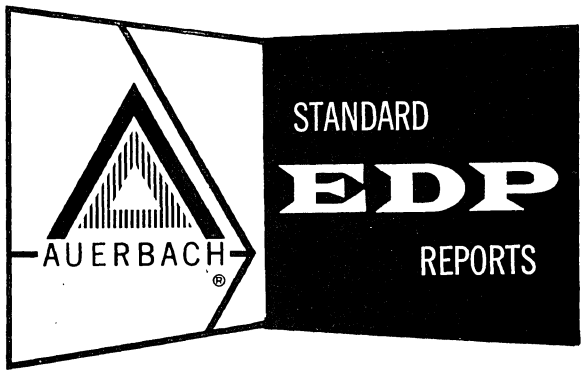
RCA 3301

Radio Corporation of America



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§ 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	
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	
Card (Model 3488):	166,400 characters	
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:

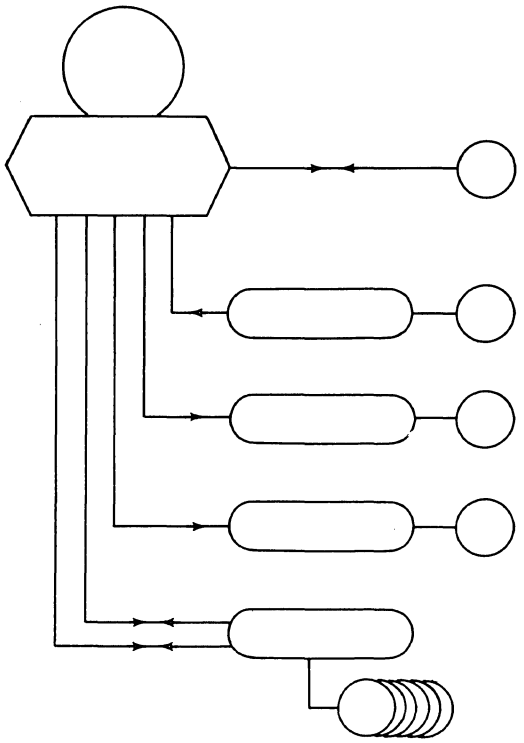
Fixed point:	8 characters.
Floating point:	8 character fraction and 2-character exponent.

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

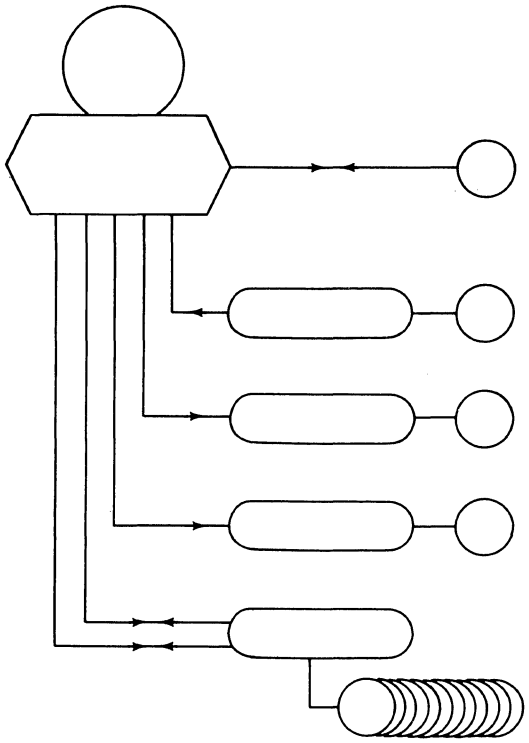
Optional Features Included: . . . . . none.

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

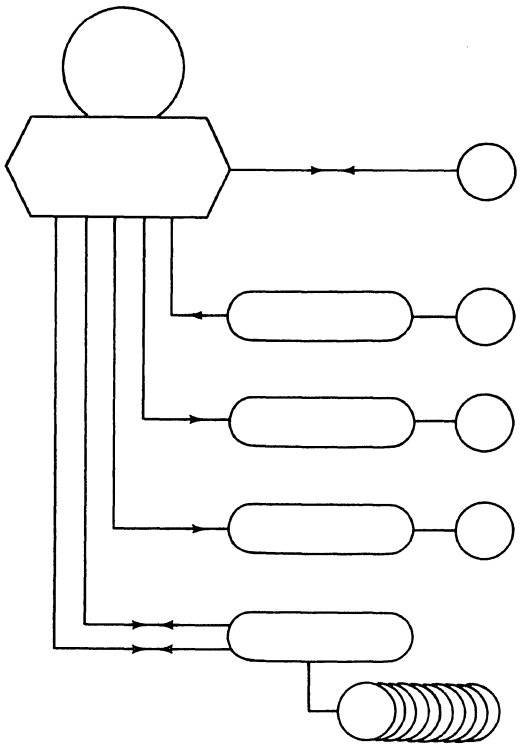
Same as Standard Configuration III, shown on Page 703:031.100, except that the Model 3303 Processor is replaced by the Model 3304 Processor with High Speed Arithmetic Unit and the Model 3361-3 Additional High Speed Memory Module, providing a total of 80,000 character positions of core storage.

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

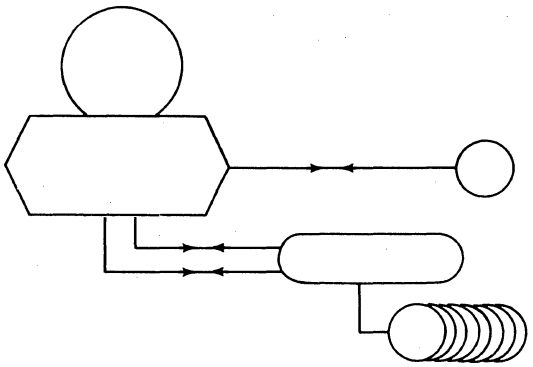
§ 031.

.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.

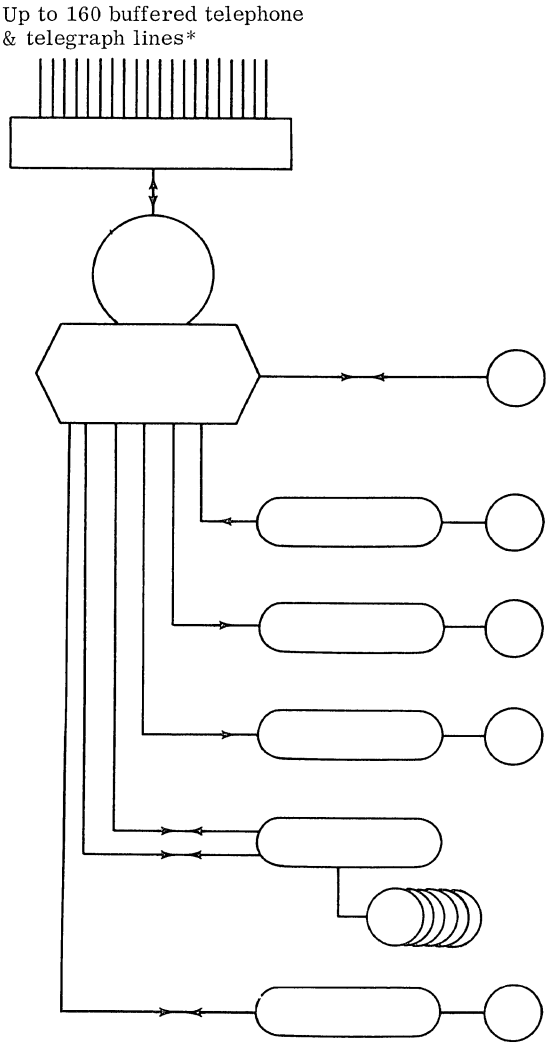
Total On-Line Equipment: $15,325

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 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.

.13 Description (Contd.)

.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	Increments	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.

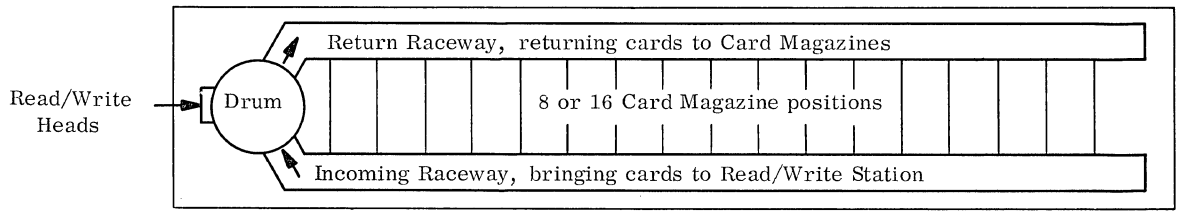


FIGURE 1: LOGICAL DIAGRAM OF A MODEL 3488 UNIT

§ 044.

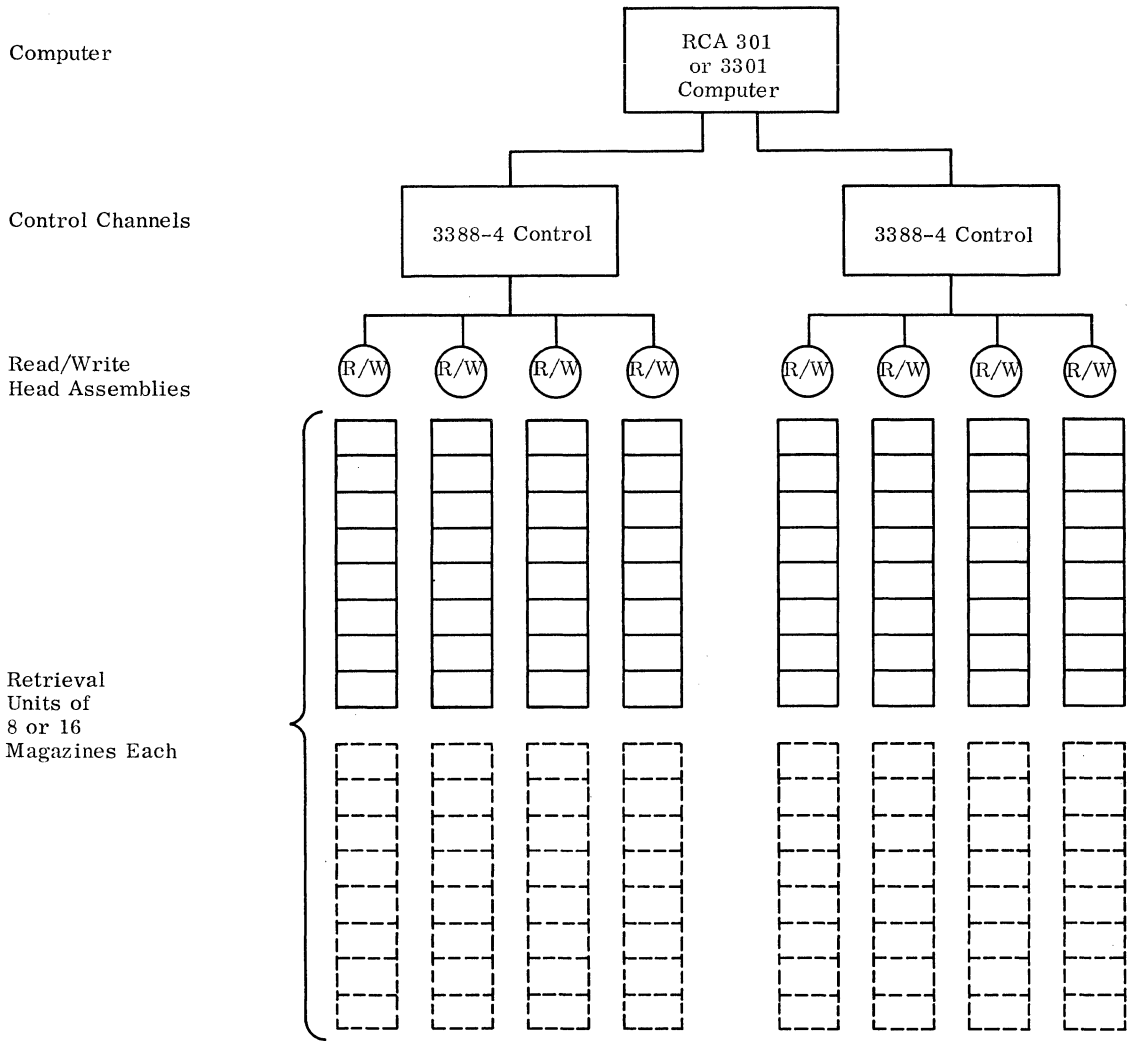


FIGURE 2: RCA 3301 COMPUTER WITH MAXIMUM COMPLEMENT OF MODEL 3488 UNITS

.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.

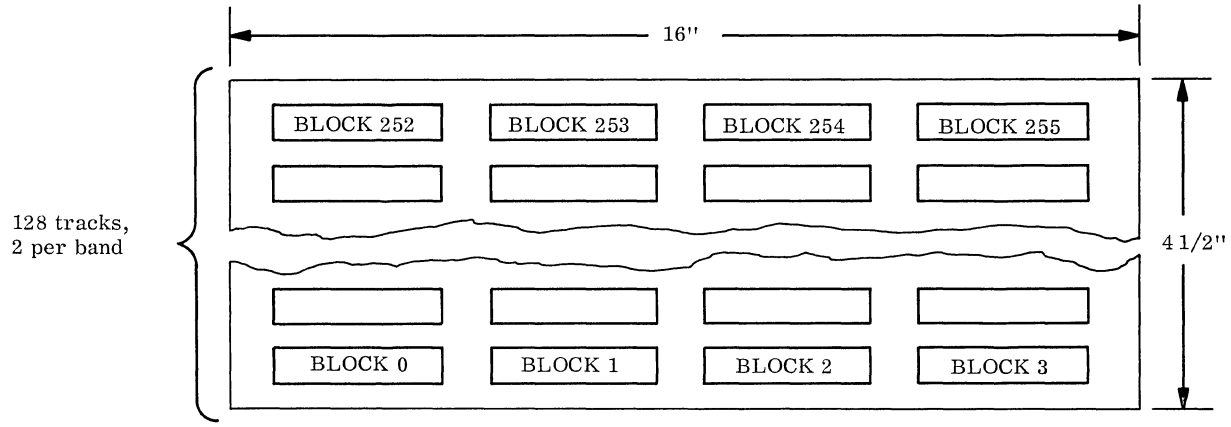


FIGURE 3: ARRANGEMENT OF THE 256 650-CHARACTER DATA BLOCKS ON EACH MAGNETIC CARD

.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.

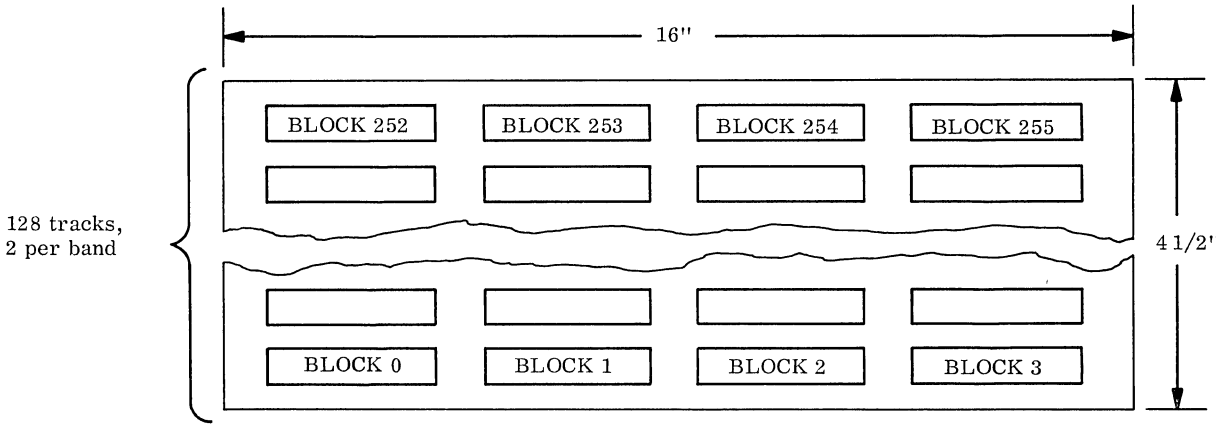


FIGURE 3: ARRANGEMENT OF THE 256 650-CHARACTER DATA BLOCKS ON EACH MAGNETIC CARD

.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.

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.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
Inclusive OR: automatic
Exclusive OR: automatic
} binary 1 thru 44 6-bit groups.

.214 Comparison
Numbers: automatic
Letters: automatic
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).

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.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.

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Real Time Interrupts		General Interrupts
System Errors:	Parity error in Processor	Arithmetic error
	Illegal operation codes	Overflow
	Addressing outside range of HSM	Input-output on-line operation complete (normal or abnormal completion signaled separately, one pair of indicators per input-output channel connected)
Requests from:	Communications Mode Control	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)
	Interrogating Typewriter	301 Compatibility
	Data Exchange Control	Program Test Mode
	Communications Control	
	Operator's Console	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.

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:	-	-	

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.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 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.

.12 Description (Contd.)

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

.12 Description (Contd.)

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)

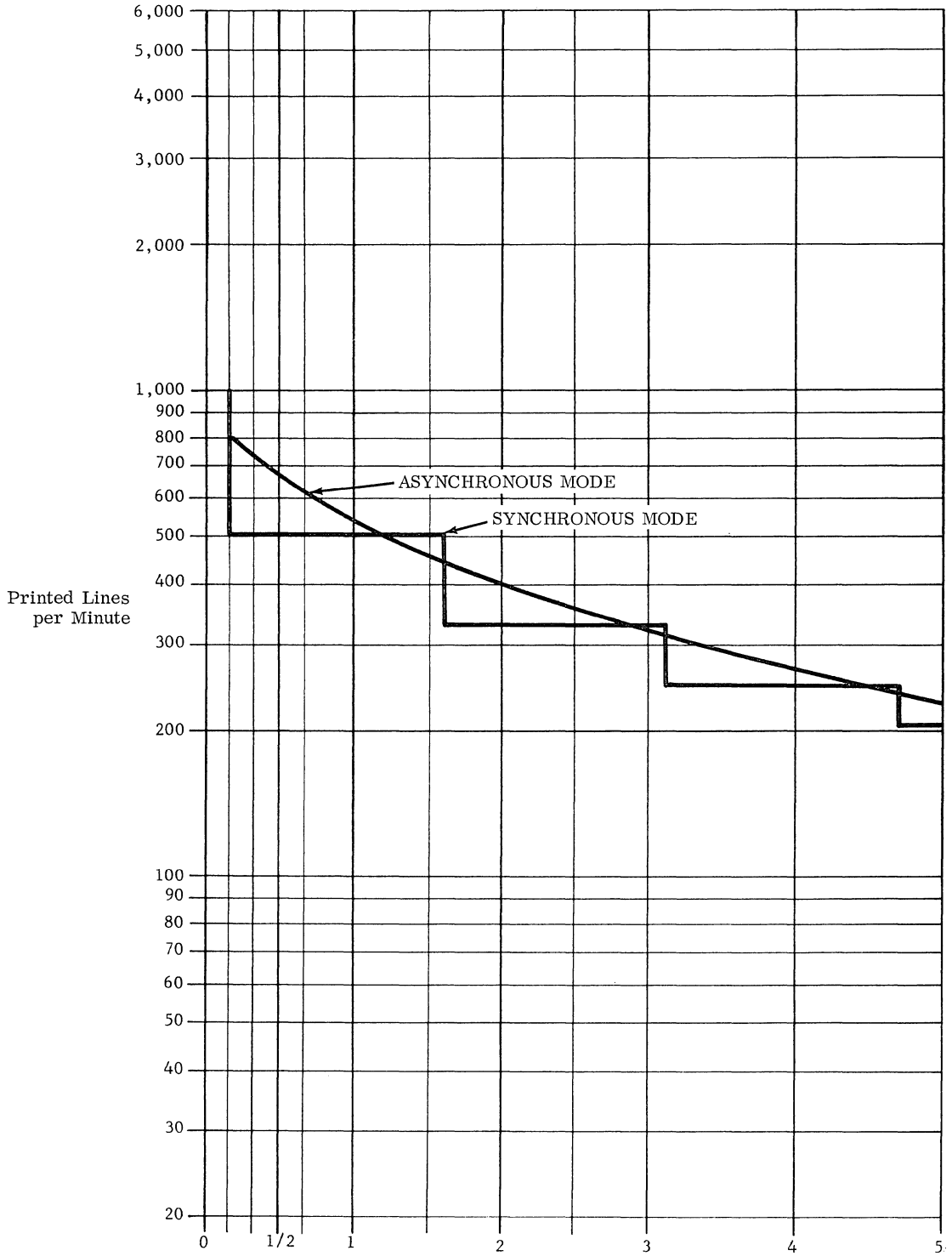
Table* Position	Character	Printed Symbol	Table* Position	Character	Printed Symbol
1	Minus	-	33	A	A
2	Plus	+	34	B	B
3	Space		35	C	C
4	Zero	0	36	D	D
5	One	1	37	E	E
6	Two	2	38	F	F
7	Three	3	39	G	G
8	Four	4	40	H	H
9	Five	5	41	I	I
10	Six	6	42	J	J
11	Seven	7	43	K	K
12	Eight	8	44	L	L
13	Nine	9	45	M	M
14	Comma	,	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

.12 Description (Contd.)

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

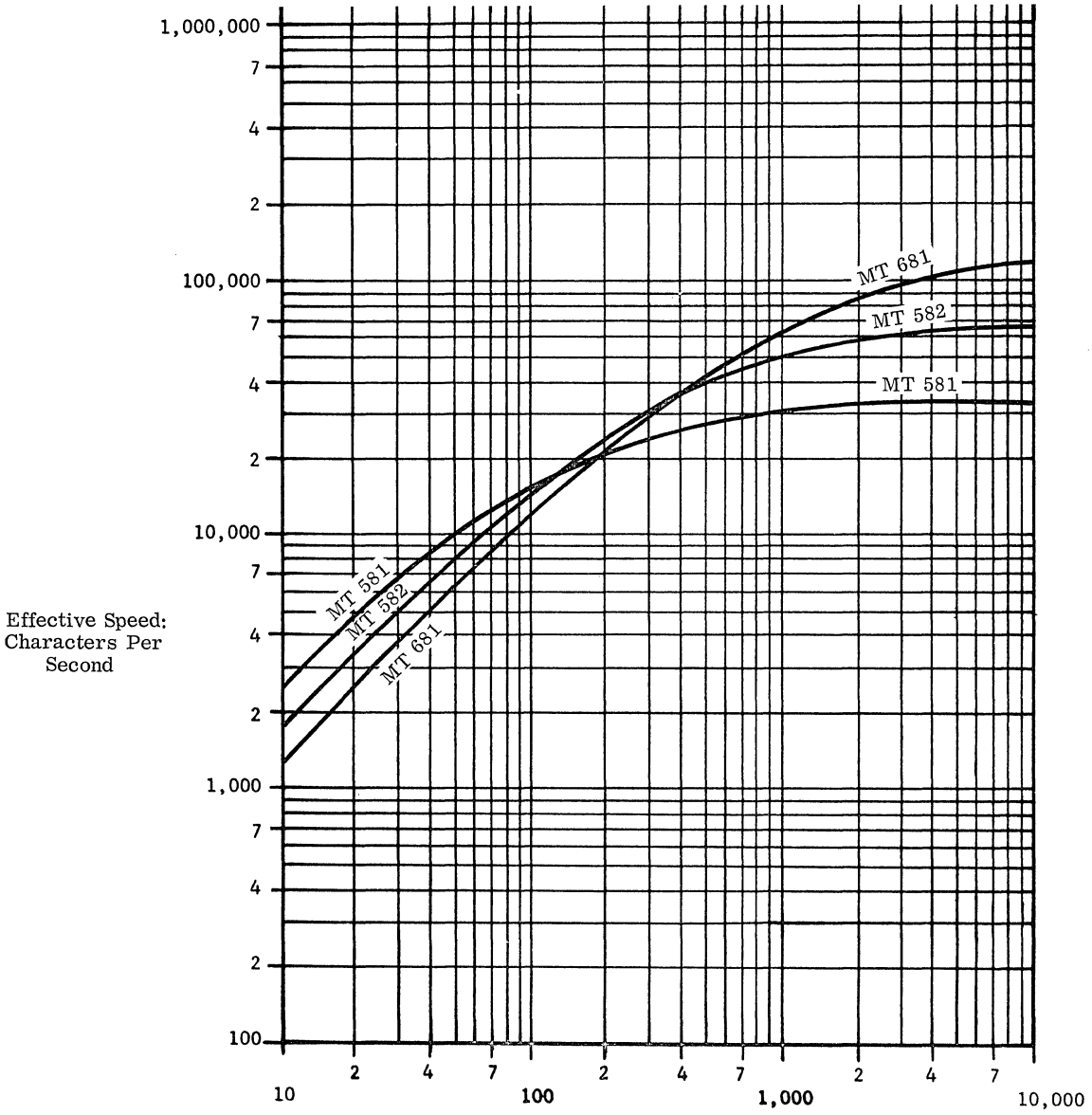
.8 ERRORS, CHECKS AND ACTION

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: Tape Station, Model 582:	by program. 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 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 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.

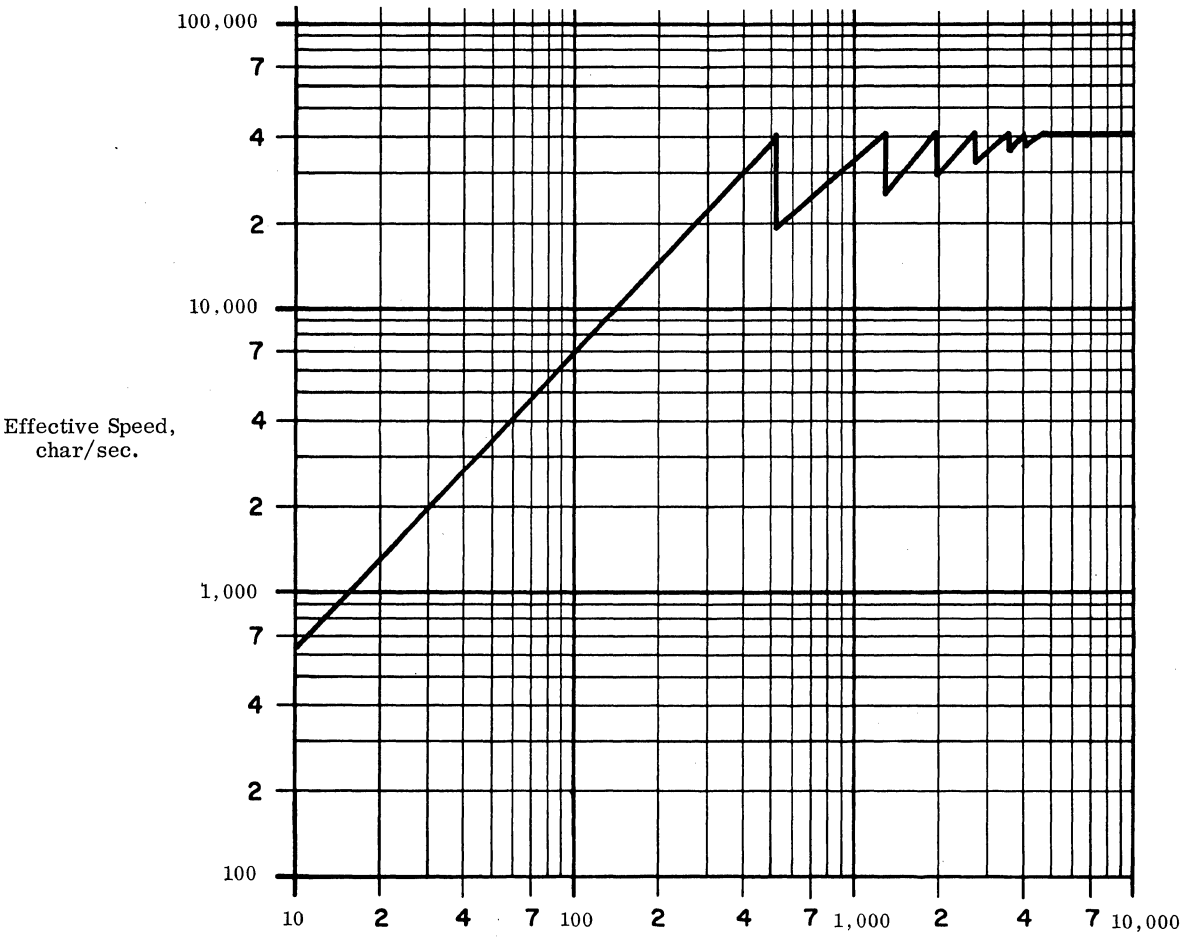
.63 Demands on System

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

.12 Description (Contd.)

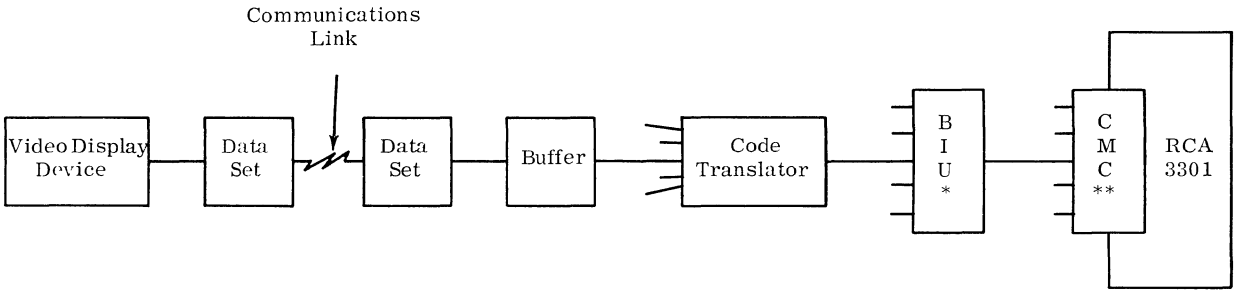
instant in time, of either 160 Model 6050 Video Data Terminals or 2,560 Model 6051 Video Data Interrogators connected via 160 controllers. Because dial facilities can be used on the communication lines, these restrictions apply only to the number of devices actually connected with the computer at the 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.

.12 Description (Contd.)

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.

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*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

MNEM-ONIC	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

MNEM-ONIC	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) Card Reader B_3 = 1 Translate Mode B_3 = 2 Binary Mode Card Punch B_3 = 1 Reject Stacker B_3 = 2 Auxiliary Stacker Magnetic Tape 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.	Paper Tape, Magnetic Tape and Console Typewriter HSM location to receive last character Card Reader 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.)

MNEMONIC	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").

DATA CODE TABLE

§ 141.

CHARACTER DESCRIPTION	CODE	PRINTED SYMBOL	MACHINE CODE P	ZONE 2^6	ZONE 2^5	ZONE 2^4	NUMERIC 2^3	NUMERIC 2^2	NUMERIC 2^1	NUMERIC 2^0	CARD CODE PUNCHED ROWS
Zero	0	0	1	0	0	0	0	0	0	0	0
One	1	1	0	0	0	0	0	0	0	1	1
Two	2	2	0	0	0	0	0	0	1	0	2
Three	3	3	1	0	0	0	0	0	1	1	3
Four	4	4	0	0	0	0	0	1	0	0	4
Five	5	5	1	0	0	0	0	1	0	1	5
Six	6	6	1	0	0	0	0	1	1	0	6
Seven	7	7	0	0	0	0	0	1	1	1	7
Eight	8	8	0	0	0	0	1	0	0	0	8
Nine	9	9	1	0	0	0	1	0	0	1	9
Space	Sp	]	1	0	0	0	1	0	1	0	
Number	#	#	0	0	0	0	1	0	1	1	3,8
At The Rate Of	@	@	1	0	0	0	1	1	0	0	4,8
Open Parenthesis	(	(	0	0	0	0	1	1	0	1	5,8
Close Parenthesis	)	)	0	0	0	0	1	1	1	0	6,8
Error	e	e*	1	0	0	0	1	1	1	1	7,8
Ampersand	&	&	0	0	0	1	0	0	0	0	Y
A	A	A	1	0	0	1	0	0	0	1	Y,1
B	B	B	1	0	0	1	0	0	1	0	Y,2
C	C	C	0	0	0	1	0	0	1	1	Y,3
D	D	D	1	0	0	1	0	1	0	0	Y,4
E	E	E	0	0	0	1	0	1	0	1	Y,5
F	F	F	0	0	0	1	0	1	1	0	Y,6
G	G	G	1	0	0	1	0	1	1	1	Y,7
H	H	H	1	0	0	1	1	0	0	0	Y,8
I	I	I	0	0	0	1	1	0	0	1	Y,9
Plus	+	+	0	0	0	1	1	0	1	0	Y,2,8
Period	.	.	1	0	0	1	1	0	1	1	Y,3,8
Semicolon	;	;	0	0	0	1	1	1	0	0	Y,4,8
Colon	:	:	1	0	0	1	1	1	0	1	Y,5,8
Apostrophe	'	'	1	0	0	1	1	1	1	0	Y,6,8
Plus zero	+0	C_R	0	0	0	1	1	1	1	1	Y,0

(Continued on back)

* Printed only by typewriter.

§ 141.

DATA CODE TABLE – Contd.

CHARACTER		PRINTED SYMBOL	MACHINE CODE							CARD CODE PUNCHED ROWS
DESCRIPTION	CODE		P	ZONE		NUMERIC				
			2^6	2^5	2^4	2^3	2^2	2^1	2^0	
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.

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.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 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

REMARKS:

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

.3 OUTPUT (Contd.)

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.)

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.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.

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.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.

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.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 REAL-COM 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.

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.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

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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.

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- 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.

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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.

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WORKSHEET DATA TABLE

	ITEM		CONFIGURATION III	IV	VI	VII A	VII B Files 3 & 4 Unblocked	VII B Files 3 & 4 Blocked	REFERENCE
1	Char/block	(File 1)	990	990	990	990	990	990	
	Records/block	K (File 1)	9	9	9	9	9	9	
Standard File Problem A Input-Output Times	msec/block	File 1 - File 2	33.2	20.4	33.2	15.6	15.6	15.6	
		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							4:200.112
		File 3							
		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.	$a_1 K$	0.1	0.1	0.1	0.1	0.1	0.1	
Standard File Problem A F = 1.0		$a_2 K$	2.5	2.5	1.3	1.3	1.3	1.3	
		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
		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)								
Standard File Problem A Space		Std. routines							
		Fixed	5-10,000	5-10,000	5-10,000	5-10,000	5-10,000	5-10,000	
		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		
Standard Mathematical Problem A	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		
	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

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.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A*

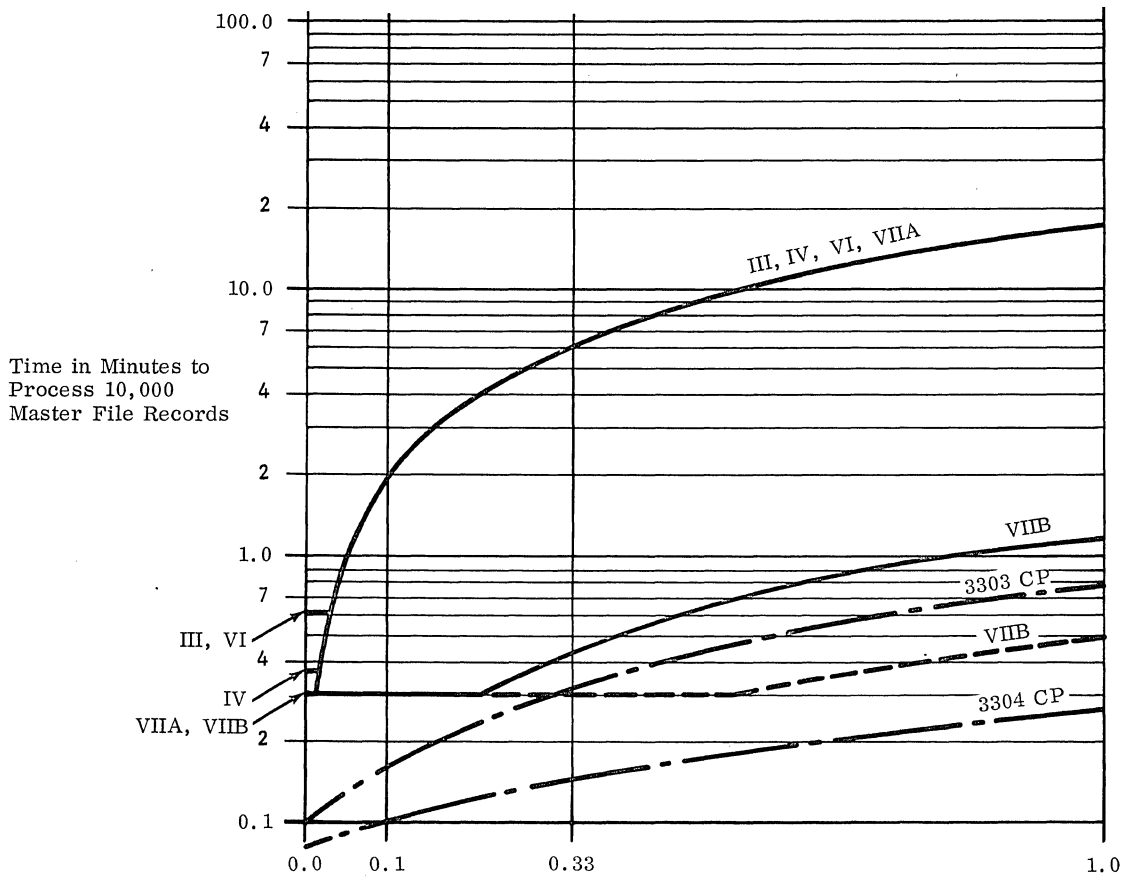
.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.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.



(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.

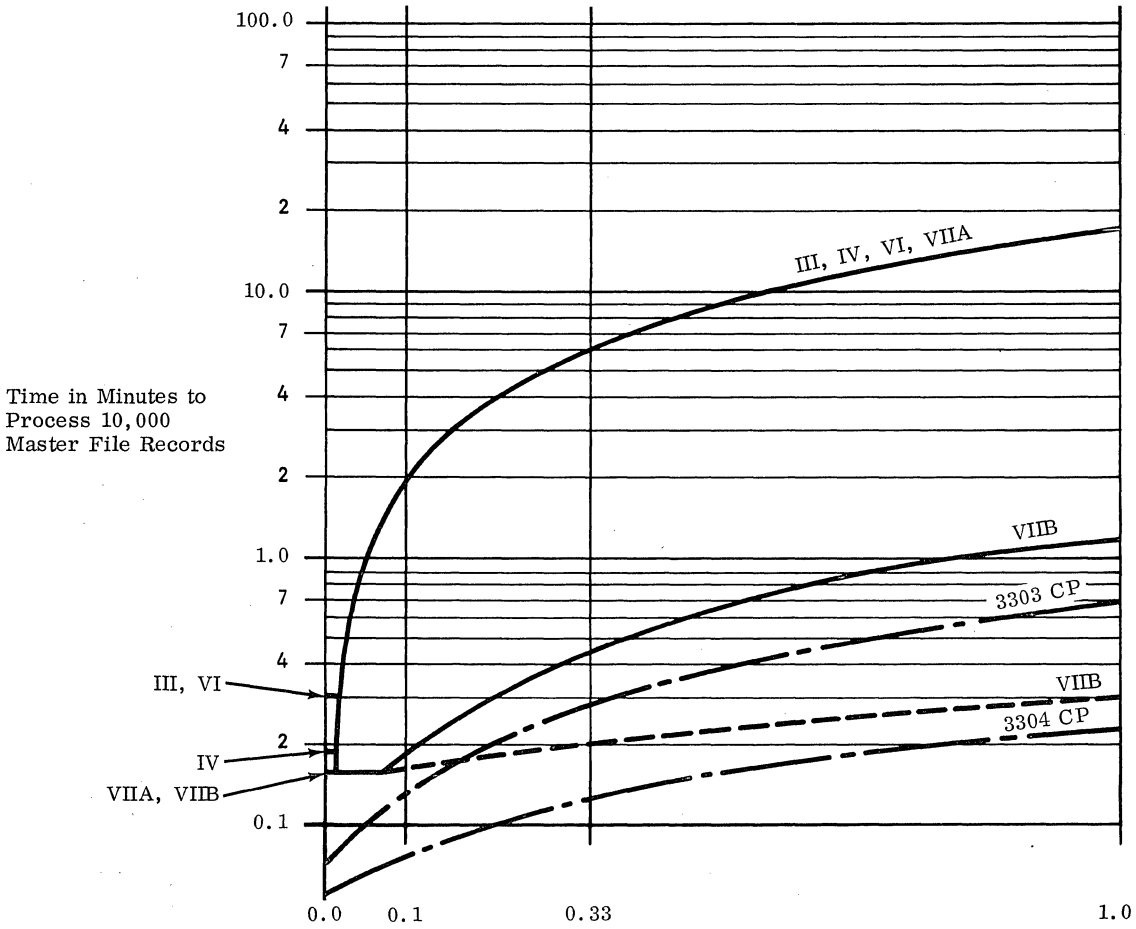
.12 Standard File Problem B

.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

Elapsed time (unblocked detail and report files)
Elapsed time (blocked detail and report files)
Central Processor (CP) time

§ 201.

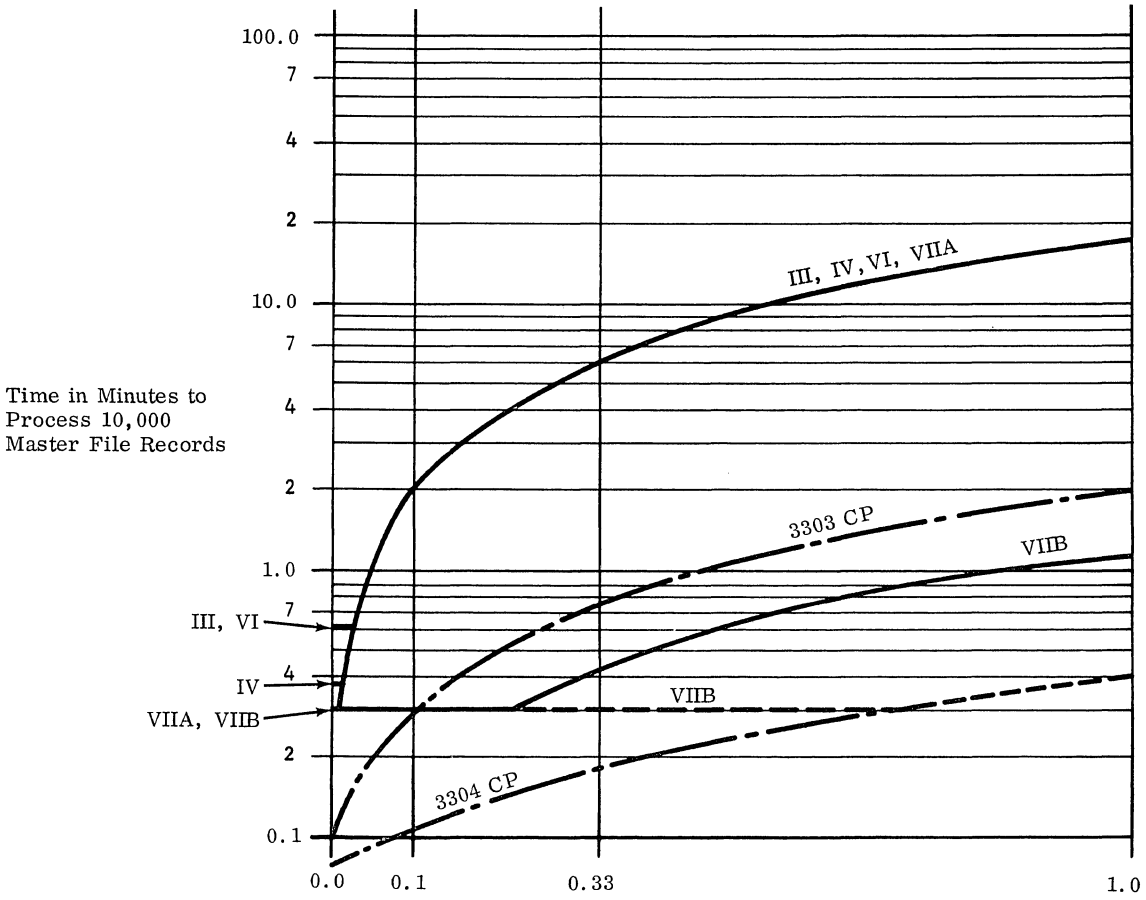
.14 Standard File Problem D

.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.



(Roman numerals denote Standard System Configurations)

LEGEND

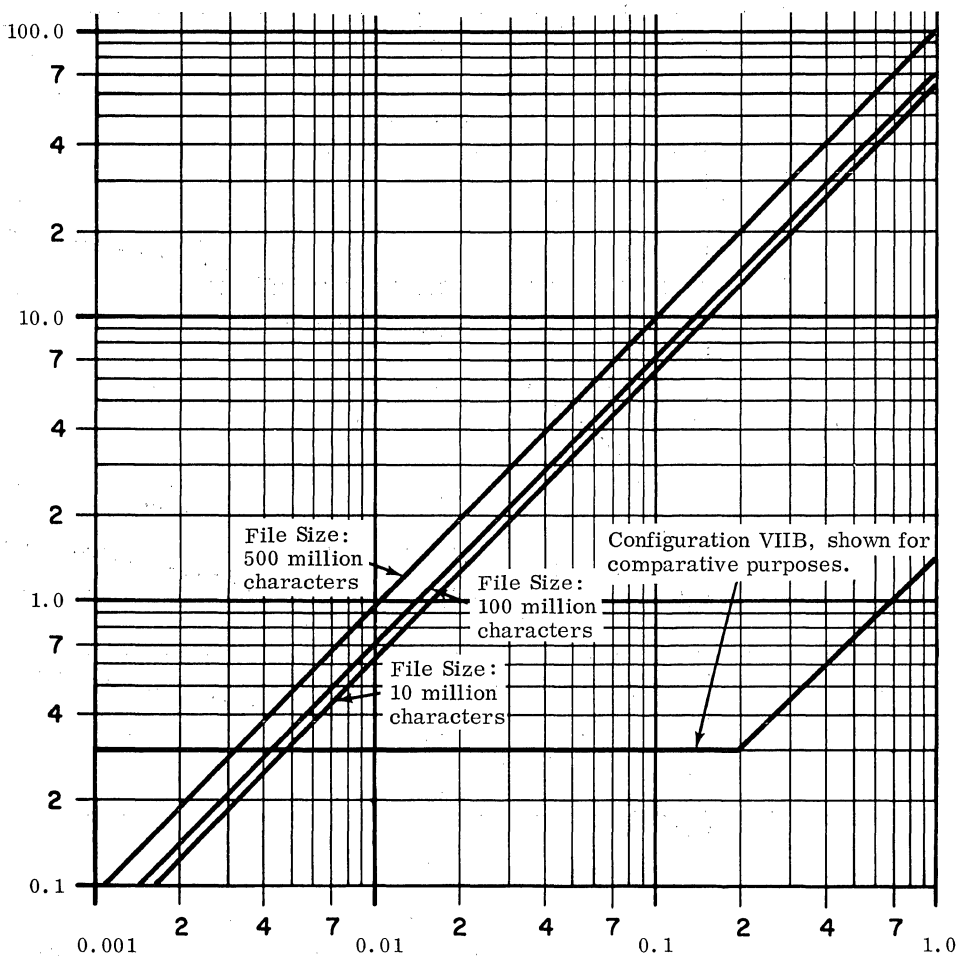
Elapsed time (unblocked detail and report files)
Elapsed time (blocked detail and report files)
Central Processor (CP) time

§ 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.

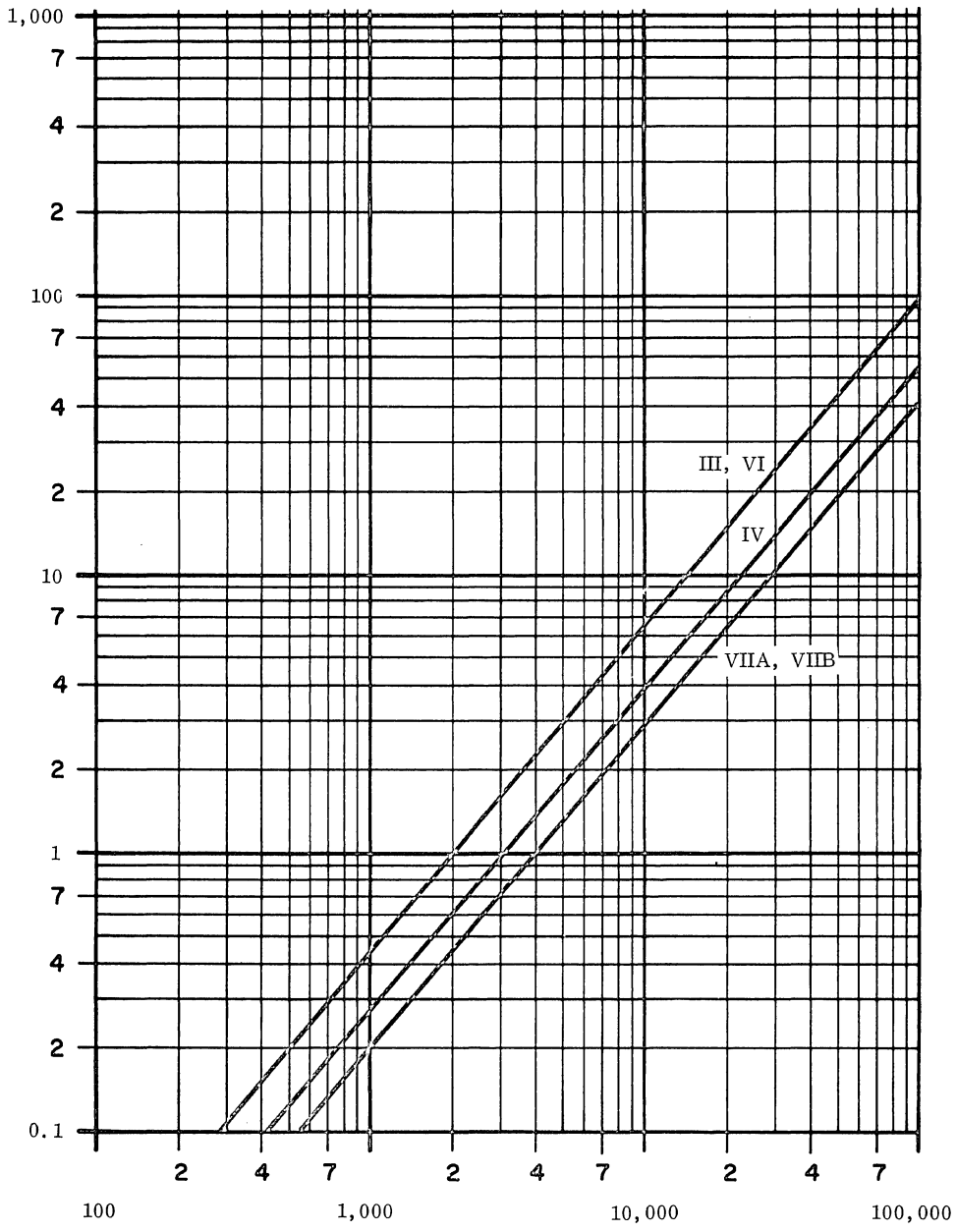
.2 SORTING

.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.)

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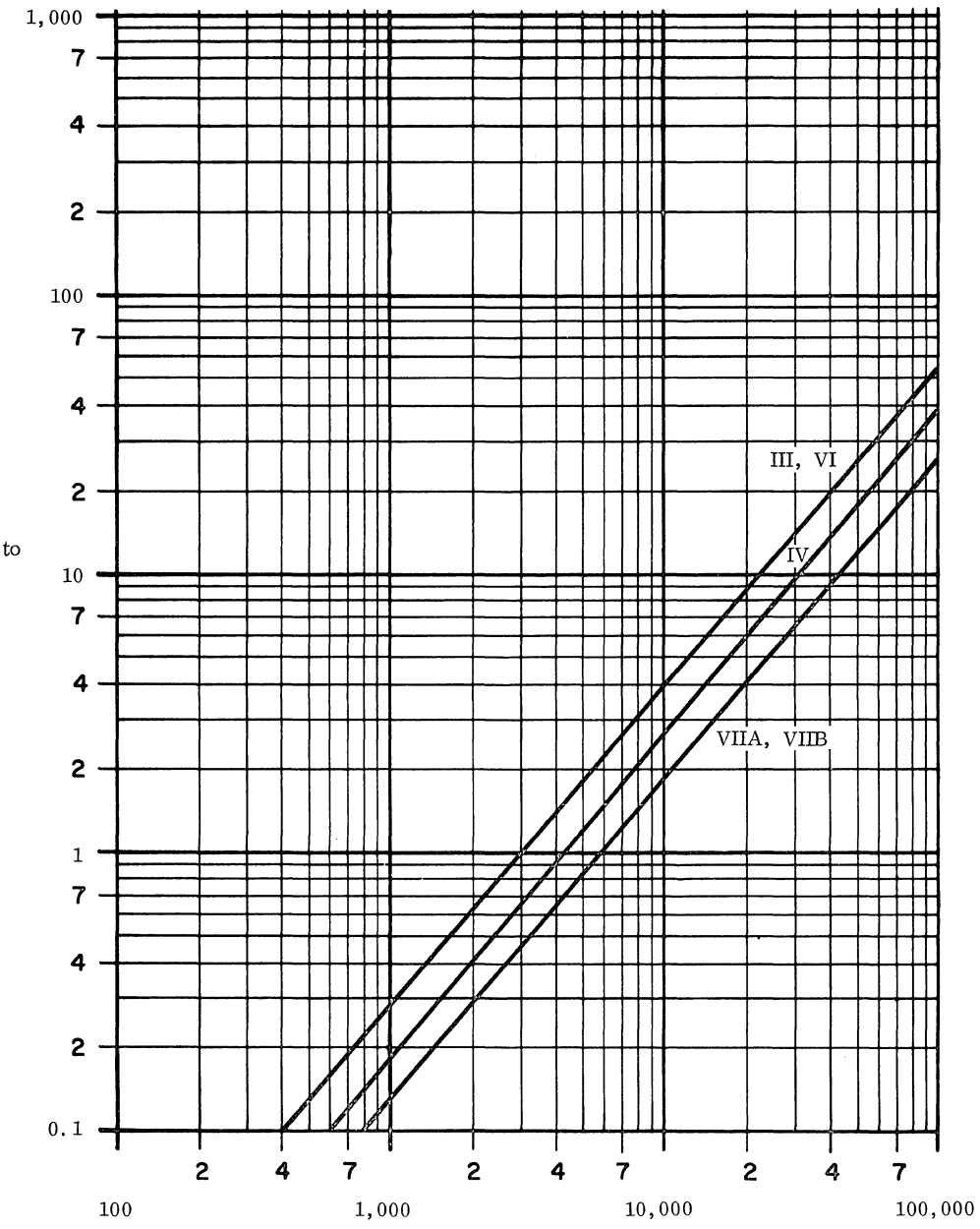
.215 Graph: . . . . . see graph below, based on a simple 3-way merge.



(Roman numerals denote Standard System Configurations)

§ 201.

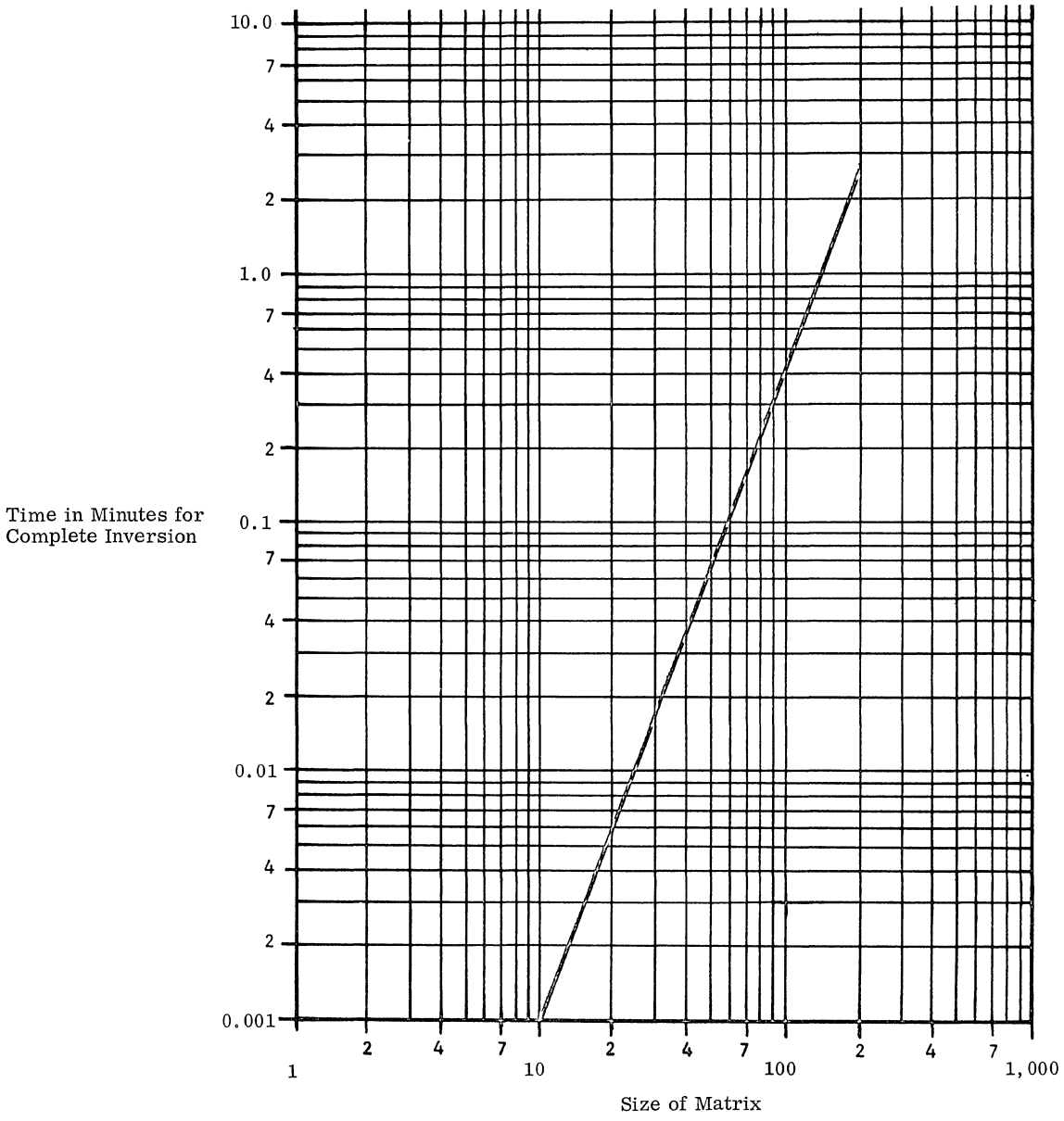
.3 MATRIX INVERSION

.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.

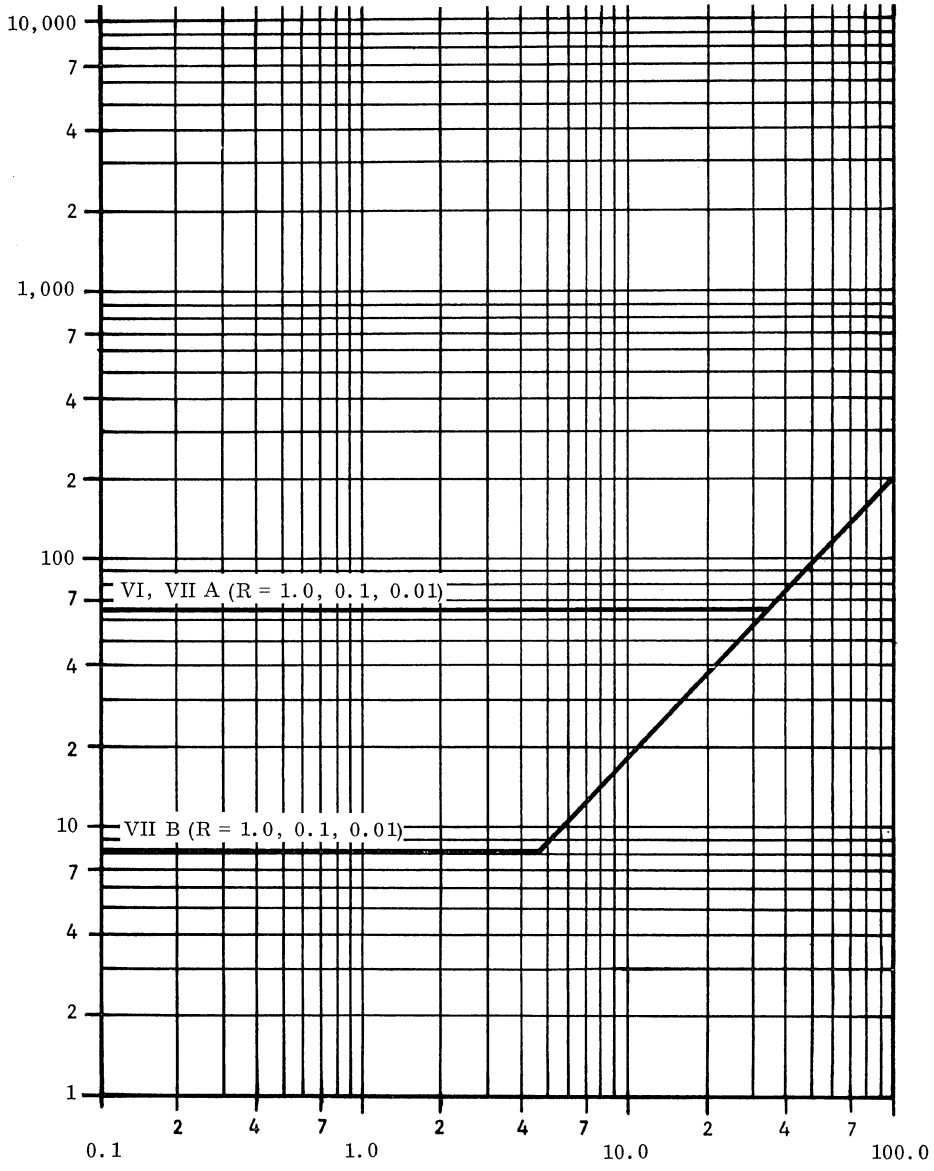
.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.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



(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