytes, During Six-Tape Sort					
50	2.09	4.64	7.24	10.2	13.0
100	3.36	7.81	12.4	17.6	22.7
200	7.62	16.9	28.1	37.1	50.4
400	16.9	37.3	61.0	81.3	106.0

.14 Report Writing (Contd.)

The 70/25 RPG can process an average of 100 source cards per minute if punched card output is specified. Approximately 300 cards per minute can be processed if magnetic tape units are available for use during the intermediate and output phases.

.15 Data Transcription

Primary Operating System Utility Programs

Reference: . . . . RCA Publication 70-00-502.
Date available: . . . . for the 70/25 — currently available.
for the 70/35, 70/45, 70/55 — June 1966.

Description:

These utility programs are designed to operate under control of the Primary Operating System. They can be stored on the 9-channel System Tape that serves as the program library for POS, and can be accessed by a series of control cards or through the console typewriter. The user can specify which portions of fixed-length input records are to be transcribed and can indicate where in the output records the selected fields are to be written. The user can also specify the blocking factor and format of output records. The programs included are:

Card to Printer
Card to Punch
Card to Punch and Printer
Card to Tape
Tape to Card
Tape to Printer
Tape to Printer/Punch
Tape to Tape.

The exclusion of direct-access device utility programs at the POS level virtually compels users of such devices to use the larger TOS/TDOS software in order to obtain software support. The minimum core storage requirement for use of this larger software is 65,536 bytes.

The Peripheral Control Program (PCP) is a useful extension to the basic peripheral device utility package offered with POS. PCP provides for concurrent operation of up to three of the following peripheral utility routines:

Card to Tape
Tape to Printer
Tape to Card.

.16 File Maintenance: . . . basic file maintenance facilities are provided in the utility programs described in Paragraph 710:151.15, above.

.17 Other Facilities

Program Test Routines

Reference: . . . . RCA Publication 70-00-502.
Date available: . . . . . for the 70/25 — currently available.
for the 70/35, 70/45, 70/55 — June 1966.

Description:

The test routines provided with RCA's Primary Operating System are not combined into an integrated package as in IBM System/360 "Autotest" or RCA's Tape Operating System "AIDS." The test routines can be incorporated in the program at assembly time or can be appended to the program through the Linkage Editor (see Section 710:191). POS test routines available are:

Memory Print
Memory Dump and Print
Tape Compare
Tape Edit
Trace
Formatted Tape Print (70/35, 70/45, 70/55 only).

PROBLEM ORIENTED FACILITIES: TAPE AND TAPE/DISC OPERATING SYSTEM

Software for the RCA Spectra 70 is classified into two principal groups, according to the operating system with which it is available and under whose control it functions. The Problem Oriented Facilities associated with the Tape and Tape/Disc Operating System (TOS/TDOS) are described in this section. Similar routines related to the Primary Operating System are described in Report Section 710:151.

Any discrepancies between this report and published RCA manuals reflect changes in RCA's software specifications which were disclosed to us by RCA as late as April 1966.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers: . . . . none. *

.12 Simulation by Other Computers: . . . . none.

.13 Data Sorting and Merging

TOS/TDOS Sort/Merge Generator

Reference: . . . . RCA Publication 70-00-503.
Record size: . . . . . . 7,000 bytes for 65K-byte systems.
Block size: . . . . 7,000 bytes for 65K-byte systems.
Key size: . . . . 256 bytes, separated into up to 12 control fields.
File size: . . . . the maximum file size is determined by taking the number of records that can be written to a reel (based on an optimized internal blocking factor) times the "way of the sort" (from 2-way to 8-way sorts are possible, depending on the number of available tape units).

Number of tape units: . from 3 to 9.

Date available: . . . . . October 1966.

Description:

The Sort/Merge program provided with TOS has two distinct phases. The Generator phase interprets parameters and creates a specialized sort program. The Object phase structures the available memory, and performs the actual sort or merge operation. After the memory areas are structured, the Object phase performs the following four distinct operations:

- Internal Sort - reads and generates strings onto work tape using a replacement selection technique.
- External Sort - performs successive reverse-reading polyphase merges.
- Final External Sort - merges the data into one sequenced string.
- File Merge - performs a forward-reading merge of input files when the merge function has been specified or when the volume limit has been exceeded.

Features of the Sort/Merge include from 2-way to 8-way merging, standard Spectra 70 label processing (as well as provisions for handling non-standard labels), and exit points in all passes for entry to own-coding routines to perform file alterations. Other features provide for program restarts prior to each External Sort pass and at the end of each Final External Sort pass. A tape unit alternation facility is also provided during passing of both input and output files.

The core storage allotments for the Sort/Merge program can be specified by the programmer. However, the minimum core storage requirement is 7,000 bytes, in addition to the storage requirements of the Tape or Tape/Disc Operating System. Equipment requirements for the operation of the Sort/Merge program also include a console typewriter and a minimum of three magnetic tape units. One Spectra 70 Selector Channel is also required for Sort/Merge operations, and increased sorting efficiency can be obtained through the use of two Selector Channels.

.14 Report Writing

TOS/TDOS Report Program Generator

Reference: . . . . RCA Publication 70-00-503.
Date available: . . . . . Non-Random Access version - September 1966. Random Access version - November 1966.

Description:

The TOS Report Program Generator (RPG) provides common report generator features including input data selection, editing, calculating, summarizing, and control breaks.

Source programs written in the Primary Operating System's RPG language can be compiled without change using the TOS/TDOS compiler. Some of the features common to both RPG languages include:

- Up to nine control breaks.
- Up to eight different reports from the same input data.

* See Sections 710:131, 710:132, 710:134, and 710:135 for detailed descriptions of the Spectra 70 "emulators" used to execute machine-language programs originally written for certain non-compatible, second-generation computer systems.

.14 Report Writing (Contd.)

- Table lookup.
- Incorporation of programmer's subroutines, in languages other than RPG.
- Editing by a mask (similar to a COBOL PICTURE).
- A sequence checking facility among records of different types within a control group, or between control groups.
- The ability to update tape files.

The only features unique to the TOS/TDOS Report Program Generator are those which allow records to be processed in a random sequence.

Equipment requirements for using the TOS/TDOS RPG include a Spectra 70/35, 70/45, or 70/55 Model E processor with 65,536 bytes of core storage, five magnetic tape devices, one card reader, and one printer.

.15 Data Transcription

TOS/TDOS Operating System Utility Programs

Reference: . . . . RCA Publication 70-00-503.
Date available: . . . . . Non-Random Access version - August 1966. Random Access version - October 1966.

Description:

These utility programs are designed to operate under control of the Tape and/or the Tape/Disc Operating System. The programs are self-loading and can scan and validate a variety of control parameters supplied by the programmer. The programmer can specify which portions of fixed-length input records are to be transferred and can indicate where in the output records the selected fields are to be written. The user can also specify the blocking factor and format of output records. The programs included are:

Card or Paper Tape to Printer and/or Punch.
Card or Paper Tape to Tape.
Tape to Printer and/or Punch.
Tape to Tape.

Random Access Data Transcription Routines

The Random Access Data Transcription routines provide a wide range of transcription facilities. Within each transcription routine, the following features are provided and selected by control cards: Copy, Reblock, Field Select, Reblock and Field Select, List (hexadecimal format), Display (both alphanumeric and hexadecimal format), and Display and Field Select. The data transcription programs included are:

Random Access Device to Tape.
Random Access Device to Printer.
Random Access Device to Random Access Device.
Random Access Device to Punch.
Card to Random Access Device.
Tape to Random Access Device.

.17 Other Facilities

Automatic Integrated Debugging System (AIDS)

Reference: . . . . RCA Publication 70-00-503.
Date available: . . . . . October 1966.

Description:

AIDS is a software package provided by RCA to monitor a program test session. The programmer preparing his program for operation under AIDS control can select any or all of the following facilities:

Test data generation.
Program patch.
Snapshot memory dump.
Trace.
Memory print.
Tape edit.

Additional Program Diagnostics

Reference: . . . . 70-00-503.
Date available: . . . . . August 1966.
Descriptive list of facilities:

Tape Compare.
Tape Print.
Random Access Edit (to be released 10/9/66).

Statistical System

Reference: . . . . RCA Publication 70-00-301.
Date available: . . . . . currently available.

Description:

The Statistical System programs described in this report include only those routines that have been completed by RCA to date. This initial offering includes:

- Analysis of Variance - This program is designed to help analyze repetitive experiments.
- Factor Analysis - This program accepts information describing a set of variables and attempts to reduce the number of variables necessary to describe a situation.
- Regression and Correlation - In many processes, it is possible to obtain repetitive independent observations of sets of variables. This program is designed to analyze the mass of data available in such situations in the hope of discovering inferred or suspected relationships.
- Non-Linear Regression - This program attempts the same solution as Regression and Correlation, but is applied to more general situations.
- Function Minimizer - This program accepts a function of many independent variables and finds the values of variables that minimize the function.

PROCESS ORIENTED LANGUAGE: TOS/TDOS FORTRAN IV

.1 GENERAL

.11 Identity: . . . . TOS/TDOS FORTRAN IV.

.12 Origin: . . . . RCA.

.13 Reference: . . . . preliminary information.

.14 Description

Mathematical processing on the larger Spectra 70 systems will be facilitated by the use of the TOS/TDOS FORTRAN IV language. TOS/TDOS FORTRAN IV is the only FORTRAN language supplied for use with the Spectra 70 series at this time. The compiler functions under control of the Tape or Tape-Disc Operating System and therefore requires a Spectra 70/35, 70/45, or 70/55 Processor and 65,536 bytes of core storage. The 65K-byte minimum core storage requirement may be excessively demanding for users of smaller systems who still desire to program in FORTRAN. Additional configuration requirements for use of the TOS/TDOS FORTRAN IV compiler include five magnetic tape devices (two for operating system use and three for FORTRAN compilation), one card reader, and one printer. (A card punch can be used if punched card output is desired, and an additional magnetic tape unit can be substituted for the card reader or printer.)

According to RCA, all of the facilities originally promised for IBM's Operating System/360 FORTRAN IV at a 200K-byte design level (with the exception of random-access device capabilities) have been included in RCA's TOS/TDOS FORTRAN IV. Paragraph .144 lists several features offered in TOS/TDOS FORTRAN IV that are not included in the full System/360 FORTRAN IV language. One extension is the ability of the TOS/TDOS Monitor, through use of an option in the PARAM statement, to allow IBM 7090 card code as input to the FORTRAN compiler. This option will permit the use of many of the existing library subroutines written for the IBM 7090. A similar option allows RCA 3301 card code to be used as input to the compiler.

TOS/TDOS FORTRAN IV closely resembles IBM 7090/7094 FORTRAN IV as described in Section 408:162. One TOS/TDOS restriction is the reduced maximum sizes of constants, as summarized below:

Type of Constant	RCA Spectra 70	IBM 7090/7094
Integer	1 to 10 digits	1 to 11 digits
Real	1 to 7 digits	1 to 9 digits
Double Precision	1 to 16 digits	1 to 17 digits

Other restrictions of Spectra 70's FORTRAN language in relation to IBM 7090/7094 FORTRAN are listed in Paragraph .142 below.

An important extension of TOS/TDOS FORTRAN IV (relative to 7090/7094 FORTRAN IV) is the capacity to use up to seven levels of subscripting. Other useful extensions include: the implementation of the "T" specification in FORMAT statements to indicate the print or punch position of data simply by column number; an "L" conversion to specify logical variables; a "G" specification for generalized data formats; and increased possible scaling of real and double-precision constants to 16^{63} (or about 10^{75}) for Spectra 70 FORTRAN, as compared to 10^{38} for 7090/7094 FORTRAN IV.

Other extensions with respect to 7090/7094 FORTRAN include a "double-precision" concept applied to integer, real, and complex variables and constants. All variables can be explicitly assigned a length value other than their standard 4-byte or 8-byte lengths. Also, by means of an IMPLICIT statement, the type of each variable can be specified according to the first letters of its name. Mixed-mode expressions (i.e., those that consist of constants and variables of various types and lengths) are also permitted.

The compiler provides a variety of options to control and format input-output data transfers, as well as additional facilities for the use of subprograms. The principal FORTRAN language extensions in relation to IBM's 7090/7094 FORTRAN are listed in Paragraph .143 below.

RCA has not released any estimated FORTRAN compiler performance figures to date.

.141 Availability

Language specifications: . . . . . February 1966.
Compiler: . . . . December 1966.

.142 Restrictions of Spectra 70 FORTRAN IV Relative to IBM 7090/7094 FORTRAN IV

(1) Integer constants can range to 2^{31-1} as compared to 2^{35-1} in 7090/7094 FORTRAN IV; real (floating-point) constants can be from 1 to 7 digits in length as compared to a maximum of 9 digits for 7090/7094 FORTRAN IV; and double precision constants can range from 1 to 16 digits as compared to a maximum of 17 digits for 7090/7094 FORTRAN IV.

(2) In FORMAT statements: O-type conversions are not available.

(3) The SSWTCH subroutine is not provided.

(4) In statement functions, a maximum of 15 variables that appear within an expression can be used as arguments of the function.

.143 Extensions of Spectra 70 FORTRAN IV Relative to IBM 7090/7094 FORTRAN IV

(1) Up to seven levels of subscripts are permitted.

(2) In FORMAT statements, the T-specification indicates the print position of the data;

.143 Extensions of Spectra 70 FORTRAN IV Relative to IBM 7090/7094 FORTRAN IV (Contd.)

L-conversion specifies logical variables; G-specification indicates a generalized format for integer, real, complex, or logical forms of data.

(3) Dumps can be in hexadecimal, logical, double-precision, real, integer, complex, or literal format.

(4) The magnitude of real and double-precision constants can range to 16^{63} (about 10^{75}) as compared to 10^{38} for 7090/7094 FORTRAN IV.

(5) Literal constants (enclosed within quotation marks) of up to 255 characters are permitted.

(6) In SUBROUTINE subprograms, exit to any numbered statement in the calling program is permitted.

(7) An IMPLICIT statement permits assignment of type-specification to the first letter of variable names.

(8) A "double-precision" concept is applied to integer, real, and complex constants and variables, and is not considered to be a separate type specification. Variables can be optionally assigned specific lengths other than the standard 4- or 8-byte lengths.

(9) Mixed modes are permitted within expressions.

(10) Subscripted variables can be used with logical operators. Complex logical expressions are permitted.

(11) A literal constant can be used with the PAUSE statement.

(12) An integer constant can be included in the STOP statement.

(13) Integer constants and variables can have real exponents.

(14) The END statement is used to define the end of a source subprogram, as well as main program.

(15) The NAMELIST statement can be used with a READ or WRITE statement to eliminate the need to enumerate list-entries after such statements.

(16) The parameters END and ERR can be used with READ statements to indicate the statement number to which transfer is made when end-of-file and error conditions are encountered.

(17) In the FORMAT statement, the length of A-fields is not limited, and literal data can be included.

(18) A "+" character can be used for carriage control purposes, indicating "no advance."

(19) Variables within EQUIVALENCE statements can have multiple subscripts.

(20) The ENTRY statement permits transfer to a subroutine or function at a point other than the first statement.

(21) Eleven additional built-in functions and mathematical subroutines are provided.

.144 Extensions of Spectra 70 FORTRAN IV Relative to IBM Operating System/360 FORTRAN IV

(1) NAMELIST names, FORMAT statement numbers, and array format names are all allowed in subprograms.

(2) Literal constants preceded by NH names are allowed.

(3) Exponentiation is defined for all combinations of type numeric base and exponent.

(4) All functions in the standard library are allowed as subprogram arguments.

(5) ABNORMAL and PROGRAM statements are allowed.

(6) RCA 3301 and IBM 7090 card codes can be used as input to the compiler.

PROCESS ORIENTED LANGUAGE: POS COBOL

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70 Primary Operating System (POS) COBOL.

.12 Origin: . . . . RCA.

.13 Reference: . . . . Preliminary information.

.14 Description

Primary Operating System (POS) COBOL is a language subset of the TOS/TDOS COBOL language described in Section 710:165. The POS COBOL compiler functions with a Spectra 70/35, 70/45, or 70/55 Processor in a minimum environment of 32,768 bytes of core storage, and requires the use of five magnetic tape devices, a card reader, card punch, printer, and console typewriter. POS COBOL compilations are performed under control of the Spectra 70 Primary Operating System.

POS COBOL includes all but six of the language facilities prescribed for implementation in Required COBOL-61. Many of COBOL-61's useful extensions and elective features are also provided to permit effective utilization of the Spectra 70 hardware.

The restrictions of the subset POS COBOL language as compared to Spectra 70's full TOS/TDOS COBOL are listed below. The restrictions, electives, and extensions of TOS/TDOS COBOL relative to both Required COBOL-61 and to IBM's Operating System/360 COBOL are listed in Section 710:165 of this computer system report.

Deficiencies of POS COBOL With Respect to TOS/TDOS COBOL

- The Report Writer and Sort features are not implemented.
- Implied subjects and relations in compound conditions are not permitted.
- The FILE-LIMIT clause is not implemented.
- The TRY option of the Debugging Packet is not provided.

RCA has not provided to date any estimated performance figures for the POS COBOL compiler.

.141 Availability

Language: . . . . February 1966.
Compiler: . . . . August 1967.

PROCESS ORIENTED LANGUAGE: TOS/TDOS COBOL

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70 TOS/TDOS COBOL.

.12 Origin: . . . . RCA.

.13 Reference: . . . . preliminary information.

.14 Description

The RCA Tape Operating System (TOS) and Tape/Disk Operating System (TDOS) COBOL language is a subset of the IBM Operating System/360 COBOL language, which, in turn, is a subset of COBOL-61 Extended. COBOL-61 Extended is the most widely accepted pseudo-English common language designed for use in business-oriented data processing applications. RCA's TOS/TDOS COBOL includes all but five of the facilities prescribed for implementation in Required COBOL-61 (See Paragraph .142 below). It also includes two valuable extensions to Required COBOL-61: the Report Writer and Sort facilities. The restrictions, extensions, and elective facilities of TOS/TDOS COBOL with respect to Required COBOL-61 are tabulated for ease of reference in Paragraphs .142 through .145.

The exclusion of five facilities prescribed for implementation in Required COBOL-61 results in a Spectra 70 COBOL compiler that has fewer language facilities than the earlier RCA 301 COBOL compiler. The COBOL compiler provided with the 301 includes all Required COBOL-61 facilities. For compatibility purposes, RCA has left unimplemented the same language facilities that IBM omitted in the Operating System/360 COBOL language. However, this action produced areas of incompatibility with older RCA COBOL languages. Conversion of COBOL source programs written for RCA 301, 501, or 3301 computer systems will require careful hand editing.

A single Spectra 70 COBOL compiler designed for use under control of the TOS/TDOS Operating System is being implemented by RCA in three phases. The first phase is scheduled for release in December 1966. The language elements provided in this initial release will parallel those offered with the COBOL language designed for use with the Spectra 70 Primary Operating System (see Section 710:165). Phase I of the compiler will support the use of magnetic tape units and other non-random-access peripheral devices.

The second phase of the TOS/TDOS COBOL compiler is scheduled for release in April 1967. This version will permit the use of random-access equipment, but only with sequentially organized files.

The third and last phase of TOS/TDOS COBOL is scheduled for field release in June 1967. The major additional features provided in this last phase are the Sort and Report Writer facilities.

TOS/TDOS COBOL requires a minimum of 65,536 bytes of core storage for its operation, in addition to four magnetic tape units, a card reader, card punch, printer and a console typewriter. A fifth magnetic tape unit is required if the COPY and INCLUDE statements are used in the source program. Still another tape unit is required when performing multiple consecutive compilations.

RCA has stated that its COBOL compilation times "will be competitive." Final performance figures will not be released until operating system overhead times are known.

A useful extension included in TOS/TDOS COBOL is a program debugging language. Debugging statements can be included anywhere in the source program, or they can be arranged in groups or "packets" according to program section-names referenced and entered for compilation immediately following the source program. A TRACE statement causes specific messages to be written as the object program enters every program paragraph or section. EXHIBIT produces formatted snapshots of any data-names listed in the statement, and (optionally) inhibits the printing of the data-names until the values contained therein are changed. Another control statement that regulates the execution of the debugging entries is ON - a conditional statement that permits the operation of specified diagnostics only when given conditions are satisfied. If the debugging statements are grouped in packets, a DEBUG statement must be used to indicate the beginning of each logical testing operation.

The Report Writer facility is implemented by entries in the Data Division and by three new verbs. Report specifications in the Data Division are contained in the File Description, Report Description, and Report Group Description entries. The latter two entries describe the format of the report page. A report group describes a set of data that is to be considered as an individual unit (i.e., a detail line, a set of constant report headings, or a series of variable control totals). The INITIATE verb initiates the processing of a particular report, the GENERATE verb links the Procedure Division to the Report Writer at object time, and the TERMINATE verb terminates the processing of a report. Additional flexibility in controlling the Report Writer is provided by the ability to enter control parameters by means of the USE BEFORE REPORTING declarative statement of the Procedure Division.

TOS/TDOS COBOL also provides the SORT feature of Extended COBOL-61. This facility can be used for two purposes: to sort an intermediate file (intermediate data is created and then sorted into some sequence for further processing); and to process data before it is sorted and to further process it after it has been sorted. The SORT facility is implemented by a Sort Description entry in the Data Division and by three new verbs. The SORT verb controls the sequencing of records, the RELEASE verb transfers records to the initial phase of a sort operation, and the RETURN verb obtains sorted records from the final phase of a sort operation.

.14 Description (Contd.)

Corresponding to the flexibility of internal data formats inherent in the Spectra 70 design, the COBOL language permits data to be maintained in storage in five different formats, as specified by the USAGE clause of the record description entry. The five USAGE entries and their corresponding data formats are as follows:

DISPLAY	one character per byte.
COMPUTATIONAL. .	binary data item.
COMPUTATIONAL-1	short (one-word) floating point.
COMPUTATIONAL-2	long (two-word) floating point.
COMPUTATIONAL-3	packed decimal (2 digits per byte).

Noteworthy elective features included within TOS/TDOS COBOL are the Source Program Library Facility and the COMPUTE verb. (A complete listing of COBOL-61 electives implemented is provided in Paragraph .144).

The Segmentation Feature of Elective COBOL is implemented in a nonstandard way in that the linking mechanism between the main program and called subprograms is not provided automatically by the compiler. Instead, the Spectra 70 programmer must construct and control the program call-in procedures according to his needs. The ENTER statement, used in conjunction with CALL or ENTRY statements, sets up the framework of communication between the COBOL object program and one or more COBOL subprograms or subprograms in other languages. Data-names describing the subprograms to be linked to the main program are listed in the ENTRY statement and defined in the Linkage Section of the Data Division. The RETURN VIA statement enables the restoration of whatever registers were saved at a subprogram entry point, and indicates the point of return in the main program.

The Source Program Library facility permits source program entries in the Spectra 70 program library to be included in the COBOL program at compile time. Thus, an installation can utilize standard COBOL file descriptions, record descriptions, or procedures without having to program them repetitively. These entries and procedures are entered into the source program by means of a COPY clause or an INCLUDE statement.

The COMPUTE verb is another valuable elective incorporated into TOS/TDOS COBOL. COMPUTE permits arithmetic operations to be expressed in a concise formula notation similar to that of FORTRAN. For example, the COBOL operations:

```
SUBTRACT B FROM A GIVING T
DIVIDE C INTO T GIVING X
```

can alternatively be expressed as:

```
COMPUTE X = (A-B)/C.
```

The only major feature of IBM's Operating System/360 COBOL F that is not included in RCA's TOS/TDOS COBOL is Asynchronous Processing, including the USE FOR RANDOM PROCESSING sentence and the HOLD and PROCESS statements.

It is expected that another COBOL compiler will be released with RCA's planned Disc Operating System (DOS). The extent of language Facilities to be provided in DOS COBOL has not been specified by RCA to date.

.141 Availability

Language: . . . . February 1966.
Compiler —
Phase 1: . . . . December 1966.
Phase 2: . . . . April 1967.
Phase 3: . . . . June 1967.

.142 Deficiencies of TOS/TDOS COBOL With Respect to Required COBOL-61

Environment Division:

- The SOURCE-COMPUTER and OBJECT-COMPUTER paragraphs cannot be copied from the COBOL library.
- The OPTIONAL, RENAMING, and MULTIPLE REEL options of the FILE-CONTROL paragraph are not implemented.

Data Division:

- The record description clauses SIZE, POINT, CLASS, ZERO SUPPRESS, CHECK PROTECT, and FLOAT DOLLAR SIGN are not allowed.
- The JUSTIFIED LEFT option in the record description section is not permitted.
- No Constant Section is permitted.

.143 Extensions of TOS/TDOS COBOL With Respect to Required COBOL-61

- A COBOL debugging language is provided which includes TRACE, EXHIBIT, ON (conditional control), and DEBUG verbs.
- The Source Program Library facility is included to permit the automatic inclusion of catalogued COBOL file descriptions, record descriptions, and procedure statements into the source program at compilation time.
- A TRANSFORM verb is provided to alter characters according to a set transformation rule. The rule is determined by the combination of FROM and TO options that is chosen. The format for the statement is:

$$\underline{\text{TRANSFORM}}\ \text{data-name-3 CHARACTERS}$$

$$\underline{\text{FROM}} \left\{ \begin{matrix} \text{figurative-constant-1} \\ \text{non-numeric-literal-1} \\ \text{data-name-1} \end{matrix} \right\}$$

$$\underline{\text{TO}} \left\{ \begin{matrix} \text{figurative-constant-2} \\ \text{non-numeric-literal-2} \\ \text{data-name-2} \end{matrix} \right\}$$

- Floating-point literals and items (external and internal) are permitted.
- A NO REWIND option is available with the OPEN verb.
- The ADD, SUBTRACT, and MOVE verbs have a CORRESPONDING option that permits selective operation on matching data items only.

(Contd. on page 710:165.145)

.144 COBOL-61 Electives Implemented in TOS/TDOS COBOL (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
1	Formula characters	+, -, *, /, **, =.
2	Semicolon	can be used for punctuation.
3	Relationship characters	=, >, and < are available.
6	Figurative constants	HIGH-VALUE(S), LOW-VALUE(S).
	File Description	
10	Label formats	NONSTANDARD labels are permitted.
	Record Description	
13	Table length	the "DEPENDING ON" option is provided so that lengths of tables and arrays can vary.
21	Label handling	labels may be omitted, or standard or non-standard labels can be used.
	Verbs	
22	COMPUTE	permits algebraic formulas.
24	ENTER	used for linkage to subroutines (not to enter a new language).
25	INCLUDE	library routines can be called (no REPLACING option).
26	USE	non-standard I/O error and label handling routines can be used.
	Verb Options	
27	LOCK	rewound tapes can be locked.
28	MOVE CORRESPONDING*	items can be moved in groups.
29	OPEN REVERSED	tapes can be read backward.
30	ADVANCING	paper advance can be specified.
31	STOP execution	coded message is printed.
32	Formulas	algebraic formulas can be used.
33	Operand size	up to 18 digits.
35	Tests	IF { } IS NOT ZERO form is provided.
36	Implied conditionals	implied operators with implied subjects are permitted.
37	Compound conditionals	ANDs and ORs can be intermixed.
38	Complex conditionals	conditional statements within conditional statements are permitted.
39	Conditional statements' sequence	INVALID KEY can follow imperative statements.
	Environment Division	
43	FILE-CONTROL	library descriptions can be copied.
46	I-O-CONTROL	SAME and APPLY clauses can be used.
	Identification Division	
47	Date-compiled	current date can be printed when program is compiled.
	Special Features	
48	Library	library routines can be called.
49	Segmentation	implemented in nonstandard manner.

.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.
5	Figurative constants	HIGH-BOUND(S), LOW-BOUND(S) not available.
7	Computer-name	no alternative computer names.
	File Description	
8	BLOCK size	no range in block size permitted.
9	FILE CONTAINS	approximate file size cannot be shown.
11	SEQUENCED ON	no list of keys can be given.
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 binary.
16	RANGE IS	value ranges of items cannot be shown.
17	RENAMES	alternate groupings of elementary items cannot be specified.
18	SIGN IS	no separate signs allowed.
19	SIZE clause option	variable length items cannot be specified.
20	Conditional range	a conditional value cannot be a range.
	Verbs	
23	DEFINE	new verbs cannot be defined.
	Verb Options	
34	Relationships	IS UNEQUAL TO, EQUALS, and EXCEEDS are not provided.
	Environment Division	
40	SOURCE-COMPUTER	only "computer name" is allowed.
41	OBJECT-COMPUTER	only "computer name" is allowed.
42	SPECIAL-NAMES	no special-names paragraph is permitted.
44	PRIORITY IS	priorities cannot be assigned to files.
45	I-O CONTROL	library descriptions cannot be used.

.143 Extensions of TOS/TDOS COBOL With Respect to Required COBOL-61 (Contd.)

- An extended Source Program Library facility provides the option of attaching a complete source COBOL program to the calling COBOL program at compilation time.
- Clauses and statements are provided to handle random processing of data stored on direct-access devices. These include: the ORGANIZATION, ACCESS, SYMBOLIC KEY, ACTUAL KEY, and ASSIGN to DIRECT-ACCESS clauses; the RESTRICTED SEARCH OF integer TRACKS option of the APPLY clause; the REWRITE statement; the I-O option of the OPEN statement; and the INVALID KEY option of the READ and WRITE verbs.
- The Report Writing facility is implemented, although with some restrictions. The following clauses are not allowed in the Report Group Description entries: CLASS, POINT, SIGNED, SIZE, USAGE, ZERO SUPPRESS, CHECK, FLOAT SIGN, and the SELECTED option of the SOURCE clause. A PRINT-SWITCH option can inhibit printing of specified report groups.
- The SORT facility is also implemented in a slightly restricted manner, maintaining compatibility with System/360 COBOL F. In the Sort Description (SD) entry, the FILE CONTAINS optional clause is omitted. Also not included are the FROM option of the RELEASE verb and the INTO option of the RETURN verb.

MACHINE ORIENTED LANGUAGE: POS ASSEMBLER

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70 Primary Operating System (POS) Assembler.

.12 Origin: . . . . RCA.

.13 Reference: . . . . RCA Publication 70-00-602.

.14 Description

Providing compatibility with the IBM System/360 at the source language level is a primary objective of RCA in its Spectra 70 Series. A large step toward this goal has been accomplished by providing assembly languages that duplicate those of the System/360.

RCA's Primary Operating System (POS) Assembler for use with the Spectra 70/35, 70/45, and 70/55 Processors offers all of the coding facilities, pseudo-instructions, macro-instructions, and symbolic machine-level instructions that are offered in both the Basic Operating System and Basic Programming Support Assemblers for the System/360. Please refer to Report Section 420:172 for a detailed description of IBM's Basic Operating System/360 assembly language facilities.

The RCA Spectra 70/25 Processor uses a restricted subset of the full instruction set used by the larger processor models. The POS Assembly language used with the 70/25 system provides only for this specialized instruction set, although all other POS Assembly language facilities are provided. The 70/25's POS Assembler translator also utilizes the specialized set of instructions and, therefore, cannot be used with the larger Spectra 70 computer systems. Please consult Report Section 710:121 for a complete list of all Spectra 70 central processor instructions and their associated mnemonic operation codes, including those instructions that are peculiar to the Spectra 70/25.

The POS Assembler functions under control of the Primary Operating System in a minimum environment of 16,384 bytes of core storage. Additional equipment requirements include four magnetic tape units, a card reader, card punch, and printer.

These equipment requirements can be modified as follows:

- The assembler can utilize up to 131,072 bytes of core storage. Increased efficiency in processing macro routines will result. An increased number of symbolic references can also be handled.
- Magnetic tape units can be substituted for the card reader, card punch, and printer.

RCA has provided us with estimated performance timings for the Primary Operating System Assembler as used with the Spectra 70/25, 70/35, 70/45, and 70/55 Processors. The three smaller processors are assumed to utilize 16,384 bytes of core storage, and the 70/55 is assumed to utilize its minimum configuration capacity of 65,536 bytes of core storage. Table I presents the estimated assembly times on the basis of a stated number of milliseconds per assembly language statement or block of statements during each of the Assembler's three passes. Timing variations due to the data transfer rate of the magnetic tape units used during the assembly operation are also shown.

TABLE I: ESTIMATED ASSEMBLY TIMES

Pass Number	Processor Model			
	70/25	70/35	70/45	70/55
I (msec/record):				
Magnetic tape input	66	42	23	11.3
Punched card input	66	42	42	42
II and III (msec/record):				
30KB tape units	3.1	3.1	3.1	3.1
60KB tape units	1.6	1.6	1.6	1.6
120KB tape units	0.8	0.8	0.8	0.8
II and III (Rewind time, msec/7-record block):				
30KB tape units	0.9	0.9	0.9	0.9
60KB tape units	0.6	0.6	0.6	0.6
120KB tape units	0.2	0.2	0.2	0.2
Time Per Macro-Instruction Tape Search:				
30KB tape units	21.8x	21.8x	21.8x	21.8x
60KB tape units	10.9x	10.9x	10.9x	10.9x
120KB tape units	5.45x	5.45x	5.45x	5.45x
Macro Processing (msec/macro)	60	40	20	7

x = number of macro blocks passed to reach desired macro.

MACHINE ORIENTED LANGUAGE: TOS/TDOS ASSEMBLER

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70 TOS/TDOS Assembler.

.12 Origin: . . . . RCA.

.13 Reference: . . . . RCA Publication 70-00-602.

.14 Description

Providing compatibility with the IBM System/360 at the source language level is a primary objective of RCA in its Spectra 70 series. A large step toward this goal has been accomplished by providing assembly languages that duplicate those of the System/360.

RCA provides the TOS/TDOS Assembler for users of Spectra 70/35, 70/45, or 7/55 systems whose programs function under control of the Tape or Tape/Disc Operating System. The TOS/TDOS Assembler offers coding facilities, pseudo-instructions, macro-instructions, and symbolic machine-level instructions that include all provisions found in the IBM System/360 Basic Programming Support and Basic Operating System Tape Assemblers. Please refer to Report Section 420:172 for a detailed description of IBM's Basic Operating System/360 assembly language.

The minimum equipment requirements for use of the RCA Spectra 70 TOS/TDOS Assembler include:

- A 70/35, 70/45, or 70/55 Model E Processor (65,536 bytes of core storage).
- 3 magnetic tape units.
- 1 card reader.
- 1 printer.

These requirements can be modified as follows:

- The assembler can utilize up to 524,288 bytes of core storage. Increased efficiency in processing macro routines will result. An increased number of symbolic references can also be handled.
- Four magnetic tape units are required if macro routines are called from magnetic tape.
- An additional magnetic tape unit is required for use of the source library maintenance option of the Tape or Tape/Disc Operating System.
- Additional magnetic tape units can be substituted for the card reader and printer.

The location of each macro call within the source program can make a significant difference in assembly processing time. RCA recommends that the programmer call all macros at the beginning of his program. In this way a single magnetic tape search suffices to gather all the requested macro routines. Subsequent calls for an identical macro will result in the generation of linkages to the previously called coding.

A comprehensive trace mode option is provided during macro expansion to display all coding generated by each macro call.

RCA has promised that its TOS/TDOS Assembly performance times will be competitive. Final performance figures will not be released until operating system overhead times are known.

.141 Availability

TOS/TDOS Assembly Language: . . . . November 1965.

TOS/TDOS Assembler: August 1966.

OPERATING ENVIRONMENT: PRIMARY OPERATING SYSTEM

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70 Primary Operating System (POS).

.12 Description

The RCA Spectra 70 Primary Operating System (POS) consists of a set of interrelated programming components that form a standard operating and programming environment for Spectra 70/25, 70/35, 70/45, and 70/55 computer systems. A Control System consisting of a Supervisor and a Job Control routine is provided to control and coordinate the execution of all programs.

Two basic programming languages are provided for preparing programs for the Spectra 70/25 through 70/55 systems — the Assembly Macro System language and a procedure-oriented Report Program Generator language. In addition, a COBOL compiler is offered for use on 70/35, 70/45, and 70/55 systems that have a minimum of 32,768 bytes of core storage.

The Primary Operating System's basic unit of program construction and smallest unit of assembly is the "program section." Program sections constitute the output of the Assembly System, the Report Program Generator, or the COBOL compiler. They are produced on punched cards or in card image form on magnetic tape. A single program can consist of several program sections. References between program sections are made possible by means of specially designated external symbols. To bind the program sections together for testing or executing, a Linkage Editor routine is provided which makes use of these external symbols.

The basic unit of execution is the "load module." A load module is a group of related coding that coexists in the processor at a given time. Loads are constructed by binding together program sections (by means of the Linkage Editor routine). A load can also consist of a single-segment program that does not require use of the Linkage Editor routine. Output from the Assembly System or the Linkage Editor can be loaded directly into memory by the POS Program Loader.

The Load Library is maintained on punched cards or magnetic tape. If maintained on magnetic tape, the Load Library can be generated by a Loadable Tape Builder (or Card Blocking) routine, which writes an Initial Program Loader routine (loader bootstrap) at the beginning of the library tape and copies the object programs that follow. The programmer must provide a Supervisor and Program Loader routine in front of the object programs that are to be transcribed to the Load Library tape. The Loadable Tape Builder can also copy these routines. The Load Library thus generated consists of:

- Initial Program Loader.
- Supervisor.
- Program Loader.
- Variable number of object programs.

Most of the Primary Operating System's control routines are contained on the master System Tape supplied by RCA. These control routines are tailored to specific equipment configurations by means of the System Tape Generator routine. Routines are also provided to print information from this tape and to update it.

The minimum general equipment requirements for use of the Primary Operating System's software facilities include:

- A Model C Processor (16,384 bytes).
- 1 input-output typewriter.
- 1 card reader.
- 1 card punch.
- 1 printer.
- 4 magnetic tape units (1 of which must be 9-level).

The Primary Operating System that is specially implemented for use with the Spectra 70/25 computer system has already been released. A limited POS package for use with the 70/35, 70/45 and 70/55 systems will be field-released in June 1966. The complete POS software (except the COBOL compiler) will be released to Spectra 70 customers one month later. POS COBOL will not be available until mid-1967.

.121 Processing Programs

The processing programs provided and controlled by the Primary Operating System include language translators, service programs, and the user's problem programs. Like all programs controlled by POS, the language translators can utilize any of the available supervisory services. The language translators available with the 16K-byte POS include:

- Assembler: Two versions of the POS Assembly System are provided — one for the Spectra 70/25, and one for the 70/35, 70/45, and 70/55. The 70/25 version provides a means of limited program compatibility with the small-scale Spectra 70/15 computer system. The POS Assembler supplied for use by Spectra 70/35, 70/45, and 70/55 systems provides a direct means of program compatibility with the IBM System/360. These two languages are described in Section 710:171.
- Report Program Generator (RPG): Two versions of the RPG are offered for use with the Primary Operating System — one for the Spectra 70/25, and one for the 70/35, 70/45, and 70/55 systems. The 70/25 version provides standard report writing and file maintenance capabilities. The 70/35, 70/45, and 70/55 version offers, in addition, file updating capability and table lookup control. Further information about the RPG is available in Section 710:151.

.121 Processing Programs (Contd.)

Spectra 70/35, 70/45, and 70/55 systems can also use the POS COBOL compiler, provided that a minimum of 32,768 bytes of core storage is available. A POS FORTRAN compiler is not provided at this time.

In addition to the language translators, a number of service programs are included among the processing programs available with the Primary Operating System. These programs can be divided into two general categories, as follows:

The first set of service programs is related to user-generated programs stored on the Program Library Tape (PLT). This set includes the Loadable Tape Builder, the PLT Update, the Initial Program Loader, and the Program Loader.

The second set of routines services those programs provided by RCA and stored on a System Tape. This set includes the System Tape Builder, the System Tape Update, the System Tape Loader, and a set of System Tape service routines for dumping of the System Tape's contents.

The Linkage Editor is a service program whose function is shared by both user and RCA-provided relocatable programs. It performs the following functions:

- Combines separate program sections into one executable program.
- Relocates a program in memory relative to a point specified by the programmer.
- Supplies linkage addresses in a program which refers to other programs.
- Produces an optional memory map showing the starting locations of each program section in a combined program.

The other, more general service programs provided with POS are described in Section 710:151, Problem Oriented Facilities. Routines included in this group of facilities are a Sort/Merge program, data transcription utility routines, and diagnostic routines to aid in program debugging.

.122 Control Programs

The remainder of this report section is devoted to the control programs of the Spectra 70 Primary Operating System. These programs can be logically grouped into two major categories: the Supervisor and the Job Control programs. The many distinct control functions within each category are themselves coordinated by the basic Supervisor routine.

Supervisor: The Supervisor routine is the most important routine of the POS control programs since it controls the execution of all programs. The Supervisor permanently occupies from 3,000 to 6,000 bytes of core storage. It is the programmer's responsibility to ensure that no program overlays the Supervisor in core storage. The following functions are performed by the Supervisor:

- Interrupt analysis and processing.
- Channel scheduling.
- Device error recovery.
- Operator communication.
- Program retrieval.
- End-of-job processing.

All functions, except interrupt processing, are available to user programs through the use of source-level macro linkages. Interrupt conditions are processed by the interrupt analysis and response functions of the Supervisor.

The interrupt analysis function of the POS Supervisor determines the cause of each interrupt and activates the appropriate interrupt response routine. Interrupt response coding for all input-output interrupts is supplied by RCA, but the programmer must supply the interrupt response coding for most other interrupt conditions. The channel scheduling function of the Supervisor is made up of several subroutines that actually transfer data between core storage and the I/O devices. The specific functions of the Channel scheduling routines are the following:

- Scheduling I/O requests on each data channel.
- Starting I/O device operations.
- Processing I/O interrupts.

The scheduling of input-output requests is performed on a first-come, first-served basis. Separate queues are maintained for each Selector Channel to which more than one device is connected. The Supervisor's Channel Scheduler also detects wrong-length records, end-of-file conditions, and peripheral device status conditions.

There are two ways that a program can effect input-output operations: by directly issuing physical I/O macros, or by using the automatic input-output control facilities of the Supervisor's File Control Processor (FCP). In the latter case, the programmer is supplied the routines for all record blocking and deblocking, data movement to work areas, and tape unit alternation. Common provisions available for either mode of operation include the reading and writing of data, processing of standard labels, generating checkpoint records for program restart operations, error condition processing, and all non-data operations (rewind, stacker select, etc.). Core storage requirements for the File Control Processor range from 4K to 6K bytes of permanently allocated storage.

The Supervisor provides a specific device error recovery routine for each type of peripheral device. If standard error recovery is not possible or not desired, the programmer can choose to bypass a record, ignore the error on the record, attempt to correct the error with his own coding, terminate the job, or issue a console typewriter message if operator assistance is required.

Job Control: The Job Control program provides the linkage between processing jobs to ensure that the Primary Operating System and its supervised problem programs operate in a continuous mode. The Job Control program resides on the POS System Tape. It can be called from the input job stream into a 4K-byte area of core storage by the Supervisor at the conclusion of a job to provide transition to the next processing step. The principal specific functions of the Job Control Program include the following:

- To prepare a program for execution by transferring it to the Supervisor's System Loader.

(Contd.)

.122 Control Programs (Contd.)

- To read and store standard label information for later use by the problem program.
- To assign symbolic names to input-output devices, permitting actual device assignment to be changed at program execution time.
- To set up a communication region containing program name, current date, user's program switches, and current machine configuration, for use by both the Supervisor and the user's problem program.
- To restart a job from a specified checkpoint by repositioning tape drives, reassigning I/O devices, and calling in the Supervisor's restart program.

.13 Availability

Spectra 70/25 POS: . . . currently in use.
Spectra 70/35, 70/45, 70/55 POS: . . . . July 1966.

.14 Originator: . . . . RCA.

.15 Maintainer: . . . . RCA.

.16 First Use: . . . . February 1966 (70/25 POS).

.2 PROGRAM LOADING

.21 Source Programs

.211 Programs for on-line libraries: . . . . core image library and relocatable program library on tape.

.212 Independent programs: loaded at execution time by Job Control cards from punched cards or tape.

.213 Data: . . . . as required by users' programs.

.214 Master routines: . . . . in core image form on resident tape file.

.22 Library Subroutines: . . macro-routines can be called from an on-line tape by macro-instructions at assembly time.

.23 Loading Sequence: . . . determined by sequence of Job Control cards in the input stream at program execution time, or by program calls embedded in the problem program.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . must be incorporated in user's program; system loader of Supervisor will perform overlays if so directed.

.312 Occupation of working storage: . . . . storage is allocated in a fixed fashion by the Linkage Editor prior to program load; overlay areas are also set aside at that time.

.32 Input-Output Units

.321 Initial assignment: . . . programmer names symbolic device; Job Control cards assign devices to the symbolic names at execution time.

.322 Alternation: . . . . prepared by Job Control statements; made operational by direct request of user's program.

.323 Reassignment: . . . . . . effected by Job Control cards if job is aborted prematurely.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: controlled by Channel Scheduler routines of Supervisor.

.42 Multiprogramming: . . concurrent Peripheral Program is the only available form of multiprogramming (see Section 710:151).

.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	Linkage Editor message.
In-out error - single:	check	interrupt routine.
In-out error - persistent:	check	interrupt routine.
Storage overflow:	check	interrupt routine.
Invalid instructions:	check	interrupt routine.
Arithmetic overflow:	check	interrupt routine.
Invalid operation:	check	interrupt routine.
Improper format:	check	interrupt routine.
Invalid address:	check	interrupt routine.
Reference to forbidden area of core memory:	check	interrupt routine.

.45 Restarts: . . . . Supervisor checkpoint routine writes checkpoint program status records when directed; a Job Control statement directs the restart routine to begin at a specific checkpoint.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . provided through use of utility routines that must reside in core storage with problem program.

.512 Snapshots: . . . . provided through utility routines.

.52 Post Mortem: . . . . . . a dump routine can be processed at an abnormal end-of-job occurrence, listing contents of core storage and general registers.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . . Supervisor-call interuption.

.612 Action required by operator: . . . . . . Supervisor-call.

.613 Reporting progress of run: . . . . Supervisor-call.

.62 Operator's Decisions: through Spectra 70 console or I/O typewriter.

.63 Operator's Signals

.631 Inquiry: . . . . through Spectra 70 console or I/O typewriter.

.632 Change of normal progress: . . . . indicated by coded messages on console or I/O typewriter.

.7 LOGGING:. . . . . as incorporated in user's program.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: 16,384 bytes of core storage.
1 Selector Channel.
1 I/O typewriter.
1 card reader.
1 card punch.
1 printer.
4 magnetic tape units.

.812 Usable extra facilities: . . . . all, except that the Spectra 70/25 system cannot use random-access devices.

.813 Reserved equipment:. . the first 3,000 to 6,000 bytes of core storage (reserved for resident Supervisor).

.82 System Overhead

.821 Loading time: . . . . . . dependent upon speed of input unit used.

.822 Reloading frequency:. . Supervisor need be loaded only once, but can be reloaded whenever desired through the initial program loading (IPL) procedure.

.83 Program Space Available:. . . . . the core storage that remains in excess of the 3,000 to 6,000 bytes of storage reserved for the Supervisor's control routines and the 4,000 to 6,000 bytes reserved for the File Control Processor (FCP).

.84 Program Loading Time:. . . . . depends upon the speed of the input device used.

.85 Program Performance: no Supervisor performance times have been made available by RCA to date.

OPERATING ENVIRONMENT: TAPE AND TAPE/DISC OPERATING SYSTEM

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70 Tape Operating System (TOS). RCA Spectra 70 Tape/Disc Operating System (TDOS).

.12 Description

The RCA Tape and Tape/Disc Operating System consists of a comprehensive set of control and processing programs integrated within a supervisory network to provide coordinated and continuous operation of the larger Spectra 70 computer systems. A minimum of 65,536 bytes of Spectra 70/35, 70/45, or 70/55 processor core storage is required for utilization of the Tape or Tape/Disc Operating System (TOS/TDOS). Moreover, a minimum of five magnetic tape units are necessary for use of the Tape Operating System (TOS).

The Tape/Disc Operating System (TDOS) offers essentially the same facilities as TOS, but offers in addition increased overall operating efficiency. TDOS uses a 70/564 Disc or 70/565 Drum unit in place of TOS' 9-track magnetic tape unit for storage of the operating system program elements. Since the other facilities of TOS and TDOS are virtually identical, this report section will usually refer in its descriptions to the basic Tape Operating System (TOS) only. The release date of the initial TOS package is August 1966; the full TDOS support is expected to be delivered by March 1967.

.122 Processing Programs

The processing programs provided and controlled by the Tape Operating System include language translators, service programs, and the user's own problem programs.

The language translators, like all programs controlled by TOS, can utilize all available control program services. The currently-announced language translators available with TOS (all of which can operate within 65,536 bytes of core storage) include the following:

- Assembler: a symbolic assembly system with extensive facilities for the use of literals and macro-language. The TOS Assembler provides a means of source-language-level program interchangeability with programs originally written for the IBM System/360. Section 710:172 presents a description of the TOS Assembly language and a comparison of its facilities with those of the various System/360 Assemblers.
- FORTRAN IV: a version of the FORTRAN IV language that generally parallels the facilities offered by IBM in its 200K-byte Operating System/360 FORTRAN IV. However, unlike IBM's FORTRAN IV, TOS FORTRAN offers no facilities for random processing of records stored on direct-access devices. TOS FORTRAN IV is described in Section 710:162, where it is also compared to IBM's Operating System/360 FORTRAN IV.
- COBOL: a version of the COBOL language that generally parallels the facilities offered by IBM in its 44K-byte Operating System/360 COBOL, except that TOS COBOL includes fewer facilities for the use of random-access devices. TOS COBOL is described in Section 710:165.
- Report Program Generator (RPG): an RPG that operates under TOS control, offering facilities to perform table-lookup operations, to update files, and to insert routines written in other source languages. The facility to accept input data from random-access storage devices will also be provided. See Section 710:152 for a detailed description of the RPG for the Tape Operating System.

In addition to the language translators, a number of service programs are included among the processing programs available with TOS.

The most noteworthy of these service programs is the Linkage Editor, a sort of intermediate assembler. The principal function of the Linkage Editor is the combining of separately assembled or compiled "program sections" of a program into a format suitable for loading and execution under control of TOS. Programming of individual control sections thus becomes feasible, and errors in one segment will not necessitate recompilation of the entire program.

The other service programs provided by the Tape Operating System are described in Section 710:152, Problem Oriented Facilities. Routines included in this group of TOS facilities are a Sort/Merge Generator, program debugging aids, data transcription routines, and file maintenance routines.

.123 Control Programs

The remainder of this report section is devoted to the Control System of the Tape Operating System. These programs can be logically grouped into three major categores: Executive, File Control Processor, and Monitor.

Executive: The Executive is the central control routine of TOS. Permanently resident in approximately 16,000 bytes of core storage, it is responsible for complete control of the computer's internal environment and associated peripheral devices. Control of the internal environment includes such functions as memory allocation, interrupt analysis and control, check-point recording, control of programs in test status, and multiprogramming control. Peripheral device control functions include device assignment, channel scheduling of I/O operations, console typewriter control, and error recovery procedures.

.123 Control Programs (Contd.)

The Executive uses and maintains a set of dynamically controlled program status lists in performing its multiprogramming and device processing functions. Each program initiated in a multiprogramming environment is allocated a portion of core storage in 2, 048-byte blocks; each program is also assigned a priority number ranging from one to six. The highest-priority program receives processing control first, and control is not passed to the program with the next lower priority until the higher-priority program temporarily relinquishes central processor time. This relinquishment takes place when a program is unable to continue processing because of the necessity to wait for completion of a peripheral operation. For this reason, the best balance of program operation in the multiprogramming environment can be obtained by assigning input/output-limited programs the higher priorities.

Monitor: The TOS Monitor is a logical part of the TOS Executive Control System. The Monitor program maintains complete control over the job input stream and the system's output data, and performs all necessary functions, when passing from the completion of one job to the initiation of the next.

A job input stream can consist of control statements, program parameters, source language statements, and/or relocatable and loadable object program modules. The control statements are used by the Monitor to identify the job process (problem program) to be executed, indicate the Monitor-controlled devices to be assigned, and specify the control options to be exercised. Processing of the total input job stream is referred to as a "Monitor session."

TOS requires that all program preparation be performed under Monitor control. Program preparation steps include language translation, linkage editing, and library maintenance of both the object module and the load libraries. In addition to its use in program preparation operations, the Monitor can also be used as a debugging tool. The program being executed can specify that program dump or patch operations shall be performed under Monitor control. These debugging routines can be requested and specified by appropriate control statements in the input job stream.

When using the Monitor program in the TOS multiprogramming environment, the Monitor is considered as one of the six programs that can run concurrently. The TOS Monitor is called into core storage from the TOS System Tape (or from a random-access device in TDOS) only as required for use. The Monitor occupies approximately 4,000 bytes of core storage.

File Control Processor: The File Control Processor (FCP) is the control system responsible for input-output operations. The programmer has the choice of working exclusively at the logical file control level by using the FCP control routines or, alternatively, at the lower physical device control level by coding in detail complete input-output device control routines. Logical file control is provided via input-output macros included in the program's source language input. The programmer who uses the automatic facilities of FCP need not be concerned with the physical reading and writing of files. If FCP is utilized, the selected routines — other than those concerned with opening and closing files — reside permanently in core storage.

Memory requirements for the principal Tape Operating System control functions are:

- 16K bytes for the Executive.
- 4K bytes for the Monitor.
- 2K to 8K bytes for the File Control Processor.

.13 Availability

Tape Operating System —
Without random-access capability: . . . . . . August 1966.
Random-access capability: . . . . . . October 1966.
Tape/Disc Operating System —
Executive: . . . . November 1966.
Assembler and utilities: . . . . January 1967.
Data communications control: . . . . March 1967.

.14 Originator: . . . . RCA.

.15 Maintainer: . . . . RCA.

.2 PROGRAM LOADING

.21 Source Programs

.211 Programs for on-line libraries: . . . . core image library and relocatable program library on tape or, in the case of TDOS, disc file.

.212 Independent programs: loaded at execution time by Job Control cards from punched cards, tape, or, in the case of TDOS, disc storage.

.213 Data: . . . . as required by users' programs.

.214 Master routines: . . . . in core image form on resident tape (TOS) or disc file (TDOS).

.22 Library Subroutines: . macro-routines can be called from an on-line tape or disc library by macro-instructions at assembly time; or the macro-routines can be included in the source deck.

.23 Loading Sequence: . . . determined by sequence of Job Control cards in the input stream at program execution time, or by program calls embedded in the problem program.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . must be incorporated in user's program; system loader of Executive program will perform overlays if so directed.

(Contd.)

.312 Occupation of working storage: . . . . storage is allocated in a fixed fashion by the Linkage Editor prior to program load; overlay areas are also set aside at that time.

.32 Input-Output Units

.321 Initial assignment: . . . programmer names symbolic device; Job Control cards assign devices to the symbolic names at execution time.

.322 Alternation: . . . . prepared by Job Control statements; made operational by direct request of user's program.

.323 Reassignment:. . . . . . effected by Job Control cards if job is aborted prematurely.

.4 RUNNING SUPERVISION

.41 Simultaneous Working: controlled by Channel Scheduler routines of the Executive.

.42 Multiprogramming: . . regulated by the Executive.

.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	Linkage Editor message.
In-out error — single:	check	interrupt routine.
In-out error — persistent:	check	interrupt routine.
Storage overflow:	check	interrupt routine.
Invalid instructions:	check	interrupt routine.
Arithmetic overflow:	check	interrupt routine.
Invalid operation:	check	interrupt routine.
Improper format:	check	interrupt routine.
Invalid address:	check	interrupt routine.
Reference to forbidden area of core memory:	check	interrupt routine.

.45 Restarts: . . . . Executive's checkpoint routine writes checkpoint program status records when directed; a Job Control statement directs the restart routine to begin at a specific checkpoint.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing:. . . . . provided through use of AIDS routines that reside in core storage with problem program (Section 710:152).

.512 Snapshots: . . . . provided through AIDS or Monitor routines.

.52 Post Mortem: . . . . . . a special dump routine is processed at any abnormal end-of-job occurrence.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . . Executive-call interruption.

.612 Action required by operator: . . . . . . Executive-call.

.613 Reporting progress of run: . . . . Executive-call.

.62 Operator's Decisions:. through Spectra 70 console or I/O Typewriter.

.63 Operator's Signals

.631 Inquiry: . . . . through Spectra 70 console or I/O Typewriter.

.632 Change of normal progress: . . . . indicated by coded messages on console or I/O Typewriter.

.7 LOGGING: . . . . as incorporated in user's program.

.8 PERFORMANCE

.81 System Requirements

.811 Minimum configuration: . . . . . 65,536 bytes of core storage.
5 magnetic tape units.*
1 card reader.
1 printer.
1 I/O Typewriter.
1 Selector Channel.

.812 Usable extra facilities: . . . . all (as incorporated in program).

.813 Reserved equipment: . approximately the first 16,000 bytes of core storage (reserved for resident Executive).

.82 System Overhead

.821 Loading time: . . . . . . dependent upon speed of input unit used.

.822 Reloading frequency: . Executive need be loaded only once, but can be reloaded whenever desired through the initial program loading (IPL) procedure.

.83 Program Space Available:. . . . . the core storage that remains in excess of the 16K bytes of storage reserved for the Executive control routines and the 2K to 8K bytes reserved for the File Control Processor (FCP).

.84 Program Loading Time: . . . . depends upon the speed of the input device used.

.85 Program Performance:. . . . . no Executive or Monitor performance times have been made available by RCA to date.

* In the Tape/Disc Operating System, one random-access device is substituted for the magnetic tape unit that is used as the System Tape in the Tape Operating System.

OPERATING ENVIRONMENT: DISC OPERATING SYSTEM

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70 Disc Operating System (DOS).

.12 Description

The RCA Spectra 70 Disc Operating System (DOS) was originally announced as a large-scale, disc-oriented, integrated operating system that would include all of the extensive control and processing facilities offered in the IBM Operating System/360 package. Among the promised capabilities were automatic control of data communications, real-time, and multiprocessor systems, all in a dynamic multiprogramming environment.

Just prior to the publication of this report, RCA informed us of a change in direction and scope for its Spectra 70 Disc Operating System. Compatibility with IBM's Operating System/360 is no longer a primary design objective. RCA now plans for DOS to be an integrated software system designed to control remote time-sharing operations. The revamped plans for DOS are currently undergoing evaluation and modification, so the ultimate form and content of DOS are presently undetermined.

It is probable that a new member of the Spectra 70 family of computer systems will be announced for use exclusively as a time-sharing system. The Disc Operating System software would then take on a highly specialized form usable only with the specially-adapted hardware, and not with any of the currently available Spectra 70 systems. RCA offers no scheduled completion date for the Spectra 70 DOS software.

SYSTEM PERFORMANCE

The overall performance of RCA Spectra 70 systems naturally varies widely, depending upon the user's choice of processor model and peripheral equipment. Therefore, the performance of the Spectra 70 line on the AUERBACH Standard EDP Reports benchmark measures of system performance has been analyzed separately for 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:

Spectra 70/15: .... Section 712:201

Spectra 70/25: .... Section 713:201

Spectra 70/35: .... Section 714:201

Spectra 70/45: .... Section 715:201

Spectra 70/55: .... Section 716:201

PHYSICAL CHARACTERISTICS

Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
Processor 70/15 A, B	50	25	62	600	1.01	3,400
Processor 70/25 C, D, E	99	25	62	1,200	1.82(C) 2.17(D) 2.53(E)	5,560(C) 7,150(D) 8,500(E)
Processor 70/35 C, D, E	104	25	62	1,900	3.0(C) 3.0(D) 3.3(E)	10,200(C) 10,200(D) 11,230(E)
Processor 70/45 C, D, E	104	25	62	1,900	5.45(C) 5.45(D) 5.68(E)	17,600(C) 17,600(D) 18,400(E)
Processor 70/45 F	128	25	62	2,300	6.62(F)	21,500(F)
Processor 70/45 G	178	25	62	3,300	8.45(G)	27,400(G)
Processor 70/55 E, F, G	120	25	62	3,500	12.0(E) 13.0(F) 17.0(G)	33,000(E) 36,000(F) 44,000(G)
Processor 70/55 H	169	25	62	4,500	34.0(H)	95,000(H)
Console 70/97:						
Typewriter table	35	32	38	35	0.32	1,020
Operator table	60	18	30	60	—	—
Standard Interface Switch 70/310-2	24	24	62	250	1.85	1,700
Random Access Controller 70/551	50	25	62	600	0.47	1,260
Disk Pack 70/563	15 (dia.)	—	4	10	—	—
Disk Storage Unit 70/564	30	24	38	390	0.75	2,000
Data Drum Memory 70/565-12:						
One drum	50	25	62	400	1.8	5,000
Two drums	50	25	62	580	2.3	6,300
Data Drum Memory 70/565-13:						
Three drums	50	25	62	950	2.8	7,650
Four drums	50	25	62	1,120	3.4	9,300
Mass Storage Unit 70/568-11	72	30	61	2,400	10.0	25,600
Card Punch 70/234	39	30	47	700	1.65	3,500
Card Punch 70/236	39	30	47	800	1.65	3,500
Card Reader 70/237	60	30	44	950	4.71	12,800
Input/Output Typewriter 70/216	19	19	43	40	0.22	300
Paper Tape Reader/ Punch 70/221	25	28	62	250	0.61	1,700
Printer, Medium Speed 70/242-10	50	30	50	1,500	2.9	8,550
Printer, Medium Speed 70/242-20	50	30	50	1,500	3.2	?
Printer, Hi-Speed 70/243-10	50	30	45	1,500	2.9	8,550
Printer, Hi-Speed 70/243-20	50	30	45	1,500	3.2	9,500
Bill Feed Printer 70/248	67	32	54	1,600	2.1	5,100
Bill Feed Printer Control 70/249	50	25	62	500	3.4	9,200

Unit	Width, inches	Depth, inches	Height, inches	Weight, pounds	Power, KVA	BTU per hr.
Magnetic Tape Unit 70/432-1	50	25	62	650	3.0	5,100(S) 8,200(O)
Magnetic Tape Unit 70/432-2	50	25	62	650	4.15	5,100(S) 11,000(O)
Magnetic Tape Unit 70/442-1	50	25	62	650	3.0	5,100(S) 8,200(O)
Magnetic Tape Unit 70/442-2	50	25	62	650	4.15	5,100(S) 11,000(O)
Magnetic Tape Station 70/445-1, -2	30	25	62	1,300	5.7	8,200(S) 9,550(O)
Tape Controller — Single Channel 70/472-108, -116	50	25	62	500	0.6	1,700
Tape Controller — Dual Channel 70/472-208, -216	75	25	62	750	1.20	3,400
Videoscan Document Reader 70/251	89	30	44	1,100	?	?
Data Exchange Control (DXC) 70/627	?	?	?	?	?	?
Communication Control — Single Channel* 70/652-25, -26	—	—	—	—	—	270
Communication Control — Single Channel 70/653-25, -26, -34	27	25	62	440	1.2	3,000
Communication Control — Multichannel 70/668	54	25	62	660 (plus buffers)	1.89 (plus buffers)	6,450 (plus buffers)
Telegraph Buffer 70/710**	—	—	—	9	0.04	140
ADS Buffer 70/720**	—	—	—	6	0.05	170
SDS Buffer 70/721**	—	—	—	12	0.05	170
STR Buffer 70/722**	—	—	—	20	0.11	375
Autodin Mode-I Buffer 70/723**	—	—	—	60	0.22	750
EDGE Demodulator/ Buffer 70/724**	—	—	—	15	0.05	170
Time Generator/ Buffer 70/780**	—	—	—	36	0.09	310
Video Data Terminal 6050:						
Terminal Rack	25	25	62	300	1.20	3,300
Viewer	15	18	20	60	0.36	1,000
Keyboard	15	10	6	25	—	?
Video Data Interrogator 6051:						
Viewer	15	23	23	50	0.3	1,000
Control Panel	16	10	6	20	—	
Interrogator Control Terminal 6077	75	25	62	1,200	3.0	10,000

* This unit is installed in the 70/15 Processor.
** These units are installed in the 70/668 Communication Control Unit.
O Operating.
S Standby.

General Requirements

Temperature: . . . . 60 to 90°F.
Relative humidity: . . . . 20 to 80%.
Power: . . . . 4-wire, 208-volt, 3-phase, 60 cycles ± 1/2 cycle.

PRICE DATA

CLASS	IDENTITY OF UNIT			PRICES		
	Model No.	Feature No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSORS	70/15-A		Processor (4,096 bytes)	800	32.00	40,000
	70/15-B		Processor (8,192 bytes)	1,000	40.00	50,000
	70/25-C		Processor (16,384 bytes)	1,850	74.00	92,500
	70/25-D		Processor (32,768 bytes)	2,750	110.00	137,500
	70/25-E		Processor (65,536 bytes)	3,950	158.00	197,500
			Features for 70/25 Processors			
		5010	Hi-Speed Selector Channel	75	3.00	3,800
		5011	Selector Channel Expansion Feature	100	4.00	5,000
		5012	Multiplexor Channel	140	5.50	7,000
		5014	Multiplexor Channel Expansion Feature	175	7.00	8,800
	70/35-C		Processor (16,384 bytes)	2,100	82.00	105,000
	70/35-D		Processor (32,768 bytes)	3,000	120.00	150,000
	70/35-E		Processor (65,536 bytes)	4,200	168.00	210,000
			Features for 70/35 Processors			
	70/97		Console	330	13.75	16,550
		5001-35	Memory Protect	125	5.00	6,300
		5002-35	Elapsed Time Clock	50	2.00	2,500
		5003-35	Direct Control	200	8.00	10,000
		5005-35	301 Emulator	400	16.00	20,000
		5006-35	1401 Emulator	325	13.00	16,300
		5030	Selector Channel	175	7.00	8,800
		5031	Selector Channel	275	11.00	13,800
	70/45-C		Processor (16,384 bytes)	3,600	144.00	180,000
	70/45-D		Processor (32,768 bytes)	4,200	168.00	210,000
	70/45-E		Processor (65,536 bytes)	5,400	216.00	270,000
	70/45-F		Processor (131,072 bytes)	7,000	280.00	350,000
	70/45-G		Processor (262,144 bytes)	10,800	432.00	540,000
			Features for 70/45 Processors			
	70/97		Console	330	13.75	16,550
		5001-45	Memory Protect	125	5.00	6,300
		5002-45	Elapsed Time Clock	50	2.00	2,500
		5003-45	Direct Control	200	8.00	10,000
		5005-45	301 Emulator	500	20.00	25,000
		5006-45	1401 Emulator	500	20.00	25,000
		5007-45	501 Emulator	650	26.00	32,500
		5015	Selector Channel	220	8.75	11,000
		5016	Selector Channel	375	15.00	18,800
		5026-45	1410 Emulator	550	22.00	27,500
		5036-45	301/501 Emulator	850	34.00	42,500
		5046-45	1401/1410 Emulator	800	32.00	40,000
	70/55-E		Processor (65,536 bytes)	8,350	334.00	417,500
	70/55-F		Processor (131,072 bytes)	9,950	398.00	497,500
	70/55-G		Processor (262,144 bytes)	13,750	550.00	687,500
	70/55-H		Processor (524,288 bytes)	22,550	902.00	1,127,500
			Features for 70/55 Processors			
	70/97		Console	330	13.75	16,550
		5001-55	Memory Protect	150	6.00	7,500
		5002-55	Elapsed Time Clock	50	2.00	2,500
		5003-55	Direct Control	250	10.00	12,500
		5020	Selector Channel	450	18.00	22,500
		5022	Selector Channel	800	32.00	40,000
		5024	Selector Channel	1,150	46.00	57,500

CLASS	IDENTITY OF UNIT			PRICES		
	Model No.	Feature No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
RANDOM ACCESS STORAGE	70/551		Random Access Controller	525	21.00	26,300
		5501-1	Input/Output Attachment feature for Model 70/564	N/C	N/C	N/C
		5502-1	Input/Output Attachment feature for Model 70/568	175	7.00	8,800
		5503-11	Input/Output Attachment feature for Model 70/565	400	16.00	20,000
		5503-12	Input/Output Attachment feature for Model 70/565	450	18.00	22,500
		5503-14	Input/Output Attachment feature for Model 70/565	500	20.00	25,000
		5511	File Scan Feature	35	1.50	1,800
		5512	Record Overflow Feature	10	.50	500
		5513-2	Multichannel Switch	100	4.00	5,000
	70/563		Disc Pack	15	*	490
	70/564		Disc Storage Unit	575	*	26,300
	70/565-12		Drum Memory	1,500	210.00	75,000
	70/565-13		Drum Memory	2,500	350.00	125,000
	70/568-11		Mass Storage Unit	2,875	230.00	145,000
PUNCHED CARD	70/234-10		Card Punch	450	63.00	22,500
	70/234-11		Card Punch	565	79.00	28,300
		5213	Scored Card Feature	10	1.50	500
	70/236-10		Card Punch	750	105.00	37,500
	70/236-11		Card Punch	865	121.00	43,300
	70/236-20		Card Punch	1,000	140.00	50,000
	70/236-21		Card Punch	1,115	156.00	55,800
		5215	Scored Card Feature	10	1.50	500
	70/237-10		Card Reader	650	91.00	32,500
	70/237-21		Card Mark-Reader	825	115.00	41,300
	70/237-22		Card Mark-Reader	825	115.00	41,300
		5202	51-Column Card Feature	10	1.50	500
		5204	Column Binary Feature	30	4.25	1,500
PAPER TAPE UNITS	70/221-10		Paper Tape Reader/Punch	500	70.00	25,000
	70/221-11		Paper Tape Reader/Punch	525	73.50	26,300
	70/211-20		Paper Tape Reader/Punch	555	77.75	27,800
	70/221-21		Paper Tape Reader/Punch	580	81.25	29,100
		5219-1	Advanced Sprocket 6-Level Read	45	6.25	2,300
PRINTERS	70/242-10		Printer, Medium Speed	700	98.00	35,000
	70/242-20		Printer, Medium Speed	1,000	140.00	50,000
	70/243-10		Printer, Hi-Speed	1,000	140.00	50,000
	70/243-20		Printer, Hi-Speed	1,300	182.00	65,000
	70/248-10		Bill Feed Printer	1,550	*	75,000
	70/248-11		Bill Feed Printer	1,725	*	84,750
		5216	Interchangeable Print Chain	75	*	3,125
	70/249-10		Bill Feed Printer Control	900	36.00	45,000
	70/249-11		Bill Feed Printer Control	1,035	41.50	51,800

* Maintenance prices are subject to contractual arrangements.

(Contd.)

CLASS	IDENTITY OF UNIT			PRICES		
	Model No.	Feature No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
MAGNETIC TAPE EQUIPMENT	70/432-1		Magnetic Tape Units	600	84.00	28,200
	70/432-2		Magnetic Tape Units	600	84.00	28,200
		5411-1	Seven-Channel Tape Feature for 70/432-1	N/C	N/C	N/C
		5411-2	Seven-Channel Tape Feature for 70/432-2	N/C	N/C	N/C
	70/442-1		Magnetic Tape Units	900	126.00	42,300
	70/442-2		Magnetic Tape Units	900	126.00	42,300
		5412-1	Seven-Channel Tape Feature for 70/442-1	N/C	N/C	N/C
		5412-2	Seven-Channel Tape Feature for 70/442-2	N/C	N/C	N/C
	70/445-1		Magnetic Tape Station	775	109.00	36,400
	70/445-2		Magnetic Tape Station	775	109.00	36,400
		5413-1	Seven-Channel Tape Feature for 70/445-1	N/C	N/C	N/C
		5413-2	Seven-Channel Tape Feature for 70/445-2	N/C	N/C	N/C
	70/472-108		Tape Controller — Single Channel	700	28.00	35,000
	70/472-116		Tape Controller — Single Channel	1,350	54.00	67,500
	70/472-208		Tape Controller — Dual Channel	975	39.00	48,800
	70/472-216		Tape Controller — Dual Channel	1,750	70.00	87,500
	70/473-108		Tape Controller — Single Channel	750	30.00	37,500
	70/473-116		Tape Controller — Single Channel	1,400	56.00	70,000
	70/473-208		Tape Controller — Dual Channel	1,050	42.00	52,600
	70/473-216		Tape Controller — Dual Channel	1,825	73.00	91,300
		5402-1	Pack/Unpack Feature for 70/473-108 or -116	50	2.00	2,500
		5402-2	Pack/Unpack Feature for 70/473-208 or -216	85	3.50	4,300
OTHER INPUT-OUTPUT UNITS	70/216		Input/Output Typewriter	180	25.25	9,050
	70/251-10		Videoscan Document Reader	2,700	378.00	126,900
	70/251-21		Videoscan Document-Mark Reader	2,915	408.00	137,000
	70/251-22		Videoscan Document-Mark Reader	2,915	408.00	137,000
	70/251-30		Videoscan Document-Card Reader	2,830	396.00	133,000
	70/251-41		Videoscan Document-Mark-Card Reader	3,000	420.00	141,000
	70/251-42		Videoscan Document-Mark-Card Reader	3,000	420.00	141,000
		5238-2	EBCDIC/Binary Feature	25	3.50	1,200
		5238-3	EBCDIC/Binary Feature	25	3.50	1,200
		5238-4	EBCDIC/Binary Feature	50	7.00	2,400
COMMUNI-CATION CONTROLS	70/627-10		Data Exchange Control	450	18.00	22,500
	70/652-25		Communication Control — Single Channel	100	4.00	5,000
	70/652-26		Communication Control — Single Channel	100	4.00	5,000
	70/653-25		Communication Control — Single Channel	300	12.00	15,000
	70/653-26		Communication Control — Single Channel	300	12.00	15,000
	70/653-34		Communication Control — Single Channel	300	12.00	15,000
	70/668-11		Communication Controller — Multichannel	700	28.00	35,000
	70/668-21		Communication Controller — Multichannel	900	36.00	45,000
	70/668-31		Communication Controller — Multichannel	1,100	44.00	55,000

CLASS	IDENTITY OF UNIT			PRICES		
	Model No.	Feature No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
COMMUNI-CATION BUFFERS	70/710		Telegraph Buffer	27	1.00	1,350
	70/720		ADS Buffer	42	1.75	2,100
		5705	Auto-Call Feature	20	.75	1,000
		5706	Local Operation Feature	N/C	N/C	N/C
	70/721		SDS Buffer	42	1.75	2,100
		5705	Auto-Call Feature	20	.75	1,000
	70/722		STR Buffer	125	5.00	6,300
		5705	Auto-Call Feature	20	75	1,000
	70/723		Autodin Mode I Buffer	200	8.00	10,000
	70/724		EDGE Demodulator/Buffer	50	2.00	2,500
	70/780		Time Generator/Buffer	110	4.50	5,500
TERMINAL EQUIPMENT	5936-1		Teletypewriter (KSR)	70	12.50	1,500
	5940-1		Teletypewriter (ASR)	80	14.50	1,800
	5941-1		Teletypewriter (KSR)	65	10.75	1,300
	5942-1		Teletypewriter (RO)	55	10.00	1,100
	6050-11		Video Data Terminal	275	38.50	11,600
	6050-12		Video Data Terminal	275	38.50	11,600
	6050-13		Video Data Terminal	275	38.50	11,600
		455-1	Station Selector Feature (for Models 6050-11-12-13)	55	7.75	2,400
	6050-21		Video Data Terminal	250	35.00	10,600
	6050-22		Video Data Terminal	250	35.00	10,600
	6050-23		Video Data Terminal	250	35.00	10,600
	6051-1		Video Data Interrogator	45	6.25	1,900
	6051-2		Video Data Interrogator	45	6.25	1,900
	6051-3		Video Data Interrogator	45	6.25	1,900
	6077		Interrogator Control Terminal	1,160	162.00	48,700

SPECTRA 70/15

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INTRODUCTION

The Spectra 70/15 is a small-scale general-purpose computer with a restricted instruction repertoire. Its primary though not exclusive function is to serve either as a satellite system for larger computers or as a remote communications terminal unit. Most peripheral units available for the Spectra 70 series can be connected to the 70/15, with the exception of all random-access devices. (Please refer to the main RCA Spectra 70 report, behind tab 710, for descriptions of the available peripheral devices.) Rentals for typical Spectra 70/15 systems fall between $2, 500 and $5, 000 per month.

The 70/15 was announced in December 1964. The first customer delivery was made during the last quarter of 1965, and the Spectra 70/15 software package was also supplied at this time. Descriptions and representative performance timings of the various software elements are included within this subreport, in Section 712:151.

Every 70/15 system includes a central processor and either 4, 096 or 8, 192 bytes of core storage with a cycle time of two microseconds per byte. Section 712:051 provides a detailed description of the 70/15 Processor's capabilities.

The input-output facilities of the Spectra 70/15 computer system consist of one input-output channel with six subchannels. Each subchannel can control up to 16 peripheral devices. Normal use of the I/O channel prevents operation of the central processor while the channel is in use. However, an auxiliary mode of operation allows either a read or write operation to occur in parallel with central processor operations. Such auxiliary read/write operations are unsupervised by the processor and come to halt only when the input-output data is exhausted or when the I/O device finishes its operation cycle. This mode can be used to advantage by the unbuffered card reader and by the magnetic tape units. Section 712:111 provides details of the demands placed upon the Spectra 70/15 Processor during the operation of the individual peripheral units. A total System Performance analysis is presented in Section 712:201.

The System Configuration section (712:031) shows two typical Spectra 70/15 equipment configurations, including monthly rental prices. Configurations shown are a typical punched-card system and a four-tape business system, arranged according to the standard rules set forth in the Users' Guide, page 4:030.120.

The Spectra 70/15 Software Package has been developed to function with a minimum complement of hardware, including 4, 096 bytes of core storage, an on-line printer, card reader and card punch. The use of magnetic tape units and 8, 192 bytes of core storage expands the power of each entry in the basic software package and reduces inter-job setup time by making available a Program Library Tape. The entries within the software package for the Spectra 70/15 are described in detail in Section 712:151. Included are a two-pass assembly system, an input-output control system, a sort/merge generator, a report program generator, a group of utility routines, a Single-Channel Communications Control System, and a Program Binder that helps to alleviate the restrictions on program size imposed by the 4K or 8K memory size. No compiler for COBOL, FORTRAN, or any other process-oriented language has been announced for the Spectra 70/15.

SYSTEM CONFIGURATION

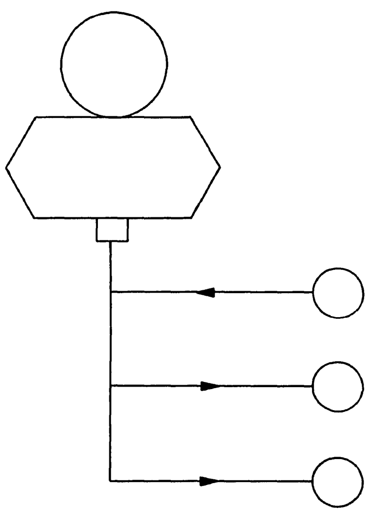
The RCA Spectra 70/15 Processor has only one input-output channel, to which up to six peripheral units or controllers can be connected. Any of the available Spectra 70 peripheral units except the random access devices can be connected to the 70/15, which uses the same standard peripheral interface used by all the Spectra 70 computers.

The 70/216 Input-Output Typewriter, when connected, will use one of the six trunks. (This unit is required for program control purposes whenever the 70/15 is used for running programs other than simple, pre-prepared, "canned" routines.) The other five trunks can be allocated as required among the card and paper tape equipment, printers, communication controls, magnetic tape units, and optical readers available for Spectra 70 systems.

These peripheral units are described in the main Spectra 70 Computer System Report, beginning on page 710:062.100. Their operation in Spectra 70/15 systems is described in the Simultaneous Operations section of this subreport, on page 713:111.100.

.1 TYPICAL CARD SYSTEM; CONFIGURATION I

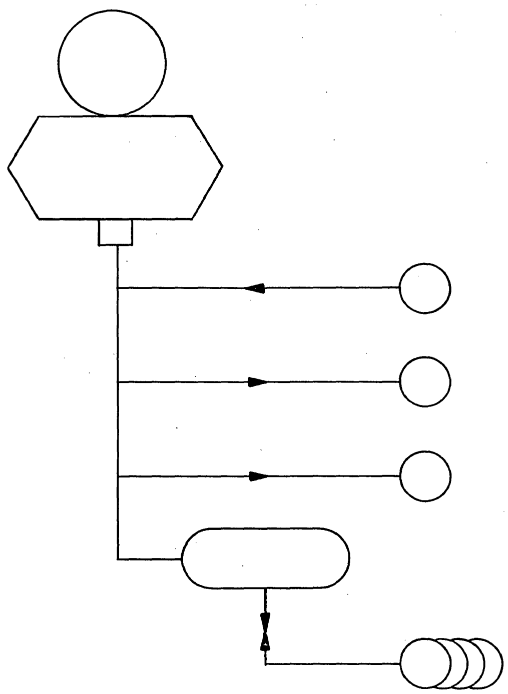
Deviations from Standard Configuration: . . . . card reader is 44% faster.
card punch is 50% faster.
printer is 25% faster.
multiply-divide is not available.
no indexing.



Equipment	Rental
Main Storage (8,192 bytes) 70/15-B Processor (includes one I/O Channel and Read Auxiliary mode)	$1,000
70/237 Card Reader: 1,435 cpm	650
70/236 Card Punch: 300 cpm	750
70/243-1 High-Speed Printer: 1,250 lpm	1,000
TOTAL:	$3,400

.2 4-TAPE BUSINESS SYSTEM; CONFIGURATION II

Deviations from Standard Configuration: . . . . printer is 20% faster.
magnetic tape is 100% faster.
card reader is 187% faster.



Equipment	Rental
Main Storage (8,192 bytes) 70/15-B Processor (includes one I/O Channel and Read Auxiliary Mode)	$1,000
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (4): 30,000 bytes/second	1,200
TOTAL:	$4,700

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70/15 Processor.

.12 Description

The RCA Spectra 70/15 Processor is a simple processor that offers no optional features which can improve its restricted processing capabilities. Decimal and binary add-subtract instructions are included in the 25 instructions which make up the machine code of this system, but there are no multiply or divide instructions in either mode. No radix conversion or code translation instructions are available, but zeros can be automatically suppressed and any characters can be inserted by means of the edit instruction. There are no table look-up facilities.

The instruction format is similar to that of the larger Spectra 70 systems, but because there are no General-Purpose Registers in the Spectra 70/15, many instruction types do not exist (e.g., Register-to-Register or Register-to-Indexed-Storage instructions). The Storage-to-Storage instructions occupy six bytes, as they do in the larger systems, although a smaller instruction size would be possible because of the core storage size limitations that apply to the Spectra 70/15.

Because there are only a restricted number of processor registers as such, some parts of core storage are pre-empted for use by the processor functions. These include the first 50 bytes, which are used for the sequence counters, interrupt control, channel controls, and temporary storage of the condition code and operation code during interrupt processing.

Interruption occurs either when an illegal instruction code is encountered or when an External Request is received from an I/O device. Conditions such as overflow, input-output terminations, machine faults, etc. cannot cause interrupts in the 70/15.

When an interrupt does occur, the sequence register of the main Processing State is saved, along with the condition code, and the Interrupt Control Processing State is entered. Each programmer must provide his own interrupt servicing routines, although software aids are available. The performance of the Spectra 70/15 is governed mainly by the 2-microsecond-per-byte access time for each operand. See Paragraph 712:051.4 for detailed processor speeds. Error-checking facilities in the 70/15 Processor include parity and illegal instruction checks.

.13 Availability: . . . . . 6 to 9 months.

.14 First Delivery

Prototype: . . . . . . December, 1964.
Customer: . . . . . . 4th quarter, 1965.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point — Add-subtract	automatic	binary	1 to 16 bytes.
		automatic	decimal	1 to 31 digits.
	Multiply:	not available.		
	Divide:	not available.		
.212	Floating point:	not available.		
.213	Boolean — AND:	automatic	binary	1 to 256 bytes.
	Inclusive OR:	automatic	binary	1 to 256 bytes.
	Exclusive OR:	automatic	binary	1 to 256 bytes.
.214	Comparison — Numbers:	automatic	decimal	up to 32 digits.
			binary	1 to 256 bytes.
	Absolute:	none.		
	Letters:	automatic		up to 31 digits.

(Contd.)

.214 Comparison (Contd.)

Operation and Variation	Provision	Radix	Size
Mixed:	automatic		up to 31 characters.

Collating sequence: Extended BCD Interchange code only: ASCII is not available.

.215 Code translation: . . . . not available.

.216 Radix conversion: . . . . . not available.

	Provision	Comment
.217 Edit format —		
Alter size:	generally make larger	2 to 256 bytes; can edit multiple fields with one instruction.
Suppress zero:	automatic	
Round off:	none	
Insert point:	automatic	
Insert spaces:	automatic	
Insert fill character:	automatic	
Float character:	none.	
Protection:	none.	

.218 Table look-up: none.

.22 Special Cases of Operands

.221 Negative numbers —
Binary: . . . . 2's complement, unsigned.
Decimal: . . . . . . sign in least significant byte.

.222 Zero —
Binary: . . . . only positive zero.
Decimal: . . . . . . positive or negative zero, treated as equal in Compare Decimal operations.

.223 Operand size determination: . . . . . . defined in the instruction.

.23 Instruction Formats

.231 Instruction structure: 2 + 0, add-to-storage type; using 2 or 3 halfwords, depending on the number of addresses specified.

.232 Instruction layout —

SIX-BYTE INSTRUCTIONS

OP	L_1	L_2	S_1	S_2

Examples:
Binary arithmetic
Decimal arithmetic
Decimal comparison
Packing and unpacking

OP	L	S_1	S_2

Examples:
Data movement
Logical operations (AND, OR, Excl. OR)
Logical comparison
Data editing

OP	T	D	S_1	S_2

Example:
Input/output

FOUR-BYTE INSTRUCTIONS

OP	M	IGN	S_1

Example:
Conditional and unconditional branch

.233 Instruction parts —

Name	Purpose
D:	input-output device number (4 bits).
IGN:	ignored (4 bits).
L:	length of first and/or second operand (8 bits).
L_1:	length of first operand (4 bits).
L_2:	length of second operand (4 bits).
M:	mask to be used (4 bits).
OP:	operation code (8 bits).
S_1:	address of first operand (13 bits).
S_2:	address of second operand (13 bits).
T:	input-output trunk number (4 bits).

.234 Basic address structure: . . . . . 2 + 0; variations in instruction length are due to the use of 2, 1, or no main storage addresses.

.235 Literals: . . . . . . none.

.236 Directly addressed operands —

.2361 Internal storage type: core storage.
Minimum size: . . 1 byte.
Maximum size: . . 256 bytes.
Volume accessible: 8,192 bytes.

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

.237 Address indexing: . none.

.238 Indirect addressing: none.

.239 Stepping: . . . . . . none.

.24 Special Processor Storage: . . . . . all registers (except Normal Mode A and B registers and Auxiliary Mode A register) are held in main core storage areas.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . 2.

.312 Arrangement: . . . 1 P-counter for the Processing State.
1 P-counter for the Interrupt State.

.313 Precedence rule: . . Interrupt State always has priority.

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

.315 Sequence control step size: . . . . halfword.

(Contd.)

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

.33 Interruption

.331 Possible causes —
Program events: . . invalid operation code. (Note: overflow does not cause an interrupt.)
Processor errors: . no interrupt occurs for any processor error.
Others: . . . . requests from console, Data Exchange Control, and Communication Control.
.332 Control by routine: . none.
.333 Operator control: . . none.
.334 Interruption conditions: . . . . (1) Interrupt cause occurs and is recognized. (2) Instruction execution completed.
.335 Interruption process: condition code and sequence counter are stored; new sequence counter is used to restart processing at a fixed location; operation code is stored if interrupt is for invalid operation; Standard Device Byte, trunk number, and device number are stored if interrupt is from an external device.
.336 Control methods: . . not yet defined.

.34 Multiprogramming: . none.

.35 Multi-sequencing: . . none.

.4 PROCESSOR SPEEDS

In DECIMAL operations, execution times are expressed in terms of D, the number of decimal digits in the operand from the user's viewpoint. (From the machine point of view, the actual operand lengths are sometimes different.) D represents the operand length in 4-bit digits, packed 2 digits per 8-bit byte, including the sign digit. Because of the byte structure of the system, the formulas yield accurate times only for even values of D.

In ALPHANUMERIC operations, times are normally expressed in terms of C, the number of alphanumeric characters, occupying one byte position each.

.41 Instruction Times in Microseconds

.411 Fixed point —
Add-subtract: . . . 28 + 3D.
Multiply: . . . . . . none.
Divide: . . . . none.
.412 Floating point: . . . . none.
.413 Additional allowance for —
Indexing: . . . . . . none.
Indirect addressing: none.
Recomplementing: . none.
.414 Control —
Compare: . . . . . . 36 + 3D (decimal). 20 + 6B (logical), where B = bytes compared before equality occurs.
Branch: . . . . 20 (branch). 18 (no branch).
.415 Counter control: . . . none.

.416 Edit: . . . . 20 + 4I + 4F + 6S, where I = number of characters inserted, F = number of fill characters, and S = number of significant decimal digits.
.417 Convert: . . . . none.
.418 Shift: . . . . none.

.42 Processor Performance in Microseconds

.421 For random addresses —

	Fixed point
c = a + b:	58 + 5D.
b = a + b:	38 + 3D.
Sum N items: . . .	(38 + 3D)N.
c = ab:	no multiply instruction.
c = a/b:	no divide instruction.

.422 For arrays of data —
$c_i = a_i + b_j$: . . . . 280 + 7D.
$b_j = a_i + b_j$: . . . . 190 + 3D.
Sum N items: . . . 140 + 3D.
$c = c + a_i b_j$: . . . . no multiply instruction.

.423 Branch based on comparison —
Numeric data: . . . 225 + 3D.
Alphabetic data: . . 225 + 6C.

.424 Switching —
Unchecked: . . . . . 218.
Checked: . . . . . . 342.
List search: . . . . 126 + (156 + 3D)N.

.425 Format control, per character —
Unpack: 5.1
Compose: 21.3

.426 Table look-up, per comparison —
For a match: . . . . 156 + 3D.
For least or greatest: 160 + 3.2D.
For interpolation point: . . . . 156 + 3D.

.427 Bit indicators —
Set bit in separate location: . . . . . 24.
Set bit in pattern: . 26.
Test bit in separate location: . . . . . 46.
Test bit in pattern: 38.

.428 Moving: . . . . 20 + 2D (packed format). 20 + 4B (unpacked format), where B is number of bytes moved.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	condition code set.
Invalid data:	none.	
Invalid operation:	check	interrupt.
Arithmetic error:	none.	
Invalid address:	none.	
Receipt of data:	parity checked	alarm.
Dispatch of data:	parity checked	alarm.

SIMULTANEOUS OPERATIONS

An RCA Spectra 70/15 system can concurrently execute:

- One machine instruction OR one supervised input-output operation; and
- One unsupervised "auxiliary" input or output operation; and
- Up to five buffered input-output operations that have been previously initiated and not yet completed.

The "unsupervised" operations include any read or write operation in which, once the operation has been initiated, the ending of the process is under the control of the peripheral unit rather than the central processor. A Read Tape operation, if unsupervised, will read in all the data in the entire physical tape block, even if this means overwriting program areas. In general, unsupervised input operations will be used only where the size of the input block is clearly defined; a typical example is a punched card read operation.

The buffered peripheral units, which include the card punches and printers, use central processor time only while their buffers are being loaded. During this period they inhibit other functions of the processor entirely.

The unbuffered peripherals, such as the magnetic tape units and communication controls, also inhibit all other functions of the central processor except when they are used for unsupervised input or output operations, as described above.

Most of the available Spectra 70 peripheral units are listed in Table I, with the demand each imposes upon the central processor (i.e., the "interference" or delay imposed upon the central processor program by each input-output operation when the peripheral unit is used in the supervised and, where possible, in the unsupervised mode).

TABLE I. INPUT-OUTPUT DEMANDS UPON THE SPECTRA 70/15 PROCESSOR

Device	Maximum Demands Upon 70/15 Processor	
	Supervised Mode	Unsupervised Mode
70/216 Input-Output Typewriter, 10 cps	100%	-
70/221 Paper Tape Reader/Punch -		
Reading, 200 cps	100%	0.02%
Punching, 100 cps	100%	0.01%
70/234 Buffered Card Punch, 100 cpm	1.6%	0.1 %
70/236 Buffered Card Punch, 300 cpm	5.0%	0.3 %
70/237 Card Reader, 1435 cpm	100%	1.5 %
70/242-1 Printer, 132 columns, 625 lpm, buffered	1.1%	1.1 %
70/242-2 Printer, 160 columns, 625 lpm, buffered	1.3%	1.3 %
70/243-1 Printer, 132 columns, 1250 lpm, buffered	2.2%	2.2 %
70/243-2 Printer, 160 columns, 1250 lpm, buffered	2.7%	2.7 %
70/248 Bill Feed Printer, buffered -		
600 lpm, forms	?	?
400 lpm, cards	?	?
70/432 Magnetic Tape Unit, 30KB/sec	100%	24%
70/442 Magnetic Tape Unit, 60KB/sec	100%	48%
70/445 Magnetic Tape, 120KB/sec	100%	96%
70/251 Videoscan Document Reader, 1300 dpm	100%	?
70/652 Communication Control (Single Channel)	100%	100% *
70/627 Data Exchange Control	100%	100% *

* Only if a transmission rate of 500 KB/sec is attained.

SOFTWARE

Because of their restricted instruction repertoire, different I/O control methods, and limited core storage, Spectra 70/15 systems utilize a unique set of software routines, different from those used by the larger Spectra 70 computer systems. Each entry in the 70/15 software package, excluding the Sort/Merge Generator, is designed to operate with a minimum of 4,096 bytes of core storage and a card reader, printer, and card punch. The Sort/Merge Generator requires an additional 4,096 bytes of core storage (contained in processor Model 70/15B) and three magnetic tape units as its minimum configuration. Other components of the Spectra 70/15 software package can make use of the additional core storage and magnetic tape units, when available, to improve their performance.

All of the Spectra 70/15 software described in the following paragraphs is available now, except for the Single-Channel Communication Control System, which is scheduled for delivery in late 1966.

.1 INPUT-OUTPUT CONTROL SYSTEM (IOCS)

IOCS consists of a set of peripheral device routines to perform read, write, and control functions. Simultaneous processing, error detection, and limited error recovery capabilities are additional features of the IOCS package. Programmer-supplied symbolic references to peripheral devices result in actual device numbers being assigned during loading of the object program.

Use of the 70/15 Input/Output Control System requires a unique control area in core storage for each device used by the problem program. This area contains information that includes the device number, simultaneous or non-simultaneous device operation, the starting and ending address of the I/O area, the address of return for program action if a fault in the device's operation is sensed, and an area for storage of control information upon device termination. If a magnetic tape unit is involved, the parameter area is expanded to include an I/O instruction to be used when re-execution of the tape unit's instruction is needed in error recovery procedures.

The following devices can be handled with Spectra 70/15 IOCS:

70/237 Card Reader.
70/251 Videoscan Document Reader (Demand Feed Mode only).
70/432, 442, 445 Magnetic Tape Units (7- or 9-channel).
70/242, 243 Printers.
70/248 Bill Feed Printer (continuous forms only).
70/234, 236 Card Punches.
70/216 Input-Output Typewriter.
70/221 Paper Tape Reader/Punch.

Four versions of the 70/15 IOCS are supplied, differing in number of facilities offered and, therefore, in resident core memory requirements:

Card version, requiring 408 bytes.
Magnetic Tape version, requiring 936 bytes.
70/25-compatible card version, requiring 440 bytes.
70/25-compatible magnetic tape version, requiring 1,018 bytes.

The approximate time required to initiate an I/O operation by way of 70/15 IOCS is 0.3 millisecond.

.2 PROGRAM BINDER

The Program Binder provides the linkage necessary to allow a set of programs or program segments to operate as logical parts of a larger programming task. Features of the Program Binder include the ability to relocate the address references relative to their originally-assembled locations and to redefine those addresses within each subprogram that refer to another subprogram segment.

.3 ASSEMBLY SYSTEM

The Assembly System for the Spectra 70/15 is a basic two-pass punched card system. Magnetic tape units can optionally be utilized for improved assembly speed and for stacked assembly operations.

All input-output routines are supplied by the Input/Output Control System and are either assembled with the program, linked with the program via the Program Binder, or loaded with the object program at execution time.

Up to 85 symbolic tags can be used when assembling on a 4K-byte 70/15 system, and up to 700 tags when using an 8K-byte system. The time required to assemble a program of 500 statements, using a 70/432 Tape Unit as input to the second pass and using 4K bytes of 70/15 core storage, is approximately 1.5 minutes, according to RCA.

.4 SORT/MERGE GENERATOR

Reference:	RCA Publication 70-15-501.
Record size:	up to 1,024 bytes (8K system, using 3 tape units).
Block size:	up to 2,048 bytes.
Key size:	up to 12 256-byte control fields.
File size:	one or more reels of input records, not to exceed the capacity of a single work tape during stringing operations.
Number of tapes: . . .	up to eight tape units.
Date available:	January 1966.

The RCA 70/15 Sort/Merge Generator includes the following features:

- Up to a 7-way sort or merge.
- Processing of standard Spectra 70 labels.
- Fixed or variable-length input records, in blocked or unblocked form.
- Program checkpoints at the end of each pass to allow for restarts.
- Tape alternation for sort input files, merge input files, and merge output files.

.4 SORT/MERGE GENERATOR (Contd.)

- Own-coding facilities to permit insertion, replacement, and deletion of records during the sort's first pass, last pass, and merge processing.
- Either ascending or descending sorting sequence.
- Individual ordering sequence for each sort key.

The Sort/Merge Generator produces sort or merge programs based on control statements supplied by the programmer. The output of the generator is in standard load card format. Approximate time for sort or merge generation ranges between 2 and 5 minutes.

Representative sort times on a Spectra 70/15 using 8K bytes of core storage and four 60KB tape units, are presented below. A record size of 50 bytes is assumed.

5,000 records: . . . 2.9 minutes.
10,000 records: . . 6.8 minutes.
20,000 records: . . 14.6 minutes.

.5 REPORT PROGRAM GENERATOR

The Report Program Generator (RPG) for the Spectra 70/15 produces object code from source-language statements in a two-pass operation. The first pass consists of six phases, each of which deals with a different logical section of the source program. These phases are:

- Interpretation of Environment Division.
- Generation of input-output calls for file processing routines in the 70/15 I/O Control System.
- Interpretation of data descriptions in the Data Division.
- Interpretation of format descriptions in the Data Division.
- Interpretation of all statements in the Procedure Division.
- Generation of object coding.

The second pass binds the generated object code and all necessary I/O routines into a standard 70/15 object program.

Some of the features of the 70/15 RPG include facilities to specify multiple variations in input fields, up to nine control breaks, multiply and divide operations, truncation and rounding of data, and own-coding routines. When writing a 70/15 RPG program to be executed in an environment of 4K bytes of core storage, the programmer is limited to use of 80 name tags. Up to 400 name tags can be used when coding RPG programs for systems with 8K bytes of core storage.

Compilation times for RPG programs on the 4K-byte minimum Spectra 70/15 card computer system average about 100 statements per minute.

.6 BASIC UTILITY PROGRAMS

In addition to a Multiply/Divide routine, the following loading and diagnostic routines are provided to facilitate Spectra 70/15 operations:

- Absolute Card Loader.
- Relocatable Card Loader.
- Absolute Program Library Tape (PLT) Loader.
- Single and Dual Phase Memory Dumps.
- Tape Edit.
- Card/Tape to Printer.
- Card/Tape to Punch.
- Card to Tape.
- PLT Update.

.7 SINGLE-CHANNEL COMMUNICATION CONTROL SYSTEM

The Single-Channel Communication Control System consists of a set of routines that facilitate reception and transmission of data between a Spectra 70/15 Processor equipped with a 70/652 Communication Control, and another RCA Spectra 70 Processor. The basic system consists of a combined Receive/Transmit routine with comprehensive error-checking capabilities. Options available to the programmer include an Automatic Dialing routine, a Code Translation routine, and an Input/Output Typewriter routine. Minimum memory requirements for the Control System are 3,500 bytes of core storage.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (712:201.100)

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 it is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of varied record sizes in the master file. Standard Problem D increases the amount of computation performed on each transaction. Each problem is estimated for activity factors (ratios of the number of detail records to the number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

In card-oriented Configuration I, the 300-card-per-minute speed of the card punch is the controlling factor under all conditions. In this configuration, both the master and detail files are assigned to the card reader and read using the Auxiliary Mode, which allows overlapping of the card read operations with computation. Buffered units are used for printing and punching.

In Configuration II, the master files are on magnetic tape. The detail file is assigned to the card reader and the report file to the printer. Card reading is performed in the Auxiliary Mode and therefore overlaps processing, tape operations, and printing (which is buffered). Tape reading and writing are performed in the normal mode, which does not overlap processing.

In Problems A, B, C, and D for Configuration II, the printer is the controlling factor at high and moderate activities. In Problems A and C, the master files control at low activity. The central processor controls at low activity in Problem B. In Problem D, where computation is trebled, the central processor controls at low activity and the master file tapes near zero activity. Program space for Configuration II had to be minimized due to core storage size limitations; the block length of master-file records was held to 528 bytes to permit the Generalized File Processing Problems to be performed in the 8,192-byte core storage.

SORTING (712:201.200)

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. The results are shown in Graph 712:201.200.

Graph 712:201.220 shows preliminary timing estimates for the 70/15 Sort/Merge routine supplied by RCA.

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)

	ITEM		CONFIGURATION I		CONFIGURATION II		REFERENCE
1 Input-Output Times	Char/block	(File 1)	80		528		4:200.112
	Records/block	K (File 1)	0.5		6		
	msec/block	File 1 = File 2	42 (File 1); 192 (File 2)		33.6		
		File 3	42		42		
		File 4	79		131		
	msec/switch	File 1 = File 2	0		0		
		File 3	0		0		
		File 4	0		0		
	msec penalty	File 1 = File 2	0.16		1.06		
		File 3	0.16		0.16		
		File 4	0.26		0.26		
2 Central Processor Times	msec/block	a_1	0.22		0.22		4:200.1132
	msec/record	a_2	1.66		1.66		
	msec/detail	b_6	0.76		0.76		
	msec/work	$b_5 + b_9$	17.01		17.01		
	msec/report	$b_7 + b_8$	2.84		2.84		
Standard Problem A at F = 1.0	msec/block for C.P. and dominant column.		C.P.	Punch	C.P.	Printer	4:200.114
		a_1	0.22		0.22		
		a_2K	0.83		9.96		
		a_3K	10.30		123.66		
		File 1: Master In	0.16		25.60		
		File 2: Master Out	0.16	192	25.60		
		File 3: Details	0.08		0.96		
		File 4: Reports	0.13		1.56	786	
		Total	11.88	192	187.56	786	
4 Standard Problem A Space	Unit of measure	(bytes)					4:200.1151
		Std. routines	450		950		
		Fixed	50		50		
		3 (Blocks 1 to 23)	546		546		
		6 (Blocks 24 to 48)	4,572		4,572		
		Files	664		1,480		
		Working	100		100		
		Total	6,382		7,698		

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

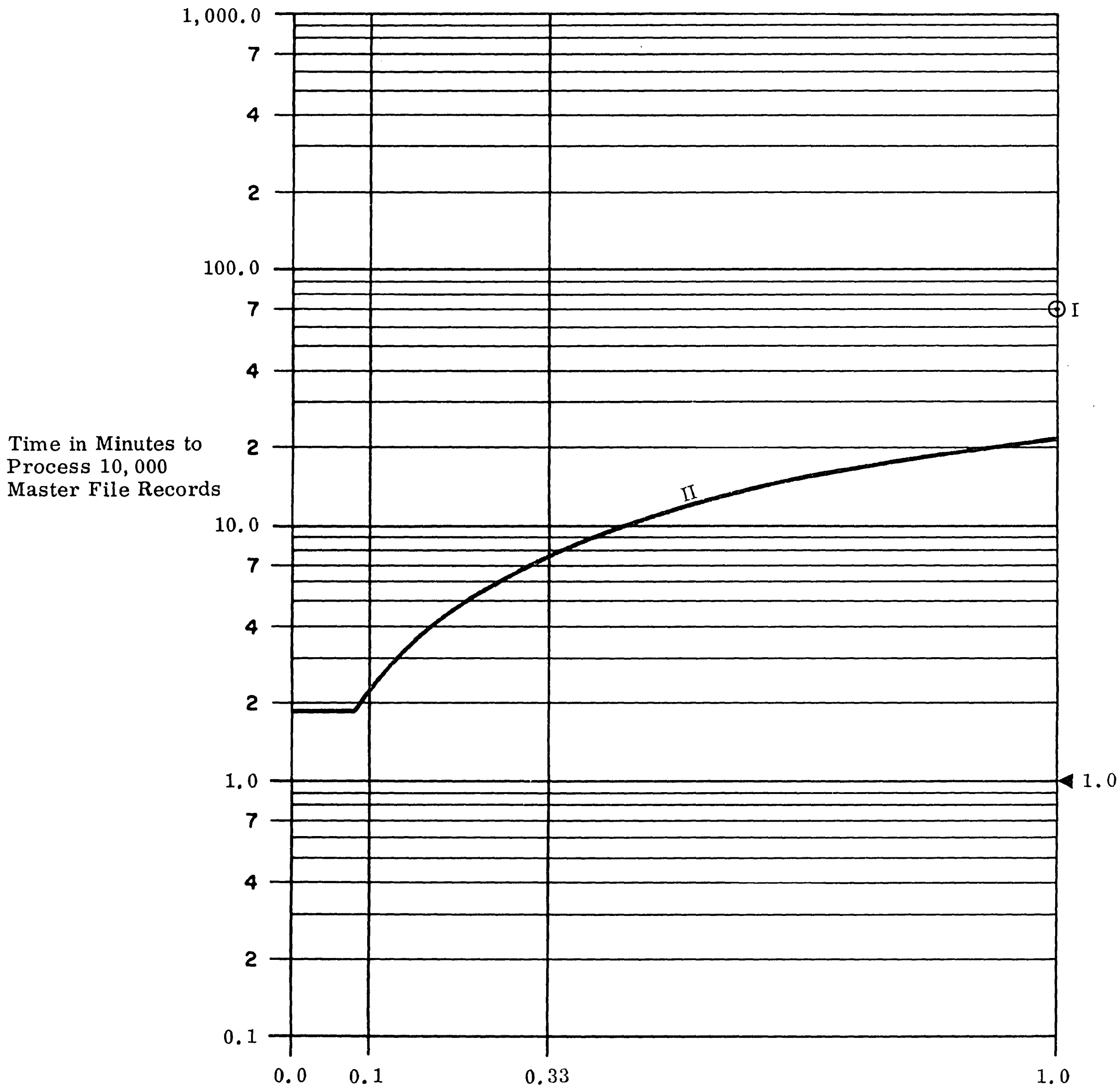
.111 Record sizes —
Master file: . . . . 108 data characters, packed as 88 eight-bit bytes.
Detail file: . . . . 1 card.
Report file: . . . . 1 line.

.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: . . 6,382 bytes.
Configuration II: . . 7,698 bytes.



Activity Factor
Average Number of Detail Records Per Master Record

(Roman numerals denote standard System Configurations.)

.12 Standard File Problem B

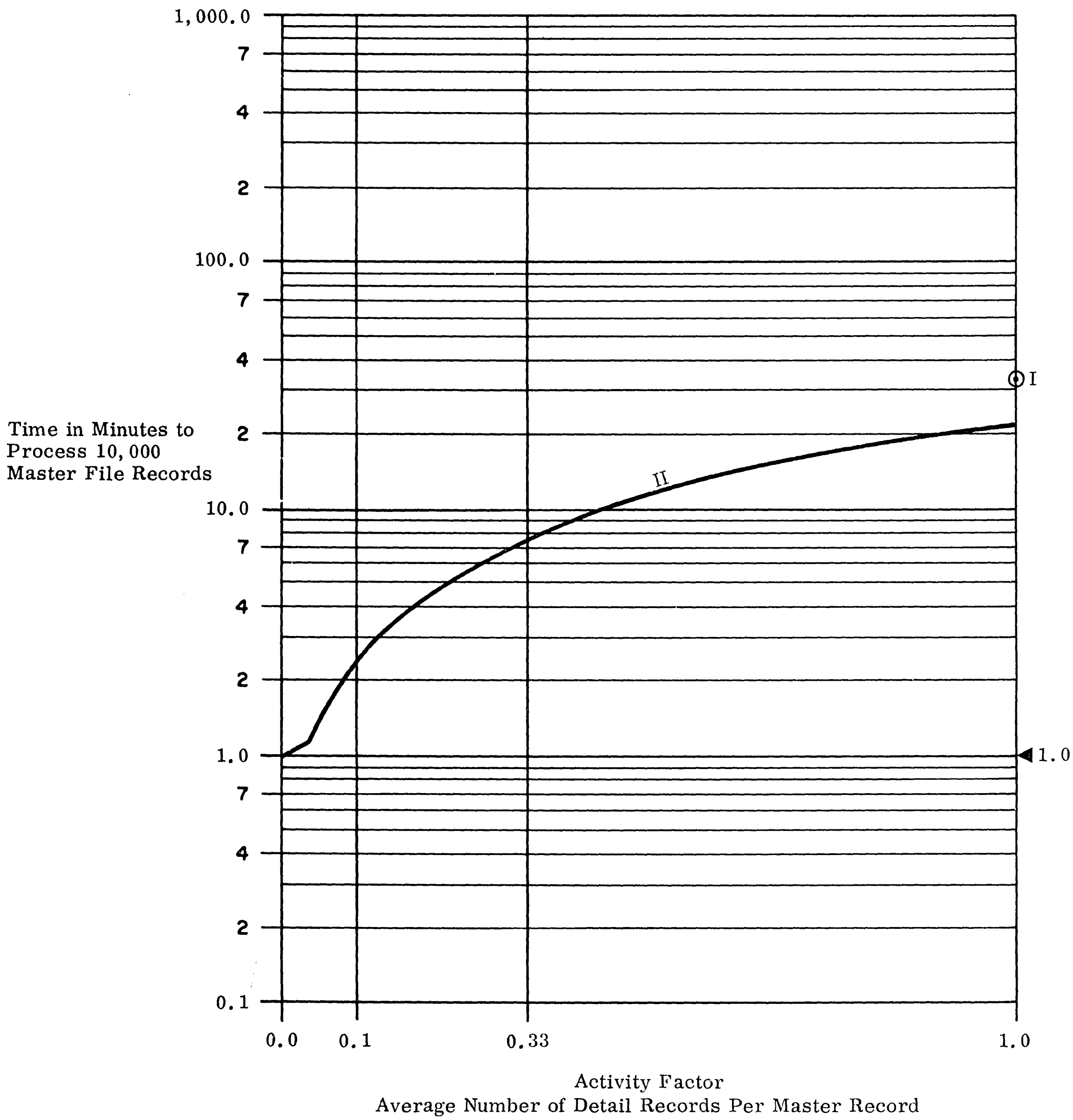
.121 Record sizes —

Master file:	54 data characters, packed as 44 eight-bit bytes.
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.)

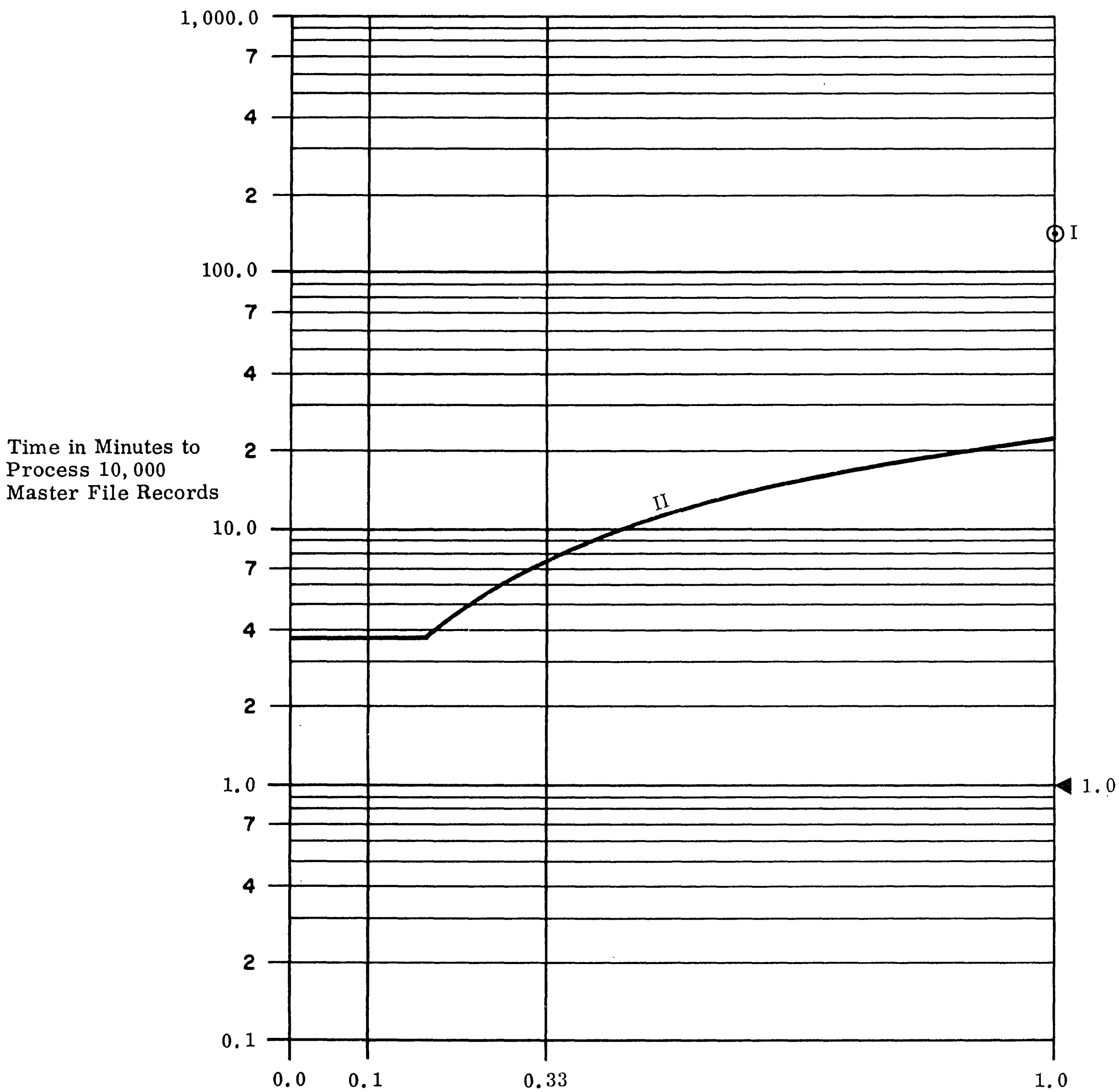
.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . 216 data characters, packed as 176 eight-bit bytes.
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.)

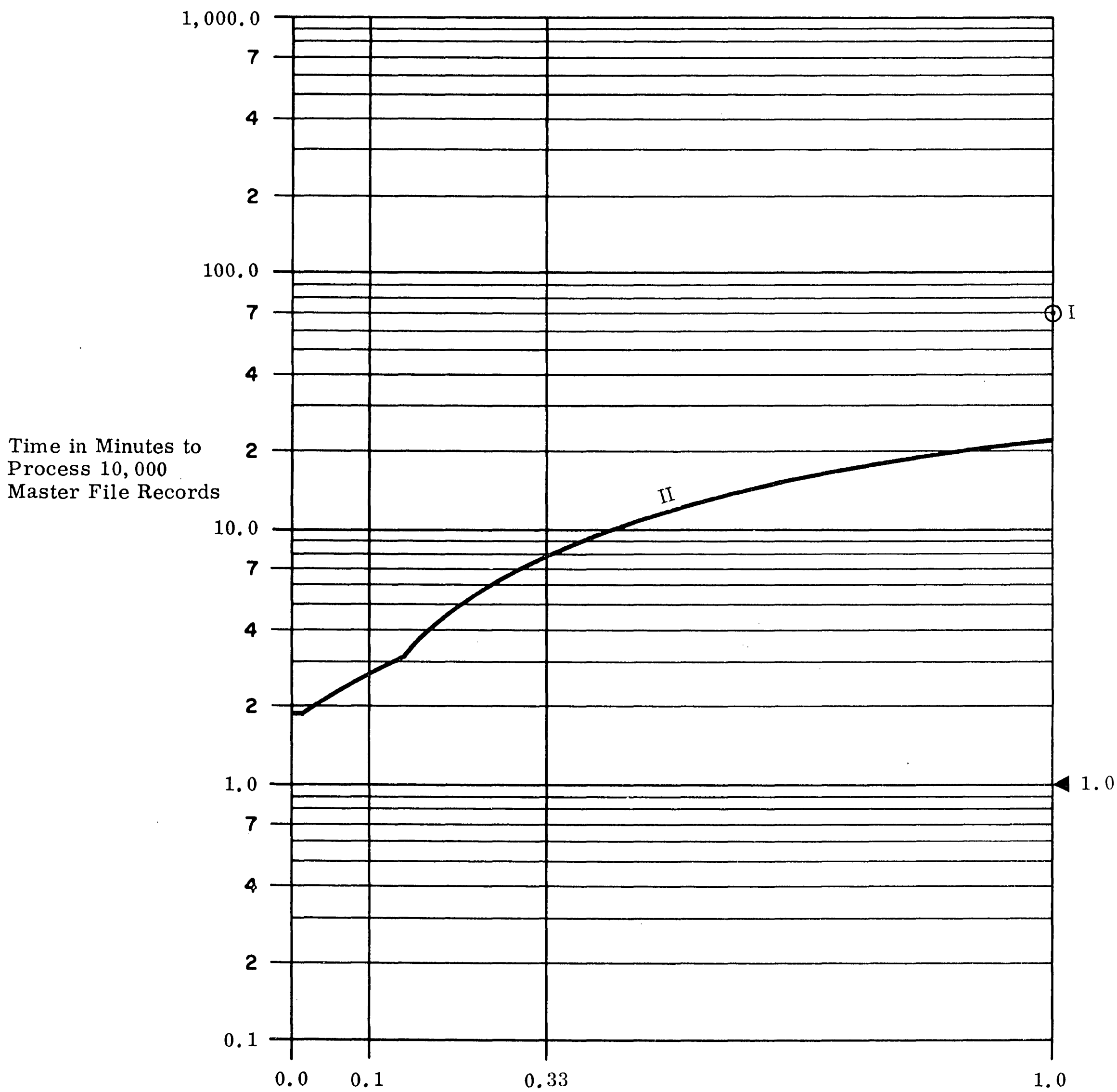
.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . 108 data characters, packed as 88 eight-bit bytes.
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

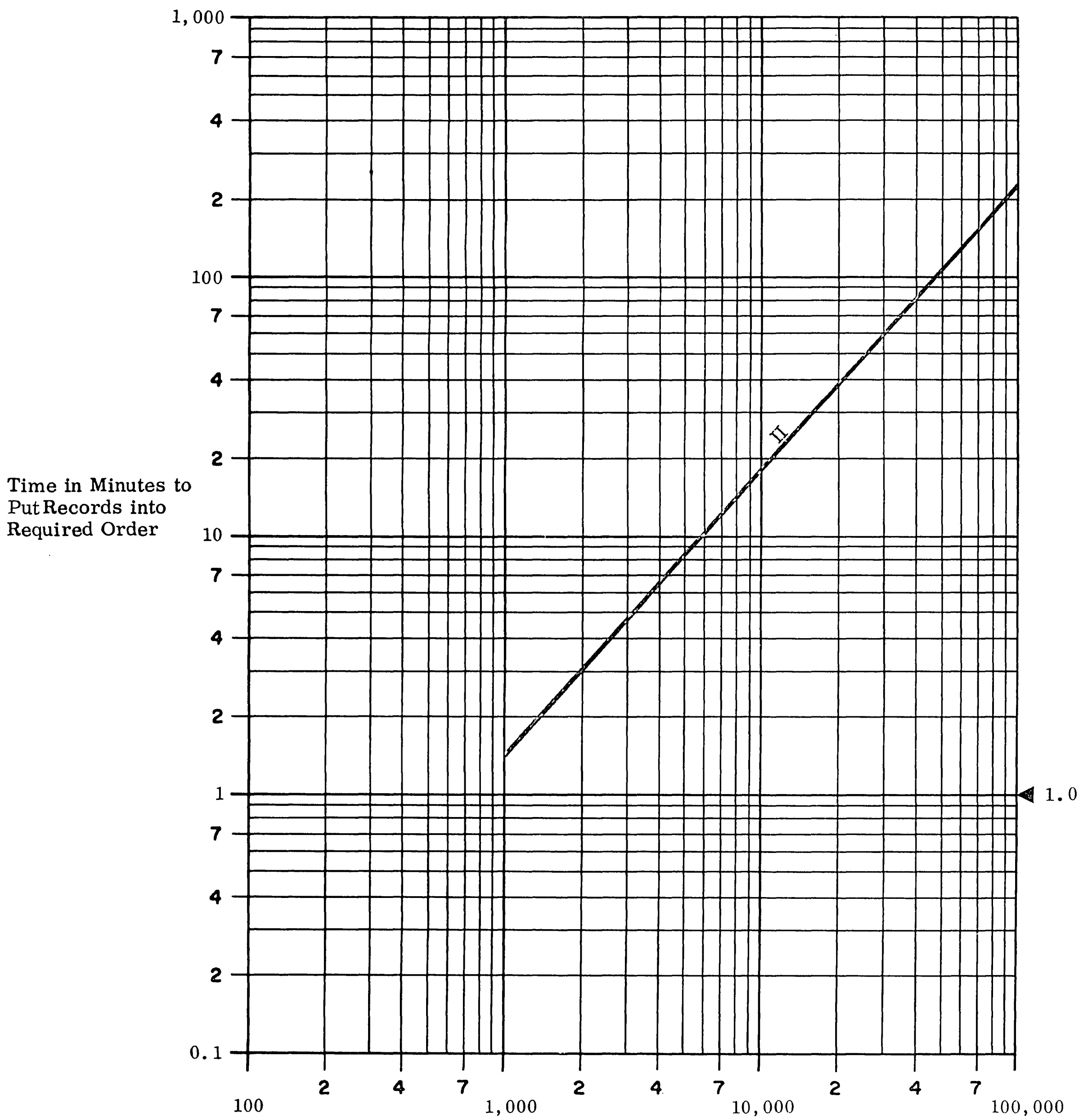
.21 Standard Problem Estimates

.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.)

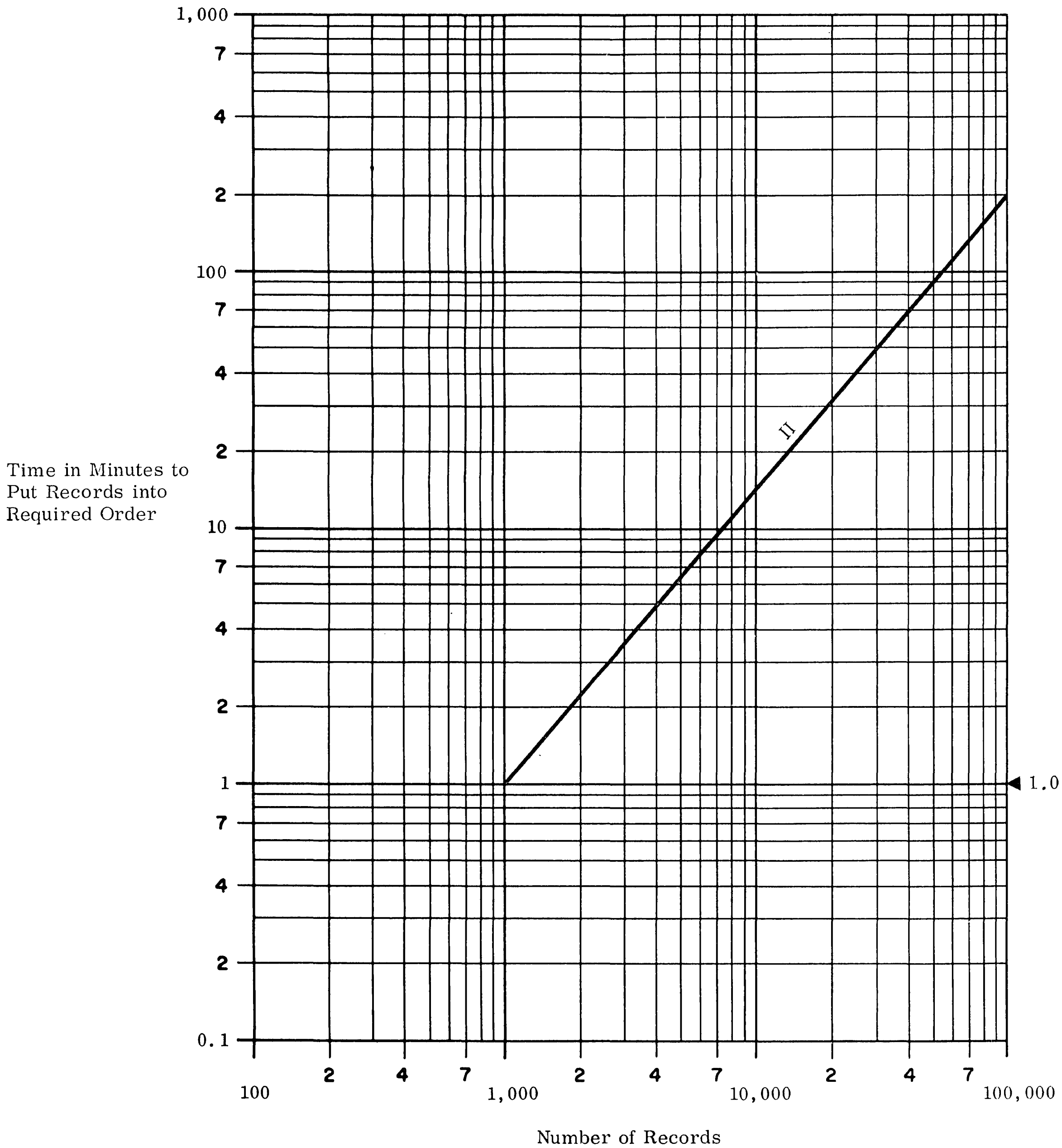
.22 70/15 Sort/Merge Times

.221 Record size: . . . . . 80 bytes each; 10 records per block.

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

.223 Timing basis: . . . . . . assumes four 30KC tape units and 8,192 bytes of core storage.

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



(Roman numerals denote standard System Configurations.)

SPECTRA 70/25

Radio Corporation of America

AUERBACH
STANDARD EDP REPORTS

AUERBACH INFO, INC.

PRINTED IN U. S. A.

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INTRODUCTION

The Spectra 70/25 is a sequential processor that uses parallel input-output channels to obtain overlapped operations. It can be connected to any of the Spectra 70 peripheral units except the random access storage units. The restricted machine instruction repertoire includes decimal add, subtract, multiply, and divide operations; binary add and subtract operations; editing and other data handling operations; logical instructions; 11 decision and control instructions; and 7 I/O instructions. (See the Instruction List, Section 710:121, for details.) No automatic facilities for conversion between binary and decimal radices or for any floating-point operations are included. The processor registers are stored as addressable parts of the main core storage. Interruption facilities are standard.

The 70/25 Processor can contain from 16,384 to 65,536 bytes of core storage. The core cycle time is 1.5 microseconds per four bytes for internal operations. Input-output operations take place one byte at a time, so the effective core cycle for input-output purposes is 1.5 microseconds per byte.

Rentals for typical Spectra 70/25 systems are expected to range from about $4,000 to $8,000 per month for unlimited use.

The Spectra 70/25 software includes an assembly language, a report program generator, and various utility systems, including a communication control system for single-line data communication operations. An operating system based on the same principles as the Primary Operating System (POS) for the larger Spectra 70 computers will be available, and concurrent data transcription operations will be possible where there are at least 32K bytes of core storage. No COBOL, FORTRAN, or other compilers have been announced for the 70/25 to date.

All of the Spectra 70/25 software is designed to work on the 70/25 itself — it is not possible, for instance, to compile a FORTRAN program on the Spectra 70/45 for operation on the Spectra 70/25. In the opposite direction, a Compatibility Support Package is being provided to assist in checking over 70/25 programs so that they can be safely run on the Spectra 70/45 or other larger Spectra 70 systems.

This report concentrates upon the characteristics and performance of the Spectra 70/25 system in particular. All general characteristics of the Spectra 70 hardware are described in Computer System Report 710: RCA Spectra 70 — General.

The System Configuration section which follows shows the Spectra 70/25 in the following standard System Configurations:

- II: 4-Tape Business System
- III: 6-Tape Business System
- IV: 12-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 713:051 provides a detailed description of the central processor capabilities and timings for the Spectra 70/25.

The input-output channel capabilities of the Spectra 70/25, and the demands upon the processor during input-output operations, are described in Section 713:111.

The software that can be used with Spectra 70/25 systems is described in Sections 710:151, 710:171, and 710:191.

The overall performance of any Spectra 70 system is heavily dependent upon the processor model used. A full System Performance analysis of the 70/25 is provided in Section 713:201.

Four input-output Selector Channels and an Elapsed-Time Clock are standard features of the Spectra 70/25. Optional processor features include an input-output Multiplexor Channel, four more Selector Channels, and the option to use two High-Speed Selector Channels. A High-Speed Selector Channel replaces two standard Selector Channels and has a maximum data rate of 500,000 bytes per second, as compared with the 200,000-bytes-per-second rate of each of the replaced channels.

SYSTEM CONFIGURATION

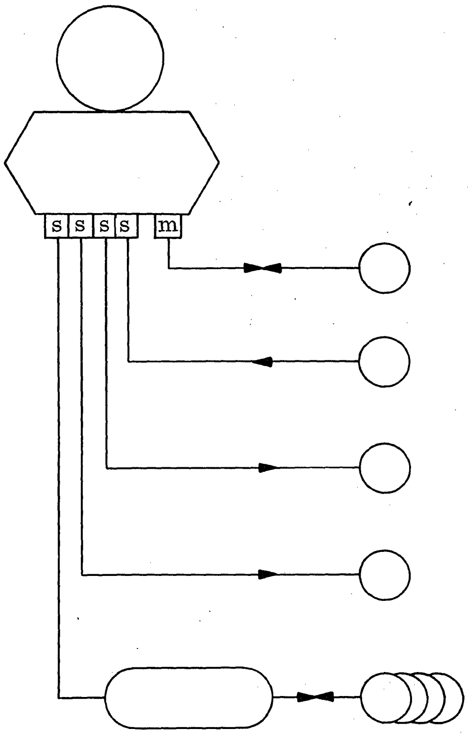
An RCA Spectra 70/25 system can have from four to eight Selector Channels, each of which can be connected to only a single peripheral unit, peripheral controller, or communication link. It may also have a Multiplexor Channel, which can be connected to up to eight peripheral units, controllers, or communication links. Any of the peripheral units in the Spectra 70 line, except the random access devices, can be used in a 70/25 system.

In general, the 70/216 Input-Output Typewriter will be a standard peripheral device with the Spectra 70/25 Processor; this unit is required for program control purposes. The other channel positions (from 3 to 15) can be allocated as required among the card, paper tape, magnetic tape, printing, and other peripheral equipment available for Spectra 70 systems.

These peripheral units are described in the main Spectra 70 Computer System Report, beginning on page 710:062.100. The operation of these units in Spectra 70/25 systems is described in the Simultaneous Operations section of this subreport, on page 713:111.100.

.1 4-TAPE BUSINESS SYSTEM; CONFIGURATION II

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 20% faster.
magnetic tape is 100% faster.
core storage is 100% larger.
console typewriter is required for programming systems.



Equipment	Rental
Main Storage (16,384 bytes); 70/25-C Processor (includes four Selector Channels)	$1,850
70/216 Input-Output Typewriter:	175
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (4): 30,000 bytes/second	1,200

Optional Features Included: . . . . Multiplexor Channel 140

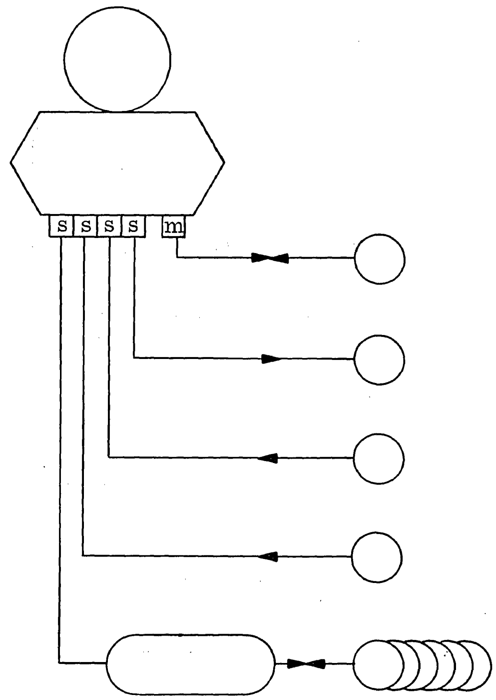
TOTAL: $5,865

m — Multiplexor Channel
s — Selector Channel

(Contd.)

.2 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 20% faster.

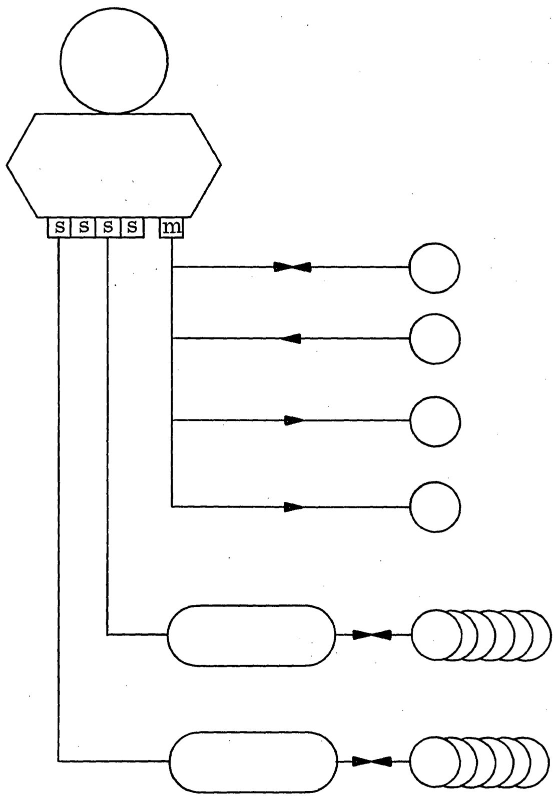


Equipment	Rental
Main Storage (16,384 bytes); 70/25-C Processor (includes four Selector Channels)	$1,850
70/216 Input-Output Typewriter:	175
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (6): 30,000 bytes/second	1,800
Optional Features Included: Multiplexor Channel	140
TOTAL:	$6,465

m – Multiplexor Channel
s – Selector Channel

.3 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 40% faster.
card punch is 50% faster.
printer is 25% faster.



Equipment	Rental
Main Storage (32,768 bytes) 70/25-D Processor (includes one Multiplexor Channel)	$2,750
70/216 Input-Output Typewriter:	175
70/237 Card Reader: 1,435 cpm	650
70/236 Card Punch: 300 cpm	750
70/243-1 High-Speed Printer: 1,250 lpm	1,000
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (3 dual-drive units): 60,000 bytes/second	2,700
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (3 dual-drive units): 60,000 bytes/second	2,700

Optional Features Included: . . . . Multiplexor Channel 140

TOTAL: $12,265

m — Multiplexor Channel
s — Selector Channel

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . . RCA Spectra 70/25 Processor.

.12 Description

The RCA Spectra 70/25 Processor is a basic processor with rather limited processing facilities. These facilities include fixed-point decimal add, subtract, multiply, and divide operations; binary addition and subtraction; logical AND and OR instructions; some editing facilities; and a translation instruction which can convert any 8-bit code into any other 8-bit code. There are no floating-point arithmetic instructions, radix conversions between decimal and binary, or table look-up facilities. The instruction format is similar to that of the larger Spectra 70 processors, although the number of instructions which are available is much smaller (31 instructions in the 70/25 versus 144 in the Spectra 70/45).

Fifteen General-Purpose Registers can act as accumulators, index registers, or control registers, as required by the program. These registers are actually held in the main core storage area, not in special fast storage as in the larger Spectra 70 processors. The instructions are two to six bytes in length, depending upon how many main storage addresses they specify.

Four types of program interrupt are available in the Spectra 70/25. The Input-Output interrupt occurs, unless inhibited, whenever an input-output operation terminates. The Processor interrupt occurs when there is an overflow condition or an attempt is made to divide by zero. The Elapsed Time Clock interrupt occurs when a clock counter overflows. The Operation Code Trap interrupt occurs when an operation code which is not implemented in the 70/25 Processor is encountered by the program. All of these interrupts except the Operation Code Trap interrupt can be inhibited by the program.

The performance of the Spectra 70/25 Processor is limited by the use of main core storage to hold the various processor registers. See Paragraph 713:051.4 for detailed processor speeds. Error-checking facilities in the 70/25 Processor include a check for invalid operations and parity checking. No checks are made on the validity of the data or of the addresses used.

.13 Availability: . . . . 6 months.

.14 First Delivery

Prototype:. . . . . December, 1964.
Customer:. . . . . 4th quarter, 1965.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point —			
	Add-subtract:	automatic	binary	1 to 16 bytes.
		automatic	decimal	1 to 31 digits.
	Multiply —			
	Short:	none.		
	Long:	automatic	decimal	variable; 1 to 15 digits.
	Divide —			
	No remainder:	none.		
	Remainder:	automatic	decimal	variable; 3 to 31 digits.
.212	Floating point:	not available.		
.213	Boolean —			
	AND:	automatic	binary	1 to 256 bytes.
	Inclusive OR:	automatic	binary	1 to 256 bytes.
	Exclusive OR:	automatic	binary	1 to 256 bytes.
.214	Comparison —			
	Numbers:	decimal or binary		up to 32 digits.
	Absolute:	none.		
	Letters:	yes		up to 31 digits.
	Mixed:	yes		up to 31 characters.
	Collating sequence:	Extended BCD Interchange Code only.		

	Provision	Between	Size
.215 Code translation:	automatic	any two 8-bit codes	1 to 256 bytes.

.216 Radix conversion: not available.

	Provision	Comment
.217 Edit format —		
Alter size:	generally make larger	2 to 256 bytes; can edit multiple fields with one instruction
Suppress zero:	automatic	
Round off:	none.	
Insert point:	automatic	
Insert spaces:	automatic	
Insert fill character:	automatic	
Float character:	none.	
Protection:	none.	

.22 Special Cases of Operands

.221 Negative numbers —
Binary: . . . . 2's complement and sign bit.
Decimal: . . . . sign in least significant byte.

.222 Zero —
Binary: . . . . only positive zero.
Decimal: . . . . positive or negative zero, treated as equal in Compare Decimal operations.

.223 Operand size determination: . . . . defined in the instruction.

.23 Instruction Formats

.231 Instruction structure: . 2 + 0, add-to-storage type; using 1 to 3 halfwords, depending on the number of main storage addresses used.

.232 Instruction layout —

SIX-BYTE INSTRUCTIONS

OP	L_1	L_2	B_1	D_1	B_2	D_2

Examples:
Binary arithmetic
Decimal arithmetic
Decimal comparison
Packing and unpacking

FOUR-BYTE INSTRUCTIONS

OP	M	IGN	B_2	D_2
OP	R_1	IGN	B_2	D_2

Example:
Conditional and unconditional branch

TWO-BYTE INSTRUCTIONS

OP	M	
OP	T	D

Examples:
Input/output (Post Status)
Halt

.233 Instruction parts —

Name	Purpose
B_1:	base register for first operand (4 bits).
B_2:	base register for second operand (4 bits).
D:	input-output device number.
D_1:	displacement (relative) address of first operand.
D_2:	displacement (relative) address of second operand.
IGN:	ignored.
L_1:	length of first operand (4 bits).
L_2:	length of second operand (4 bits).
M:	mask.
OP:	operation code (8 bits).
R1:	operand register specification (4 bits).

.234 Basic address structure: . . . . 2 + 0; variations in instruction length are due to the use of 2, 1, or no main storage addresses.
.235 Literals: . . . . none.
.236 Directly addressed operands —
.2361 Internal storage type: core storage.
Minimum size: . . . . . 1 byte.
Maximum size: . . . . 256 bytes.
Volume accessible: . . 65,536 bytes.
.2362 Increased address capacity: . . . . none.
.237 Address indexing —
.2371 Number of methods: . 1.
.2372 Name: . . . . indexing, using base address.
.2373 Indexing rule: . . . . . base address is treated as a 24-bit positive binary integer; displacement is treated as a 12-bit positive binary integer. These are added to form a 24-bit binary integer, ignoring overflows.

(Contd.)

.2374 Index specification: . . base register (B) field of the instruction specifies the number of a General-Purpose Register containing the base address itself.
.2376 Addresses which can be indexed: . . . . . . all core storage addresses.
.2377 Cumulative indexing: . none.
.2378 Combined index and step: . . . . none.
.238 Indirect addressing: . . none.
.239 Stepping: . . . . available, with the increment always implied as minus one, and automatic branch at zero.

.24 Special Processor Storage: . . . . none; all registers are held in main core storage areas.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . 2.
.312 Arrangement: . . . . . . 1 P-counter for the Processing State.
1 P-counter for the Interrupt State.
.313 Precedence rule: . . . . Interrupt State always has priority.
.314 Special sub-sequence counters: . . . . none.
.315 Sequence control step size: . . . . halfword.

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

.33 Interruption

.331 Possible causes —
Input-output units: . . end of operation.
Program events: . . . overflow.
zero divisor.
invalid operation code.
Processor errors: . . none.
Others: . . . . console request.
Elapsed Time Clock overflow.
.332 Control by routine —
Individual control: . . each of the eight input-output channels, the Multiplexor Channel (as a single unit), arithmetic overflow, and the Elapsed Time Clock can be individually inhibited from initiating interrupts. The invalid operation code interrupt cannot be inhibited.
Method: . . . . inhibits are controlled by setting bits in a mask. Two different masks are used, one 8-bit and one 3-bit.
Restriction: . . . . none.
.333 Operator control: . . . . none.
.334 Interruption conditions: . . . . (1) Interrupt cause occurs and is recognized.
(2) Processor not in Interrupt State.
(3) Interrupt condition not inhibited.
(4) Instruction execution completed.
.335 Interruption process: . condition code and sequence counter are stored. New sequence counter is used to start interrupt response processing at fixed location.
.336 Control methods: . . . . not yet defined.

.34 Multiprogramming: . . possible only with packaged Peripheral Control Routine, allowing up to three data transcription routines to be run concurrently.

.35 Multi-sequencing: . . . . none.

.4 PROCESSOR SPEEDS

In DECIMAL operations, execution times are expressed in terms of D, the number of decimal digits in the operand from the user's viewpoint. (From the machine point of view, the actual operand lengths are sometimes different.) D represents the operand length in 4-bit digits, packed 2 digits per 8-bit byte, including the sign digit. Because of the byte structure of the system, the formulas yield accurate times only for even values of D.

In ALPHANUMERIC operations, times are normally expressed in terms of C, the number of alphanumeric characters, occupying one byte position each.

Note: For all "move character" operations, it is assumed that data is in multiples of 4-byte words. In cases where data is not word-aligned, an additional 3 microseconds per byte transferred is required.

.41 Instruction Times in Microseconds

.411 Fixed point —
Add-subtract: . . . . . $21.75 + 1.88D$
Multiply: . . . . $26.25 + 21.75D + 8.44D^2$
Divide: . . . . $22.5 + 15.75D + 9.38D^2$
.412 Floating point: . . . . . . none.
.413 Additional allowance for —
Indexing: . . . . ?
Indirect addressing: . none.
Recomplementing: . . none.
.414 Control —
Compare: . . . . $19.5 + 1.88D$ (decimal).
$15.0 + 1.5D$ (logical).
Branch: . . . . 11.25 (branch).
9.5 (no branch).
.415 Counter control —
Step and test: . . . . . . 15.75 (branch).
11.25 (no branch).
.416 Edit: . . . . $13.5 + 2I + 2F + 2.5D$, where I = number of characters inserted and F = number of fill characters.
.417 Convert: . . . . none.
.418 Shift: . . . . none.

.42 Processor Performance in Microseconds

.421 For random addresses —

	Fixed point
$c = a + b$:	35.25 + 2.25D
$b = a + b$:	21.75 + 1.88D
Sum N items:	(21.75 + 1.88D)N
$c = ab$:	53.25 + 22.5D + 8.44D^2
$c = a/b$:	49.5 + 16.5D + 9.38D^2

.422 For arrays of data —

$c_i = a_i + b_j$:	80.25 + 2.25D
$b_j = a_i + b_j$:	66.75 + 1.88D
Sum N items:	(37.5 + 1.88D)N
$c = c + a_i b_j$:	120.0 + 24.38D + 8.44D^2

.423 Branch based on comparison —

Numeric data:	84.5 + 1.88D
Alphabetic data:	84.5 + 3.76C

.424 Switching —

Unchecked:	148.5
Checked:	229.5
List search:	24.0 + (44.75 + 1.88D)N

.425 Format control, per character —

Unpack:	3.82
Compose:	10.0

.426 Table look-up, comparison —

For a match:	44.75 + 1.88D
For least or greatest:	46.35 + 1.91D
For interpolation point:	44.75 + 1.88D

.427 Bit indicators —

Set bit in separate location:	16.5
Set bit in pattern:	17.25
Test bit in separate location:	29.25
Test bit in pattern:	21.75

.428 Moving: . . . . 13.5 + 3W + 3B, where W = number of 4-byte words; B = number of 8-bit bytes outside full-word boundaries.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	interrupt.
Zero divisor:	check	interrupt.
Invalid data:	no check.	
Invalid operation:	check	interrupt.
Arithmetic error:	no check.	
Invalid address:	no check.	
Receipt of data:	check	interrupt.
Dispatch of data:	send parity bit.	

SIMULTANEOUS OPERATIONS

An RCA Spectra 70/25 system can concurrently execute:

- One machine instruction; and
- Up to eight input-output operations, one on each of the Selector Channels; and
- Up to eight additional input-output operations, one on each of the individual subchannels included in the optional Multiplexor Channel.

The demand on the central processor (i.e., the "interference" or delay imposed upon the central processor program by each individual input-output operation) will vary depending on whether the peripheral device is connected to one of the Selector Channels or to the Multiplexor Channel. (See the general discussion of Spectra 70 Simultaneous Operations on page 710:111.100.) In Table I, the processor demands imposed by each of the peripheral units are listed for both types of channels (next page).

The specific characteristics of the Spectra 70/25 Selector and Multiplexor Channels can be summarized as follows:

Selector Channels

Maximum number: . . . . 8.
Maximum data rate per channel: . . . . 200 KB/sec (Medium Speed Channels). 500 KB/sec (High Speed Channels*).
Number of trunks per channel: . . . . 1.
Causes processor delays during —
Input-output initiation and termination: . . . yes.
Data transfers: . . . . yes; each byte.

* A High Speed Selector Channel may be substituted for a standard Medium Speed Selector Channel.

Multiplexor Channels

Maximum number: . . . . 1.
Maximum number of trunks per channel: . . . 8.
Maximum data rate (multiplexed): . . . . 111 KB/sec.
Maximum data rate (burst mode): . . . . not possible.
Causes processor delays during
all input-output processing: . . . . yes.

TABLE I: INPUT-OUTPUT DEMANDS UPON THE SPECTRA 70/25 PROCESSOR

Device	Average Data Rate (Kilobytes/ second)	Peak Data Rate (Kilobytes/ second)	Maximum Demands Upon 70/25 Processor	
			Via Selector Channel	Via Multiplexor Channel
70/216 Input-Output Typewriter, 10 cps	0.01	0.01	<0.01%	<0.01%
70/221 Paper Tape Reader/Punch —				
Reading, 200 cps	0.2	0.2	0.03%	0.18%
Punching, 100 cps	0.1	0.1	0.02%	0.09%
70/234 Buffered Card Punch, 100 cpm	0.1	120.0	0.02%	0.09%
70/236 Buffered Card Punch, 300 cpm	0.4	120.0	0.06%	0.36%
70/237 Card Reader, 1435 cpm	1.9	1.9	0.28%	1.71%
70/242-1 Printer, 132 columns, 600 lpm, buffered	1.3	120.0	0.20%	1.17%
70/242-2 Printer, 160 columns, 600 lpm, buffered	1.6	120.0	0.24%	1.44%
70/243-1 Printer, 132 columns, 1250 lpm, buffered	2.7	120.0	0.41%	2.43%
70/243-2 Printer, 160 columns, 1250 lpm, buffered	3.3	120.0	0.49%	2.97%
70/248 Bill Feed Printer, buffered —				
600 lpm, forms	1.3	27.0	0.20%	1.17%
400 lpm, cards	0.8	9.0	0.12%	0.72%
70/432 Magnetic Tape Unit, 30KB/sec	30.0	30.0	4.5%	27.0%
70/442 Magnetic Tape Unit, 60KB/sec	60.0	60.0	9.0%	54.0%
70/445 Magnetic Tape, Unit, 120KB/sec	120.0	120.0	18.0%	—
70/251 Videoscan Document Reader, 1300 dpm	1.5	1.5	0.22%	1.35%
70/653 Communication Control (Single Channel)	0.2	5.1	0.03%	0.18%
70/627 Data Exchange Control	*	*	—	—

* Speed is determined by the memory cycle time of the slower of the two communicating Spectra 70 processors.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (713:201.100)

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 it is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of varied record sizes in the master file. Standard Problem D increases the amount of computation performed on each transaction. Each problem is estimated for activity factors (ratios of the number of detail records to the number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

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. Word boundaries were observed in the master file record layout to improve input-output performance efficiency. The controlling factor in the curves for Configurations II, III, and IV is the printer at high and moderate activities and the master file tape at low activity.

SORTING (713:201.200)

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 713:201.200. Graph 713:201.220 presents RCA-supplied sort times based on the sort/merge routine used with the Spectra 70/25 Primary Operating System (see Section 710:151.13).

MATRIX INVERSION AND GENERALIZED MATHEMATICAL PROCESSING

It is not possible to install automatic floating-point operations in the Spectra 70/25 Processor, and in many cases the Spectra 70/25 will not be a stand-alone system but will be associated with a larger Spectra 70 system; therefore, these two mathematically-oriented standard problems have not been coded for the 70/25.

WORKSHEET DATA TABLE 1 (STANDARD FILE PROBLEM A)							
	ITEM		II & III		IV		REFERENCE
1 Input-Output Times	Char/block	(File 1)	1,056		1,056		4:200.112
	Records/block	K (File 1)	12		12		
	msec/block	File 1 = File 2	51.2		25.6		
		File 3	42		42		
		File 4	131		79		
	msec/switch	File 1 = File 2	0		0		
		File 3	0		0		
		File 4	0		0		
	msec penalty	File 1 = File 2	1.58		1.58		
		File 3	0.12		0.12		
		File 4	0.20		0.20		
2 Central Processor Times	msec/block	a_1	0.24		0.24		4:200.1132
	msec/record	a_2	0.53		0.53		
	msec/detail	b_6	0.43		0.43		
	msec/work	$b_5 + b_9$	0.53		2.53		
	msec/report	$b_7 + b_8$	1.43		1.43		
3 Standard File Problem A F = 1.0	msec/block for C.P. and dominant column.		C.P.	Printer	C.P.	Printer	4:200.114
		a_1	0.2		0.2		
		a_2K	6.4		6.4		
		a_3K	52.7		52.7		
		File 1: Master In	1.6		1.6		
		File 2: Master Out	1.6		1.6		
		File 3: Details	1.4		1.4		
		File 4: Reports	2.4	1,572	2.4	948	
		Total	66.3	1,572	66.3	948	
4 Standard File Problem A Space	Unit of measure	(bytes)					4:200.1151
		Std. routines	1,032		1,032		
		Fixed	250		250		
		3(Blocks 1 to 23)	612		612		
		6(Blocks 24 to 48)	3,768		3,768		
		Files	4,648		4,648		
		Working	100		100		
		Total	10,410		10,410		

(Contd.)

.1 GENERALIZED FILE PROCESSING

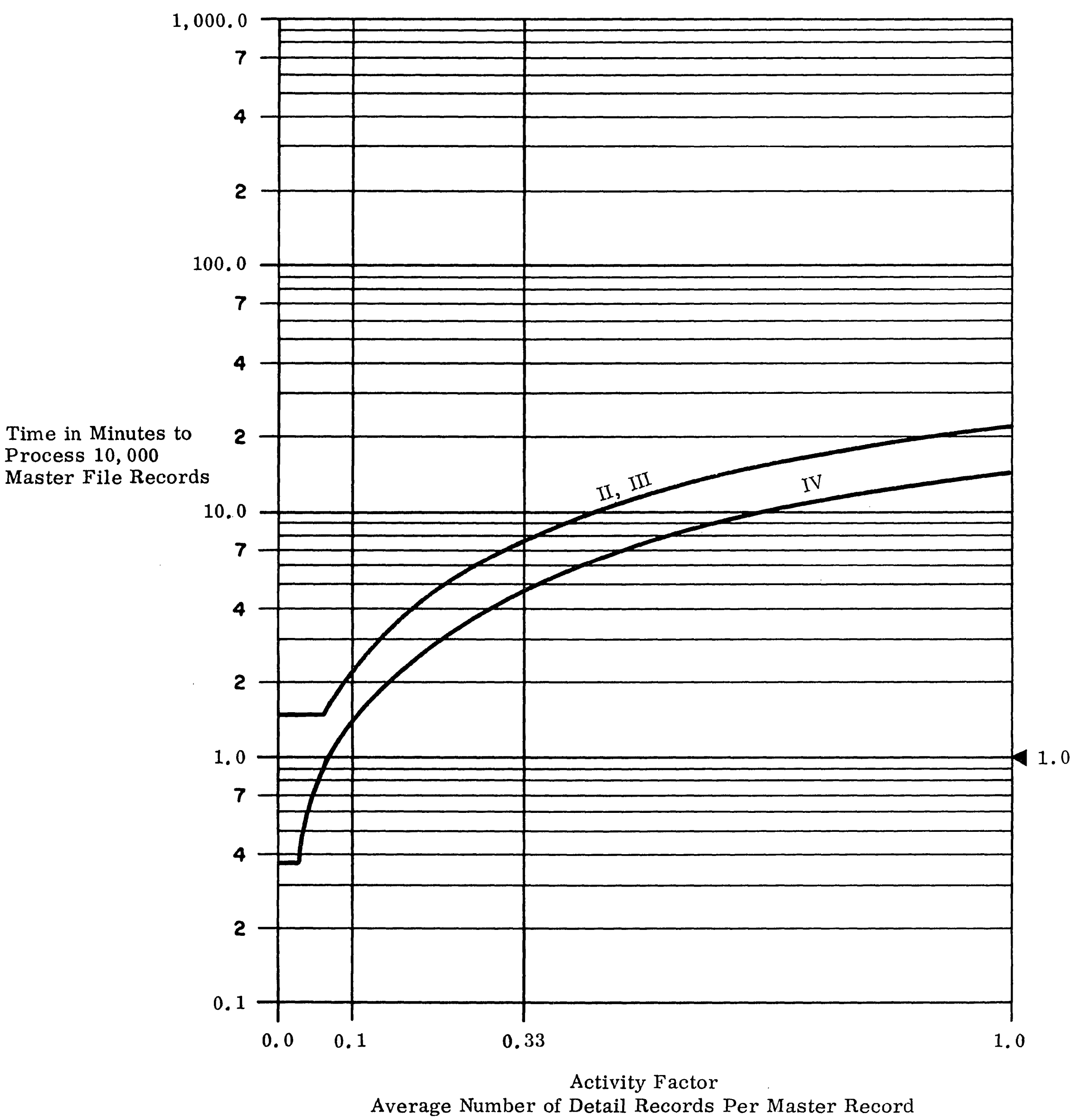
.11 Standard File Problem A

.111 Record sizes —

Master file: . . . . . 108 characters, packed as 88 eight-bit bytes.
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: . . 10,410 bytes.
Configuration III: . . 10,410 bytes.
Configuration IV: . . 10,410 bytes.



(Roman numerals denote standard System Configurations.)

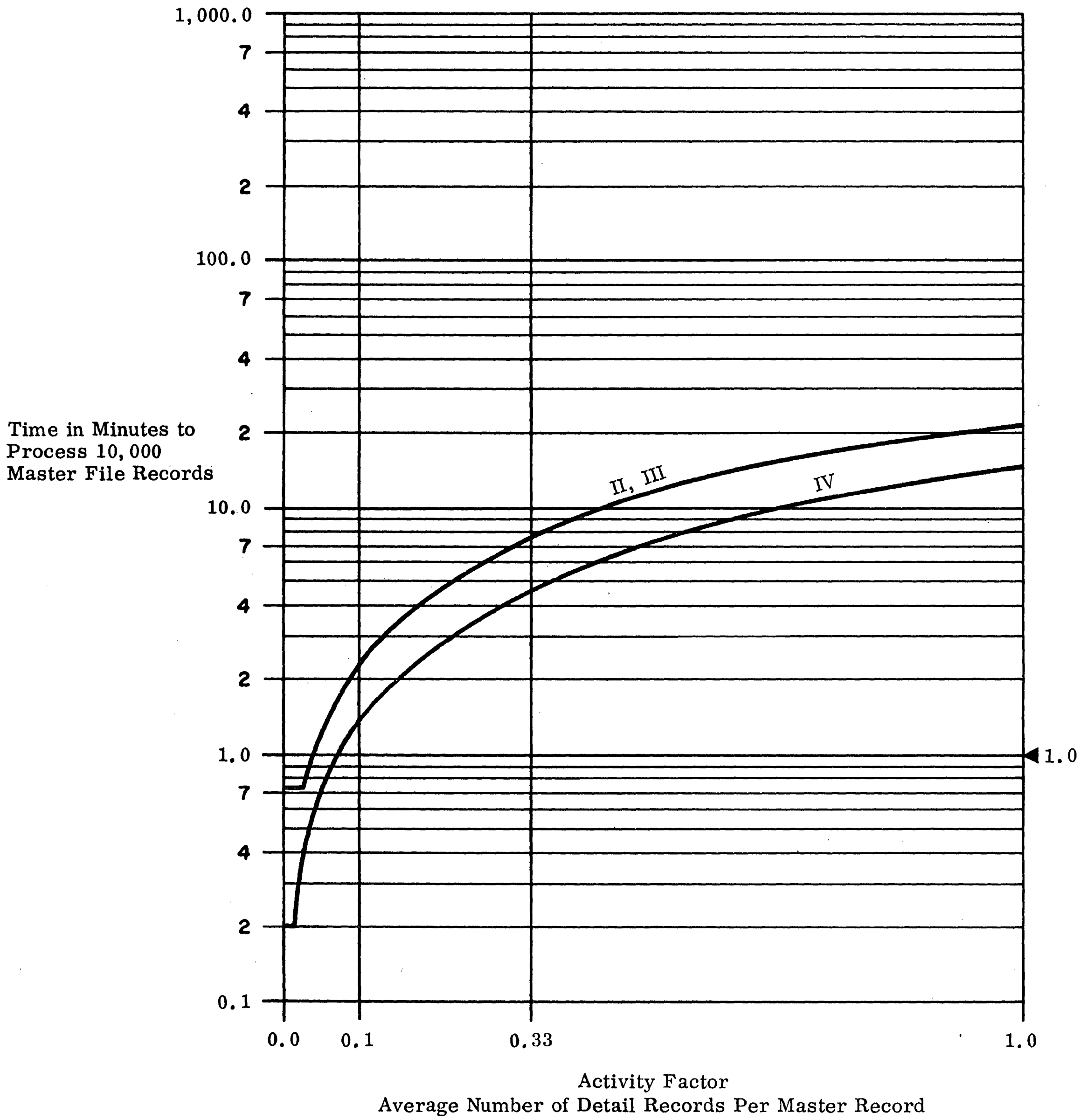
.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . 54 characters, packed as 44 eight-bit bytes.
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

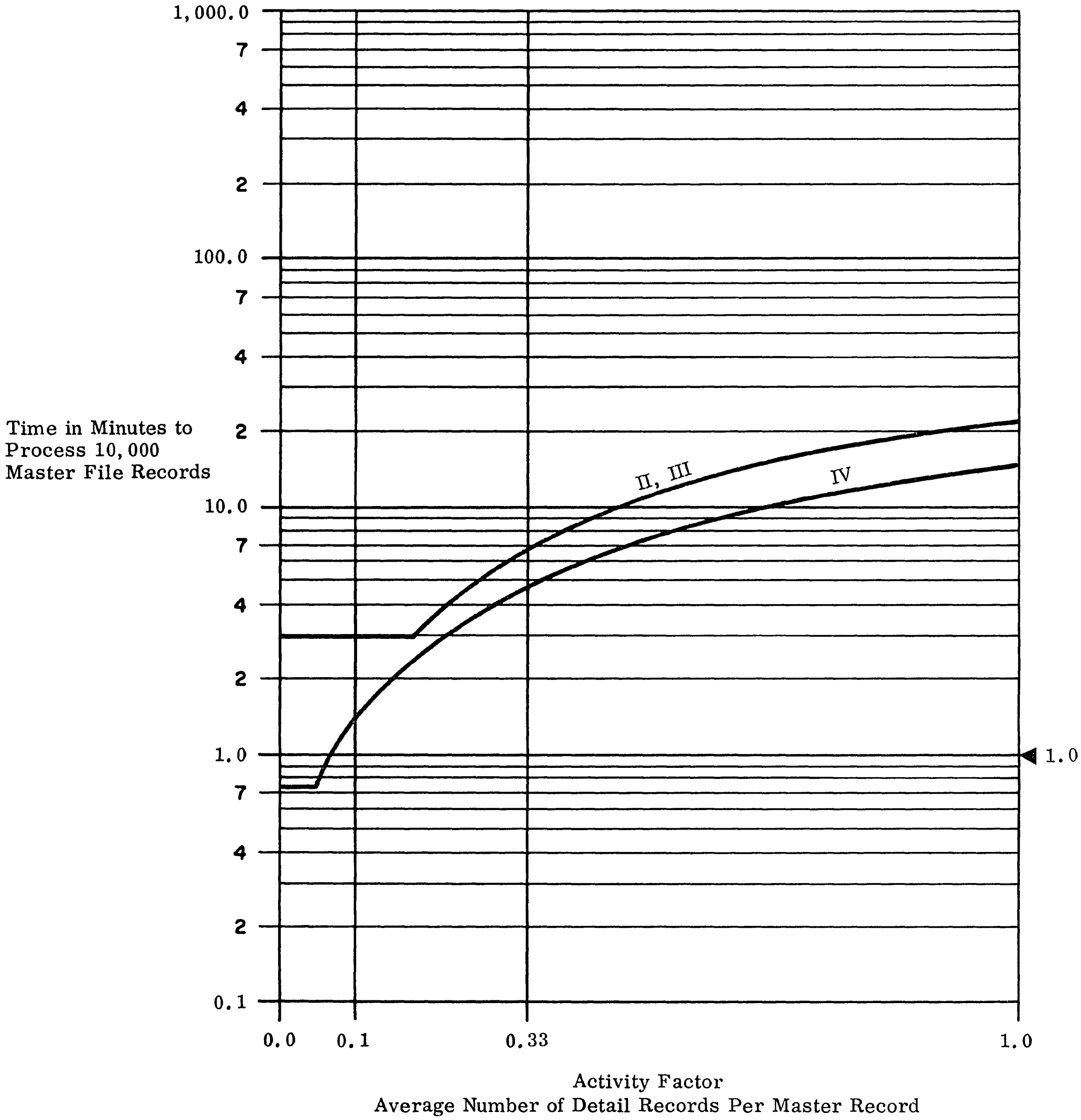
.131 Record sizes —

Master file:	216 characters, packed as 176 eight-bit bytes.
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.



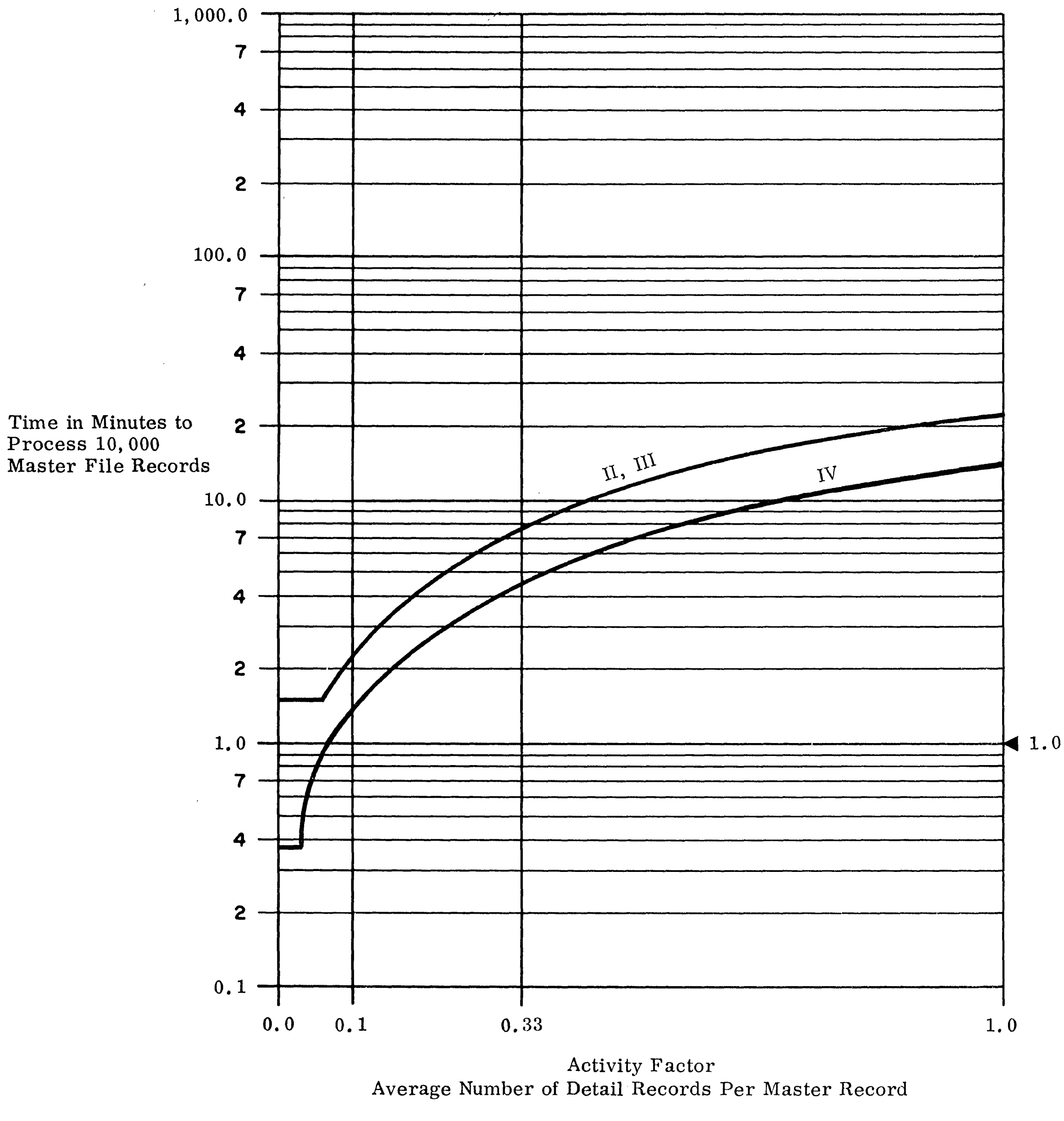
(Roman numerals denote standard System Configurations.)

.14 Standard File Problem D

.141 Record sizes —

Master file:	108 characters, packed as 88 eight-bit bytes.
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

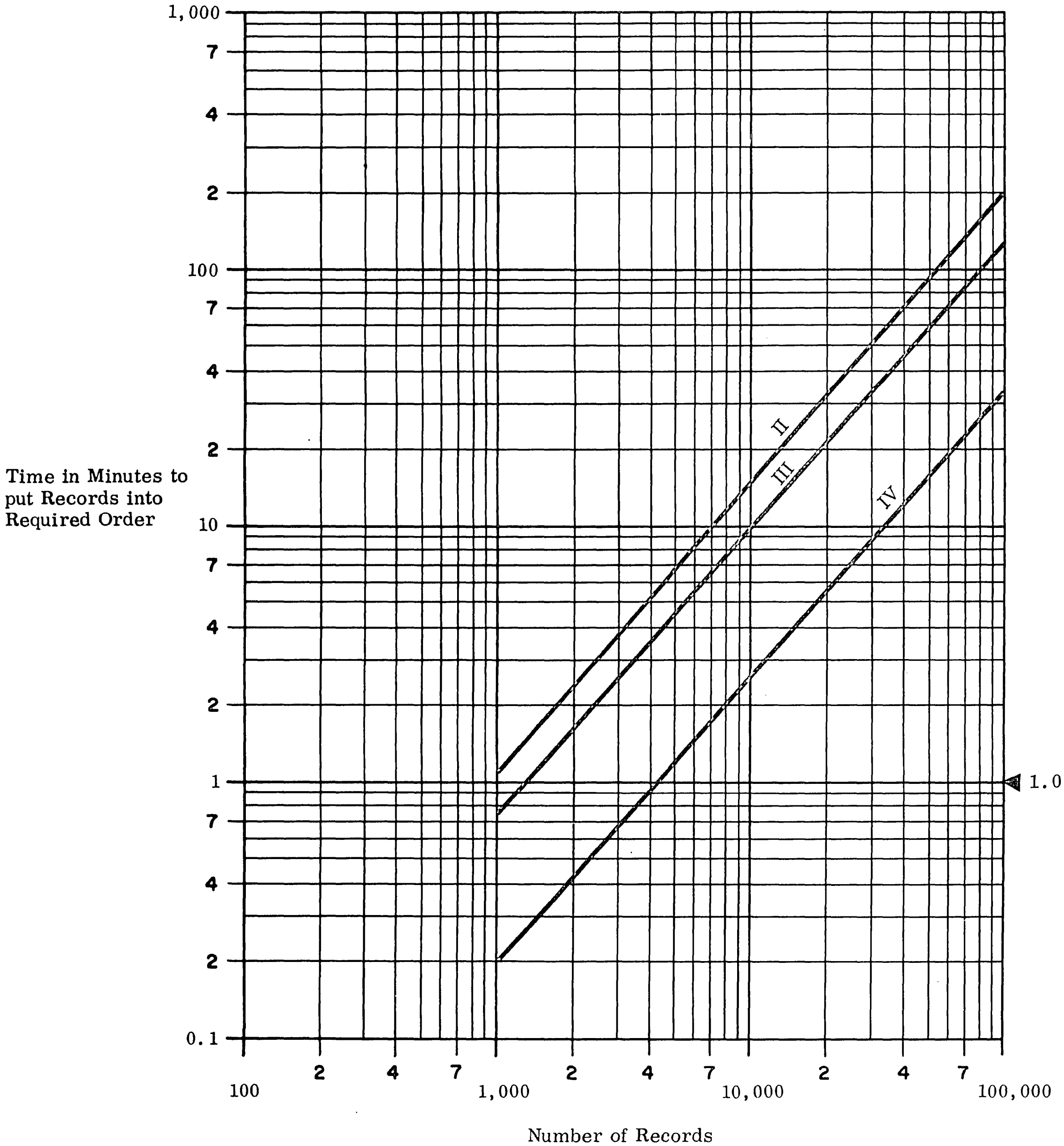
.21 Standard Problem Estimates

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

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

.213 Timing basis: . . . using estimating procedure outlined in Users' Guide, 4:200.213.

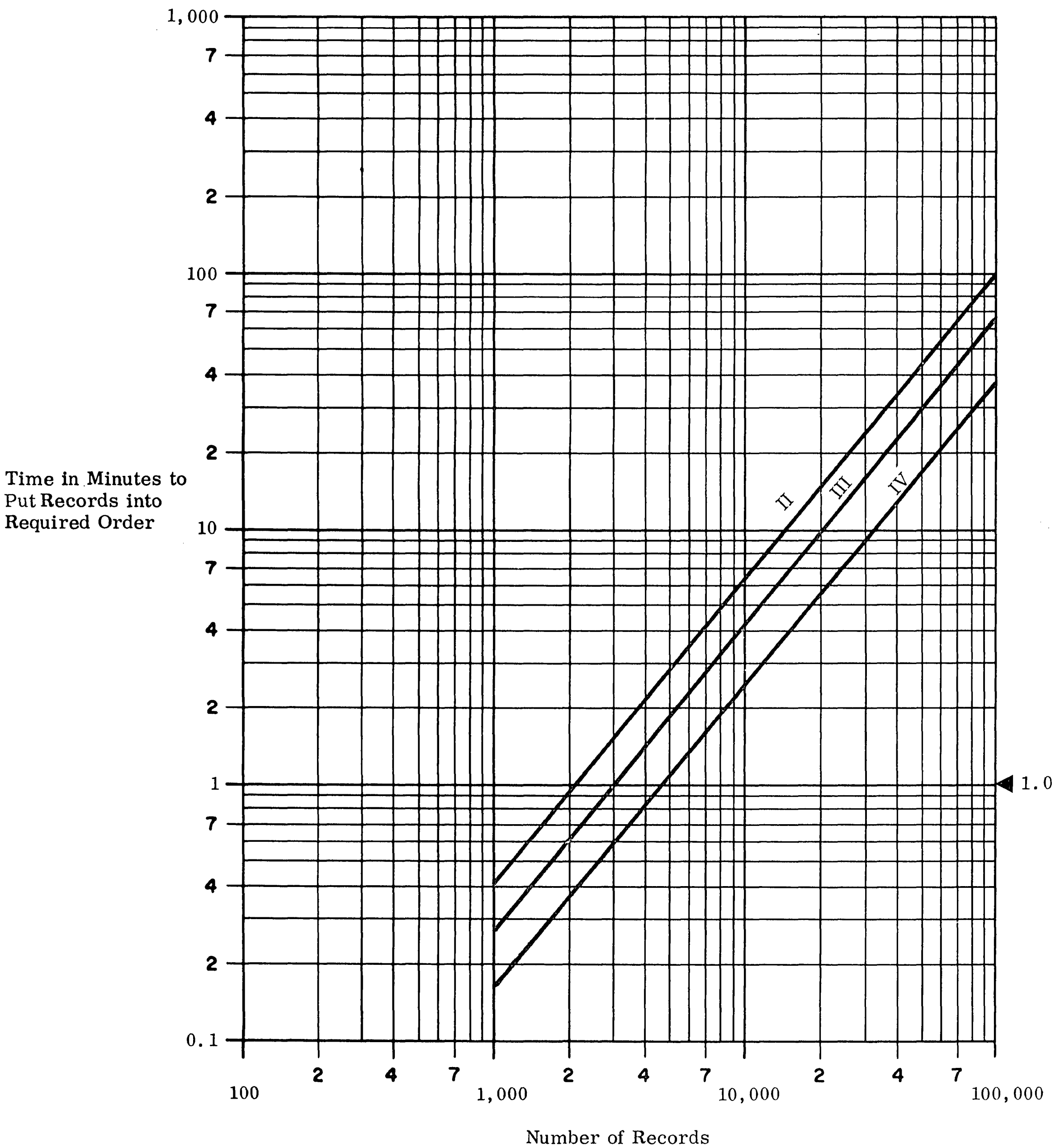
.214 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

.22 Primary Operating System Sort/Merge Times

.221 Record size: . . . . 100 characters.
.222 Key size: . . . . not specified.
.223 Timing basis: . . . . . . RCA-supplied times; input-output blocking factors as indicated in legend below.
.224 Graph: . . . . see graph below.



(Roman numerals denote standard System Configurations.)

Configuration	I/O Blocking
Standard Configuration II:	15 records/block
Standard Configuration III:	9 records/block
Standard Configuration IV:	13 records/block

SPECTRA 70/35

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INTRODUCTION

The Spectra 70/35 computer system was formally announced by RCA in September 1965, nine months after the original announcement of the Spectra 70 line. First delivery of a 70/35 system is scheduled for February 1967. The 70/35 Processor is the least expensive of the program-compatible Spectra 70/35, 70/45, and 70/55 processors. The performance of the Spectra 70/35 system generally falls somewhere between that of IBM System/360 Models 30 and 40.

Internal storage capacity of Spectra 70/35 systems can range from 16, 384 to 65, 536 bytes of core storage. In addition, "Non-Addressable" core storage is supplied to provide control registers for each input-output device. Non-Addressable core storage also provides the processor's general registers, floating-point registers, and various other control registers. The core storage cycle time is 1.44 microseconds per two bytes.

The rental for typical Spectra 70/35 systems will range between $5, 000 and $13, 000 per month. A Spectra 70/35 system arranged in AUERBACH's Standard Configuration III, with 16K bytes of core storage, six 30KB magnetic tape units, printer, card reader and punch, rents for $6, 905 per month (see Report Section 714:031).

To hold the optional emulators that enable it to execute machine-language programs written for IBM 1401/1460 or RCA 301 computer systems, the Spectra 70/35 utilizes a read-only memory unit similar to that used in the Spectra 70/45. Each 54-bit word of read-only memory holds two processor "elementary operations," twice the capacity of the Spectra 70/45's read-only memory. As a result, the Spectra 70/35 emulators will require less memory and will generally perform more efficiently than the emulators used with the Spectra 70/45 system. Detailed descriptions of the emulators for the 70/35 can be found in Sections 710:131 and 710:134.

This subreport concentrates upon the characteristics and performance of the Spectra 70/35 system in particular. All general characteristics of the Spectra 70 hardware and software are described in Computer System Report 710: RCA Spectra 70 — General.

The System Configuration section which follows shows the Spectra 70/35 in the following standard System Configurations:

I: Typical Card System
II: 4-Tape Business System
III: 6-Tape Business System
VI: 6-Tape Business/Scientific System
VIIA: 10-Tape General System (Integrated).

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 714:051 provides detailed central processor timings for the Spectra 70/35. See Section 710:051 for all the other characteristics of the Spectra 70 processors.

The input-output channel capabilities of the Spectra 70/35, and the demands upon the processor during input-output operations, are described in Section 714:111, Simultaneous Operations. The Selector Channels used with the Spectra 70/35 have a 50% greater transmission-rate capability than those used with the faster 70/45 Processor. However, the effective 70/35 Multiplexor Channel transmission-rate capabilities are 50% slower than those possible with the 70/45 Multiplexor Channel.

The software that can be used with a given Spectra 70 system configuration depends upon the amount of core storage and the number and type of peripheral devices that are available. A detailed description of the software that can be used with the Spectra 70/35 and other Spectra 70 systems can be found in Sections 710:151 through 710:193.

The overall performance of any Spectra 70 system is heavily dependent upon the processor model used. A full System Performance analysis of the 70/35 system is provided in Section 714:201 of this subreport.

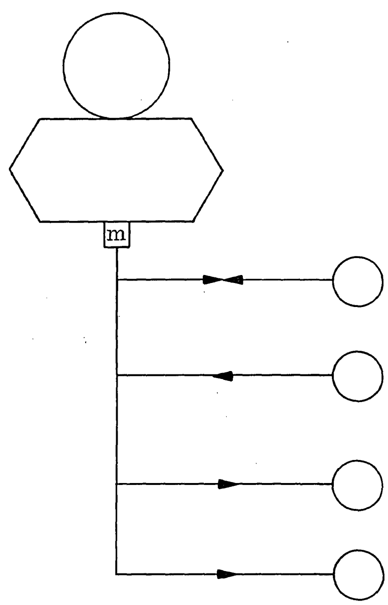
The Multiplexor Channel, with seven subchannels, is a standard feature of the RCA Spectra 70/35 Processor. Memory Protect, an Elapsed-Time Clock, Direct Control, an RCA 301 Emulator, an IBM 1401/1460 Emulator, and up to two Selector Channels are optional features.

SYSTEM CONFIGURATION

System configuration rules for the RCA Spectra 70/35 and other Spectra 70 computer systems are summarized in Report Section 710:031. This report section shows Spectra 70/35 systems arranged in several of our Standard Configurations according to the specifications set forth in the Users' Guide, page 4:030.120.

.1 TYPICAL CARD SYSTEM; CONFIGURATION I

Deviations from Standard Configuration: . . . . main storage is 100% larger.
card reader is 44% faster.
card punch is 50% faster.
printer is 25% faster.
console typewriter is required for programming systems.

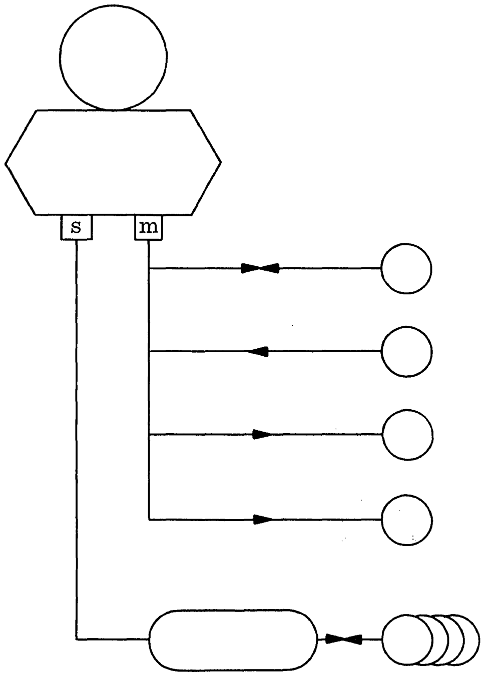


Equipment	Rental
Main Storage (16,384 bytes); 70/35-C Processor (includes one Multiplexor Channel)	$2,100
70/97 Console and Typewriter	330
70/237-10 Card Reader: 1,435 cpm	650
70/236-10 Card Punch: 300 cpm	750
70/243-10 High-Speed Printer: 1,250 lpm	1,000
TOTAL:	$4,830

m — Multiplexor Channel

.2 4-TAPE BUSINESS SYSTEM; CONFIGURATION II

Deviations from Standard Configuration: . . . . printer is 25% faster.
magnetic tape is 100% faster.
core storage is 100% larger.
card reader is 187% faster.
console typewriter is required for programming systems.



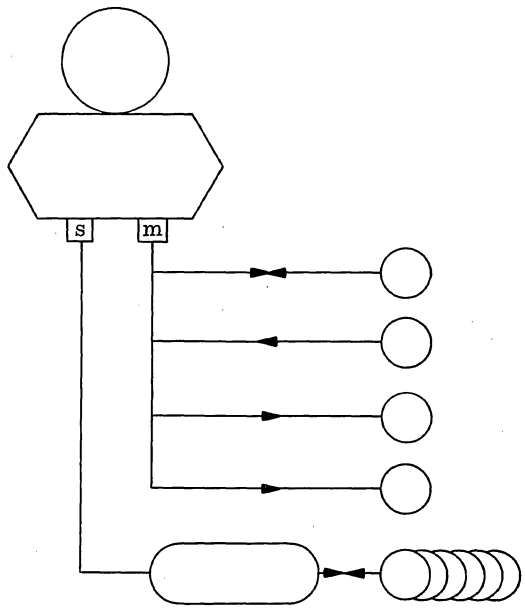
Equipment	Rental
Main Storage (16,384 bytes); 70/35-C Processor (includes one Multiplexor Channel)	$2,100
70/97 Console and Typewriter	330
70/237-10 Card Reader: 1,435 cpm	650
70/234-10 Card Punch: 100 cpm	450
70/242-10 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (4): 30,000 bytes/second	1,200
Optional Features Included: . . . . Selector Channel Feature (includes 1 Channel)	175
TOTAL:	$6,305

m — Multiplexor Channel
s — Selector Channel

(Contd.)

.3 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 25% faster.



Equipment	Rental
Main Storage (16,384 bytes) 70/35-C Processor (includes one Multiplexor Channel)	$2,100
70/97 Console and Typewriter	330
70/236-10 Card Reader: 1,435 cpm	650
70/234-10 Card Punch: 100 cpm	450
70/242-10 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (6): 30,000 bytes/second	1,800
Optional Features Included: . . . . Selector Channel Feature (includes 1 channel)	175
TOTAL:	$6,905

m — Multiplexor Channel
s – Selector Channel

Note: Standard Configuration V — 6-Tape Auxiliary Storage System — requires, in addition to the above:

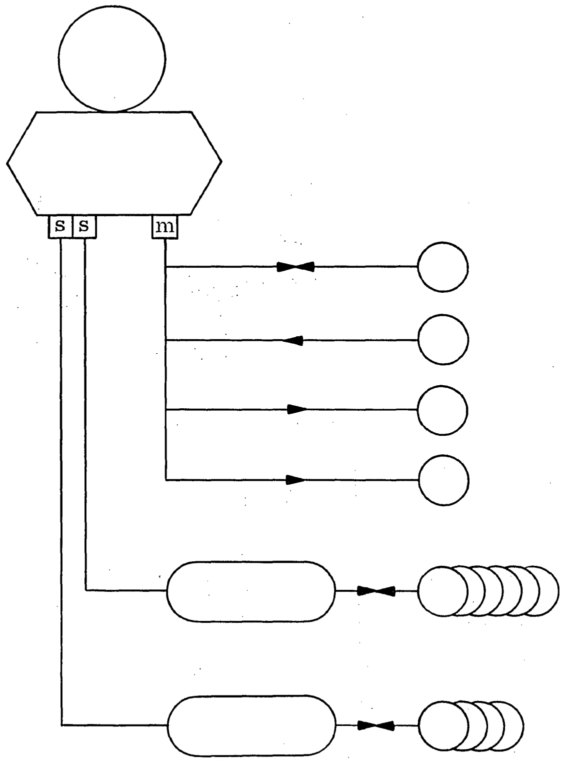
Another Selector Channel	100
70/551 Random Access Controller	525
Input/Output Attachment Feature for 70/564	N/C
70/564 Disc Storage Units (3) 7.25 million bytes per unit 97.5 msec average seek time	1,725
TOTAL:	$9,255

Standard Configuration VI — 6-Tape Business/Scientific System — is identical with Configuration III as shown above except for the use of Processor Model 70/35-E, with 65,536 bytes of Main Storage.

TOTAL: $9,005

.4 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIA

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 150% faster.



Equipment	Rental
Main Storage (65, 536 bytes) 70/35-E Processor (includes one Multiplexor Channel)	$4, 200
70/97 Console and Typewriter	330
70/237-10 Card Reader: 1,435 cpm	650
70/234-10 Card Punch: 100 cpm	450
70/243-10 Printer: 1,250 lpm	1, 000
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (3 dual-drive units): 60, 000 bytes/second	2,700
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (2 dual-drive units): 60, 000 bytes/second	1, 800

Optional Features Included: . . . .

Selector Channel Feature (includes 2 channels)	275
Memory Protect	125
TOTAL:	$12, 930

m - Multiplexor Channel
s - Selector Channel

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70/35 Processor.

.12 Description

See Section 710:051 for a comprehensive description of the characteristics of the 70/35 Processor and the other processors in the Spectra 70 Series.

See Sections 710:132 and 710:136 for a description of the characteristics of the 70/35 Processor when using a machine code defined by one of the emulator options (i.e., when executing programs written for an IBM 1401 or RCA 301).

See the Introduction to this subreport, Section 714:011, for a summary of the distinguishing features of the 70/35 Processor as used in Spectra 70 systems.

The Instruction Times and Processor Performance times for Spectra 70/35 systems, in all four modes of arithmetic, are listed below. See Paragraphs 4:050.41 and 4:050.42 of the Users' Guide for the definition of these standard measures of central processor performance.

.4 PROCESSOR SPEEDS

In decimal operations, execution times are expressed in terms of D, the number of decimal digits in the operand. D represents the operand length in 4-bit digits, packed 2 digits per 8-bit byte, including the sign digit. Because of the byte structure of the system, the formulas yield accurate times only for even values of D.

In binary operations, fixed-point times normally reflect one-word (32-bit) operands. Short floating-point operands are one word long and provide a minimum precision of 21 bits; long floating-point operands are two words long and provide a minimum precision of 53 bits.

.41 Instruction Times in Microseconds

.411 Fixed point —

	Binary	Decimal
Add-subtract:	19.0	39.36 + 2.76D
Multiply:	131.0	$42.72 + 28.36D + 13.3D^2$
Divide:	211.0	$13.44 + 67.68D + 26.4D^2$

.412 Floating point —

	Long	Short
Add-subtract:	73.62	46.33
Multiply:	494.11	168.06
Divide:	1,239.86	410.89

.413 Additional allowance for —
Single indexing: . . . . 1.44 μsec. (RX instructions only).
Double indexing: . . . 1.44 μsec.
Indirect addressing: . none.
Recomplementing: . . none.

.414 Control —
Compare:
Fixed point: 19.04
Decimal: . . . . 35.52 + 2.76D
Floating point:
Long: 61.66
Short: 38.62
Logical: 18.40
Branch: 10.56

.415 Counter control —
Step: 12.00
Step and test: 12.96
Test: 11.52

.416 Edit: . . . . 14.40 + 6.72D + 2.88K, where K = number of control characters.

.417 Convert —
To binary: . . . . 43.20 + 18.24D
To decimal: . . . . . . 60.96 + 26.88D

.418 Shift (under 16 bits) —
Left: . . . . 18.24 + 0.48N (single); 58.08 + 0.96N (double).
Right: . . . . 18.72 + 0.48N (single); 64.32 + 0.96N (double), where N = number of bits to be shifted.

.42 Processor Performance in Microseconds

.421 For random addresses —

	Fixed Point	Floating Point
$c = a + b$:	5.12 (binary)	115.9 (long)
	58.74 + 4.68D (decimal)	80.9 (short)
$b = a + b$:	51.2 (binary)	115.9 (long)
	44.82 + 2.76D (decimal)	80.9 (short)
Sum N items:	19.0N (binary)	73.62N (long)
	(44.82 + 2.76D)N (decimal)	46.33N (short)
$c = ab$:	163.2 (binary)	536.4 (long)
	$53.3 + 33.2D + 13.3D^2$ (decimal)	202.6 (short)
$c = a/b$:	243.2 (binary)	1282.1 (long)
	$24.0 + 78.5D + 26.4D^2$ (decimal)	445.5 (short)

.422 For arrays of data —

	Fixed Point	Floating Point
$c_i = a_i + b_j$:	105.45 (binary)	164.82 (long)
	115.74 + 4.68D (decimal)	127.93 (short)
$b_j = a_i + b_j$:	86.8 (binary)	147.54 (long)
	82.82 + 2.76D (decimal)	119.29 (short)
Sum N items:	38.0N (binary)	81.78N (long)
	(82.82 + 2.76D)N (decimal)	55.45N (short)
$c = c + a_i b_j$:	211.81 (binary)	636.37 (long)
	$149.78 + 35.96D + 13.3D^2$ (decimal)	283.03 (short)

.423 Branch based on comparison —
- Numeric data: 94.96
- Alphabetic data: 94.96

.424 Switching —
- Unchecked: 62.96
- Checking: 113.57
- List search: . . . . . . 87.34 + 36.18N

.425 Format control, per character —
- Unpack: 4.8
- Compose: 18.24

.426 Table lookup, per comparison —
- For a match: 38.18N
- For least or greatest: 47.46N
- For interpolation point: 38.18N

.427 Bit indicators —
- Set bit in separate location: 10.08
- Set bit in pattern: . . . 13.92
- Test bit in separate location: 15.48
- Test bit in pattern: . . 12.00 + 1.92D

.428 Moving: . . . . 13.92 + 1.92D

SIMULTANEOUS OPERATIONS

An RCA 70/35 system can concurrently execute:

- One machine instruction; and
- Up to two input-output operations, one on each of the optional Selector Channels; and
- Up to seven additional input-output operations, one on each of the individual subchannels included in the standard Multiplexor Channel.

The demand on the central processor (i.e., the "interference" or delay imposed upon the central processor program by each individual input-output operation) will vary depending on whether the peripheral device is connected to one of the Selector Channels or to the Multiplexor Channel. (See the general discussion of Spectra 70 Simultaneous Operations on page 710:111.100.) In Table I, the processor demands imposed by each of the peripheral units are listed for both types of channels (next page).

The specific characteristics of the Spectra 70/35 Selector and Multiplexor Channels can be summarized as follows:

Selector Channels

Maximum number: . . . . 2.
Maximum data rate per channel: . . . . . . 694 kilobytes/second (70/35 Processor throughput limitation).
Number of trunks per channel: . . . . 2.
Causes processor delay during —
 Input-output initiation and termination: . . . . yes.
 Data transfers: . . . . yes; each byte.
 Chaining: . . . . yes.

Multiplexor Channels

Maximum number: . . . . 1.
Maximum number of trunks per channel: . . . . 7.
Data rate range during concurrent Selector Channel operation (multiplexed): . . . . 0 to 31 KB/sec.
Maximum data rate range without concurrent Selector Channel operation (multiplexed): . . . . 61 to 63.1 KB/sec.
Maximum data rate (burst mode): . . . . . 417 KB/sec.
Causes processor delays during all input-output processing: . . . . yes.

TABLE I: INPUT-OUTPUT DEMANDS UPON THE SPECTRA 70/35 PROCESSOR

Device	Average Data Rate (Kilobytes/second)	Peak Data Rate (Kilobytes/second)	Maximum Demands Upon 70/35 Processor	
			Via Selector Channel	Via Multiplexor Channel †
70/216 Input-Output Typewriter, 10 cps	0.01	0.01	—	—
70/221 Paper Tape Reader/Punch —				
Reading, 200 cps	0.2	0.2	0.03%	0.65%
Punching, 100 cps	0.1	0.1	0.01%	0.32%
70/234 Buffered Card Punch, 100 cpm	0.1	120.0	0.01%	0.32%
70/236 Buffered Card Punch, 300 cpm	0.4	120.0	0.06%	1.3%
70/237 Card Reader, 1435 cpm	1.9	1.9	0.27%	6.1%
70/242-1 Printer 132 columns, 625 lpm, buffered	1.4	120.0	0.19%	4.5%
70/242-2 Printer 160 columns, 625 lpm, buffered	1.7	120.0	0.24%	5.5%
70/243-1 Printer 132 columns, 1250 lpm, buffered	2.7	120.0	0.39%	8.7%
70/253-2 Printer 160 columns, 1250 lpm	3.3	120.0	0.48%	10.7%
70/248 Bill Feed Printer, buffered —				
600 lpm, forms	1.3	27.0	0.19%	4.2%
400 lpm, cards	0.8	9.0	0.08%	2.6%
70/432 Magnetic Tape Unit, 30 KB/sec	30.0	30.0	4.3%	96.8%
70/442 Magnetic Tape Unit, 60 KB/sec	60.0	60.0	8.6%	100%
70/445 Magnetic Tape Unit, 120 KB/sec	120.0	120.0	17.3%	100%
70/251 Videoscan Document Reader, 1300 dpm	1.5	1.5	0.22%	4.8%
70/627 Data Exchange Control	*	*	—	—
70/564 Disc Storage Unit	156.0	156.0	22.5%	100%
70/568-11 Mass Storage Unit	70.0	70.0	10.0%	100%
70/565-3 Drum Memory Unit	210.0	210.0	30.3%	100%

* Speed is determined by the memory cycle time of the slower of the two communicating Spectra 70 processors.

† Processor delays via Multiplexor Channel assume the concurrent usage of a 70/35 Selector Channel.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (714:201.100)

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 it is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of varied record sizes in the master file. Standard Problem D increases the amount of computation performed on each transaction. Each problem is estimated for activity factors (ratios of the number of detail records to the number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

In Configurations 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. The controlling factor in these curves is the printer at high and moderate activities and the master file tapes at low activity.

Because multiprogramming, or concurrent execution of two or more independent programs, is a featured capability of the Spectra 70/35, the time actually used by the central processor (CP) is also plotted. By comparing the curves of total time for the various configurations with the central processor curves, it can be seen that even in the worst case (Configuration VIIA, when the computation load has been trebled), some 15% of the available processing capacity is not in use. A comparison of the central processor curves for a standard amount of computation and for trebled computation (i.e., the curves for Problems A and D, respectively) shows the effect of increasing the computational workload.

SORTING (714:201.200)

The standard estimate for sorting 80-character records by straightforward merging on magnetic tape was developed from the time for Standard File Processing Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide. A three-way merge was used in all the configurations shown.

MATRIX INVERSION (714:201.300)

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. Obtaining this precision in the Spectra 70/35 requires use of the double-precision floating-point instructions; however, because the shorter single-precision form, which provides just over 6 decimal digits' precision, will be used wherever practical, the times for single-precision operation have also been computed and included in the graph.

GENERALIZED MATHEMATICAL PROCESSING (714:201.400)

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. All computations are carried out in the double-precision floating-point mode because the single-precision mode was considered to have insufficient accuracy for this type of computation. As in the File Processing problems, the total elapsed time is shown by the solid lines in Graph 714:201.400, while the curves marked "CP" show central processor time.

WORKSHEET DATA TABLE

	Item		CONFIGURATION I	CONFIGURATION II, III, VI	CONFIGURATION VIIA	REFERENCE
1 Standard File Problem A Input-Output Times	Char/block	(File 1)	80	1,056	1,056	4:200.112
	Records/block	K (File 1)	0.5	12	12	
	msec/block	File 1 = File 2	42(File 1); 192(File 2)	51.2	25.6	
		File 3	42	42	42	
		File 4	79	131	79	
	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	0.13	1.52	1.52	
		File 3	0.12	0.12	0.12	
		File 4	0.19	0.19	0.19	
2 Central Processor Times	msec/block	a_1	0.46	0.46	0.46	4:200.1132
	msec/record	a_2	0.50	0.50	0.50	
	msec/detail	b_6	0.81	0.81	0.81	
	msec/work	$b_5 + b_9$	1.19	1.19	1.19	
	msec/report	$b_7 + b_8$	2.87	2.87	2.87	

	Item		I C.P.	I Punch	II, III, VI C.P.	II, III, VI Printer	VIIA C.P.	VIIA Printer	REFERENCE
3 Standard File Problem A F = 1.0	msec/block for C.P. and dominant column.	a_1	0.46		0.46		0.46		4:200.114
		a2	0.25		6.02		6.02		
		a_3K	2.44		58.44		58.44		
		File 1: Master In	0.13		1.52		1.52		
		File 2: Master Out	0.13	192	1.52		1.52		
		File 3: Details	0.06		1.44		1.44		
		File 4: Reports	0.09		2.28	1,572	2.28	1,572	
		Total	3.56	192	71.68	1,572	71.68	1,572	

	Item		I	II, III, VI	VIIA	REFERENCE
4 Standard File Problem A Space	Unit of measure	(bytes)				4:200.1151
		Std. routines	—	—	—	
		Fixed	6,000*	6,000*	6,000*	
		3(Blocks 1 to 23)	648	648	648	
		6(Blocks 24 to 48)	4,092	4,092	4,092	
		Files	664	4,648	4,648	
		Working	100	100	100	
		Total	11,504	15,488	15,488	

	ITEM		CONFIGURATION I, VIIA	CONFIGURATION II, III, VI	
5 Standard Mathematical Problem A	Fixed/Floating point		Floating point	Floating point	4:200.413
	Unit name	input	70/237 Reader	70/237 Reader	
		output	70/243 Printer	70/243 Printer	
	Size of record	input	80 bytes	80 bytes	
		output	132 bytes	132 bytes	
	msec/block	input T_1	42.	42.	
		output T_2	47.2	96.	
	msec penalty	input T_3	0.11	0.11	
		output T_4	0.19	0.19	
	msec/record	T_5	11.47	11.47	
	msec/5 loops	T_6	34.4	34.4	
	msec/report	T_7	3.86	3.86	

* Estimated storage requirements for Primary Operating System resident routines.

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

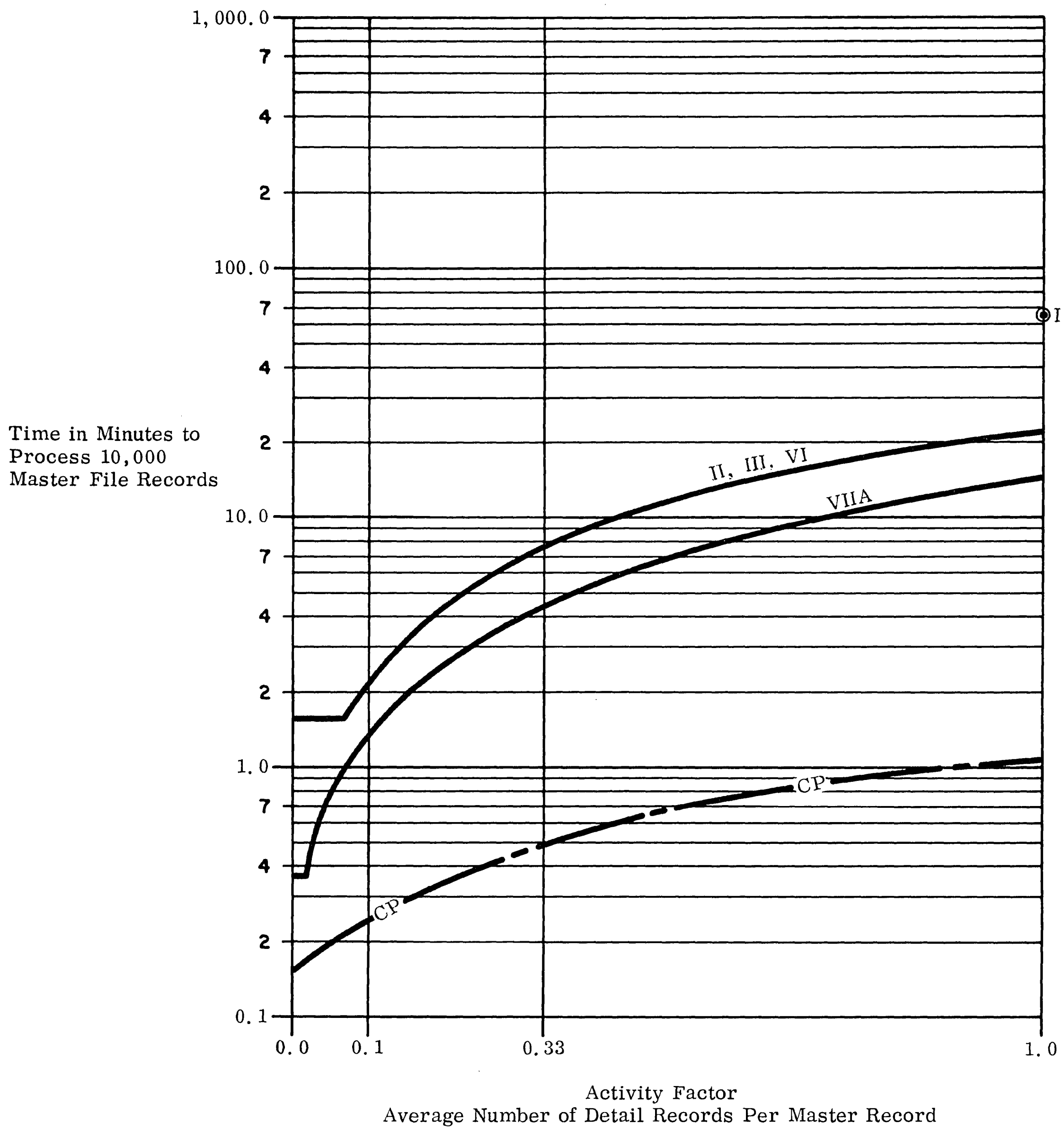
.111 Record sizes —
Master file: . . . . . . 108 characters, packed as 88 eight-bit bytes.
Detail file: . . . . 1 card.
Report file:. . . . . . . 1 line.

.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, in bytes —
Configuration I: . . . . 11,504.
Configuration II: . . . 15,488.
Configuration III: . . . 15,488.
Configuration VI: . . . 15,488.
Configuration VIIA: . 15,488.



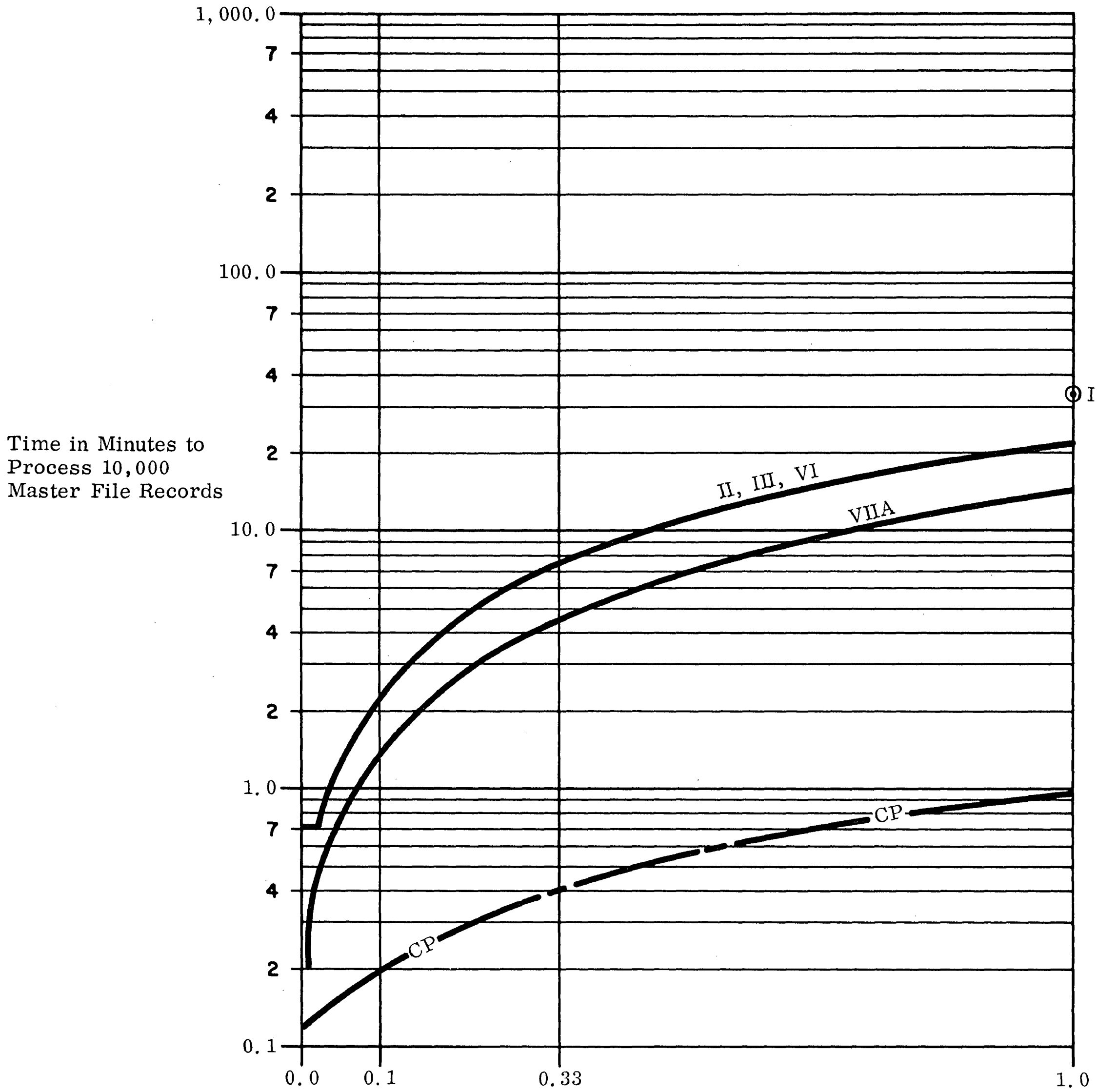
(Roman numerals denote standard System Configurations.)

LEGEND
Elapsed time; unblocked Files 3 & 4
CP Central Processor time (all configurations)

.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . . 54 characters, packed as 44 eight-bit bytes.
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.)

LEGEND

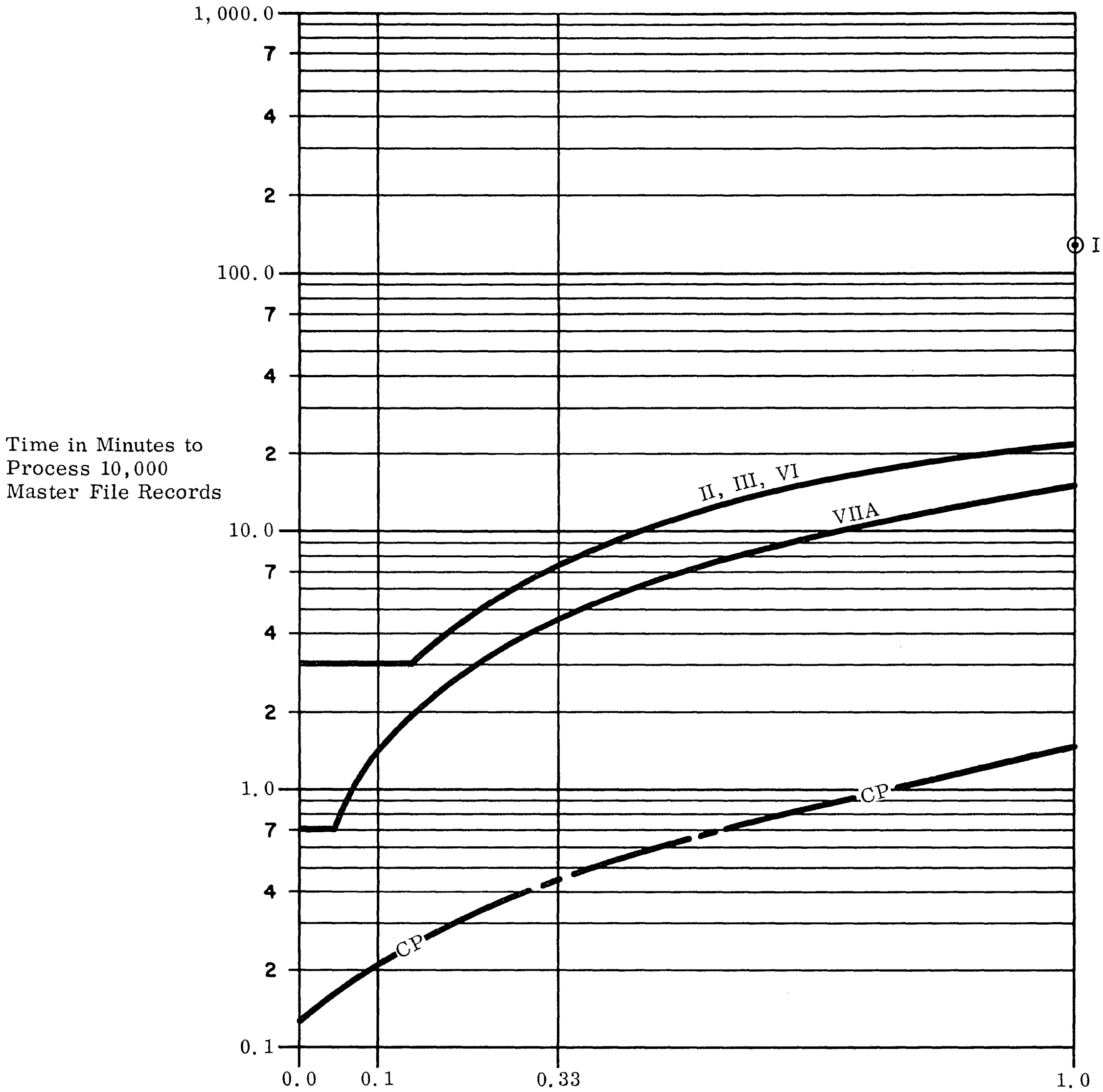
Elapsed time; unblocked Files 3 & 4
CP Central Processor time (all configurations)

(Contd.)

.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . . 216 characters, packed as 176 eight-bit bytes.
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

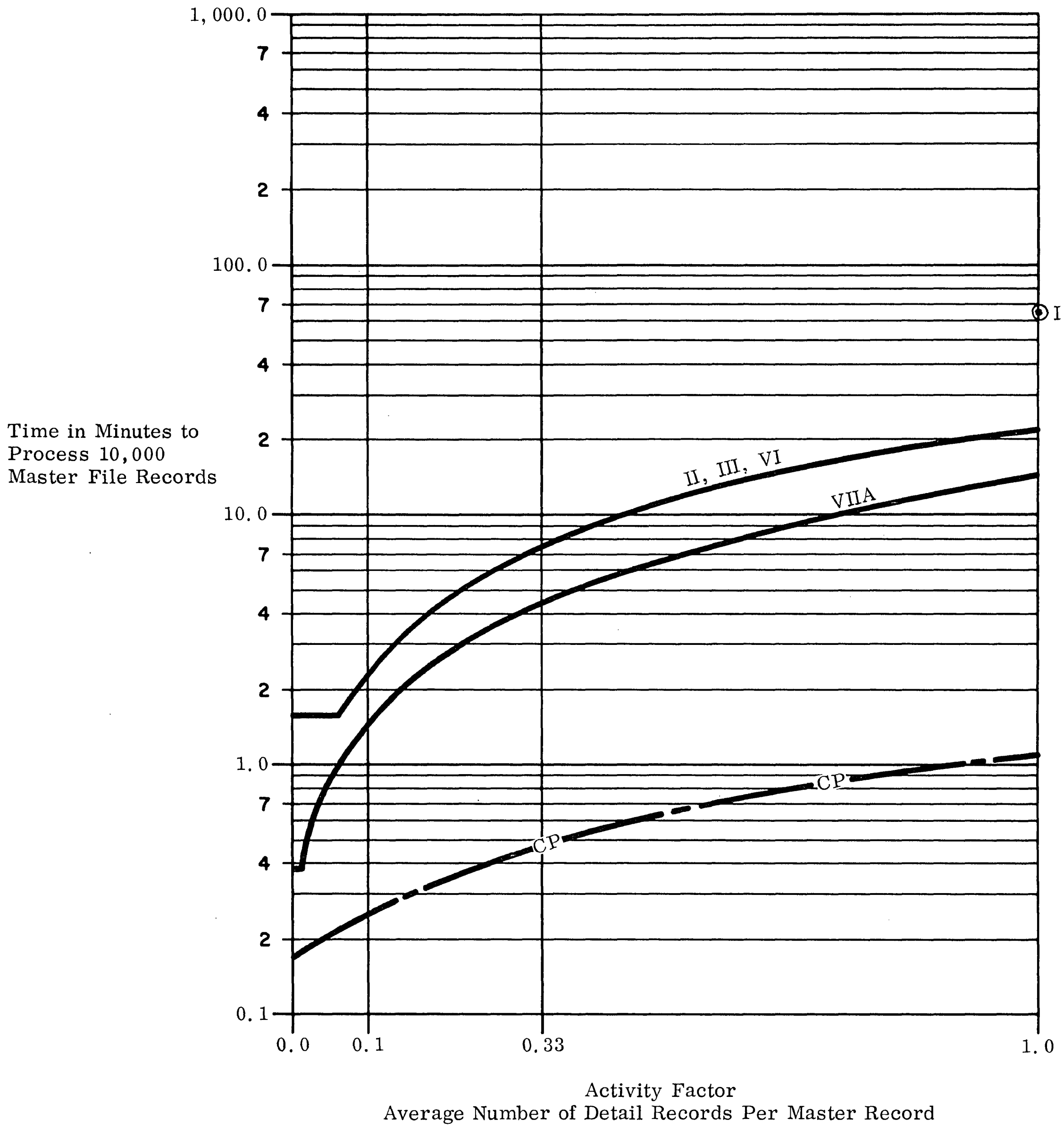
Elapsed time; unblocked Files 3 & 4

CP Central Processor time (all configurations)

.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . . . 108 characters, packed as 88 eight-bit bytes.
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.)

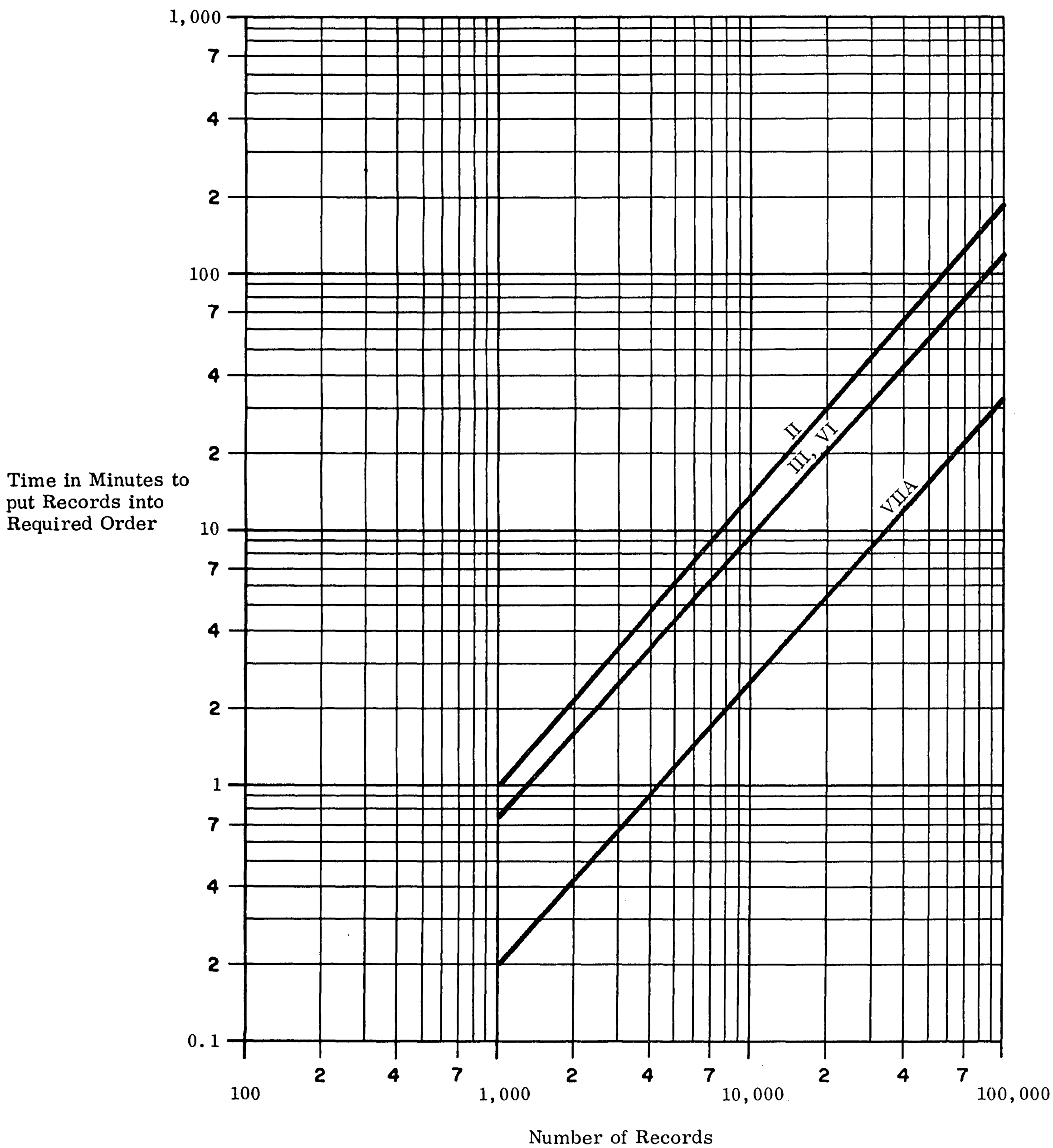
LEGEND
Elapsed time; unblocked Files 3 & 4
CP Central Processor time (all configurations)

(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.)

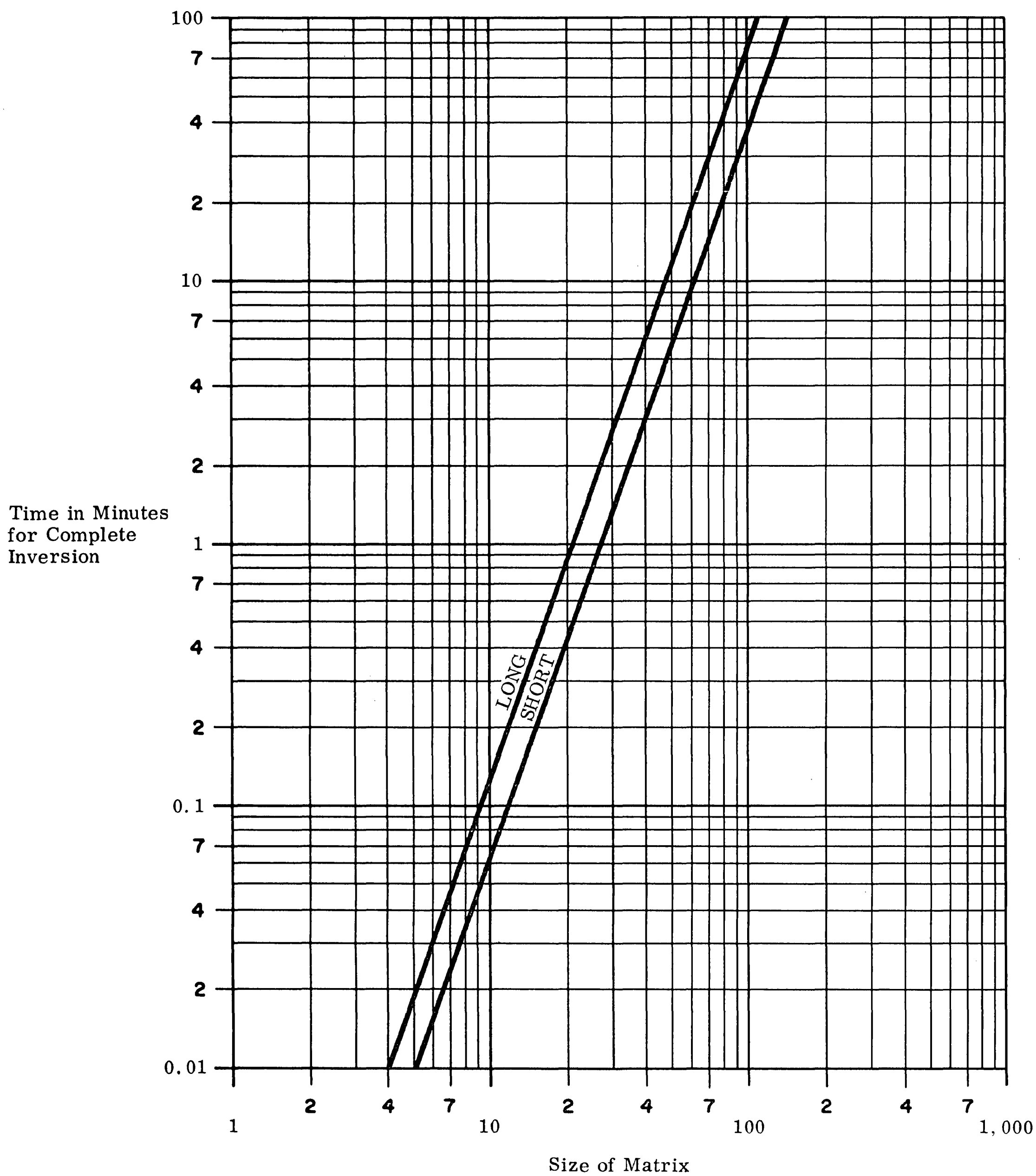
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to a precision of approximately 6 decimal digits in the SHORT format and 16 digits in the LONG format.

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

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



(Contd.)

.4 GENERALIZED MATHEMATICAL PROCESSING

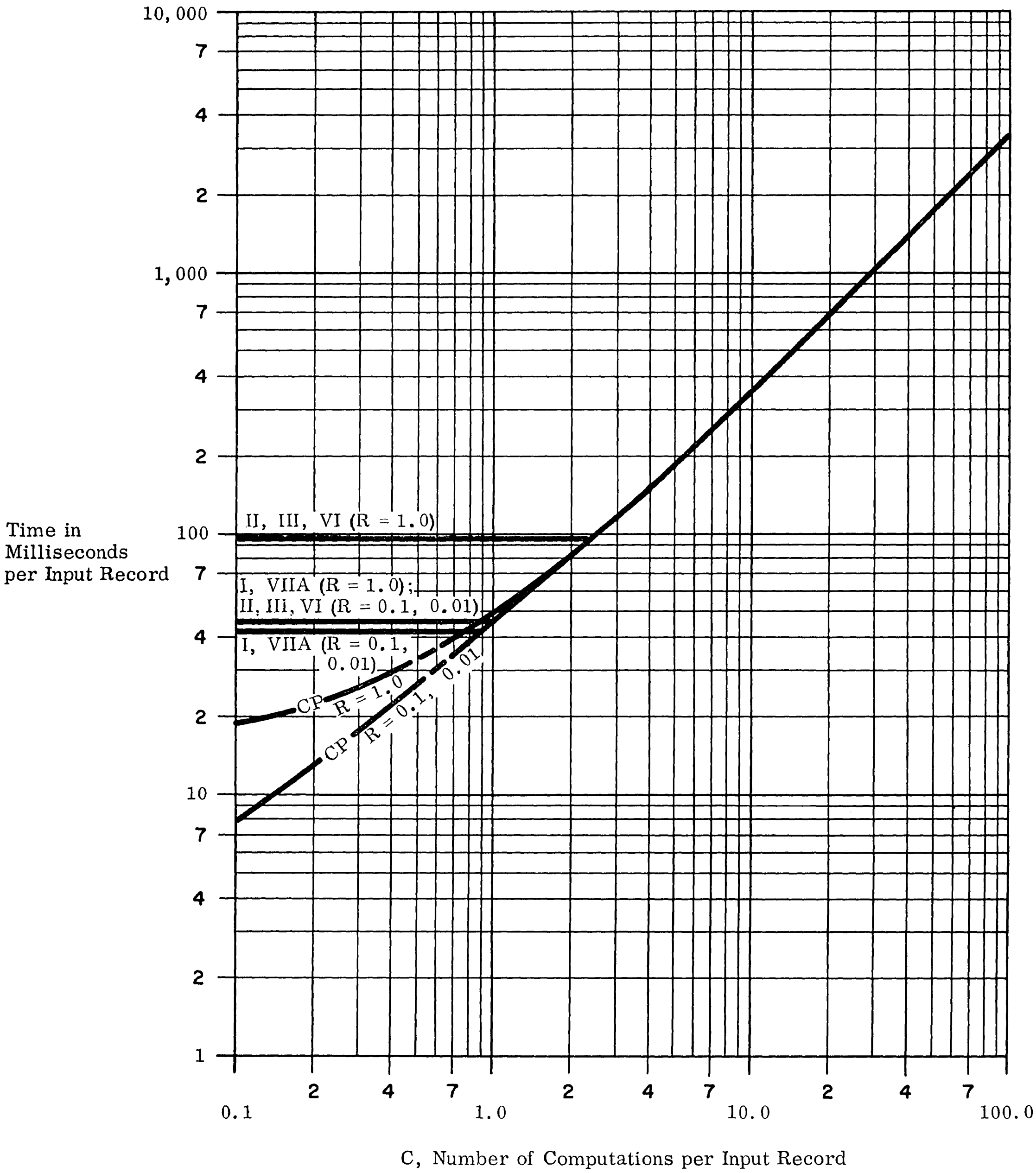
.41 Standard Mathematical Problem A Estimates

.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 in "long" floating-point mode (16-digit precision).

.413 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



Roman numerals denote Standard Configurations.
R = number of output records per input record.
Curves marked "CP" show Central Processor time.

SPECTRA 70/45

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INTRODUCTION

The Spectra 70/45 Processor can be connected to any of the Spectra 70 peripheral units, can control a communications network, and can handle a read/write Direct Control channel. Sharing of core memory between different processors is not currently possible in the Spectra 70/45, but memory-to-memory transfers can be made by means of the Data Exchange Control.

The 70/45 Processor contains from 16,384 to 262,144 bytes of core storage for program data, in addition to some non-addressable core storage used for input-output purposes. The core cycle time is 1.44 microseconds per two bytes.

The rental for typical Spectra 70/45 systems will generally fall between $7,500 and $15,000 per month, with Standard Configuration III (16K core, six 30KC magnetic tape units, reader, punch, and printer) renting at $8,450 per month for unlimited use.

The Spectra 70/45 uses a read-only memory as an internal control system, which can be expanded to permit the "emulation" of other computer machine languages. The characteristics of the 70/45 as an emulator for RCA 301 and 501 programs, as well as for IBM 1401 and 1410 programs, are discussed in Sections 710:131 through 710:135.

This report concentrates upon the characteristics and performance of the Spectra 70/45 in particular. All general characteristics of the Spectra 70 hardware and software are described in Computer System Report 710: Spectra 70 — General.

The System Configuration section which follows shows the Spectra 70/45 in the following standard 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).

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. As a matter of general interest, the rentals that would be incurred if faster magnetic tape units were installed are listed on the diagrams for Configurations VIIA and VIIB.

Section 715:051 provides detailed central processor timings for the Spectra 70/45. See Section 710:051 for all the other general characteristics of the Spectra 70 processors.

The input-output channel capabilities of the Spectra 70/45, and the demands upon the processor during input-output operations, are described in Section 715:111.

Two integrated software systems are available for use with the Spectra 70/45: the Primary Operating System and Tape-Tape/Disc Operating System. The Primary Operating System offers small-scale software (16K-byte design level) that includes an assembler, report program generator, and COBOL compiler (requiring 32K bytes of core storage) for use in a sequential processing environment. The Tape-Tape/Disc Operating System is designed at a 65K-byte level, offering more extensive and more powerful software than the Primary Operating System. The Tape-Tape/Disc Operating System features multiprogramming control for up to six concurrently-operating programs. COBOL and FORTRAN compilers and a full assembly system are also provided. Please refer to Sections 710:151 through 710:192 for descriptions of the principal software elements supplied for use with the Spectra 70/45 system.

The overall performance of any Spectra 70 system is heavily dependent upon the processor model used. A full System Performance analysis of the 70/45 is provided in Section 715:201.

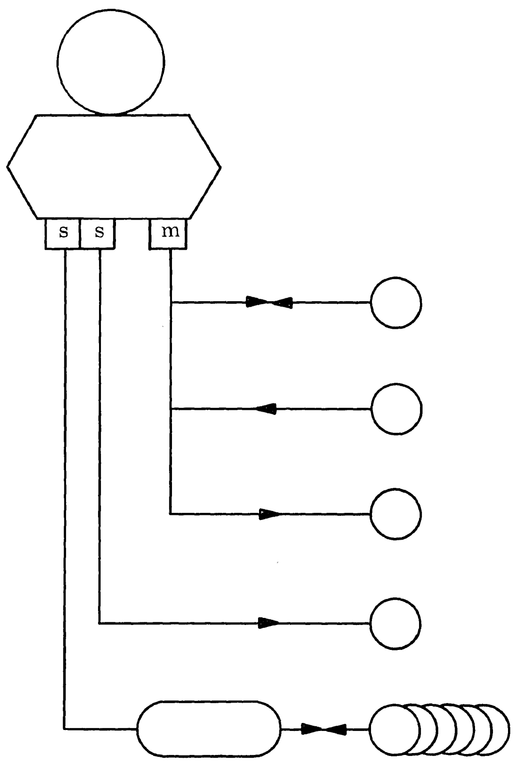
The Multiplexor Channel, with eight subchannels, is a standard feature of the RCA Spectra 70/45 processor. Memory Protect, an Elapsed-Time Clock, Direct Control, and up to three Selector Channels are optional features.

SYSTEM CONFIGURATION

System Configuration rules for the RCA Spectra 70/45 and other Spectra 70 computer systems are summarized in Report Section 710:031. This report section shows Spectra 70/45 systems arranged in several of our Standard Configurations, according to the specifications set forth in the Users' Guide, page 4:030.120.

.1 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 25% faster.



Equipment	Rental
Main Storage (16,384 bytes)	$ 3,600
70/45-C Processor (includes one Multiplexor Channel)	
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (6): 30,000 bytes/second	1,800

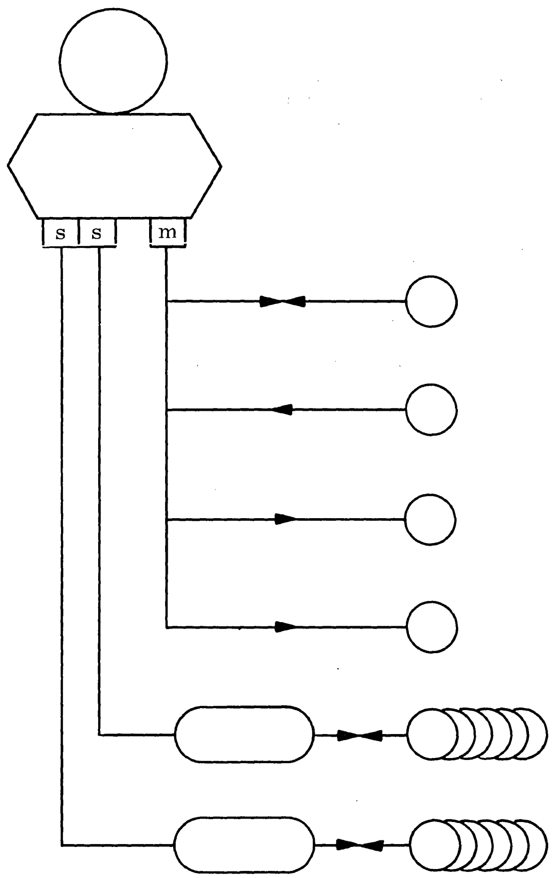
Optional Features Included: . . . . Selector Channel Feature (includes 2 channels) 220

TOTAL: $ 8,450

m - Multiplexor Channel
s - Selector Channel

.2 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 44% faster.
card punch is 50% faster.
printer is 25% faster.



Equipment	Rental
Main Storage (32,768 bytes); 70/45-D Processor (includes one Multiplexor Channel)	$4,200
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/236 Card Punch: 300 cpm	750
70/243-1 High-Speed Printer: 1,250 lpm	1,000
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (3 dual-drive units): 60,000 bytes/second	2,700
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (3 dual-drive units): 60,000 bytes/second	2,700

Optional Features Included: . . . . Selector Channel Feature (includes 2 channels) 220

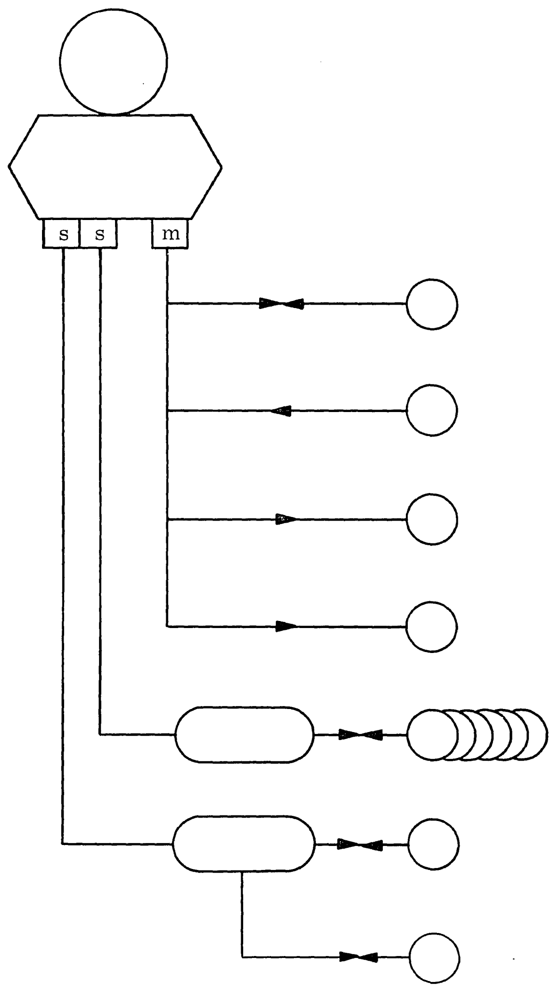
TOTAL: $13,950

m - Multiplexor Channel
s - Selector Channel

(Contd.)

.3 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 20% faster.
541 million bytes more auxiliary storage.
70/564 Disc Storage Unit is required for TDOS operating system.



Equipment	Rental
Main Storage (16,384 bytes); 70/45-C Processor (includes one Multiplexor Channel)	$3,600
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (3 dual-drive units): 30,000 bytes/second	1,800
70/568-11 Mass Storage Unit: (over 561 million bytes storage; 385 msec average access time)	2,775
70/551 Random Access Controller	525
I/O attachment feature for 70/568	175
70/564 Disc Storage Unit	575
I/O attachment feature for 70/564	NC

Optional Features Included: . . . . Selector Channel Feature (includes 2 channels) 220

TOTAL: $12,500

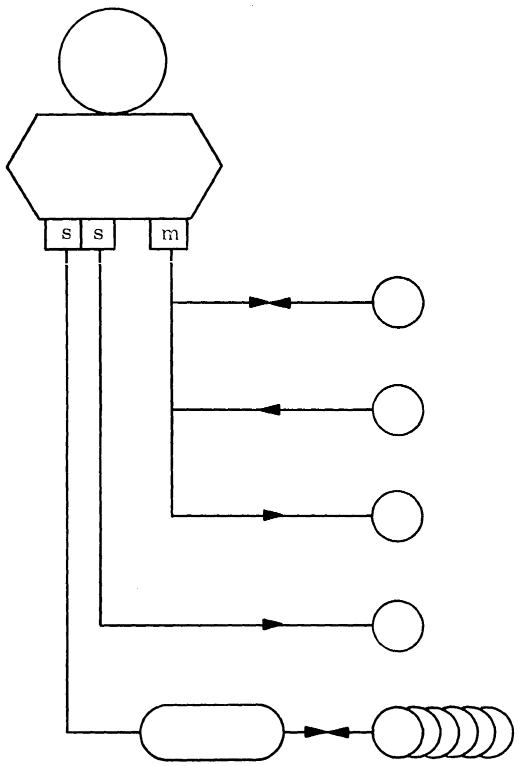
Note: The following can be used in place of the 70/568-11 Mass Storage Unit, resulting in the indicated total rental:

70/564 Disc Storage Units (3) — average access time: 97.5 msec; 21.75 million bytes storage: . . . TOTAL: $11,275

m - Multiplexor Channel
s - Selector Channel

.4 6-TAPE BUSINESS/SCIENTIFIC SYSTEM; CONFIGURATION VI

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 25% faster.



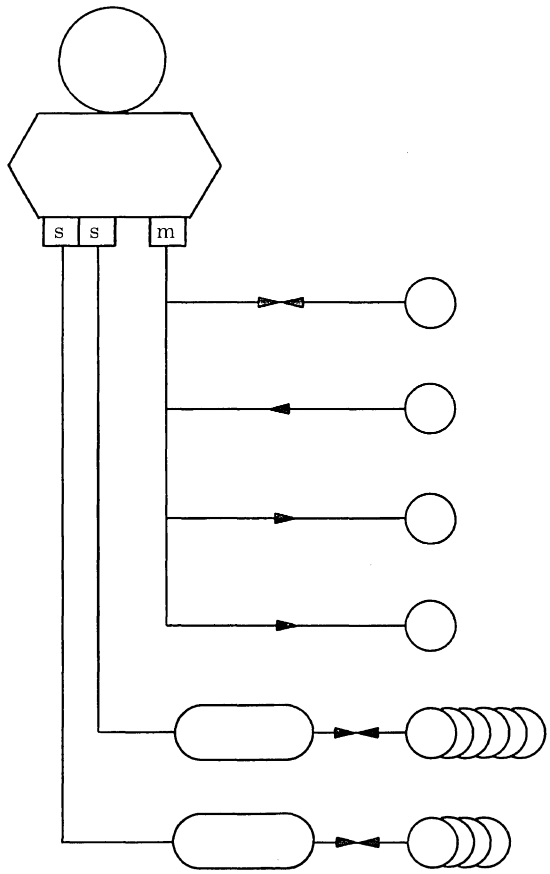
Equipment	Rental
Main Storage (65, 536 bytes) 70/45-E Processor (includes one Multiplexor Channel)	$5, 400
70/97 Console and Typewriter	330
70/237 Card Reader: 1, 435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (6): 30, 000 bytes/second	1, 800
Optional Features Included: Selector Channel Feature (includes 2 channels)	220
TOTAL:	$10, 250

m - Multiplexor Channel
s - Selector Channel

(Contd.)

.5 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIA

Deviations from Standard Configuration: . . . . card reader is 187% faster. printer is 25% faster.



Equipment	Rental
Main Storage (65,536 bytes)	$5,400
70/45-E Processor (includes one Multiplexor Channel)	
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (3 dual-drive units): 60,000 bytes/second*	2,700
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (2 dual-drive units): 60,000 bytes/second*	1,800

Optional Features Included: . . . .

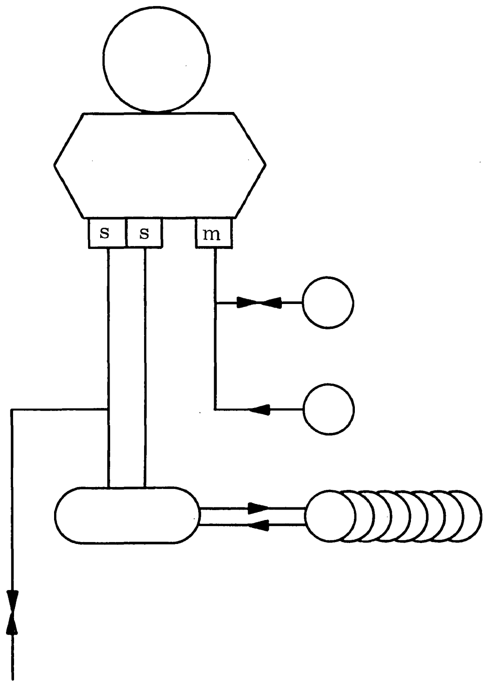
Selector Channel Feature (includes 2 channels)	220
Memory Protect	125
TOTAL:	$13,775

* The total rental using 70/445 tape drives (120,000 bytes/second) is $17,025.

m - Multiplexor Channel
s - Selector Channel

.6 10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIIB

Deviations from Standard Configuration: . . . . direct connection to satellite system.



To Satellite System
(at right)

On-Line Equipment	Rental
Main Storage (65,536 bytes) / 70/45-E Processor (includes one Multiplexor Channel)	$ 5,400
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/472-208 Tape Controller	975
70/442-2 Magnetic Tape Units (4 dual-drive units): 60,000 bytes/second*	3,600

Optional Features Included: . . . . Selector Channel Feature (includes 2 channels) 220

TOTAL ON-LINE EQUIPMENT:	$10,975*
TOTAL SATELLITE EQUIPMENT:	$ 4,725
TOTAL RENTAL:	$15,700

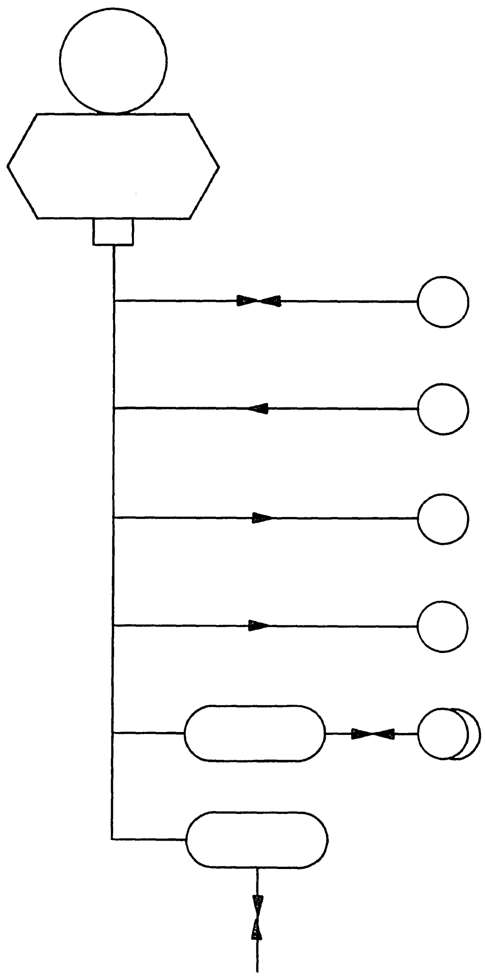
* The total rental using 70/445 Magnetic Tape Stations (120,000 bytes/second) is $18,300.

m - Multiplexor Channel
s - Selector Channel

(Contd.)

SATELLITE EQUIPMENT; CONFIGURATION VIIB (Contd.)

Deviations from Standard Configuration: . . . . core memory is 134% larger.
card reader is 187% faster.
printer is 25% faster.



to Main System
(at left)

Satellite Equipment	Rental
Main Storage (8,192 bytes) 70/15 Processor (includes one I/O Channel and Read Auxiliary Mode)	$1,000
70/216 Input-Output Typewriter	175
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Unit (one dual-drive unit): 30,000 bytes/second	600
70/627 Data Exchange Control	450
TOTAL SATELLITE EQUIPMENT:	$ 4,725

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70/45 Processor.

.12 Description

See Section 710:051 for a comprehensive description of the general characteristics of the 70/45 Processor and other processors in the Spectra 70 line.

See Sections 710:131 through 710:135 for descriptions of the characteristics of the 70/45 Processor when using a machine code defined by one of the emulator options (i.e., when executing programs written for an IBM 1401 or 1410, or an RCA 301 or 501).

See the Introduction to this subreport, Section 715:011, for a summary of the distinguishing features of the 70/45 Processor as used in Spectra 70 computer systems.

The Instruction Times and Processor Performance times for Spectra 70/45 systems, in all four modes of arithmetic, are listed below. See Paragraphs 4:050.41 and 4:050.42 of the Users' Guide for the definition of these standard measures of central processor performance.

.4 PROCESSOR SPEEDS

In DECIMAL operations, execution times are expressed in terms of D, the number of decimal digits in the operand from the user's viewpoint. (From the machine point of view, the actual operand lengths are sometimes different.) D represents the operand length in 4-bit digits, packed 2 digits per 8-bit byte, including the sign digit. Because of the byte structure of the system, the formulas yield accurate times only for even values of D.

In BINARY operations, fixed-point times normally reflect one-word (32-bit) operands. Short floating-point operands are one word long and provide a minimum precision of 21 bits; long floating-point operands are two words long and provide a minimum precision of 53 bits.

.41 Instruction Times in Microseconds

.411 Fixed point —

	Binary	Decimal
Add-subtract:	8.88	15.36 + 2.2D
Multiply:	65.64	$28.94 + 9.78D + 1.17D^2$
Divide:	94.89	$26.33 + 19.14D + 2.7D^2$

.412 Floating point —

	Long	Short
Add-subtract:	27.69	19.20
Multiply:	186.55	49.42
Divide:	280.27	83.00

.413 Additional allowance for —
- Single indexing: . . . . 0.
- Double indexing: . . . ?
- Indirect addressing: . none.
- Recomplementing: . . none.

.414 Control:
- Compare —
  - Fixed point: 8.40
  - Decimal: . . . . 16.80 + 1.5D
  - Floating point:
    - Long: 23.52
    - Short: 15.36
  - Logical: 8.40
- Branch: 4.56

.415 Counter control —
- Step: 5.28
- Step and test: 5.76
- Test: 5.28

.416 Edit: . . . . 10.56 + 4.92D - 0.6K where K = number of control characters.

.417 Convert —
- To binary: 91.20
- To decimal: . . . . . . 68.88 to 91.92

.418 Shift (under 16 bits) —

Left:	7.92 + 0.48N (single); 7.68 + 0.96N (double).
Right:	8.88 + 0.48N (single); 7.44 + 0.96N (double), where N = number of bit positions to be shifted.

.42 Processor Performance in Microseconds

.421 For random addresses —

	Fixed Point	Floating Point
c = a + b:	25.2 (binary)	52.6 (long)
	25.74 + 2.94D (decimal)	37.4 (short)
b = a + b:	25.2 (binary)	52.6 (long)
	16.8 + 1.5D (decimal)	37.4 (short)
Sum N items:	8.88N (binary)	23.52N (long)
	(16.8 + 1.5D)N (decimal)	15.36N (short)
c = ab:	81.9 (binary)	211.5 (long)
	$38.84 + 10.89D + 1.17D^2$ (decimal)	67.6 (short)
c = a/b:	111.2 (binary)	305.2 (long)
	$36.23 + 20.3D + 2.7D^2$ (decimal)	101.2 (short)

.422 For arrays of data —

$c_i = a_i + b_j$:	45.84 (binary)	79.72 (long)
	43.56 + 5.16D (decimal)	63.68 (short)
$b_j = a_i + b_j$:	37.44 (binary)	74.44 (long)
	33.66 + 2.94D (decimal)	58.40 (short)
Sum N items:	37.44 (binary)	74.44N (long)
	33.66 + 2.94D (decimal)	58.40N (short)
$c = c + a_ib_j$:	93.68 (binary)	244.22 (long)
	$78.2 + 11.65K + 1.17D^2$ (decimal)	96.80 (short)

.423 Branch based on comparison —

Numeric:	44.16
Alphabetic data:	44.16

.424 Switching —

Unchecked:	29.28
Checked:	52.8
List search:	36.62 + 27.12D

.425 Format control, per character —

Unpack:	2.88
Compose:	8.4

.426 Table look-up, per comparison —

For a match:	27.12N
For least or greatest:	31.75N
For interpolation point:	27.12N

.427 Bit indicators —

Set bit in separate location:	5.04
Set bit in pattern:	6.96
Test bit in separate location:	12.24
Test bit in pattern:	13.20

.428 Moving: . . . . 8.94 + 1.44D

SIMULTANEOUS OPERATIONS

An RCA Spectra 70/45 system can concurrently execute:

- One machine instruction; and
- Up to three input-output operations, one on each of the optional Selector Channels; and
- Up to eight additional input-output operations, one on each of the individual subchannels included in the standard Multiplexor Channel.

The demand on the central processor (i.e., the "interference" or delay imposed upon the central processor program by each individual input-output operation) will vary depending on whether the peripheral device is connected to one of the Selector Channels or to the Multiplexor Channel. (See the general discussion of Spectra 70 Simultaneous Operations on page 710:111.100.) Selector Channel I/O operations require one 1.44-microsecond memory cycle for each one-byte load of data transferred into or out of core storage; for Multiplexor Channel operations, the demands are much higher. In Table I, the processor demands imposed by each of the peripheral units are listed for both types of channels (next page).

The specific characteristics of the Spectra 70/45 Selector and Multiplexor Channels can be summarized as follows:

Selector Channels

Maximum number:	3.
Maximum data rate per channel:	465 kilobytes/second (70/45 Processor throughput limit).
Number of trunks per channel:	2.
Causes processor delay during—	
Input-output initiation and termination:	yes.
Data transfers:	yes, each byte.
Chaining:	yes.

Multiplexor Channels

Maximum number:	1.
Maximum number of trunks per channel:	8.
Maximum data rate (multiplexed):	62 kilobytes/second.
Maximum data rate (burst mode):	465 kilobytes/second.
Causes processor delays during all input-output processing:	yes.

TABLE I: INPUT-OUTPUT DEMANDS UPON THE SPECTRA 70/45 PROCESSOR

Device	Average Data Rate (Kilobytes/ second)	Peak Data Rate (Kilobytes/ second)	Maximum Demands Upon 70/45 Processor	
			Via Selector Channel	Via Multiplexor Channel
70/97 Console and Typewriter, 10 cps	0.01	0.01	-	-
70/221 Paper Tape Reader/Punch -				
Reading, 200 cps	0.2	0.2	0.03%	0.32%
Punching, 100 cps	0.1	0.1	0.01%	0.16%
70/234 Buffered Card Punch, 100 cpm	0.1	8.0	0.01%	0.16%
70/236 Buffered Card Punch, 300 cpm	0.4	8.0	0.06%	0.64%
70/237 Card Reader, 1435 cpm	1.9	1.9	0.27%	3.1%
70/242-1 Printer, 132 columns, 625 lpm, buffered	1.4	27.0	0.19%	2.3%
70/242-2 Printer, 160 columns, 625 lpm, buffered	1.7	32.2	0.24%	2.7%
70/243-1 Printer, 132 columns, 1250 lpm, buffered	2.7	27.0	0.39%	4.4%
70/243-2 Printer, 160 columns, 1250 lpm	3.3	32.2	0.48%	5.3%
70/248 Bill Feed Printer, buffered —				
600 lpm, forms	1.3	27.0	0.19%	2.1%
400 lpm, cards	0.8	9.0	0.08%	1.3%
70/432 Magnetic Tape Unit, 30KB/sec	30.0	30.0	4.3%	48.4%
70/442 Magnetic Tape Unit, 60KB/sec	60.0	60.0	8.6%	96.7%
70/445 Magnetic Tape Unit, 120KB/sec	120.0	120.0	17.3%	100 %
70/251 Videoscan Document Reader, 1300 dpm	1.5	1.5	0.22%	2.4%
70/653 Communication Control (Single Channel)	0.2	5.1	0.03%	0.32%
70/627 Data Exchange Control	*	*	-	-
70/564 Disc Storage Unit	156.0	156.0	22.5%	100 %
70/568-11 Mass Storage Unit	62.0	62.0	10.1%	100 %
70/565-13 Drum Memory Unit	117.0	117.0	30.3%	100 %

*Speed is determined by the memory cycle time of the slower of the two communicating Spectra 70 processors.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (715:201.100)

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 it is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of varied record sizes in the master file. Standard Problem D increases the amount of computation performed on each transaction. Each problem is estimated for activity factors (ratios of the number of detail records to the number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

In Configurations 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. The controlling factor in these curves is the printer at high and moderate activities and the master file tapes at low activity.

In Configuration VIIB, all files - master, detail, and report - are assigned to magnetic tape. The detail and report file tapes are assumed to be transcribed off-line from punched cards and to the printer. Configuration VIIB is shown with the report and detail file tapes both blocked (dashed curves) and unblocked (solid curves). The controlling factor at all activities is a combination of one master file tape and the report file tape. Because multiprogramming, or concurrent execution of two or more independent programs, is a featured capability of the Spectra 70/45, the time actually used by the central processor (CP) is also plotted. By comparing the curves of total time for the various configurations with the central processor curves, it can be seen that even in the worst case (Configuration VIIB using blocked detail and report files, when the computation load has been trebled), some 30% of the available processing capacity is not in use. A comparison of the central processor curves for a standard amount of computation and for trebled computation (i.e., the curves for Problems A and D, respectively) shows the effect of increasing the computational workload.

SORTING (715:201.200)

The standard estimate for sorting 80-character records by straightforward merging on magnetic tape was developed from the time for Standard File Processing Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide. A three-way merge was used in all the configurations shown.

MATRIX INVERSION (715:201.300)

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. Obtaining this precision in the Spectra 70/45 requires use of the double-precision floating-point instructions; however, because the shorter single-precision form, which provides just over 6 decimal digits' precision, will be used wherever practical, the times for single-precision operation have also been computed and included in the graph.

GENERALIZED MATHEMATICAL PROCESSING (715:201.400)

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. All computations are carried out in the double-precision floating-point mode because the single-precision mode was considered to have insufficient accuracy for this type of computation. As in the File Processing problems, the total elapsed time is shown by the solid lines in Graph 715:201.400, while the curves marked "CP" show central processor time.

WORKSHEET DATA TABLE 1

	ITEM		III & VI	IV	VIIA	VIIB (blocked Files 3 & 4)	VIIB (unblocked Files 3 & 4)	REFERENCE
1	Char/block	(File 1)	1,056	1,056	1,056	1,056	1,056	
Standard File Problem A Input-Output Times	Records/block	K (File 1)	12	12	12	12	12	
	msec/block	File 1 = File 2	51.2	25.6	25.6	25.6	25.6	
		File 3	42	42	42	24.0*	9.3	
		File 4	131	79	131	32.4*	10.2	
	msec/switch	File 1 = File 2	0	0	0	0	0	4:200.112
		File 3	0	0	0	0	0	
		File 4	0	0	0	0	0	
	msec penalty	File 1 = File 2	1.52	1.52	1.52	1.52	1.52	
		File 3	0.12	0.12	0.12	1.38*	0.12	
		File 4	0.19	0.19	0.19	2.28*	0.19	
2	msec/block	a_1	0.22	0.22	0.22	0.22	0.22	
Central Processor Times	msec/record	a_2	0.32	0.32	0.32	0.32	0.32	4:200.1132
	msec/detail	b_6	0.61	0.61	0.61	0.61	0.61	
	msec/work	$b_5 + b_9$	0.63	0.63	0.63	0.63	0.63	
	msec/report	$b_7 + b_8$	1.14	1.14	1.14	1.14	1.14	

	ITEM		III & VI C.P.	III & VI Printer	IV C.P.	IV Printer	VIIA C.P.	VIIA Printer	VIIB (blocked) C.P.	VIIB (blocked) Tapes	VIIB (unblocked) C.P.	VIIB (unblocked) Tapes	REFERENCE
3	msec/block	a_1	0.2		0.2		0.2		0.2		0.2		
Standard Problem A at F = 1.0	for C.P.	a_2K	3.8		3.8		3.8		3.8		3.8		
	and	a_3K	28.6		28.6		28.6		28.6		28.6		
	dominant	File 1: Master In	1.5		1.5		1.5		1.5		1.5		
	column.	File 2: Master Out	1.5		1.5		1.5		1.5	25.6	1.5	25.6	4:200.114
		File 3: Details	1.4		1.4		1.4		1.4		1.4		
		File 4: Report	2.3	1,572	2.3	948	2.3	1,572	2.3	34.4	2.3	122.4	
		Total	39.3	1,572	39.3	948	39.3	1,572	39.3	60.0	39.3	148.0	

	ITEM		III & VI	IV	VIIA	VIIB (blocked Files 3 & 4)	VIIB (unblocked Files 3 & 4)	REFERENCE
4	Unit of measure	(bytes)						
Standard Problem A Space		Std. routines	6,000	6,000	6,000	6,000	6,000	
		Fixed	128	128	128	128	128	
		3(Blocks 1 to 23)	648	648	648	648	648	
		6(Blocks 24 to 48)	4,092	4,092	4,092	4,092	4,092	4:200.1151
		Files	4,648	4,648	4,648	9,312	4,648	
		Working	100	100	100	100	100	
		Total	15,616	15,616	15,616	20,280	15,616	

	ITEM		CONFIGURATION III, VI, VIIA	IV	VIIB	REFERENCE
5	Fixed/Floating point		Floating Point	Floating Point	Floating Point	
Standard Mathematical Problem A	Unit name	input	70/237 Reader	70/237 Reader	70/442 Tape	
		output	70/242 Printer	70/243 Printer	70/442 Tape	
	Size of record	input	80 bytes	80 bytes	80 bytes	
		output	132 bytes	132 bytes	80 bytes	
	msec/block	input T_1	42.	42.	9.4	4:200.413
		output T_2	96.	47.2	9.4	
	msec penalty	input T_3	0.11	0.11	0.11	
		output T_4	0.19	0.19	0.11	
	msec/record	T_5	3.45	3.45	3.45	
	msec/5 loops	T_6	10.35	10.35	10.35	
	msec/report	T_7	1.76	1.76	1.76	

* Files 3 and 4 blocked 12 records/block.

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

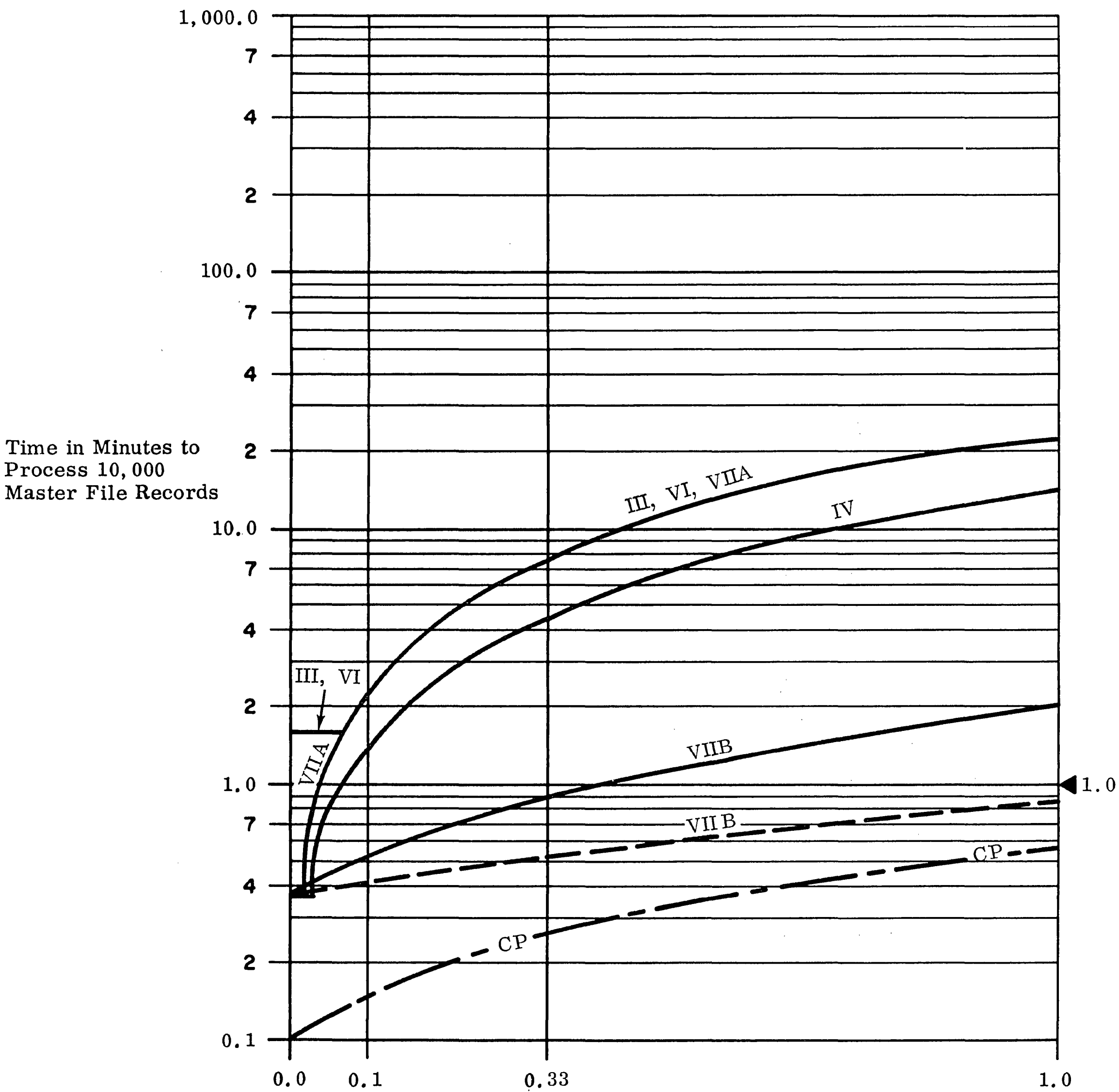
.111 Record sizes —
- Master file: . . . . . 108 characters, packed as 88 eight-bit bytes.
- Detail file: . . . . . 1 card.
- Report file: . . . . . 1 line.

.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, VI, VIIA: . . . . 15,616 bytes.
- Configuration IV: . . 15,616 bytes.
- Configuration VIIB (unblocked Files 3 & 4) . . . . 15,616 bytes.
- Configuration VIIB (blocked Files 3 & 4). . . . . . . 20,280 bytes.



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 (all configurations)

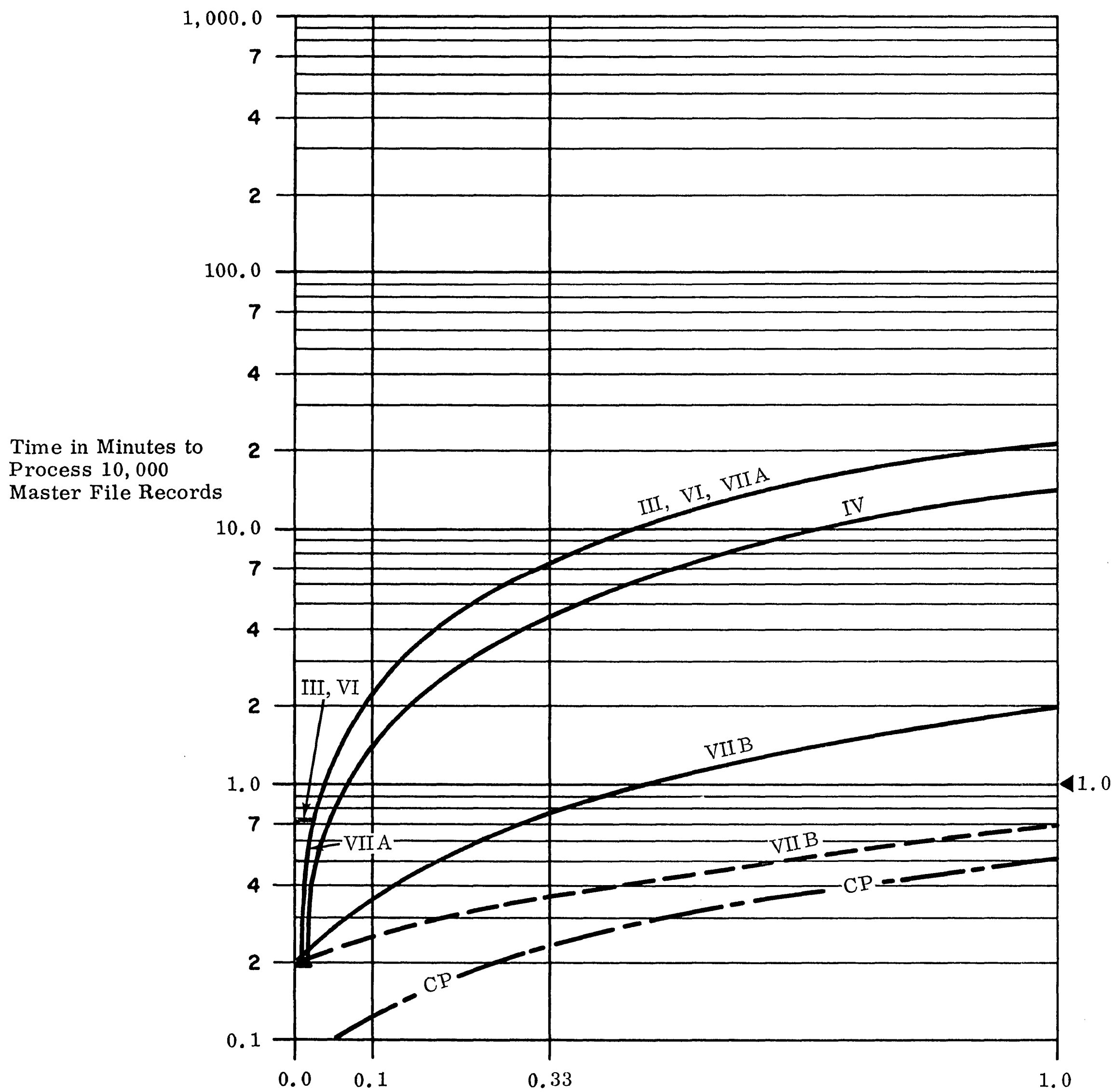
.12 Standard File Problem B

.121 Record sizes —
- Master file: . . . . . 54 characters, packed as 44 eight-bit bytes.
- 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 (all configurations)

(Contd.)

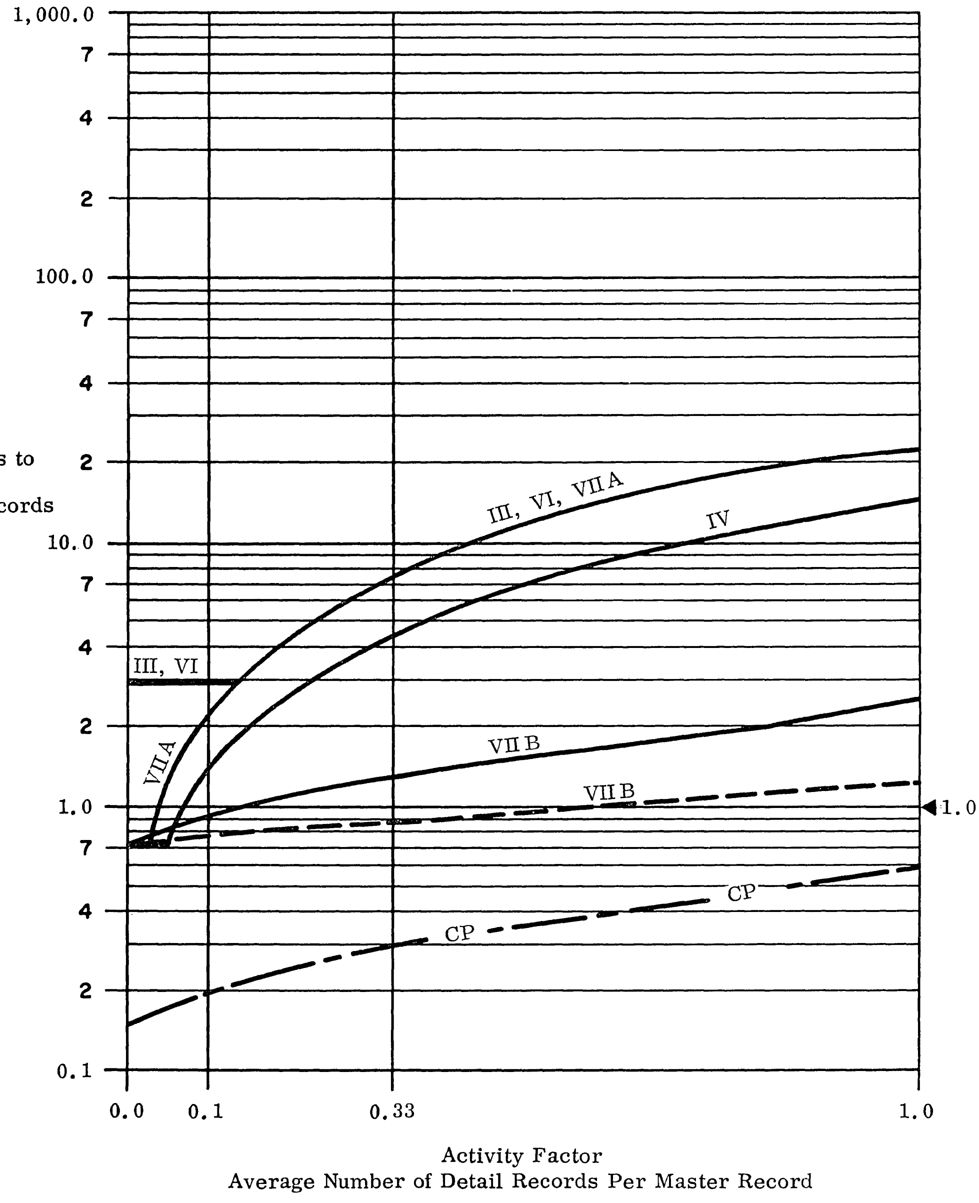
.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . 216 characters, packed as 176 eight-bit bytes.
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 (all configurations)

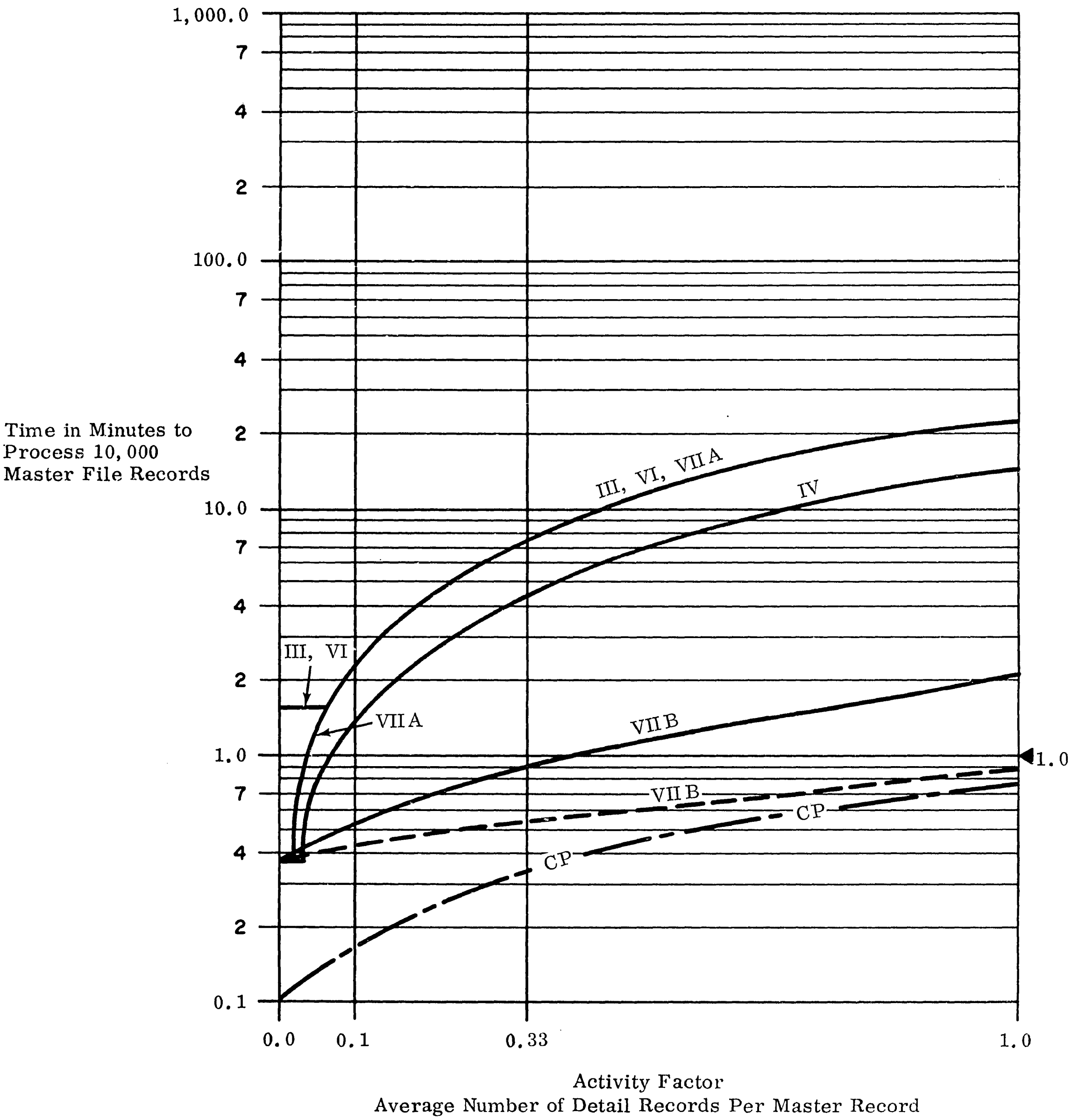
.14 Standard File Problem D

.141 Record sizes —
Master file: . . . . . 108 characters, packed as 88 eight-bit bytes.
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.)

LEGEND

Elapsed time; unblocked Files 3 & 4
Elapsed time; blocked Files 3 & 4
CP Central Processor time (all configurations)

(Contd.)

.2 SORTING

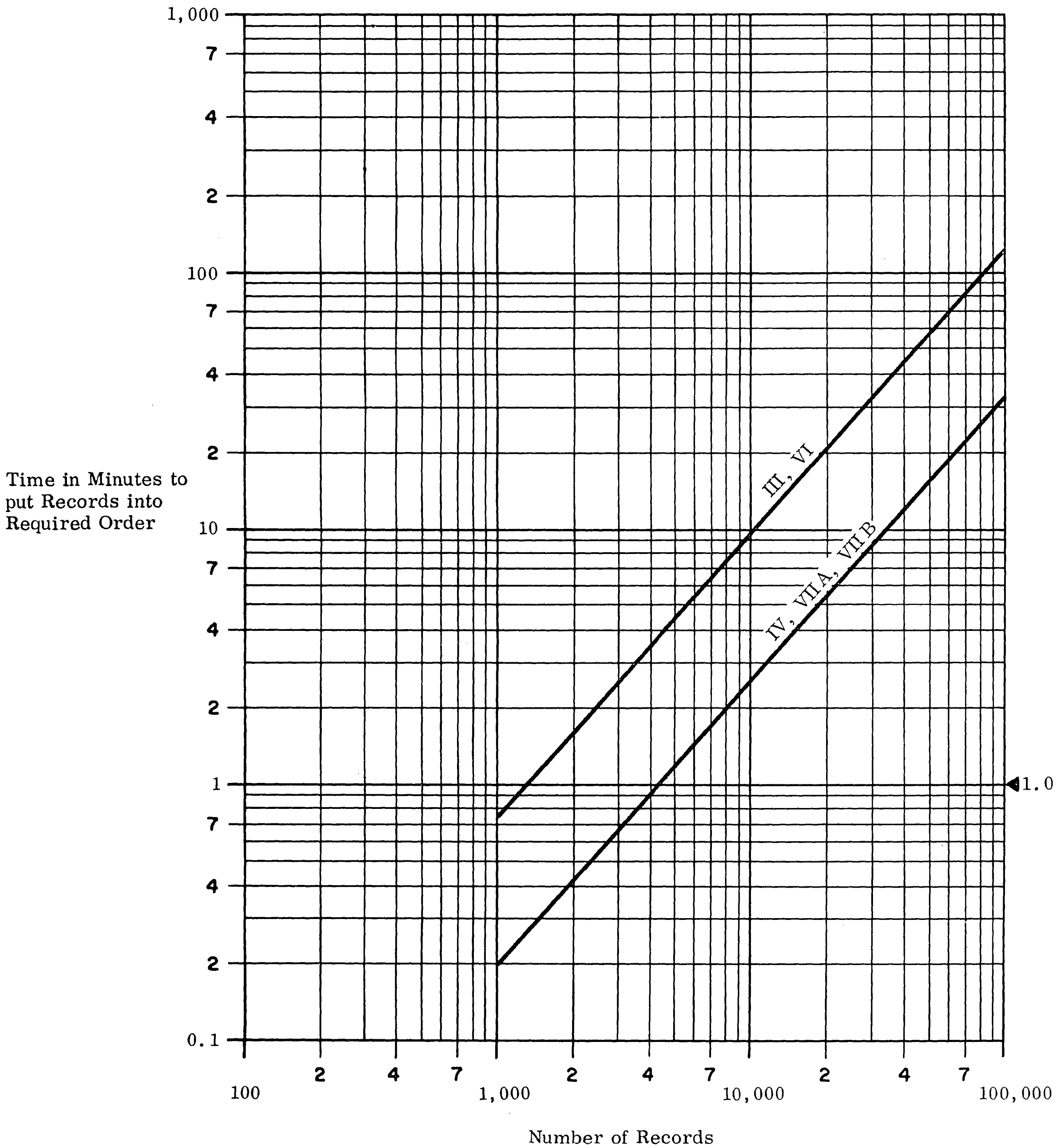
.21 Standard Problem Estimates

.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.)

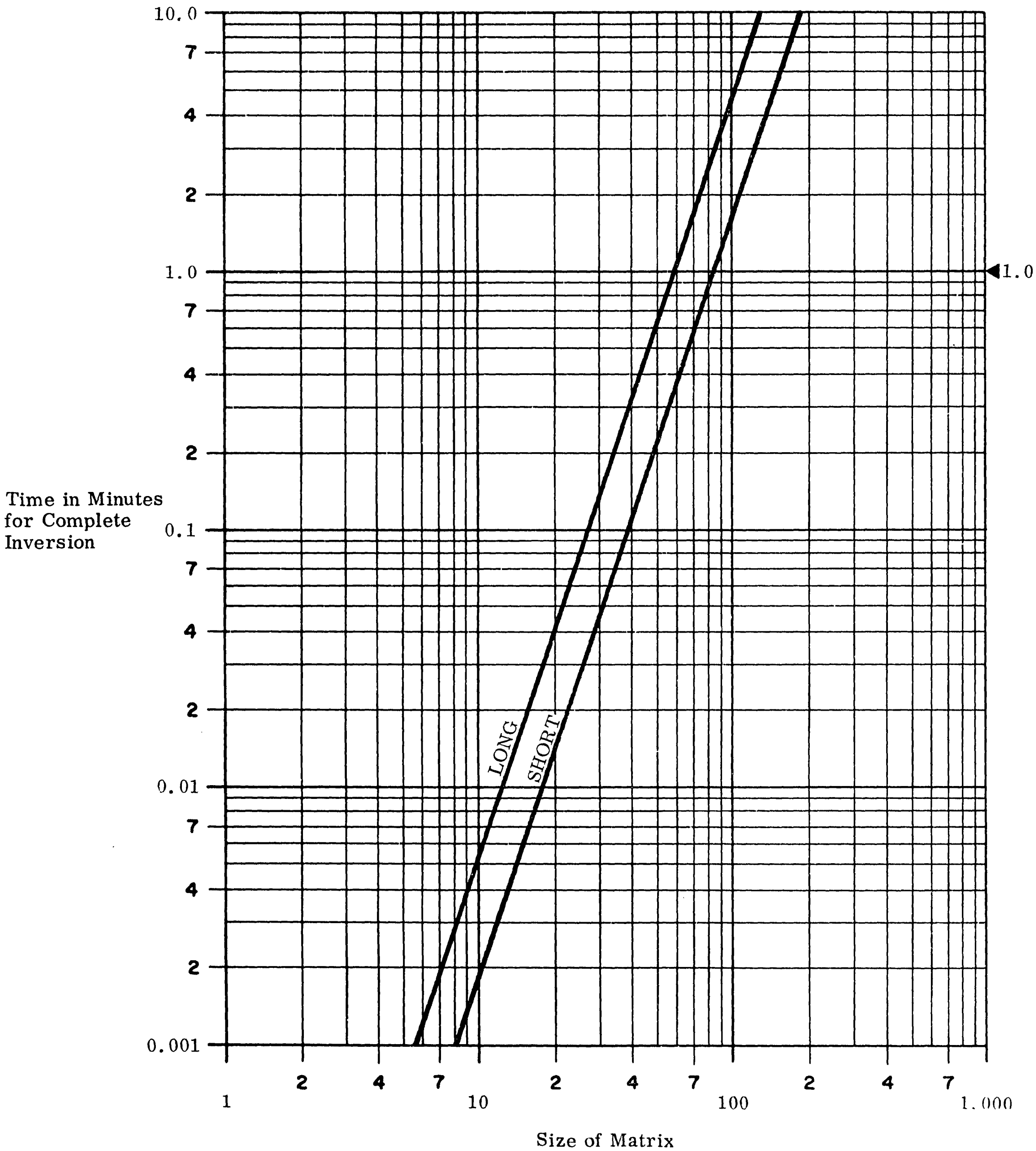
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to a precision of approximately 6 decimal digits in the SHORT format and 16 digits in the LONG format.

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

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



(Contd.)

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.4 GENERALIZED MATHEMATICAL PROCESSING

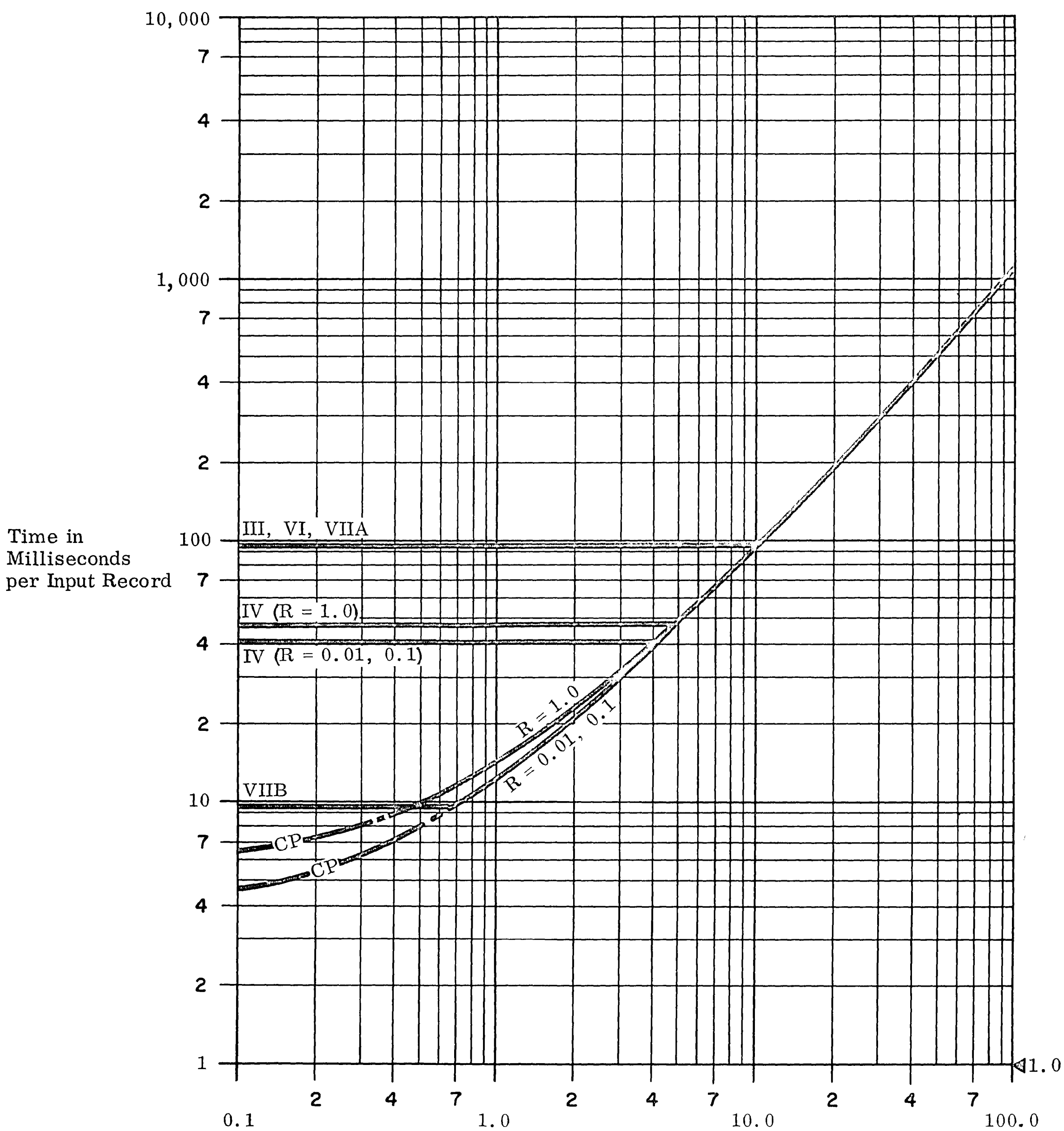
.41 Standard Mathematical Problem A Estimates

.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 in "long" floating-point mode (16-digit precision).

.413 Timing basis: . . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



C, Number of Computations per Input Record

Roman numerals denote Standard Configurations.
R = number of output records per input record.
Curves marked "CP" show central processor time.

SPECTRA 70/55

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INTRODUCTION

The Spectra 70/55 Processor can be connected to any of the Spectra 70 peripheral units, can handle a read/write Direct Control channel, and can control a data communications network. Communication between different computers can be via memory-to-memory transfers or via core memory modules shared with another Spectra 70/55 processor.

Processor control is not by read-only memory, as in the Spectra 70/35 and 70/45; conventional wired circuits are used for control purposes. It is not possible to add read-only memories to the 70/55 Processor, so there is no compatibility between previous RCA or IBM systems and the Spectra 70/55 through the compatibility technique called "emulation."

The 70/55 Processor contains from 65,536 to 524,288 bytes of core storage for program data, in addition to some non-addressable core storage which is used for input-output purposes. The core cycle time is 0.84 microseconds per four bytes.

The rental for typical Spectra 70/55 systems will generally fall between $10,000 and $30,000 per month, with standard Configuration VIIB (65K core, eight 60KC magnetic tape units, and a satellite Spectra 70/15 Processor) renting at $19,080 per month for unlimited use.

This report concentrates upon the characteristics and performance of the Spectra 70/55 in particular. All general characteristics of the Spectra 70 hardware and software are described in Computer System Report 710: RCA Spectra 70 — General.

The System Configuration section which follows shows the Spectra 70/55 in the following standard 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)
VIIIB:	20-Tape General System (Paired).

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. As a matter of general interest, the rentals that would be incurred if faster magnetic tape units were installed are listed on the diagrams for Configurations VIIA and VIIB.

Section 716:051 provides detailed central processor timings for the Spectra 70/55. See Section 710:051 for all the other general characteristics of the Spectra 70 processors.

The input-output channel capabilities of the Spectra 70/55, and the demands upon the processor during input-output operations, are described in Section 716:111.

Two integrated software systems are available for use with the Spectra 70/55: the Primary Operating System and Tape-Tape/Disc Operating System. The Primary Operating System offers small-scale software (16K-byte design level) that includes an assembler, report program generator, and COBOL compiler (requiring 32K bytes of core storage) for use in a sequential processing environment. The Tape-Tape/Disc Operating System is designed at a 65K-byte level, offering more extensive and more powerful software than the Primary Operating System. The Tape-Tape/Disc Operating System features multiprogramming control for up to six concurrently-operating programs. COBOL and FORTRAN compilers and a full assembly system are also provided. Please refer to Sections 710:151 through 710:192 for descriptions of the principal software elements supplied for use with the Spectra 70/55 system.

The overall performance of any Spectra 70 system is heavily dependent upon the processor model used. A full System Performance analysis of the 70/55 is provided in Section 716:201.

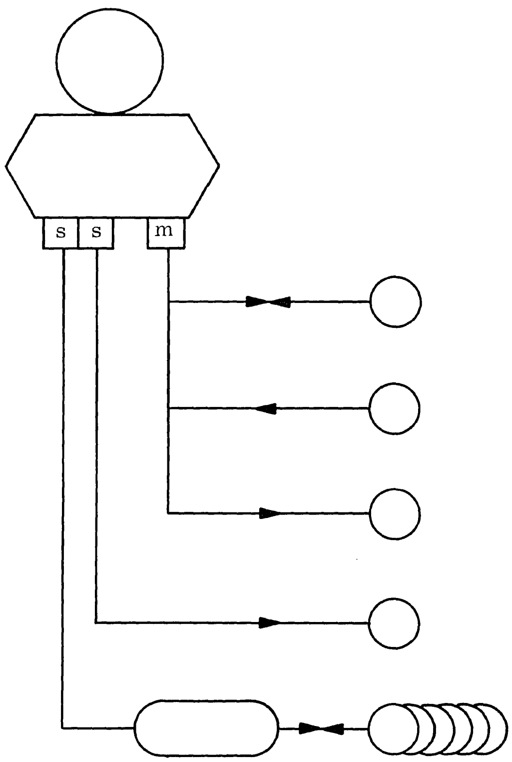
The Multiplexor Channel, with eight subchannels, is a standard feature of the RCA Spectra 70/45 processor. Memory Protect, an Elapsed-Time Clock, Direct Control, and up to six Selector Channels are optional features.

SYSTEM CONFIGURATION

System Configuration rules for the RCA Spectra 70/55 and other Spectra 70 computer systems are summarized in Report Section 710:031. This report section shows Spectra 70/55 systems arranged in several of our Standard Configurations, according to the specifications set forth in the Users' Guide, page 4:030.120.

.1 6-TAPE BUSINESS SYSTEM; CONFIGURATION III

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 25% faster.
core storage is 300% larger.

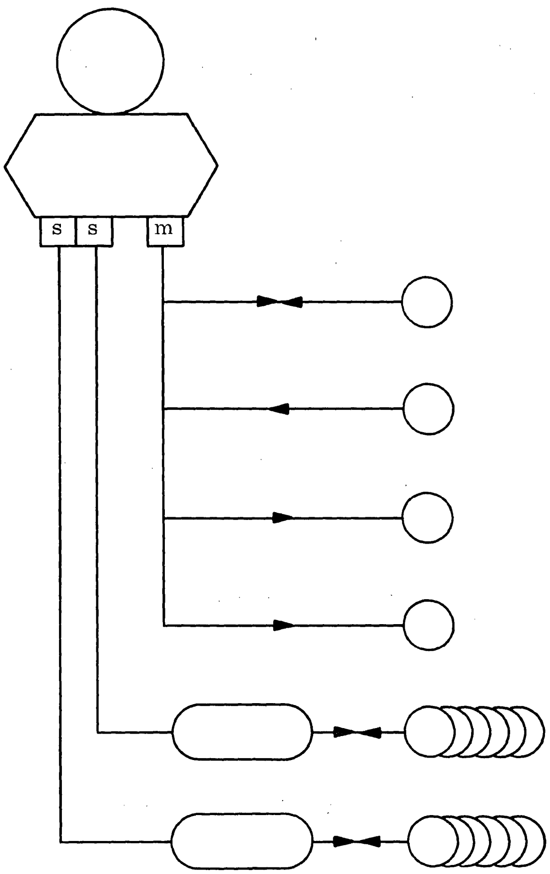


Equipment	Rental
Main Storage (65,536 bytes)	$ 8,350
70/55-E Processor (includes one Multiplexor Channel)	
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (6): 30,000 bytes/second	1,800
Optional Features Included: Selector Channel Feature (includes 2 channels)	450
TOTAL:	$13,430

m - Multiplexor Channel
s - Selector Channel

.2 12-TAPE BUSINESS SYSTEM; CONFIGURATION IV

Deviations from Standard Configuration: . . . . card reader is 44% faster.
card punch is 50% faster.
printer is 25% faster.
core storage is 100% larger.



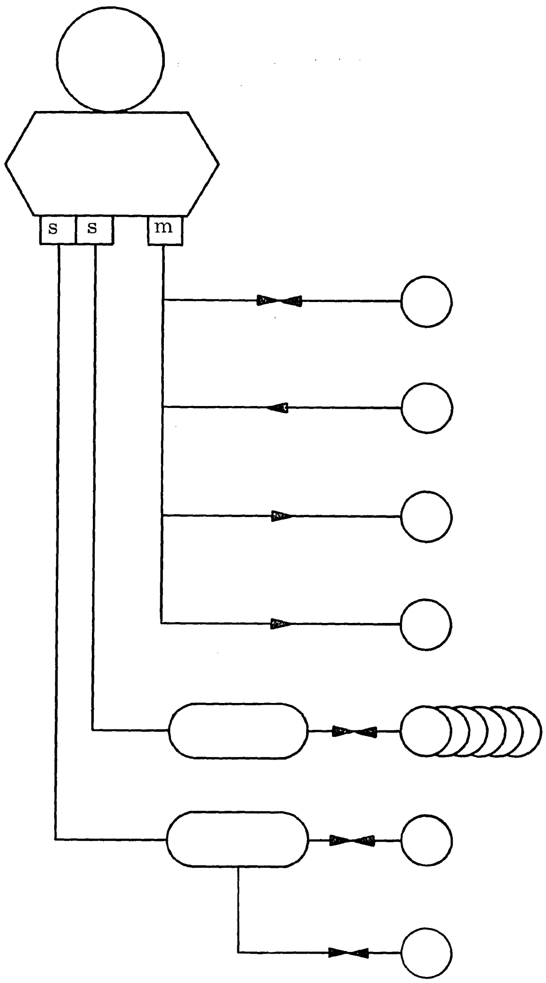
Equipment	Rental
Main Storage (65, 536 bytes) 70/55-E Processor (includes one Multiplexor Channel)	$ 8, 350
70/97 Console and Typewriter	330
70/237 Card Reader: 1, 435 cpm	650
70/236 Card Punch: 300 cpm	750
70/243-1 High-Speed Printer: 1, 250 lpm	1, 000
70/472-108 Tape Controller (3 dual-drive units): 60, 000 bytes/second	700 2, 700
70/472-108 Tape Controller 70/442-1 Magnetic Tape Units (3 dual-drive units): 60, 000 bytes/second	700 2, 700
Optional Features Included: . . . . Selector Channel Feature (includes 2 channels)	450
TOTAL:	$18, 330

m - Multiplexor Channel
s - Selector Channel

(Contd.)

.3 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 20% faster.
541 million bytes more auxiliary storage.
core storage is 300% larger.
70/564 Disc Storage Unit is required for TDOS operating system.



Equipment	Rental
Main Storage (65,536 bytes)	$ 8,350
70/55-E Processor (includes one Multiplexor Channel)	
70/97 Console and Typewriter	330
70/232 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (3 dual-drive units): 30,000 bytes/second	1,800
70/568-11 Mass Storage Unit (over 561 million bytes storage; 385 msec average access time)	2,775
70/551 Random Access Controller	525
I/O attachment feature for 70/568	175
70/564 Disc Storage Unit	575
I/O attachment feature for 70/564	NC
Optional Features Included: Selector Channel Feature (includes 2 channels)	450
TOTAL:	$17,480

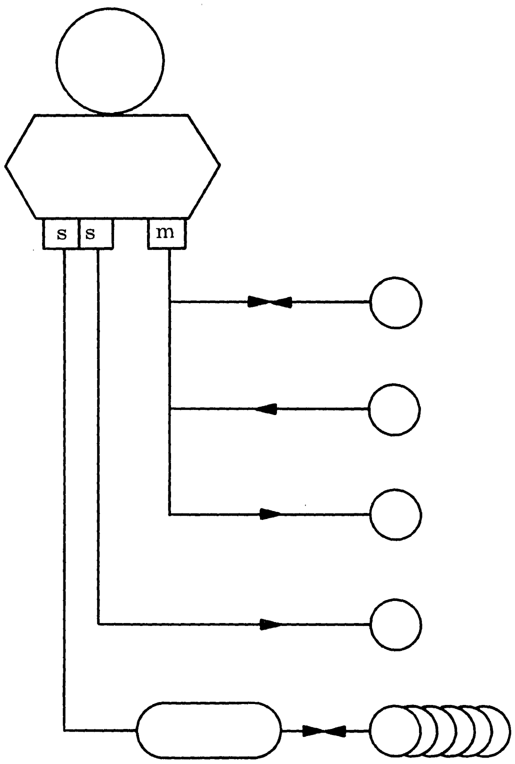
Note: The following can be used in place of the 568-11 Unit, resulting in the indicated total rentals:

70/564 Disc Storage Units (3) — average access time: 97.5 msec; 21.75 million bytes storage . . . . . TOTAL: $16,255

m - Multiplexor Channel
s - Selector Channel

.4 6-TAPE BUSINESS/SCIENTIFIC SYSTEM; CONFIGURATION VI

Deviations from Standard Configuration: . . . . card reader is 187% faster. printer is 25% faster.



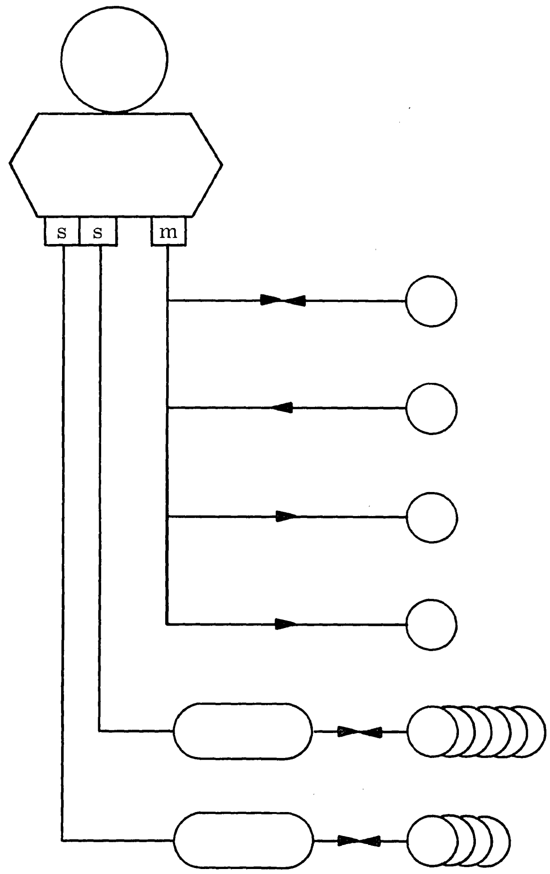
Equipment	Rental
Main Storage (65,536 bytes) 70/55-E Processor (includes one Multiplexor Channel)	$ 8,350
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Units (6): 30,000 bytes/second	1,800
Optional Features Included: . . . . Selector Channel Feature (includes 2 channels)	450
TOTAL:	$13,430

m - Multiplexor Channel
s - Selector Channel

(Contd.)

.5 10-TAPE GENERAL SYSTEM (INTEGRATED); CONFIGURATION VIIA

Deviations from Standard Configuration: . . . . card reader is 187% faster. printer is 25% faster.



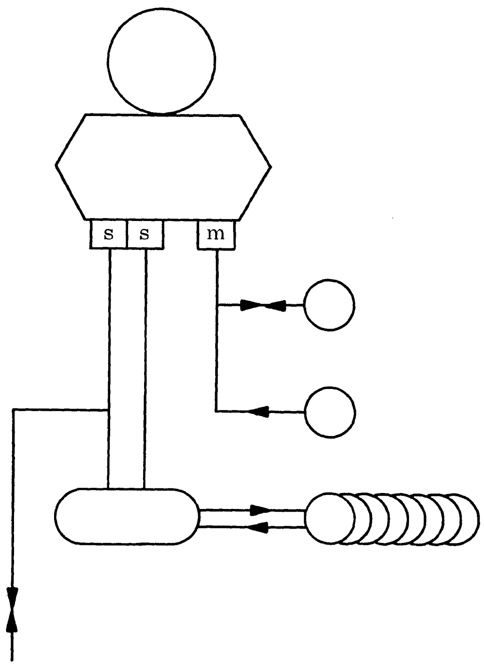
Equipment	Rental
Main Storage (65,536 bytes) 70/55-E Processor (includes one Multiplexor Channel)	$ 8,350
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (3 dual-drive units): 60,000 bytes/second*	2,700
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (2 dual-drive units): 60,000 bytes/second*	1,800
Optional Features Included: Selector Channel Feature (includes 2 channels)	450
TOTAL:	$16,830

* The total rental using 70/445 tape drives (120,000 bytes/second) is $20,080.

m - Multiplexor Channel
s - Selector Channel

10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIIB

Deviations from Standard Configuration: . . . . direct connection to satellite system.



To Satellite System
(at right)

On-Line Equipment	Rental
Main Storage (65,536 bytes) 70/55-E Processor (includes one Multiplexor Channel)	$ 8,350
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/472-208 Tape Controller	975
70/442-2 Magnetic Tape Units (4 dual-drive units): 60,000 bytes/second *	3,600

Optional Features Included: . . . .

Selector Channel Feature (includes 2 channels)	450
TOTAL ON-LINE EQUIPMENT:	$14,355
TOTAL SATELLITE EQUIPMENT:	$ 4,725
TOTAL RENTAL:	$19,080

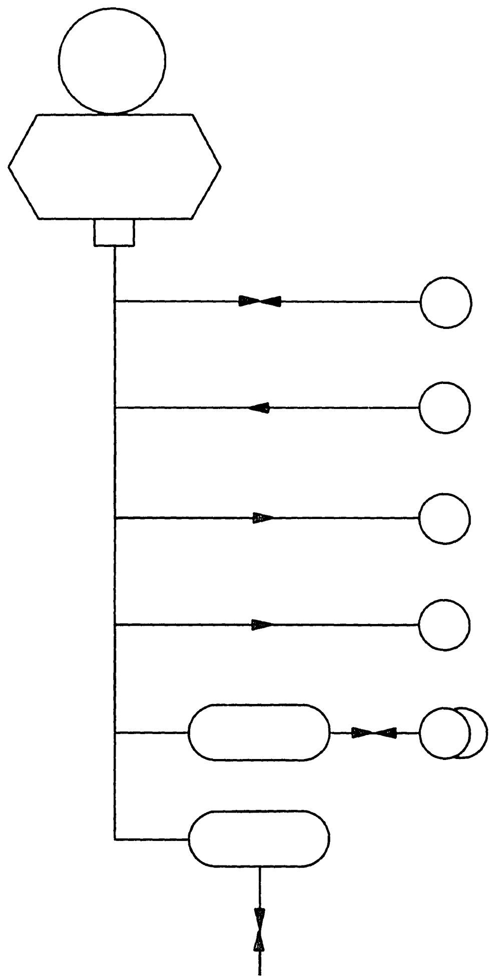
* The total rental using 70/445 tape drives (120,000 bytes/second) is $21,680.

m - Multiplexor Channel
s - Selector Channel

(Contd.)

SATELLITE EQUIPMENT; CONFIGURATION VIIB (Contd.)

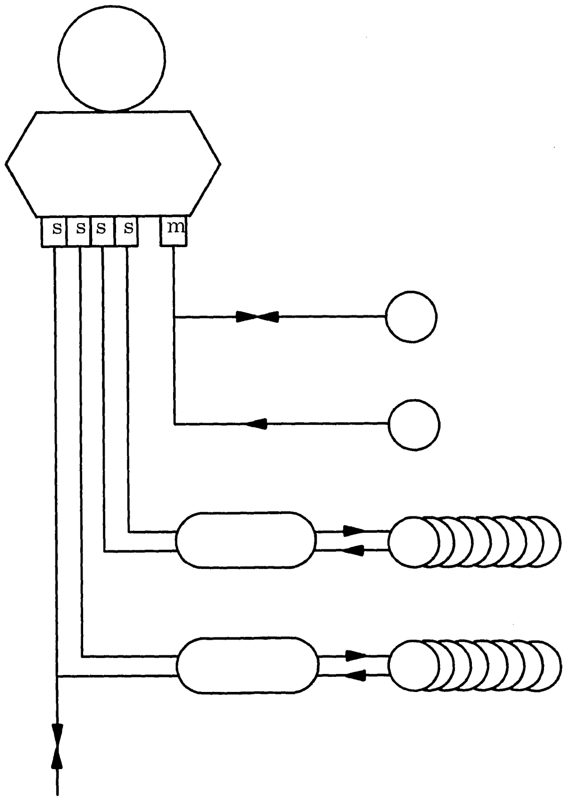
Deviations from Standard Configuration: . . . . card reader is 187% faster.
printer is 25% faster.
core storage is 134% larger.



Satellite Equipment	Rental
Main Storage (4,096 bytes); 70/15 Processor (includes one I/O Channel and Read Auxiliary Mode)	$ 1,000
70/216 Input-Output Typewriter	175
70/237 Card Reader: 1,435 cpm	650
70/234 Card Punch: 100 cpm	450
70/242-1 Printer: 625 lpm	700
70/472-108 Tape Controller	700
70/432-1 Magnetic Tape Unit (one dual-drive unit): 30,000 bytes/second	600
70/627 Data Exchange Control	450
TOTAL SATELLITE EQUIPMENT:	$ 4,725

.7 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIIIB

Deviations from Standard Configuration: . . . . direct connection to satellite system.



to Satellite System
(at right)

On-Line Equipment	Rental
Main Storage (131,072 bytes); 70/55-F Processor (includes one Multiplexor Channel)	$ 9,950
70/97 Console and Typewriter	330
70/237 Card Reader: 1,435 cpm	650
70/472-208 Tape Controller	975
70/445-2 Magnetic Tape Stations (8): 120,000 bytes/second	6,200
70/472-208 Tape Controller	975
70/445-2 Magnetic Tape Stations (8): 120,000 bytes/second	6,200

Optional Features Included: . . . . Selector Channel Feature (includes 4 channels) — 800

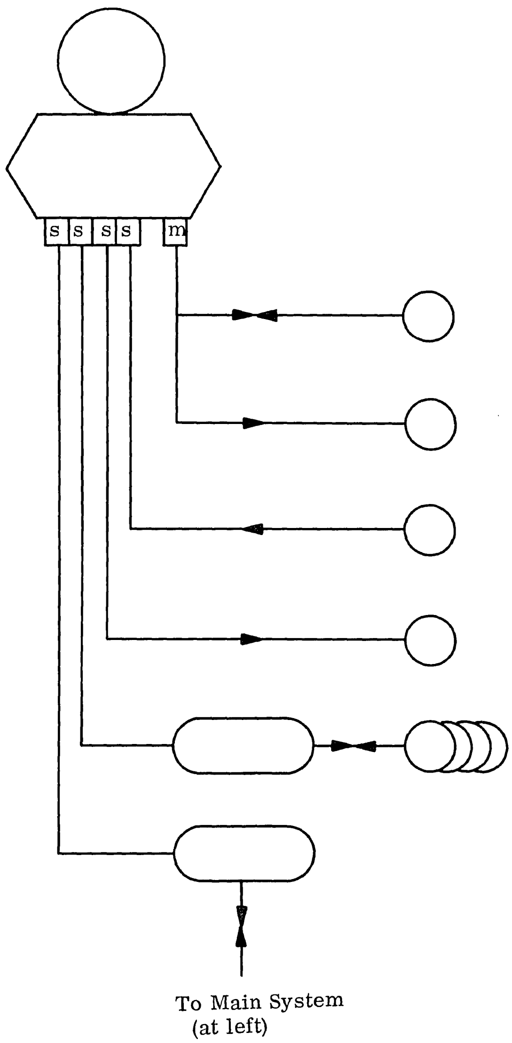
TOTAL ON-LINE EQUIPMENT:	$25,430
TOTAL SATELLITE EQUIPMENT:	$ 7,515
TOTAL RENTAL:	$32,945

m - Multiplexor Channel
s - Selector Channel

(Contd.)

SATELLITE EQUIPMENT; CONFIGURATION VIIIB (Contd.)

Deviations from Standard Configuration: . . . . card reader is 44% faster.
card punch is 50% faster.
printer is 25% faster.
core storage is 100% larger.



Satellite Equipment	Rental
Main Storage (16,384 bytes); 70/25 Processor (includes four Selector Channels)	$ 1,850
70/216 Input-Output Typewriter	175
70/236 Card Punch: 300 cpm	750
70/237 Card Reader: 1,435 cpm	650
70/243-1 High-Speed Printer: 1,250 lpm	1,000
70/472-108 Tape Controller	700
70/442-1 Magnetic Tape Units (2 dual-drive units): 60,000 bytes/second	1,800
70/627 Data Exchange Control	450
Multiplexor Channel	140
TOTAL SATELLITE EQUIPMENT:	$ 7,515

CENTRAL PROCESSOR

.1 GENERAL

.11 Identity: . . . . RCA Spectra 70/55 Processor.

.12 Description

See Section 710:051 for a comprehensive description of the general characteristics of the Spectra 70/55 and the other Spectra 70 processors.

See the Introduction to this subreport, Section 716:011, for a summary of the distinguishing features of the 70/55 Processor as used in Spectra 70 computer systems.

The Instruction Times and Processor Performance times for Spectra 70/55 systems, in all four modes of arithmetic, are listed below. See Paragraphs 4:050.41 and 4:050.42 of the Users' Guide for the definition of these standard measures of central processor performance.

.4 PROCESSOR SPEEDS

In DECIMAL operations, execution times are expressed in terms of D, the number of decimal digits in the operand from the user's viewpoint. (From the machine point of view, the actual operand lengths are sometimes different.) D represents the operand length in 4-bit digits, packed 2 digits per 8-bit byte, including the sign digit. Because of the byte structure of the system, the formulas yield accurate times only for even values of D.

In BINARY operations, fixed-point times normally reflect one-word (32-bit) operands. Short floating-point operands are one word long and provide a minimum precision of 21 bits; long floating-point operands are two words long and provide a minimum precision of 53 bits.

.41 Instruction Times in Microseconds

.411 Fixed point —

	Binary	Decimal
Add-subtract:	2.58	$5.4 + 0.6D$
Multiply:	12.78	$8.88 + 4.49D + 0.195D^2$
Divide:	19.86	$11.28 + 1.725D + 0.323D^2$

.412 Floating point —

	Long	Short
Add-subtract:	10.5	7.62
Multiply:	44.58	18.42
Divide:	75.30	22.86

.413 Additional allowance for —
Single indexing: . . . . 0.36 μsec (RX instructions only).
Double indexing: . . . 0.36 μsec (RX instructions only).
Indirect addressing: . none.
Recomplementing: . . none

.414 Control —
Compare:
Fixed point: 2.58
Decimal: . . . . $5.4 + 0.5D$
Floating point (long): 7.38
Floating point (short):. 6.66
Logical: 2.58
Branch: 2.10

.415 Counter control —
Step: 2.58
Step and test: . . . . . 2.58 (increment of -1).
3.72 (increment of any value).
Test: 2.58

.416 Edit: . . . . $3.72 + 0.96D + 0.36K$, where K = number of control characters.

.417 Convert —
To binary: . . . . 5.34 to 26.34
To decimal: . . . . . . 5.70 to 23.82

.418 Shift: . . . . variable.

.42 Processor Performance in Microseconds

.421 For random addresses —

	Fixed point	Floating point
$c = a + b$:	7.84 (binary)	19.02 (long).
	11.16 + 1.01D (decimal)	13.38 (short).
$b = a + b$:	7.84 (binary)	19.02 (long).
	5.4 + 0.6D (decimal)	13.38 (short).
Sum N items:	2.58N (binary)	10.5N (long).
	(5.4 + 0.6D)N (decimal)	7.62N (short).
$c = ab$:	17.94 (binary)	53.10 (long).
$c = a/b$:	25.02 (binary)	83.82 (long).
	$22.8 + 2.55D + 0.323D^2$ (decimal)	28.62 (short).

.422 For arrays of data —

	Fixed point	Floating point
$c_i = a_i + b_j$:	12.9 (binary)	24.18 (long).
	16.32 + 1.01D (decimal)	18.54 (short).
$b_j = a_i + b_j$:	12.9 (binary)	24.18 (long).
	10.56 + 0.6D (decimal)	18.54 (short).
Sum N items:	5.04N (binary)	13.08N (long).
	(7.98 + 0.6D)N (decimal)	10.20N (short).
$c = c + a_i b_j$:	25.68 (binary)	68.76 (long).
	$30.96 + 5.91D + 0.195D^2$ (decimal)	36.96 (short).

.423 Branch based on comparison —
- Numeric data: 13.38N
- Alphabetic data: 13.38N

.424 Switching —
- Unchecked: 10.92
- Checked: 19.32
- List search: . . . . . 9.84 + 8.04N

.425 Format control, per character —
- Unpack: . . . . 1.07 (does not include radix conversion).
- Compose: 3.06

.426 Table look-up, per comparison —
- For a match: 8.04
- For least or greatest: 9.27
- For interpolation point: 8.04

.427 Bit indicators —
- Set bit in separate location: 3.18
- Set bit in pattern: . . . 3.18
- Test bit in separate location: 4.56
- Test bit in pattern: . . 5.28

.428 Moving: . . . . 5.76 + 0.41D

SIMULTANEOUS OPERATIONS

An RCA Spectra 70/55 system can concurrently execute:

- One machine instruction; and
- Up to six input-output operations, one on each of the optional Selector Channels; and
- Up to eight additional input-output operations, one on each of the individual subchannels included in the standard Multiplexor Channel.

The demand on the central processor (i.e., the "interference" or delay imposed upon the central processor program by each individual input-output operation) will vary depending on whether the peripheral device is connected to one of the Selector Channels or to the Multiplexor Channel. (See the general discussion of Spectra 70 Simultaneous Operations on page 710:111.100.) Selector Channel I/O operations require one 0.84-microsecond memory cycle for each four-byte load of data transferred into or out of core storage; for Multiplexor Channel operations, the demands are much higher. In Table I, the processor demands imposed by each of the peripheral units are listed for both types of channels (next page).

The specific characteristics of the Spectra 70/55 Selector and Multiplexor Channels can be summarized as follows:

Selector Channels

Maximum number:	6.
Maximum data rate per channel:	640 kilobytes/second.
Number of trunks per channel:	4.*
Causes processor delays during —	
Input-output initiation and termination:	yes.
Data transfers:	yes, each four-byte load.
Chaining:	yes.

Multiplexor Channels

Maximum number:	1.
Maximum number of trunks per channel:	8.*
Maximum data rate (multiplexed):	160 kilobytes/second.
Maximum data rate (burst mode):	590 kilobytes/second.
Causes processor delays during all input-output operations:	yes.

* The maximum number of I/O trunks permitted per 70/55 system is 24.

TABLE I: INPUT-OUTPUT DEMANDS UPON THE SPECTRA 70/55 PROCESSOR

Device	Average Data Rate (Kilobytes/second)	Peak Data Rate (Kilobytes/second)	Maximum Demands Upon 70/55 Processor	
			Via Selector Channel	Via Multiplexor Channel
70/97 Console and Typewriter, 10 cps	0.01	0.01	-	-
70/221 Paper Tape Reader/Punch -				
Reading, 200 cps	0.2	0.2	0.004%	0.12%
Punching, 100 cps	0.1	0.1	0.002%	0.06%
70/234 Buffered Card Punch, 100 cpm	0.1	8.0	0.002%	0.06%
70/236 Buffered Card Punch, 300 cpm	0.4	8.0	0.008%	0.25%
70/237 Card Reader, 1435 cpm	1.9	1.9	0.04%	1.19%
70/242-1 Printer, 132 columns, 625 lpm, buffered	1.4	27.0	0.03%	0.87%
70/242-2 Printer, 160 columns, 625 lpm, buffered	1.7	32.2	0.04%	1.06%
70/243-1 Printer, 132 columns, 1250 lpm, buffered	2.7	27.0	0.06%	1.68%
70/243-2 Printer, 160 columns, 1250 lpm, buffered	3.3	32.0	0.07%	2.06%
70/248 Bill Feed Printer, buffered -				
600 lpm, forms	1.3	27.0	0.03%	0.81%
400 lpm, cards	0.52	9.0	0.01%	0.32%
70/432 Magnetic Tape Unit, 30KB/sec	30.0	30.0	0.63%	18.7%
70/442 Magnetic Tape Unit, 60KB/sec	60.0	60.0	1.26%	37.5%
70/445 Magnetic Tape Unit, 120KB/sec	120.0	120.0	2.52%	75.0%
70/251 Videoscan Document Reader, 1300 dpm	1.5	1.5	0.03%	0.94%
70/653 Communication Control (Single Channel)	0.2	5.1	0.04%	0.12%
70/627 Data Exchange Control	*	*	-	-
70/564 Disc Storage Unit	156.0	156.0	3.28%	97.5%
70/568-11 Mass Storage Unit	62.0	62.0	1.47%	43.7%
70/565-13 Drum Memory Unit	117.0	117.0	4.76%	100 %

*Speed is determined by the memory cycle time of the slower of the two communicating Spectra 70 processors.

SYSTEM PERFORMANCE

GENERALIZED FILE PROCESSING (716:201.100)

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 it is fully described in Section 4:200.1 of the Users' Guide. Standard File Problems A, B, and C show the effects of varied record sizes in the master file. Standard Problem D increases the amount of computation performed on each transaction. Each problem is estimated for activity factors (ratios of the number of detail records to the number of master records) of zero to unity. In all cases a uniform distribution of activity is assumed.

In Configurations 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. The controlling factor in these curves is the printer at high and moderate activities and the master file tapes at low activity.

In Configurations VIIB and VIIIB, all files - master, detail, and report - are assigned to magnetic tape. The detail and report file tapes are assumed to be transcribed off-line from punched cards and to the printer. Configurations VIIB and VIIIB are shown with the report and detail file tapes both blocked (dashed curves) and unblocked (solid curves). The controlling factor for Configuration VIIB at all activities is a combination of one master file tape and the report file tape.

For Configuration VIIIB with blocked detail and report files, the report file tape controls at high activity and one master file tape at moderate and low activities in Problem A. In Problem B, the central processor controls at moderate activity. One master file tape controls at all activities in Problem C. In Problem D, the central processor controls at high activity and one master file tape at moderate and low activities. For Configuration VIIIB with unblocked detail and report files, one master file tape controls at the lower activities and the report file tape controls at the higher activities in all four Standard File Problems.

Because multiprogramming, or concurrent execution of two or more independent programs, is a featured capability of the Spectra 70/55, the time actually used by the central processor (CP) is also plotted. By comparing the curves of total time for the various configurations with the central processor curves, it can be seen that even in the worst case (Configuration VIIIB using blocked detail and report files, when the computation load has been trebled), some 20% of the available processing capacity is not in use. A comparison of the central processor curves for a standard amount of computation and for trebled computation (i.e., the curves for Problems A and D, respectively) shows the effect of increasing the computational workload.

SORTING (716:201.200)

The standard estimate for sorting 80-character records by straightforward merging on magnetic tape was developed from the time for Standard File Processing Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide. A three-way merge was used in all the configurations shown.

MATRIX INVERSION (716:201.300)

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. Obtaining this precision in the Spectra 70/45 requires use of the double-precision floating-point instructions; however, because the shorter single-precision form, which provides just over 6 decimal digits' precision, will be used wherever practical, the times for single-precision operation have also been computed and included in the graph.

GENERALIZED MATHEMATICAL PROCESSING (716:201.400)

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. All computations are carried out in the double-precision floating-point mode because the single-precision mode was considered to have insufficient accuracy for this type of computation. As in the File Processing problems, the total elapsed time is shown by the solid lines in Graph 716:201.400, while the curves marked "CP" show central processor time.

WORKSHEET DATA TABLE 1

	ITEM		CONFIGURATION III & VI	IV	VIIA	VIIB (blocked)	VIIB (unblocked)	VIIIB (blocked)	VIIIB (unblocked)	REFERENCE
1 Standard File Problem A Input-Output Times	Char/block	(File 1)	1,056	1,056	1,056	1,056	1,056	1,056	1,056	4:200.112
	Records/block	K (File 1)	12	12	12	12	12	12	12	
	msec/block	File 1 - File 2	51.2	25.6	25.6	25.6	25.6	12.8	12.8	
		File 3	42	42	42	24.0*	9.3	12.0*	4.7	
		File 4	131	79	131	34.4*	10.2	17.2*	5.1	
	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	0.22	0.22	0.22	0.22	0.22	0.22	0.22	
		File 3	0.017	0.017	0.017	0.017	0.017	0.017	0.017	
		File 4	0.03	0.03	0.03	0.33	0.03	0.33	0.33	
2 Central Processor Times	msec/block	a_1	0.10	0.10	0.10	0.10	0.10	0.10	0.10	4:200.1132
	msec/record	a_2	0.14	0.14	0.14	0.14	0.14	0.14	0.14	
	msec/detail	b_6	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
	msec/work	$b_5 + b_9$	0.18	0.18	0.18	0.18	0.18	0.18	0.18	
	msec/report	$b_7 + b_8$	0.42	0.42	0.42	0.42	0.42	0.42	0.42	

	ITEM		III & VI C.P.	III & VI Printer	IV C.P.	IV Printer	VIIA C.P.	VIIA Printer	VIIB (blocked) C.P.	VIIB (blocked) Tapes	VIIB (unblocked) C.P.	VIIB (unblocked) Tapes	VIIIB (blocked) C.P.	VIIIB (blocked) Tape	VIIIB (unblocked) C.P.	VIIIB (unblocked) Tape	REFERENCE
3 Standard Problem A at F = 1.0	msec/block for C.P. and dominant column	a_1	0.1		0.1		0.1		0.1		0.1		0.1		0.1		4:200.114
		a_2K	1.7		1.7		1.7		1.7		1.7		1.7		1.7		
		a_3K	9.5		9.5		9.5		9.5		9.5		9.5		9.5		
		File 1: Master In	0.2		0.2		0.2		0.2		0.2		0.2		0.2		
		File 2: Master Out	0.2		0.2		0.2		0.2	25.6	0.2	25.6	0.2		0.2		
		File 3: Details	0.2		0.2		0.2		0.2		0.2		0.2		0.2		
		File 4: Reports	0.3	1,572	0.3	948	0.3	1,572	0.3	34.4	0.3	122.4	0.3	17.2	0.3	61.2	
		Total	12.2	1,572	12.2	948	12.2	1,572	12.2	60.0	12.2	148.6	12.2	17.2	12.2	61.2	

	ITEM		III & VI	IV	VIIA	VIIB (blocked)	VIIB (unblocked)	VIIIB (blocked)	VIIIB (unblocked)	REFERENCE
4 Standard Problem A Space	Unit of measure	(bytes)								4:200.1151
		Std. routines	6,000	6,000	6,000	6,000	6,000	6,000	6,000	
		Fixed	128	128	128	128	128	128	128	
		3(Blocks 1 to 23)	648	648	648	648	648	648	648	
		6(Blocks 24 to 48)	4,092	4,092	4,092	4,092	4,092	4,092	4,092	
		Files	4,648	4,648	4,648	9,312	4,648	9,312	4,648	
		Working	100	100	100	100	100	100	100	
		Total	15,616	15,616	15,616	20,280	15,616	20,280	15,616	

	ITEM		CONFIGURATION III, VI, VIIA	IV	VIIB	VIIIB	REFERENCE
5 Standard Mathematical Problem A	Fixed/Floating Point		Floating Point	Floating Point	Floating Point	Floating Point	4:200.413
	Unit name	input	70/232 Reader	70/237 Reader	70/442 Tape	70/445 Tape	
		output	70/242 Printer	70/243 Printer	70/442 Tape	70/445 Tape	
	Size of record	input	80 bytes	80 bytes	80 bytes	80 bytes	
		output	132 bytes	132 bytes	80 bytes	80 bytes	
	msec/block	input T_1	42	42	9.4	4.7	
		output T_2	96	47.2	9.4	4.7	
	msec penalty	input T_3	0.02	0.02	0.02	0.02	
		output T_4	0.03	0.03	0.02	0.02	
	msec/record	T_5	0.94	0.94	0.94	0.94	
	msec/5 loops	T_6	2.82	2.82	2.82	2.82	
	msec/report	T_7	0.48	0.48	0.48	0.48	

* Files 3 and 4 blocked 12 records/block.

(Contd.)

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

.111 Record sizes —

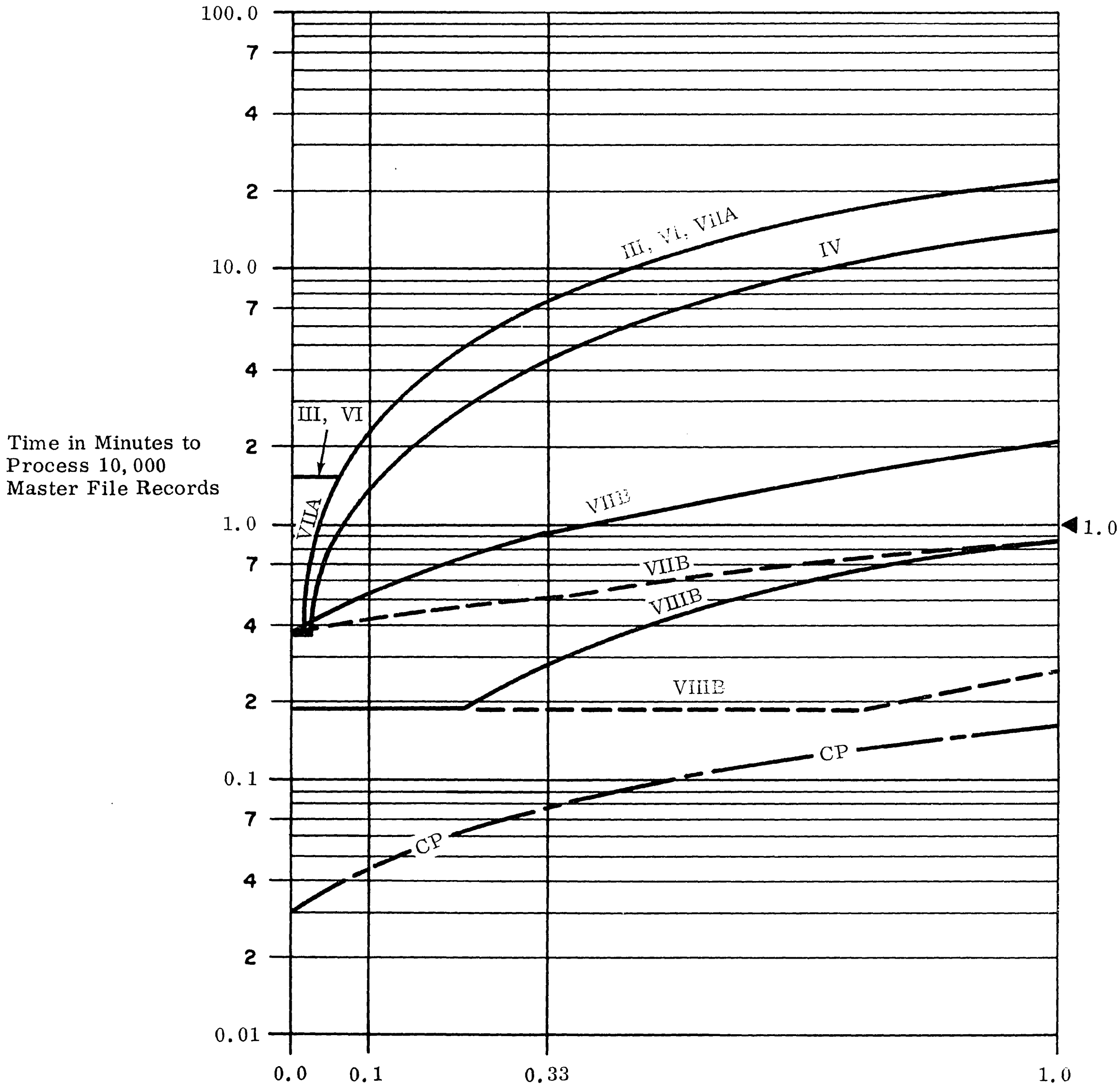
Master file: . . . . . 108 characters, packed as 88 eight-bit bytes.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.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: . . . 15,616 bytes.
Configuration VIIB (blocked Files 3 & 4): 20,280 bytes.
Configuration VIIB (unblocked Files 3 & 4) . . . . 15,616 bytes.
Configuration VIIIB (blocked Files 3 & 4): 20,280 bytes.
Configuration VIIIB (unblocked Files 3 & 4) . . . . 15,616 bytes.



(Roman numerals denote standard System Configurations.)

LEGEND

Elapsed time; unblocked Files 3 & 4
Elapsed time; blocked Files 3 & 4
CP Central Processor time (all configurations)

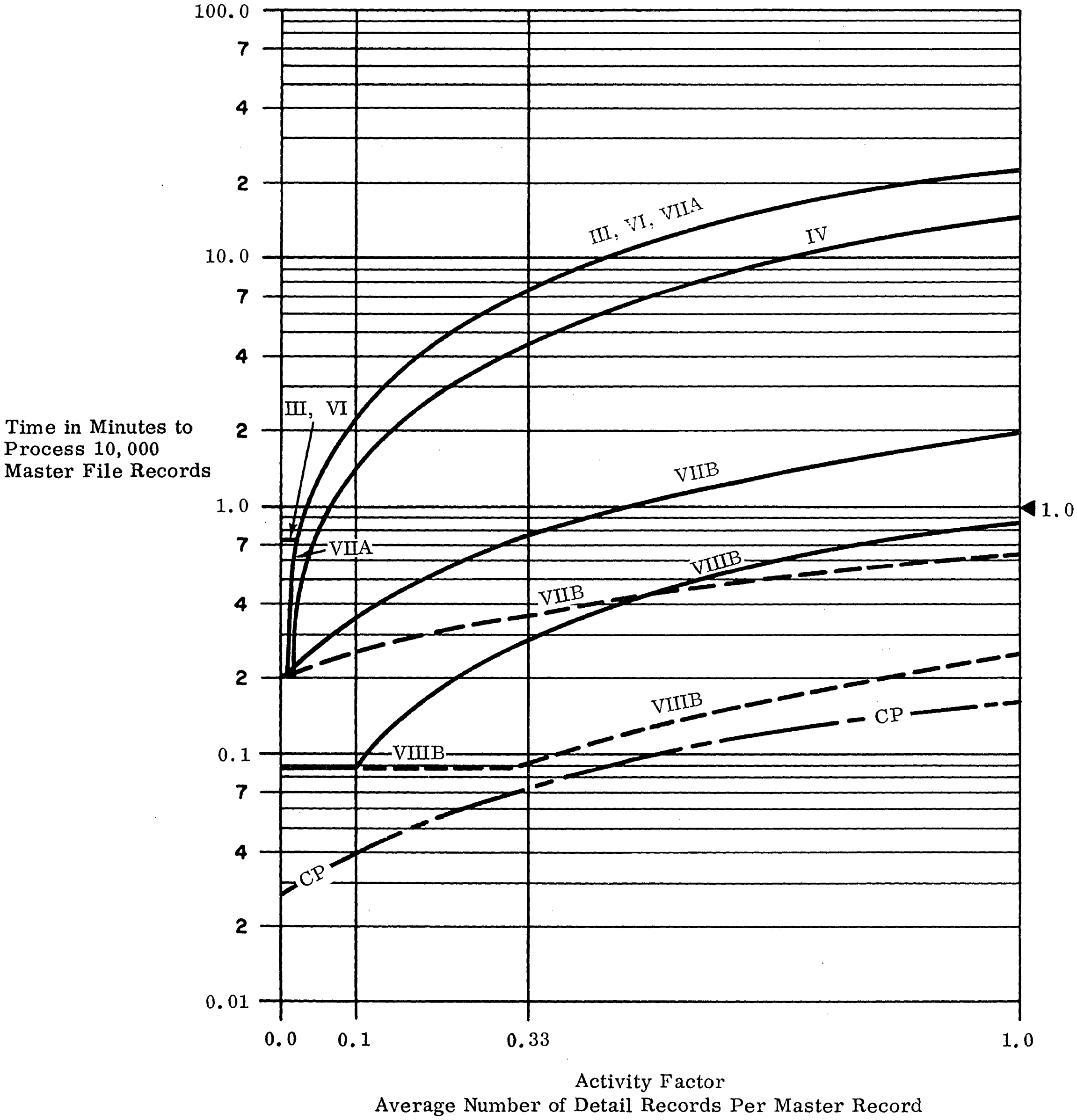
.12 Standard File Problem B

.121 Record sizes —
Master file: . . . . . 54 characters, packed as 44 eight-bit bytes.
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 (all configurations)

(Contd.)

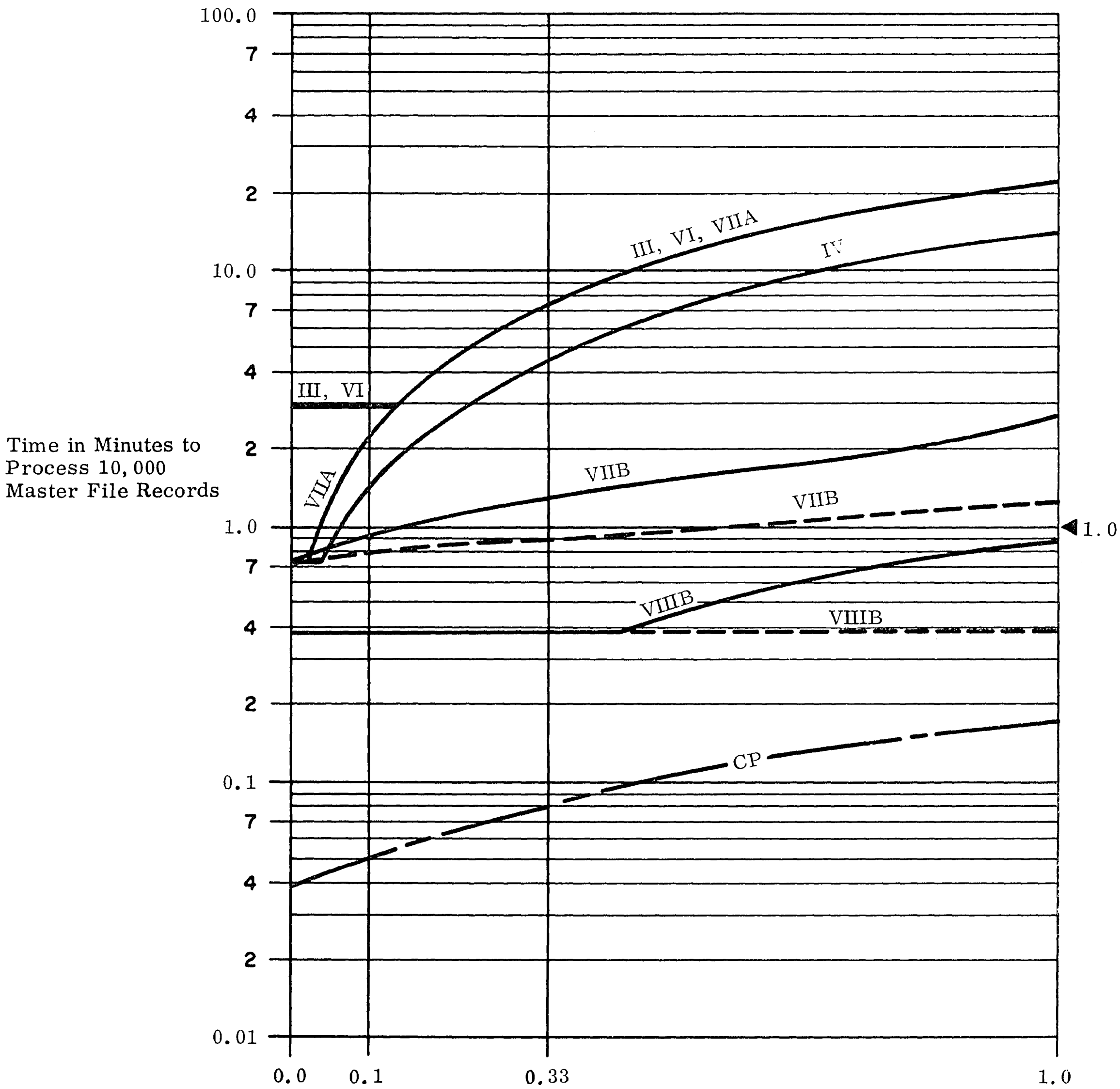
.13 Standard File Problem C

.131 Record sizes —
Master file: . . . . . 216 characters, packed as 176 eight-bit bytes.
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 (all configurations)

.14 Standard File Problem D

.141 Record sizes —

Master file: . . . . . 108 characters, packed as 88 eight-bit bytes.

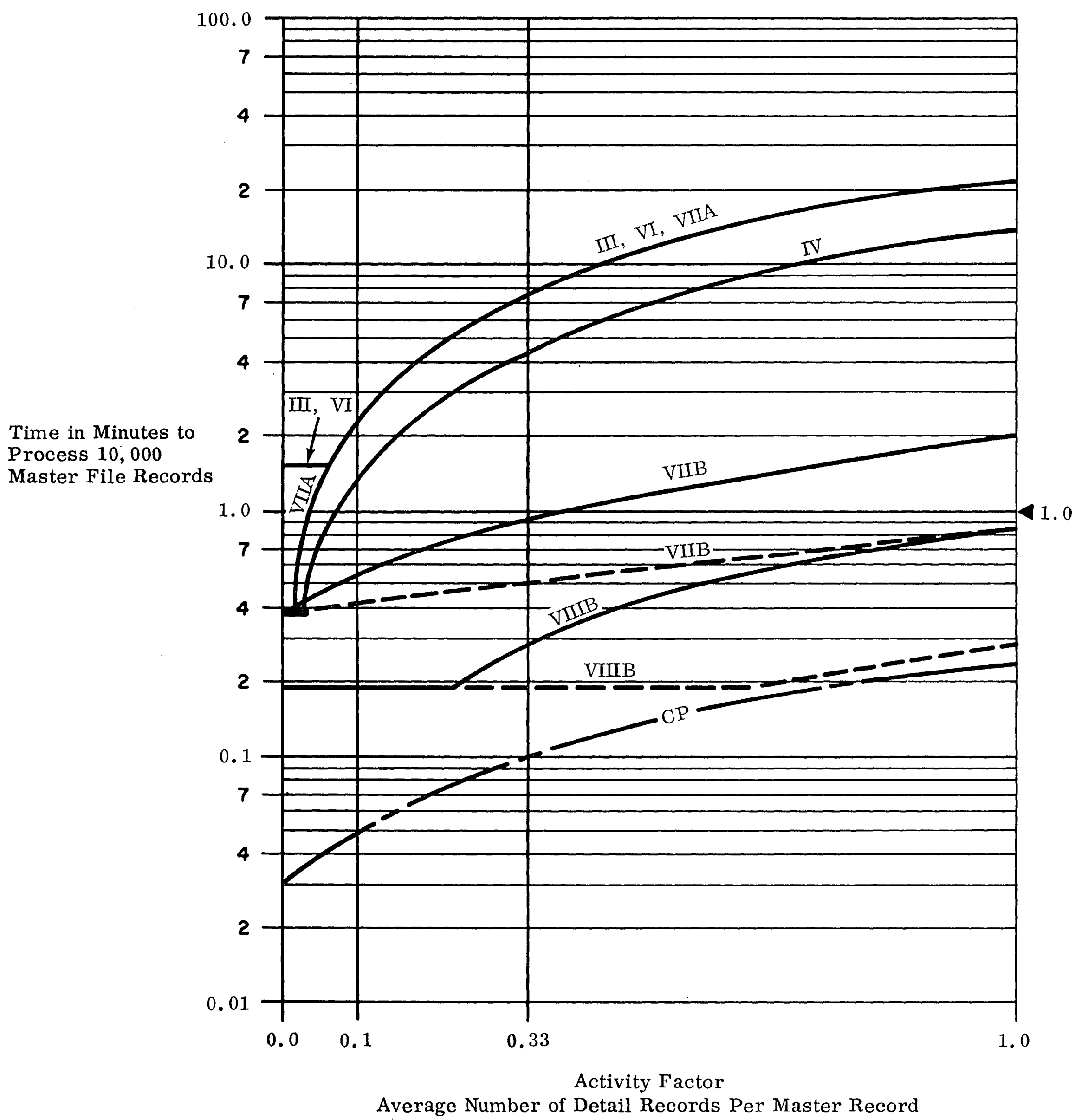
Detail file: . . . . . 1 card.

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.)

LEGEND

——— Elapsed time; unblocked Files 3 & 4

– – – Elapsed time; blocked Files 3 & 4

—CP— – — Central Processor time (all configurations)

(Contd.)

.2 SORTING

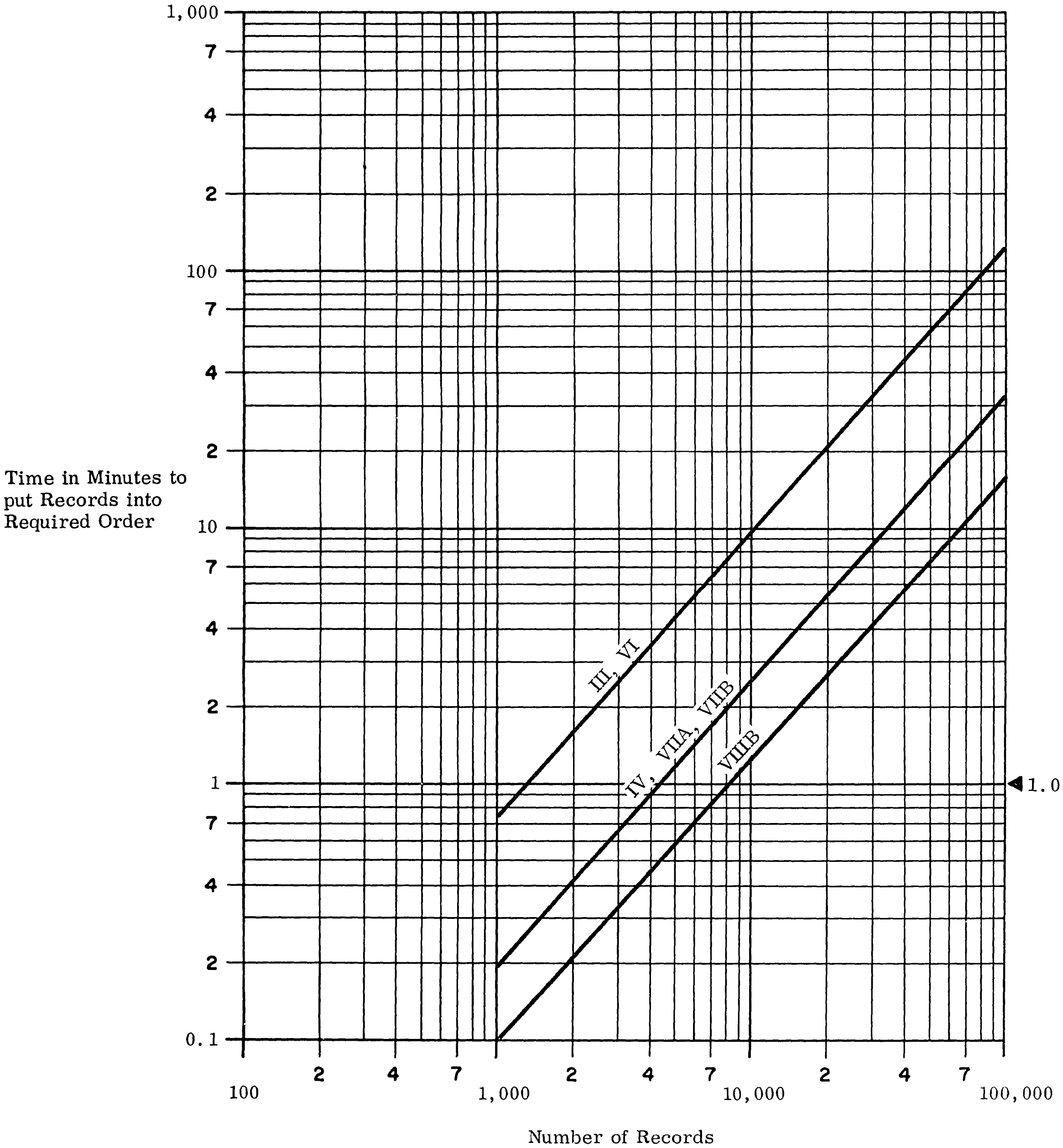
.21 Standard Problem Estimates

.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.)

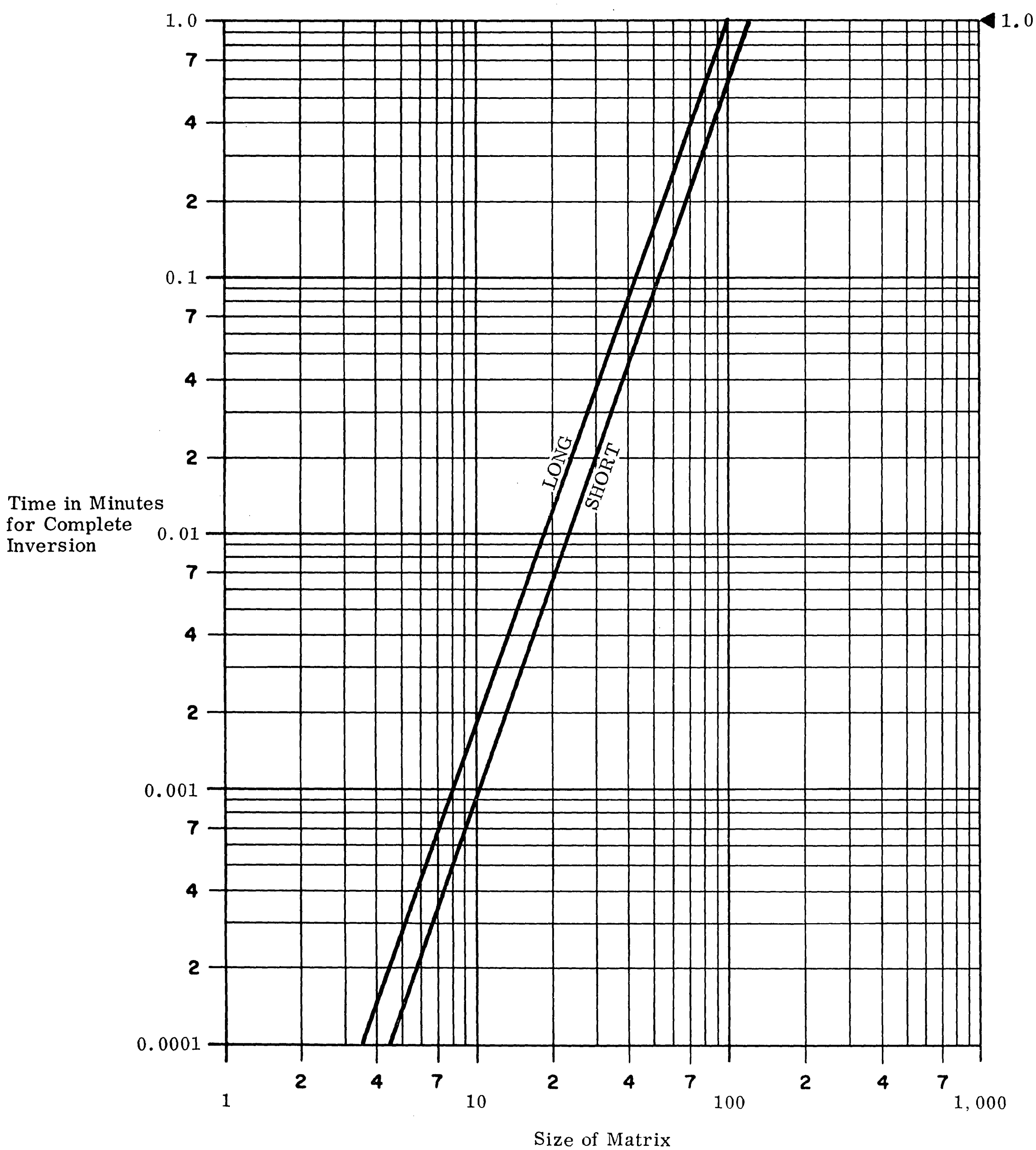
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . general, non-symmetric matrices, using floating point to a precision of approximately 6 decimal digits in the SHORT format and 16 digits in the LONG format.

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

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



(Contd.)

.4 GENERALIZED MATHEMATICAL PROCESSING

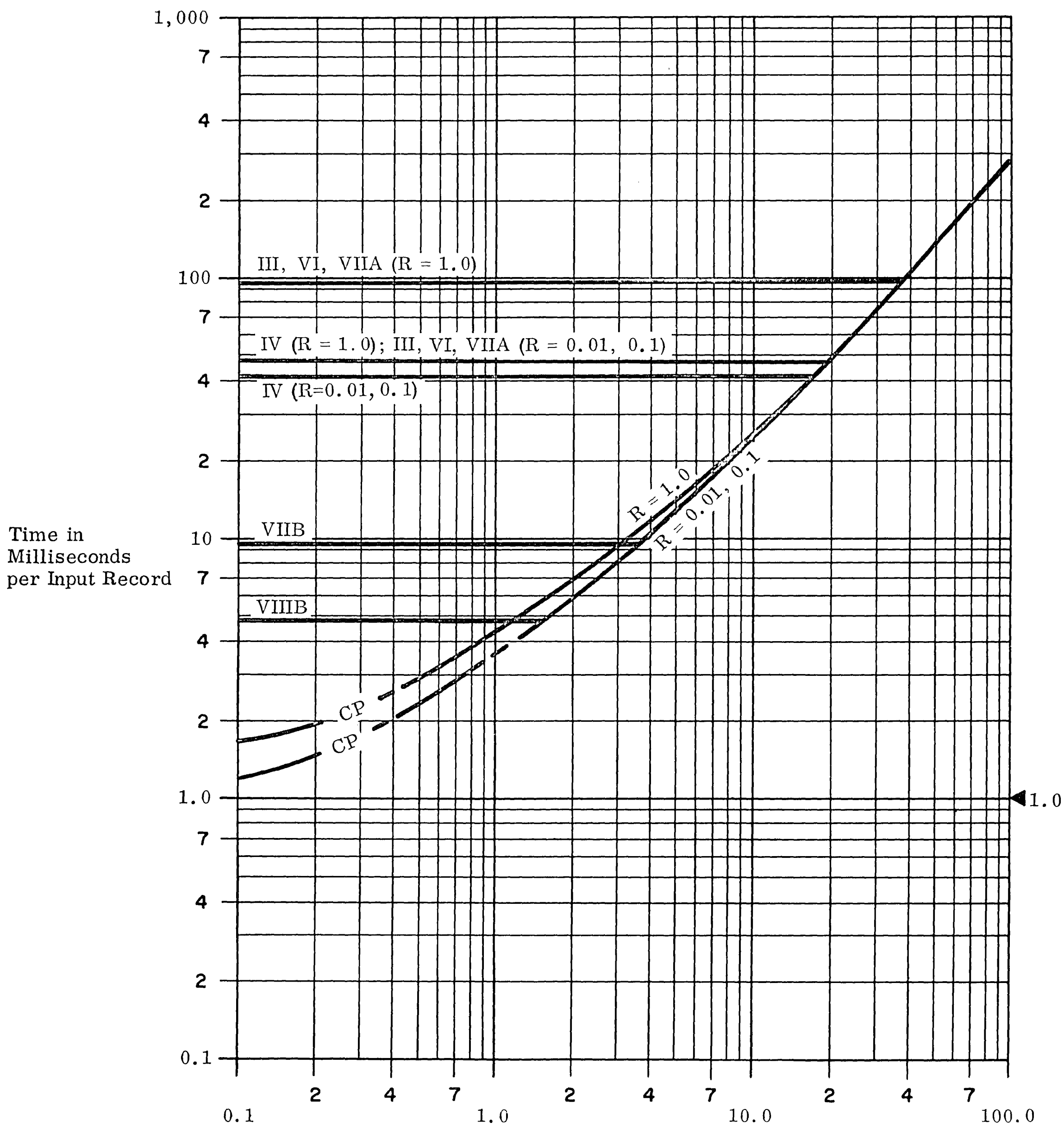
.41 Standard Mathematical Problem A Estimates

.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 in "long" floating-point mode (16-digit precision).

.413 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . see graph below.



Roman numerals denote Standard Configurations.
R = number of output records per input record.
Curves marked "CP" show Central Processor time.

SDS SIGMA 7

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SUMMARY REPORT: SDS SIGMA 7

.01 INTRODUCTION

.011 Sigma 7

Scientific Data Systems announced a new computer system, Sigma 7, on March 15, 1966. Sigma 7 was heralded as the first of a new family of Sigma computers from SDS that would provide "at least two times more computations per dollar than any other machine in the industry". With the announcement of the general-purpose Sigma 7, SDS has begun a gradual expansion of its marketing goals to include not only scientific-oriented computing (where SDS has earned a fine reputation), but also business data processing.

Sigma 7 is a medium-scale computer that is compatible with the IBM System/360 in internal data structure, external data codes, input-output media, and FORTRAN and PL/I languages. Source language compatibility is facilitated by internal fixed-point and floating-point arithmetic formats that are virtually identical with those used in the System/360 processors.

Sigma 7 makes extensive use of monolithic integrated circuitry in a central processor whose internal design is radically different from that of the IBM System/360. Monthly rental prices for typical Sigma 7 system configurations range from $5,000 to $25,000. Core storage sizes range from 4,096 to 131,072 32-bit words, with a cycle time of 1.2 microseconds per word.

Sigma 7 is a general-purpose, highly modular system designed to function in a wide variety of application areas and in several different processing modes. The primary design goal is to produce a fast, responsive real-time system that can provide the full services of the computer to multiple user programs. In small-scale configurations, Sigma 7 can function as a relatively inexpensive but powerful scientific processor that executes one program at a time. In somewhat larger configurations, Sigma 7 can serve as a medium-scale business/scientific system capable of multiprogrammed processing of one "background" production program and one "foreground" real-time inquiry program. Configurations with mass storage devices and at least 12K words of main memory can provide full hardware/software control of the operating environment and multiprogrammed operation for three concurrent programs. In large-scale disc-oriented configurations, Sigma 7 can handle remote, interactive time-sharing operations for up to 200 competing users, concurrently with processing background production programs. Sigma 7 hardware and software also permit multiple central processors to share common core storage and peripheral units.

The central components of every Sigma 7 system — central processor, core storage, and I/O control system — feature flexibility, expandability, and capability for asynchronous independent operations. The instruction set is large and powerful, and the input-output system (which can include up to eight channel controllers of the selector and/or 32-subchannel multiplexor variety) is comparable to the I/O systems in higher-priced, large-scale computers. Up to eight core storage modules are capable of independent operation, and up to six of the modules can be accessed simultaneously. Sigma 7 core storage is large in capacity (up to 524,288 bytes) and among the least expensive in the industry.

SDS currently offers a limited number and variety of input-output devices for use with Sigma 7, although it is expected that interface units will be announced to permit connection of I/O devices from other manufacturers. The Price Data section (page 740:221.101) lists the current peripheral devices and their rated speeds. At present SDS offers one Sigma 7 mass storage device: a 1.5 million-byte, fast-access unit of comparatively high price. However, SDS has indicated that several low-cost, head-per-track disc files of various capacities and speeds are under development and due for release in the near future. Apart from manufacturing its own disc files and magnetic tape units, SDS does not appear interested in competing at this time in the development of a broad range of special-purpose peripheral devices.

Software for Sigma 7 is provided at four levels, all upward-compatible, and features real-time multiprogramming and disc-oriented operating systems. Table I summarizes the software facilities and their availability dates. FORTRAN IV and PL/I compilers will be supplied in three different versions: debug, high-efficiency, and conversational. Assemblers will be provided with the first systems delivered, beginning in the fourth quarter of 1966. Although the availability of a COBOL compiler was not announced in the earliest Sigma 7 software

.011 Sigma 7 (Contd.)

schedules, it is expected that SDS will shortly announce a COBOL, probably supplied on a lease or purchase basis. An IBM 1401 Simulator program is also expected to be announced in the near future. SDS states that the Sigma 7 software development effort began almost two years ago and that all published delivery schedules are being adhered to. More than half of the initially scheduled software systems will be written by outside software contractors.

TABLE I: SIGMA 7 SOFTWARE AVAILABILITY

Class	Name	Availability
Monitors	Basic Control Monitor	1st Qtr. 1967
	Batch Processing Monitor	2nd Qtr. 1967
	Universal Time-Sharing Monitor:	
	Standard version	4th Qtr. 1967
	Extended version	1st Qtr. 1968
Compilers	Basic FORTRAN IV	4th Qtr. 1966
	Debug FORTRAN IV	2nd Qtr. 1966
	High Efficiency FORTRAN IV	2nd Qtr. 1967
	Conversational FORTRAN IV	4th Qtr. 1967
	Debug PL/I	3rd Qtr. 1967
	High Efficiency PL/I	4th Qtr. 1967
	Conversational PL/I	4th Qtr. 1967
	COBOL	to be announced
Assemblers	Basic Symbol Assembler	4th Qtr. 1966
	Meta-Symbol Assembler	2nd Qtr. 1967
Services	ADAPT Application Package	2nd Qtr. 1967
	Sort/Merge	to be announced
	MANAGE with RPG	to be announced
	IBM 1401 Simulator	to be announced
	Application Programs	to be announced

Price/performance comparisons between Sigma 7 and the IBM System/360 Model 50 indicate that in comparable central configurations (i.e., with equivalent central processors, core storage, and I/O control facilities), Sigma 7 is approximately 10 to 20 per cent less expensive than the Model 50 and the basic processing power of Sigma 7 is approximately 40 to 50 per cent greater than that of the Model 50. There are indications that this advantage in basic processing speed will increase still further, as SDS contemplates improving the Sigma 7 core storage unit by reducing the cycle time from 1.2 to 0.9 microsecond per 32-bit word.

.012 Sigma 2

On August 1, 1966, Sigma 7 officially became a family member when SDS announced the small-scale Sigma 2 computer system. Sigma 2 is a low-cost computer system designed for scientific, engineering, and process control applications. Sigma 2 has good real-time processing capabilities and hardware facilities that will permit multiprogrammed operation of a background production program and a foreground real-time program. The purchase price of a basic Sigma 2 configuration (consisting of a processor with four I/O channels, 4,096 words of core storage, and a keyboard/printer device with slow-speed paper tape reader and punch) is $26,000; the same configuration under terms of the standard 4-year lease contract rents for $875 per month. Deliveries of the Sigma 2 systems are expected to begin during the first quarter of 1967.

Sigma 2 contains an internal core storage unit that ranges in size from 4,096 to 16,384 16-bit words. Core storage access time is 0.9 microsecond per word. The core storage capacity can be increased to 65,536 words by the addition of Sigma 7 memory modules. Thus the Sigma 2 can share core storage with the Sigma 7, permitting multiprocessing operations. Real-time processing is facilitated by an interrupt system than can service up to 148 different interrupt levels, and memory protection is available to safeguard programs and data in core storage.

The instruction set of the Sigma 2 is limited to 35 standard 16-bit instructions, with multiply and divide instructions optional. All arithmetic is performed in fixed-point binary format, and no radix conversion nor code translation instructions are provided. Add, subtract, load, and store instructions can be executed in 2.25 microseconds, and 16-bit binary multiply in 10.35 microseconds. Comprehensive software that will be provided to utilize the Sigma 2 computation speeds includes two monitor-controlled operating systems, a Basic FORTRAN and a FORTRAN IV compiler, two assemblers, and a number of library and utility programs. Consistent with the design and scope of Sigma 2, no business data processing software will be provided. Sigma 2 can use all of the peripheral units announced for use with Sigma 7 (and listed in the Price Data section). There is no program compatibility between the two current Sigma systems.

The SDS Sigma family is expected to increase by the addition of still another computer system within a few months. The new system will probably be smaller and less expensive than the Sigma 7, but completely compatible.

(Contd.)

.012 Sigma 2 (Contd.)

The remainder of this Summary Report analyzes the characteristics and components of Sigma 7 hardware and software. Sigma 7 is considered the central computer system in the Sigma family, and all future Sigma systems will probably be based on the Sigma 7 design.

.02 DATA STRUCTURE

The basic unit of data storage in the SDS Sigma 7, as in the System/360 Model 50, is the 32-bit word. Each word also has a single parity bit. The word represents the amount of information that can be read from or written into main memory during a single core storage cycle. Two consecutive Sigma 7 words are combined by some instructions to form a 64-bit element of data called a "doubleword."

A Sigma 7 word can be logically divided into two 16-bit halfwords, each of which can be accessed directly. Each 16-bit halfword can consist of two 8-bit bytes; each byte is individually addressable and can store one alphanumeric character, one zoned decimal number, or two four-bit packed decimal digits.

For efficiency of system operation, all data must be stored according to rigid "information boundary" conventions. A byte must be located in bit positions 0 through 7, 8 through 15, 16 through 23, or 24 through 31 of a word. A halfword must be stored beginning at bit position 0 or 16 of a word, and a doubleword must be stored only at an even-numbered core storage address.

The basic Sigma 7 arithmetic operand is the 32-bit fixed-point binary word. Most fixed-point operations can alternatively specify the use of 16-bit halfword operations. Doubleword operands can also be used in load/store and add/subtract fixed-point operations.

The decimal and floating-point arithmetic operands use the same formats as similar operands in IBM System/360 arithmetic. Decimal arithmetic is performed upon 4-bit BCD digits, packed (by special instruction) two to a byte, with a sign in the rightmost four bits of the low-order byte. Decimal operands can be up to 16 bytes (31 digits plus sign) in length. Floating-point numbers are represented in either a "short" (32-bit) or "long" (64-bit) format. These numbers all contain a one-bit sign. The fractional part occupies 24 bits in the short format and 56 bits in the long (doubleword) format. The exponent of the floating-point numbers is a 7-bit hexadecimal characteristic in both formats, permitting representation of numbers that range from 10^{-78} to 10^{75}.

The Sigma 7 instruction format — unlike that of the IBM System/360 — has a uniform length of one 32-bit word for all classes of instructions, as described in Paragraph .052.

.03 SYSTEM CONFIGURATION

The basic Sigma 7 system consists of three principal elements: a central processor, a core storage module, and an input-output processor (or channel controller) — each capable of asynchronous, independent operation, and interconnected by means of a two-way central core storage bus. The basic system can be expanded by adding core storage modules (up to eight), by using three-way or six-way memory bus structures, and by adding both input-output and central processors.

A single system can accommodate up to eight input-output processors of the multiplexor and/or selector variety. Both types of input-output processors (IOP's) permit permanent connection of up to 32 peripheral device control units. A maximum of 32 low-to-medium-speed peripheral units can operate simultaneously over the 32 subchannels of a multiplexor IOP, provided the combined input-output data rate over these subchannels does not exceed 250,000 bytes per second. A selector IOP can control the transfer of 8-, 16-, 24-, or 32-bit-wide data between core storage and a single peripheral control unit at speeds up to 3.3 million bytes per second — the maximum capacity of a Sigma 7 core storage module. Normally, each IOP is connected to a single memory bus, but, if desired, two selector IOP's can share the same bus.

The number of peripheral devices that can be connected to each peripheral control unit ranges from 1 to 16, depending on the type of control unit. A maximum of 704 peripheral devices can be handled by a Sigma 7 system.

All components and features of a Sigma 7 system can be installed in the field (for a one-time installation fee), emphasizing the intent of SDS to provide truly modular, naturally expandable systems.

Presented below are five representative Sigma 7 configurations, arranged according to the specifications for our Standard System Configurations as tabulated in Section 4:030 of the Users' Guide. All necessary components and features are listed, together with their corresponding monthly lease rentals under a one-year lease contract. Prices under the SDS standard four-year lease contract are generally 18 to 19 per cent less than the one-year lease prices, as shown in Section 740:221, Price Data.

.031 12-Tape Business System; Configuration IV

Equipment		Rental
1 - 8401 Central Processor with Two Real-Time Clocks and Control Panel		$ 3,030
1 - 8451 Memory Module (16,384 bytes)		1,110
1 - 8452 Memory Increment (16,384 bytes)		495
1 - 8471 Multiplexor Input-Output Processor with eight Multiplexor Channels		555
2 - 7321 Magnetic Tape Controllers		560
12 - 7322 60KB Magnetic Tape Units		8,640
1 - 7010 Keyboard/Printer		165
1 - 7445 Buffered Line Printer (1,000 lpm)		1,110
1 - 7140 Card Reader (800 cpm)		665
1 - 7160 Card Punch (300 cpm)		890
	Total Rental:	$17,220

.032 6-Tape Auxiliary Storage System; Configuration V

Equipment		Rental
1 - 8401 Central Processor with two Real-Time Clocks and Control Panel		$ 3,030
1 - 8451 Memory Module (16,384 bytes)		1,110
1 - 8471 Multiplexor Input-Output Processor with eight Multiplexor Channels		560
1 - 8481 Selector Input-Output Processor		415
1 - 7010 Keyboard/Printer		165
2 - 7201 Data Storage Controllers		440
14 - 7205 Rapid-Access Data (RAD) Storage Units (21 million bytes)		10,430
1 - 7321 Magnetic Tape Controller		280
6 - 7322 60KB Magnetic Tape Units		4,320
1 - 7440 Buffered Line Printer (600 lpm)		970
1 - 7120 Card Reader (400 cpm)		445
1 - 7160 Card Punch (300 cpm)		890
1 - 8456 Three-Way Memory Access Feature		130
	Total Rental:	$23,185

.033 6-Tape Business/Scientific System; Configuration VI

Equipment		Rental
1 - 8401 Central Processor with two Real-Time Clocks and Control Panel		$ 3,030
3 - 8452 Memory Increments (49,152 bytes)		1,485
1 - 8451 Memory Module (16,384 bytes)		1,110
1 - 8471 Multiplexor Input-Output Processor with eight Multiplexor Channels		555
1 - 7010 Keyboard/Printer		165
1 - 7321 Magnetic Tape Controller		280
6 - 7322 60KB Magnetic Tape Units		4,320
1 - 7440 Buffered Line Printer (600 lpm)		970
1 - 7120 Card Reader (400 cpm)		445
1 - 7160 Card Punch (300 cpm)		890
1 - 8418 Floating Point Arithmetic Feature		835
	Total Rental:	$14,085

.034 10-Tape General System (Integrated); Configuration VIIA

Equipment		Rental
1 - 8401 Central Processor with two Real-Time Clocks and Control Panel		$ 3,030
2 - 8451 Memory Modules (32,768 bytes)		2,220
3 - 8452 Memory Increments (49,152 bytes)		1,485
1 - 8471 Multiplexor Input-Output Processor with eight Multiplexor Channels		555
1 - 7010 Keyboard Printer		165
2 - 7321 Magnetic Tape Controllers		560
10 - 7322 60KB Magnetic Tape Units		7,200
1 - 7740 Buffered Line Printer (600 lpm)		970
1 - 7120 Card Reader (400 cpm)		445
1 - 7160 Card Punch (300 cpm)		890
1 - 8418 Floating Point Arithmetic Feature		835
	Total Rental:	$18,355

(Contd.)

.035 Punched Tape Scientific System; Configuration X

Equipment		Rental
1 - 8401 Central Processor with two Real-Time Clocks and Control Panel		$ 3,030
1 - 8451 Memory Module (16,384 bytes)		1,110
2 - 8452 Memory Increments (32,768) bytes)		990
1 - 8471 Multiplexor Input-Output Processor with eight Multiplexor Channels		555
1 - 7010 Keyboard/Printer		165
1 - 7060 Paper Tape Input-Output System with 300-cps Reader, 120-cps Punch, and Spooler		335
1 - 8418 Floating Point Arithmetic Feature		835
	Total Rental:	$ 7,020

Note: The cost of adding the Decimal Arithmetic Feature to any of the above configurations is $1,000 per month under a 1-year lease contract or $810 under the standard 4-year lease contract.

.04 INTERNAL STORAGE

.041 Core Memory

Sigma 7 magnetic core memory is organized in 32-bit words (plus single-bit parity). Core storage is expandable from 4,096 words (16K bytes) to 131,072 words (524K bytes), in module increments of 4,096, 8,192, 12,888, and 16,384 words. Thus, 32 different memory sizes are available. All memory modules can be installed in the field.

The basic memory cycle time is 1.2 microseconds per 32-bit word, developing a potential transfer of 3.3 million bytes per second per module. Every word in core storage is directly addressable by the basic instruction word without using base registers, indexing, or indirect addressing.

Up to eight memory modules (of any of the four available module sizes and in any combination) can form the nucleus of a single Sigma 7 system. Each module is functionally independent of the others, and each of eight modules functioning at its peak transfer rate can result in a combined transfer rate of 26 million bytes per second. Up to six modules can be accessed simultaneously by the central processors, multiplexor I/O processors, and selector I/O processors. When more than one memory module is available, interleaving of memory addresses takes place automatically, permitting in some cases overlapping of instruction and data accesses. When memory overlap occurs, the effective core storage cycle time can be as low as 700 nanoseconds per 32-bit word.

Each Sigma 7 memory module has two memory ports as standard equipment, providing independent access paths for two processors (central or I/O). Optional Feature 8456 provides a selected module with a third memory port, and Feature 8457 adds three more ports to a module for a maximum of six memory ports. When more than one module is installed, each processor can access every module by means of a central bus structure.

A total of 320 words of Sigma 7 core storage is reserved for use by the control system software.

.042 Central Processor Private Memory

Special high-speed memory units, implemented in integrated circuitry, are available for the private use of the arithmetic and control unit of the Sigma 7 central processor. The basic central processor contains a private memory of sixteen 32-bit words used as general-purpose registers (see Paragraph .05). Seven of these registers can be used as index registers. Available as optional features are 31 additional 16-word blocks of registers, providing up to 512 general registers. With this capability, each of up to 32 programs in a multiprogramming mix can have its private set of registers, eliminating the need for storage and retrieval of register contents when transferring control between programs. A five-bit control field in the central processor specifies the register block currently in use.

Additional private high-speed memory units are provided with optional Feature 8415 — Memory Map. This feature provides a set of 256 eight-bit registers that are used as an automatically functioning associative memory unit to permit effective overlay control, memory fragmentation, and dynamic program relocation. Also supplied with the Memory Map feature is a corresponding set of 256 two-bit access-control registers used to read-protect and/or write-protect all of the 256 (maximum) 512-word blocks of core storage.

.042 Central Processor Private Memory (Contd.)

Normally, all Sigma 7 core storage addresses are direct, actual addresses. However, when the Memory Map feature is installed (and selectively turned on), all programmer-supplied or dynamically-computed addresses are considered to be virtual addresses. The programmer can assume that 256 512-word pages of virtual memory are available to him, regardless of how small the actual memory may be. When an instruction is accessed, the eight high-order bits of its virtual operand address are replaced (without any overhead time penalty) by the contents of the Memory Map register that is associated with the particular page of virtual addresses within which the operand's address falls. The newly-formed address is an actual, physical core storage address. Each of the 256 pages of virtual memory has a two-bit access-control register which functions in conjunction with the Memory Map, guarding non-privileged mode (i.e., slave mode) programs against reading, writing, and/or accessing instructions within the specific 512-word page of custom-protected virtual core memory. The contents of the map and access-control registers are regulated by the executive program (operating in "master mode"), providing a simple, fast means of achieving dynamic relocation of programs and of fragmenting blocks of large programs over non-contiguous portions of core storage.

Operating independently of the Memory Map and access-control registers is a fourth private central processor memory unit: the optional memory write protection registers. These are a series of 256 two-bit registers, called write locks, that are provided for each 512-word page of actual core memory addresses. The write locks operate in conjunction with a two-bit field — the write key — in the arithmetic and control portion of the central processor. Each program has a write key assigned to it, and only master mode programs can change the settings of program keys. If a program's write key matches the lock register setting for the block of memory being accessed, a write operation is permitted. The 256 core memory write locks are set only by privileged master-mode programs, usually by the executive routine alone. A lock value of 00 unlocks the block of memory to memory writing by any program, but any of three other lock settings permit writing only if a match occurs with the key of the accessing program. A "skeleton key" value of 00 permits writing anywhere in core storage, regardless of lock settings. Both master-mode and slave-mode programs are subject to the write-protection rules.

.043 Random-Access Data (RAD) Storage

SDS currently offers a single Random-Access Data (RAD) Storage unit for use with Sigma 7. The Model 7205 RAD Storage Unit provides 1.5 million bytes of storage with an average random access time of 17.5 milliseconds. The one-year monthly lease price of this unit is $745.

The RAD device is manufactured by SDS; it is the first of a series of such devices of widely varying capacities that SDS is designing for use with all Sigma computer systems. Featuring fixed head-per-track design and permanently installed discs, the future RAD units are expected to bring the price per byte of stored data down to among the lowest in the industry for random-access storage devices. Due for imminent announcement, according to SDS, is a 3-million-byte RAD unit that will rent for approximately the same price as the currently available Model 7205 RAD unit. The new unit will have a data transfer rate double that of the present RAD device.

Also due for announcement in the near future is a high-performance RAD unit that will store 4 million bytes of data, with an average access time of 17.5 milliseconds and a data transfer rate of 2 million bytes per second. This unit will rent for approximately $1,450 per month. According to SDS, several large-capacity RAD units are also due for imminent announcement, all featuring average access times of 17.5 milliseconds and data transfer rates of 200,000 bytes per second. A 24-million-byte storage system will rent for about $2,000 per month; a 96-million-byte system will cost about $5,000 per month; and a 192-million-byte system will be priced at approximately $8,000 per month.

A current RAD system consists of one Model 7201 Data Storage Controller and one to eight Model 7205 RAD units. The 7201 Controller connects directly to a channel of a Sigma 7 Multiplexor or Selector I/O Processor. The basic addressable unit of recorded information is a sector of 360 8-bit bytes. Each of the 512 tracks of the one recorded disc surface contains 8 sectors, providing each unit with a maximum storage capacity of 1.5 million bytes. Information is transferred between the Model 7205 RAD unit and Sigma 7 core storage at a maximum rate of 90,000 bytes per second.

.05 CENTRAL PROCESSOR

The Sigma 7 Model 8401 Processing Unit contains the registers and other circuitry necessary to address core storage, to perform arithmetic and logical operations, to sequence and control instruction execution, and to control the exchange of information between core storage and the input-output processors. Up to five Sigma 7 central processors can share a single core storage system.

.051 Processor Registers

The "private memory" of the central processor consists of a large number of processor control registers implemented in high-speed integrated circuitry. These registers are described in Paragraph .042.

From one (standard) to 32 blocks of general-purpose registers can be installed in a Sigma 7 central processor; each block contains 16 registers. Only one block of registers is active or "current" at any given instant. Any of the general registers can be used as accumulators for fixed-point and floating-point arithmetic operations, for temporary storage of data, and for control information such as data addresses, counters, pointers, etc. Within a register block, registers 1 through 7 can serve as index registers, and registers 12 through 15 are automatically used as decimal accumulators whenever a decimal instruction is executed. The index and decimal registers can also be used as standard general-purpose registers.

See Paragraph .042 for a description of the processor's Memory Map optional feature (256 eight-bit registers used for dynamic relocation of 512-word program blocks). Also described in Paragraph .042 are the 256 two-bit registers used for memory access protection in conjunction with the Memory Map feature, and the 256 two-bit optional write-lock registers used to provide all memory blocks with memory write protection against both privileged and non-privileged instructions.

All critical control conditions of the one program that is currently active at any instant are stored in a collection of central processor registers and flip-flops known as the Program Status Doubleword (PSD). When the PSD is stored in core storage, it occupies a 64-bit doubleword. The contents of any program's PSD can be altered by the Load Program Status Doubleword (LPSD) and Load Register Block Pointer (LRP) privileged instructions. The Exchange Program Status Doubleword (XPSD) privileged instruction can store the entire current PSD and load a new PSD for another program in the multiprogramming mix in 6.3 microseconds.

The PSD contains a 4-bit condition code which indicates the results of every instruction execution. Among other information stored in the PSD are the following fields: a 17-bit instruction address of the next instruction to be executed; a 2-bit program write key; a master/slave mode control bit; a memory map activate bit; a 5-bit register block pointer; interrupt inhibit bits; and bits used to control the mode of floating-point arithmetic operations and to control trapping operations if exceptional conditions occur during the execution of fixed-point and decimal arithmetic operations.

.052 Instruction Formats

All Sigma 7 central processor instructions are of one size: a single 32-bit word. There are three basic instruction formats:

- Standard Direct Memory and Register Instruction

1	OP	R	X	Reference Address

- Immediate Operand Instruction

0	OP	R	Operand

- Byte String Instruction

0	OP	R	Displacement

1 = 1-bit indirect addressing specification.
0 = 1-bit code indicating lack of indirect addressing.
OP = 7-bit field that designates the operation to be performed.
R = 4-bit general register designator.
X = 3-bit index register designator.
Reference Address = 17-bit field containing initial virtual address of operand.
Operand = 20-bit field used as an immediate operand or literal.
Displacement = 20-bit field used to form an effective address or used as a direct operand address.

The standard instruction uses a two-address format, one a register address and the other a direct core storage address. If the high-order bit of these instructions is a one, single-level indirect addressing takes place. If the X-field contains a value from 1 to 7, address indexing takes place according to the contents of the so-specified 32-bit index register. Indirect addressing always occurs before indexing.

.052 Instruction Formats (Contd.)

A valuable feature of Sigma 7 indexing operations is called "displacement indexing." This means that the increment value in the index register effectively varies in value depending on the size of the operand field being addressed by an instruction. Thus, a doubleword-addressing instruction that uses an index register with a value of 2 will automatically address the second doubleword beyond the original reference address. The same value in the same index register will automatically point to the second word, second halfword, or second byte beyond the reference address, depending on the size of operand accessed by various instructions. This feature gives each index register increased capability and should be extremely useful in manipulating arrays of various-sized data fields.

The immediate operand instructions use a 20-bit literal value and the contents of a general register as operands. Five immediate operand instructions are provided, including Immediate Add, Multiply, and Compare. Instructions of this type cannot use the indexing and indirect addressing features.

The five byte-string instructions are actually in the immediate operand instruction class in that they are not modifiable by indexing and cannot use indirect addressing. However, in these instructions the operand field contains a signed 20-bit byte displacement value that normally modifies the address found in register R to form an effective source address in core storage for the byte-manipulating instructions. The destination address in core storage is normally specified by the contents of register R + 1 without displacement modification. Register R + 1 also contains the count (from 1 to 256) of the number of bytes involved in the operation. If R is zero, the source address is the direct value of the displacement field, and the destination address is the address in general register 1.

The byte-string instructions proceed one byte at a time (except for Move Byte String, which proceeds four bytes at a time under certain conditions). These instructions can be interrupted after each individual byte operation.

.053 Processing Facilities

The standard instruction repertoire of the Sigma 7 central processor contains 87 instructions that provide powerful and surprisingly simple facilities for performing logical, arithmetic, and control operations on binary operands of various sizes: byte, halfword, word, doubleword, and multiple-word (up to sixteen 32-bit words). The basic arithmetic mode is fixed-point binary, and instructions are provided to convert between the binary data code and any other data code, such as BCD.

Available as optional features are Floating Point Arithmetic and Decimal Arithmetic. Feature 8418, Floating Point Arithmetic, provides eight arithmetic instructions that use single-precision (24-bit) and double-precision (56-bit) floating-point operands. Underflow and overflow detection is provided, as is zero result control and result normalization control. Floating point instructions cannot be interrupted once execution has begun.

Feature 8419, Decimal Arithmetic, provides 11 additional instructions that permit processing of data in the 4-bit decimal digit format. All decimal arithmetic instructions operate exclusively on decimal digits that are packed two digits per byte. The decimal operands consist of from 1 to 31 decimal digits plus a four-bit decimal sign. Decimal Multiply, Decimal Divide, and the Edit Byte String instructions can be interrupted and continued after the interrupt has been serviced. The edit instruction formats a string of packed decimal digits according to a set pattern in the destination field.

Table II contains the complete Sigma 7 instruction list, including the instruction execution times.

The Load, Store, Push, and Pull Multiple instructions are useful in quickly manipulating entire blocks of general-purpose registers for program-switching efficiency in multiprogramming and time-sharing environments. Five push/pull memory stack instructions are provided for last-in, first-out operand processing that is especially beneficial in recursive routines and general compiler operations. Stack limits are automatically checked. The four Call instructions give the programmer the ability to trap out automatically to any of 64 dynamically-variable Monitor routines or user-defined hardware simulation routines, thereby significantly increasing the power of the built-in Sigma 7 instruction set. The Analyze instruction generates the effective address (including indirect addressing and indexing) of an operand within a specified instruction without actually executing the instruction. The Interpret instruction provides bit manipulation capability that should assist the compilers to generate efficient object code.

The Exchange PSD instruction permits rapid switching (6.3 microseconds) of current Program Status Doublewords, also useful in multiprogramming environments. If the two programs involved have been assigned individual blocks of general registers, no further storing of program status conditions need take place when transferring control to the newly-active program. Another useful instruction in the set is Translate Byte String, which can perform any 8-bit code translations for fields of up to 256 consecutive bytes.

(Contd.)

.053 Processing Facilities (Contd.)

The five privileged input-output instructions direct the Sigma 7 input-output processors to control I/O operations according to the contents of an addressed Current Command Doubleword. This I/O system makes possible both data chaining (scatter-read and gather-write) and command chaining (permitting the I/O processor to access a chain of commands and perform the specified operations without central processor intervention).

.054 Operational States

The Sigma 7 central processor operates in either the master mode or slave mode, controlled by a bit setting in the active program's Program Status Doubleword. In the master mode, all valid instructions can be executed. The resident executive program (Monitor) always operates in the master mode and controls the operating mode of all other programs. In the slave or "problem solving" mode, certain "privileged" instructions are prohibited. Privileged instructions are all those related to input-output operations and modifications to the basic control state of the central processor. Although slave-mode programs cannot use certain instructions reserved for use by the master-mode Monitor, they can gain direct access to certain Monitor routines by means of 64 user-defined Call operations.

.055 Interrupt System

A Sigma 7 central processor can be equipped with a powerful priority interrupt system that will assist in efficient handling of real-time and time-sharing operations. Five priority levels of interrupt are provided as standard equipment (parity, input-output, control panel, and two counters), and six additional counter and two power on/off levels can optionally be installed with Feature 8413 — Power Fail Safe. More significantly, up to 14 groups of external interrupt levels can be installed, and each group contains 16 distinct interrupt sublevels. The user specifies the priority order for his input-output and external interrupt levels. Each of the 232 potential Sigma 7 interrupt levels is assigned a unique interrupt service location in core storage, each has a unique priority, and each can be selectively enabled by the central processor. The processor can also trigger any interrupt level, for example, to test the interrupt servicing routine prior to use by special problem programs.

.056 Trap System

The Sigma 7 trap system permits immediate handling of exception conditions related to the execution of all instructions without entering a service-priority queue. Eleven core storage locations are reserved for accessing routines to process the following exception conditions before branching back to the program execution sequence:

Nonexistent instruction
Nonexistent memory address
Privileged instruction in slave mode
Memory protection violation
Interrupt system fault
Unimplemented instruction
Push-down stack limit reached
Fixed-point arithmetic overflow
Floating-point divide by zero
Floating-point significance check
Decimal arithmetic fault
Floating-point characteristic overflow
Watchdog timer runout
Call instructions.

.06 CONSOLE

There are three possible operator control centers for a Sigma 7 system: a processor control panel mounted on one of the central processor cabinets; an optional free-standing operator's console (Feature 8495); and an optional keyboard-printer device.

The central processor control panel contains a maintenance section (used primarily for diagnostic and maintenance operations and program debugging) and an operator's section. The controls, indicators, and displays of the operator's section are functionally duplicated on the free-standing 8495 System Supervisory Console. This optional Console provides easy-to-use switches and large, legible data displays. Among the many facilities provided by the operator's console are the ability to interrupt the central processor, to display and alter the current Program Status Doubleword (PSD), to display and alter the contents of any general register or core storage location, and to control the setting of the program sequence counter. If standard Sigma 7 software is used, a Model 7010 or 7020 Keyboard/Printer must be provided for messages between the operator and the resident monitor program.

TABLE II: INSTRUCTION EXECUTION TIMES

Instruction	Mnemonic	Time in Microseconds	
		Max.	Min.
LOAD/STORE			
Load Immediate	LI	1.2	1.2
Load Byte	LB	2.4	2.0
Load Halfword	LH	2.4	2.0
Load Word	LW	2.4	2.0
Load Doubleword	LD	3.6	2.8
Load Absolute Halfword	LAH	2.4	2.0
Load Absolute Word	LAW	2.4	2.0
Load Absolute Doubleword	LAD	3.6	3.4
Load Complement Halfword	LCH	2.4	2.0
Load Complement Word	LCW	2.4	2.0
Load Complement Doubleword	LCD	3.6	2.8
Load Selective	LS	3.0	3.0
Load Multiple	LM	2.2 + 1.2N	2.2 + 1.2N
Store Byte	STB	2.6	2.6
Store Halfword	STH	2.6	2.6
Store Word	STW	2.4	2.2
Store Doubleword	STD	3.6	3.1
Store Selective	STS	3.8	3.7
Store Multiple	STM	2.2 + 1.2N	2.2 + 1.2N
Exchange Word	XW	3.6	3.3
ARITHMETIC			
Add Halfword	AH	2.4	2.2
Subtract Halfword	SH	2.4	2.2
Multiply Halfword	MH	4.0	4.0
Divide Halfword	DH	12.8	12.8
Add Immediate	AI	1.2	1.2
Multiply Immediate	MI	4.3	4.3
Add Word	AW	2.4	2.0
Subtract Word	SW	2.4	2.0
Multiply Word	MW	4.9	4.9
Divide Word	DW	12.5	12.5
Add Doubleword	AD	3.6	2.9
Subtract Doubleword	SD	3.6	2.9
Modify and Test Byte	MTB	3.9	3.9
Modify and Test Halfword	MTH	3.9	3.9
Modify and Test Word	MTW	3.6	3.4
Add Word to Memory	AWM	3.6	3.5
BYTE STRING			
Move Byte String	MBS	3.7 + 1.2B	3.7 + 1.2B
Compare Byte String	CBS	3.7 + 3.7B	3.6 + 3.7B
Test Byte String	TBS	2.8 + 3.9B	2.8 + 3.9B
Translate and Test Byte String	TTBS	2.8 + 4.1B	2.8 + 4.1B
Edit Byte String (optional)	EBS	4.3 + 5.9P	4.3 + 5.9P
PUSH/PULL			
Push Word	PSW	7.8	7.7
Pull Word	PLW	8.6	8.5
Push Multiple	PSM	7.9 + 1.2N	7.8 + 1.2N
Pull Multiple	PLM	8.9 + 1.2N	8.8 + 1.2N
Modify Stack Pointer	MSP	6.7	6.6
CONVERSION			
Convert by Addition	CVA	12.2 + 1.2C	12.2 + 1.2C
Convert by Subtraction	CVS	50.6	50.6
INPUT-OUTPUT			
Start I/O	SIO	8.9	8.3
Halt I/O	HIO	8.3	7.8
Test I/O	TIO	8.3	7.8
Test Device	TDV	8.3	7.8
Acknowledge I/O Interrupt	AIO	6.4 + 0.1d	5.8 + 0.1d
EXECUTE AND BRANCH			
Execute	EXU	1.5	1.5
Branch on Incrementing Register	BIR-Branch	2.0	2.0
Branch on Incrementing Register	BIR-No Br.	3.6	3.6
Branch on Decrementing Register	BDR-Branch	2.0	2.0
Branch on Decrementing Register	BDR-No Br.	3.6	3.6
Branch on Conditions Set	BCS-Branch	2.0	2.0
Branch on Conditions Set	BCS-No Br.	3.6	3.6
Branch on Conditions Reset	BCR-Branch	2.0	2.0
Branch on Conditions Reset	BCR-No Br.	3.6	3.6
Branch and Link	BAL	2.0	2.0

(Contd.)

TABLE II: INSTRUCTION EXECUTION TIMES (Contd.)

Instruction	Mnemonic	Time in Microseconds	
		Max.	Min.
FLOATING POINT (optional)			
Floating Add Short	FAS	3.9	3.9
Floating Add Long	FAL	4.5	4.5
Floating Subtract Short	FSS	3.9	3.9
Floating Subtract Long	FSL	4.5	4.5
Floating Multiply Short	FMS	5.4	5.4
Floating Multiply Long	FML	8.0	8.0
Floating Divide Short	FDS	12.3	12.3
Floating Divide Long	FDL	24.5	24.5
LOGICAL			
OR Word	OR	2.4	2.1
Exclusive OR Word	EOR	2.4	2.1
AND Word	AND	2.4	2.1
COMPARISON			
Compare Byte	CB	2.4	2.4
Compare Halfword	CH	2.4	2.4
Compare Word	CW	2.4	2.4
Compare Doubleword	CD	3.6	2.8
Compare Immediate	CI	1.8	1.8
Compare Selective	CS	3.3	3.3
Compare with Limits in Register	CLR	2.4	2.4
Compare with Limits in Memory	CLM	3.6	2.6
SHIFT			
Shift Left	S	2.5 + 0.075b	2.5 + 0.075b
Shift Right	S	2.4 + 0.15b	2.4 + 0.15b
Shift Floating Left Short	SF	2.7 + 0.3H	2.7 + 0.3H
Shift Floating Right Short	SF	2.7 + 0.6H	2.7 + 0.6H
Shift Floating Left Long	SF	3.7 + 0.3H	3.7 + 0.3H
Shift Floating Right Long	SF	3.7 + 0.6H	3.7 + 0.6H
DECIMAL (optional)			
Decimal Load	DL	10.4 + 0.4D	10.4 + 0.4D
Decimal Store	DST	10.8 + 0.6D	10.8 + 0.6D
Decimal Add	DA	17.4 + 0.4D	17.4 + 0.4D
Decimal Subtract	DS	17.6 + 0.4D	17.6 + 0.4D
Decimal Multiply	DM	19.3 + 0.4Mm	19.3 + 0.4Mm
Decimal Divide	DD	19.3 + 0.5VQ	19.3 + 0.5VQ
Decimal Compare	DC	10.4 + 0.4D	10.4 + 0.4D
Decimal Shift Arithmetic	DSA	19.4	19.4
Pack Decimal Digits	PACK	10.4 + 0.6B	10.4 + 0.6B
Unpack Decimal Digits	UNPACK	10.4 + 1.2B	10.4 + 1.2B
CONTROL			
Exchange Program Status Doubleword	XPSD	6.4	6.3
Load Program Status Doubleword	LPSD	4.5	4.5
Load Register Pointer	LRP	2.7	2.7
Load Conditions and Floating Control	LCF	2.4	2.0
Load Conditions and Floating Immediate	LCFI	1.2	1.2
Store Conditions and Floating Control	STCF	2.6	2.6
Read Direct	RD	2.6	2.6
Write Direct	WD	2.6	2.6
Interpret	INT	2.7	2.7
Analyze	ANLZ	2.9	2.9
Wait	WAIT	1.8	1.8
Move to Memory Control	MMC	1.7 + 2.4N	1.7 + 2.4N
Call 1	CAL1	3.6	3.6
Call 2	CAL2	3.6	3.6
Call 3	CAL3	3.6	3.6
Call 4	CAL4	3.6	3.6

NOTES: (1) All times include indexing and mapping operations wherever applicable.

(2) Max. is the maximum instruction execution time, assuming no memory overlap operations; Min. is the shortest possible execution time, assuming the best possible use of memory overlap operations.

(3) Floating point times assume normalized, non-zero operands.

LEGEND

B = number of bytes.
b = number of bit positions shifted.
C = number of binary "ones" in the word being converted.
D = number of decimal digits.
d = number of higher-priority devices awaiting service.
H = number of hexadecimal positions shifted.
M = number of digits in multiplicand, including sign.
m = number of digits in multiplier.
N = number of 32-bit words.
P = number of bytes in the editing pattern.
Q = number of digits in quotient.
V = number of digits in divisor, including sign.

.06 CONSOLE (Contd.)

The Model 7010 Keyboard/Printer is basically a Teletype Model 35 KSR unit with controller, using the standard Teletype console keyboard and a character-at-a-time printer which SDS rates at 20 characters per second. The 7010 can be used either at the central computer site or at remote locations.

The Model 7020 Keyboard/Printer is basically a Teletype Model 35 ASR unit, with built-in controller, paper tape reader and paper tape punch. According to SDS, the 7020 can read or punch 8-level, 1-inch paper or Mylar tape at 20 characters per second. The keyboard, printer, and paper tape units can also be used off-line to perform data transcription operations. These units must be installed within 500 feet of a Sigma 7 input-output processor.

All Keyboard/Printer units are connected to a Sigma 7 system via a channel of a multiplexor or selector input-output processor. All data is sent and received in 8-bit EBCDIC format. The primary functions of the Keyboard/Printer units are to permit direct, manual input to the Sigma 7 computer system and to report error and status messages sent by the system's monitor program.

.07 PERIPHERAL UNITS

The standard Sigma 7 peripheral units are conventional in design and performance. The characteristics of the mass storage peripheral devices are described in Paragraph .043 and the several available console devices are described in Paragraph .06. Section 740:221, Price Data, lists all available peripheral devices in the standard Sigma 7 product line with their essential characteristics.

.071 Magnetic Tape Units

SDS manufactures its own Model 7321/7322 Magnetic Tape System for use with the Sigma Computers. The system consists of one 7321 Controller and from one to eight 7322 Magnetic Tape Transports. The transports read and write standard 1/2-inch magnetic tape and record in a data format fully compatible with that used by the IBM 2400 Series 9-track, 800 bpi tape units. The tape transport speed is 75 inches per second, developing a peak data transfer rate of 60,000 bytes per second at the 800 bpi packing density. Tape units that record at 1600 bpi have not been announced by SDS to date.

The tape transport features a single servo-controlled capstan that controls all tape motion and eliminates the need for pinch rollers. The tape path is friction-free since positive air pressures within the tape guides prevent the tape from contacting the guide surfaces. Another feature is the POPO (Push On, Pull Off) reel hub assembly that permits the operator to mount a tape reel with a single pushing action and to remove the reel with a single pull.

.072 Other Peripheral Devices

SDS states that a variety of digital plotters, display devices, and data communications equipment can be connected to a Sigma 7 system. SDS will supply the interface units necessary to connect a Sigma system to such devices from the product lines of its earlier computer systems (SDS 92, 910, 925, 930, 9300, and 940) and those of competing computer manufacturers. Specifically, an interface is expected to be announced shortly that will permit the connection of most of the standard peripheral devices currently offered with the IBM System/360.

.11 SIMULTANEOUS OPERATIONS

As described in Paragraph .03, System Configuration, all input-output operations are controlled by up to eight channel controllers, called input-output processors, and each processor can control up to 32 peripheral device control units. These multiplexor and selector I/O processors operate independently of the central processor, permitting all I/O data transfer operations to be performed concurrently with computing. Theoretically, up to 256 I/O devices can transfer data to and from core storage concurrently with central processor computation.

The central processor can also operate completely independently of the core storage memory modules. Up to eight memory modules can be attached to a Sigma 7 system and up to six modules can be accessed simultaneously by different system processors, both central processors and I/O processors. Also, up to five central processors can be connected to a Sigma 7 system, permitting the concurrent execution of five central processor instructions.

.12 INSTRUCTION LIST

See Table II for a complete list of Sigma 7 instructions and their execution times.

(Contd.)

.13 COMPATIBILITY

Sigma 7's degree of compatibility with the IBM System/360 is described in Paragraph .011.

.14 DATA CODES

The basic internal code of the Sigma 7 system is the Extended Binary-Coded Decimal Interchange Code (EBCDIC), as used in the IBM System/360. Certain arithmetic and comparison instructions can be performed on 8-bit ASCII data, but all standard software will use EBCDIC exclusively. Punched card, paper tape, and magnetic tape codes are fully compatible with similar codes used with the System/360. Since the Sigma 7 central processor is equipped with two code-translate instructions, all current and future 8-bit data codes will be handled efficiently.

.15 SOFTWARE

SDS provides users of its Sigma 7 system a choice of four levels of software support: a non-integrated package of stand-alone programs and three levels of integrated operating systems.

The stand-alone programs do not use a resident monitor program and all programs are processed in standard sequential mode — one program at a time. Sigma 7 stand-alone programs include a Basic FORTRAN IV compiler, a basic Assembler ("Symbol"), a loader, debugging package, and library and maintenance routines. These stand-alone programs can function in a minimum hardware environment of 4,096 32-bit words of core storage with one multiplexor input-output processor, one Model 7010 Keyboard/Printer, and one Model 7060 High Speed Paper Tape Reader/Punch. These programs, like all Sigma 7 software programs, are fully compatible subsystems of the larger Sigma 7 operating systems.

The software availability dates for the stand-alone programs and all language and control programs of the three Sigma 7 operating systems are listed in Table I.

.151 Basic Control Monitor

The Basic Control Monitor (BCM) offers users of Sigma 7 systems with at least 8,192 words of core storage an integrated operating system capable of controlling, in a multiprogramming mode, the concurrent execution of two user programs: a "background" production program and a "foreground" real-time task. The BCM operating system requires the presence of only a multiplexor input-output processor, a Keyboard/Printer, a paper tape reader/punch, Memory Protect, and 8K words of main memory. The optional Interrupt Control and External Interrupt Levels will be desirable additions to the real-time configuration, and the Floating Point Arithmetic feature will permit the software components and user programs to operate more efficiently.

The Monitor program of the BCM package is a control program for real-time programs; it includes central input-output, memory protection, and interrupt and trap handling routines. The Monitor is assembled with and appended to each real-time program at assembly time and it consumes about 2,500 words of core storage when controlling execution of the real-time program. The operator can request via the console to enter a non-related, lower-priority background program at any time; this program will automatically receive the services of the central processor whenever the real-time foreground program becomes inactive. Background programs (including system compilers and assemblers) can initialize the loading and execution of programs awaiting processing in an input device. The Basic Control Monitor can also control the sequential execution of batched programs.

The use of magnetic tape devices and Rapid Access Data (RAD) Storage Units is not required by BCM. However, by adding a single RAD device (1.5 million bytes), the Disc Checkpoint software feature can be supported. This feature permits the operator (or the foreground program in a two-program mix) to transfer the background program to the RAD unit whenever the usage of the entire core storage unit is required by the real-time program. The Disc Checkpoint routine is assembled into the Basic Control Monitor and occupies approximately 500 additional words of core storage.

Software programs that are supplied to function under control of BCM in the minimum 8K-word environment include a Basic FORTRAN IV compiler, the Symbol assembler, a debugging package, loader, and library maintenance and power fail-safe routines. All programs are upward-compatible with the programs of the two higher-level operating systems.

.152 Batch Processing Monitor

Users of Sigma 7 systems that have at least 12K words (49,152 bytes) of core storage can use the expanded facilities of the Batch Processing Monitor (BPM) operating system and can thereby utilize to a greater extent the multiprogramming and real-time capabilities of the Sigma 7

.152 Batch Processing Monitor (Contd.)

hardware. BPM is oriented toward efficient sequential processing of batched production programs, but it has complete facilities for concurrently servicing a foreground real-time program. In addition, BPM permits the operator or user program to initiate an SDS-supplied "symbiont" or standard peripheral device data transcription routine. Thus, up to three programs can be concurrently controlled by the Batch Processing Monitor.

In addition to a minimum of 12,288 words of core storage, the Batch Processing Monitor also requires use of a multiplexor input-output processor, a keyboard/printer, card reader, one magnetic tape unit, and one Random Access Data (RAD) storage unit. A disc management package is used for storing the various components of the BPM operating system, input-output data buffering, job stacking and scheduling, remote batch processing, controlling overlays and general working storage, and checkpointing or "rolling-out" active programs. BPM also requires exclusive use of its own block of general-purpose registers, necessitating the installation of at least two such register blocks, including one for user programs. Optional feature 8214, Memory Protect, must also be installed in order to use BPM. Presence of the following central processor features will be desirable for efficient operations: Floating Point Arithmetic, Decimal Arithmetic, and at least two groups of external priority interrupt levels.

The resident portion of the Batch Processing Monitor requires approximately 3,500 words of core storage. The addition of optional software features, such as symbionts (approximately 1,000 bytes) and remote batch processing, will increase this basic requirement. BPM can effectively utilize a maximum of 131,072 words of core storage.

Efficient batch processing is made possible by BPM routines that supply central input-output control, automatic assignment of peripheral devices, job accounting on elapsed time and machine time bases, automatic stacking of sequential jobs, and (optionally) priority scheduling of programs stored on a RAD device. Remote stacking of jobs is also possible through use of the Monitor's data transmission symbiont routine, which places the remotely-entered jobs in the local job stack.

Among the powerful language processors supplied with the Batch Processing Monitor for use in 12K to 20K-word environments are a quick-compile, debugging-oriented FORTRAN IV compiler, a high-efficiency FORTRAN IV compiler, debug and high-efficiency versions of PL/I, and a large-scale symbolic assembler ("Meta-Symbol") in which efforts have been made to keep the language as simple as possible. Meta-Symbol encourages the user to define his own procedures and, in a sense, to write his own specialized compilers. The FORTRAN and PL/I compilers are constructed in re-entrant code, and they generate re-entrant code in their object program output.

In addition to these and all programs supplied with the Basic Control Monitor, the Batch Processing Monitor can also use a business-oriented processing package called MANAGE which will include a Report Program Generator and generalized management information services. A Sort/Merge program is also expected to be developed in the near future.

.153 Universal Time-Sharing Monitor

The third and highest level of Sigma 7 software support is the operating system called Universal Time-Sharing Monitor (UTS). As its name states, UTS is used to control true remote time-sharing operations, but it can concurrently control batched-job processing, real-time processing, and input-output data transcription operations (symbionts). UTS can also support multiprocessor Sigma 7 configurations that share common core storage.

Listed in Table III are the Sigma 7 hardware requirements for use of the Universal Time-Sharing Monitor. This operating system can take advantage of the maximum Sigma 7 core storage size (131K words) and a large complement of RAD storage units.

The design goal of the UTS system is to provide Sigma 7 computer services to multiple users without long delays. Parameters of UTS can be set by each installation to establish the type(s) of multi-user services that should be provided and to guarantee that the system will not be excessively loaded at any one time.

Dynamic queuing and scheduling of user programs are the primary functions of UTS. The standard control programs can schedule four types of program queues: high-priority (where fast response is critical), on-line interactive, on-line processing, and batch production. The user can specify the number of possible queues and their priorities, the scheduling and program switching algorithin for each queue (e.g., switch at I/O interrupt, switch when time "slice" expires, etc.), the size of allotted time slices, and the maximum number of users in each queue level. Program queuing operations make use of RAD storage units, and program swapping between core storage and a RAD unit takes place whenever necessary. Provision of common re-entrant subroutines and the use of compilers that generate re-entrant object code

(Contd.)

TABLE III: UNIVERSAL TIME-SHARING MONITOR HARDWARE REQUIREMENTS

Minimum Requirements			
1	8401	Central Processor	
1	8451	4K-word Memory Module	131,072 bytes
7	8452	4K-word Memory Increments	
2	8456	Three-Way Memory Access Options	
1	8414	Memory Protect Option	
1	8415	Memory Map Option	
1	8416	Additional Register Block	
1	8471	Multiplexor Input-Output Processor	
1	8481	Selector Input-Output Processor	
1	7201	Rapid Access Data Control Unit	
2	7205	1.5-million-byte RAD Storage Units	
1	7321	Magnetic Tape Control Unit	
1	7322	Magnetic Tape Transport	
1	7120	Card Reader	
1	7010	Keyboard/Printer	
Recommended Additional Equipment			
1	8418	Floating Point Arithmetic Option	
1	8419	Decimal Arithmetic Option	
1	8416	Additional Register Block*	
1	7205	RAD Storage Unit	
1	7322	Magnetic Tape Transport	
1	7160	Card Punch	
1	7440	Buffered Line Printer	

* Each real-time program that demands instantaneous response should have available its own dedicated block of general-purpose registers.

.153 Universal Time-Sharing Monitor (Contd.)

will minimize the amount of program swapping required. Re-entrant routines are non-modifiable, and an exact copy of every re-entrant program is stored on a RAD unit.

Among the many service and control functions performed by the Universal Time-Sharing Monitor are the following:

- Comprehensive input-output services.
- Automatic stacking of sequential jobs.
- Dynamic initiation and execution of real-time programs concurrently with processing of background production programs.
- Management of RAD secondary storage devices.
- Operator communication.
- Dynamic priority scheduling.
- Program overlay control.
- Memory protection and memory map maintenance.
- Program-to-program communication (tasking).
- Dynamic program relocation.
- Data communications control routines for remote terminal units.
- Program swapping.
- Checkpoint services.
- Automatic job accounting.
- Concurrent data transcription routines (symbionts).
- Exception condition handling.

The Universal Time-Sharing Monitor is an upward-compatible extension of the Batch Processing Monitor (described in Paragraph .152). As such, UTS handles batch processing, real-time processing, and symbionts in much the same manner as BPM. Also, UTS uses all of the language processors and service programs available with BPM. However, the UTS Meta-Symbol assembler differs from its BPM counterpart in that it is a re-entrant program and it generates re-entrant object code (like the PL/I and FORTRAN IV compilers of both BPM and UTS).

PRICE DATA

CLASS	IDENTITY OF UNIT		PRICES			
	No.	Name	Monthly Rental $ 1-year lease	Monthly Rental $ 4-year lease	Monthly Maintenance $	Purchase $
SIGMA 7 CENTRAL SYSTEM		Central Processor				
	8401	Sigma 7 Central Processing Unit with 2 real-time clocks, control panel, and power supplies	3,030	2,475	450	110,000
		Processor Options				
	8411	Two Additional Real-Time Clocks	30	20	5	1,000
	8413	Power Fail Safe	30	20	5	1,000
	8414	Memory Write Protect	140	115	20	5,000
	8415	Memory Map	665	540	80	20,000
	8416	Additional Register Block	85	65	10	2,500
	8418	Floating Point Arithmetic	835	675	100	25,000
	8419	Decimal Arithmetic	1,000	810	120	30,000
	8421	Interrupt Control Chassis	60	50	10	2,200
	8422	Priority Interrupt, 2 levels	10	8	NC	350
	8495	System Supervisory Console	695	565	100	25,000
		Core Storage				
	8451	Memory Module: 4,096 words	1,110	900	160	40,000
	8452	Memory Increment: 4,096 words	495	400	40	17,500
	8456	Three-Way Access	130	115	20	5,000
	8457	Six-Way Access	335	270	50	10,000
		Input-Output Processors				
	8471	Multiplexor Input-Output Processor, with 8 Multiplexor Channels	555	450	80	20,000
	8472	Additional 8 Multiplexor Channels	130	110	15	4,000
	8481	Selector Input-Output Processor	415	340	60	15,000
	8482	Additional Selector Channel	280	215	40	10,000
INPUT DEVICES	7120	Card Reader, 400 cpm	445	360	100	16,000
	7140	Card Reader, 800 cpm	665	540	150	24,000
	7061	Paper Tape Controller and Equipment Cabinet	200	610	30	7,000
	7062	Paper Tape Reader, 300 cps	55	45	15	2,000
	7064	Paper Tape Spooler	45	35	10	1,500
OUTPUT DEVICES	7160	Card Punch, 300 cpm	890	720	210	32,000
	7063	Paper Tape Punch, 120 cps	65	55	25	2,500
	7440	Buffered Line Printer, 600 lpm	970	790	230	35,000
	7445	Buffered Line Printer, 1,000 lpm	1,110	900	255	40,000
INPUT-OUTPUT DEVICES	7010	Keyboard/Printer	165	135	35	6,000
	7020	Keyboard/Printer, with Paper Tape Reader and Punch	220	180	50	7,500
	7060	Paper Tape Reader (Model 7062), with 7063 Paper Tape Punch, 7064 Spooler, and 7061 Controller	335	270	80	12,000
		Mass Storage Devices				
	7201	RAD Controller	220	180	35	8,000
	7205	RAD Storage Unit, 1.5 million bytes	745	610	155	27,000
		Magnetic Tape Units				
	7321	Magnetic Tape Controller	280	225	40	10,000
	7322	Magnetic Tape Unit, 9-channel, 800 bpi, 60KB	720	585	185	27,000
	7371	Seven-Channel Magnetic Tape Controller	335	270	50	12,000
	7372	Magnetic Tape Unit, 7-channel, 200/556/800 bpi, 60KC max.	720	585	185	27,000