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Burroughs
B 200 SERIES ELECTRONIC DATA PROCESSING SYSTEMS
REFERENCE MANUAL

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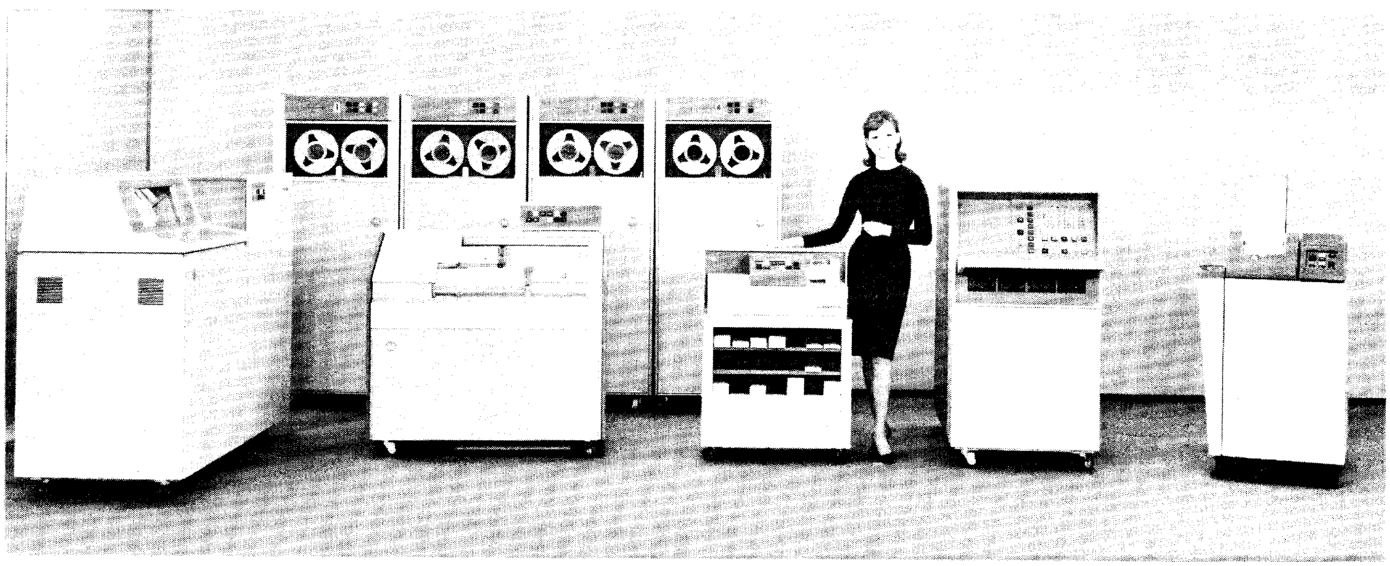

BURROUGHS B 280 SERIES SYSTEM

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INTRODUCTION

This reference manual describes the Burroughs B 200 Series Electronic Data Processing Systems which includes Model 0 (B 260, B 270, B 280), Improved Model 0, and the new B 263, B 273, and B 283 Systems. These systems are compact high-speed, solid-state computers that use common components, in several problem-oriented equipment configurations. They are capable of handling a wide variety of data processing application media such as punch cards, paper tapes, magnetic tapes and MICR documents. Each system incorporates its own associated input and output units, thus providing a greater throughput capability.

It is intended that this publication provide the user with reference information concerning the characteristics and configurations of the various systems that comprise the B 200 Series as well as their functional capabilities, programing techniques, component description and usage, special features, and operating functions.

The manual is divided into the following seven sections, and provides a complete reference guide for B 200 Series information.

SYSTEMS DESCRIPTION . . . Describes the various sytems that comprise the B 200 Series.

PERIPHERAL UNITS . . . Depicts the peripheral equipment that make up the various systems in the B 200 Series.

SYSTEM FEATURES . . . Discusses the special features included with B 200 Series Systems.

STORED PROGRAM INSTRUCTIONS . . . Describes the individual instructions which control all processing by the systems.

ASSEMBLER PROGRAM . . . An illustrated discussion of the use of the Burroughs Basic Assembler.

TIMING CONSIDERATIONS . . . Illustrates and describes the means to determine the processing time required for any particular application.

INPUT/OUTPUT MEDIA AND FORMS DESIGN . . . . A description of the punch cards, paper documents, record cards, and journals used with B 200 Series Systems.

SECTION 1
SYSTEMS DESCRIPTION

GENERAL

1-1. Data processing is the performance of a series of operations on specific data for the purpose of achieving desired results. To perform these operations, a data processing system requires five basic functions: input, control, storage, arithmetic, and output (figure 1-1).

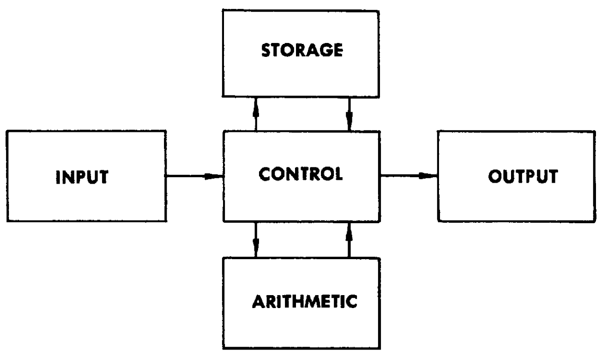


Figure 1-1. Functions of a Data Processing System

1-2. The input function transmits data to the system by means of several devices, depending on the desired input media.

1-3. The storage section retains the data received from the input device until it is required for operation by other sections of the system.

1-4. The arithmetic function handles the actual processing, or manipulation, of data. This is the computing unit of the system that accomplishes all mathematical aspects of problem solving.

1-5. The output function transfers processed results from storage to the output device(s).

1-6. The control function directs the flow of data from input to storage, storage to arithmetic, arithmetic to storage, and from storage to output.

FUNCTIONAL DESCRIPTION

1-7. B 200 Series high-speed components are designed to function together as a total system. Through the use of special buffering techniques, the system is able to maintain rated speeds of all components despite differences in individual unit speeds. In this manner, work flows continuously through the system in the minimum amount of time. All system operations are directed by the program stored in the central processor. A powerful three-address logic permits the use of a minimum number of commands.

SYSTEM DESIGN

1-8. B 200 Series Systems use only three types of components: input units, central processors, and output units. A basic system consists of a central processor and a minimum of one input and one output unit. Systems can be expanded at the installation site by the addition of input/output units.

1-9. The B 200 Series presently consists of three major models and/or reference designations, they are: VRC, B 260, B 270, B 280 Series; the Improved Model B 260, B 270, B 280 Series, and the new B 263, B 273, and B 283 Series. The primary differences between these systems are in the central processor capabilities.

NOTE

For information regarding the VRC system, consult the VRC Reference Manual.

B 260 System

1-10. The B 260 (figure 1-2) is a high-speed card processing system. It is capable of reading up to 1600 cards-per-minute, punching 300 cards-per-minute, and printing 700 lines-per-minute. This system can combine in a single run, collating, calculating, summarizing, summary punching, and printing operations which presently require multiple runs in conventional tabulating equipment. The components which make up a typical B 260 System are:

Central Processor (table 1-1)
Card Reader (1 or 2)
Card Punch
Line Printer
or
Multiple Tape Lister (1 or 2)

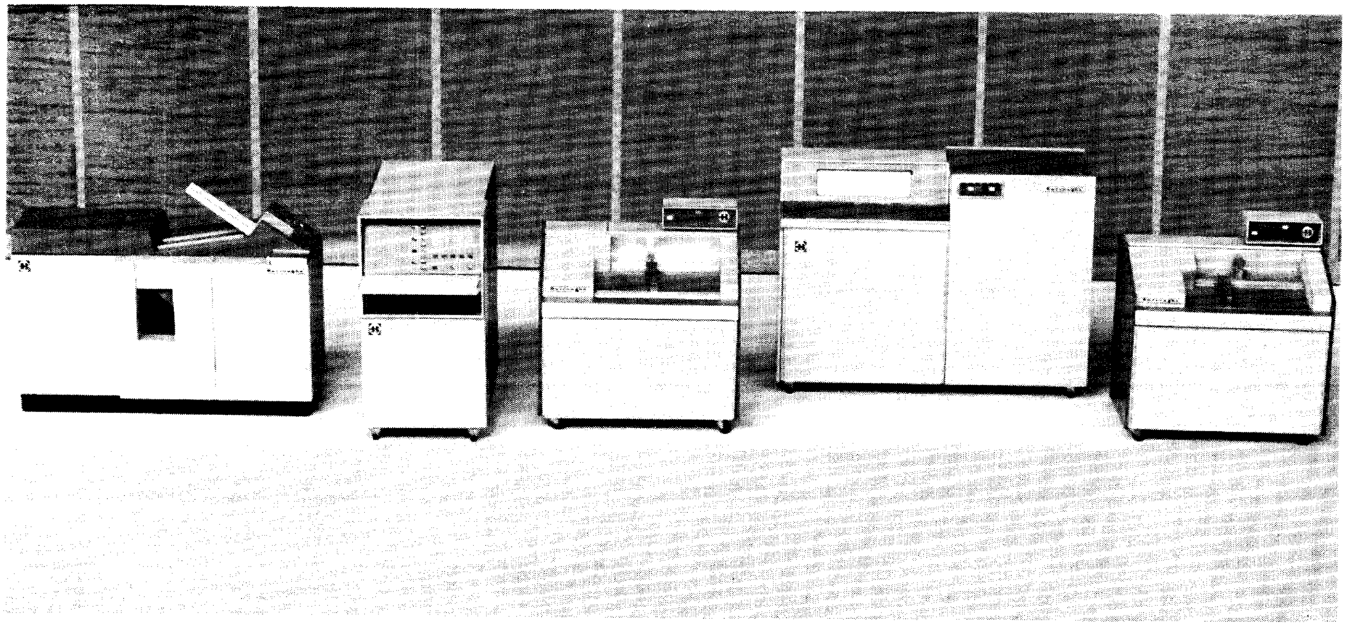
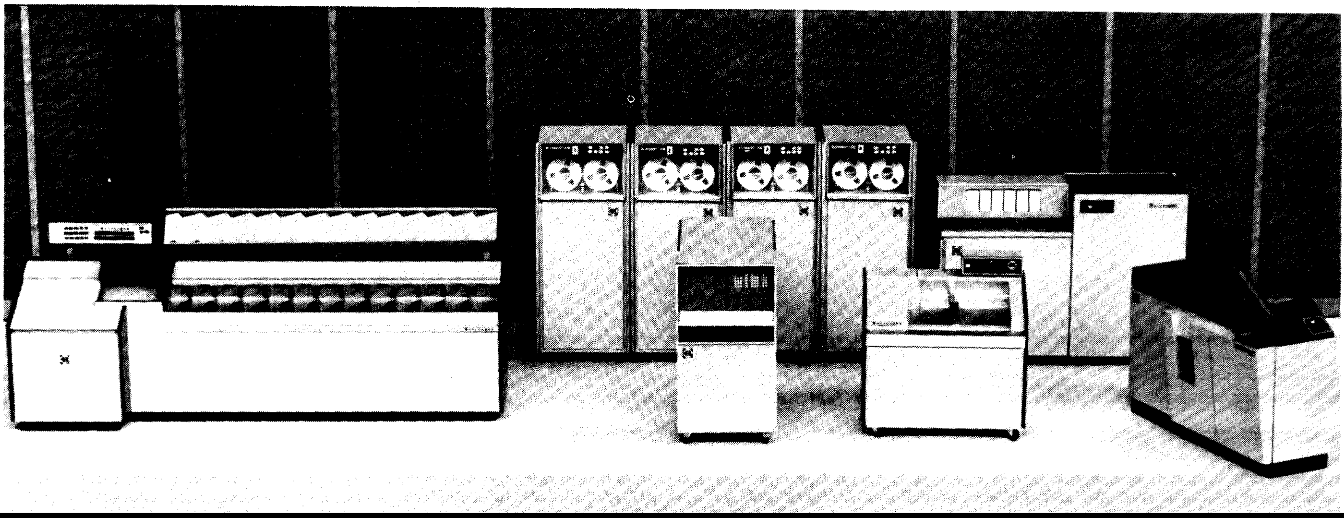


Figure 1-2. B 260 System

B 270 System

1-11. This system (figure 1-3) is designed to handle, as input media, MICR encoded documents, punched cards, and magnetic tape. As a financial institution system, it features the processing of MICR checks and deposits at speeds up to 1565 items-per-minute. As output media, the system prepares magnetic tape, punch cards, and is unique in that it automatically produces up to 12 complete detail and master listings. These show the identity, amount, and distribution of every MICR item processed in proof, transit, and other operations. As a general-purpose system, it includes all punched cards and line printing capabilities of the B 260 System along with magnetic tape processing. The system may also be used as an off-line satellite for large-scale computer systems e.g., the Burroughs B 5000. The components that are used with the B 270 System are:

Central Processor (table 1-1)
Card Reader (2 if sorter-reader not used)
Sorter-Reader
Card Punch
Magnetic Tape Storage Unit (1 to 6)
Line Printer
or
Multiple Tape Lister (1 to 2)



B 280 System

1-12. The B 280 (figure 1-4) unites the high-speed and storage capabilities of magnetic tape with the productivity and convenience of punched card processing. The B 280 can also be used as a low cost magnetic tape data processing system or as an off-line system performing peripheral operations for the B 5000 or other large-scale or medium-scale computers. The following peripheral units are used in a B 280 System:

Central Processor (table 1-1)
Card Reader (1 or 2)
Card Punch
Magnetic Tape Unit (1 to 6)
Line Printer
or
Multiple Tape Lister (1 or 2)

IMPROVED B 200 SYSTEMS

B 260 System

1-13. This system (figure 1-5) is also a high-speed punched card processing system. It is capable of reading a maximum of 1600 cards-per-minute, punching 300 cards-per-minute, and printing 1400 lines-per-minute. This system can also combine in a single run, collating, calculating, summarizing, summary punching, and printing operations. However, the design and application of this system is expanded to handle paper tape input and provide paper tape output through the addition and incorporation of the B 341 Paper Tape Punch and the B 141 Paper Tape Reader. Also, two line printers can be used simultaneously with this system when one of the printers contain a dual printer module. The components that are used with the Improved B 260 Systems are:

Central Processor (table 1-1)
Card Reader (1 or 2)
Paper Tape Reader (1 or 2)
Card Punch
Paper Tape Punch
Line Printer (1 or 2)
or
Multiple Tape Lister (1 or 2)

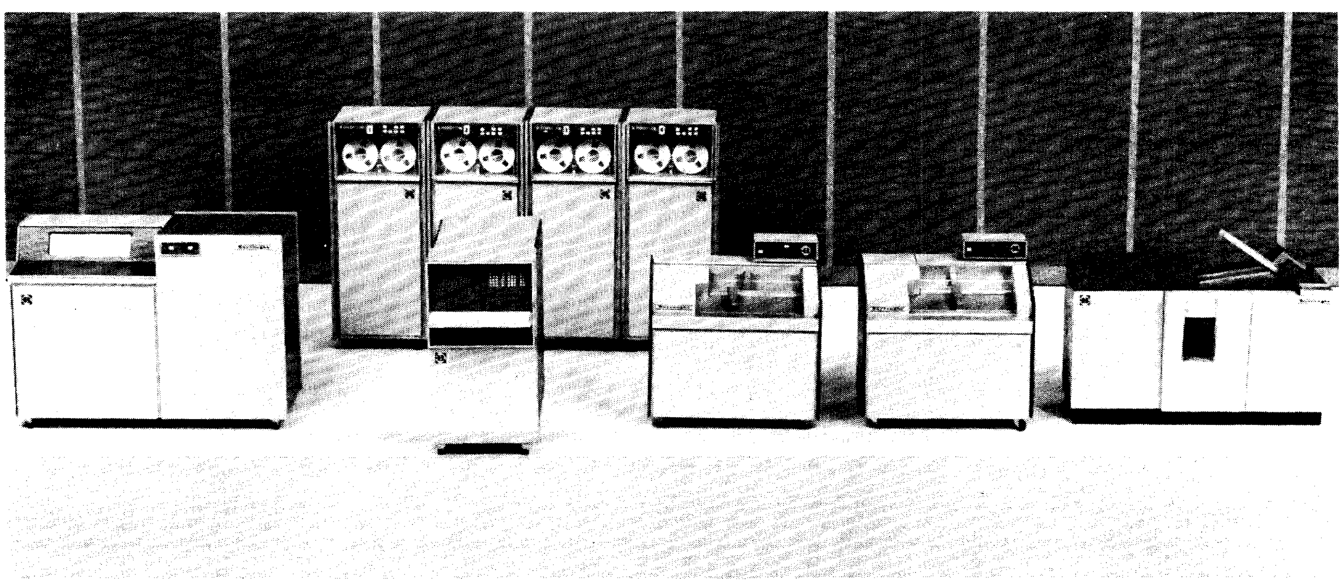


Figure 1-4. B 280 System

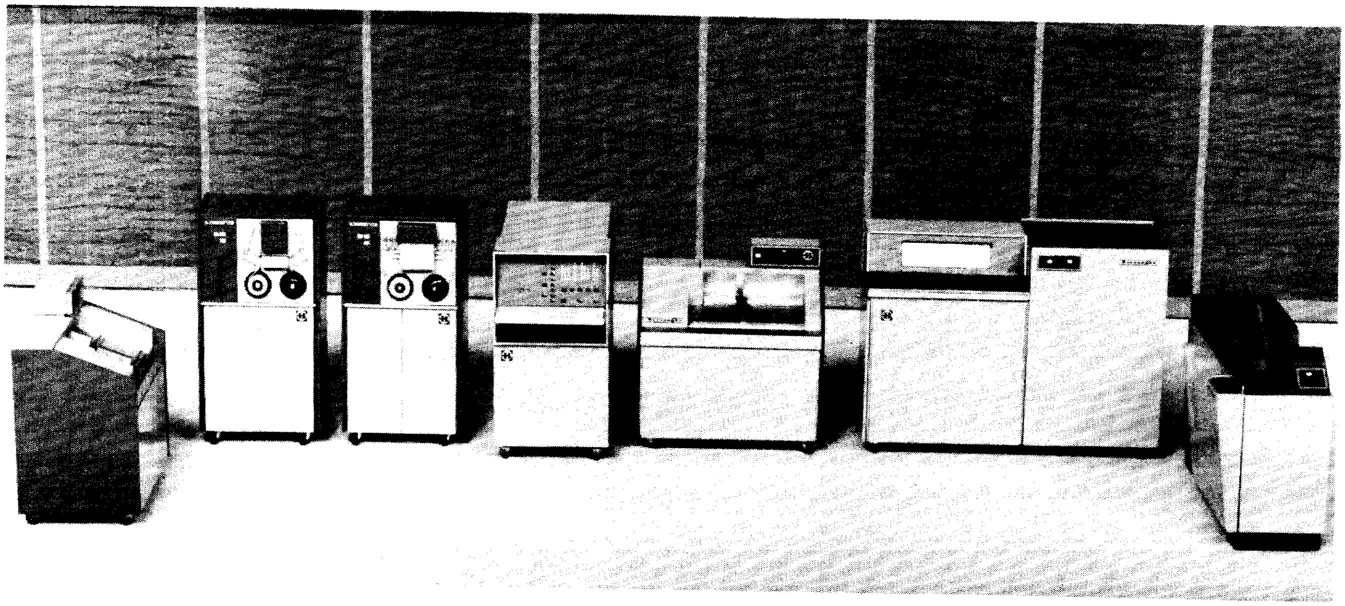


Figure 1-5. Improved B 260 System

B 270 System

1-14. This system (figure 1-6) features added throughput capability by handling paper tape input and paper tape output with the addition of the B 341 Paper Tape Punch and the B 141 Paper Tape Reader to the system. The Improved B 270 System may also be used as an off-line satellite for large scale computers such as the Burroughs B 5000 System. Two line printers can be used with this system when one of the printers contain a dual printer module. The peripheral units associated with the Improved B 270 are:

Central Processor (table 1-1)
Card Reader (2 if sorter-reader not used)
Paper Tape Reader (2 if sorter-reader not used)
Sorter-Reader
Card Punch
Paper Tape Punch
Magnetic Tape Unit (1 to 6)
Line Printer (1 or 2)
or
Multiple Tape Lister (1 or 2)

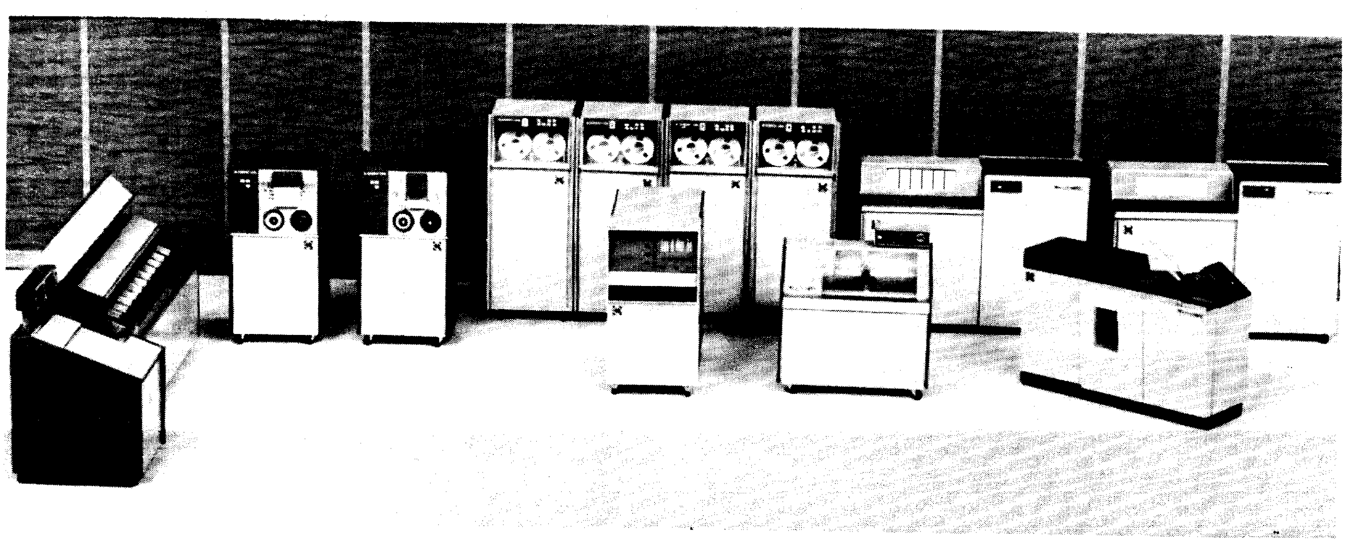


Figure 1-6. Improved B 270 System

B 280 System

1-15. The Improved Model B 280 (figure 1-7) has the flexibility of handling the high-speed card processing applications of the Model 0 B 260 System with the added advantage of magnetic tape storage as well as providing paper tape input and paper tape output capability. However, it can also be used as a low-cost Electronic Data Processing system or as an off-line satellite for large-size computer systems. Two line printers may be used with this system if one of the printers contains a dual printer module. The following peripheral units are associated with the Improved B 280 System:

Central Processor (table 1-1)
Card Reader (1 or 2)
Paper Tape Reader (1 or 2)
Card Punch
Paper Tape Punch
Magnetic Tape Unit (1 to 6)
Line Printer (1 or 2)
or
Multiple Tape Lister (1 or 2)

B 263, B 273, B 283 SYSTEMS

B 263 System

1-16. This system (figure 1-8) includes all the high-speed card processing capabilities of the Model 0 B 260 Systems. However, the B 263 features an expanded memory option. This option provides the user with the choice of either of two memory modules: one memory module has a capacity of 4800 characters, the other memory module has a capacity of 9600 characters. Two line printers or two multiple tape listers can be used with the B 263 System when one of the printers contains a dual printer module. The peripheral units associated with the B 263 System are:

Central Processor (table 1-1)
Card Reader (1 or 2)
Paper Tape Reader (1 or 2)
Card Punch
Paper Tape Punch
Line Printers (1 or 2)
or
Multiple Tape Listers (1 or 2)

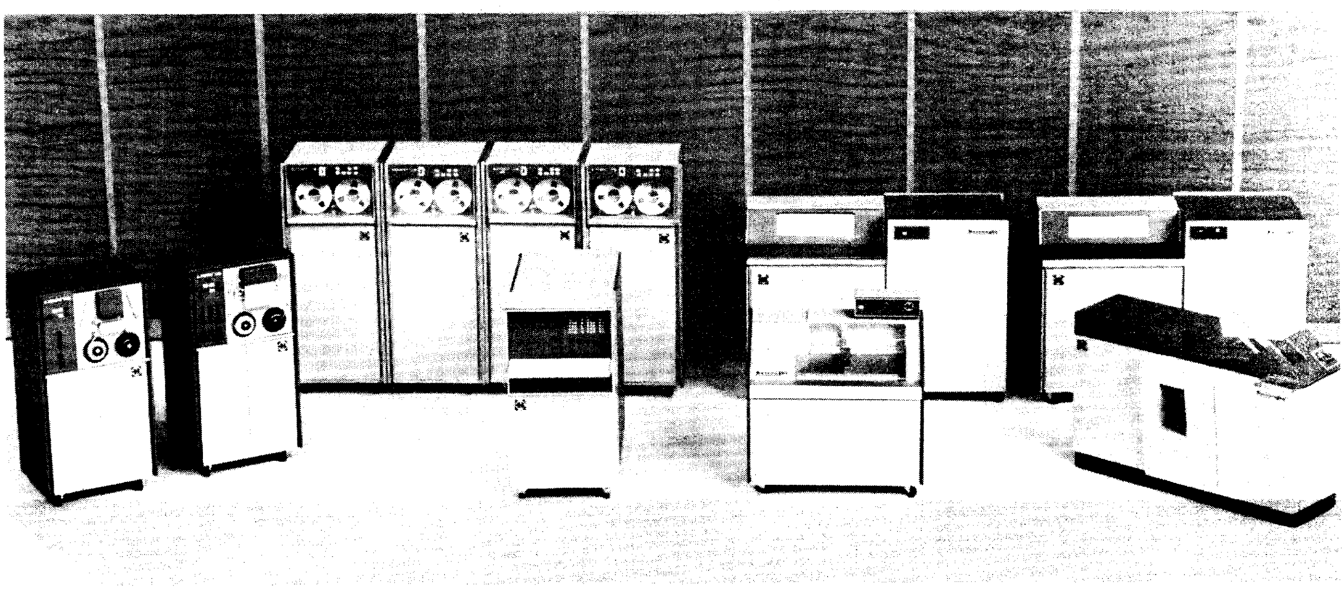


Figure 1-7. Improved B 280 System

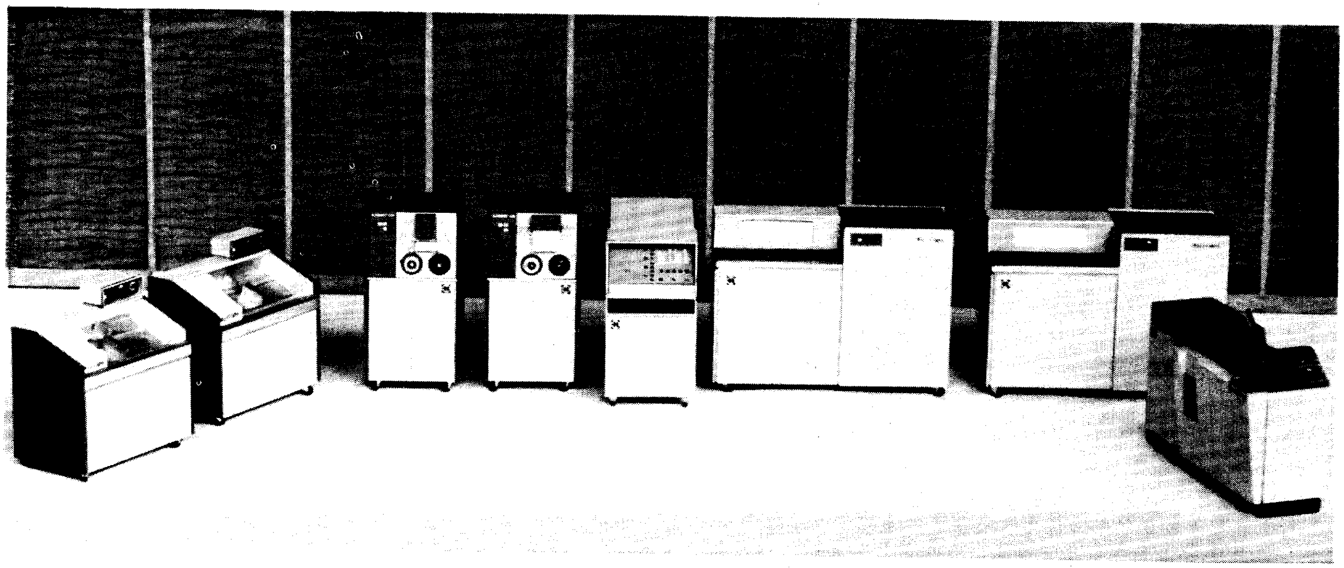


Figure 1-8. B 263 System

B 273 System

1-17. This system (figure 1-9) features optional expanded memory (up to 9600 characters), on-line random access storage capability, and a data communication system. Together these features provide a wider range of user applications by featuring 480 million alphanumeric characters of stored information, and a means of handling an extremely broad range of inquiry traffic requirements. In addition, the system incorporates high-speed magnetic tape processing capabilities as well as maintaining those capabilities of the Improved B 270 System. Two line printers may also be used with this system if one of the printers contains a dual printer module. The peripheral units associated with this system are:

Central Processor (table 1-1)
Card Reader (2 if sorter-reader is not used)
Paper Tape Reader (2 if sorter-reader is not used)
Sorter-Reader
Card Punch
Paper Tape Punch
Magnetic Tape Unit (1 to 6)
Disk File/Data Communication System
Supervisory Printer
Line Printer (1 or 2)
or
Multiple Tape Lister (1 or 2)

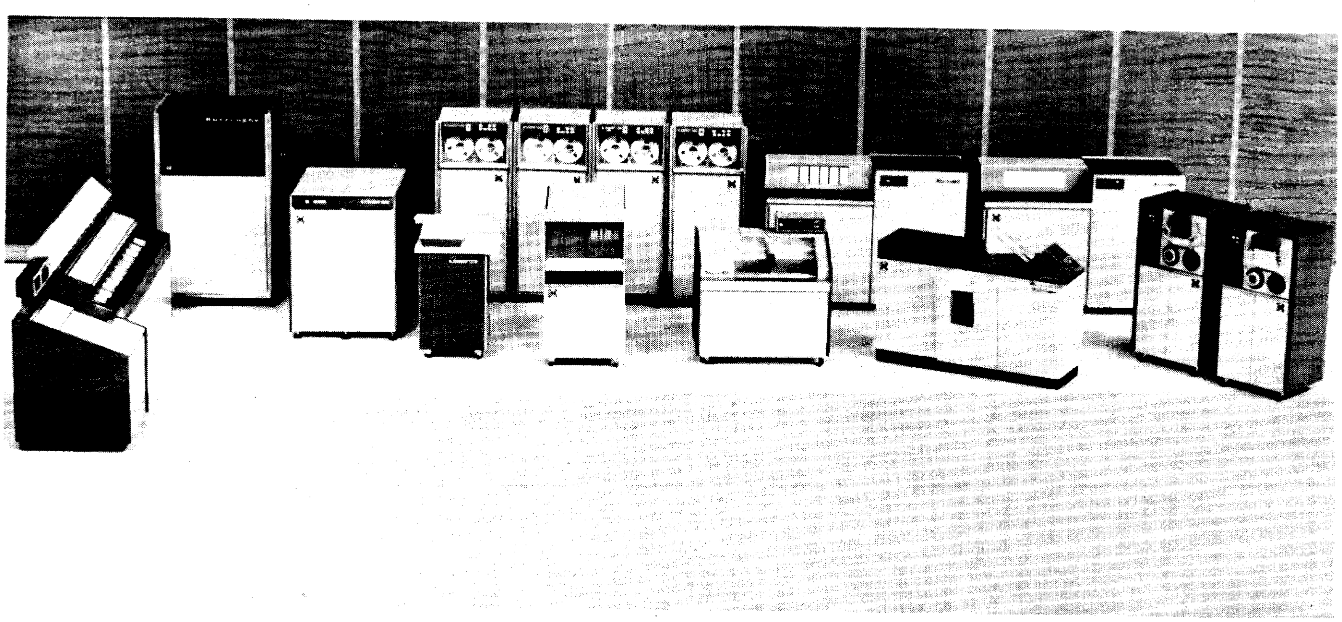


Figure 1-9. B 273 System

B 283 System

1-18. The B 283 (figure 1-10) is a powerful high-speed punched card and magnetic tape system. It features the capability of on-line random access storage and data communication inquiry, paper tape input, and paper tape output, plus the availability of either of two memory modules: 4800 character capacity, and 9600 character capacity. Another feature of this system is that two line printers may be used simultaneously when one of the printers contains a dual printer module. The following peripheral units are used with the B 283 System:

- Central Processor (table 1-1)
- Card Reader (1 or 2)
- Paper Tape Reader (1 or 2)
- Card Punch
- Paper Tape Punch
- Magnetic Tape Unit (1 to 6)
- Supervisory Printer
- Line Printer (1 or 2)
  or
- Multiple Tape Lister (1 or 2)

DISK FILE AND DATA COMMUNICATION SYSTEM

1-19. In addition to the series of B 200 Systems described, the Burroughs On-Line Disk File and Data Communication System (figure 1-11) can be incorporated with the B 273 and B 283 Systems (table 1-1).

1-20. The disk file and data communication system, when integrated with either the B 273 or B 283 System, provides a maximum storage capacity of 480,000,000 alphanumeric characters of on-line storage, plus the ability to handle a wide range of inquiry traffic requirements.

1-21. The system features magnetic disks which store information through means of small magnetic read/write heads positioned above each data track on the disk surface. The components which make up a disk file and data communication system are:

- Disk File Control Unit (1)
- Disk File Storage Unit (1 to 10)
- Disk File Storage Module (1 to 40)
- Data Communication Control Unit (1)
- Teletype Terminal Unit (1 to 15)
- Typewriter Terminal Unit (1 to 15)
- Typewriter Station (1 to 120)
- TWX Terminal Unit (1 to 15)

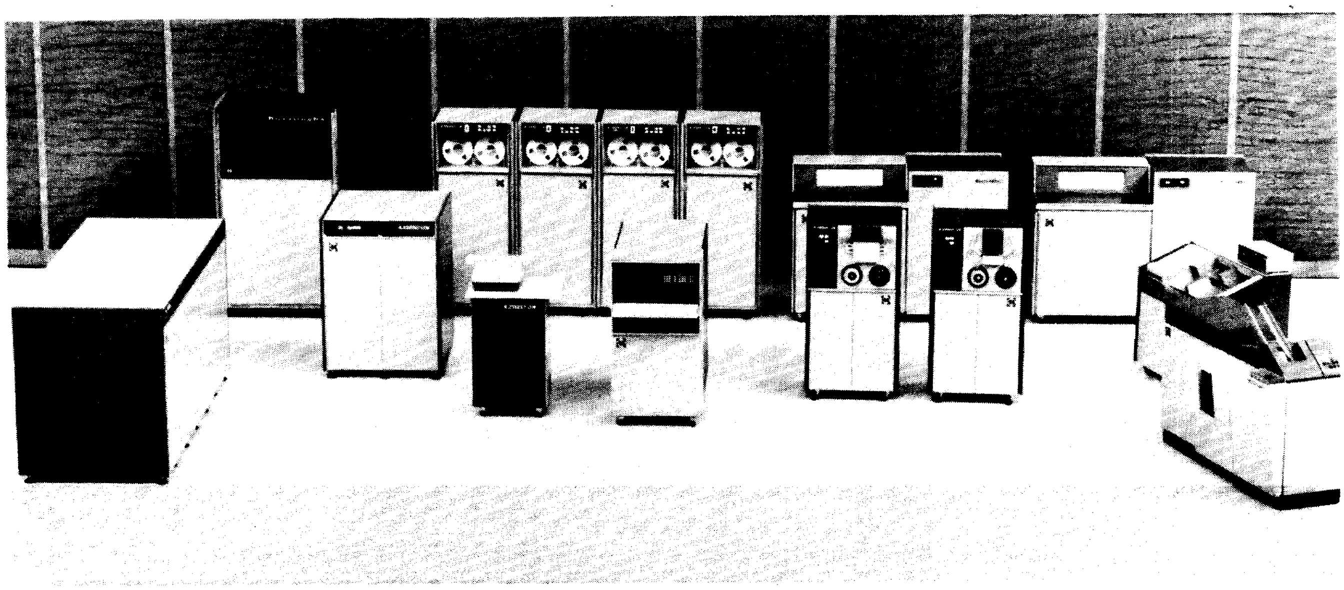


Figure 1-10. B 283 System

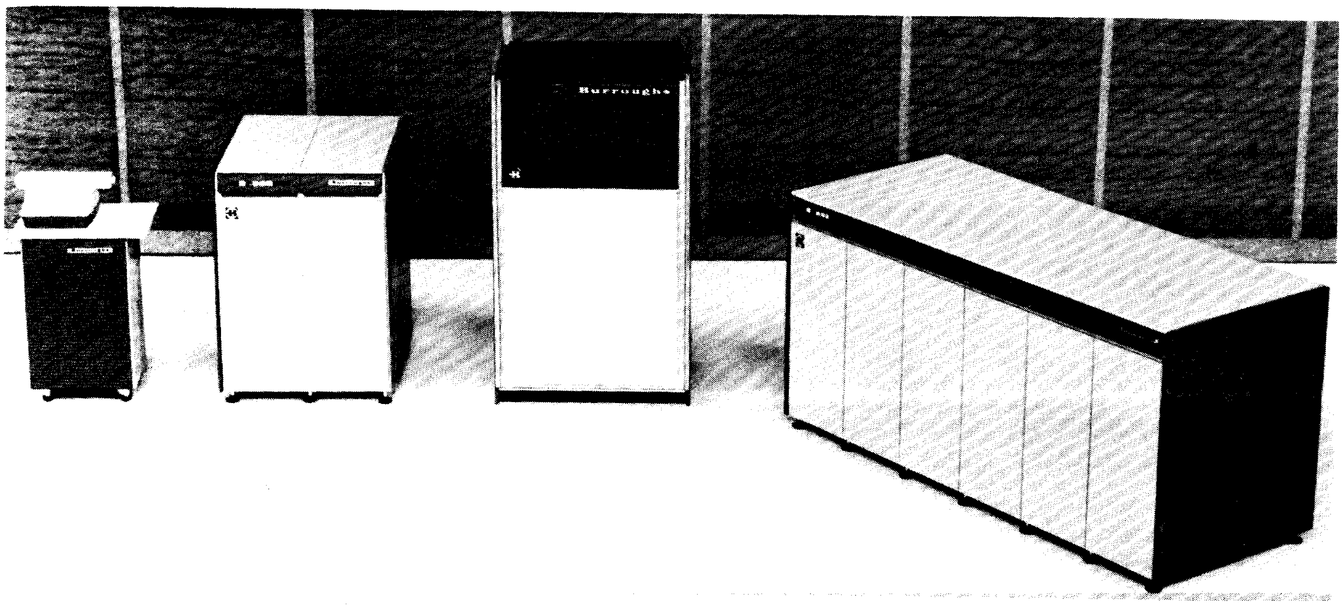


Figure 1-11. Disk File and Data Communication System

B 200 SERIES SYSTEM INDEX

1-22. The various peripheral units that comprise the B 200 Series Systems are listed in table 1-1 and are divided into two groups. Group 1 consists of the components and special features which are available with B 200 Series Systems. Group 2 consists of the modules required in the central processor, depending on system configuration. Most modules are standard, however, certain modules are optional at additional cost and are referenced by number, i.e. B 241. When referring to the table, several notations must be observed, namely:

a. An "X" in a system column (B 260, B 273, etc.) indicates availability of the component module with the system.

b. When a letter other than "X" is used in Group 1, a module in Group 2 is required for operation. For example, a B 141 Paper Tape Reader requires a paper tape module (J).

c. A letter, when circled, indicates a special feature which may be incorporated (at users' option) into the system.

d. More than one letter per unit indicates a choice of one, except when an ampersand (&) is used, for example, H&J indicates the requirements for H and J modules listed in Group 2.

B 200 SERIES SYSTEM CONFIGURATION RESTRICTIONS

a. No more than two input units, one of which may be the sorter-reader, can be connected simultaneously to the input buffers of a central processor.

b. No more than one punch unit (card or paper tape) can be actively connected to a central processor at one time.

c. No more than two line printers (one of which contains the dual printer module) can be connected simultaneously to a central processor (Improved Model 0 B 260, B 270, B 280 and new B 263, B 273, B 283 central processors only).

d. Installation of a paper tape module in an Improved B 260 or new B 263 central processor must be specified at the time of order.

e. Only one disk file/data communication control system, one disk file control unit, and one data communication control unit can be connected to a central processor (B 273 and B 283 only).

f. A maximum of 15 terminal units, in any combination of teletype or typewriter station can be connected to a data communication control unit

   1) A maximum of 399 teletype stations can be connected to a single teletype terminal unit.

   2) A maximum of eight typewriter stations can be connected to a single typewriter terminal unit.

g. The B 144 Sorter-Reader Transfer switch permits switching of the sorter-reader between two central processors.

h. The B 144 Printer/Lister Selector switch permits manual switching between line printers and multiple tape listers.

1-23. Throughout the remainder of this manual, those features that are common to all three systems will be referred to in terms of the B 200 Series Systems. Features applicable only to specific systems will be identified with a reference to that particular system, i.e., B 260, Improved B 260, B 263, etc.

TABLE 1-1

B 200 Series System Index

UNIT NUMBER	DESCRIPTION	MODEL 0 VRC	MODEL 0 B 260	MODEL 0 B 270	MODEL 0 B 280	IMPROVED MODEL 0 B 260	IMPROVED MODEL 0 B 270	IMPROVED MODEL 0 B 280	B 263	B 273	B 283
	GROUP 1.										
B 141	Paper Tape Reader (2 maximum)...					J	J/I	J	J	J/I	J
B 142	Input Code Translator..........					(X)	(X)	(X)	(X)	(X)	(X)
B 143	Reader Switch................					(X)	(X)	(X)	(X)	(X)	(X)
B 341	Paper Tape Punch (1 maximum)....					J	J/I	J	J	J/I	J
B 342	Output Code Translator.........					(X)	(X)	(X)	(X)	(X)	(X)
B 343	Punch Switch.................					(X)	(X)	(X)	(X)	(X)	(X)
B 450	Disk File/Data Communication Basic Control......................									C	C
B 247	Disk File Control Unit (1 maximum)									C	C
B 472	Disk File Storage Unit (contains one storage module)............									C	C
B 475	Disk File Storage Module........									(X)	(X)
B 248	Data Communication Control Unit (1 maximum)..................									H & C	H & C
B 481	Teletype Terminal Unit..........									H & C	H & C
B 483	Typewriter Terminal Unit........									H & C	H & C
B 493	Typewriter Station.............									H & C	H & C
B 484	Dial TWX Terminal Unit.........									H & C	H & C
B 495	Supervisory Printer..............									E	E
B 102	Sorter-Reader (standby station) (1 maximum)..................	X		X			D/I			D/I	
B 103	Sorter-Reader (endorser)..........			X			D/I			D/I	
B 106	Sorter-Reader (standby station) (1 maximum)..................			X			D/I			D/I	
B 107	Sorter-Reader (endorser)..........			X			D/I			D/I	
B 122	200 CPM Card Reader (2 maximum)	X	X	X	X	X	X	X	X	X	X
B 123	475 CPM Card Reader (2 maximum)		X	X	X	X	X	X	X	X	X
B 124	800 CPM Card Reader (2 maximum)	K	X	X	X	X	X	X	X	X	X

TABLE 1-1 (Cont.)

B 200 Series System Index

UNIT NUMBER	DESCRIPTION	MODEL 0			IMPROVED MODEL 0						
		VRC	B 260	B 270	B 280	B 260	B 270	B 280	B 263	B 273	B 283
B 124	800 CPM Card Reader—ICT Code (2 maximum)									X	X
B 124	800 CPM Card Reader—Bull Code (2 maximum)									X	X
B 125	Postal Money Order	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ
B 128	40 Column Read Switch	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ
B 303	100 CPM Card Punch (1 maximum)	K	X	X	X	X	X	X	X	X Ⓕ Ⓖ	X Ⓕ Ⓖ
B 304	300 CPM Card Punch (1 maximum)	K	X	X	X	X	X	X	X	X Ⓕ Ⓖ	X Ⓕ Ⓖ
B 320	Line Printer (2 maximum on Improved Model 0 and B 263, B 273, B 283 only)		X	X	X	X	X	X	X	X	X
B 321	Line Printer (2 maximum on Improved Model 0 and B 263, B 273, B 283 only)	K	X	X	X	X	X	X	X	X	X
B 324	Dual Printer Module					Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ
B 321	Bull or ICT Code (special print drum required)									X	X
B 325	Line Printer (132 print positions)	Ⓚ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ
B 322	Multiple Tape Lister (2 maximum)		X	X	X	X	X	X	X	X	X
B 327	Simultaneous Skipping of Tapes (optional B 322, Stand. B 323)		Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ
B 323	Multiple Tape Lister (alphanumeric)		X	X	X	X	X	X	X	X	X
B 326	Multiple Tape Lister (2 maximum)		X	X	X	X	X	X	X	X	X
B 344	Printer/Lister Selector Switch		Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ
B 401	Record Processor	X									
B 421	Magnetic Tape Unit (6 maximum)			A & L	A & L		A & L	A & L		A & L/C	A & L/C
B 422	Magnetic Tape Unit (6 maximum)									B & L/C	B & L/C
B 423	Magnetic Tape Unit (6 maximum)			A & L	A & L		A & L	A & L		A & L/C	A & L/C

TABLE 1-1 (Cont.)

B 200 Series System Index

UNIT NUMBER	DESCRIPTION	MODEL 0				IMPROVED MODEL 0					
		VRC	B 260	B 270	B 280	B 260	B 270	B 280	B 263	B 273	B 283
	GROUP 2.										
	4800 Character Memory Module...	X	X	X	X	X	X	X	X	X	X
B 466	9600 Character Memory Module...								X	X	X
	50 Cycle Power Module..........					X	X	X	X	X	X
	A—Magnetic Tape Module (18 & 50 KC: 200 & 555 CPI)...........			X	X		X	X		X	X
B 426	B—Magnetic Tape Module (66 KC: 555 CPI)....................									X	X
	C—Magnetic Tape/Disk File Module (either tape speed)...........									X	X
	D—Sorter-Reader Module.........	X		X			X			X	
	E—Supervisory Printer Module.....									X	X
	F—ICT Card Code Module........									X	X
	G—Bull Card Code Module.......									X	X
	H—Data Communication Module....									X	X
	I—Sorter-Reader/Paper Tape Module.....................						X			X	
B 241	J—Paper Tape Module...........					X	X	X	X	X	X
B 242	K—VRC Conversion Module....... (Required on B 251 only)	X									
	L—Basic Magnetic Tape Module....			X	X		X	X	X	X	X

SECTION 2

PERIPHERAL UNITS

GENERAL

2-1. Peripheral units are those units which are separate from the main computer (central processor) and which perform independently of the central processor, but are always under program control of the central processor. The peripheral units are sometimes referred to as input/output equipment.

2-2. This section describes the central processors and the peripheral units that are used with the B 200 Series. Included in this description are the operating characteristics, controls, and indicators. The following peripheral units are discussed:

a. Central Processors
b. B 102/103/106/107 Sorter-Readers
c. B 122 Card Reader (200 CPM)
d. B 123 Card Reader (475 CPM)
e. B 124 Card Reader (800 CPM)
f. B 303 Card Punch (100 CPM)
g. B 304 Card Punch (300 CPM)
h. B 141 Paper Tape Reader
i. B 341 Paper Tape Punch
j. B 320 Line Printer (475 LPM)
k. B 321 Line Printer (700 LPM)
l. B 322 Multiple Tape Lister
m. B 323 Multiple Tape Lister
n. B 326 Multiple Tape Lister
o. B 421 Magnetic Tape Unit
p. B 422 Magnetic Tape Unit
q. B 423 Magnetic Tape Unit
r. B 247 Disk File Control Unit
s. B 472 Disk File Storage Unit
t. B 248 Data Communication Control Unit
u. B 493 Typewriter Station
v. B 495 Supervisor Printer

CENTRAL PROCESSORS

2-3. The central processors for B 200 Series Systems contain the buffers, electronic circuitry, and internal logic necessary to control all input, output, formatting, checking, logical decisions and basic arithmetic functions (figure 2-1).

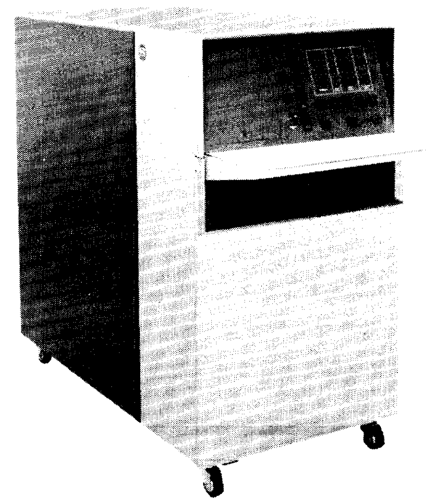


Figure 2-1. Central Processor

Model 0 Central Processor

2-4. The central processor used in Model 0 systems is a solid-state, digital computer with a magnetic core memory storage of 4800 alphanumeric and symbolic positions. Each position contains seven-bits; six are used for information representation and the seventh for parity checking. Every position in memory is individually addressable by a three-character address, thus permitting variable length data fields. The internally stored programs utilize an instruction format of 12-character fixed word length with a three-address command structure.

2-5. The magnetic core storage is composed of 40 sections; each section is composed of 10 fields and each field is composed of 12 characters. The hundred's position of the address represents the section, the ten's position represents the field, and the unit's position represents the character.

2-6. The memory map (figure 2-2) gives the address for every position of memory. The sections are addressed by the 10 numeric digits (0-9), 26 alphabetic characters, and four special characters (+ — blank /).

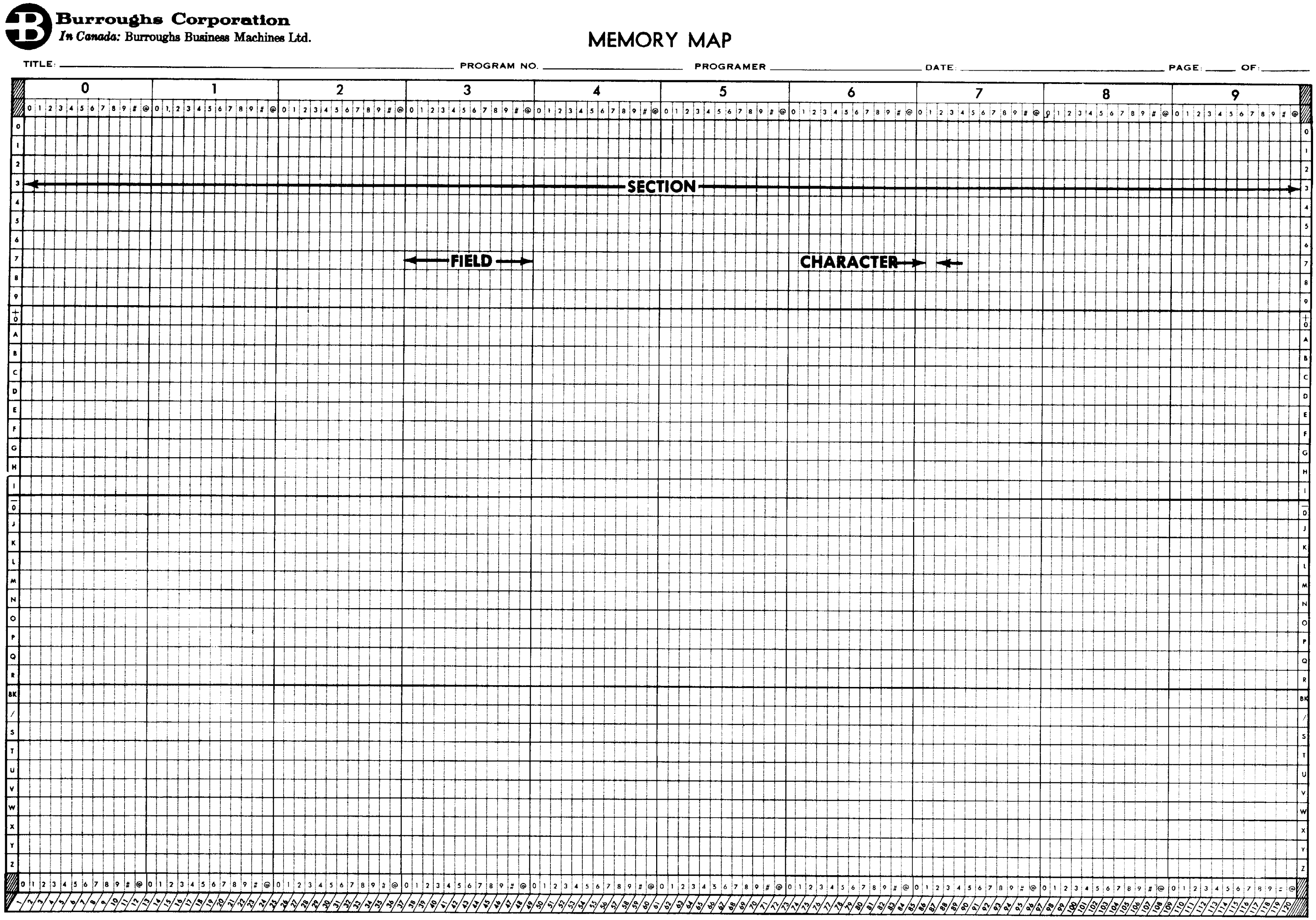


Figure 2-2. Memory Map

2-7. The fields within each section are addressed by the Arabic numerals 0-9 and the characters within each field are sequentially referenced by 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, #, and @ (figure 2-3).

SECTION	FIELD	CHARACTER
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
+0		#
A		@
B		
C		
D		
E		
F		
G		
H		
I		
—0		
J		
K		
L		
M		
N		
O		
P		
Q		
R		
Blank		
/		
S		
T		
U		
V		
W		
X		
Y		
Z		

Figure 2-3. Character Address

Improved Model 0 Central Processor

2-8. The improved Model 0 Central Processor includes all the features of the present Model 0 Central Processors plus the additional capability of handling paper tape input through the installation of a paper tape adapter module. Also, a paper tape reader switch that provides operational interchangeability between the paper tape reader and a card reader, and an optional Input Code Translator for automatic code translation may be used with improved Model 0 Central Processors. A paper tape punch switch that provides interchangeability between the paper tape punch and card punch, and an optional output code translator for automatic code translation are available with this central processor. In addition, the input power requirements include 50 cycle power for compatibility with overseas power. Two Line Printers can be made to operate simultaneously with this central processor if one of the line printers has a dual printer module installed. Additional and modified instructions are included for greater flexibility.

B 263, B 273, and B 283 Central Processors

2-9. The central processor used in the B 263, B 273, and B 283 Systems includes all of the features of the present Model 0 and Improved Model 0 Central Processor, plus it incorporates the following new and improved features:

a. Expanded Memory: Either of two memory modules are available for use with the B 263, B 273, and B 283 Systems. One memory module has a 4800 character capacity, while the second memory module features a 9600 character capacity. The latter half of the 9600 character module is addressed with a B-bit in the tens position of the instruction address. The B-bits and associated indicators are added to the memory address register and instruction register. The load instruction reads data into memory from reader 1 unit until all data is read or memory is filled, either 4800 or 9600 characters. The expanded memory capability does not alter the buffering abilities of the central processor.

b. Disk File System: A B 450 Disk File/Data Communication Basic Control, B 247 Disk File Control Unit, a B 472 Disk File Storage Unit, and a B 475 Disk File Storage Module can be used on B 273 and B 283 Systems only, when a magnetic tape/disk module is installed in the central processor. Necessary commands are included in the central processor for programmatic control (section 4).

c. Data Communications System: A B 450 Disk File/Data Communication Basic Control, a B 248 Data Communications Control Unit, a B 481 Teletype Terminal Unit, and a B 483 Typewriter Terminal Unit and a 493 Typewriter Station may be used with a B 273 or B 283 System only, when a data communication module and a magnetic tape/disk file module is installed in the central processor. All the necessary commands have been added to the central processor for programmatic control (section 4).

d. Supervisory Printer: With accommodation for installation of a supervisory module on the central processor, a B 495 Supervisory Printer may be used with B 273 and B 283 Systems only. All appropriate commands have been added to the central processor for programmatic control (section 4).

e. High Speed Tape Compatibility: High Speed Magnetic Tape Units, Model B 422, may be used with B 273, B 283 Central Processors. These units have a tape speed of 120 inches per second and a packing density of both 200 (24 KC) and 555.5 (66 KC) frames per inch. B 421 (90 inches per second), B 422 (120 inches per second), and B 423 (120 inches per second) Magnetic Tape Units cannot be intermixed on a system. A 66 KC module must be installed in the central processor of B 273 and B 283 Systems in order to use the B 422 Magnetic Tape Units.

f. Bull Code Compatibility: A special version of the 800 CPM reader provides for Bull code compatibility. This card reader will read only 80-column Hollerith cards punched with a modified Bull T-8 code. The line printer incorporating a print drum with the Bull Character set provides compatibility for the printing of Bull codes. When the Bull Card Code Module is installed in a processor, Bull card codes can be punched on the standard punch (B 303 or B 304). The punch command permits punching BCL, Bull, and ICT Card Codes. See ICT Code Compatibility.

g. ICT Code Compatibility: A special version of the 800 CPM reader provides for both BCL and ICT code compatibility, but not on the same run. A manual switch can be set by the operator for either code.

A line printer incorporating the ICT character set provides compatibility for the printing of ICT codes.

When the processor includes the ICT Card Code Module, ICT codes can be punched. However, only 80-column Hollerith cards with an expanded version of the ICT 5-3 zone (A-2) code can be read or punched. The Bull Card Code Module can be installed along with the ICT Card Code Module. This allows punching of BULL, ICT, and BCL codes. No change is required in the standard punch equipment.

NOTE

Bull code is the code used on punched card equipment manufactured by Bull Inc., of France. ICT is the code used by punched card equipment manufactured by International Computers and Tabulators, Ltd., of England. With the addition of either or both modules (BULL or ITC), the B 303 and B 304 Card Punch can be used with systems using these codes. Also, the B 124 Card Reader can be used for reading BULL or ICT codes when a BULL or ICT translator is installed in the card reader, at time of order.

h. Increased clock speed: The clock speed is increased from 100 KC to 166 KC, thus reducing the execution time of the following commands to 0.6 of the corresponding 100 KC Model 0 and Improved Model 0 times:

(1) No-Op.
(2) Add
(3) Subtract
(4) Multiply
(5) Divide
(6) Compare
(7) Branch
(8) Transfer
(9) Transfer Zone
(10) Mask
(11) Address Modification
(12) Halt
(13) Card Read
(14) Sorter-Read-Buffered Only

(15) Punch
(16) Paper Tape Write
(17) Paper Tape Read-
Buffered Only
(18) Paper Tape Space
(19) Paper Tape Backspace
(20) Paper Tape Rewind

i. Additional and modified instructions are included for greater flexibility.

Central Processor Console

2-10. The B 200 Series Central Processor provides a control panel (figure 2-4), containing all the switches and indicators necessary for operation of the system. The function of each switch and indicator is described in table 2-1.

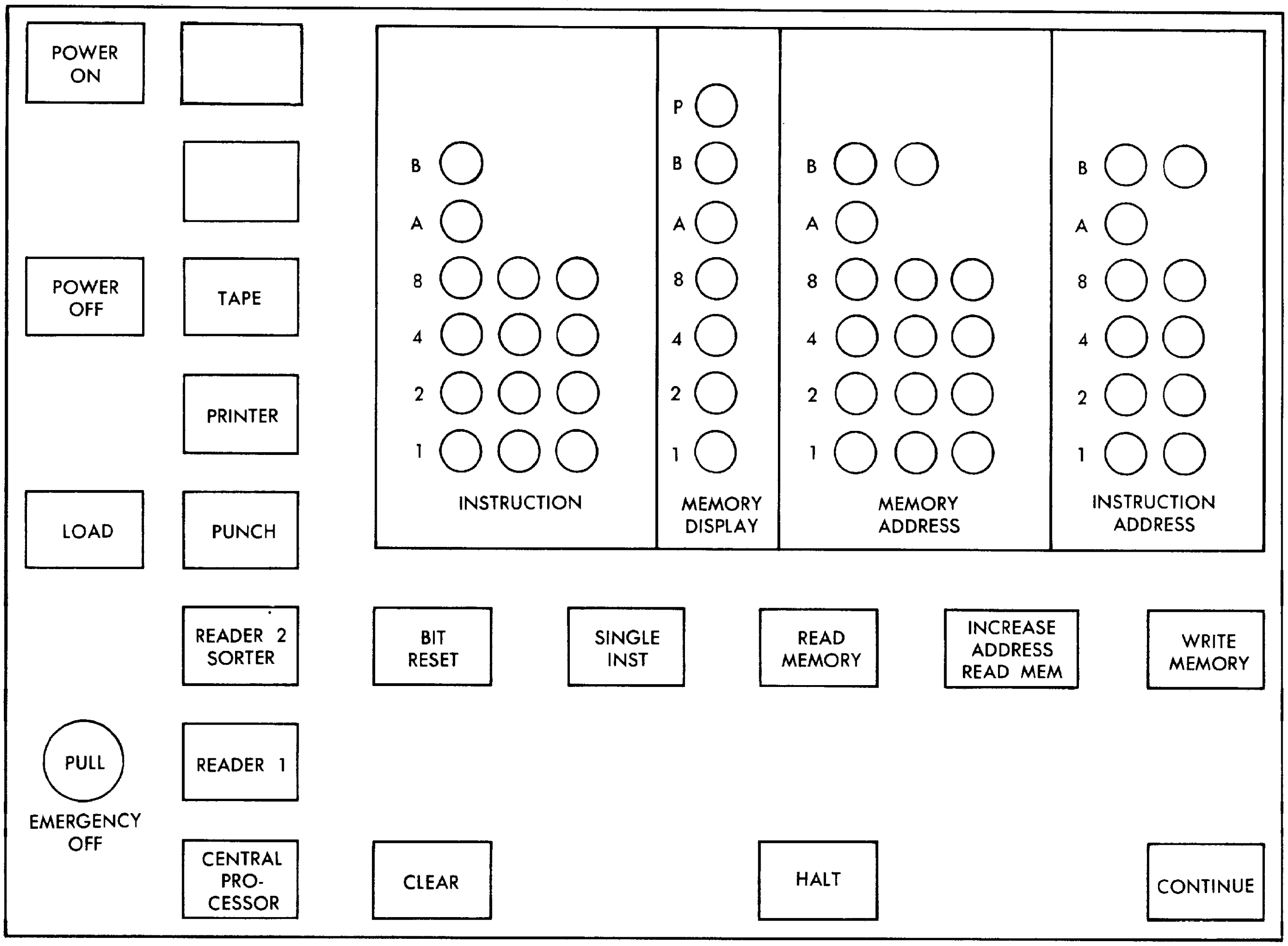


Figure 2-4. Central Processor Console

TABLE 2-1

Model 0, Improved Model 0 and B 263, B 273, B 283 Central Processor Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	A self-indicating switch/indicator that turns system power on in correct sequence, and lights, indicating that power is on for the central processor. It also provides a turn-on signal, at the correct time, to all peripheral equipment with the exception of the magnetic tape units and the sorter-reader.
POWER OFF	This switch turns systems power off including peripheral equipment in correct sequence where required.
LOAD	This switch initiates the instruction to read data from the card reader into memory, starting with 000 and continuing until memory is filled or the hopper is empty. **NOTE** Load can be started at any pre-set address which is a multiple of 5-words and can be used with paper tape as well as cards. However, when used with paper tape, the depression of the LOAD button causes memory to be loaded, starting from the address displayed in the memory address register and continuing to end-of-memory, or to the first stop character encountered on the paper tape. After load, the CLEAR button must be pressed.
EMERGENCY OFF	When pulled, turns off all power to all units in the system including the central processor (except the circuit breaker at entry to the unit and convenience outlets). When this switch is pulled, only a field engineer can restore the power.
READER 1 READER 2 SORTER PUNCH PRINTER TAPE	These indicators are the system-unit lights and are lit when the command in the INSTRUCTION register refers to the unit named on the light. If the system stops, the light which remains lit indicates the unit which is unable to complete its function. **NOTE** Indicators READER 1 & 2 are labeled CARD 1 and CARD 2 on Model 0 Central Processors.
CENTRAL PROCESSOR	Illuminates, indicating that a parity error is sensed when information leaves memory, i.e., during command execution or buffer access. **NOTE** Sensing a parity error causes the central processor to stop. To re-establish automatic operation, operator must manually correct the error in memory and cause the command to be re-executed.

TABLE 2-1 (cont)

Model 0, Improved Model 0 and B 263, B 273, and B 283 Central Processor
Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
INSTRUCTION	Three columns of lights which display the operation code and M and N variants of the instruction to be executed. **NOTE** B 263/273/283 Central Processors include a B-bit to display new OP codes.
MEMORY DISPLAY	An array of seven lights which displays one character-at-a-time; either one called from storage for display or change, or a character manually inserted in the register for transfer to storage.
MEMORY ADDRESS	Three columns of lights which display a storage address. The address displayed in either that of the location of a character from storage to be transferred to the Memory Display or that of a location in which a character from the Memory Display is to be stored.
INSTRUCTION ADDRESS	Two columns of lights which display the address of the next instruction to be executed. Since the third character of a machine language instruction address is always zero, only the first two digits are displayed. **NOTE** A B-bit indicator in the tens position of the Instruction and Memory address is included on B 263/273/283 Central Processor.
BIT RESET	This switch when held down, and at the same time momentarily pressing any bit light on the display panel, turns off the light and its associated flip-flops.
SINGLE INST	Used to execute programs one instruction at a time under manual control.
READ MEMORY	Reads and displays the one character in the memory display as signified by the memory-address register.
INCREASE ADDRESS READ MEM	When pressed, the memory-address register advances by one and displays the character in that address in the memory display.
WRITE MEMORY	Writes into memory, in the address displayed by the memory address register, the character shown in the memory display.
CLEAR	This switch clears all flip-flops and their corresponding lights in central processor. **NOTE** This switch does not clear the central processor input and output buffers.
HALT	A self-indicating switch/indicator that halts the system at the completion of all operations in progress. However, execution of instructions for all peripheral equipment in process is completed before the system stops.

TABLE 2-1 (cont)

Model 0, Improved Model 0 and B 263, B 273, B 283 Central Processor
Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
CONTINUE	A self-indicating switch that initiates automatic operation after all error conditions have been reset in the central processor. This switch is also used as a START switch for continuing operation.

B 102/103/106 AND B 107 SORTER-READERS

2-11. The Burroughs B 102/103 Sorter-Readers are physically and operationally identical with the B 106/107 respectively. The major difference is that the B 106 and B 107 Sorter-Readers are designed to operate at speeds of up to 1200 items-per-minute. Whereas the B 102 and B 103 Sorter-Readers are designed to operate at speeds of up to 1565 items-per-minute. Since the units are identical (with the exception of operational speeds), only the B 102 and B 103 Sorter-Readers are described.

B 102/103 SORTER READER

2-12. The B 102/103 Sorter-Reader (figure 2-5), is capable of reading and sorting documents encoded with magnetic ink at speeds up to 1565 items-per-minute. Information encoded on the documents is converted to Burroughs Common Language (BCL) representation and transferred to core storage in the central processor. When used with a magnetic tape system, information can be transferred to the central processor for editing and then to magnetic tape. When under program control, the sorter-reader can operate in two modes: demand and flow. In demand mode, documents are fed one at a time, as required by the program, at a maximum rate of 400 items-per-minute. In flow mode, documents are read and sorted at the free flow rate of the sorter-reader which is up to 1565 items-per-minute, depending upon document size (section 7).

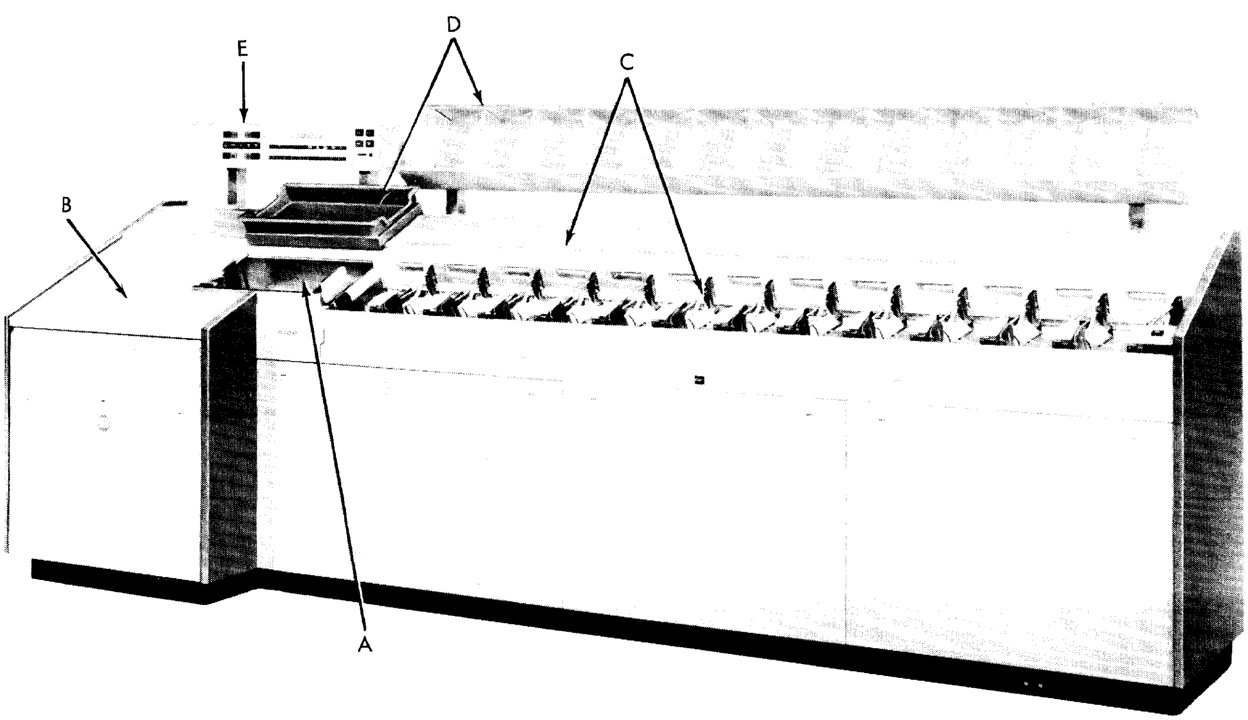


Figure 2-5. B 102/103 Sorter-Reader

2-13. The sorter-reader is comprised of five distinct areas illustrated in figure 2-5 and identified by the letters A through E:

a. Document feeding area.
b. Transport and read area.
c. Transport and pocket area.
d. Temporary storage area and mobile carrier.
e. Control panel.

Document Feeding Area

2-14. This area encompasses the document hopper, the feeder belt, the hold belt, and the acceleration drum.

2-15. The document hopper (figure 2-6) is 15 inches long, 9½ inches wide, and can hold approximately 3000 documents. Documents are placed in the hopper with the front of the document facing to the left. It is possible to load the hopper during sorting by the combination of two mechanical devices which are engineered to insure positive document feeding at every stage of the loading process. These devices are known as the follow block and the end block.

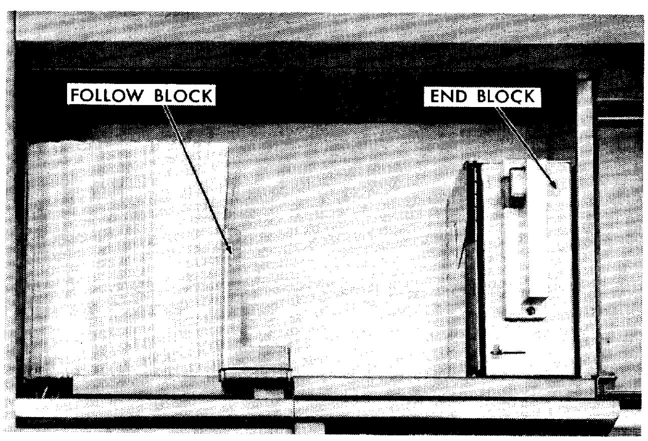


Figure 2-6. Document Hopper

2-16. The follow block provides the necessary pressure to move the documents into the feeder belt. It moves smoothly along a guide rail which extends the length of the hopper and can easily be tilted out of the hopper when desired.

2-17. The end block can be used to provide temporary pressure on the documents in the hopper while the follow block is being repositioned. When not in use, the end block is positioned to the far right of the hopper. To load documents while sorting takes place, the new documents are placed in back of the follow block and the end block is released from its position and moved to the left to hold the new documents in place. The follow block is then raised from its position between the two groups of documents and repositioned in the entry slot of the end block. This guides the face of the follow block directly behind the last document in the hopper. Once the follow block is in position, it provides the pressure to the documents and the end block can be returned to its normal position.

2-18. As stated previously, the follow block is normally used to supply the necessary pressure on the documents during sorting. However, when only a small number of items are to be sorted, the end block may be utilized. By moving the lever on the top of the end block to the right, a pressure plate is released which provides pressure to guide the documents into the feeder belt. When the end block is returned to the right end of the hopper, the pressure plate can be locked in place by moving the lever to the left while compressing the plate to the end block. Figure 2-7 illustrates the end block with the pressure plate and lever in the open and closed positions.

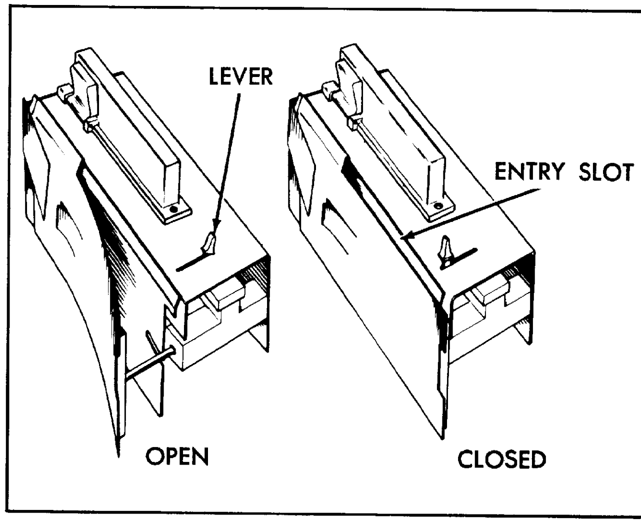


Figure 2-7. End Block

2-19. The hold back belt, in combination with the feeder belt, restricts feeding to one document at a time. The function of the hold back belt is to separate the documents, thus permitting only one document at a time to be transported to the read station. Figure 2-8 illustrates the two belts in relation to their position in the document feeding mechanism.

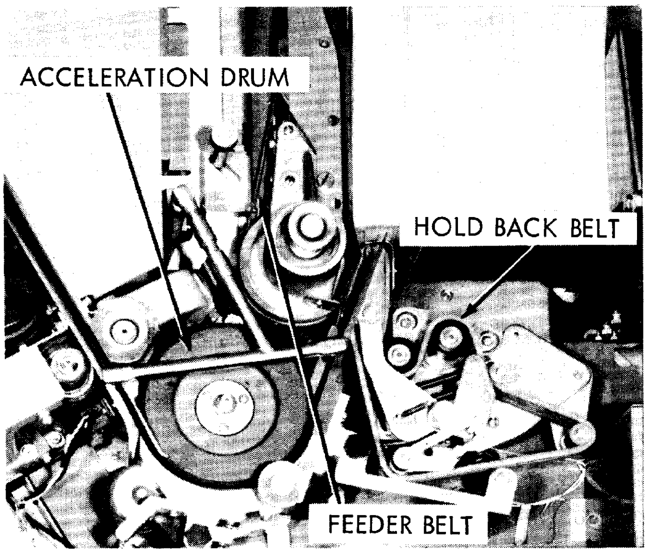


Figure 2-8. Document Feeding Area

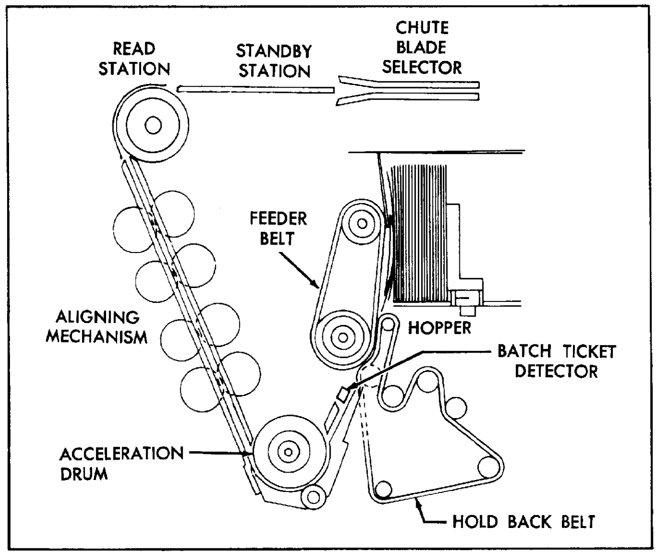


Figure 2-9. Transport and Read Area

2-20. Documents are selected from the hopper by the feeder belt at the rate of 150 inches-per-second and accelerated to 400 inches-per-second by the acceleration drum. Proper spacing between documents is important to ensure reading and sorting of each document. Improper spacing between documents is detected by strategically located beams of light which cause such documents to be sorted into a reject pocket. Document feeding is stopped for 300 milliseconds to permit the reject and then automatically continues. Such rejects also occur when a document fails to meet minimum or maximum size specifications.

2-21. The document feeding area also includes a device called the batch ticket detector. This is an optical sensing device located between the hopper and the acceleration drum to provide the means of stopping the feeding of documents upon the detection of a black band on the front of the batch ticket. By stopping the flow of items, all items in the preceding batch can be completely processed before continuing with the next batch.

Transport and Read Area

2-22. This area is made-up of four functional control points which are located between the document feeding area and the pocket area. The four functional points illustrated in figure 2-9 are as follows:

The aligning mechanism.

The read station.

The standby station.

The chute blade selector.

2-23. After the documents pass the acceleration drum, they enter the alignment mechanism which positions the documents by the application of a firm, but gentle, downward pressure by a series of eight alignment rollers, four of which are located on each side of the document transport belt. By the time the document reaches the end of the alignment mechanism, its lower edge is in the correct position for entry into the read station.

2-24. To assure that the characters to be read have been properly magnetized before the document passes the read head, it is passed over a permanent magnet. This permanent magnet is mounted in the stationary hub of the read drum assembly. A non-magnetic metallic strap is used to guide the document through the read station and to maintain a constant pressure between the magnetized characters and the read head. After passing the permanent magnet, the characters on the document are read by the read head and the the resultant impulses are routed to the central processor memory.

2-25. The third control point, the stand-by station, is used in the B 102 Sorter-Reader. Items which have passed the read station are held in the stand-by station until a pocket select command is received from the central processor. This type of operation occurs in demand mode and the maximum rate of document processing is 400 items-per-minute. In the B 103 Sorter-Reader, the stand-by station is replaced with an endorser unit. This high-speed endorser provides the ability to endorse all items as they pass through the sorter-reader. The endorsement is printed on the backs of all documents as they move from the read station to the chute blades. The use of the endorser prevents the use of the demand mode.

2-26. The fourth control point is made-up of the chute blade selector and magnetic assemblies which are used to control the path of the documents to the pockets and are under control of the central processor. There are 12 moveable chute blades. In actuality, the chute blades are in two sections and so positioned that they cover the lower and upper portions of the document as it is routed to its pocket. The blades extend the entire length of the transport mechanism ending at the entrance to the document pocket. This assures that once an item enters the chute blades, it will only be routed to the selected pocket.

Transport and Pocket Area

2-27. The transport area is located above and behind the pocket area and carries documents from the chute blades to the pocket determined by the chute blade opening. Once the proper chute selection is made, the document cannot be delivered to any other pocket. Figure 2-10 shows the sorter-reader with the cover raised and a document in the transport area.

Figure 2-10. Transport and Pocket Area

2-28. The sorter-reader has 13 pockets positioned left to right from the document hopper and designated in the following order: Reject, 0 through 9, X, and Y. Each pocket is 4 inches wide and has the capacity for approximately 800 documents. Items are sorted to any of the 13 pockets based upon the program instructions in core storage. All checking functions are also under control of the central processor.

2-29. There are two plastic worm gears in the bottom of each pocket which guide the lower edges of the document toward a sliding pocket wall (figure 2-11). These worm gears are friction driven so that light finger pressure will immediately stop their operation, thus protecting the operator.

2-30. As the documents enter the pocket, their leading edges are "caught" by the pull-in wheels. These wheels serve two purposes — they pull the items to the front of the pocket and keep the items from rebounding after hitting the front of the pocket.

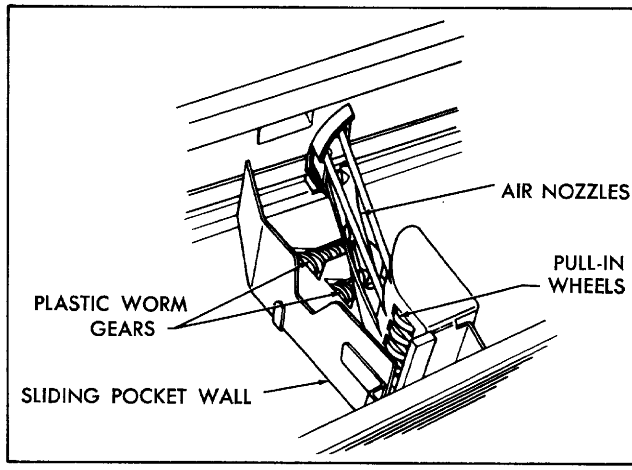


Figure 2-11. Pocket Mechanism

2-31. While the bottom edge of the document is being guided by the plastic worm gears, a continuous jet of air from three air nozzles is directed against the top rear of the documents from the instant they enter the pocket. This helps position the documents and produces a more orderly pack of stacked items.

2-32. The right side of the pocket is engineered to guide the documents along smooth guide rails into their proper position in the pocket. The sliding pocket wall permits the pocket size to vary according to the number of items in the pocket. When the pocket is empty, the sliding pocket wall is adjacent to the right side of the pocket. As documents enter the pocket, the sliding pocket wall moves to the left. When the pocket is filled to ¾ of its capacity (approximately 600 items), a pocket warning light, located immediately above the pocket, is turned on automatically. When the capacity of the pocket is reached, the document feeder automatically stops and a Full Pocket Indicator on the control panel illuminates.

2-33. Each pocket can be unloaded while the sorter-reader continues its normal sorting pattern by the use of a Divider Block which is similar in construction to the Follow Block in the Document Feeder. By inserting the Divider Block into the pack of documents in the pocket, the items to the left of the Divider Block can be easily removed while documents are entering the pocket during this operation. When the items have been removed, the sliding pocket wall, which provides the expansion pressure required to hold the items in place, returns to its normal position and the Divider Block can be returned to the left side of the pocket.

2-34. Figure 2-12 shows the Divider Block in its normal position to the left of the sliding pocket wall while figure 2-13 shows the Divider Block inserted in the pack of documents in the pocket prior to document removal.

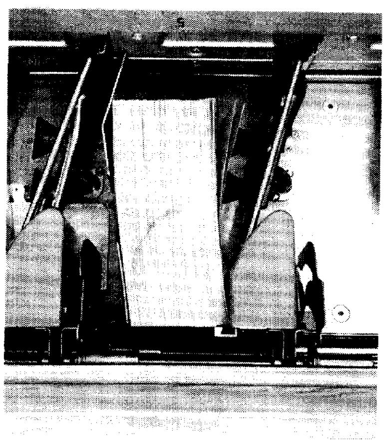


Figure 2-12. Divider Block—Normal

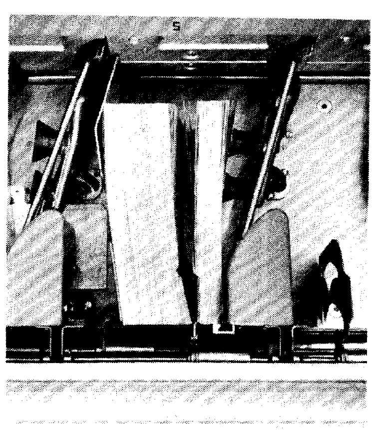


Figure 2-13. Divider Block—Inserted

Temporary Storage Area and Mobile Carrier

2-35. The Temporary Storage Area and Mobile Carrier assist in the removal and storage of sorted documents efficiently while sorting operations continue.

2-36. Documents removed from the pockets during sorting can be placed in the corresponding compartments of the Temporary Storage Area located above the transport area. Up to 4000 documents can be loaded in the removable item tray, which moves in either direction with the mobile carrier. Figure 2-14 illustrates the two features.

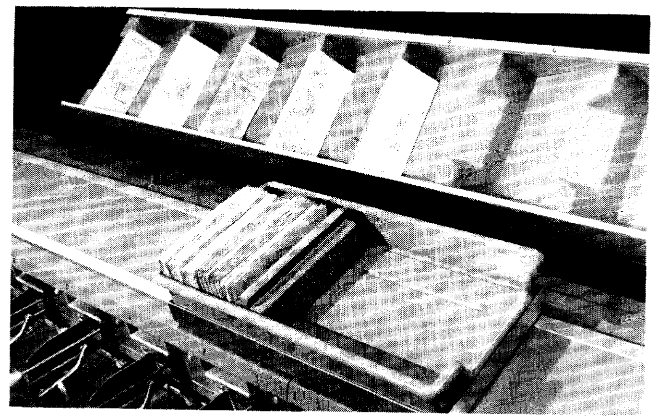


Figure 2-14. Temporary Storage Area and Mobile Carrier

2-37. The B 102/103 Sorter-Readers can also be used independently of the B 200 Series Systems. When used off-line, sorting is controlled by a patchboard housed in the rear of the control panel. A detailed explanation of the use of the sorter-reader off-line is available in the Sorter-Reader Operator's Manual, 100-21002-D.

Sorter-Reader Control Panels

2-38. The sorter-reader control panels contain a number of switches, indicators and selection keys that provide a communication link between the operator and the sorter-reader. There are four major elements of the control panel:

a. Operating switches.
b. Communication indicators.
c. Field selection keys.
d. Digit selection keys.

Figure 2-15 illustrates the control panels of the B 102 and B 103 Sorter-Readers. The B 103 control panel contains more switches and indicators than the B 102 due to its endorser operation. The function of these switches and indicators is provided in the tables 2-2 and 2-3.

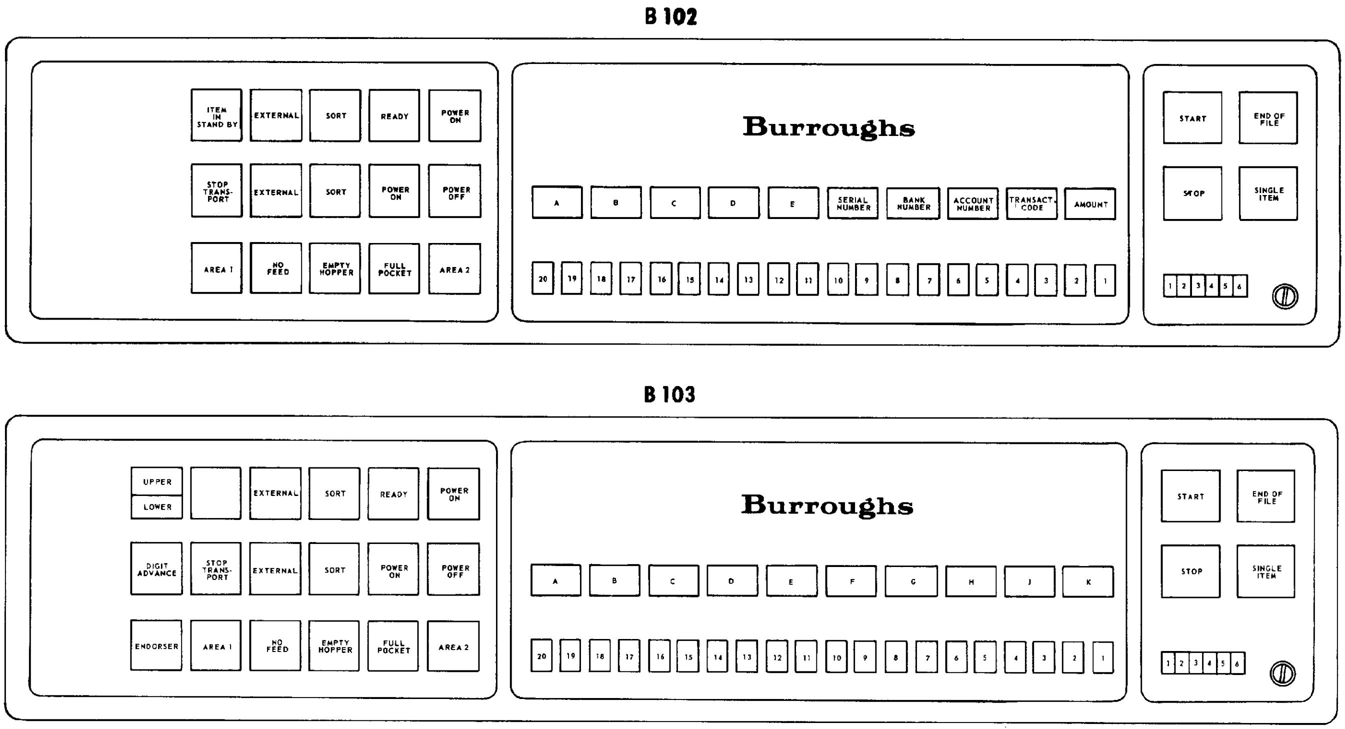


Figure 2-15. B 102/103 Control Panels

TABLE 2-2

Sorter-Reader Control Panel Operating Switches

SWITCH	FUNCTION
(Left Side of Control Panel)	
DIGIT ADVANCE	This switch (B 103 only) is used off-line to advance the three-digit batch number in the endorser unit by one (1). It is inactive if the document feeder is running. It has no function during on-line operation since the batch number is advanced by the external unit under program control.
STOP TRANSPORT	This switch (B 103 only) is used to stop the transport system. The NO FEED indicator will turn on. To return the sorter-reader to the "Ready" state, it is necessary to use the SINGLE ITEM switch.
EXTERNAL	When power is turned on, the sorter-reader is automatically put in sort mode. This switch is used to transfer control to the central processor when the sorter-reader is used for input purposes. This switch can be used before the sorter-reader is in a "Ready" state.
SORT	This switch has no function when the sorter-reader is used on-line.
POWER ON	This switch applies power to the sorter-reader. The POWER ON indicator will light.

TABLE 2-2 (cont)

Sorter-Reader Control Panel
Operating Switches

SWITCH	FUNCTION
POWER OFF	This switch removes power from the equipment. An auxiliary POWER OFF switch is located immediately to the right of the Y pocket (figure 2-16). It serves the same function as the one on the control panel.

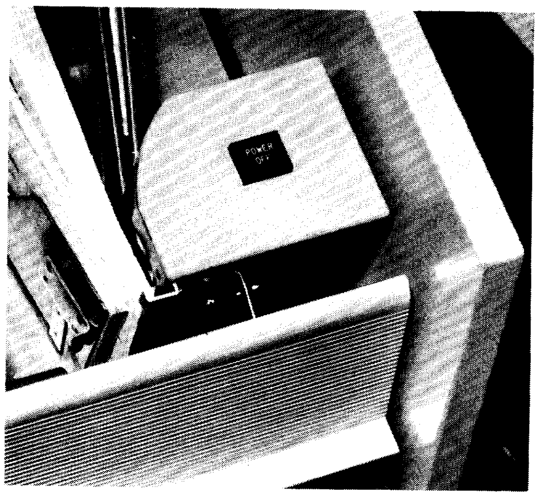


Figure 2-16. Auxiliary POWER OFF Switch

SWITCH	FUNCTION
(Right side of Control Panel)	
START	This switch sends a signal to the central processor. Document feeding starts on command from the central processor. Specifically, if the program has stopped because of an empty hopper, the program will restart automatically upon loading the hopper and using the START switch. In other instances, it is used simply to turn off the EMPTY HOPPER indicator.
END OF FILE	This switch is used whenever an end-of-file branch is called for by the program. The EMPTY HOPPER indicator will light to signal this requirement.
STOP	This switch is used to stop the feeding of documents. An interlock prevents the covers from being raised. The sorter-reader remains in a "Ready" state when this switch is used. Item flow is resumed by using the START switch. Two other STOP switches are located in front of document pockets 2 and 8 for the operator's convenience (figure 2-17).

TABLE 2-2 (cont)

Sorter-Reader Control Panel
Operating Switches

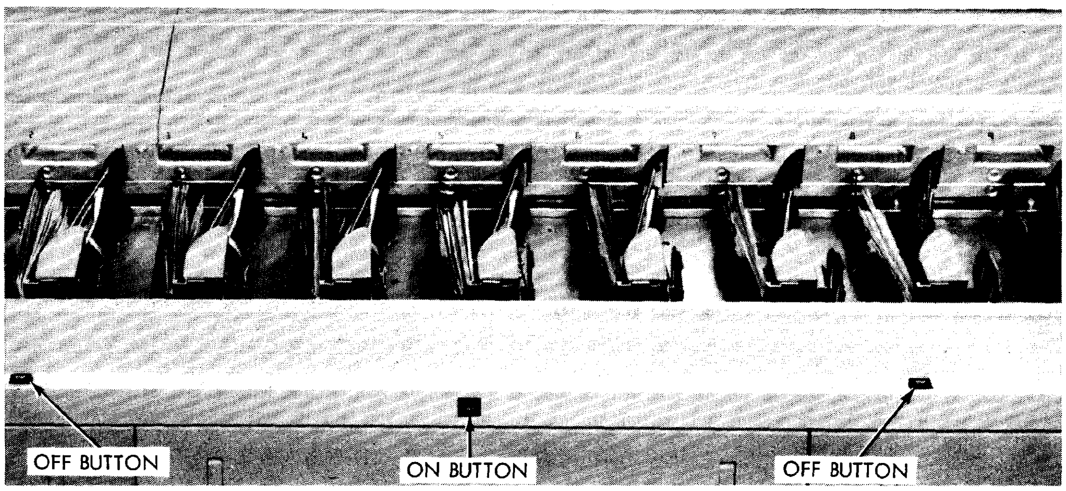


Figure 2-17. Auxiliary Start Stop Switches

SWITCH	FUNCTION
SINGLE ITEM	This switch must be used to put the sorter-reader in a "Ready" state after a "No Feed" or Area 1 or Area 2 stop condition has occurred. A document is not fed in this instance. This switch should not be used to feed a single document when the sorter-reader is used on-line.

TABLE 2-3

Sorter-Reader Control Panel
Indicators

INDICATOR	FUNCTION
(Left side of Control Panel—Top Row)	
UPPER LOWER	This is a two-part indicator that operates only during the endorsing operation of the B 103. The lower half is labeled LOWER and is green; the upper half is labeled UPPER and is amber. The lights indicate which of the two endorsing bands is active. When the endorser is active, one of the indicators will be lit.
ITEM IN STANDBY	This indicator appears only on the B 102. In demand mode, it indicates that an item is in the standby station awaiting disposition. In flow mode the indicator is inoperative.
EXTERNAL	This indicator indicates that the sorter-reader is being operated on-line and under control of the central processor. Sorting is determined by the program being executed.

TABLE 2-3 (cont)

Sorter-Reader Control Panel
Indicators

INDICATOR	FUNCTION
SORT	This indicator is only operative when the sorter-reader is used off-line.
READY	This indicator signals that the sorter-reader is ready for use after power is turned on or a stop condition has been corrected.
POWER ON	This indicator lights when power is applied to the sorter-reader.
(Left side of Control Panel—Bottom Row)	
ENDORSER	This is a combination switch-indicator for control of the endorser device (B 103 only). When the endorser is off, pressing this switch will activate the device and the indicator will light. When the endorser is active, pressing this switch will turn the device off and the indicator will go out.
AREA 1	Signals a document jam or a potential jam condition, in the area between the acceleration drum and the chute blades. The indicator is turned off by pressing the SINGLE ITEM switch after Area 1 is checked and/or cleared, and the Area 1 cover is closed.
NO FEED	This indicator lights when an item is not fed from the document hopper within 150 milliseconds after the preceding item or when a document jam occurs in the document feeding area. The indicator is turned off by use of the SINGLE ITEM switch provided a stop condition is corrected and the Area 1 cover is closed.
EMPTY HOPPER	This indicator lights when a sorter-reader instruction cannot be executed because a document is not present at the read station due to an empty hopper condition. The system will halt when this occurs. To continue processing, the hopper must be refilled and the START switch pressed to turn off the indicator. If the processing run has been completed, the END OF FILE switch is used to complete the run.
FULL POCKET	This indicator lights when a pocket reaches capacity. Document feeding stops, and all documents in the transport system are directed to their respective pockets. At this point the system halts. The documents should be removed from the pocket and the START switch pressed to resume processing.
AREA 2	Signals a document jam or a potential jam, in the area encompassing the chute blades and the individual pockets. The indicator is turned off by use of the SINGLE ITEM switch.

NOTE

On the right side of the control panel is a six-digit, resettable item counter which counts the number of documents that pass through the sorter-reader. The switch to the right of the counter is used to reset the counter to 000000.

The field and digit select switches located in the center of the control panel pertain only to the operation of the sorter-reader while in the off-line mode. These are described in the B 100 Sorter-Reader Operator's Manual, 100-21002-D.

B 122 CARD READER

2-39. The B 122 Card Reader (figure 2-18) is designed for use as a compact general-purpose card reader capable of reading 80-column punched cards at a maximum rate of 200 cards-per-minute (CPM), under control of the central processor. Buffered operation permits computations to proceed while the card data is being read. The time required to transfer the contents of the buffer to memory is 2 milliseconds (m s.). The time required to process another card, which refills the buffer, is 300 ms. The card reader can handle cards that are cut on any four corners and cards that are notched during verification.

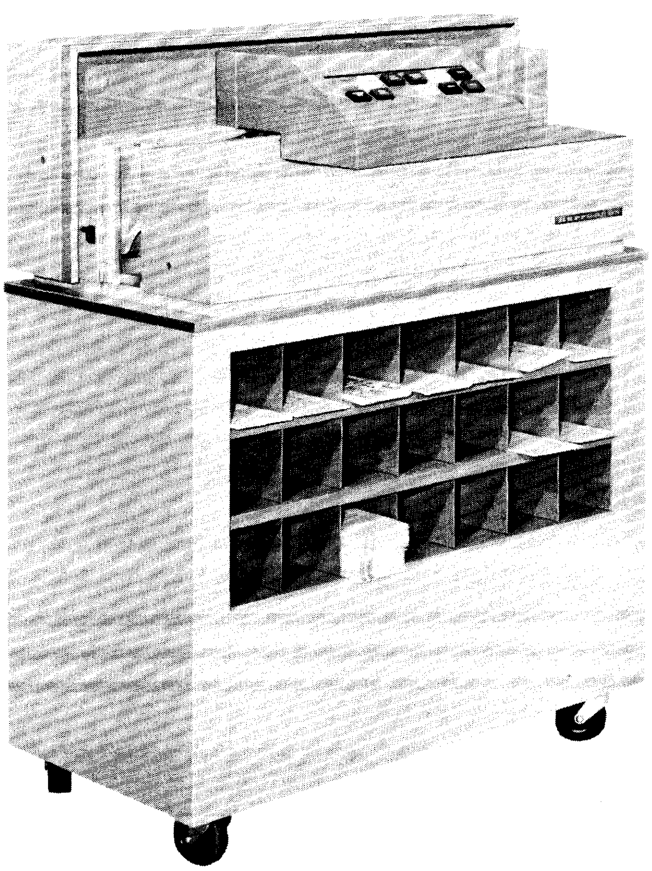


Figure 2-18. B 122 Card Reader

Functional Characteristics

2-40. A single path mechanism transports cards from the picking mechanism, through the read station and into the stacker. A failure to feed or feed jams cause a "Not-Ready" signal to be relayed to the associated central processor. A jam will halt the Card Read operation with no more than two cards in a jammed condition. Information punched in the card is read, translated to BCL code, and transferred into the input buffer, parallel by bit, serially by column. By use of a switch on the control panel, the validity of each character in the card can be checked.

2-41. A demand-type card picking mechanism permits the complete reading of an 80-column card in a total time of 315 ms. or less after a start feed signal is received. The card hopper has a capacity of 450 cards; and cards can be placed into the hopper while the unit is operating, as long as approximately 150 cards are still in the hopper. During loading, the cards in the hopper remain in proper position for continuous feeding, without manual support from the operator. A single one-column data reading station reads the cards column-by-column serially for the entire 80 columns. The card data read are in tabulating card code and are transferred to the input buffer of the associated central processor in six-bit binary BCL code. The cards are stacked in the stacker in the same sequence as they are fed and cannot be removed from the stacker while the unit is operating.

B 122 Card Reader Control Panel

2-42. The B 122 Card Reader control panel (figure 2-19) contains the switches and indicators for operation of the unit and to indicate error conditions. The function of each of these elements is provided in table 2-4.

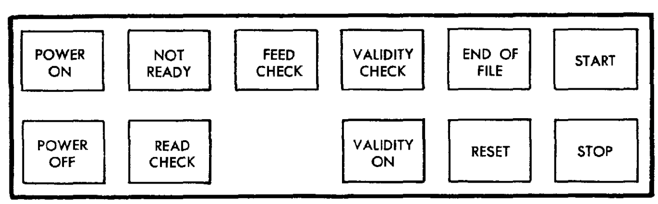


Figure 2-19. B 122 Card Reader Control Panel

TABLE 2-4
B 122 Card Reader Control Panel
Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This is a combination switch-indicator that applies power to the card reader and lights when it is pressed.
NOT READY	This indicator lights when any of the following conditions exist: card jam, stacker full, cover not in place, empty hopper, STOP switch pressed, read error, or VALIDITY CHECK indicator lit. The condition causing the NOT READY indicator to light must be corrected before processing can be resumed.
FEED CHECK	This indicator will light as a result of a card jam or a failure to feed or stack a card properly.
VALIDITY CHECK	This indicator lights when an invalid character is read by the card reader and the system will halt on the next Card Read instruction. The VALIDITY CHECK indicator and its associated circuitry are only operative when the VALIDITY ON switch-indicator is lit.
END OF FILE	When the last card is read from the hopper, the program will halt upon encountering the next Card Read instruction. By pressing this switch and then START, the program will branch automatically to the end-of-file routine specified by the BBB address of the Card Read instruction that caused the program to halt. This indicator will light when the switch is pressed.
START	This switch serves two purposes. First, it is used to condition the card reader (turn the NOT READY indicator off) for feeding cards under program control of the central processor. Second, it is used to restart the card reader after an empty hopper has been reloaded.
STOP	This switch is used to stop the card reader from feeding cards. When the switch is pressed, the program will halt upon encountering the next Card Read instruction.
RESET	This switch clears all error indicators on the card reader. However, the NOT READY indicator is not turned off by pressing this switch.
VALIDITY ON	This switch-indicator provides the means of performing a validity check by the card reader. Validity checking is performed when the switch is pressed and the indicator lights. Validity checking is disabled when the switch is pressed and the indicator goes out.
READ CHECK	This indicator lights when the read check circuitry detects an operational failure. The card reader is placed in a "Not-Ready" state and the system will halt upon encountering the next Card Read instruction.
POWER OFF	This switch removes power from the unit.

B 123/B 124 CARD READERS

2-43. The B 123 and B 124 Card Readers are both designed for use as heavy-duty, high-volume card readers. They are physically identical and differ only in their operating speed. That is, the B 123 Card Reader is designed to operate at speeds of up to 475 cards-per-minute, whereas the B 124 Card Reader is designed to read punched cards at speeds of up to 800 cards-per-minute. Since the difference between the two units is their operating speed, only the B 124 Card Reader is described in this manual.

B 124 CARD READER

2-44. The B 124 Card Reader (figure 2-20) is used to process punched cards of 51-, 60-, 66-, or 80-columns of either standard or post-card thickness, under control of the central processor, at a rate of 800 cards-per-minute (CPM). An immediate access clutch provides demand feeding. Read data is transferred to the central processor through an 80-character input buffer. Time required to read one card and fill the input buffer is 75 ms. Cards cut on any four corners and cards that have been verified (notched on the right edge) may be used. However, card stock thickness and length must be consistent during any one run. Certain types of scored cards are acceptable for reading with the stubs removed. The scores may be on either edge of the card, however, it is recommended that the score not be used on the leading edge, unless specifically required, since the score does not always tear evenly and causes the card reader to reject the card. The OM-2, M-2A, M-3, M-4, M-5, and OM-3 scores are acceptable. The B 124 and the B 122 Card Readers are interchangeable; and a maximum of two card readers may be used with any B 200 Series System, except when a Sorter-Reader is used as an input unit. When this is the case, only one card reader can be used.

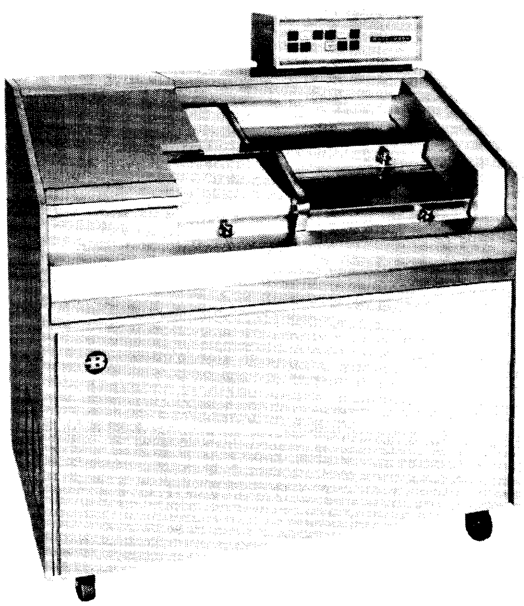


Figure 2-20. B 124 Card Reader

Functional Characteristics

2-45. A single one-column reading station reads the cards, column-by-column, with column 1 being read first. The tabulating card code is translated into six-bit binary coded decimal and transferred to the input buffer of the associated central processor. A demand-type card picking mechanism picks the cards from the card hopper; and if an initial pick fails, a second pick is automatically attempted. Formatting of data is not done by the card reader. However, the unit provides 80 timing signals, one for each column position, regardless of card length and unpunched or missing columns are filled in as blanks.

2-46. The card hopper has a capacity of 2400 cards and can be loaded by the operator while the unit is operating. The operator does not have to hold the cards already in the hopper in position when loading additional cards. Cards are conveyed from the hopper to the card stacker by means of a card transport mechanism. Failure to feed a card will cause a missing card condition and the card reader will be placed in a "Not-Ready" state. A card jam will not cause mechanical damage, but the unit will stop operating when two cards are jammed. The cards are then stacked into the card stacker in the same sequence and manner in which they were fed. The stacker will hold a maximum of 2400 cards. Cards may be removed from the stacker during operation without holding the remaining cards in position.

NOTE

Whenever a B 122 and a B 124 Card Reader are used in a single system, place the B 124 on input buffer No. 1 and the B 122 on input buffer No. 2. This permits either card reader to be turned off while the other card reader is operating. When two B 124 Card Readers are connected and only one is required, use the B 124 connected to input buffer No. 1, thus allowing the other B 124 to be turned off. Otherwise turn both B 124 Card Readers on, thus permitting correct operation when either B 124 is in use.

2-47. As an optional feature, a B 125 Postal Money Order modification may be made on the B 124 Card Reader when requested at time of purchase. The B 125 allows the reading of postal money orders which consists of 51-column punch cards, punched with round holes, that occupy the space of two standard size rectangular holes. Also, a 40-Column Read switch may be added to the B 124 Card Reader. This 40-column read switch, allows the card reader to read the first 40-columns of a punched card only, and will ignore the last 40-columns of information punched on the card.

B 124 Card Reader Control Panel

2-48. The B 124 Card Reader contains a control panel (figure 2-21) for communication with the central processor and to indicate error conditions. The function of each switch and indicator on the control panel is provided in table 2-5.

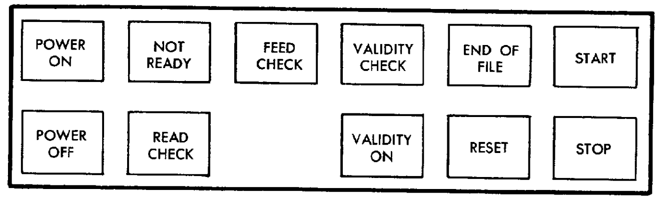


Figure 2-21. B 124 Card Reader Control Panel

TABLE 2-5

B 124 Card Reader Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This is a combination switch-indicator that applies power to the card reader and lights when pressed.
NOT READY	This indicator lights when any one of the following conditions exists: card jam, stacker full, card line mechanism not locked, empty hopper, STOP switch pressed, read error, or VALIDITY CHECK indicator lit. The condition causing the NOT READY indicator to light must be corrected before processing can be resumed.
FEED CHECK	This indicator will light as a result of a card jam or a failure to feed or stack a card properly.
VALIDITY CHECK	This indicator lights when an invalid character is read by the card reader and the system will halt on the next Card Read instruction. The VALIDITY CHECK indicator and its associated circuitry are only operative when the VALIDITY ON switch-indicator is lit.
END OF FILE	When the last card is read from the hopper, the program will halt upon encountering the next Card Read instruction. By pressing this switch and then START, the program will branch to the end-of-file routine specified by the BBB address of the Card Read instruction that caused the program to halt. This indicator lights when the switch is pressed.
START	This switch serves two purposes. First, it is used to condition the card reader (turn the NOT READY indicator off) for feeding cards under program control of the central processor. Second, it is used to restart the card reader after an empty hopper has been reloaded.

TABLE 2-5 (cont)

B 124 Card Reader Control Panel
Switches and Indicators

SWITCH/INDICATOR	FUNCTION
STOP	This switch is used to stop the card reader from feeding cards. When the switch is pressed, the program halts upon encountering the next Card Read instruction.
RESET	This switch clears all error indicators on the card reader. However, the NOT READY indicator is not turned off by pressing this switch.
VALIDITY ON	This switch-indicator provides the means of performing a validity check by the card reader. Validity checking is performed when the switch is pressed and the indicator lights. Validity checking is disabled when the switch is pressed and the indicator goes out.
READ CHECK	This indicator lights when the read check circuitry detects an operational failure. The card reader is placed in a "Not-Ready" state and the system will halt upon encountering the next Card Read instruction.
POWER OFF	This switch removes power from the unit.

B 303 CARD PUNCH

2-49. The B 303 Card Punch (figure 2-22) feeds, punches, checks, and stacks 80-column cards in both standard and post card thickness at the maximum rate of 100 cards per minute. The cards may be cut on any of four corners and may also be scribed for ease of folding or tearing. However, certain types of scribed cards may generate error signals if used with the PUNCH CHECK ON switch (table 2-6). A plugboard is not required in the B 303 Card Punch since all formatting is under control of the program. The B 303 operation is completely buffered, thus allowing internal processing between card punch cycles. After the buffer is filled, a card is punched. The difference in time is necessitated by the clutching mechanism. When punching is intermittent, it is delayed until the clutch is properly positioned.

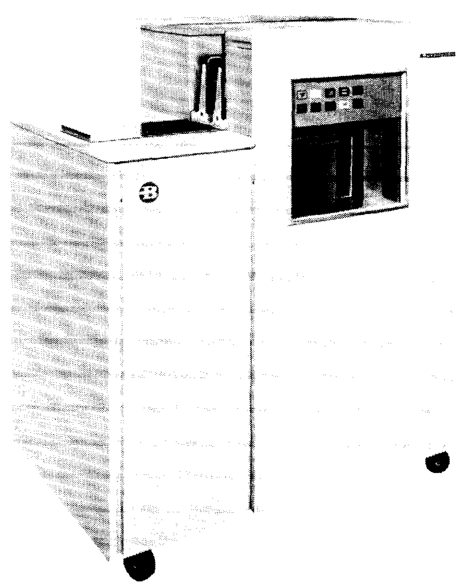


Figure 2-22. B 303 Card Punch

B 303 Functional Characteristics

2-50. Cards that are to be punched are placed in the hopper face down, 12-edge first. Card stock thickness must be consistent during any one run and can be loaded into the hopper while the unit is operating without disturbing the cards that are already loaded in the hopper. Entry of cards into the feed rollers is accomplished by feed knives which select cards sequentially when activated by a feed signal. Cards are under positive control of pairs of feed rolls during their travel from hopper to stacker (figure 2-23).

2-51. The punch unit in the B 303 is capable of punching up to 80 columns simultaneously in any one row of a standard card without overloading. Up to 60 columns can be punched in post card stock cards. Card jams will not cause any damage to the punch mechanism.

2-52. The stacker holds 800 cards and can be unloaded while the unit is punching. The B 303 is capable of idling with cards in the feed mechanism. Card movement is controlled by central processor signals. Card registration is not adversely affected.

B 303 Card Punch Control Panel

2-53. The B 303 Card Punch control panel (figure 2-24) contains switches and indicators for operation of the unit and indication of error conditions. The function of each of these elements is provided in table 2-6.

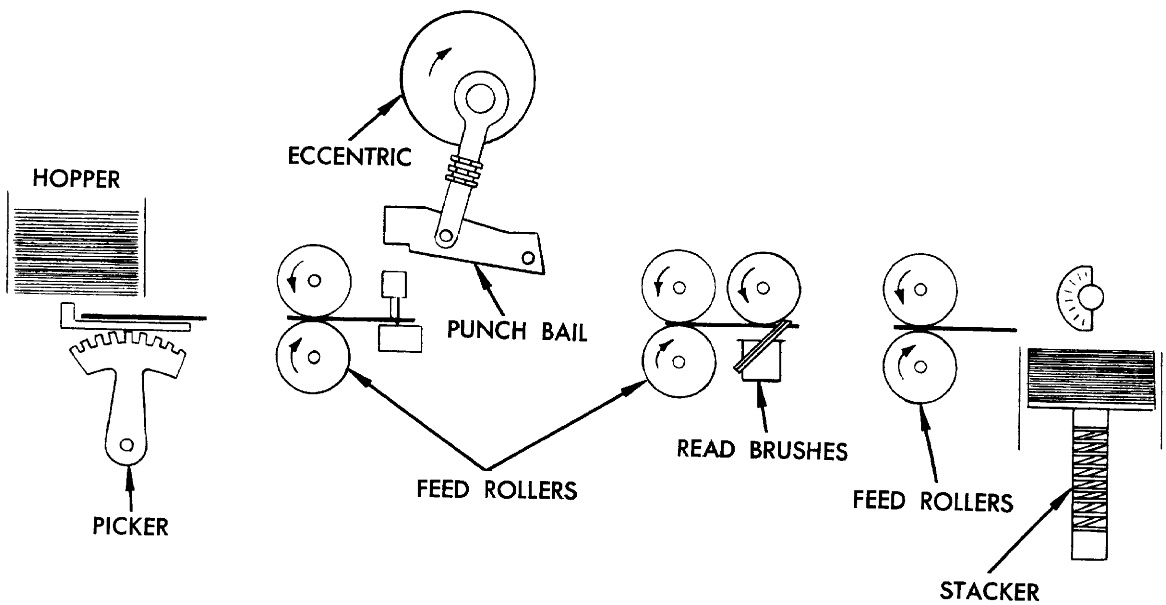


Figure 2-23. B 303 Card Punch Feed Mechanism

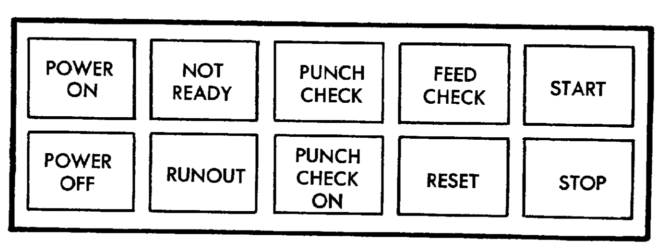


Figure 2-24. B 303 Card Punch Control Panel

TABLE 2-6

B 303 Card Punch Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This is a combination switch-indicator that applies power to the unit when pressed. The indicator lights when power is on.
NOT READY	This indicator will light when any one of the following conditions exists: STOP switch pressed, empty hopper, improperly registered card, punch die not in place, card line mechanism not locked, stacker full, chip box not in place, and punching error. The condition causing the "Not-Ready" state must be corrected and the start switch depressed, before operation can be resumed.
PUNCH CHECK	This indicator will light if fewer than 80 data bits are received for each row or if more or fewer than 12 row cycles are counted (punch station check). It will also light if the number of punched holes does not agree with the number of bits in the original data received from the central processor (post-punch read station check).
FEED CHECK	This indicator will light when either a failure to feed or a jammed condition exists.
START	Pressing this switch causes one card to move from the hopper to the ready station, provided that all "Not-Ready" conditions listed above have been corrected. When pressed, the switch sends a signal to the central processor. Pressing the switch does not clear PUNCH CHECK or FEED CHECK conditions.
STOP	Pressing this switch will stop card feeding, light the NOT READY indicator, and sets the unit to a "Not-Ready" state. When the switch is pressed, cards that are in motion will be processed completely through the duration of the cycle.
RESET	Pressing this switch clears the FEED CHECK and PUNCH CHECK conditions.
PUNCH CHECK ON	This is a switch indicator that selects between full punch checking and partial punch checking. The switch includes a mechanical toggle which reverses its choice each time it is pressed. When the switch is pressed and the indicator lights, a check is made of both punch station error conditions and post-punch read station error conditions. When the indicator is not lit, a check is only made on punch station error conditions. This feature allows the use of pre-punched and certain pre-scribed cards.
RUNOUT	As long as this switch is pressed, cards will pass through the unit without being punched. The switch is only effective when the unit is in a "Not-Ready" state. Error conditions, if any, are not cleared.
POWER OFF	Pressing this switch removes power from the unit.

B 304 CARD PUNCH

2-54. The B 304 Card Punch (figure 2-25) serves as a high-speed output device for B 200 Series Systems. It has a maximum card punching capacity of 300 cards per minute. The format of the output cards is under program control; therefore, no plugboard is used.

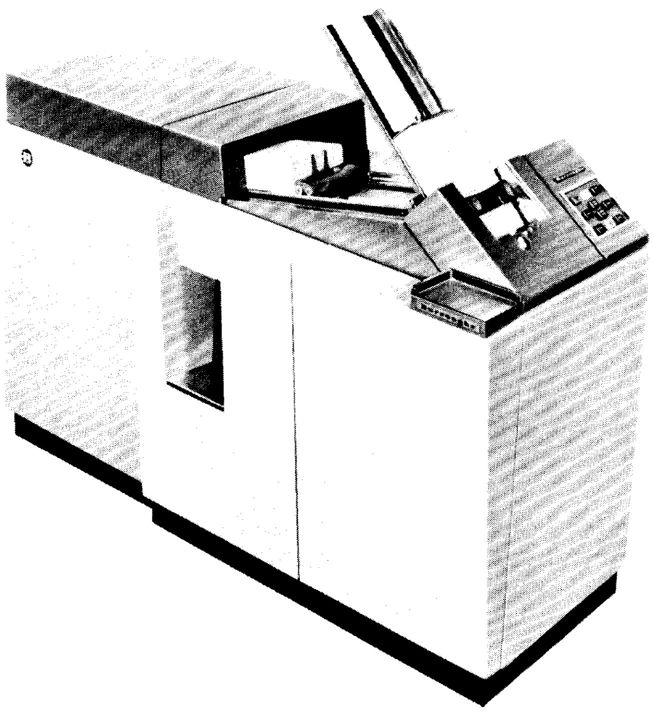


Figure 2-25. B 304 Card Punch

2-55. An 80-character output buffer in the central processor allows internal processing time between card punch and cycles. After the buffer is filled, a card is punched. Cards can be held at the punch station for as much as 5 minutes while awaiting a punch command without any damage to the card. After 5 minutes, the card is released to the error stacker. The next punch cycle will then require 400 ms. to complete. Cards can be held in the punch station for as long as 8 hours, with the unit turned off, without any apparent damage to the card.

2-56. Cards can be cut on any of four corners, or scribed for ease of tearing or folding. Certain types of scribing may generate error signals if used with the PUNCH CHECK ON switch (table 2-7). Cards of varying thicknesses *CANNOT* be used during any one run.

B 304 Functional Characteristics

2-57. The B 304 card hopper holds approximately 500 eighty-column of either standard or post card thickness cards which are placed in the hopper face down, 12 edge first (figure 2-26). A removable ramp can be placed on the hopper to increase its capacity by an additional 3000 cards. The ramp automatically feeds cards into the hopper as they are required. As cards are fed from the ramp into the hopper, they are automatically "joggled." Cards can be loaded into the ramp while the unit is operating without holding the previous cards in position. When there are no cards in the ramp or if the ramp is not used, a follow block is required for proper feeding from the hopper.

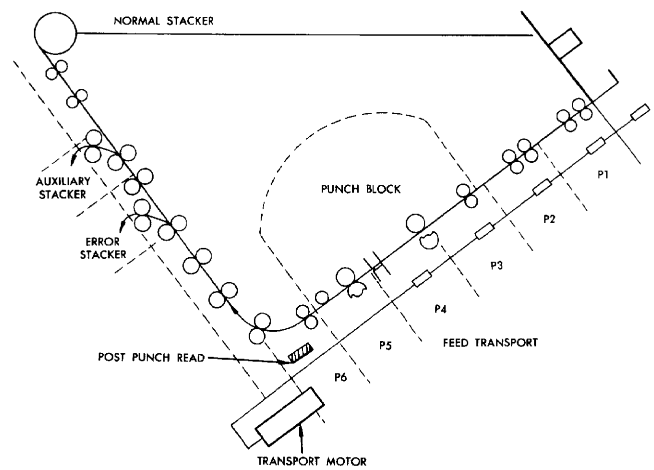


Figure 2-26. B 304 Card Punch Feed Mechanism

2-58. Cards are punched by a single row of 80 punch dies. A punch station holds the card until it is punched. The same or random alphanumeric characters can be punched in all 80 columns of every card. Punching of all 960 holes in several successive cards due to punch or system malfunction does not result in equipment damage. Cards are not visibly deformed as a result of processing within the punch. A post-punch read station is used for punch checking. The reading is done by a row of 80 brushes.

2-59. The B 304 includes three card stackers; primary, error, and auxiliary. The primary stacker is a ramp-type with a follow block that keeps the cards stacked neatly. Cards can be unloaded from the primary stacker while punching takes place. A full stacker will cause a "Not-Ready" condition. Error cards, ejected cards, and runout cards are stacked in the error stacker. A full stacker causes a "Not-Ready" condition. The capacity of this stacker is 750 cards.

2-60. The operator can manually switch from the primary stacker to the auxiliary stacker by means of a switch. The switch is not located on the control panel but it is accessible to the operator. A full stacker causes a "Not-Ready" condition. The capacity of this stacker is 850 cards.

B 304 Card Punch Control Panel

2-61. The B 304 Card Punch control panel (figure 2-27) is located to the right of the card hopper and contains the switches and indicators for operation of the unit and for error indication. The function of these elements is contained in table 2-7.

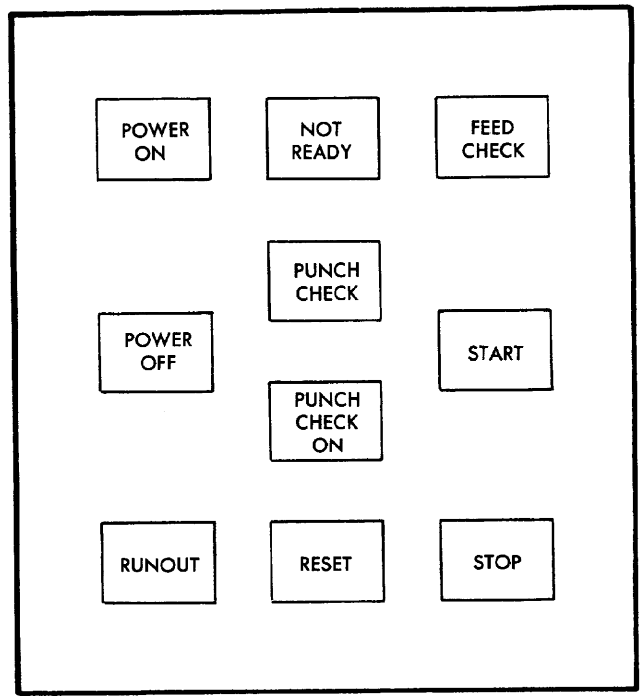


Figure 2-27. B 304 Card Punch Control Panel

TABLE 2-7

B 304 Card Punch Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This is a switch-indicator that applies power to the unit and lights when pressed.
NOT READY	This indicator lights when one of the following conditions exist: no card at the punch station; feed check condition; card transport mechanism open; punch die not in place; covers not in place; punch error; and primary, auxiliary, or error stacker full. The error conditions must be cleared before processing can begin.
FEED CHECK	This indicator lights when there is no card present at the punch station because of either a failure to feed or a card jam (except when automatically ejected because of delayed punching).
PUNCH CHECK	This indicator will light if fewer than 80 bits of data are received for each row, or if more or less than 12 row cycles are counted (punch station check). It will also light if the number of punched holes does not agree with the number of bits in the original data received from the central processor (post-punch read station check).
POWER OFF	This switch removes power from the unit.

TABLE 2-7 (cont)

B 304 Card Punch Control Panel
Switches and Indicators

SWITCH/INDICATOR	FUNCTION
START	This switch conditions the machine to accept start feed signals and causes cards to enter and follow the transport system to the proper card positions. It also sends a continue signal to the central processor only if the central processor is in a PCH command. The switch does not reset FEED CHECK or PUNCH CHECK error conditions.
PUNCH CHECK ON	This is a switch-indicator that selects between full punch checking and partial punch checking. The switch includes a mechanical toggle that reverses its choice each time it is pressed. When the switch is pressed and the indicator lights, a check is made of both punch station error conditions and post-punch read station error conditions. When the indicator is not lit, a check is only made on punch station error conditions. This feature allows the use of pre-punched and certain pre-scribed cards.
RUNOUT	This switch causes cards in the feed line to pass through the machine without being punched. No additional cards are fed from the hopper. The switch is only effective when the unit is in the "Not-Ready" state. Runout cards are directed to the error stacker. Error conditions, if any, are not reset.
RESET	This switch clears the FEED CHECK and PUNCH CHECK error conditions.
STOP	This switch causes the punch operation to stop after completing the punching of the card in the dies and then places the unit in the "Not-Ready" state.

B 141 PAPER TAPE READER

2-62. The B 141 Paper Tape Reader (figure 2-28) is capable of reading punched paper tape at speeds of 1000 characters per second. If metalized Mylar or fanfold tape is to be read, the maximum rate is 500 characters per second. The B 141 can accommodate 5, 6, 7, or 8 channel tape, as selected by the operator. Optional code translation facilities are available if required. Tape guides provide positive detent action to handle $^{11}/_{16}$, $^{7}/_{8}$, and 1-inch tape interchangeably. Beginning and end-of-tape are via adhesive opaque strips on the tape being read. Tape reels can be either 5.5 or 7 inches in diameter.

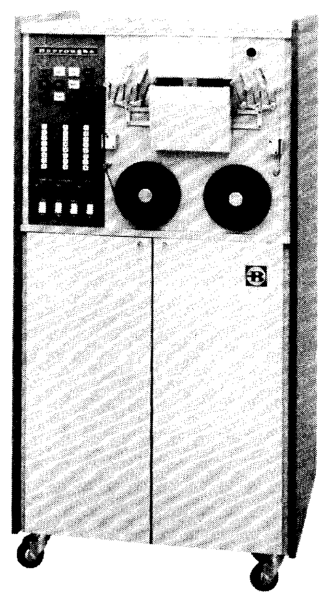


Figure 2-28. B 141 Paper Tape Reader

2-63. The paper tape reader can be used with Improved Model 0 and B 262/273/283 systems and two paper tape readers may be used in one system (figure 2-29). The unit makes use of the same input buffers as the card readers. Optional switches located on the paper tape readers can be used to change from punched card operation to paper tape operation (figure 2-30). If a Paper Tape instruction is encountered when the switch is in the card reader position, the central processor will halt.

SWITCH	INSTRUCTION	RESULT
P.T.	P.T.	RUN
P.T.	CARD	HALT
CARD	P.T.	HALT
CARD	CARD	RUN

The B 141 is also capable of checking a tape for parity errors as an on-line or off-line operation. In the off-line mode, the B 141 will stop upon detection of a parity error.

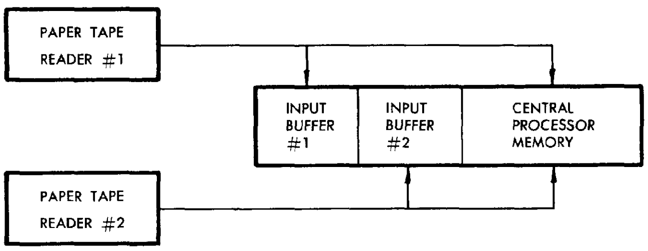


Figure 2-29. B 141 Paper Tape Reader Input

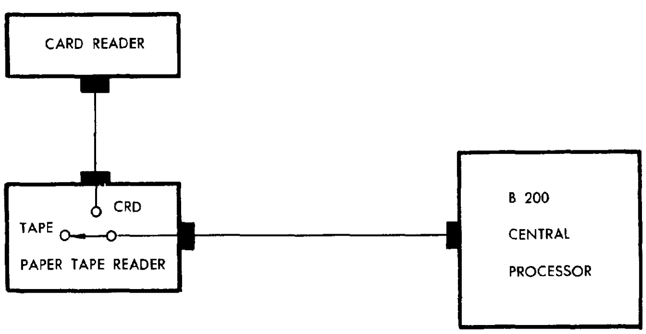


Figure 2-30. Optional Card Reader/Paper Tape Interchangeability Switch

B 141 Functional Characteristics

2-64. Start time for the paper tape reader is 5 ms. or less. Start time (when using 10 characters per inch tape) is defined as the duration from the moment a start signal is received until the next character is read. The paper tape reader requires 20 ms. stop stabilization time prior to executing another instruction. When reading paper tape or Mylar tape punched 10 characters-per-inch at speeds up to 1000 characters-per-second, the B 141 will stop in position to read the next character when signaled from the central processor. A minimum of four feet of tape leader is required with reeling. For strip reading, a one-foot tape leader is required. If a broken tape condition occurs, the tape reel motors are shut off automatically. Rewind can be initiated by the central processor.

NOTE

Each B 141 is delivered with eight seven-inch reels, two five and one-half inch reels, ten five-inch wires, and ten bottle (Jack) plugs for use with the Channel Select Plugboard.

Channel Select Plugboard

2-65. A channel select plugboard is provided for interchanging channels to any format required. This action changes the bit configuration from paper tape to an interchanged bit configuration in memory.

(All codes other than BCL wil be converted to internal code as though it were BCL code. A direct image is not placed in memory). Paper tape with even parity can be accommodated by inverting one channel. All unused channels must be connected to the corresponding C channel. Figure 2-31 illustrates the channel select plugboard BCL teletype wiring configuration. The Output read head hub is wired to the Inverter "In" hub and the Inverter "Out" hub is wired to the Input Reader Logic.

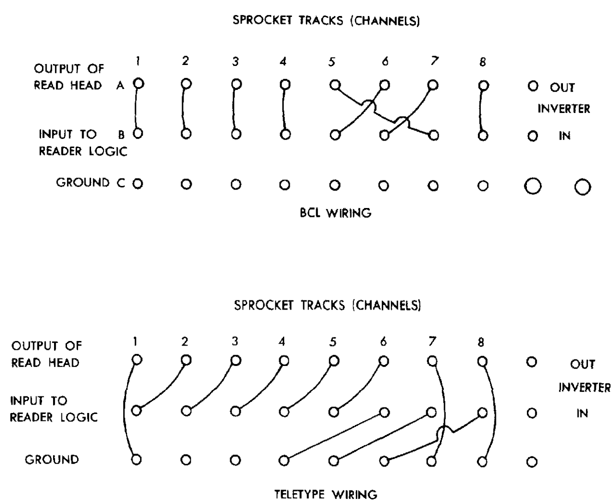


Figure 2-31. Channel Selector Plugboard

CODE TRANSLATOR

2-66. The code translator, which is an optional feature, permits translation of 5, 6, 7, or 8-level codes to BCL. Any one of 256 possible paper tape codes can be translated to any one of the 64 BCL characters. The code translator is located in the paper tape reader cabinet. The following describes the plugboard layout (figure 2-32):

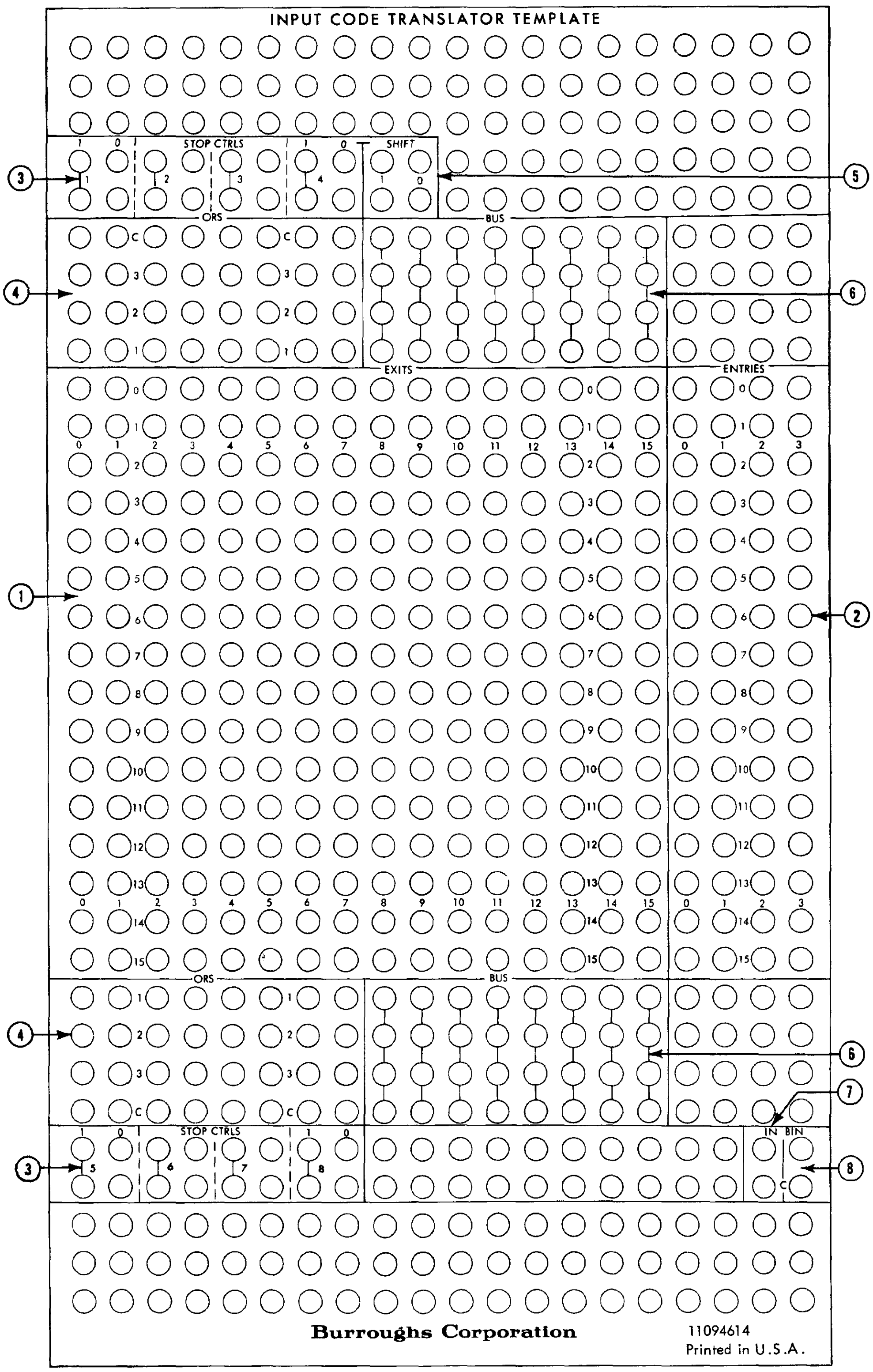


Figure 2-32. Plugboard Layout

a. Exits ① . The exit hubs represent data as received from the paper tape channel select plugboard and consists of 256 possible configurations. Column numbers are the decimal equivalent of the binary numbers represented by the input-to-reader logic hubs (B) 1 to 4 of the channel select plugboard. An example of this would be:

Channel	1	2	3	4
Binary Equivalent	(1)	(2)	(4)	(8)
Input-to-Reader Logic (B)	0	1	0	1 = column 10

Row numbers are the decimal equivalent of the binary numbers represented by the input-to-reader logic hubs (B) 5 to 8 of the channel select plugboard. An example of this would be:

Channel	5	6	7	8
Binary Equivalent	(1)	(2)	(4)	(8)
Input-to Reader Logic (B)	0	1	1	1 = row 14

b. Entries ② . The entry hubs represent data sent to the central processor consisting of the possible 64 BCL combinations. Column numbers are the decimal equivalents of the binary numbers represented by the A and B bits of the BCL code (AB = 0, 1, 2, and 3). An A and B bit would represent column 3. To illustrate:

1	2	4	8	A	B
0	0	0	0	1	1 = column 3

Row numbers are the decimal equivalents of the binary numbers represented by the 1, 2, 4, and 8 bits of the BCL code. If row 7 is connected, the bit configuration is represented as:

1	2	4	8	A	B
1	1	1	0	0	0 = row 7

If row 7 of column 3 is connected, the bit configuration is represented as:

1	2	4	8	A	B
1	1	1	0	1	1 = BCL character G

c. Stop Controls ③ . There are eight sets of stop control hubs. To designate a stop code, an exit hub is wired to the input of a stop control. Only one exit can be wired to an entry hub. Any exit code not wired is deleted and is not transferred to the central processor.

d. Shift Codes ⑤ . The shift code is designated by wiring an exit to the upper shift code input. An unshift code is designated by wiring an exit hub to the lower shift code input. The shift code is made functional by connecting two shift output hubs together. When in the shift case, channel 8 (channel select plugboard) is set to one. When in the unshift case, channel 8 is set to zero.

NOTE

Teletype code can be converted to a single case code via the teletype switch (no translation).

e. BCL/Binary Input ⑦ and ⑧ . To enable the translator, the two enable hubs must be connected together. If they are not connected, the translator is bypassed and normal BCL paper tape code to BCL code conversion takes place. When the binary hubs are connected together, the central processor will perform a BCL to internal code translation from the image sent from the channel select plugboard.

f. OR Hubs ④ . The OR hubs permit up to three different codes, designated by the exit hubs, to initiate one common code or action. The following combinations of OR hubs and BUS hubs are permitted:

1) Up to nine exits can be connected to a single entry by using three OR elements and one BUS element.
2) Up to nine exits can be connected to a single stop control by using three OR elements and one BUS element.
3) Up to six exits can be connected to a single stop control by using two OR elements (no BUS required).

g. BUS Hubs ⑥ . There are eight sets of BUS hubs. Each set permits multiple connections to a single hub. The permissible combinations of BUS hubs and OR hubs are the same as those outlined in step f above.

NOTE

The following supplies are included with each optional Code Translator:

1 — Plugboard
100 — Six inch wires
25 — Nine inch wires
25 — Twelve inch wires
25 — Templates

B 141 Paper Tape Reader Control Panel

2-67. The B 141 Paper Tape Reader control panel (figure 2-33) contains switches and indicators for operation of the unit and for the detection of errors. The function of each of these elements is contained in table 2-8.

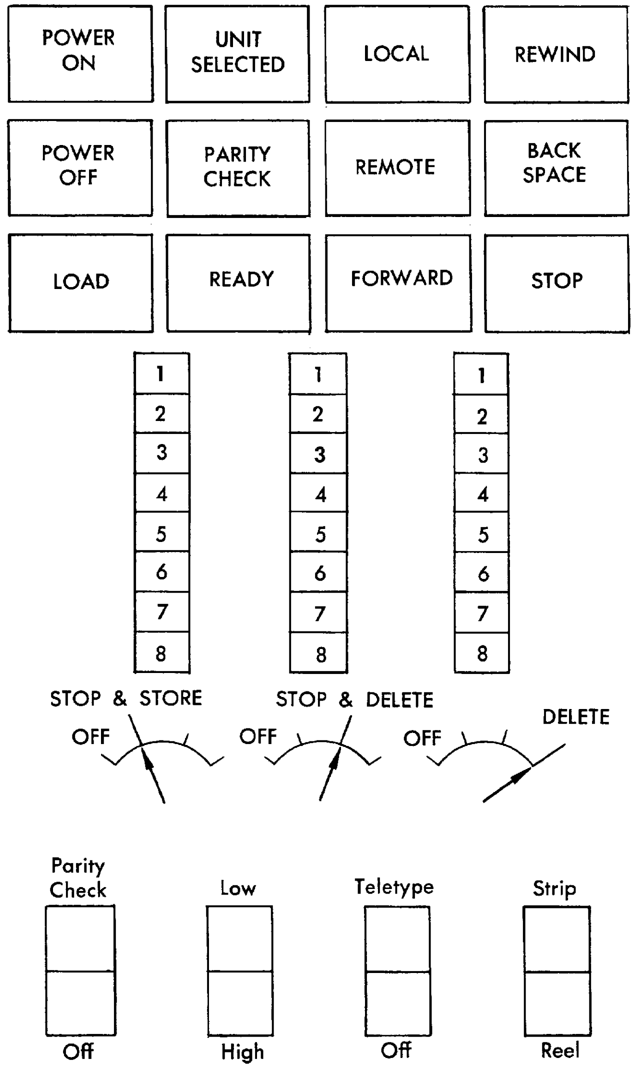


Figure 2-33. B 141 Paper Tape Reader Control Panel

TABLE 2-8

B 141 Paper Tape Reader Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This switch/indicator lights when pressed, indicating that power is applied to the unit.
UNIT SELECTED	This indicator lights when the B 141 is selected by the operator.
LOCAL	This switch places the B 141 in a local condition and is not available to the associated central processor. The LOCAL indicator will also light.
REWIND	When pressed, the paper tape moves in the reverse direction until a beginning-of-tape condition is detected. The tape will then stop. This switch is active only when the unit is in a LOCAL state and the STRIP/REEL switch is in the REEL position.
POWER OFF	When pressed, removes power from the unit.
PARITY CHECK	This indicator lights when a parity error is detected.
REMOTE	This switch/indicator lights when pressed indicating that the unit is under control of the associated central processor.
BACK SPACE	Moves the tape in a reverse direction to the next control code, or beginning-of-tape. This switch is active only when the unit is in a local condition. The switch may also be used to check parity off-line while rewinding tape.
LOAD	This switch releases the brakes, allowing loading of the paper tape. This switch is active only when the unit is in the local condition.
READY	When pressed, this switch sets the brakes and starts the capstan rollers. The servos are also activated when the STRIP/REEL is in the REEL position and the tape properly positioned.
FORWARD	This switch moves the tape forward to the next control code or to the end-of-tape.
STOP	The operation of the B 141 will stop when this switch is pressed.
CONTROL CODE	A set of three switches that provide manual selection of three different control codes. Any combination of control codes may be used concurrently. The control code characters may be stored or not stored, as selected. The button positions correspond to the B row of the channel select plugboard. A four position switch for each code set determines the action taken when the control code is detected. The Control Code switches are active in either the local or remote condition. The four positions of the switch are: OFF, STOP & STORE, STOP & DELETE, and DELETE.
PARITY ON-OFF	When in the ON position, parity checking is enabled. The parity error level is reset when in the OFF position.
HIGH-LOW	In the HIGH position, high speed operation is selected (1000 CPS); in the LOW position, low speed operation is selected (500 CPS).
TELETYPE ON-OFF	When in the ON position, a 6th level is added to the teletype code.

TABLE 2-8 (cont)

B 141 Paper Tape Reader Control Panel
Switches and Indicators

SWITCH/INDICATOR	FUNCTION
STRIP-REEL	In the STRIP position, the reel motors are deactivated and the NO TAPE switch is by-passed. In REEL position, the reel motors are activated and the NO TAPE switch is activated.
NO TAPE	This switch is activated when the STRIP REEL switch is in the REEL position and there is no tape loaded or the tape breaks. Activation of this switch deactivates the reel motors.
GUIDE SELECTION SWITCH	This switch is located to the right of the read mechanism. The switch adjusts the paper guiding to the width of the tape being used.

B 341 PAPER TAPE PUNCH

2-68. The B 341 Paper Tape Punch is basically a teletype paper tape punch which is capable of punching standard paper tape format in BCL code. The B 341 will punch 5, 6, 7, or 8-level tape at a minimum rate of 100 characters per second, ten characters per inch (figure 2-34). Standard tape widths of $^{11}\!/_{16}$, $^{7}\!/_{8}$ and 1 inch may be punched, as selected by the operator. Either oiled paper tape, dry paper tape, metalized or laminated Mylar paper tape may be used on the B 341 for punching information.

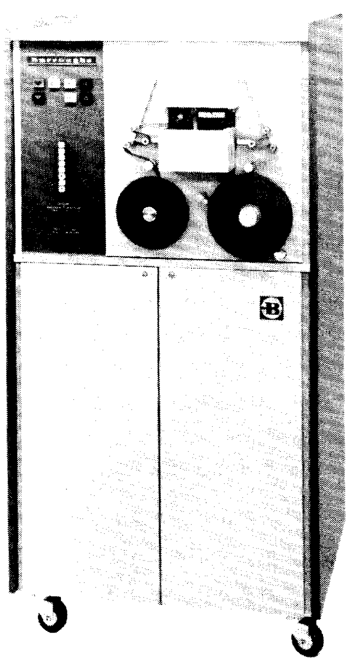


Figure 2-34. B 341 Paper Tape Punch

2-69. The maximum size supply reel that can be placed on the B 341 is eight inches in diameter. The reel hub measures two inches in diameter. The punched tape is wound onto a five and one-half or seven-inch diameter take-up reel. It is not necessary to have the take-up reel when punching tape. The end-of-tape is indicated by the LOW TAPE indicator when approximately 35 feet of tape remain on the supply reel.

2-70. The B 341 uses the same output buffer as the card punch. To allow the accommodation of both the paper tape punch and the card punch, an optional switch located on the paper tape punch is used to change from paper tape operation to card punch operation (figure 2-35). If a paper tape instruction is encountered when the switch is in the CARD position, the central processor will halt. Conversely, if a punch card instruction is encountered when the switch is in the TAPE position, the central processor will halt.

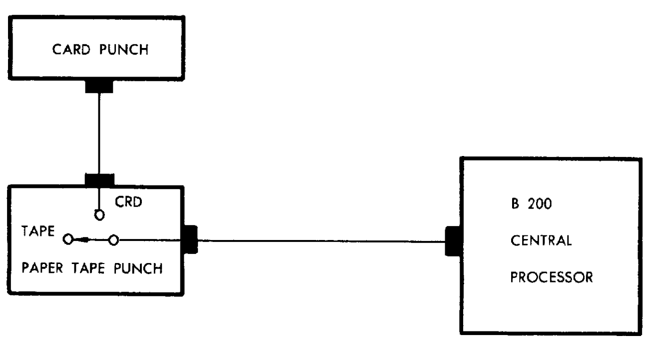


Figure 2-35. Optional Card Punch/Paper Tape Punch Interchangeability Switch

Functional Characteristics

2-71. A method is provided for the operator, through the channel select plugboard wiring, to interchange any of the 5, 6, 7, or 8 channels that might be desired. Undesignated channels in the channel select plugboard are not punched or sensed as controls for the B 341. Up to 64 different alphanumeric characters and special characters can be punched.

2-72. When the B 341 receives a paper tape write instruction from the central processor, paper tape will be punched in a forward direction. The output record length is determined by a specific control code in the data stream which is manually designated by a switch setting on the B 341 control panel or translator. The code is punched or suppressed as indicated by the control code switch or translator plugboard wiring. BCL codes are transferred from the central processor output buffer one-character-at-a-time to the paper tape punch.

2-73. The code translator permits the translation of BCL to a single frame code by means of a removable plugboard. Also, Teletype codes can be translated. Teletype is a double case code (Figures /Letters Shift) with several special requirements. To accommodate the shift used by Teletype Code, each of the allowable characters is designated as a Figures or a Letters code. Whenever a character is of a different case (figure/letter) than its predecessor, the appropriate shift code must be punched prior to the character. The two shift codes used for teletype tape can be designated by code translator plugboard wiring. The special requirements used for teletype codes are:

a. Automatic generation of codes for the Figures shift after SPACE, TAB, LINE FEED, and CARRIAGE RETURN.

b. Automatic generation of codes for the Carriage Return and Line Feed only must be generated immediately following all end-of-line codes.

2-74. CHANNEL SELECT PLUGBOARD. This plugboard is provided mainly for purposes not requiring a translator. It is possible for the operator to select any of the 6 BCL internal code levels and interchange them to any of the 8 possible paper tape channels. Paper tape with even parity can be accommodated by inverting one channel. All unused channels must be connected to the corresponding C channel. Figure 2-36 illustrates the channel select plugboard BCL and Teletype wiring configuration.

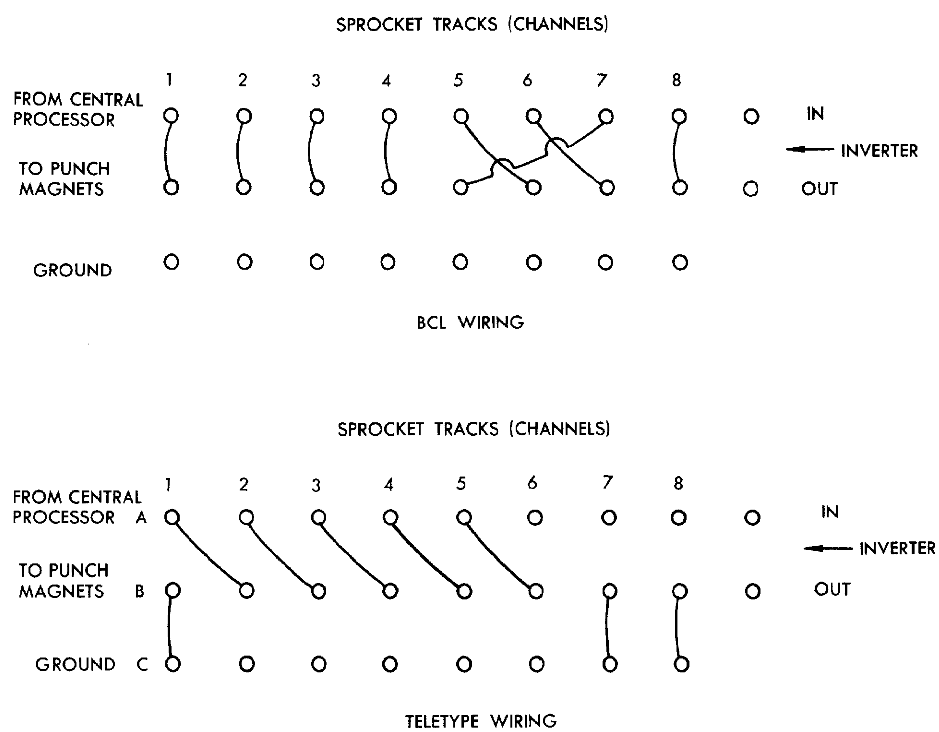


Figure 2-36. Channel Selector Plugboard

CODE TRANSLATOR

2-75. The code translator, which is an optional feature, permits translation of BCL code to any 5, 6, 7, or 8 channel code. Up to 64 codes can be translated. The code translator is located in the paper tape punch cabinet. Character (code) flow is from the processor to the translator to the channel select plugboard to the paper tape punch. The following describes the plugboard layout (figure 2-37).

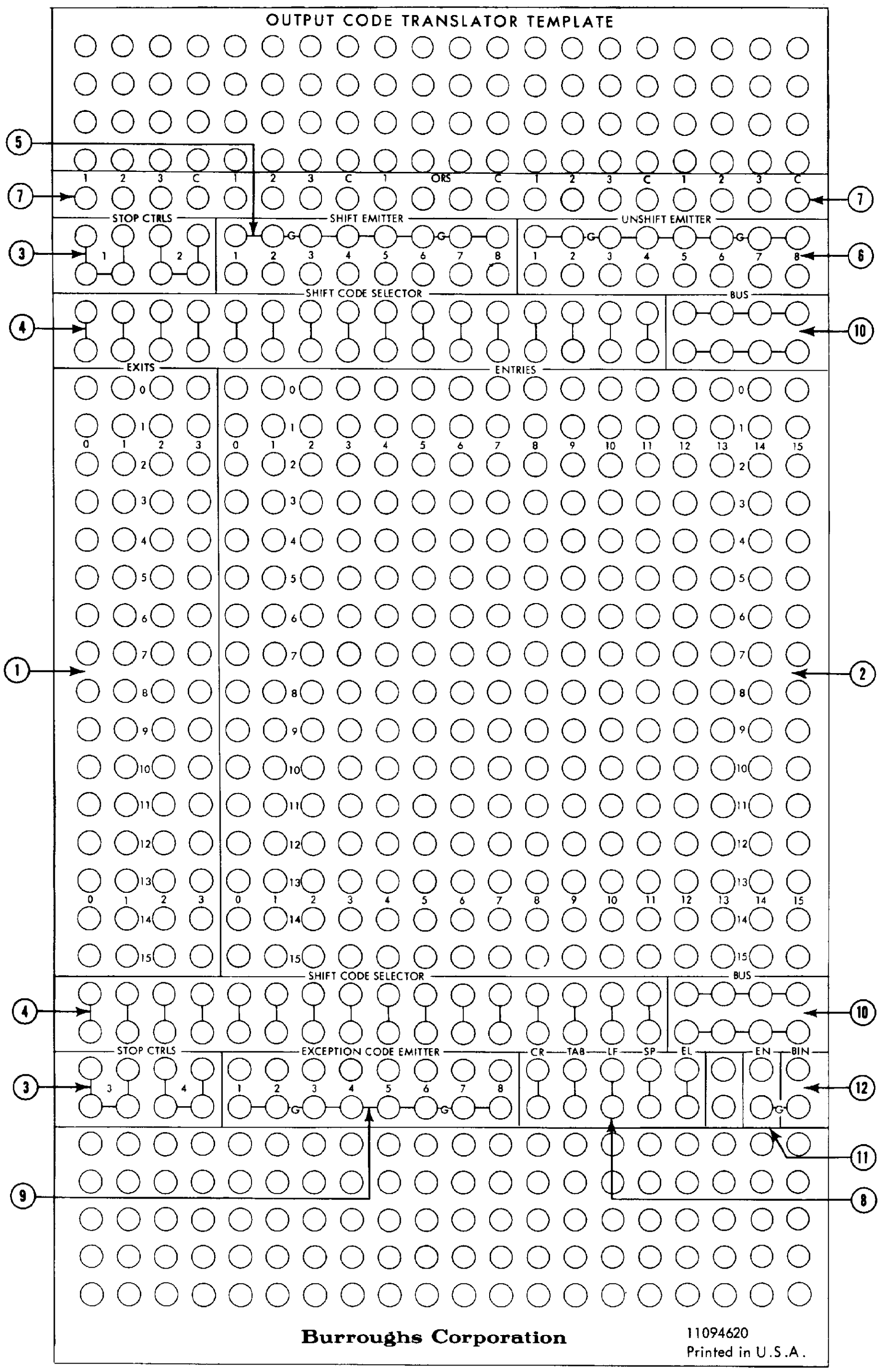


Figure 2-37. Plugboard Layout

a. Exits ①. The exit hubs represent data sent from the central processor to the translator plugboard in any of the 64 BCL characters. Assume the following bit configuration:

Binary Equivalent	1	2	4	8	A	B
Bits	0	1	1	0	1	1 = BCL character W

Bits A and B identify the exit columns 0-3. The example above shows column 3.

Bits 1, 2, 4, and 8 identify the exit rows 0-15. The example above shows row 6.

Therefore, the BCL character W would be represented by the hub located in column 3, row 6.

b. Entries ②. The entry hubs, when impulsed, generate the selected 5-, 6-, 7-, or 8-channel output character to be punched via the channel select plugboard. There are 256 possible combinations. The code that is punched is determined by column and row. The decimal value of the column and row is converted to a binary value and emitted from channel A of the channel select plugboard as follows:

1) The binary value of the column is emitted from A channels 1-4 of the channel select plugboard. For example, column 10 would punch:

Channel	1	2	3	4
Binary Equivalent	(1)	(2)	(4)	(8)
Output from Translator (A)	0	1	0	1

2) The binary value of the row is emitted from A channels 5-8 of the channel select plugboard. For example, row 7 would punch:

Channel	5	6	7	8
Binary Equivalent	(1)	(2)	(4)	(8)
Output from Translator (A)	1	1	1	0

3) Therefore, if a column 10 of row 7 was impulsed, the following code would be emitted from the A channels.

Channel	1	2	3	4	5	6	7	8
Output from Translator (A)	0	1	0	1	1	1	1	0

c. Stop Controls ③. There are four sets of stop control hubs. To designate a stop code, an exit hub is wired to a stop control hub. If the stop code is to be stored, a stop control hub, impulsed by a connected exit hub, is connected to the desired entry hub. If an entry hub is not connected to the stop control hub, the stop code will not be punched.

d. Shift Codes ④. These hubs are required when the output data requires shift and unshift codes. These hubs are connected to exit hubs to determine which codes require a shift code (maximum 32). Any codes not connected to these hubs are considered as requiring un unshift code. The associated hub is connected to an entry hub for the required code translation. Whenever a change is required from an unshift code to a shift code or visa versa, as selected on these hubs, the appropriate shift or unshift code is punched.

e. Shift Emitter ⑤ and ⑥. Any 5-, 6-, 7-, or 8-bit code can be selected as the shift code by connecting the channel requiring a bit to the hub located directly above the designated channel. All channels unconnected will be considered as a zero (no bit). This code will be punched when required, as designated by the shift code selection.

Unshift Emitter. Any 5-, 6-, 7-, or 8-bit code can be selected as the unshift code by selecting the channel requiring a bit to the hub located directly above the designated channel. All channels unconnected will be considered as a zero (no bit). This code will be punched when required, as designated by the unselected codes; that is, those not connected to the shift code selector hubs.

f. OR Hubs ⑦. The OR hubs permit up to three different codes, designated by the exit hubs, to initiate one common code or action. The following combinations of OR hubs and BUS hubs are permitted:

1) Up to nine exits can be connected to a single entry by using three OR elements and one BUS element.

2) Up to nine exits can be connected to a single stop control by using three OR elements and one BUS element.

3) Up to nine exits can be connected to a single stop control by using three OR elements (no BUS required).

g. Exception Codes ⑧ . These hubs are provided to handle special teletype code set problems. These codes are CR, TAB, LF, SP, and EL. These codes are connected from the exit hubs and to the selected entry hubs. Since these codes will not be selected as shift codes, they will be considered as unshift codes. The EL or end-of-line will initiate the punching of the exception code before the actual code is punched. The exception codes are set up in the exception code emitter.

h. Exception Code Emitter ⑨ . Any 5-, 6-, 7-, or 8-bit code can be selected as this code by connecting the channel requiring a bit to the hub located directly above the designated channel. All channels unconnected will be considered as a zero (no bit). This code will be punched when required by the designated EL code.

i. BUS Hubs ⑩ . There are two sets of BUS hubs. Each set permits connection to a single hub. The permissible combination of BUS hubs and OR hubs are the same as those outlined in step f above.

j. Enable Hubs ⑪ . These hubs must be connected to activate the translator. If not connected, the normal translation of BCL code to BCL paper tape code will take place.

k. Binary Hubs ⑫ . When these hubs are connected together, only an internal to BCL code conversion will take place. All other translation in the B 341 will be bypassed.

B 341 Paper Tape Punch Control Panel

2-76. The B 341 Paper Tape Punch control panel (figure 2-38), contains the switches and indicators for operation and error indication. The function of each element is provided in table 2-9.

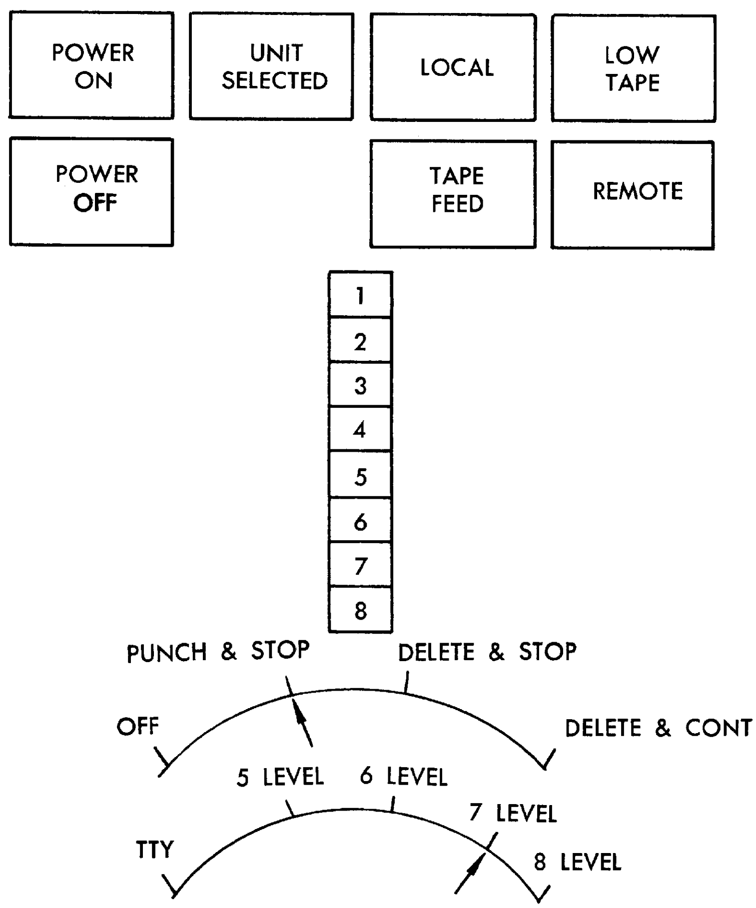


Figure 2-38. B 341 Paper Tape Punch Control Panel

TABLE 2-9

B 341 Paper Tape Punch Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This switch/indicator lights when pressed indicating that power is applied to the unit.
UNIT SELECTED	This indicator will light when the paper tape punch is on-line.
LOCAL	This switch/indicator places the B 341 in a local condition and is not available to the associated central processor.
LOW TAPE	This indicator will light when 35 feet of tape, or less, remains on the supply reel.
POWER OFF	This switch removes power from the unit.
TAPE FEED	This switch feeds tape with all holes punched. The switch is active when the LOCAL switch is activated. Tape feed rate is 100 characters-per-second.
REMOTE	This switch/indicator lights when pressed, indicating that the unit is under control of the associated central processor.
CONTROL CODE	This switch allows the operator to designate a control code. The code may or may not be punched. The switch is active in REMOTE or LOCAL and has four positions which determine the action taken when a control code is detected. The four positions of the switch are: OFF, PUNCH & STOP, DELETE & STOP, and DELETE & CONTINUE.
LEVEL DESIGNATION	This switch is used to select the number of channels and type of paper tape to be used.

NOTE

Each B 341 Paper Tape Punch is delivered with one 1000 foot roll of paper tape; eight seven-inch reels, two five and one-half inch reels, ten five-inch wires and ten bottle (Jack) plugs. Also, the following supplies are included with each optional code translator:

1 — Plugboard
100 — Six inch wires
25 — Nine inch wires
25 — Twelve inch wires
25 — Bottle (Jack) plugs
25 — Templates

B 320/B 321 LINE PRINTER

2-77. The B 320 and B 321 Line Printers provide high-quality, high-speed, alphanumeric output. The B 320 Line Printer is designed to operate at 475 lines-per-minute single spaced, and 450 lines-per-minute double spaced. While the B 321 Line Printer is designed to operate at 700 lines-per-minute single spaced, and 650 lines-per-minute double spaced. Formatting, editing, and forms skipping and spacing of both line printers are under program control. The functional characteristics of the two line printers are the same and they are physically identical in appearance. Since the two units differ only in operating speed, the B 321 Line Printer only will be described in this manual.

B 321 LINE PRINTER

2-78. The B 321 Line Printer (figure 2-39), is a drum-type printer capable of printing 700 lines per minute when single spacing or 650 lines per minute when double spacing. Formatting, editing (the insertion of commas, decimals, dollar signs, zero print control, etc.), and forms skipping and spacing are under program control.

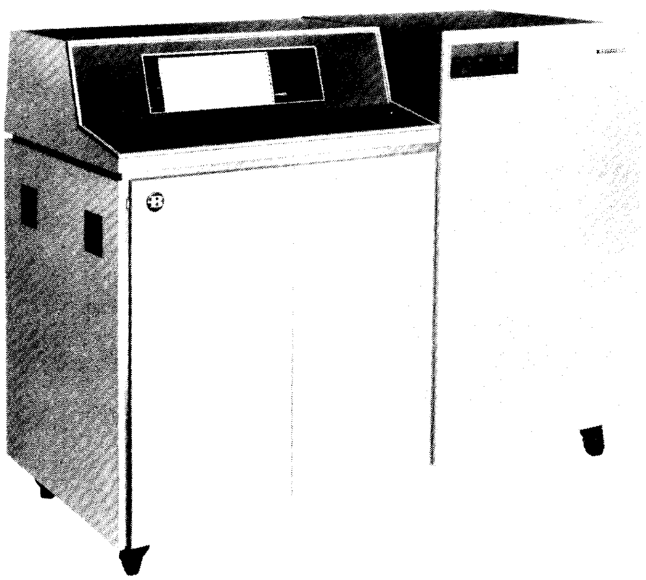


Figure 2-39. B 321 Line Printer

2-79. The B 321 accepts binary coded decimal, alphanumeric information from the associated central processor in parallel-by-bit, serial-by-character mode and stores this data in a 120-position buffer. Upon completion of buffer loading, and paper movement of the previous instruction, the format data is accepted from the central processor and the characters in the buffer are printed. The transfer of print data from core storage to the printer buffer is accomplished in 1.3 ms.

2-80. The printer drum mechanism contains 120 print positions from which any one of the 64 characters may be printed, as specified by the data in the printer buffer. Horizontal spacing is 10 characters to the inch and vertical spacing can be either six or eight lines to the inch and is under control of the operator.

B 321 Functional Characteristics

2-81. The 64 characters contained in each print position consists of 26 alphabetic, 10 numeric, and 28 special characters figure 2-40). When B 200 Series Systems are used as input/output conversion systems (satellite systems) for large-scale computers such as the B 5000, they often require the use of special characters. For this reason, the 28-special character set is provided as standard equipment. These special characters are usually used for formulating problem statements in ALGOrithmic Language (ALGOL) and in COmmon Business Oriented Language (COBOL).

Blank	—
.	/
[	,
(	%
<	=
←	]
&	"
$	#
*	@
)	:
;	>
≤	≥
≠	+
×	?

Figure 2-40. Special Character Set

2-82. Printing is done on continuous paper forms which may be from 5 to 20 inches in width including marginal punch strips. Length can be 22 inches (at 6 lines per inch) or 16½ inches (at 8 lines per inch). The forms are loaded in the cabinet below the printing mechanism. The forms are transported through the unit, by means of pinfed tractors, to the stacker. All printed forms are neatly stacked to a height of at least 7 inches without attention from the operator.

2-83. As many as five carbons plus the original may be printed. In general, the printer can process legible copy forms up to 0.02 inches in over-all thickness. The thinnest form that can be processed is 0.0025 inches. The optimum number of copies can be legibly printed by using premium paper and carbon. A clearance adjustment, required when changing from one form thickness to another, is available to the operator and can be accomplished within 30 seconds without the aid of tools.

Tape Controlled Carriage

2-84. The B 321 Line Printer does not directly control the feeding and spacing of the forms. This is performed by the tape controlled carriage of the printer in conjunction with instructions from the central processor.

Control Tape

2-85. The carriage control tape (figure 2-41) has column positions (1-12) called channels. Horizontal lines can be skipped up to 132 lines for control of a form. For ease in preparation, the tape is somewhat longer than required. Prepunched holes located in the center of the tape are used by a pin feed mechanism to move the tape past the sensing device. Movement of the carriage control tape is synchronized with the movement of the form through the carriage.

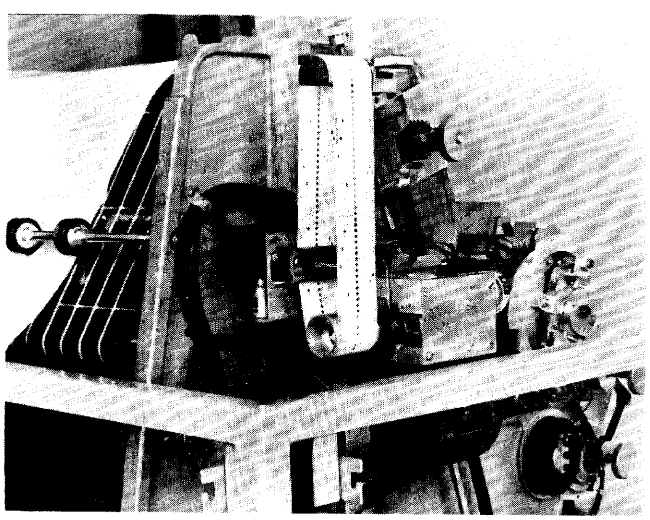


Figure 2-41. Carriage Control Tape

2-86. Skipping the form to any predetermined position is accomplished by the central processor addressing any one of 11 holes in the carriage control tape. A twelfth channel in the control tape is used to signal the last print line on the form. When a hole in this position is sensed, the printer sends a signal to the central processor which causes the print or skip instruction to take the "end-of-page" branch when programmatically desired after printing on the last line has been accomplished.

2-87. The twelve carriage control tape channels are usually punched to control the following functions:

a. Channel 1 will normally be used to identify the first print line (home station) of a form.

b. Channel 2 will usually be used to indicate the first body line of a form on which detail information appears. In an invoicing operation, where the first printing line and first body line are not one and the same, Channel 1 would be used to indicate the first printing line on the form, in this case a name and address. Channel 2 would correspond to the first printed line of detail information.

c. Channel 3-11 will normally be used to identify any one of 9 user determined print positions. These channels may be used in any desired sequence.

d. Channel 12 is reserved for punching the hole indicative of the last printing line in the body of a form. When a channel 12 punch is sensed during a spacing operation, program control will branch to an "end-of-page" routine if programmatically desired, after printing on this line has been accomplished.

Tape Punching

2-88. A commercially available tape punch is used to punch carriage control tapes. Before punching, the tape should be marked so as to conform to the various predetermined positions on the form. This can be accomplished (when lines are printed six lines per inch) by laying the tape along side the left edge of the form with the first line of the tape even with the top edge of the form. A mark is made in the desired channel, normally channel 1, on the line that corresponds to the first print line of the form. Additional marks are made in the selected channels for each of the other skip stops. If forms are to be printed eight lines per inch, this relationship will not exist. One-sixth of an inch on the tape will correspond to one-eighth of an inch on the form (i.e., $2\frac{1}{2}$ inches of form equal $3\frac{1}{3}$ inches of tape).

2-89. The marking of the tape for one form should be duplicated on the remaining usable tape as many times as possible; therefore, a tape may usually be marked to control two 11-inch forms, three 7-inch forms, or one 12-inch form.

2-90. When the tape is used to control multiple forms per revolution, its life is increased. The last step in marking a tape consists of marking the line corresponding to the bottom edge of the last form to be controlled. After punching the holes in the marked channels, the tape will be cut at this mark.

2-91. The tape is inserted in the punch by placing the line to be punched over a guide line on the base of the punch and placing the center feed holes of the tape over the pins projecting from the base. The dial is then turned until the arrow points to the number of the channel to be punched. Pressing on the top of the punch, toward the back, cuts a rectangular hole in the intersection of the vertical and horizontal line in the required channel of the tape. The tape may be punched with holes in more than one channel on the same line.

2-92. After the tape is punched, it is cut and looped into a continuous belt. The bottom line is glued to the top line, at the section marked GLUE, after the glaze has been removed with an ink eraser.

2-93. The last hole punched in the tape should not be less than four lines from the cut edge, since approximately the last half inch of the tape overlaps the GLUE section when the two ends are spliced. If it is necessary to punch a hole lower than four lines from the bottom of the form, punch the hole which may be overlapped after the tape has been glued.

B 321 Line Printer Control Panel

2-94. The B 321 Line Printer control panel (figure 2-42), contains switches and indicators for operation of the equipment and for error indications. The control panel is located at the front of the unit, to the right of the print section. The function of the switches and indicators is listed in table 2-10.

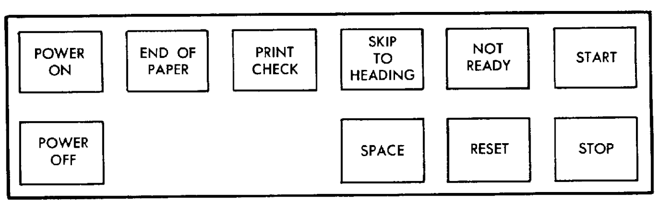


Figure 2-42. B 321 Line Printer Control Panel

TABLE 2-10

B 321 Line Printer Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This is a switch-indicator that applies power to the unit and lights when it is pressed.
END OF PAPER	This switch/indicator signals nearing an out-of-paper condition. Pressing this switch removes the end-of-paper condition and extinguishes the light. One line can then be printed; thereafter the unit returns to end-of-paper condition. Successive depressions of this switch enable printing successive lines.
PRINT CHECK	This indicator lights when a print check error has been sensed or when the print drum is not properly synchronized.
SKIP TO HEADING	Pressing this switch causes the carriage to skip to the first punch in Channel 1 of the carriage control tape.
NOT READY	This indicator lights when any one of the following conditions exist: the END OF PAPER indicator is lit, the 6/8 lines-per-inch switch is in position N, the unit "slews" paper for more than one second, or the START switch is not pressed.
START	This switch is used to signal the central processor that the printer is ready for use. It is also used to restart system operations halted by a printer "not-ready" condition.
STOP	Pressing this switch stops the printer prior to the execution of the next print instruction. The print buffer will not be loaded after the switch has been depressed, and the system will halt on the next print instruction.
RESET	Pressing this switch resets the PRINT CHECK indicator.
SPACE	Pressing this switch causes the forms to be single spaced.
POWER OFF	This switch removes power from the unit.

B 322/B 323/B 326 Multiple Tape Listers

2-95. The B 322, B 323, and B 326 Multiple Tape Listers are electromechanical, buffered drum-type printers each containing six separate print units. Output from B 200 Series Systems can be printed out on any one of these multiple tape listers. The B 326 Multiple Tape Lister is designed to operate at a printing speed of 1250 lines-per-minute, while the B 322 and B 323 Multiple Tape Listers are designed to operate at 1565 lines-per-minute. Because the B 326 Multiple Tape Lister differs only in operating speed from the B 322 Multiple Tape Lister (they physically appear and functionally operate the same), only the B 322 and B 323 Multiple Tape Listers are described in this manual.

B 322 MULTIPLE TAPE LISTER

2-96. The B 322 Multiple Tape Lister (figure 2-43) is an electromechanical, buffered drum-type printer with six separate print units. Output from B 200 Series Systems can be printed out on one or two B 322s. When two are used, they have the ability to print simultaneously on any two of 12 paper tapes at the rate of 1565 lines-per-minute per-tape.

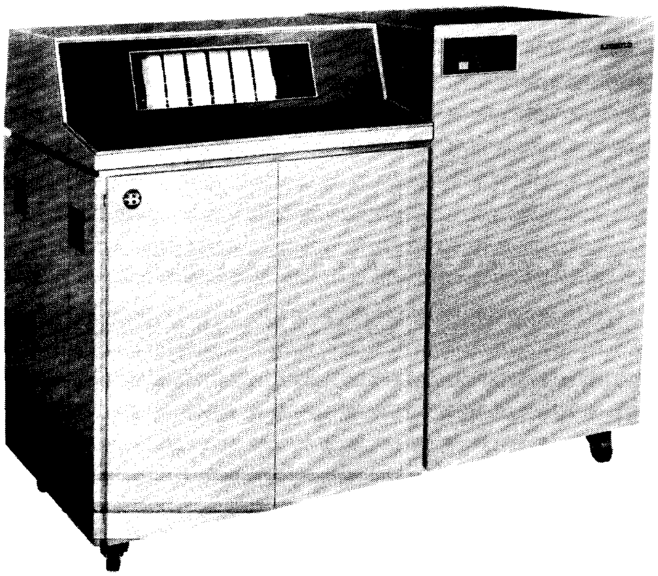


Figure 2-43. B 322 Multiple Tape Lister

2-97. As an optional feature, the B 322 can be modified to skip all tapes (6 or 12) or all tapes with the exception of the master tape. This is accomplished by the addition of the B 327 Simultaneous Skipping of Listing Tape modification, which may be field installed.

2-98. The B 322 accepts binary coded decimal, alphanumeric information from the central processor in parallel-by-bit, serial-by-character mode and stores this data in a 44-position B 322 buffer. The central processor controls the formatting of the 22 print positions in accordance with an internally stored editing instruction. The B 322 can print the following 24 characters in any print position:

0	B (Batch)
1	C (Credit)
2	D (Difference)
3	L (List)
4	M (Misc.)
5	R (Reject)
6	S (Subtotal)
7	T (Total)
8	X (Pocket X)
9	Y (Pocket Y)
	. (Decimal Point)
	, (Comma)
	— (Minus)
	* (Asterisk)

Character spacing is 10 to the inch; line spacing is 6 to the inch. All forms are adding machine type without margin-hole strips. The forms may be single-part or two-part with carbon backed or plastic-backed first sheet. If single part forms are used, the form can be exited from the machine through either the top tear strip opening, or through the rear exit opening, as required by the operator. Forms exited from the rear opening can be torn off or fan folded. Single part forms that exit from the top tear strip opening cannot be fan folded or restacked. Restacking of forms in the fanfold condition can only be accomplished with forms that are exited through the rear opening. If two-part forms are used, both can be exited from the machine as a non-decollated unit through either the top tear strip opening or through the rear exit. The carbon copy from the rear exit can be restacked in fan-folds. The stacker (figure 2-44) has a capacity of 1000 feet (min) of single-part, fan-folded forms.

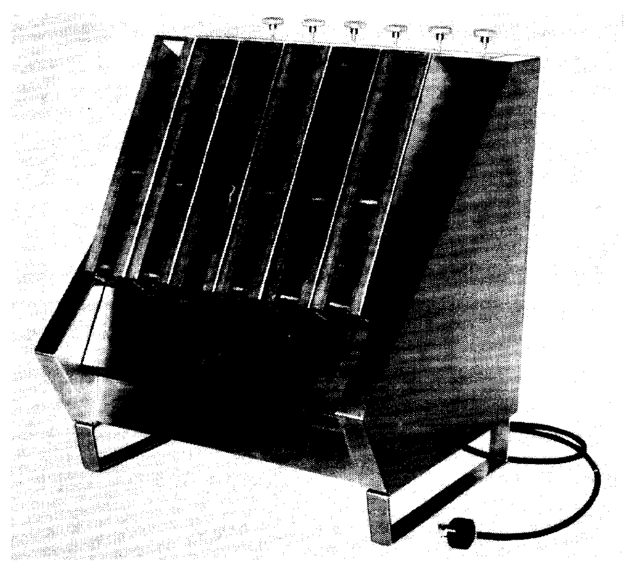


Figure 2-44. B 322 Stacker

B 323 Multiple Tape Lister

2-99. The B 323 Multiple Tape Lister is physically identical to the B 322. The internal operations and performance differs only in the following exceptions. To maintain a printing rate of 1565 lines-per-minute, only 16 characters may be used. They are:

0-9
, (Comma)
. (Decimal)

x (Pocket X)

y (Pocket Y)

R (Reject)

* (Asterisk)

2-100. To process the full alpha character set, a printing rate of 600 lines-per-minute is established. There are a total of 40 printable characters. They are:

0-9

, (Comma)

. (Decimal)

A thru Z

- (Hyphen)

* (Asterisk)

2-101. The B 327 Simultaneous Skipping of Lister Tapes is a standard feature on all B 323 Multiple Tape Listers. This allows the skipping of all tapes (6 or 12) or all tapes, except master tapes.

B 322 and B 323 Multiple Tape Lister Control Panel

2-102. The B 322 and B 323 Multiple Tape Lister control panel (figure 2-45) contains operating switches and indicators. The control panel is located on the front of the unit, to the right of the print section. In addition, several switches are provided at the rear of the unit (figure 2-46) for operator convenience. The function of the switches and indicators is provided in table 2-11.

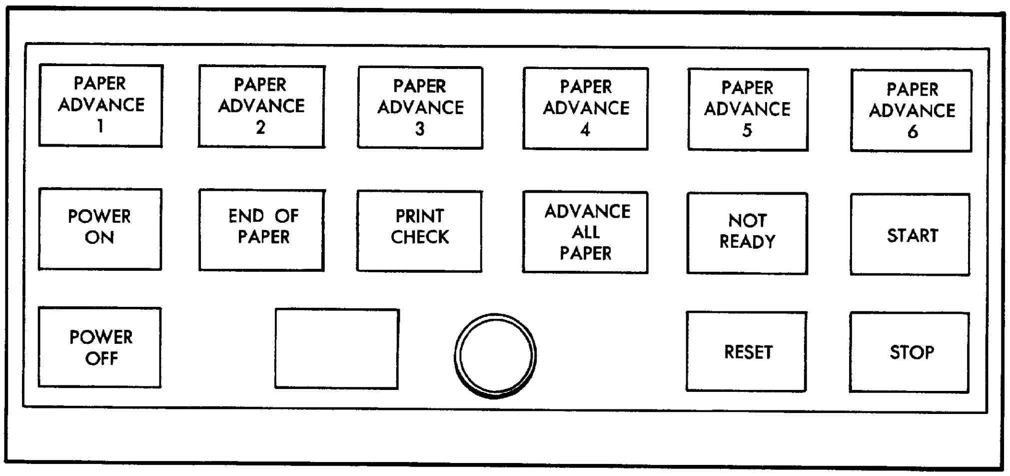


Figure 2-45. B 322 & B 323 Multiple Tape Lister Control Panel

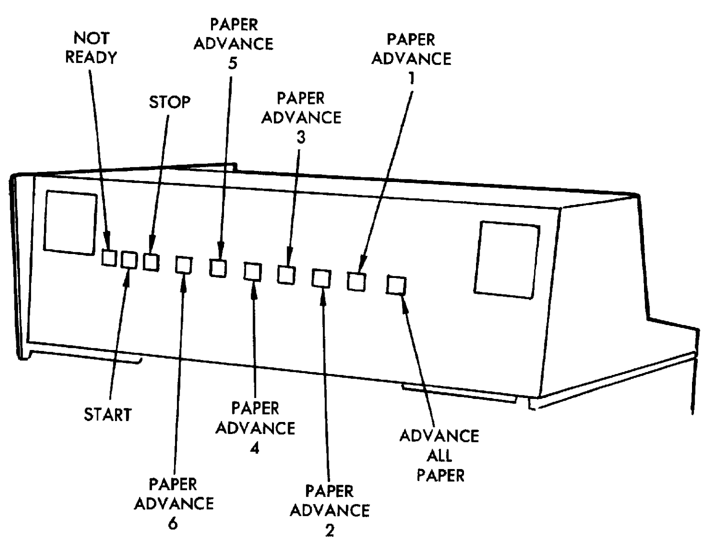


Figure 2-46. B 322 & B 323 Multiple Tape Lister Rear Control Panel

TABLE 2-11

B 322 and B 323 Multiple Tape Lister Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
PAPER ADVANCE 1 through PAPER ADVANCE 6	Pressing these switches will cause the corresponding tape to be advanced, until the switch is released when in the Not Ready condition. Duplicate switches are located at the rear of the unit.
POWER ON	Pressing this switch applies power to the unit.
END OF PAPER	This indicator will light when one of the sub-units is almost out of forms or if a feeding problem exists. If this condition is sensed during a skip or print instruction, the program will branch to the BBB address upon execution of the instruction. The condition causing the indicator to light must be corrected and the RESET and START switches pressed.
PRINT CHECK	This indicator will light when a print check error is sensed in any print position or if the drum is not synchronized with the drum position counter. A signal is sent to the central processor and the next print instruction will be inhibited, thus causing the system to halt.
ADVANCE ALL PAPER	When in Not-Ready condition, pressing this switch causes all paper to be advanced until the switch is released. A duplicate switch is located at the rear of the unit.
NOT READY	This indicator will light if one of the following conditions exist: START switch not pressed, paper slews for more than one second, end-of-paper condition exists, or tears within the unit. A duplicate indicator is located at the rear of the unit.
START	Pressing this switch conditions the B 322 or B 323 to accept instructions from the central processor. A duplicate switch is located at the rear of the unit.
STOP	Pressing this switch places the unit in the "not-ready" state. If a B 322 or B 323 instruction is being executed when the switch is pressed, the instruction will be completed before the unit halts. Upon encountering the next instruction, the central processor will stop. A duplicate switch is located at the rear of the unit.
RESET	Pressing this switch with the unit in the "ready" state resets the print check circuitry and extinguishes the PRINT CHECK indicator. With the lister in the "not-ready" state, pressing the switch clears all error circuitry except NOT READY. The START switch must be pressed to clear this indicator.
POWER OFF	Pressing this switch removes power from the unit.
MASTER CONTROL	This is a seven-position rotary switch for the selection of one of the six sub-units as the master tape. The switch positions (1 through 6 and N) are designated by use of a SPHERICULAR® tube along side of the switch. When in the N position, the switch is disabled.

®Registered Burroughs Trademark

B 421 MAGNETIC TAPE UNIT

2-103. Model 0 B 270, B 280, Improved B 270, B 280, and the B 273, B 283 Systems can utilize up to six on-line B 421 Magnetic Tape Units (figure 2-47), which are capable of reading, writing, erasing, backspacing, and rewinding magnetic tape under control of the central processor. Each tape unit is capable of reading and writing magnetic tape at the following related speeds and densities:

1. 50,000 characters per second at a density of 555.5 characters per inch (50 KC/sec.).
2. 18,000 characters per second at a density of 200.0 characters per inch (18 KC/sec.).

NOTE

Reading is done only in the forward direction.

Each tape reel can hold up to 2400 feet of magnetic tape, thereby, storing over 15,000,000 characters when using high density tape.

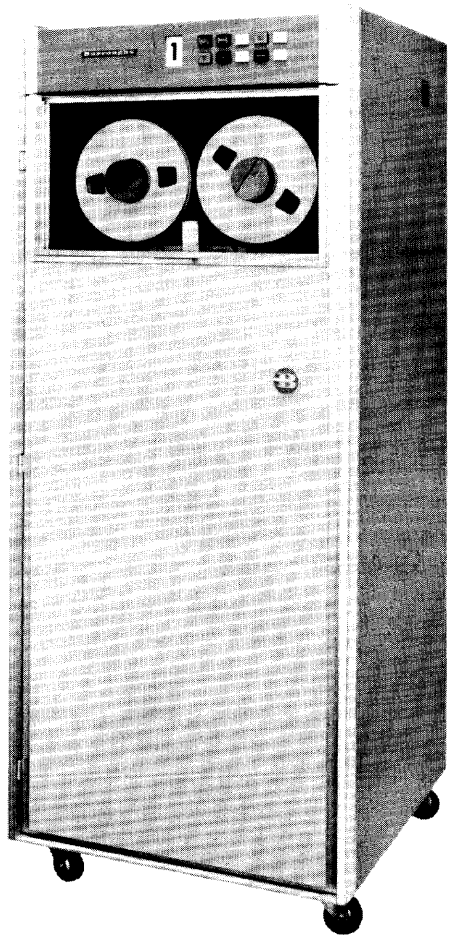


Figure 2-47. B 421 Magnetic Tape Unit

B 421 Magnetic Tape Unit Transport

2-104. Figure 2-48 illustrates the position of the tape reels in relation to the read-write head and feed rollers. When reading or writing, tape is passed from the file reel past the read-write head to the take-up reel. During rewind, the motion is reversed. To prevent tape breakage and to minimize start time, two vacuum columns are used. As the tape is drawn from one vacuum column, it is replenished from the reel above. As it is fed into the other vacuum, the associated reel takes up the slack tape. Movement of the tape past the read head is at 90 inches per second. Approximately 2400 feet of tape can be rewound in 90 seconds.

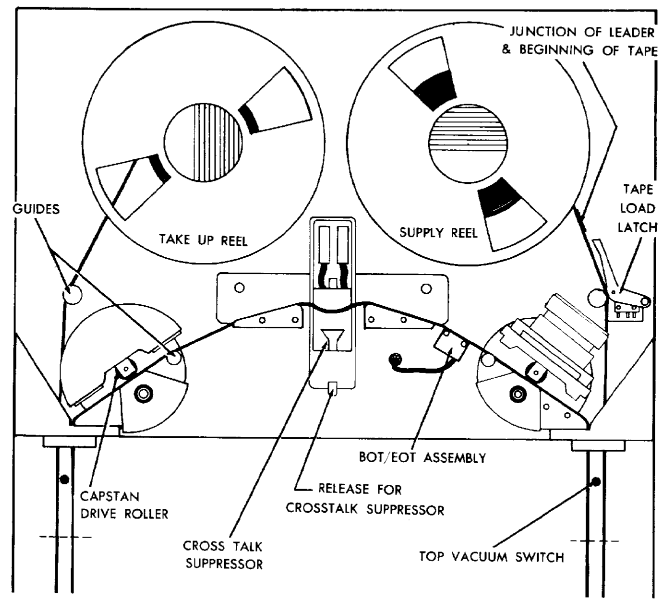


Figure 2-48. B 421 Magnetic Tape Unit Transport Mechanism

2-105. Start time is the time lapse between issuing a tape order (Read, Write, Erase, Backspace) until the first character is read, written, erased or bypassed. Start distance is not relevant.

Magnetic Tape

2-106. The magnetic tape used with the B 421 Magnetic Tape Unit is 0.5 inches wide, 2.0 mils thick and approximately 2400 (±20) feet in length. The base material of the tape is Mylar with a heavy duty binder for longer wearing characteristics. The tape units feature devices called "latch leaders" (figure 2-49). The purpose of the latch leader is to minimize tape load-unload time. The leaders are two-part: male and female. The male leader is opaque-black Mylar and is nonmagnetic. The length of this leader is approximately 6 inches from the end of the leader to the magnetic tape splice which is on the file reel. The leader is supplied on all late model Burroughs tape reels. Additional leaders can be obtained for splicing to other tapes. The female leader is opaque Mylar and is manually wound onto the take-up reel by the operator, one time only. The female leader is approximately 14 feet in length. A permanent female leader is provided with each take-up reel. Spares are also available. The tape unit contains a latching device which holds the female leader in place during loading and unloading. When the reels rewind for unloading. the transport will move the leaders back until their connection is on the file reel-side of the tape latch. Then the latch is closed to grip the female leader while the male leader is disconnected. After a new file reel has been placed in the unit and leaders connected, the tape latch is opened.

B 421 Magnetic Tape Unit Control Panel

2-107. The B 421 Magnetic Tape Unit control panel (figure 2-50) contains switches and indicators for operation of the equipment. The function of these switches and indicators is contained in table 2-12.

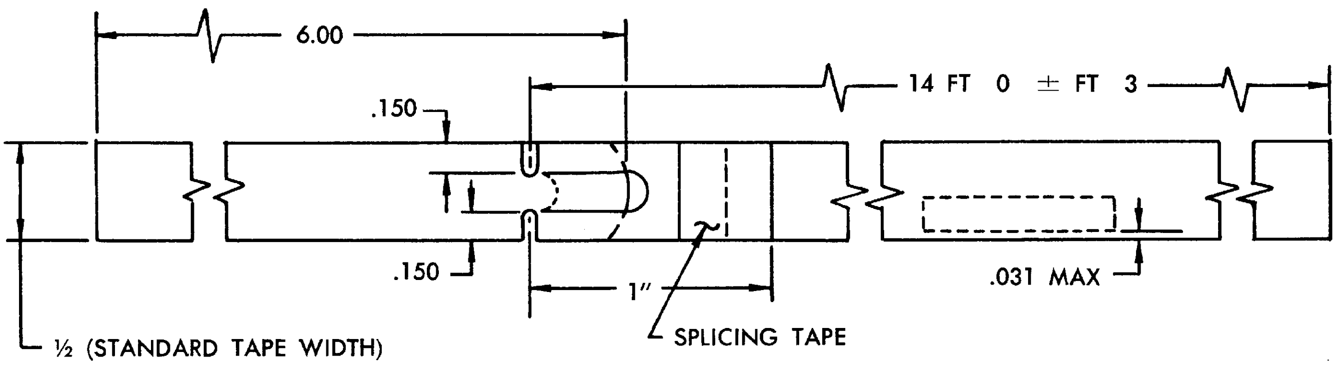


Figure 2-49. Magnetic Tape, "Latch Leaders"

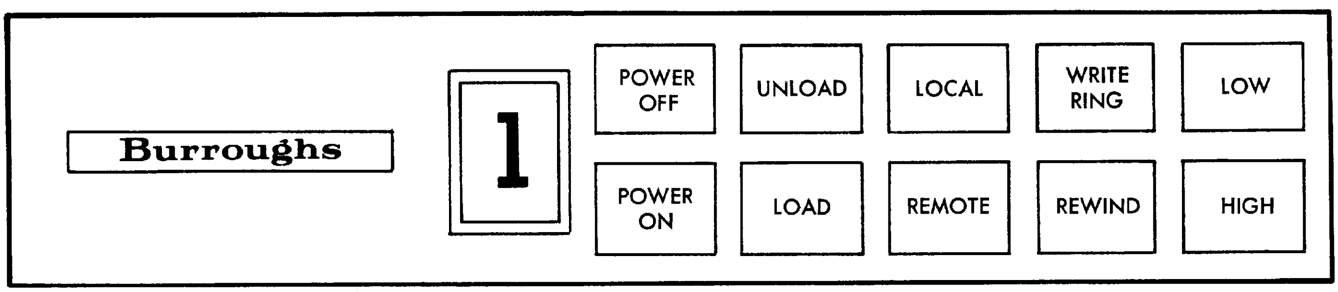


Figure 2-50. B 421 Magnetic Tape Unit Control Panel

TABLE 2-12

B 421 Magnetic Tape Unit Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER OFF	Removes power from the tape unit.
UNLOAD	Positions tape to the point where the latch leader is on the file reel-side of the tape latch, thereby permitting the operator to unload the tape.
LOCAL	Removes the tape unit from control of the central processor. The switch lights when pressed.
WRITE RING	Signals that the file reel has a write ring installed and that writing can be performed on the tape.
LOW	Selects the 18,000 character-per-second reading and writing rate (200 character/inch density). The switch lights when pressed.
HIGH	Selects the 50,000 character-per-second reading and writing rate (555.5 characters/inch density). The switch lights when pressed.
REWIND	Rewinds the tape to the beginning-of-tape mark. Rewind speed is 320 inches per second. This switch is active only when the unit is in a LOCAL condition.
REMOTE	Places the tape unit under control of the central processor. The switch lights when pressed.
LOAD	Causes tape to be drawn into the vacuum columns and moves the tape so that the beginning-of-tape is at the read-write head.
POWER ON	Applies power to the unit. The switch lights when pressed.
UNIT DESIGNATORS 1-6	Identifies a tape unit and relates it to a specific variant character in each magnetic tape command. This illuminated rotary switch should be operated only when the tape unit is in local mode. When a unit designate is at the blank (undesignated) position, it will operate as a unit designation of 6.

B 422 MAGNETIC TAPE UNIT

2-108. The B 422 Magnetic Tape Unit can be used only with the B 273 and B 283 System when a 66KC Module is installed in the B 273 and B 283 Central Processor. This magnetic tape unit has a tape speed rate of 120 inches per second with packing densities of both 200 (24KC) and 555.5 (66KC) frames per inch. The B 422 and B 421 Magnetic Tape units physically appear the same and with the exception of different tape speeds, they are functionally identical. However, they cannot be intermixed on a system.

B 423 MAGNETIC TAPE UNIT

2-109. The B 423 Magnetic Tape Unit processes 10½ inch tape reels of up to 2400 feet of ½-inch tape. The B 423 is designed to read and write on tape at a speed of 120 inches per-second, with a recording density of 200 frames-per-inch (24KC). The B 421, B 422, B 423 Magnetic Tape Units physically appear similar.

B 450 DISK FILE/DATA COMMUNICATION BASIC CONTROL

2-110. The B 450 (figure 2-51) houses the disk file control and data communications control assemblies (B 247 and B 248) when attached to a B 273 or B 283 System. All control units contained within the cabinet and/or which make up the disk file/data communication system are individually described in the following paragraphs (table 1-1):

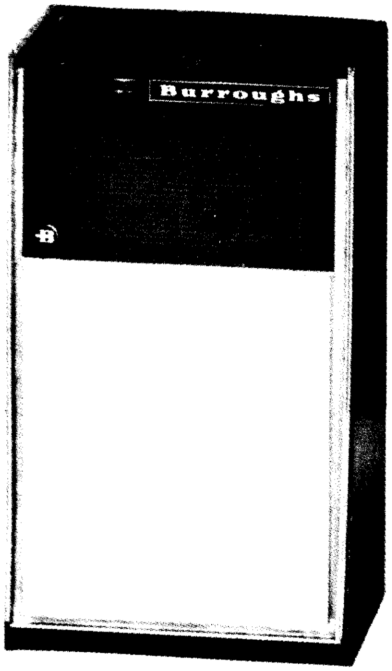


Figure 2-51. B 450 Disk File/Data Communication Basic Control

B 247 DISK FILE CONTROL UNIT

2-111. The B 247 contains the power supply, control, and checking circuitry to accommodate a maximum of ten disk file storage units (48 million alphanumeric characters per storage unit). All information transfer and addressing from these storage units is controlled by the B 247.

Because independent checking features are incorporated in the unit, the central processor is free to execute other commands or input/output operations when the control unit is performing a check operation. Provision for checking of each disk file address, as it is transferred from the central processor, is provided; and if a parity error occurs, the transfer operation stops and no data will be transferred. Also, an address parity indicator will be set. For each segment of data written during a write operation, a multiple character check code is developed and written. This code is regenerated and compared against the written check code during a read operation. If the comparison is unequal, an information error indicator is set. When a nonexistent address is referenced, the operation is terminated; and an invalid indicator is set. Attempting to write on a disk which is locked out will set a write lockout indicator. Reading or writing is prevented while the control unit is in a "busy or Not-Ready" status. The control unit is in a "not-ready" status if either of the power switches (AC-DC) are OFF or if the REMOTE/LOCAL switch is set to the LOCAL position.

B 472 DISK FILE STORAGE UNIT

2-112. The B 472 Disk File Storage Unit (figure 2-52) incorporates all of the disk file system electronics for controlling a maximum of 48,000,000 alphanumeric characters of information (5 modules) in addressable segments of 96, 240, or 480 characters. The unit contains the main air pressure system starting controls, basic head switching logic, and read/write amplifiers for a maximum of five storage modules. Lockout switches for the unit and for individual disks are provided on the control panel. The unit lockout switch prevents writing on the entire unit. Individual disk lockout switches allows disks to be individually locked out. Whenever the unit or disk is placed in a write-lockout state, it is still possible to read from the unit and/or disk. The unit is made ready for operation when the POWER ON switch is ON and the REMOTE/LOCAL switch is set to the REMOTE position. One B 475 Storage Module is included as part of the B 472 Storage Unit.

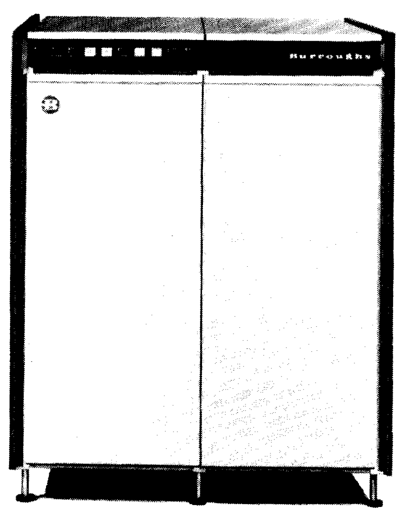


Figure 2-52. B 472 Storage Unit

B 472 Control Panel

2-113. The switches and indicators located on the control panel (figure 2-53) used for the operation of the B 472 Disk File Storage Unit are described in table 2-13.

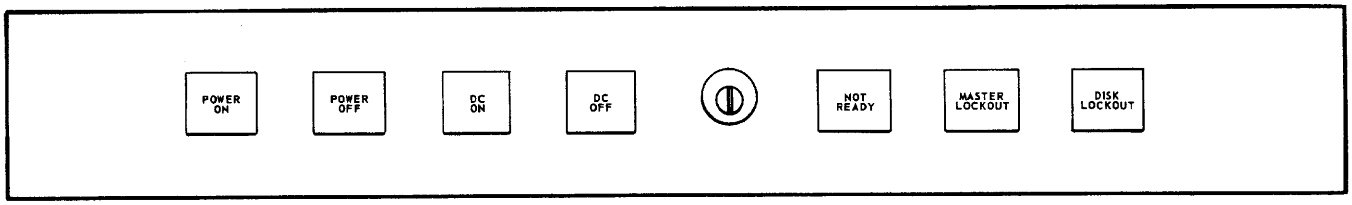


Figure 2-53. B 472 Control Panel

TABLE 2-13

B 472 Disk File Storage Unit Control Panel Switches and Indicators

SWITCH/INDICATOR	FUNCTION
POWER ON	This switch applies AC power to the storage unit and the storage modules connected to it, provided that the AC ON switch of the B 247 Control Unit is also on.
POWER OFF	This switch removes AC power from the storage unit and from the storage modules connected to it. The switch should only be used when absolutely necessary since the storage modules require two hours to return to operating condition after power is turned on once more.
NOT READY	This indicator will light when one of the following conditions exists: a. AC power is off. b. DC power is off. c. REMOTE/LOCAL switch is in the LOCAL portion. d. All disks in the storage modules are not up to speed. e. Air pressure is low.
DC ON	This switch applies DC power to the storage unit and to the storage modules attached to it.
DC OFF	This switch removes DC power from the storage unit and the storage modules connected to it.
MASTER LOCKOUT	This indicator lights when the master lockout switch (located under a hinged cover) is pressed to lock out all of the disks connected to the particular disk file storage unit.
DISK LOCKOUT	This indicator lights when one or more of the disk lockout switches (located under the hinged cover) are pressed to lock out the disks connected to the particular disk file control unit.

B 475 DISK FILE STORAGE MODULE

2-114. The B 475 Disk File Storage Module (figure 2-54) consists of four vertically mounted magnetic disks comprising a storage capacity of 9.6 million alphanumeric characters. Each disk surface has 50 data-tracks which are divided into addressable segment sizes of 96, 240, or 480 alphanumeric characters. One data-track has a 24,000 character capacity. Every track is equipped with its own read/write head and by means of electronic switching, the heads can rapidly access data from the tracks. A fail-safe mechanism within each storage module prevents the read/write heads from contacting or damaging the magnetic disk surface.

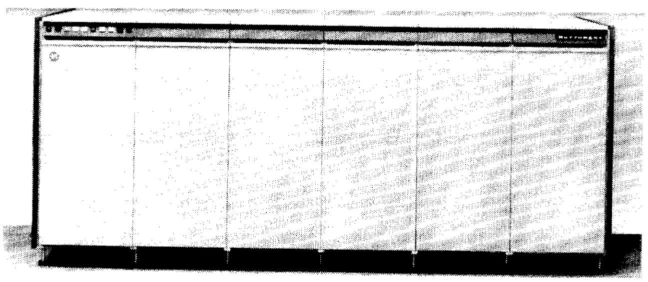


Figure 2-54. B 475 Disk File Storage Module (four shown with B 472)

2-115. The magnetic disks rotate at 1500 revolutions per minute (RPM), and with the head-per-track design incorporated for reading and writing data, the average time required to access data from disk storage is one-half disk revolution or 20 ms. regardless of file size or organization of records. All data recorded onto the disks will remain on the disks until replaced with new information. Transfer of information from and to the file is at a rate of 100,000 characters-per-second.

2-116. The B 475 Disk File Storage Module must be used in conjunction with the B 472 Disk File Storage Unit. Four B 475 Storage Modules and one B 472 Disk File Storage Unit (which contains one storage module) constitutes a complete disk file storage unit with a total storage capacity of 48 million characters. Ten B 472 Storage Units with 40 B 475 Storage Modules may be attached to either a B 273 or B 283 giving that system a 480 million character capacity.

B 475 Disk File Storage Module Control Panel

2-117. The controls for operating the B 475 Storage Module are located on the B 472 Disk File Storage Unit. This unit provides individual disk lockout switches for the disks within the storage module. These switches allow individual disks to be locked out. For a complete functional description of the switches and indicators, refer to table 2-14.

B 248 DATA COMMUNICATION CONTROL UNIT

2-118. The B 248 Data Communication Control Unit provides the interface between the central processor and the various terminal units. Only one B 248 may be connected to a B 273 or B 283 System and it can serve from one to fifteen terminal units of any combination. The B 248 may have a cable length of up to 50 feet from the associated central processor and is under the control of the central processor only when loading or unloading a terminal unit buffer to or from core memory.

B 248 Functional Characteristics

2-119. The B 248 provides the code translation facility for conversion between Burroughs Common Language (BCL) and Baudot Code. In a system where different types of terminal units are used, BCL to Baudot conversion takes place only when the Scanner in the B 248 is addressing a teletype terminal unit.

2-120. The B 248 can recognize that any terminal unit is in one of four possible states: Busy, Input Ready, Output Ready, or Not-Ready.

2-121. When a designated terminal unit is in the "Busy" state, the associated central processor or the B 248 cannot communicate with that terminal unit. A "Busy" state occurs when:

> The terminal unit is receiving an input message from one of its stations; or if the terminal unit is transmitting the contents of its buffer to an inquiry station; or if there is a nonrelated call on the net of a teletype terminal unit; or if the terminal unit is idle when designated by a read order; or when loading or unloading a terminal unit buffer to or from the central processor.

2-122. A terminal unit that has received a complete message from an inquiry station is in the "Input Ready" state. The completing of an input message is recognized by an end-of-message character which is transmitted to the associated central processor as a group mark (BCL-011 1111).

2-123. A terminal unit is in the "Output Ready" state after it has completed transferring the contents of its buffer to an inquiry station and has *not* detected an End-of-Reply (group mark) character.

2-124. The B 248 also provides an interrupt to the central processor. This interrupt is set when any terminal unit is in the "Input Ready" or the "Output Ready" state, and the terminal unit is being addressed by the scanner.

2-125. The character transfer rate through the B 248 is a maximum of 30,000 characters-per-second. Transfer is serial-by-character, parallel-by-bit; and in all cases of inquiry reply, the message must be terminated by a group mark character.

2-126. The scanner in the B 248 has the facility to connect any of the terminal units to the central processor. The time required for the scanner to examine adjacent channels for "ready" status is a maximum of 20 microseconds; and the B 248 gives priority, in undirectional sequence, to terminal units that are in the "Output Ready" state

B 481 TELETYPE TERMINAL UNIT

2-127. The B 481 Teletype Terminal Unit provides the interface between the B 248 and the teletype stations on a net. From 1 to 399 teletype station sets may be serviced by a single B 481 Teletype Terminal allowing a possible 5,985 teletype stations in a network if only teletype terminals are used (1 to 15 terminal units per B 248). The B 481 may have a cable length of up to 50 feet from the B 248 and, as an optional device may have a teletype page printer included as part of the terminal unit.

B 481 Functional Characteristics

2-128. The B 481 Teletype Terminal Unit provides serial-parallel code conversion, special teletype character deletion and insertion, and buffer storage capability. Control and timing levels are generated and sensed to that the B 481 is compatible with the B 248.

2-129. Physically, the B 481 is a model 28 Sequential Selector with selective calling features. A parallel to series converter is furnished as an available feature with the sequential selector, and code reading contacts are used to convert serial-by-bit characters for transmission to the B 248. A character-control unit is provided for the insertion and deletion of special teletype characters such as "Line Feed". The character control also provides the end-of-reply, and the station disconnect signals for the teletype net. The character-control further inserts change of print mode signals in the data being sent to the teletype stations when there is a change from either figures (FIGS) to letters (LTRS).

2-130. The B 481 Teletype Terminal Unit incorporates a buffer which stores six-bit characters. Buffer size may be 120 or 240 characters and the access time for the terminal buffer is 20 microseconds. An inquiry message may be entered via the keyboard of any station on the net by selectively calling the B 481. The B 481 Teletype Terminal Unit can service only one station at a time.

2-131. A teletype page printer may be included as part of the B 481 Teletype Terminal Unit. This printer can be used for monitoring all messages on the net.

B 483 TYPEWRITER TERMINAL UNIT

2-132. The B 483 Typewriter Terminal Unit provides the interface between the B 248 and the typewriter inquiry stations on a net. The B 483 provides facilities for one to eight typewriter stations and includes the input station selection circuitry, and an input/output buffer of 480 characters. Control and timing levels are generated and sensed so that it will be compatible with the B 248. The typewriter terminal unit may have a cable length of up to 50 feet from the B 248.

2-133. The unit provides buffers to store simultaneous inputs from each typewriter inquiry station. Buffer size for each typewriter inquiry station depends on the number of stations per terminal.

2-134. The B 483 Typewriter Terminal Unit also provides input scanning facilities to accept data from any of the eight possible typewriter inquiry stations. This data is picked off and stored as it is available, a character-at-a-time, and is directed to the proper portion of the buffer.

2-135. In addition, the unit provides an input latch facility which interrupts the scanner and holds the buffer to a station while data is transferred through the B 248 to the central processor. The latch is initiated when the end-of-message input character is stored.

2-136. The buffer will store a reply message from the processor when latched to the B 248. The flow of data into the buffer is governed by timing levels generated in the terminal unit. The buffer will unload a reply message when latched to the typewriter inquiry station and the flow of data from the buffer is governed by timing levels generated in the typewriter inquiry station.

B 484 DIAL TWX TERMINAL UNIT

2-137. The B 484 Dial TWX Terminal Unit provides the interface between the dial TWX network and the B 248. It provides facilities for one to eight channels of the dial TWX network and an input/output buffer of up to 480 characters. A Dataset 103 is required for the interface to the dial TWX network and may be located 50 feet from the terminal unit.

Functional Characteristics

2-138. The terminal unit provides buffers to each channel. To store simultaneous messages for each channel depends on the number of channels required in the terminal. The operator dials the Dial TWX Terminal Unit using normal dialing procedures. When a connection has been established, the message is typed and stored until an "End-Of-Message" signal is received.

2-139. The scanning facilities provided with the terminal unit provide a connection to each buffer when required and the input message is unloaded from the buffer to the system. The buffers will also store output messages from the processor when connected to the system. The flow rate of data into the buffer is governed in the terminal unit with the message being terminated by a group mark. The message is then transferred to the connected station while the terminal is servicing other channels.

B 493 TYPEWRITER INQUIRY STATION

2-140. The B 493 Typewriter Inquiry Station utilizes a Send-Receive Page Printer set. The alphanumeric keyboard is provided with contacts suitable for keying of alphanumeric input data.

Functional Characteristics

2-141. The B 493 Typewriter Inquiry Station communicates with the B 483 Typewriter Terminal Unit via a single multiple conductor cable. These cables may be up to 2000 feet from the B 483 to the inquiry station. The station set operates at a standard rate of 10 characters-per-second by selectively pressing the keys and space bar of the keyboard in the same manner as typing.

B 495 SUPERVISORY PRINTER

2-142. The B 495 Supervisory Printer (figure 2-55) furnishes a permanent printed document between the operator and the system through use of a modified electric typewriter as an input/output device. The printer can only be used with a B 273 or B 283 System and is most useful when associated with a control unit since it can print the beginning of a message and the end of the message. A LOCAL switch on the printer allows the operator to manually type comments when desired.

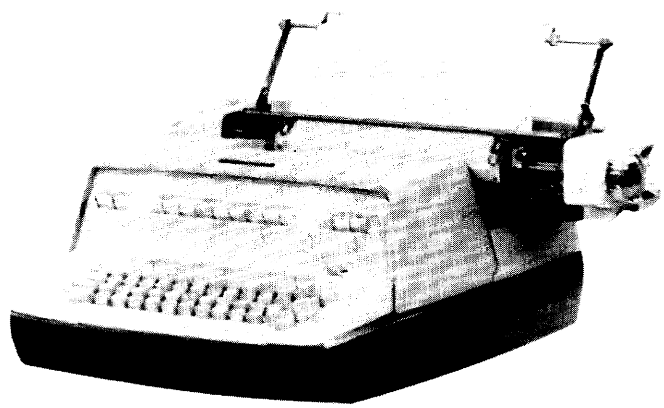


Figure 2-55. B 495 Supervisory Printer

Functional Characteristics

2-143. The B 495 has a print format of 10 characters-per-inch horizontally and six characters-per-inch vertically with an output rate of 10 characters-per-second. The printed output is displayed on continuous fan-fold paper of 9⅞ inches including the removable sprocket hole. Two carbon copies can be printed along with the original first print copy. The right-hand margin is permanently preset to provide a maximum line length of 72 characters with the left-hand margin preset at one inch from the left edge of the paper. Neither margin can be preset manually. The typewriter carriage will return upon pressing the carriage return key; printing of the 72nd character in a line; a left pointing arrow (←) in the output data, or by depressing the end-of-message key during input.

B 495 Supervisory Printer Controls

2-144. The B 495 Supervisory Printer (figure 2-56) contain switches and indicators which control the operation of the printer and are described in table 2-14.

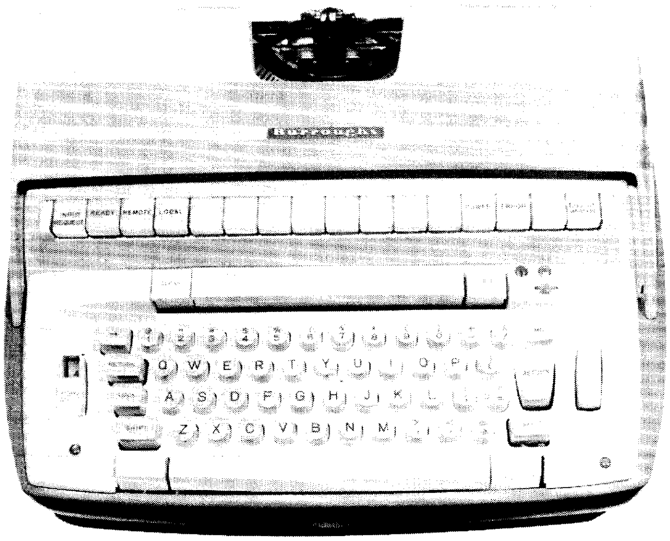


Figure 2-56. B 495 Controls

TABLE 2-14

B 495 Supervisory Printer
Switches and Indicators

SWITCH/INDICATOR	FUNCTION
INPUT REQUEST	A momentary contact switch that begins feeding the input message stored in memory when depressed.
READY	This indicator lights when the computer reaches a Read Supervisory Print instruction.
REMOTE	A self-indicating switch that places the printer under control of the associated central processor.
LOCAL	A self-indicating switch that removes the printer from control of the central processor. The operator can type comments when this switch is on.
POWER	This indicator lights when power is applied to the unit.
ERROR	The operator momentarily presses this switch in the event of an operator input error (i.e., keystroke error). The program control will continue in sequence.
END-OF-MESSAGE	Momentarily pressing this switch terminates the message. A group mark is stored in memory and the READY indicator is extinguished.

SECTION 3
SYSTEM FEATURES

GENERAL

3-1. B 200 Series Systems feature special storage methods, buffering techniques, and checking capabilities that provide each system with built-in flexibility for individual system expansion. This section describes the features incorporated in all B 200 Series Systems.

STORAGE METHODS

3-2. Two different types of storage are used in B 200 Series Systems: internal and external. Internal storage is that which is an integral part of the computer and without which the computer could not operate. External storage is separate from the computer, but capable of retaining information in a form acceptable to the computer. B 200 Series Systems make use of three types of storage: magnetic core, magnetic tape and disk file. Each of the three types have been designed to meet specific requirements. Magnetic core, magnetic tape and disk file will retain alphanumeric information. In each type of storage, data is represented in Binary Coded Decimal (BCD). The contents of the three types of storage are not altered by reading out the information. The contents of magnetic media can only be changed by writing new information.

Magnetic Core Storage

3-3. The B 200 Central Processors contain either 4800 or 9600 positions of internal magnetic core storage, depending on the model of the particular central processor. Core storage is used to store program instructions and data during processing runs. The use of magnetic core storage permits rapid access to the data stored in memory.

3-4. Each character position of memory consists of seven magnetic cores. Magnetic cores are "doughnut" shaped devices that have the inherent characteristic of becoming magnetized, and remaining so, when a current is passed through the center of the core (figure 3-1). The direction of the magnetic lines of force about the core depends upon the direction of the current through the center of the core. If the current is passed through the core in the opposite direction, the direction of the magnetic lines of force will be reversed. The resultant magnetism is thereby designated as a bit (on or one) or no-bit (off or zero) condition. In either case the core is magnetized, the "on" and "off" designations are strictly arbitrary. Six of the cores in each character position are used to represent data; the seventh is used for internal parity checking (discussed in subsequent paragraphs).

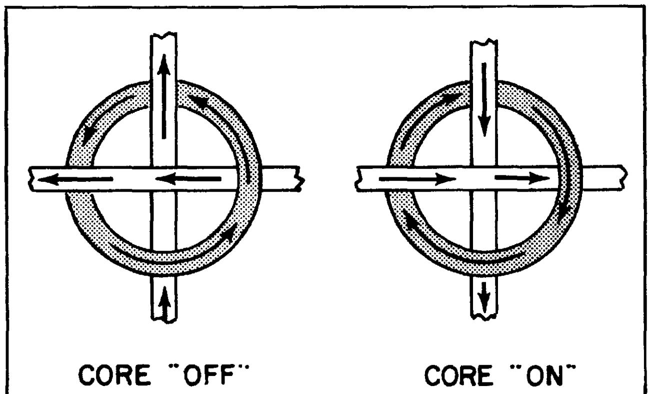


Figure 3-1. Magnetic Core Conditions

3-5. Figure 3-2 illustrates one position of memory with the value of each core shown above. If a core is magnetized in the "on" direction, the core will represent the value shown. Figure 3-3 depicts the coding of digits zero through nine in magnetic core storage. A shaded "doughnut" indicates that the core is "on". The four-level (8,4,2,1) method of representation of numbers is known as Binary Coded Decimal (BCD). The other three levels of each character position (P,B,A) are used for parity checking, alphabetic and most special character representation. Alphabetic and most special characters are represented by a combination of numeric and the A and/or B cores.

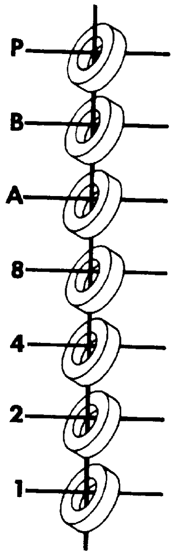


Figure 3-2. One Memory Position

3-6. When a character enters the central processor, its bit count is checked. If the bits are even, the parity core for that character location will be turned on. If the number of bits in the character is odd, the parity core will be turned off. Thereafter, as data is processed internally or transferred to an output unit, the number of "on" cores in each character is accumulated. Whenever an even core count results, the system will stop, indicating the type and location of the error.

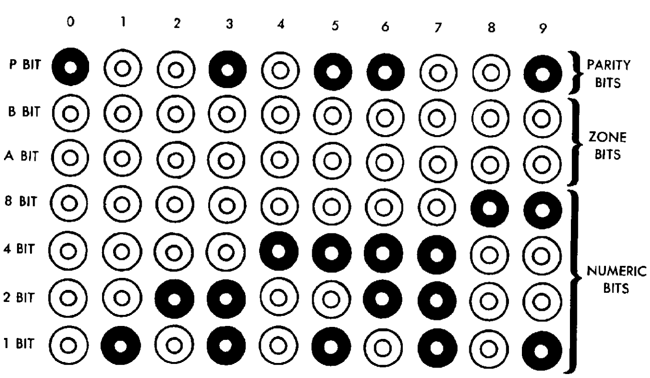


Figure 3-3. Magnetic Core Character Representation

3-7. In punched card code, the alphabetic characters are represented by a numeric (1 through 9) and zone (12, 11 and 0) punch. In the central processor memory, the alphabetic characters are represented by the same numeric character plus a zone punch-value of A, B, or A and B. For example:

12 ZONE — A	11 ZONE — B	0 ZONE — AB
A—A, 1	J—B, 1	
B—A, 2	K—B, 2	S—A, B, 2
C—A, 3	L—B, 3	T—A, B, 3
D—A, 4	M—B, 4	U—A, B, 4
E—A, 5	N—B, 5	V—A, B, 5
F—A, 6	O—B, 6	W—A, B, 6
G—A, 7	P—B, 7	X—A, B, 7
H—A, 8	Q—B, 8	Y—A, B, 8
I—A, 9	R—B, 9	Z—A, B, 9

Magnetic Tape Storage

3-8. As many as 15,000,000 characters of information may be contained on a single reel of magnetic tape. To store this quantity of data on punched cards would require 187,500 cards with data punched in every one of the 80 available card columns.

3-9. Information is stored on magnetic tape in the form of records. Record lengths (i.e., number of characters per second) can vary from record to record, depending solely on the quantity of information required. This is in sharp contrast to the fixed record lengths associated with punched cards. In addition, magnetic tape is easily handled, reusable, and requires a minimum of storage space.

3-10. The Model 0 B 270, B 280, Improved Model 0 B 270/B 280 and the B 273/B 283 Systems have the ability to sort and process information on magnetic tape, convert data from punched cards to magnetic tape for subsequent use by large-scale systems, and serve as an output system for preparing printed or punched card output from magnetic tapes generated by large scale systems, e.g., the B 5000.

3-11. The magnetic tape used with B 200 Series Systems is made of a plastic material which is coated with a metallic oxide. The oxide coating has the property of being easily magnetized with patterns of tiny spots. A magnetic tape record is a series of characters (minimum of seven) recorded consecutively on the tape. Records are separated from each other by approximately ¾-inch blank (unrecorded) tape which is called an interrecord gap. The characters are written on tape vertically in seven channels which correspond to the seven levels of core memory. Figure 3-4 illustrates a section of magnetic tape containing the characters "B 200 SERIES".

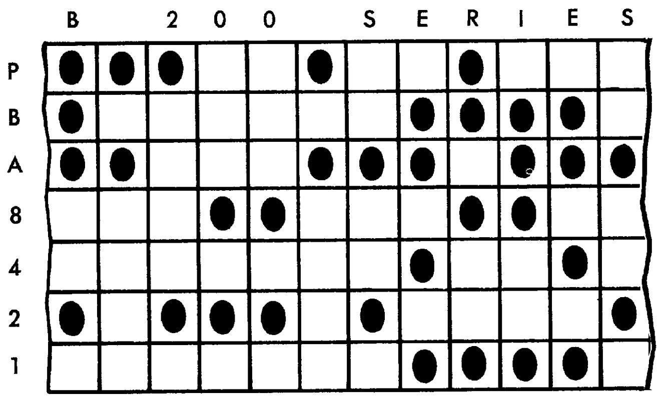


Figure 3-4. Magnetic Tape Character Representation

3-12. Six of the channels (1, 2, 4, 8, A, and B) are used to represent alphanumeric information. The seventh bit (P) is on if the number of bits comprising the character is odd. By using parity check on each character, accuracy for tape-read and tape-write operations is assured.

3-13. Following the last character in each record, there is a logitudinal check character (LCC). This check character consists of a check bit, automatically written into each channel for the entire record regardless of the code used. It should be noted that it is possible for the check character to be blank.

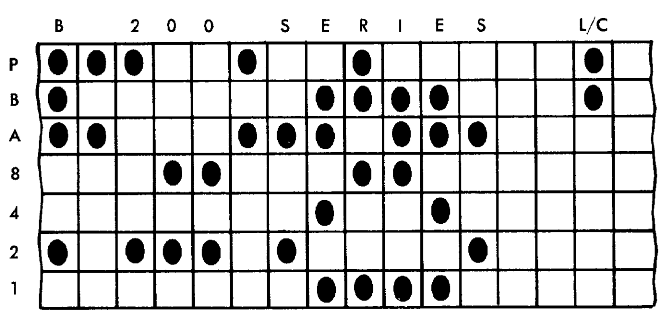


Figure 3-5. Magnetic Tape Logitudinal Check Character

3-14. A two-character gap exists between the last character of the record and the LCC. When this gap is sensed, a group mark (figure 3-6), is written in core memory or 0011111. When the LCC is sensed, it signals the central processor to cease reading from magnetic tape. It should be noted that the group mark appears only in memory, not on magnetic tape.

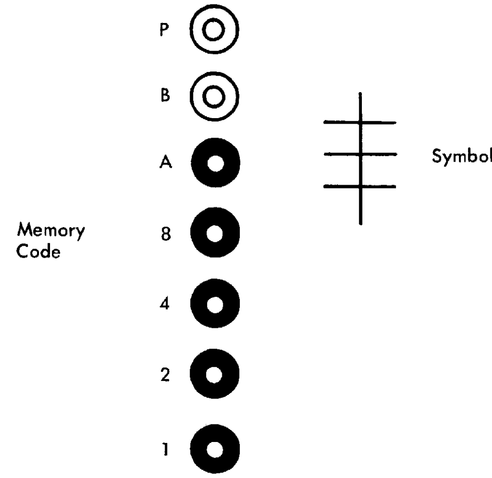


Figure 3-6. Group Mark

3-15. A tape mark (figure 3-7) is written on the tape after the last record of a file has been written. When reading magnetic tape, this mark will be recognized automatically, usually programmatically initiating an End-of-File routine. Several different files may be stored on one reel, each separated by a tape mark.

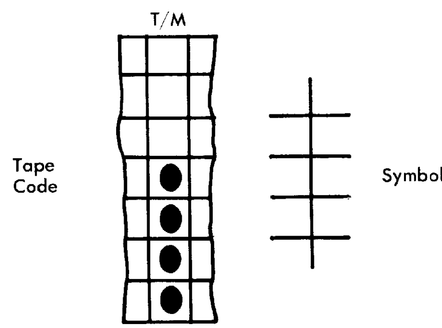


Figure 3-7. Tape Mark

NOTE

A two-character record consisting of Tape Mark-Group Mark consistutes an End-of-File record in memory.

Disk File Storage

3-16. Additional storage is available with the B 273 and B 283 Systems when equipped with a disk file system, B 247 Control Unit. The B 247 controls up to ten B 472 Disk File Storage Units. A maximum of 9.6 million six-bit alphanumeric characters of information can be stored on four vertically mounted magnetic disks contained in each storage unit. Thus a total of 480,000,000 alphanumeric characters can be stored when a maximum of ten storage units are used. Table 3-1 lists the capacity of the disk file system.

TABLE 3-1

Disk File System Capacity

	Alphanumeric Characters per—	Segments per—	Data Tracks per—	Disks per—	Modules per—	Storage Units per—	Control Units per—
Segments	96 240 480		250 100 50				
Data Tracks	24,000	50 480 char. 100 240 char. 250 96 char.					
Disk	2,400,000	5,000 480 char. 10,000 240 char. 25,000 96 char.					
Module	9,600,000	20,000 480 char. 40,000 240 char. 100,000 96 char.		4			
Storage Unit	48,000,000	100,000 480 char. 200,000 240 char. 500,000 96 char.		20	5		
Control	480,000,000	1,000,000 480 char. 2,000,000 240 char. 5,000,000 96 char.		200	50	10	
B 273 or B 283	480,000,000	1,000,000 480 char. 2,000,000 240 char. 5,000,000 96 char.		200	50	10	1

3-17. The magnetic storage disk is designed and shaped similar to a commercial recording disk; however, it is much larger and is constructed of brass. The disk surface is plated with an extremely thin magnetic film.

3-18. Every disk-surface contains 50 data-tracks. One data-track has a capacity of 24,000 characters. Each data-track has a fixed predetermined clock frequency so that the information packing density in all of the data-tracks will approximate 1000 bits per inch.

3-19. The data-tracks are serviced by their own individual read/write head. The read/write head records the information to be stored onto the disk surface serially by bit in 48-bit words. In addition, each word contains check and spacer bits.

3-20. Data tracks are further divided into addressable segments of 96, 240, or 480 alphanumeric characters. Segments are decimally and consecutively numbered within each storage unit. Consecutively numbered segments may be read or written with a single command.

3-21. Each segment is individually numbered within a storage unit and is assigned a seven-digit address. The address format and range varies with segment size. The following indicates the range and address format for each segment size:

96 CHARACTER SEGMENT ADDRESS FORMAT

U	S	S	S	S	S	S
Storage Unit Number 0-9	Segment Number 000000-499999					

Number of addressable segments:

Module	100,000
Full Capacity Storage Unit	500,000

240 CHARACTER SEGMENT ADDRESS FORMAT.

U	S	S	S	S	S	S
Storage Unit Number 0-9	Segment Number 000000-199999					

Number of addressable segments:

Module	40,000
Full Capacity Storage Unit	200,000

480 CHARACTER SEGMENT ADDRESS FORMAT.

U	UNUSED	S	S	S	S	S
Storage Unit Number 0-9	Segment Number 00000-99999					

Number of addressable segments:

Module	20,000
Full Capacity Storage Unit	100,000

3-22. The disk storage reading and writing speed is extremely fast, and transfer of information from and to the file occurs at the rate of 100,000 characters per second.

3-23. This data rate facilitates efficient loading and unloading of files, file scanning, sorting, and report generation. The time to read or write each of the three data segment sizes are:

Segment Size	Read/Write Time
96 char.	0.96 ms
240 char.	2.40 ms
480 char.	4.80 ms

CHECKING

3-24. Also incorporated in B 200 Series Systems are a number of internal checking features which are described in the paragraphs that follow.

Parity Checking

3-25. All characters in the B 200 Central Processor memory must be represented by an odd number of bits ("on" cores). As stated previously, each character position in memory consists of seven cores; six to represent the character and one for parity checking.

3-26. The same method of checking is used on magnetic tape. However, as information is being written on magnetic tape in BCD mode, the odd count is converted to an even-count parity. When an error is detected, the magnetic tape operation in progress will halt and an error indication will be signaled.

Electromechanical Failure

3-27. An error condition is detected at the punch station, if fewer than 80 bits of data is received for each row or if more or fewer than 12 row cycles are counted.

Valid Character

3-28. As cards are read by the card readers, the character punched in each card column is tested. If it is an invalid character, and the VALIDITY ON switch is active, the following takes place:

a. A binary 12 (1001100) will be read into the buffer in lieu of the invalid character.
b. The system stops on the next Card Read instruction prior to the transfer of the contents of the buffer to core storage.
c. The VALIDITY CHECK indicator on the card reader control panel lights.
d. The card in error becomes the last card in the stacker.

3-29. When the VALIDITY ON switch is off, the following takes place:

a. A binary 12 (1001100) will be read into the buffer in lieu of the invalid character and the system continues its operation.

Marginal Electronic Circuit Detection

3-30. The photoelectric read circuitry in the card reader is checked between read cycles to ensure that it is functioning properly. If the circuitry is inoperable or below acceptable performance standards, the system will stop on the next Card Read instruction, indicating a read error condition.

Printed Report Verification

3-31. Accuracy of data printed by either the Line Printer or the Multiple Tape Lister is assured by parity checking the contents of the print buffer and clocking the print drum(s). In the event that a print error occurs, the system will halt, indicating a print-check error.

Buffering

3-32. The transfer of information between the central processor and selected I/0 units is aided by the use of buffers. These buffers serve as temporary storage areas for the data being transferred from the central processor to an I/0 unit, and data being transferred to the central processor from an I/0 unit. Buffers are capable of accepting data at one transfer rate and transmitting it later at a different rate of speed (measured in characters per second). At the same time, they permit the central processor to continue computing during the more time-consuming input/output operations.

3-33. An input buffer accepts data from an input unit at the speed of that unit, which is relatively slow. When the central processor calls for this input data, the buffer transfers it at a greatly increased rate of speed. An output buffer accepts data from the central processor at central processor speed and makes this data available to an output unit at the slower speed of the output unit.

3-34. By communicating with the buffers, the central processor is capable of transmitting and receiving information at high speeds. For example, the B 321 Line Printer speed is 700 lines per minute (120 characters per line) or a total of 1400 characters per second. The output buffer accepts print data at the rate of 92,300 characters per second and transfers the data to the printer at 1400 characters per second. Once the central processor has prepared a line of print, the information is transferred to the printer buffer in approximately 1.3 milliseconds. The central processor is then free to continue processing additional data for future printing. During the following 84.4 ms., while the central processor continues to operate, the printer buffer transfers the information just received to the print section. By the time the line of print has been processed (printed), the central processor will normally have prepared additional information for printing. Thus, multiple operations can take place at the same time.

3-35. The timing sequence is reversed for input operations. For example, if a punched card is read, its contents are transferred to one of the central processor input buffers. During this data transfer, the central processor is free to continue its normal operations. When the central processor requires punched card input information, the contents of the previously filled input buffer are transferred to memory within 2 ms. As soon as the contents of the buffer have been transferred to the central processor memory, the card reader refills the buffer with additional information for future use by the central processor. During the period that the buffer is being refilled, the central processor is free to continue its normal processing operations.

3-36. The B 321 Line Printers contain 120-character buffers and the B 322 Multiple Tape Listers contain 44-character buffers. These buffers function in the same manner as the central processor buffers. The use of the various buffers permits several input/output operations to take place simultaneously while internal computation proceeds unhindered. To illustrate, as many as five input/output units can be operating during computation (two card readers, one card punch, and two multiple tape listers, figure 3-8).

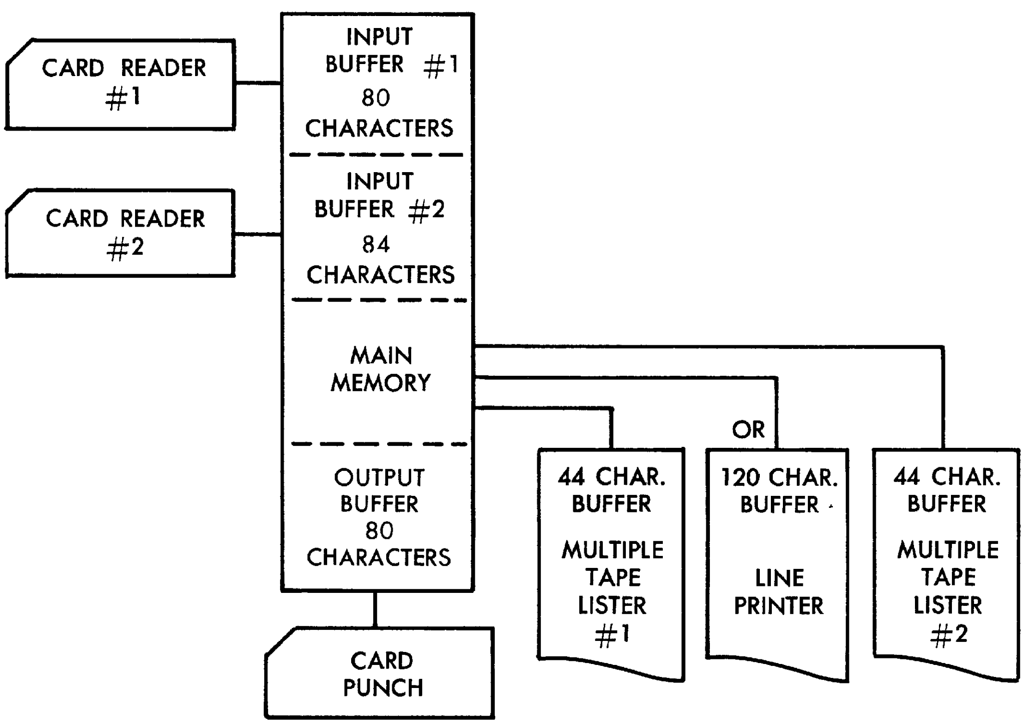


Figure 3-8. B 200 Central Processor

SECTION 4

STORED PROGRAM INSTRUCTIONS

GENERAL

4-1. Data processing has been defined as the performance of a series of actions and operations on data for the purpose of achieving desired results. In order to control the operation of data processing within a computer system, a series or instructions, called a program, is introduced to the computer to "tell it" under what circumstances to perform a particular operation on the data being processed. Since these instructions are held in core storage, they are referred to as the stored program.

4-2. This section contains a detail description of the individual instructions that comprise the stored program within the B 200 Series System Central Processors.

INSTRUCTION DESCRIPTION

4-3. The instructions that comprise the stored program in all B 200 Series Systems are usually classified into four categories. These categories are:

a. Input/Output Instructions—These instructions control on-line operation of tabulating card reading and punching, paper tape reading and punching, high speed printing and listing, MICR document reading, magnetic tape processing, disk file writing, reading, checking and interrogating, data communication reading, writing, and interrogating, and supervisory printer reading and writing.

b. Arithmetic Instructions — The central processor executes the standard operations of add, subtract, multiply, and divide. Each operation is accomplished with a single instruction. Multiply and divide operations do not require subroutines. The result of an arithmetic operation is stored in algebraic form (a negative result does not require further processing to convert or decomplement the answer).

c. Control Instructions — In data processing systems, control is defined as the ability to process data in accordance with conditions defined by the programmer. These logical functions are performed by the use of instructions which can test for a wide variety of conditions and, on the basis of the result, direct control to the required processing routines under program control. This is normally accomplished through the use of electronic devices (comparison indicators) within the central processor. The comparison indicators electronically indicate conditions resulting from the execution of various instructions. The conditions existing in the comparison indicators may be any one of the following, depending only upon the previously executed instruction; high (positive) or greater than zero, equal or zero, and low (negative) or less than zero. The comparison indicators may be interrogated under program control to direct processing as required.

d. Editing Instructions—Editing is the function of punctuating (with commas, decimals, dollar signs, etc.), positioning, and zero-print controlling the data to be printed. All editing is performed under program control.

INSTRUCTION FORMAT

4-4. All instructions in core storage are a fixed length of 12-character positions. Since all instructions do not utilize the full complement of 12 characters, certain unused character positions are available for storage of constants, control counters, etc. These "free" positions are discussed in subsequent paragraphs, along with the discussion of the individual instructions. The instruction format and the identifying digit, or character, for each position is illustrated in figure 4-1. For reference purposes, the "0" position starting the instruction is the most significant digit (MSD) and the @ position is the least significant digit (LSD).

Format	O	M	N	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3
Digit	0	1	2	3	4	5	6	7	8	9	#	@

Figure 4-1. Instruction Format

4-5. The instruction format is defined as follows:

a. O — A single character position which identifies the type of instruction to be executed. This operation code (Op Code) must be in the MSD position of the field.

b. M — The second character position of the instruction is termed the M variant. It is used to modify the Op Code by providing information such as field length, variations of the basic instruction, and forms control.

c. N — The third character position of the instruction is termed the N variant. It also is used to complete the definition of the Op Code by providing such information as field length, input/output unit numbers, forms control, sorter-reader pockets, etc.

d. AAA — The three-character address (MSD) position of a field or a character. Depending upon the Op Code, it is usually used to reference either data or another instruction.

e. BBB — The three-character address (MSD) position of a field or a character. Depending upon the Op Code, it is usually used to reference either data or another instruction.

f. CCC — The three-character address (MSD) position of a field or a character. Depending upon the Op Code, it is usually used to reference either data or another instruction.

4-6. As mentioned previously, there are some instructions which do not use all 12 available positions of core storage. These "free" positions are designated by a "b" in the description of the individual instructions and are classified as follows:

a. Available to Programmer — Positions with this classification may be used for any purpose as long as the adjacent characters or bits indicated for other uses are not disturbed.

b. Reserved for Expansion — These positions may NOT be used when programing and must be left blank. Future command modifications may be accomplished by using these positions.

c. Used by Machine—These positions are NOT to be used for data storage when programing any application. The positions are used by the hardware during the execution of the instruction in which they appear and any data stored there may either adversely affect the execution of the instruction, or may be affected adversely by the execution of the instruction.

4-7. In addition to the classifications mentioned above, the units position of the AAA, BBB, and CCC addresses are sometimes designated by a "b". This is normally the case when the address references an instruction. Since all instructions in B 200 Series Systems contain 12 character positions, the third character of the instruction address is always zero. During processor operation, the units position of the instruction address is always treated as a zero unless the BCD value is greater than @ (11). Therefore, it is quite possible to use this unit position for storage if precautions are taken to make certain the stored character does not affect processor operation, or that the stored data is not destroyed by processor operation before the data can be used.

4-8. In the description of program instructions contained in this section, the format used is:

MSK 8 M N AAA BBB CCC Set to Equal (comparison indicator status)

The mnemonic code MSK which is used with the B 200 Assembler appears first, followed by the instruction format 8 M N AAA BBB CCC. The setting of the comparison indicators denotes their status AFTER the execution of the instruction. In the case of the instruction format (8 M N AAA BBB CCC), the capital letters M, N, A, B, and C in the proper position of the instruction designate that the position is used in the instruction execution. A "b" in any position denotes that that position is not used in the execution of the instruction and falls into one of the categories listed in paragraphs 4-6 and 4-7.

4-9. The instruction examples that follow are given in machine language. Instruction execution time is provided in section 6.

MODEL 0 CENTRAL PROCESSOR INSTRUCTIONS

4-10. A description of all instructions available for use with Model 0 Central Processors is provided in the paragraphs that follow. Improved Model 0 and B 263, B 273, and B 283 Central Processor instructions are discussed later in this section.

Input/Output Instructions

4-11. The various types of input/output equipment used with Model 0 Central Processor necessitates the need for a wide variety of input/output instructions. This variety of instructions include the following operations:

a. Punch card reading and punching.
b. High speed printing and listing.
c. MICR document reading.
d. Magnetic tape processing.

Card Read and Punch Instructions

4-12. There are two instructions, Card Read and Card Punch, which control the operation of the punch card equipment. As mentioned previously, the card units are completely buffered, thereby providing sufficient processing time between I/0 instructions.

4-13. **CARD READ.** The format for this instruction is:

CRD # M N bbb BBb CCC Set to Equal

where:

O: Operation Code; #—machine language, CRD—symbolic

M: Reserved for expansion—must be left blank

N: Designates input buffer
1—buffer 1
2—buffer 2

AAA: Available to programmer

BBB: Branching address on End-of-File (MSD)

CCC: Store address (MSD)

4-14. This instruction transfers the contents of one of the input buffers (specified by an N variant of 1 or 2) into core storage at the location specified by CCC. The execution of this instruction also includes an automatic reload of the buffer with information from the next punched card as it passes the read station. The buffer unload operation mentioned above requires 2 milliseconds (ms). Reloading the buffer requires 73 ms. at 800 cards per minute (B 124 Card Reader) and 298 ms. at 200 cards per minute (B 122 Card Reader). The buffer is interlocked during this time.

4-15. If, during the reloading of the buffer, a card read error or a failure to feed occurs, the system will halt on the next Card Read instruction, thereby preventing the transfer of erroneous information into memory (VALIDITY ON).

4-16. When there are no cards left in the hopper, pressing the END OF FILE switch on the card reader and the CONTINUE switch on the central processor (or the START switch on the card reader) will cause the program to branch to BBb* immediately.

4-17. On all 51, 60, 66, and 80-column cards, column 1 is stored in the MSD position of the CCC address. On short cards (51, 60, and 66-columns), the buffer will contain blanks for the remaining number of unavailable card columns (29, 20, and 14 respectively).

4-18. **CARD PUNCH.** The format for this instruction is:

PCH @ b b AAA bbb bbb Not Affected

where:

O: Operation Code; @—machine language, PCH—symbolic

M: Reserved for expansion—must be left blank

N: Reserved for expansion—must be left blank

AAA: Transfer from address (MSD)

BBB: Available to programmer

CCC: Available to programmer

4-19. This instruction transfers the contents of 80 consecutive memory positions, starting at AAA, into the punch buffer within 2.5 ms., after which a card is punched. The actual punching requires a minimum of 197.5 ms. when using the B 304 Card Punch and 597.5 ms. when using the B 303 Card Punch. During these times, the buffer is interlocked. A punch error condition is detected at either the punch station or at the post-punch read station. The PUNCH CHECK indicator will

*Refer to Branching, paragraph 4-90.

light when an error is detected, however, the punch error signal is not made available to the central processor until the suspect card has passed the post-punch read station and the following card has been punched. The card that follows the suspect card will be punched regardless of the time interval between punch instructions. Therefore, if three cards are to be punched and a punch error occurs in the first card, the system will not halt until the third punch instruction is encountered, stopping the third from being punched. The first two cards will have been punched; therefore, if re-creation of mis-punched cards proves difficult, the output should be programmatically "tanked."

Line Printer Instructions

4-20. Two instructions, Print on Printer and Skip Printer, are used to control operation of the line printer. The print instruction is used to print a line and to control skipping and/or spacing after printing. The skip instruction is used for forms control without printing.

4-21. In both instructions, the M and N variants are used for spacing and skipping respectively. The M variant digits of 0, 1, and 2 designate space suppression, single space, and double space. All spacing is performed after printing.

4-22. The N variant digits of 1 through 9, #, and @ which control skipping correspond to channels 1-11 in the carriage control tape. An N variant of 0 indicates no skipping. In all spacing operations N must be 0. The 12 channel in the carriage control tape is reserved for indicating End-of-Page to the central processor. End-of-Page indication is a means of identifying the last print line on a form, and permits programing a skip to the first print line of the next page.

4-23. **PRINT ON PRINTER.** The format for this instruction is:

PRT A M N AAA BBb bbb Not Affected

where:

- O: Operation Code; A—machine language, PRT—symbolic
- M: Form spacing after print (0, 1, 2)
- *N: Form skipping after print (1-11, 12 is denoted by 0)
- AAA: Print-from address (MSD)
- BBB: Branching address on Page Overflow when N = 0
- CCC: Available to programmer

4-24. This instruction transfers 120 characters from core storage beginning at the address specified by AAA to the printer buffer. When the printer buffer is filled (1.3 ms.), one line will be printed. Spacing after printing is controlled by the M variant. If skipping after printing is desired, the N variant is used. If a print error occurs, the system will stop on the next print instruction (print or skip) that references the printer. If an End-of-Page indication is sensed during a preceding space operation, the program will branch to BBb after printing without paper motion, if the present Print instruction contains an N variant of zero. The three character positions of the CCC address is available to the programmer and may be used for storage.

4-25. **SKIP ON PRINTER.** The format for this instruction is:

SKP B M N bbb BBb bbb Not Affected

where:

- O: Operation Code; B—machine language, SKP—symbolic
- M: Controls form spacing (0, 1, 2)
- *N: Controls form skipping (1-11, 12 is denoted by 0)
- AAA: Available to programmer
- BBB: Branch address on Page Overflow when N = 0
- CCC: Available to programmer

4-26. This instruction controls spacing and skipping before printing and is included to complement the spacing and skipping features of the print instruction. If an End-of-Page indication is sensed during the previous space operation, the program will branch to BBb without paper motion, if the present Skip instruction contains an N variant of zero. The three character positions of the AAA and CCC addresses are available to the programmer and may be used for storage.

Multiple Tape Lister Instructions

4-27. A maximum of two B 322 Multiple Tape Listers may be used with a B 200 Series System.

*On B 263, B 273 or B 283 systems a blank or any other character containing a B set in the N variant can never be used or a branch to the address specified by CCC will always be taken.

Each multiple tape lister contains six tapes. When one B 322 Tape Lister is used, one of the tapes will be designated the master and the other five will be detail tapes. When two B 322 Tape Listers are used, one master and 11 detail tapes are available.

4-28. By use of the M and N variants, it is possible to designate either one or two of the 12 lister tapes. Normally, the master (M variant) and one of the detail tapes (N variant) will be printed. This being the case, the master will be printed more than any of the detail tapes. As a result, the ribbon in the master tape area would have a tendency to wear out much sooner than the remainder of the ribbon. To avoid this situation, the B 322 Tape Lister is provided with a master tape selection switch.

4-29. The switch has seven positions, 1 through 6 and N. By use of the switch, the operator can designate any one of the six tapes as the master. When the switch is in the N position, it is disabled. If two B 322 Tape Listers are used, any one of the 12 tapes can be designated as the master. This is accomplished by the M variants of 0 and 1. An M variant of 1 will place the master tape in unit number 1. An M variant of 0 places the master in tape unit 2. The tape lister that does NOT contain the master tape must always have its master tape selection switch in the N position. When M is 0, the N variant can not be 7. If the M variant is 1, the N variant can not be 1. An M or N variant of BCD 15 will suppress printing.

4-30. If, during the printing of a master and detail tape, the detail tape specified by the N variant is the same as for the tape designated by the master tape selection switch, the detail information will be printed on the left most tape of the unit containing the master (1 or 7). For example, if the master tape selection switch is set to 3, all master information will be printed on tape 3 and all detail information programed to print on tape 3 will be printed on tape 1. If tape lister 2 contains the master tape and its switch is set to 3, the master information will be printed on tape 9 and the detail information will be printed on tape 7.

4-31. If both tape listers have their master tape selection switch set to N, all 12 tapes can be designated as detail tapes. However, in this situation, the first 22 positions of buffer storage will be lost and only the second 22 positions will be printed on the detail tape. The following M and N variants must be used with multiple tape lister instructions:

a. Printing.
   1) M—0 Print master on unit 2 (master determined by switch setting). Unit 1 switch set to N.
      1 Print master on unit 1 (master determined by switch setting). Unit 2 switch set to N.
      15 Suppress master printing.
   2) N—1 Not permissable when M=1.
      7 Not permissible when M=0.
      2-6
      7-11 Designated detail tape (1—12)
      0(=12)
      15 Suppresses detail designation.

b. Skipping.
   1) M=0 Skip master on unit 2 and skip detail.
      2 Skip master on unit 1 and skip detail.
      14 Suppress master and skip detail.
      1 Space master on unit 1 and space detail.
      7 Space master on unit 2 and space detail.
      15 Suppress master and space detail.

c. N=1-11,0 Designates detail tape.
   (0=12)
   15 Suppress detail tape.

4-32. In addition to periodically changing the designation of the master tapes, it is recommended (when using two B 322 Tape Listers) that periodic changing of lister designations be made to lengthen the life of the mechanical components. This can be accomplished by a Field Engineer in a relatively short time.

4-33. **PRINT ON LISTER.** The format for this instruction is:

PRL A M N AAA BBb bbb Not Affected

where:

O: Operation Code; A — machine language, PRL — symbolic

M: 0 — print master on lister 2

1 — print master on lister 1

15 — suppress print on master

With M = 1

N: 2-6, 7-11, 0 (for 12) — designates detail tape.

1 — not permissible

15 — suppress detail designation

With M = 0

1-6, 8-11, 0 (for 12) — designates detail tape

7 — not permissible

15 — suppress detail designation

AAA: Transfer-from address (MSD)

BBB: Branching address on End-of-Paper

CCC: Reserved for expansion — must be left blank

4-34. Execution of the PRL instruction transfers the contents of 44 positions of storage, starting at the location specified by the AAA address, to the printer buffer in 0.7 ms. As soon as the buffer is filled, printing will take place. The first 22 positions of the buffer, as specified by AAA, will be printed on the tape designation by M. The second 22 positions will be printed on the tape designated by N. A variant of 15 indicates no printing. If a print error occurs, the system will stop when the next lister instruction is encountered. Single spacing is automatic.

4-35. **SKIP ON LISTER.** The format for this instruction is:

SKL B M N bbb BBb bbb Not Affected

where:

O: Operation Code; B — machine language, SKL — symbolic

M: 0 — skip the master designated by the selector switch on lister 2

2 — skip the master designated by the selector switch on lister 1

14 — suppress master

1 — space the master designated by the selector switch on lister 1

7 — space the master designated by the selector switch on lister 2

15 — suppress master

*N: 2 through 11 or 0 when M = 1 or 2

1 through 6, 8 through 11, or 0 when M = 0 or 7

15 suppress detail

AAA: Available to programer

BBB: Branching address on End-of-Paper

CCC: Reserved for expansion — must be left blank.

4-36. The SKL instruction controls forms movement of one lister tape when no printing is desired. An M variant of 0 denotes a forms skip of approximately 2.5 inches; an M variant of 1 denotes a single space. The N variant designates the tape that is to be spaced or skipped.

4-37. If an End-of-Paper condition is sensed during a skip or print operation, the program will branch to BBb upon execution of the instruction.

Sorter-Reader Instructions

4-38. The B 102/B 103 Sorter-Reader operates as an input device under program control. Three modes of operation are used with these units which are:

a. Flow mode — documents are fed at speeds up to 1560 items per minute. The information from the documents is read directly into memory.
b. Buffered flow mode — operation is the same speed as flow mode with the exception that the information is read into the buffer instead of directly into memory.
c. Demand mode — documents are fed, as required by the program, up to a maximum of 400 items per minute. The information is read into the buffer.

4-39. The complete function of reading an item in all modes is accomplished by two commands; the Control Sorter command and the Sorter Read command. Operating together, these two instructions perform the following sequence of operation:

a. Control Sorter instruction starts, stops, and

*ON B 263, 273 and B 283 Systems, a blank or any other character containing a B-bit in the N variant can never be used or a branch to the address specified by BBB will always be taken.

maintains the mode of the Read operation and selects the pocket for all documents.

b. Sorter Read instruction reads the information either from the document or from the buffer and directs it to the memory, depending upon the type of Read instruction given.

4-40. This read cycle of two instructions (Control Sorter and Sorter Read) is maintained in all modes; therefore, a Control Sorter instruction is required prior to reading the first document to enter the system.

4-41. The formatting specifications of MICR data read into memory is outlined in section 3 under the paragraph entitled, Word Formatting of MICR Information in Storage.

4-42. Double document (piggyback item) detection will be active via a third transit symbol detector in all Read variants except when N is 5 (end read at second transit symbol.)

4-43. Sorter jams or feed check conditions will fill the read input area with blanks and exit via the Can't Read branch. Non-coded items will also fill the read input area with blanks and the Sorter Read instruction will exit via the Can't Read branch.

4-44. **SORTER READ FLOW.** The format for this instruction is:

SRF # M N AAb BBb CCC Set to Equal

where:

O: Operation Code; #—machine language, SRF — symbolic

M: b or 0,1

N: 4 — stop at "F" light or end of document in flow mode
5 — stop read at second transit symbol in flow mode
6 — buffered read, demand and buffer flow modes

AAA: Branching address on Can't Read or non-encoded item signal

BBB: Branching address on End-of-File

CCC: Store address (MSD)

4-45. This instruction transfers characters from MICR documents directly to core storage, starting at the address specified by CCC. The information is represented in seven, twelve-character fields with the beginning amount symbol of the amount field stored in CCC + 83.

4-46. An N variant of 4 specifies that the entire document is to be read, while an N variant of 5 specifies that only those fields, up to and including the transit number, are to be read. When a Can't Read condition occurs, a binary coded 15 is inserted in core storage in place of the invalid character(s), and program control branches to AAb automatically.

4-47. When M is 1 and N is 4, the Can't Read branch (and validity check) is disabled after the second transit symbol is read. When M is 1 and N is 5, the Can't Read branch will be disabled after the first transit symbol, and reading will stop at the second transit symbol. When N is 4 or 5, a missing amount field will result in a Can't Read branch.

4-48. A Control Sorter instruction must follow an SRF instruction within a specified time (approximately 10 ms.) or the system will halt (see section 6).

4-49. If a Control Sorter instruction initiates a Stop Flow, or the batch ticket detection initiates a Stop Flow signal, the sorter feeder will be turned off. When an empty hopper condition exists, depression of the sorter END OF FILE switch and the sorter START switch will transfer control to the BBb address of the Sorter Read Flow instruction. If a Stop Flow is initiated by a CTL instruction, the sorter feeder will be turned off and approximately three documents will be in the transport system of the sorter-reader. These documents must be processed. If the batch ticket detection device initiated a Stop Flow, the flow is stopped at the feeder by the batch ticket detector and no more items will be fed until a Start Flow is initiated by a Control Sorter instruction. The automatic End-of-File (BBb) exit must always be used in conjunction with a Stop Flow instruction or batch ticket detection. Start Flow can not be re-initiated within 300 milliseconds following a Stop Flow or batch ticket detection.

4-50. If a document reaches the read head before the SRF instruction is executed, all checks in the transport will reject, the feeder will turn off, and the sorter NO FEED indicator will light.

4-51. **SORTER READ DEMAND AND BUFFERED FLOW READ.** The format for this instruction is:

SRD # M N AAb BBb CCC Set to Equal

4-52. This instruction is used for either demand mode or buffered flow mode. It differs from the

SRF instruction by an N variant of 6. Execution of the SRD instruction transfers MICR characters from the buffer to core storage, starting at the location specified by CCC. The information is formatted into seven, twelve-character fields. The beginning amount symbol will be in CCC + 83. A Control Sorter instruction must be used with the SRD instruction.

4-53. When M equals 1, the Can't Read branch (and validity check) is disabled after the second transit symbol is read. When a Can't Read condition occurs, program control branches to AAb automatically. An End-of-File condition may be initiated by the same technique described in the Sorter Read Flow discussion, starting with paragraph 4-44.

4-54. As in the Sorter Read Flow instruction, the low-order positions of the AAA and BBB addresses may be used for storage (refer to paragraph 4-90).

4-55. **CONTROL SORTER.** The format for this instruction is:

CTL C M N bbb bbb bbb Set to Equal
where:

O: Operation Code; C — machine language, CTL — symbolic

M: Determines type of control (0, 2, 4, 6, 7, 8)

N: Selects pocket (0-11, 15)

AAA: Available to programmer

BBB: Available to Programmer

CCC: Available to programmer

4-56. This instruction controls the pocket selection of items and maintains the mode of sorting (SRF and SRD). The M variant is used to designate the following types of control:

a. 0 — pocket select only (as designated by the N variant).

b. 2 — demand feed and pocket select, (B 102 only).

c. 4 — stop flow and pocket select.

d. 6 — start flow and pocket select.

e. 7 — start buffered flow and pocket select.

f. 8 — increase batch counter by 1 (B 103).

4-57. The N variants of 0 through 9, #, @, and ǂ corresponds to pockets 0 through 9, X, Y, and R (reject) on the sorter-reader.

4-58. If a pocket select instruction has not been completed within 10 milliseconds after a document has reached the control point (beam-of-light) in flow mode, this document and all subsequent documents will reject. The feeder will turn off and the sorter indicator will light. This is termed an overlength program error.

Magnetic Tape Instructions

4-59. The machine language operation code for this instruction is the character D. The M variant is used to designate the type of tape instruction and the N variant (1-6) selects the proper magnetic tape unit.

4-60. **MAGNETIC TAPE READ.** The format for this instruction is:

TRD D M N AAb BBb CCC Set to Equal
where:

O: Operation Code; D — machine language, TRD — symbolic

M: 1

N: Unit designation (1-6)

AAA: Branching address on read error

BBB: Branching address on tape mark (End-of-File)

CCC: Store address (MSD)

4-61. This instruction is identified by the M variant 1. The instruction reads data from the magnetic tape unit, specified by the N variant (1-6), into core storage starting at CCC, up to the first inter-record gap encountered. When this gap is sensed, reading will stop and a group mark (ǂ) will be stored in memory following the last information character read. If a parity error (either vertical or logitudinal) occurs during reading, the program will branch to the address specified by AAb. An End-of-File record (ǂ) will be sensed automatically and the program will branch to the BBb address after completion of the read instruction. A tape read error branch takes precedence over an End-of-File branch. Characters which produce parity errors during input, will be translated to the question mark code in memory (8, 4 configuration).

4-62. **MAGNETIC TAPE WRITE.** The format for this instruction is:

TWR D M N AAA BBb CCb Set to Equal

where:

O: Operation Code; D — machine language, TWR — symbolic

M: 2

N: Unit designation (1-6)

AAA: Transfer-from address (MSD)

BBB: Branch on Physical-End-of-Tape

CCC: Branch address on write error

4-63. This instruction is identified by an M variant of 2. The execution of this instruction causes the data beginning at the AAA address, up to but not including the first group mark, to be written onto magnetic tape. The tape unit is specified by the N variant (1-6). If Physical-End-of-Tape is sensed during a write instruction, the program will branch to the instruction specified by BBb, after execution. The routine starting in BBb should, among other things, write an EOF record on the tape. A tape write error will cause the program to branch immediately to the instruction specified by the CCb address, and takes precedence over a Physical-End-of-Tape branch. All tape records must be at least seven characters long in memory, including the group mark, with the exception of End-of-File records which must contain only two characters, EOF and group mark. The character, question mark (?) will be translated to the BCL Character representing greater than and equal to during output to tape.

4-64. **MAGNETIC TAPE ERASE.** The format for this instruction is:

TER D M N AAA BBb bbb Set to Equal
where:

O: Operation Code; D — machine language, TER — symbolic

M: 3

N: Unit designation (1-6)

AAA: MSD of pseudo record

BBB: Branching address on End-of-Tape

CCC: Available to programmer

4-65. This instruction is identified by the M variant 3. This instruction causes the tape unit identified by N (1-6) to erase forward until a group mark is encountered in core storage. AAA will usually be the address of the record on which a write error occurred, thus ensuring that the corresponding length of tape is erased. This instruction is used in a corrective routine which will first backspace the tape to the end of the preceding record and attempt to re-write this record. If repeated attempts to write the record fail, a TER instruction will be given to cause the tape to move forward, erasing all recorded data (erroneous) previously written. The erase operation will stop when a group mark is encountered in storage. This will ensure that the record previously written on tape will be erased. The correction routine should also make provision for writing the record that was not written correctly the first time, or branch back to the original TWR instruction. The program will branch to the instruction specified by BBb if the End-of-Tape mark is encountered during the erase operation. An area of erased tape will have no effect upon the reading of the tape in a subsequent operation since the unit will consider it to be part of the normal inter-record gap.

4-66. **MAGNETIC TAPE BACKSPACE.** The format for this instruction is:

BSP D M N bbb bbb bbb Set to Equal
where:

O: Operation Code; D — machine language, BSP — symbolic

M: 4

N: Unit designation (1-6)

AAA: Available to programmer

BBB: Available to programmer

CCC: Available to programmer

4-67. The M variant must be 4. Backspace the tape on the unit designated by the N variant (1-6) to the preceding inter-record gap. If a backspace is executed at Physical-Beginning-of-Tape, the unit referenced will go into a Not Ready status.

4-68. **MAGNETIC TAPE REWIND.** The format for this instruction is:

RWD D M N bbb bbb bbb Set to Equal
where:

O: Operation Code; D — machine language, RWD — symbolic

M: 5

N: Unit designation (1-6)

AAA: Available to programmer

BBB: Available to programmer

CCC: Available to programmer

4-69. The M variant is 5. This instruction causes the tape on the unit specified by the N variant (1-6) to be rewound. Rewind speed is 320 inches per second and is accomplished independently of the central processor.

Arithmetic Instructions

4-70. Add, Subtract, Multiply, and Divide instructions are standard on B 200 Series Systems. These four instructions perform all necessary arithmetic operations.

4-71. In all arithmetic instructions, the M and N variants (1-@) specify the number of digits in the AAA and BBB fields respectively. When either M or N is blank (b) or 0, the length of the associated field is 12 digits.

4-72. The comparison indicators are set at the completion of each arithmetic instruction to correspond to one of the three conditions that can result from the execution of the instruction. The three conditions are; high or greater than zero, equal or zero, and low or less than zero.

4-73. In all arithmetic instructions, the signs of all fields are located in the LSD (units) position; zone bits other than in the units position of the fields starting at AAA and BBB will not be considered or stored in the result.

4-74. SIGN CONTROL. All arithmetic instructions resulting in significant digits in the result field are algebraically performed as illustrated in figures 4-2 through 4-5.

4-75. OVERFLOW. An overflow occurs when the result of executing an Add or Subtract instruction exceeds the size of the longest field. The only value that the overflow can ever represent is 1. Overflows are not detected in the central processor and their detection must be provided for by the programmer. This may be accomplished by increasing the length of the longest field by one position (the length and value of which must be known to the programmer in advance) which will, in turn, increase the size of the result field. Following the execution of either an Add or Subtract instruction, the value of the high-order position of the CCC field can be compared with the known value of the extended field. If a variance exists, an overflow occurred.

A FIELD	+	+	−	−
B FIELD	+	−	+	−
RESULT	+	SIGN OF GREATER		−

Figure 4-2. Sign Control, Addition

A FIELD	+	+	−	−
B FIELD	+	−	+	−
RESULT B > A	−	+	−	+
RESULT A > B	+	+	−	−

Figure 4-3. Sign Control, Subtraction

MULTIPLICAND (A)	+	+	−	−
MULTIPLIER (B)	+	−	+	−
PRODUCT	+	−	−	+

Figure 4-4. Sign Control, Multiplication

DIVIDEND (A)	+	+	−	−
DIVISOR (B)	+	−	+	−
QUOTIENT	+	−	−	+
REMAINDER	+	+	−	−

Figure 4-5. Sign Control, Division

4-76. DECIMAL POINT CONTROL. The B 200 and any other computer that operates with "fixed point" logic does not process data and keep track of the location of the decimal point. For example, 4725 could mean $47.25, $4.725, $.4725, etc. The value placed on the data must be known to the programmer.

4-77. **ADD.** The format for this instruction is:

ADD 1 M N AAA BBB CCC Conditioned where:

O: Operation Code; 1 — machine language, ADD — symbolic

M: Length of A field: 1-11, 12 is denoted by a 0 or blank

N: Length of B field: 1-11, 12 is denoted by a 0 or blank

AAA: Addend address (MSD)

BBB: Augend address (MSD)

CCC: Sum address (MSD)

4-78. This instruction adds the numeric contents of the field starting at AAA to the numeric contents of the field starting at BBB and stores the result in the field starting at CCC. The length of CCC will equal the larger of the M and N variants. Figures 4-6 through 4-9 illustrate the results of several additions.

OP	M	N	AAA	BBB	CCC
1	3	4	100	200	300

	BEFORE	AFTER
AAA	018+	018+
BBB	7018+	7018+
CCC	018+	7036+
COMP. INDIC.		High

Figure 4-6. Normal Addition

OP	M	N	AAA	BBB	CCC
1	3	5	100	200	300

	BEFORE	AFTER
AAA	072+	072+
BBB	42100—	42100—
CCC	72978	42028—
COMP. INDIC.		Low

Figure 4-7. Addition With Negative B Field

OP	M	N	AAA	BBB	CCC
1	3	3	100	200	300

	BEFORE	AFTER
AAA	909+	909+
BBB	181+	181+
CCC	xxx	090+
COMP. INDIC.	High	High

Figure 4-8. Addition with Carry Lost due to Insufficient Field Length

OP	M	N	AAA	BBB	CCC
1	2	2	100	200	300

	BEFORE	AFTER
AAA	09—	09—
BBB	02—	02—
CCC	xx	11—
COMP. INDIC.	Equal	Low

Figure 4-9. Adding Two Negative Amounts

4-79. Notice, in the examples of "alpha addition" (figures 4-10 and 4-11), that the LSD of the field added makes a difference in whether the answer is positive or negative. This is caused by the computer's logic scan of the B bit position and actual addition of the numeric portions of the character. Refer to appendix B for character values.

OP	M	N	AAA	BBB	CCC
1	3	4	100	200	200

	BEFORE	AFTER
AAA	SAD+	SAD+
BBB	GLAD+	GLAD+
CCC	GLAD+	7528+
COMP. INDIC.	Equal	High

Figure 4-10. Adding Alphabetic Characters, Example 1

OP	M	N	AAA	BBB	CCC
1	2	4	100	200	300

	BEFORE	AFTER
AAA	UP—	UP—
BBB	DOWN—	DOWN—
CCC	xxxx	4712—
COMP. INDIC.	Equal	Low

Figure 4-11. Adding Alphabetic Characters, Example 2

4-80. **SUBTRACT.** The format for this instruction is:

SUB 2 M N AAA BBB CCC Conditioned

where:

O: Operation Code; 2 — machine language, SUB — symbolic

M: Length of A field: 1-11; 12 denoted by a 0 or blank

N: Length of B field: 1-11; 12 denoted by a 0 or blank

AAA: Minuend address (MSD)

BBB: Subtrahend address (MSD)

CCC: Difference address (MSD)

4-81. This instruction subtracts the numeric contents of the field starting at BBB from the numeric contents of the field starting at AAA and stores the numeric result in the field starting at CCC. The length of CCC will be equal to that specified by the larger of the M and N variants. Figures 4-12 through 4-16 illustrate the results of several subtractions.

OP	M	N	AAA	BBB	CCC
2	3	3	100	200	300

	BEFORE	AFTER
AAA	062+	062+
BBB	014+	014+
CCC	xxx	048+
COMP. INDIC.	Equal	High

Figure 4-12. Normal Subtraction

OP	M	N	AAA	BBB	CCC
2	3	3	100	200	300

	BEFORE	AFTER
AAA	029—	029—
BBB	035—	035—
CCC	xxx	006+
COMP. INDIC.	Low	High

Figure 4-13. Subtraction with Negative A and B Fields

OP	M	N	AAA	BBB	CCC
2	3	2	100	200	300

	BEFORE	AFTER
AAA	121+	121+
BBB	71—	71—
CCC	xxx	192+
COMP. INDIC.	Low	High

Figure 4-14. Subtraction with Negative B Field

OP	M	N	AAA	BBB	CCC
2	4	3	100	200	300

	BEFORE	AFTER
AAA	GLAD+	GLAD+
BBB	CAR—	CAR—
CCC	xxxx	7633+
COMP. INDIC.	High	High

Figure 4-15. Alphabetic Subtraction

OP	M	N	AAA	BBB	CCC
2	3	3	100	200	300

	BEFORE	AFTER
AAA	138+	138+
BBB	259+	259+
CCC	xxx	121—
COMP. INDIC.	Low	Low

Figure 4-16. Subtraction, B Greater than A

4-82. **MULTIPLY.** The format for this instruction is:

MUL 3 M N AAA BBB CCC Conditioned

where:

O: Operation Code; 3 — machine language, MUL — symbolic

M: Length of A field: 1-11; 12 is denoted by a 0 or blank

N: Length of B field: 1-11; 12 is denoted by a 0 or blank

AAA: Multiplicand address (MSD)

BBB: Multiplier address (MSD)

CCC: Product address (MSD)

4-83: This instruction multiplies the numeric contents of the field starting at AAA by the numeric contents of the field starting at BBB and stores the numeric result in the field starting at CCC. The length of the CCC field is the sum of the M and N digits. Figures 4-17 through 4-18 illustrate the result of two multiplications.

OP	M	N	AAA	BBB	CCC
3	4	3	100	200	300

	BEFORE	AFTER
AAA	3487+	3487+
BBB	921—	921—
CCC	xxxxxxx	3211527—
COMP. INDIC.	Equal	Low

Figure 4-17. Multiplication of Unlike Signs

OP	M	N	AAA	BBB	CCC
3	4	2	100	200	300

	BEFORE	AFTER
AAA	1426—	1426—
BBB	AM—	AM—
CCC	xxxxxx	019964+
COMP. INDIC.	Equal	High

Figure 4-18. Multiplication of Like Signs, Alphabetic Multiplier

4-84. As may be noted in figure 4-19, the result of multiplication appears right justified in the CCC field.

OP	M	N	AAA	BBB	CCC
3	4	2	100	200	300

	BEFORE	AFTER
AAA	1324+	1324+
BBB	11+	11+
CCC	329416—	014564+
COMP. INDIC.	Equal	High

Figure 4-19. Multiplication of Like Signs

4.85. **DIVISION.** The format for this instruction is:

DIV 4 M N AAA BBB CCC Conditioned

where:

O: Operation code; 4—machine language, DIV—symbolic

M: Length of A field: 1-11, 12 is denoted by a 0 or blank

N: Length of B field: 1-11; 12 is denoted by a 0 or blank.

AAA: Dividend address (MSD)

BBB: Divisor address (MSD)

CCC: Quotient address (MSD)

4-86. This instruction divides the numeric contents of the field starting at AAA by the numeric contents of the field starting at BBB and stores the numeric result in the field starting at CCC. The dividend, AAA, will be set to zero and the remainder stored in AAA, right justified. The CCC length is determined by the difference between M and N (e.g., CCC will be four characters long when M is nine and N is five).

4-87. The absolute value of the divisor must be greater than the absolute value of the corresponding high-order positions of the dividend, otherwise, the resulting quotient will be zero and the dividend modified. For example, if 75 were divided by 3, the result will be zero since the quotient can not be expressed in one position (length of dividend—length of divisor). However, if 075 were divided by 3, the result would be 25.

4-88. Anytime the M and N variants are equal in a Divide instruction, the unit will halt prior to executing the instruction and will display the operation code on the central processor control console. Figures 4-20 through 4-25 illustrate the results of several divisions.

OP	M	N	AAA	BBB	CCC
4	4	1	100	200	300

	BEFORE	AFTER
AAA	0101+	0002+
BBB	9+	9+
CCC	xxxx	011+
COMP. INDIC.	Low	High

Figure 4-20. Normal Division

OP	M	N	AAA	BBB	CCC
4	5	2	100	200	300

	BEFORE	AFTER
AAA	00187—	00007—
BBB	12—	12—
CCC	xxx	015+
COMP. INDIC.	High	High

Figure 4-21. Division With Negative Dividend and Divisor

OP	M	N	AAA	BBB	CCC
4	5	3	100	200	300

	BEFORE	AFTER
AAA	03920+	00140+
BBB	180—	180—
CCC	xx	21—
COMP. INDIC.	Equal	Low

Figure 4-22. Division With Negative Divisor

OP	M	N	AAA	BBB	CCC
4	4	3	100	200	300

	BEFORE	AFTER
AAA	AR1B+	0928+
BBB	9QD+	9QD+
CCC	x	1+
COMP. INDIC.	High	High

Figure 4-23. Alphabetic Division

OP	M	N	AAA	BBB	CCC
4	4	4	100	200	300

	BEFORE	AFTER
AAA	0452+	0452+
BBB	0012+	0012+
CCC	xxxx	xxxx
COMP. INDIC.	Low	Equal

Figure 4-24. Division where M and N Variants are Equal

OP	M	N	AAA	BBB	CCC
4	5	3	100	200	300

	BEFORE	AFTER
AAA	29451+	xxxxxx
BBB	017+	017+
CCC	xx	00+
COMP. INDIC.	Equal	Equal

Figure 4-25. Division where the Absolute Value of the Divisor is not Greater than Absolute Value of the Corresponding High Order Positions of the Dividend

Control Instructions

4-89. Unlike the previously discussed instructions which use data to provide an end result, the control instructions are used to analyze program operation and to control program routines. There are four basic control instructions, namely:

a. Branch.

b. Compare.

c. Halt.

d. No Operation.

Branching

4-90. There are two types of branching instructions: Branch Conditional and Branch Unconditional. Using the Branch Conditional instruction, the central processor interrogates the comparison indicators and branches (transfers control) to one of three addresses (AAb, BBb, and CCb) as a result of the instruction executed. Branch Unconditional causes the program to branch to the instruction located at the AAA address, regardless of the setting of the comparison indicators. Since the AAb, BBb, and CCb addresses of a branch conditional will always refer to an instruction location, the LSD of each address will be considered to be zero by the central processor, unless it exceeds BCD 11. If the LSD exceeds BCD 11, a carry of 1 into the tens position will result.

4-91. **BRANCH CONDITIONAL.** The format for this instruction is:

BRC 6 M N AAb BBb CCb Not Affected

where:

O: Operation Code; 6—machine language, BRC—symbolic

M: 0

N: 0—no interrogation for third transit symbol (or with no sorter)

AAA: Branch address if comparison indicators are low or less than 0 (negative)

BBB: Branch address if comparison indicators are equal or zero

CCC: Branch address if comparison indicators are high, or greater than zero (positive)

4-92. This instruction is identified by the M variant 0. The comparison indicators determine which one of the three addresses the program will branch to. The program will branch to AAb if the comparison indicators are set to low or minus. The program will branch to BBb if the comparison indicators are set to equal or zero. The program will branch to CCb if the comparison indicators are set to high or plus. When a minus zero results from an arithmetic operation, control will be transferred to the BBb address.

4-93. **BRANCH UNCONDITIONAL.** The format for this instruction is:

BRU 6 M N AAb BBb bbb Not Affected

where:

- O: Operation Code; 6—machine language, BRU—symbolic
- M: 1—unconditional branch
- N: 0—no interrogation for third transit symbol (piggyback item), or when no sorter-reader is used.

  1—interrogate for third transit symbol
- AAA: N=0, branch address on unconditional branch

  N=1, branch address if interrogation shows no third transit symbol (piggyback item)
- BBB: N=0, available to programmer

  N=1, branch address if interrogation detects a third transit symbol (piggyback item)
- CCC: Available to programmer

4-94. This instruction is identified by an M variant of 1. With an N variant of 0 or blank, the program will branch automatically to the instruction located at AAb, regardless of the setting of the comparison indicators, prior to the execution of the instruction. An N variant of 1 is used to provide control over double feeding of documents in the B 102/B 103 Sorter-Reader.

4-95. Due to extremely bad items, the sorter-reader may double feed a document (called a piggyback item). The logic of the sorter, combined with the logic of the central processor, perform a test of the item being read and check for the presence of piggyback items. The BBb branch address will be taken should the previous Read instruction detect a piggyback item. Control will Branch Unconditionally to the AAb address if a double document has not been detected.

4-96. The branch control instruction can be employed at both the normal exit as well as the Can't Read exit of the sorter-reader instruction. It should be noted that the sorter double document detection feature is always in effect and cannot be programed out of the Read instruction.

Comparing

4-97. This instruction is used in two ways; controlling and sequencing. Controlling is accomplished by comparing two fields and then branching. The branch will be determined by comparison indicators, usually based on either a comparison or an arithmetic operation. Sequencing permits the programmer to check the sequence of the input data and to arrange the data internally.

4-98. The following types of comparisons may be performed by the central processor; alphabetic, zone, and numeric. The selected type of comparison is identified by the M variant. Alphabetic comparison is a comparison of both the numeric and zone bits of every character in the two fields being compared. Zone comparison is a comparison of the zone bits only (A and B); numeric comparison is a comparison of the numeric bits only (8, 4, 2, 1). The N variant designates the length of the AAA and BBB fields, both of which must be the same.

4-99. The three types of comparisons are made for either an equal or unequal condition, branching as a result of the comparison. For example, if the instruction was for an alphabetic comparison with a branch-on-equal designation, the AAA field would be compared to the BBB field and, if the fields were equal, control would immediately branch to the address specified by CCC. If either of the other two conditions (high or low) had been set, control would continue to the instruction immediately following the Compare instruction. Had the instruction specified a branch-on-unequal comparison, control would branch to CCC if the AAA and BBB fields were unequal.

4-100. The collating sequence for the alphabetic comparison is shown in abbreviated form in figure 4-26.

Special Characters		
12 Zone	A-I Alphabetic	A, No B
11 Zone	J-R Alphabetic	B, No A
0 Zone	S-Z Alphabetic	A, B
No Zone	0-9 Numeric	No A, No B

Figure 4-26. Collating Sequence

4-101. The numeric comparison is performed on a binary configuration of the 8, 4, 2, and 1 bits only. The comparison works on a low of zero to a high of 15.

4-102. The zone comparison is performed on the A and B bits of a character only. The sequence is illustrated in figure 4-27.

A bit	LOW
B bit	
A and B bit	
No A or B bit	HIGH

Figure 4-27. Zone Comparison Collating Sequence

4-103. **COMPARE ALPHABETIC, BRANCH ON EQUAL.** The format for this instruction is:

CAE 5 M N AAA BBB CCb Conditioned

where:

O: Operation Code; 5—machine language, CAE—symbolic

M: 0—alpha compare, branch on equal

N: Length of A and B field; 1-11, 12 denoted by a 0 or blank

AAA: Address of field to be compared (MSD)

BBB: Address of field to be compared with (MSD)

CCC: Branch address if field A equal to field B

4-104. This instruction is identified by an M variant of 0. It makes an alphabetic comparison of the field beginning at AAA to the field beginning at BBB (zone bits and numeric bits). The N variant designates the length of both fields (1 -@, 0). If the field contents are equal, branch to CCb; if not, execute the next instruction in sequence. Two examples of the CAE instruction are provided in figures 4-28 and 4-29.

OP	M	N	AAA	BBB	CCC
5	0	5	100	200	xxx

	BEFORE	AFTER
AAA	SMILE+	SMILE+
BBB	FROWN—	FROWN—
CCC	xxx	xxx
COMP. INDIC.		High
No Branch		

Figure 4-28. Alphabetic Comparison for Equal, No Branch on Unequal

OP	M	N	AAA	BBB	CCC
5	0	5	100	200	xxx

	BEFORE	AFTER
AAA	79267+	79267+
BBB	79267+	79267+
CCC	xxx	xxx
COMP. INDIC.		Equal
Branch to instruction at xxx		

Figure 4-29. Alphabetic Comparison for Equal, Branch on Equal

4-105. **COMPARE ZONE, BRANCH ON EQUAL.** The format for this instruction is:

CZE 5 M N AAA BBB CCb Conditioned

This instruction is identified by an M variant of 1. It compares only the zone bits (A and B bits) in the fields beginning at AAA and BBB. The N variant designates the length (1-@, 0) of both fields. If the contents of both fields are equal, branch to CCb; if equal, execute the next instruction in sequence. Figures 4-30 and 4-31 illustrate two results of zone comparison for equal.

OP	M	N	AAA	BBB	CCC
5	1	3	100	200	xxx

	BEFORE	AFTER
AAA	EF3	EF3
BBB	A62	A62
CCC	xxx	xxx
COMP. INDIC.		LOW
No Branch		

Figure 4-30. Zone comparison for Equal, No Branch on Unequal

OP	M	N	AAA	BBB	CCC
5	1	3	100	200	xxx

	BEFORE	AFTER
AAA	24A	24A
BBB	79B	79B
CCC	xxx	xxx
COMP. INDIC.		Equal
Branch to instruction at xxx		

Figure 4-31. Zone Comparison for Equal, Branch on Equal

OP	M	N	AAA	BBB	CCC
5	2	1	100	200	xxx

	BEFORE	AFTER
AAA	6	6
BBB	F	F
CCC	xxx	xxx
COMP. INDIC.		EQUAL
Branch to instruction at xxx		

Figure 4-32. Numeric Comparison for Equal, Branch on Equal

OP	M	N	AAA	BBB	CCC
5	2	1	100	200	xxx

	BEFORE	AFTER
AAA	6	6
BBB	G	G
CCC	xxx	xxx
COMP. INDIC.		Low
No Branch		

Figure 4-33. Numeric Comparison for Equal, No Branch on Unequal

4-106. **COMPARE NUMERIC, BRANCH ON EQUAL.** The format for this instruction is:

CNE 5 M N AAA BBB CCb Conditioned

This instruction is identified by an M variant of 2. It compares only the numeric bits (8, 4, 2, 1) of all characters in the field beginning at AAA and BBB. The N variant designates the length of both fields. If the numeric bits of all characters in both fields are equal, branch to CCb; if unequal, execute the next instruction in sequence. Figures 4-32 and 4-33 illustrate the results of numeric comparisons for equal.

4-107. **COMPARE ALPHABETIC, BRANCH ON UNEQUAL.**

The format for this instruction is:

CAU 5 M N AAA BBB CCb Conditioned

This instruction is identified by an M variant of 4. It alphabetically compares the contents of the fields beginning at AAA and BBB. The N variant designates the length of both fields. If the fields are not equal, branch to CCb; if equal, execute the next instruction in sequence. Figures 4-34 and 4-35 illustrate the results of two alphabetic comparisons for unequal.

OP	M	N	AAA	BBB	CCC
5	4	2	100	200	xxx

	BEFORE	AFTER
AAA	12+	12+
BBB	12+	12+
CCC	xxx	xxx
COMP. INDIC.		Equal
No Branch		

Figure 4-34. Alphabetic Comparison for Unequal, No Branch on Equal

OP	M	N	AAA	BBB	CCC
5	4	2	100	200	xxx

	BEFORE	AFTER
AAA	12+	12+
BBB	17+	17+
CCC	xxx	xxx
COMP. INDIC.		Low
Branch to instruction at xxx		

Figure 4-35. Alphabetic Comparison for Unequal, Branch on Unequal

OP	M	N	AAA	BBB	CCC
5	5	3	100	200	xxx

	BEFORE	AFTER
AAA	2F3	2F3
BBB	A62	A62
CCC	xxx	xxx
COMP. INDIC.		High
Branch to instruction at xxx		

Figure 4-36. Zone Comparison for Unequal, Branch on Unequal

OP	M	N	AAA	BBB	CCC
5	5	3	100	200	xxx

	BEFORE	AFTER
AAA	24A	24A
BBB	79B	79B
CCC	xxx	xxx
COMP. INDIC.		Equal
No Branch		

Figure 4-37. Zone Comparison for Unequal, No Branch on Equal

4-108. COMPARE ZONE, BRANCH ON UNEQUAL.

The format for this instruction is:

CZU 5 M N AAA BBB CCb Conditioned

This instruction is identified by an M variant of 5. It compares only the zone bits (A and B bits) in the fields beginning at AAA and BBB. The N variant designates the length of both fields (1-@, 0). If the contents of both fields are not equal, branch to CCb; if equal, execute the next instruction in sequence. Two examples of this type of Compare are illustrated in figures 4-36 and 4-37.

4-109. COMPARE NUMERIC, BRANCH ON UNEQUAL.

The format for this instruction is:

CNU 5 M N AAA BBB CCb Conditioned

This instruction is identified by an M variant of 6. The instruction causes a comparison of the numeric bits (8, 4, 2, 1) in the fields beginning at AAA and BBB. The N variant determines the number of characters to be compared. If the numeric bits are unequal, branch to CCb; if equal, execute the next instruction in sequence. Figures 4-38 and 4-39 illustrate the results of two numeric comparisons for unequal.

OP	M	N	AAA	BBB	CCC
5	6	3	100	200	xxx

	BEFORE	AFTER
AAA	327	327
BBB	CBP	CBP
CCC	xxx	xxx
COMP. INDIC.		Equal
No Branch		

Figure 4-38. Numeric Comparison for Unequal, No Branch on Equal

OP	M	N	AAA	BBB	CCC
5	6	3	100	200	xxx

	BEFORE	AFTER
AAA	496	496
BBB	396	396
CCC	xxx	xxx
COMP. INDIC.		High
Branch to instruction at xxx		

Figure 4-39. Numeric Comparison for Unequal, Branch on Unequal

Halt and No Operation

4-110. The Halt and No Operation instructions are used to modify and/or control various routines with a minimum of operator intervention. By means of the M and N variants in the Halt instruction which are displayed on the central processor control console, the operator may be instructed to change magnetic tapes, change paper forms, or be alerted to any error condition that exists in the input data, etc. The No Operation instruction is normally used as a means of by-passing an instruction. This is done by coding the program so that under certain conditions, a blank or $\overset{+}{0}$ (Op Code for No Operation) is transferred into the Op Code position of another instruction. Assuming its instruction was a BRU, it will now be by-passed and the program will continue in sequence and not branch out. Usually, the first instruction following this modified BRU will set the instruction Op Code back to its original Op Code.

4-111. **HALT.** The format for this instruction is.

HLT 9 M N bbb bbb bbb Not Affected

where:

O: Operation Code; 9—machine language, HLT—symbolic

M: 0-15

N: 0-15

AAA: Available to programmer

BBB: Available to programmer

CCC: Available to programmer

4-112. This instruction halts the entire system after all operations in progress have been executed. The M and N variants may be any binary-coded digit 0-15. The central processor control console will display the Op Code, and the M and N digits of the instruction.

4-113. When used in conjunction with the B 102/B 103 Sorter-Reader, any M variant having a 1-bit on will cause a sorter-reader pocket light, as indicated by the N variant, to light while the system is stopped.

4-114. **NO OPERATION.** The format for this instruction is:

NOP b or $\overset{+}{0}$ b b bbb bbb bbb Not Affected

where:

O: Operation Code; b or $\overset{+}{0}$—machine language, NOP—symbolic

M: Available to programmer

N: Available to programmer

AAA: Available to programmer

BBB: Available to programmer

CCC: Available to programmer

When this instruction is encountered, no action is taken and the program proceeds to the next instruction in sequence.

Editing Instructions

4-115. The editing instructions play an important role in the B 200 Series Systems. With the two editing instructions, Transfer and Mask, the programmer is able to accomplish formatting and transferring of data with a minimum amount of effort.

4-116. **TRANSFER.** The format for this instruction is:

TFR 7 M N AAA bbb CCC Not Affected

where:

O: Operation Code; 7—machine language, TFR—symbolic

M: Number of 12-character words: 0-9

N: Number of remaining characters: 1-11; 12 is denoted by a 0 or blank

AAA: Address of information to be transferred (MSD)

BBB: Available to programmer

CCC: Address to which information is to be transferred (MSD)

4-117. This instruction will transfer up to 120 characters of information from the field beginning at AAA to the field beginning at CCC. The number of characters to be transferred is determined by the M and N variants. The M variant (1-9 and 0) designates the number of 12-character fields to be transferred. The N variant (0-9, #, and @) designates the number of characters, 0-11. When M and N are both zero or blank, 120 characters will be transferred. An example of a Transfer instruction is illustrated in figure 4-40.

OP	M	N	AAA	BBB	CCC
7	0	3	100	xxx	200

	BEFORE	AFTER
AAA	123+	123+
BBB	xxx	xxx
CCC	xxx	123+
COMP. INDIC.	NOT AFFECTED	

Figure 4-40. Transfer of Data

4-118. **MASK.** The format for this instruction is:

MSK 8 M b AAA BBB CCC Set to Equal

where:

O: Operating Code; 8—machine language, MSK—symbolic

M: Length of AAA: 1-11; 12 is denoted by a 0 or blank

N: Reserved for expansion—must be left blank

AAA: Address of field to be masked (MSD)

BBB: Address of mask (MSD)

CCC: Address of masked field (MSD)

4-119. This instruction transfers the contents of the field beginning at AAA to the field beginning at CCC, masking the information according to the mask in the field beginning at BBB. The M variant (1-9, #, @, and b or 0) determines the length of the AAA field, the maximum length of which is 12 digits. The length of the CCC field is the sum of the number of characters in the data field (AAA) plus the sign, plus the number of the following characters:

a. Dollar ($).

b. Comma (,).

c. Decimal point (.).

A typical mask would be:

$ * * * , b b b , b b b . b b -

4-120. The purpose of this instruction is to insert ($), (,), and (.)'s and enable zero suppression in numeric data. Zero suppression results from substitution of the mask character in place of each non-significant zero of the source (AAA). Should a character with zone bits occur in the source field, only its numeric bits are transferred to the result (CCC). The exception to this is the sign (low order position). An example of zero suppression is illustrated in figure 4-41.

Information	0 0 0 8 4 3 0
Mask	b b , b b b . b b —
Result	8 4 . 3 0 b

Figure 4-41. Zero Suppression

4-121. The first character transferred to the CCC field is the first character of the mask (BBB) except for the following:

a. If the first character of the mask (BBB) is a comma, the first character of result (CCC) will be a zero. This zero cannot be suppressed.

b. If the first source (AAA) character is non-zero and the first mask (BBB) character is not a ($) or (.), the first character of the result (CCC) is the first character of the source field (AAA).

4-122. In regions of non-significant zeros in the source (AAA), the corresponding mask character replaces each zero in the result (CCC). The previous mask character replaces commas in the mask.

4-123. A decimal point in the mask (BBB) or a non-zero digit in the source (AAA) establishes significance. Thereafter, digits are transferred from the source with dollar signs, commas, and decimal points inserted as such from the mask.

4-124. The decimal point position in a mask identifies the end of leading zero suppression. These positions in the mask, located to the right of the decimal point, are available for storing constants or working storage. The characters stored in these positions will not be inserted in the masked field; however, the LSD of the mask will be inserted if the sign is negative. An example of this is illustrated in figure 4-42.

Information	0 0 1 0 7 0 $\bar{0}$
Mask	b b b . A B C D #
Result	1 . 0 7 0 0 #

Figure 4-42. Masking, Using Mask Position for Storage

4-125. The units position of the source field (AAA) is examined for sign control. If the units position contains a B bit, the sign character of the mask field (BBB) will be stored following the units position of the masked field (CCC). If the units position does not contain a B bit, a blank will be stored following the units position of the masked field (CCC). Figures 4-43 and 4-44 illustrate this point. It should also be noted that if leading zero suppression is not desired, zeros may be used in the mask instead of blanks.

Information	0 0 0 8 4 3 $\bar{0}$
Mask	0 0 , 0 0 0 . b b #
Result	0 0 0 0 8 4 . 3 0 #

Figure 4-43. Masking a Negative Quantity with Sign Control

Information	0 0 0 8 4 3 $\overset{+}{0}$
Mask	0 0 , 0 0 0 . b b —
Result	0 0 0 0 8 4 . 3 0 b

Figure 4-44. Masking a Positive Quantity with Sign Control

4-126. Since a decimal point establishes significance, ".00" will always result when masking a field which contains either zeros or blanks. In addition, if the field contains blanks, the sign character from the mask (BBB) will be printed immediately to the right of the low order digit of the masked field (CCC) since a blank character contains a B bit, therefore being interpreted as a minus.

4-127. Check protection asterisks can be stored in the masked field (CCC) by use of the Mask instruction. Figure 4-45 illustrates the manner in which this can be accomplished.

Information	0 0 0 8 4 3 $\overset{+}{0}$
Mask	$ * * * * * . b b —
Result	$ * * * 8 4 . 3 0 b

Figure 4-45. Masking, Asterisks to Left of Significant Digits

4-128. The field to be masked (AAA) must be the same length as the number of characters other than $. , and sign characters in the mask. If a ten-digit field is masked conventionally, the mask will be ten digits long, plus a dollar sign, two commas, a decimal, and a sign character for a total of 15 positions.

IMPROVED MODEL 0 CENTRAL PROCESSOR INSTRUCTIONS

4-129. The instructions listed below comprise the stored program capabilities of all Improved Model 0 Central Processors. To accommodate the added input/output capabilities of the Improved Model 0 Central Processors, additional as well as modified instructions are necessary. These instructions are denoted by an asterisk (*) and described in the paragraphs that follow:

4-130. **HALT (AND BRANCH).** This instruction format is the same as for Model 0 Central Processors. The instruction has been modified so that if the 2-bit of the M variant is on, the system will branch to the address specified by AAb when the system is restarted after the Halt has been executed. Thus the system will branch to AAb whenever the M variant is equal to 2, 3, 6, 7, B, C, F, etc. Whenever the system halts, with branching to take place upon resuming operation, the address stored in AAb of the Halt instruction will be displayed in the MEMORY ADDRESS register.

4-131. This modification to the Halt instruction does not change the function of the 1-bit of the M variant as applied to systems using the B 102 or B 103 Sorter-Reader. If the 1-bit is also on in the N variant, a sorter-reader pocket light, as indicated by the N variant, will light while the system is stopped.

4-132. **PRINT ON PRINTER.** The format for this instruction is:

PRT   A M N AAA BBb bbb   Not Affected

where:

O: Operation Code; A — machine language, PRT — symbolic

M: Form spacing after print and unit selection

Select Printer 1	*Select Printer 2 (Modular Option)*
0 — space suppress	4 — space suppress
1 — single space	5 — single space
2 — double space	6 — double space

*N: Form skipping after print; 1-11, where 0 is "no skip"

AAA: Print—from address (MSD)

BBB: Branching address on Page Overflow when N = 0

CCC: Available to programmer

4-133. New variants are added to this instruction in order to control two Line Printers. The 120 characters of data will be transferred to the buffer of each line printer starting at address

*On B 263, B 273 and B 283 Systems, a blank or any other character containing a B - bit in the N variant can never be used. A branch to the address in CCC will always be taken.

AAA. When the buffer is filled, one line of information will be printed. The comparison indicators are not affected by this instruction. The page format, spacing or skipping, is controlled by the M and N variants. Branching to address BBb will occur when a hole in the carriage tape, channel 12, has been sensed by a previous spacing operation (with or without printing).

4-134. Since skipping always takes precedence over spacing and page overflow 12-punches are not sensed during skipping, the BBb branch will not be taken during the execution of any print (or skip) instruction following a paper skip. When page overflow is taken, the paper will not move. On a sync or parity error, the next Print or Skip instruction that designates the printer containing the error will not be executed and the system will stop.

4-135. To use two B 321 Line Printers, the B 324 dual printer module must be installed in one of the line printers. Without this module, the 4-bit has no significance.

4-136. Designation of each printer is switch-set by the operator. When the switch is set to designate one printer as #1 and the other as #2, then the two printers will function independently. If the switch is set to activate both printers for every PRT instruction, commands for either designation will perform the same action on both printers simultaneously. Each printer contains its own buffer and both printers can operate at their rated speed. In order to place the second printer in operation (when using two printers), the first printer must be turned on.

4-137. **SKIP ON PRINTER.** The format for this instruction is:

SKP B M N bbb BBb bbb Not Affected

where:

O: Operation Code; B—machine language, SKP — symbolic

M: Controls form spacing and unit selection

Select Printer	*Select Printer 2 (Modular Option)*
0 — space suppress	4 — space suppress
1 — single space	5 — single space
2 — double space	6 — double space

*N: Form skipping; 1-11, where 0 is "no skip"

AAA: Available to programmer

BBB: Branch address on Page Overflow when N = 0

CCC: Available to programmer

4-138. New variants are added to this instruction to control the spacing and skipping of two B 321 Line Printers in one system. The instruction is used to space or skip in accordance with the digits in the M and N variants. A branch to address BBb will occur when a punch in the carriage tape channel 12 has been sensed by a previous space operation. The comparison indicators are not affected by the instruction. To use the two line printers, it is mandatory that a B 324 dual printer module be installed in one of the printers. If the module is not installed, the 4-bit will have no significance.

4-139. With the use of a switch, the operator can designate one printer as #1 and the other printer as #2. In this manner, the printers will function as independent units. However, if the switch is set to activate both printers on every printer instruction, commands for either designation will perform the same action on both printers simultaneously.

4-140. Both printers can operate at their rated speed. However, in order to use the second printer (not necessarily the printer designated as printer #2), the first printer must be turned on.

4-141. **ADDRESS MODIFICATION.** The format for this instruction is:

ADM J b b AAA BBB bbb Not Affected

where:

O: Operation Code; J — machine language, ADM — symbolic

M: Reserved for expansion — must be left blank

N: Reserved for expansion — must be left blank

AAA: The modifier (the quantity, not its address) 0 - 1199

*On B 263, B 273, and B 283 Systems, a blank or any other character containing a B-bit in the N variant can never be used. The system will always branch to the address in BBB.

BBB: Address of the three-character field to be modified (MSD)

CCC: Available to programmer

4-142. This instruction is used to increment one 3-character address, specified by BBB, by the quantity stored in the AAA address of the instruction. The address being incremented can be located anywhere in memory. However, the modified address cannot be relocated in memory by use of the ADM instruction. The quantity (AAA) is not altered when the instruction is executed.

4-143. When an address within an instruction is to be modified, B_1, B_2 (see figure 4-1) would specify the command, and B_3 would specify the address. If B_3 equals 3, the AAA address would be modified. If B_3 equals 6, the BBB address would be modified. If B_3 equals 9, the CCC address would be modified.

4-144. The modifier in AAA has a base-twelve units position and must be used in terms of words and characters. If an address is to be incremented by 14 character positions (1 word and 2 characters), AAA of the ADM instruction would be 012. The B 200 Assembler Program will convert total characters (0000-1199) to words and characters (000-99@). Figure 4-46 illustrates two methods of coding the ADM instruction. In the first example, the quantity (AAA) is given in symbolic language (38 characters). In the second example, the quantity is given in machine language (32 — meaning — three words and two characters).

NOTE

When coding the quality (AAA) in machine language, on B 263, B 273, B 283 Systems, always fill out the tens and hundreds positions with zeros when not required for word representation.

Illustrated below these two examples is the manner in which both ADM instruction would appear in the program listing.

Op 0 (7 8 9)	M 1 (10 11)	N 2 (12 13)	A Address 3 (PG 14 15, R 16, I 17)	B Address 6 (PG 18 19, R 20, I 21)	C Add[ress] 9 (PG 22 23)
ADM			0038	20KA	
ADM			M032	20KA	

```
O M N AAA BBB CCC
J     032 K03
```

Figure 4-46. Coding ADM Instruction

4-145. One modifying command must be executed for each address modified, therefore, three modification instructions are required to modify all three addresses of one instruction.

NOTE

The quantity added to an address to modify it is placed in the modifying (ADM) command in character positions AA — i.e., this AAA is not an address, but a quantity expressed in machine language. Additions are always add absolute.

4-146. The instruction automatically modifies three characters: the first and second characters of the modifier are base 10 while the third character is base 12. Zone bits over the units and tens positions of the address being modified are unaffected.

4-147. If modification creates an address greater than the maximum of the processor, it is translated as Mod 4800, (Mod 9600 on "double memory" systems) i.e., end-around-carry-over occurs. The comparison indicators are not affected by this command.

4-148. **TRANSFER ZONE.** The format for this instruction is:

TFZ P M N AAA bbb CCC Not Affected

where:

O: Operation Code; P — machine language, TFZ — symbolic

M: Number of 12-character fields (0-9)

N: Number of remaining characters (0-11)

AAA: Address of information to be transferred (MSD)

BBB: Available to programmer

CCC: Address to which information is to be transferred (MSD)

4-149. This instruction transfers the zones (A and B bits) of (12 M + N) characters of information from address AAA to address CCC. The AAA characters are not changed, and the digits of the CCC field are not changed.

4-150. A zero or blank in M or N denotes a field length of zero. When M and N are both equal to zero or blank, the zone bits of 120 characters are transferred. Transfer starts with the MSD of the field. The comparison indicators are not affected by this instruction.

4-151. **PAPER TAPE WRITE.** The format for this instruction is:

PWR E M N AAA BBb CCb Not Affected

where:

- O: Operation Code; E—machine language, PWR—symbolic
- M: 1—punch all holes (tape feed) for each character position
  - 2—punch until a designated control code on the punch is detected, or 80 characters are punched, whichever occurs first.
- N: Reserved for expansion—must be left blank
- AAA: Transfer-from address (MSD)
- BBB: Branch address on End-of-Paper detected during the preceding Paper Tape Write operation
- CCC: Branch on Not-Ready

4-152. This instruction will load the output buffer with 80 characters. The contents of the output buffer are punched, a character at a time, until a designated control code is detected or the buffer is empty. The comparison indicators are not affected by this instruction.

4-153. After the output buffer is loaded, the operation is independent of the processor. Should an End-of-Paper condition occur during a Paper Tape Write operation, the operation continues in the normal manner. The control codes are set up by the operator using pushbutton switches located on the paper tape punch. Branch on Not Ready takes precedence over branch on End-of-Tape.

4-154. **PAPER TAPE READ.** The format for this instruction is:

PRD F M N AAb BBb CCC Not Affected

where:

- O: Operation Code; F—machine language, PRD—symbolic
- M: 1—load 80 characters (maximum) or until a designated control code is detected (buffered mode)
  - 2—load to a designated control code or until end of memory is reached (unbuffered mode)
- N: 1—unit 1
  - 2—unit 2
- AAA: Branch address if a parity error is detected during the transfer of information into memory
- BBB: Branching address if End-of-Tape was detected during preceding operation
- CCC: Store address (MSD)

4-155. When M equals 1, this instruction loads the contents of the designated input buffer (N) to memory starting at CCC, and reloads the input buffer. The buffer is not cleared between buffer reads. For example, when reading variable length records, if an 80-character record is read and then a 60-character record is read, the remaining 20 characters will still be in the buffer. If a parity error was detected during the preceding Paper Tape Read operation, branch to AAA after loading the erroneous buffer contents into memory. The buffer is then left empty.

4-156. When M equals 2, read directly into memory (unbuffered) until designated control code is detected or until the last location in memory is filled. If a parity error is detected during this Read command, branch to AAA after the read is completed.

4-157. The comparison indicators are not affected by this instruction. When M equals 1, the buffer load is independent of the processor after the contents of the input buffer are loaded into the processor memory. The first buffered Read command enters the first record in memory (through the designated buffer) and loads the buffer with the next record.

4-158. Detection of End-of-Tape during a Read operation stops the tape and terminates the operation. Parity error is reset by initiation of the next Read, Space, Backspace, or Rewind. Branching on parity error takes precedence over branch on End-of-Tape. If both a parity error and End-of-Tape occur during the reading of a record, part of the record will not be in memory.

4-159. Paper Tape programs can be loaded by pressing the LOAD switch. The operation is terminated by end-of-memory or by a stop character. Paper tape programs must consist of a continuous information stream of 4800, 9600, or less characters, NOT 60 program characters, 20 "unused" characters, 60 program characters, etc., as in auto-load punched cards. Do not intermix buffered and unbuffered Paper Tape Read commands.

4-160. **PAPER TAPE SPACE FORWARD.** The format for this instruction is:

PSF F M N bbb BBb bbb Not Affected

where:

O: Operation Code; F—machine language, PSF — symbolic

M: 4 — space (forward motion)

N: 1 — unit 1
2 — unit 2

AAA: Available to programmer

BBB: Branching address if End-of-Tape was detected during preceding forward motion operation

CCC: Available to programmer

4-161. This instruction will space the tape to the next operator-designated control code on the unit specified by the N variant. After the operation is initiated, it proceeds independently of the central processor. The detection of an End-of-Tape during a space operation will stop the tape, terminate the operation, and branch to BBb. Initiation of a Space instruction clears the associated buffer which prevents any previously loaded information from being read into memory. The comparison indicators are not affected by this instruction.

4-162. **PAPER TAPE BACKSPACE.** The format for this instruction is:

PSB F M N bbb bbb CCb Not Affected

where:

O: Operation Code; F—machine language, PSB — symbolic

M: &—space (backward motion—internal code = 01 1100)

N: 1 — unit 1
2 — unit 2

AAA: Available to programmer

BBB: Available to programmer

CCC: Branch address if Beginning-of-Tape was detected during a preceding Paper Tape Backspace operation (M = 12).

4-163. This instruction will backspace the tape to the next operator-designated control code on the unit specified by the N variant. Once the operation is initiated, it proceeds independently of the central processor.

4-164. When M equals 12, detection of Beginning-of-Tape during a backspace operation will stop the tape, terminate the operation, and branch to CCb. Initiation of the Backspace instruction clears the associated buffer which prevents any previously loaded information from being read into memory. The comparison indicators are not affected by this instruction.

4-165. **PAPER TAPE REWIND.** The format for this instruction is:

PRW F M N bbb BBb CCb Not Affected

where:

O: Operation Code; F—machine language, PRW — symbolic

M: 8 — rewind

N: 1 — unit 1
2 — unit 2

AAA: Available to programmer

BBB: Branch address on Not Ready

CCC: Branch address if Beginning-of-Tape was detected during a preceding operation.

4-166. This instruction will rewind the paper tape on the reader unit specified by the N variant. After the read operation is initiated, it proceeds independently of the central processor. The comparison indicators are not affected by this instruction.

4-167. The rewind operation is terminated if a Beginning-of-Tape condition exists at the time the command is executed and control branches to CCb. A Not Ready condition causes control to branch to BBb. Branch on Not Ready takes precedence over branch on Beginning-of-Tape. The initiation of a rewind command clears the associated buffer which prevents any previously loaded information from being read into memory. The paper tape punch cannot be rewound programmatically.

B 263/B 273/B 283 CENTRAL PROCESSOR INSTRUCTIONS

4-168. The stored program for B 263, B 273, and B 283 Central Processors is comprised of the instructions listed below. The new and modified instructions used only in B 263/B 273/B 283 Central Processors are denoted by an asterisk (*) and described in the paragraphs that follow.

4-169. **MASK.** The format for this instruction is:

MSK 8 M N AAA BBB CCC Set to Equal

where:

O: Operation Code; 8—machine language, MSK — symbolic

M: Length of AAA; 1-11, 12 is denoted by a 0 or blank

N: 0 — standard mask

1 — inverted mask
Any character containing the appropriate bit will cause the inverted alphanumeric mask.

2 — alphanumeric mask
Any character containing the appropriate bit will cause the inverted alphanumeric mask.

AAA: Address of field to be masked (MSD)

BBB: Address of mask (MSD)

CCC: Address of masked field (MSD)

4-170. This instruction has been modified by adding new variants in order to perform special masking. The instruction transfers the contents of address AAA to address CCC, masking the information according to the mask in BBB. The length of the AAA field is determined by the M variant. The length of the CCC field is the sum of the M variant (plus one for the sign when N equals 0 or 1) and the number of insert characters in the mask. These are three types of masks as determined by the N variant: Fiscal-standard, fiscal-inverted, and alphanumeric.

Fiscal-Standard: N = 0.

4-171. The purpose of this mask is to insert ($), (,), and (.)'s, and to permit leading zero suppression in numeric data. Zone bits occurring in the source field (AAA) will not be transferred to the result field (CCC).

a. The first character (MSD) of the mask field (BBB) is the first character transferred to the result field (CCC) if it is a dollar sign ($) or a decimal point (.).

b. In regions of non-significant zeros in the source field (AAA), the corresponding mask character replaces each zero in the result field (CCC), except if the corresponding mask character is a comma (,). In this case, the previous mask character replaces the non-significant zero in the result field.

c. A decimal point in the mask field, or a non-zero digit in the source field, establishes significance. Thereafter, digits are transferred from the source with ($), (,), and (.) characters inserted, as such, from the mask.

4-172. Characters in the mask, other than ($), (,), and (.)'s, can be alphanumeric characters. They will be transferred to the result field as described above. The comparison indicators are set to equal (zero) by this instruction.

4-173. Maximum length of the AAA field is 12 characters. Maximum length of the BBB field and CCC field is 24 characters. Normal length of an edited fiscal field, when AAA equals 12, is 18 digits in the CCC field. For example, $X,XXX,XXX,XXX.XXb (b — if negative). Characters are transferred from left to right.

Fiscal — Inverted: N = 1.

4-174. The conditions stated for fiscal-standard (N = 0) apply to fiscal-inverted (N = 1) except that a decimal point is treated functionally as a comma and a comma is treated functionally as a decimal point. Figure 4-47 illustrates this difference.

FISCAL-STANDARD (N=0)

	+
INFORMATION	0 0 0 6 1 2 3 4 5
MASK	$ * , * * * , * * * . b b –
RESULT	$ * * * * 6 , 1 2 3 . 4 5 b

FISCAL-INVERTED (N=1)

	+
INFORMATION	0 0 0 6 1 2 3 4 5
MASK	$ * . * * * . * * * , b b –
RESULT	$ * * * * 6 . 1 2 3 , 4 5 b

Figure 4-47. Differences of Fiscal-Standard and Fiscal-Inverted Mask

Alphanumeric Mask: (N = 2).

4-175. Normal data movement proceeds from the AAA field to the CCC field when an ampersand is contained in the corresponding BBB field. Any other character in the BBB field is inserted in the CCC field. Insertions can be any of 63 characters, including the "invalid character" but excluding the ampersand. Maximum field lengths are:

a. AAA — 12 characters.

b. BBB — 24 characters.

c. CCC — 24 characters.

4-176. The alphanumeric mask effects transfer of a field with insertions from a mask. When a character is inserted from the mask (BBB), no transfer from the source field (AAA) to the result field (CCC) takes place. Transfer of data from the source field to the result field takes place only as a result of an ampersand in the mask field. For example, if a social security number was to be printed with the appropriate spacing, the mask would be; &&&b&&b&&&& where b is blank. If dashes were to be inserted in place of blank spaces, the mask would appear as; &&&-&&-&&&&. Multiple insertions between characters may take place. If the social security number was to be printed as XXX — XX — XXXX, a mask of &&&b-b&&b-b&&&& would be used.

4-177. Alphanumeric information may be masked. The A and B bits will be transferred from the AAA field to the CCC field. No sign testing of the AAA field, or insertion of a sign character (or blank), will take place in the CCC field. If there are less & (ampersands) in the mask than data characters in length, masking will take place for 24 character positions (maximum length) thereby possibly replacing instructions or data.

4-178. **MAGNETIC TAPE MEMORY WRITE.** The format for this instruction is:

MWR D M N AAA BBb CCb Set to Equal

where:

O: Operation Code; D—machine language, MWR — symbolic

M: 8 — Memory dump

N: Tape unit designate (1-6)

AAA: Transfer-from address (MSD)

BBB: Branch address on End-of-Tape

CCC: Branch address on write error

4-179. This instruction is identified by an M variant of 8. The instruction writes one tape record starting at address AAA onto the tape unit specified by the N variant. A tape record is defined as the information between address AAA and the end of memory. A group mark may be written. The comparison indicators are set to zero (equal) on this command.

4-180. With the exception of the tape mark, a minimum of seven characters must be written for all records. The Magnetic Tape Write instruction (TWR) is used to write a tape mark record.

4-181. If the end-of-tape reflective strip is sensed during the MWR instruction, a branch-to-address BBb will occur at the completion of the instruction. If an error is detected in the written information, a branch-to-address CCb will occur at the completion of the instruction. A branch-on-write-error takes precedence over a branch-on-end-of-tape. Write checking is accomplished with a dual-gap head.

The character question mark (?), will be translated to the BCL character representing greater than and equal to during output to tape.

4-182. **MAGNETIC TAPE WRITE BINARY.** The format for this instruction is:

BWR D M N AAA BBb CCb Set to Equal

where:

O: Operation Code; D — machine language, BWR — symbolic

M: 10 — Binary Write (#)

N: Tape unit designation (1-6)

AAA: Transfer-from address (MSD)

BBB: Branch address on End-of-Tape

CCC: Branch address on write error

4-183. This instruction is identified by an M variant of 10. The instruction writes one tape record starting at address AAA onto the tape unit specified by the N variant. A tape record is defined as the information between address AAA and the end of memory. Tapes are written with odd vertical parity. Any character may be written and all information is written in internal BCL code. The comparison indicators are set to zero (equal) on this instruction.

4-184. A minimum of seven characters must be written for all valid records with the exception of a Tape Mark record which is a single character record. The Magnetic Tape Write instruction is used to write a Tape Mark record. If the end-of-tape reflective strip is sensed during the execution of the BWR instruction, a branch-to-address BBb will occur at the completion of the instruction. If an error is detected in the written information, a branch-to-address CCb will occur. The write error branch takes precedence over the end-of-tape branch. Write checking is accomplished with a dual-gap head. The character, question mark (?), will be written on tape as a question mark.

4-185. **MAGNETIC TAPE READ BINARY.** The format for this instruction is:

BRD D M N AAb BBb CCC Set to Equal

where:

O: Operation Code; D — machine language, BRD — symbolic

M: 9 — Binary Read

N: Tape unit designation (1-6)

AAA: Branch address on read error

BBB: Branch address on End-of-File (tape mark)

CCC: Store address (MSD)

4-186. This instruction is identified by an M variant of 9. The instruction reads one record from the tape unit specified by the N variant and stores the record in memory, beginning at location CCC. The record can be of variable length, from seven characters to memory capacity. The inter-record gap on tape causes the operation to terminate. A group mark is not stored in memory. The comparison indicators are set to zero (equal) on this instruction.

4-187. If a vertical parity (odd) or longitudinal parity error occurs during the read, a branch to address AAb will occur. If a Tape Mark record is read, a branch to address BBb will occur after the read is completed. The end-of-file branch takes precedence over the read error branch. When reading fills memory (4800 or 9600 positions), the next character that is read is stored at memory location 000. Each following character is stored in a successively higher address. Characters which produce parity errors during input will be translated to the question mark code in memory.

4-188. **PRINT ON SUPERVISORY PRINTER.** The format for this instruction is:

SPO Q M b AAA bbb bbb Not Affected

where:

O: Operation Code; Q—machine language, SPO — symbolic

M: 1 — print

N: Reserved for expansion — must be left blank

AAA: Source address (MSD)

BBB: Available to programmer

CCC: Available to programmer

4-189. This instruction will print on the supervisory printer, the information stored in memory starting at the address specified by AAA. It will continue printing until a group mark is encountered. Carriage return and line feed take place at the end of each line of print (72 characters) and when the group mark is encountered. Upon detection of the group mark, the execution of the instruction is complete and the next instruction in sequence is executed. The group mark is not printed. If the printer is not ready when addressed by the processor, the system will halt.

4-190. **SUPERVISORY PRINTER READ.** The format for this instruction is:

SPR Q M N bbb BBb CCC Not Affected

where:

O: Operation Code; Q—machine language; SPR — symbolic

M: 2 — read

N: Reserved for expansion — must be left blank

AAA: Available to programmer

BBB: Branch on input message

CCC: Destination address (MSD)

4-191. The operation sequence for this instruction is initiated in the following manner:

a. The operator presses the INPUT REQUEST key on the printer.

b. When the processor reaches a Supervisory Printer Read instruction, the READY indicator on the printer is turned on.

c. The operator enters the input message which is stored in memory starting at address CCC.

d. The operator terminates the message by pressing the END OF INPUT key (non-printing). A group mark is stored in memory and the READY indicator will go out. Carriage return-line feed takes place when the END OF MESSAGE key is pressed.

e. Control of the instruction sequence branches to the BBb address.

4-192. If the operator does not press the INPUT REQUEST key, or if the printer is not ready, the Supervisory Printer Read instruction acts as a No Op and control continues in sequence.

4-193. In the event of an operator input error (i.e., keystroke error), the operator presses the ERROR key. Program control will then continue in sequence. The operator may type comments without entering them into the processor by pressing the LOCAL key.

4-194. **PRINT ON LISTER.** The format for this instruction is:

PRL A M N AAA BBb CCC Not Affected

where:

O: Operation Code; A—machine language, PRL — symbolic

Stop on Print Error

M: 0 — print master on lister #2
1 — print master on lister #1
15 — suppress print on master

Branch on Print Error

7 — print master on lister #2
2 — print master on lister #1
14 — suppress print on master

With M = 1

*N: 2-6, 7-11, 0 (for 12) — designates detail tape
1 — not admissable
15 — suppress detail designation

*On B 263, B 273, and B 283 Systems, a blank or any other character containing a B-bit in the N variant can never be used. A branch to the address specified by CCC will always be taken.

With M = 2

1-6, 8-11, 0 (for 12)—designates detail tape

7 — not admissable

15 — suppress detail designation

AAA: Transfer-from address (MSD)

BBB: Branch address on Out-of-Paper

CCC: When M = 7, 2, or 14 — branch address on print error

When M = 0, 1, or 15 — available to programmer

4-195. The function of this instruction is the same as discussed in paragraphs 4-32 through 4-34 except for the addition of a print error branch. This branch is affected through the use of an M variant of 7, 2, or 14 and the CCC address.

4-196. When a multiple tape lister receives a print instruction, after a Print Check error has occurred but is not cleared, the instruction is executed and the information is printed, thus clearing the error. Control will then branch to CCb. Branch on print error takes precedence over branch on Out-of-Paper. The comparison indicators are not affected by this instruction.

4-197. Printing of a master tape is also controlled by the M variants of 7 (print master on lister #1), 2 (print master on lister #2), and 14 (suppress print on master). If these three variants are not used to affect the print error branch, the CCC address of the instruction may be used by the programmer. It should be noted at this time that the Skip on Lister instruction does not halt on a print error.

4-198. **CARD READ.** The format for this instruction is:

CRD # M N AAA BBB CCC Set to Equal

where:

O: Operation Code; #—machine language; CRD—symbolic

M: 0 — halt on not ready; wait for reloading on busy

1 — branch on busy or not ready (any character containing a 1-bit will cause branching)

N: Designates input buffer

1 — buffer 1

2 — buffer 2

AAA: When M = 0 — available to programmer

When M = 1 — branch address on busy or not ready (MSD)

BBB: Branching address on End-of-File (MSD)

CCC: Store address (MSD)

4-199. The function of this instruction is the same as described in paragraph 4-13 except for the addition of M variants. The function of this variant is as follows:

a. When M = 0:

1) If the buffer is full, the contents of the buffer are transferred to memory starting at the address specified by CCC.

2) If the card reader is busy, wait until the card has been read into the buffer, then transfer the buffer contents to memory starting at the address specified by CCC.

3) If the card reader is not ready, halt.

b. When M = 1:

1) If the buffer is full, the contents of the buffer are transferred to memory starting at the address specified by CCC.

2) If the card reader is busy or not ready, branch to the address specified by AAA.

4-200. **CARD PUNCH.** The format for this instruction is:

PCH @ M b AAA bbb bbb Not Affected

where:

O: Operation Code; @ — machine language, PCH — symbolic

M: 0 — punch BCL code

1 — punch Bull code

Any character containing the appropriate bits will cause BULL or ICT punching

2 — punch ICT code

Any character containing the appropriate bits will cause BULL or ICT punching

N: Reserved for expansion — must be left blank

AAA: Transfer-from address (MSD)

BBB: Available to programmer

CCC: Available to programmer

4-201. The function of this instruction is the same as described in paragraph 4-18 except that it includes BULL and ICT capabilities. These capabilities are provided through use of M variants of 0, 1, and 2. An M variant of 0 permits punching of BCL codes, and an M variant of 1 permits punching of BULL Codes, and an M variant of 2 permits punching of ICT codes. All other areas of the instruction are the same as described in paragraph 4-18.

4-202. **DISK FILE WRITE.** The format for this instruction is:

DFW K M N AAA BBB CCb Not Affected

where:

- O: Operation Code; K—machine language, DFW — symbolic
- M: 0 — write
- N: Number of segments; 1-9, 0 (0 = 10 segments)
- AAA: Disk file address word (MSD)
- BBB: Memory location containing data to be written (MSD)
- CCC: Branch on designated storage unit not ready

4-203. This instruction is identified by an M variant of 0. The instruction transfers the contents of memory starting at BBB to the disk file. The disk file location is specified by a seven digit address which is stored in memory beginning at the address specified by AAA. The number of disk file segments to be written is specified by the N variant. From one to 10 segments may be written using N variants of 0-9, where 0 indicates 10 segments. An error check code is generated and written with each segment of data during the write operation. The comparison indicators are not affected by this instruction.

4-204. If the designated storage unit is not ready, the program will branch to the instruction specified by the CCb address. If a Disk File Write instruction is initiated without prior issuance of a Disk File Interrogate instruction (refer to paragraph 4-211), and the control unit is in a busy or not ready status, the processor will halt. A disk file address parity error will terminate the operation, set an address parity error indicator, and continue the program in sequence without executing the instruction. An attempt to write on a locked-out storage unit or disk, or an invalid address, terminates the operation but does not halt the program. The write lockout indicator will be set.

4-205. **DISK FILE READ.** The format for this instruction is:

DFR K M N AAA BBB CCb Not Affected

where:

- O: Operation Code; K—machine language, DFR — symbolic
- M: 2 — read
- N: Number of data segments; 1-9, 0 (0 = 10 segments)
- AAA: Disk file addressing word (MSD)
- BBB: Memory location to receive data (MSD)
- CCC: Branch on designated storage unit not ready

4-206. This instruction is identified by an M variant of 2. The instruction transfers the contents of a disk file, beginning with the data segment specified by the seven-digit disk file address, to core storage. The disk file address is stored in memory beginning at the address specified by AAA. The data from the disk file is transferred to memory beginning at the address specified by BBB. The number of segment to be read is specified by the N variant. From one to 10 segments may be read using the N variants of 0-9, where 0 indicates 10 segments. During the read operation, the error check code is regenerated and compared to the error check code written with the record. If the comparison is unequal, a read error indicator is set. The comparison indicators are not affected by this instruction.

4-207. If the designated storage unit is not ready, the program will branch to the instruction specified by the CCb address. If a read operation is initiated without prior issuance of a Disk File Interrogate instruction, and the control unit is in a busy or not ready status, the processor will halt. A disk file address parity error will terminate the operation, set an address parity error indicator, and continue the program in sequence without executing the instruction.

4-208. **DISK FILE CHECK.** The format for this instruction is:

DFC K M N AAA bbb CCb Not Affected

where:

O: Operation Code; K—machine language, DFC — symbolic

M: 4 — read check

N: Number of data segments; 1-9, 0 (0 = 10 segments

AAA: Disk file addressing word (MSD)

BBB: Available to programmer

CCC: Branch on designated storage unit not ready

4-209. This instruction is identified by an M variant of 4. The instruction reads the record, regenerates the error check code, and compares it with the check code written with the record. No information is transferred to memory and the program will continue in sequence as soon as the operation is initiated. If the check code comparison is unequal, a check code indicator is set. The AAA address specifies the memory address of the disk file address to be used. The BBB portion of the instruction is not used and is available to the programmer. The comparison indicators are not affected by this instruction.

4-210. If the storage unit is not ready, the program will branch to the instruction specified by the CCb address. If a Disk File Check instruction is initiated without prior issuance of a Disk File Interrogate instruction, and the control unit is in a busy or not ready status, the processor will halt. A disk file address parity error will terminate the operation, set an address parity error indicator, and continue the program in sequence without executing the instruction.

4-211. **DISK FILE INTERROGATE.** The format for this instruction is:

DFI K M b AAb BBb CCb Not Affected

where:

O: Operation Code; K—machine language, DFI — symbolic

M: 8 — interrogate

N: Reserved for expansion — must be left blank

AAA: Branch on disk file control unit busy

BBB: Branch on error (address transfer error or read error)

CCC: Branch on write lockout or attempt to address a nonexistent disk, or an attempt to address beyond the maximum possible storage unit address

4-212. This instruction is identified by an M variant of 8. The instruction determines which of the three addresses, AAA, BBB, or CCC, the program will branch to in the following order of preference:

a. To AAA if the disk file control unit is busy or not ready.

b. To BBB if the address parity or read error indicator is on.

c. To CCC if write lockout occurs, addressing a nonexistent disk, or addressing beyond the maximum possible storage unit address.

4-213. The comparison indicators are not affected when the branch is taken.

4-214. **DATA COMMUNICATION WRITE.** The format for this instruction is:

DCW L M N AAA BBb CCb Not Affected

where:

O: Operation Code; L—machine language, DCW — symbolic

M: 4 — write inquiry

N: Designates terminal unit (1-15)

AAA: Transfer address (MSD)

BBB: Branch on busy or "input ready"

CCC: Available to programmer

4-215. This instruction is identified by an M variant of 4. The execution of this instruction transfers the data beginning at memory location AAA to the terminal unit buffer designated by the N variant. Data transfer continues until either the buffer is full or until the first group mark is encountered in memory. The comparison indicators are not affected by this command. If the designated terminal unit is busy or "input ready", the program will branch to the instruction specified by the BBb address.

4-216. **DATA COMMUNICATION READ.** The format for this instruction is:

DCR L M N AAb BBb CCC Not Affected

where:

O: Operation Code; L—machine language, DCR — symbolic

M: 2 — read inquiry

N: Designates terminal unit number (1-15)

AAA: Available to programmer

BBB: Branch on busy or "output ready"

CCC: Store address (MSD)

4-217. This instruction is identified by an M variant of 2. Execution of this instruction transfers the contents of the terminal unit buffer, designated by the N variant, to memory beginning at the location specified by CCC. Data transfer continues until either the buffer is empty or the end-of-message character in the inquiry is detected. The comparison indicators are not affected by this instruction.

4-218. If the designated terminal unit is busy or "output ready", the program will branch to the instruction specified by the BBb address.

4-219. **DATA COMMUNICATION INTERROGATE.** The format for this instruction is:

DCI L M N AAb BBB CCC Not Affected

where:

O: Operation Code; L—machine language, DCI — symbolic

M: 1 — interrogate inquiry ready

N: Designated terminal unit number (1-15) Inquiry control unit designated terminal number (0)

AAA: Branch on "input ready"

BBB: Terminal unit number store address

CCC: Branch on "output busy"

4-220. This instruction is identified by an M variant of 1. The execution of this instruction causes the data communication control unit scanner to stop at the terminal unit designated by the N variant (1-15) and interrogate its status. If the designated terminal unit is "input ready", the program will branch to the instruction specified by the AAb address. If the designated terminal unit is idle, busy, or not ready, the program continues in sequence. If the designated terminal unit is not ready, an ampersand (&) character is stored in the memory address specified by BBB, and the program continues in sequence.

4-221. If the N variant is 0, the control unit scans each terminal unit in sequence beginning with terminal #1 and stops at the first one which is ready. The comparison indicators are not affected by this instruction.

SECTION 5

B 200 SERIES BASIC ASSEMBLER PROGRAM

GENERAL

5-1. An assembler program, such as the Burroughs B 200 Series Basic Assembler, is a programing tool designed to alleviate part of the effort required in coding programs. In addition, assemblers provide hard copy documentation for future reference.

5-2. Assemblers accept symbolic language as input and convert this input, automatically, to internal machine language. The term symbolic refers to the use of non-machine-language addresses and mnemonic operation codes in place of machine language codes. For example, an employee's gross pay might be located in memory at the symbolic address PAY which might be equal to the actual machine address of A16. Three-character operation codes in symbolic language, such as ADD, are converted by the assembler to their machine language equivalents, in this case 1. By using an assembler program for coding, the programmer is not burdened with keeping track of the memory locations used, their addresses, or the actual machine language for the instructions being used. Since the assembly program will do this, and more, the programmer is free to code programs at a greater speed; in most instances, the speed will be limited only by operator ability to solve the problem at hand.

5-3. Several versions of the Burroughs B 200 Series Basic Assembler are available to users; both for punched card and magnetic tape systems. The use of any one of these assemblers is based solely on equipment availability and final program format desired.

5-4. This section describes the Burroughs B 200 Series Basic Assembler and the use of the Burroughs Basic Assembler coding form.

THE CODING FORM

5-5. Throughout this section references will be made to the coding form illustrated in figure 5-1. The fields of the form and their various uses are described in the paragraphs that follow.

CODING PROCEDURES

5-6. Each line of the coding form represents one entry and is divided into 12 fields. In preparing the symbolic program, it is very important that all entries be made in the correct field and columns within the field.

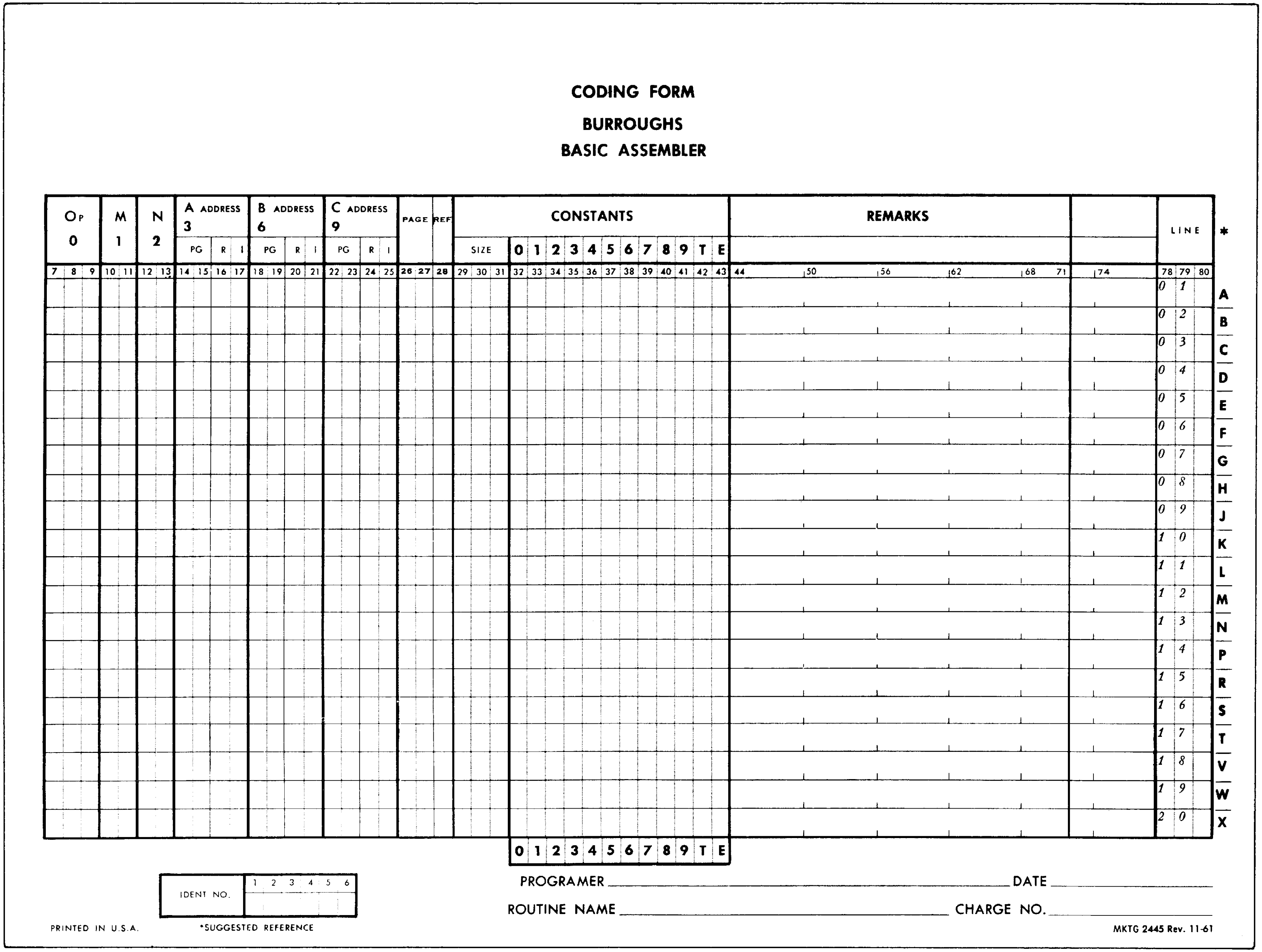


Figure 5-1. Coding Form

Ident No.

5-7. This is a six-column, alphanumeric field (located in the lower-left corner of the form) used for coding identification.

OP

5-8. This is a three-column alphabetic field for coding the standard mnemonic codes used with the B 200 Series Basic Assembler. Every symbolic entry must have its op code in the OP field.

M

5-9. This is a two-column alphanumeric field used for coding the M variant of the instruction. Single characters must be right-justified in this field. Leading zeros cannot be used in this field.

N

5-10. This is a two-column alphanumeric field used for coding the N variant of the instruction. Single characters must be right-justified in this field. Leading zeros cannot be used.

NOTE

> The Transfer instruction is coded in terms of number of characters rather than in fields and characters as in machine language. If the number of characters to be transferred exceeds 99, the hundreds digit (1) is coded in the low-order of the M field.

A Address; B Address; C Address

5-11. These three four-column fields are used for coding the addresses of the operands, instructions, input/output areas, etc., specified by the operation code (OP Code). Each of the three fields has the following format:

a. PG—a two-column field, normally numeric, used to insert the page number of the instruction or data field being addressed.

b. R—a one-column field, normally alphabetic, used to identify the desired reference (line) on a specified page.

c. I—A one-column alphanumeric field normally used to increment a Page and Reference to specify a particular character position within the page line. It is also used to increment addresses.

Page

5-12. This is a two-column field, normally numeric, used to assign the page number to the coding sheet. Pages are normally numbered in ascending sequence, and no two pages should bear the same number. If user programs always utilize numeric page numbers, and all service routines and diagnostics are prepared with alphabetic page numbers, there will never be a conflict with user programs.

NOTE

> Any alphabetic page number may be used except those with the most significant digit (MSD) of A or M (refer to paragraphs 5-33 and 5-46).

REF

5-13. This is a one-column alphabetic field called the reference symbol. It is used only when the entry on that line is referred to by any instruction. Any alphabetic character may be used, not necessarily in sequence. However, no character may be used more than once per page.

5-14. The PAGE and REF together make up the symbolic address (name) of an instruction and/or data field. This address will be unique to only one entry. Up to 140 such references are permitted in most versions.

Size

5-15. This is a three-column numeric field used for inserting the number of characters in a constant; only the numerals 001 through 999 may be inserted in this field.

Constants

5-16. A twelve-column alphanumeric field used for coding the numerals or characters to be assembled as constants in the assembled program. Up to 12 characters may be assembled in one CONSTANTS field. If the SIZE field calls for more than 12 characters, the first 12 positions will be assembled as constants and the remaining number of positions will be reserved as working storage (blanks). Every constant entry must have CST coded in the OP field.

Remarks

5-17. This 28-column field is used for the insertion of remarks pertaining to the program instructions which are coded on the left-hand side of the coding form. The information written in this field will not affect the assembly process but it will be reproduced on the output media for documentation and future reference by the programmer. Columns 72-77 are reserved for use by the assembler program and must be left blank.

Line

5-18. This is a three-column field whose primary use is input sequencing. The first two columns designate the line number. The third column is reserved for inserts, enabling the programmer to "insert" up to nine additional entries without destroying the original sequence. Every entry must have a line number.

Miscellaneous Coding Form Data

5-19. Appearing on the extreme right-hand margin of the form is a list of suggested line references (REF.). These suggested references will aid the programmer. Without these, he may neglect to reference a desired instruction while coding and yet continue to reference other entries in straight alphabetic sequence. When attempting to later code the omitted reference, when coded, will be out of sequence. As a result, subsequent references to the page of coding will be more time consuming. In addition, the possibility exists that he will duplicate a previous reference. By utilizing the suggested references, this chance for error is eliminated. To eliminate other erroneous coding possibilities, the letters I, O, Q and U do not appear as suggested references since these letters are often mistaken for numerals and/or other letters.

5-20. There are six numerals inserted in the instruction portion of the coding form; one numeral appears in each of the fields of an instruction. These numerals (0, 1, 2, 3, 6, and 9) serve as an aid to the programmer when using character addressing which is discussed in paragraph 5-34. There are 10 numerals and two letters in the CONSTANTS field of the coding form which are used to simplify character addressing.

ASSEMBLY PROGRAM USE

5-21. In coding a symbolic program for use with the assembly program, the programmer will normally follow this procedure:

a. Identify the program.

b. Define working storage, accumulation, and I/O areas as constants.

c. Establish or control the beginning location of assembly for all or part of the program.

d. Code the program.

Identification and Heading

5-22. Identification will consist of assigning a code name or number to the program and inserting it in the IDENT NO. field. Further identification can be obtained by the use of heading cards. These cards are identified by the mnemonic code HDG in the Op field of the coding sheet as illustrated in figure 5-2. HDG permits the programmer to use the remaining fields for identification or explanatory remarks. However, if the programmer uses all of these fields, the resultant output may not make much sense to the reader due to the intervening blank spaces that normally occur between the various fields during print out. Therefore, it is recommended that the programmer use only the REMARKS portion of the coding form for any necessary comments. The PAGE field will contain the page number. HDG cards may be placed throughout the program as desired and are processed by the assembly program for hard copy reference only.

NOTE

Ø = Alphabetic "O"

0 = Zero

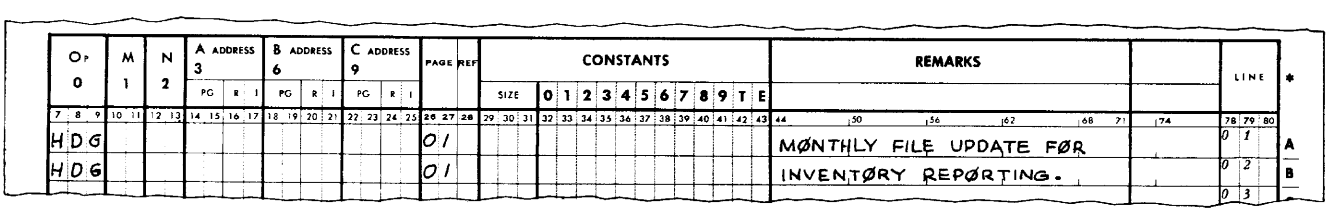


Figure 5-2. Identification by Heading Card

Constants

5-23. A constant (CST) is used to establish an input/output area and other types of intermediate and working storage areas, as well as constant data and masks. A constant is identified by the mnemonic code CST entered in the OP field of the coding form. The length of the field is entered in the SIZE field and the constant data in the CONSTANTS field. The PAGE number and the REF will be the symbolic address of the constant and will identify each particular one.

5-24. Figure 5-3 illustrates the manner in which a card read-in area may be set up. Each constant identifies a particular field in the card and this field may be addressed through the use of PAGE and REF which make up the symbolic address of that field. Print areas, punch areas, counters, and working storage areas are established in the same manner.

5-25. Figure 5-4 illustrates the manner in which constant data and masks are set up. When all necessary areas have been defined, the programmer may refer to them by their symbolic addresses in the high-order or most significant digit (MSD) position of the field. The mnemonic code CST must be entered in the OP CODE field for every constant.

Program Coding Example

5-26. The coding form and its use have been described briefly. In order to illustrate the manner in which the coding is done, a sample problem and one method of its solution is presented. Figure 5-5 illustrates the input card format from which data is to be derived for printing the report shown in figure 5-6.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE	REF	SIZE	CONSTANTS	REMARKS
CST						03	A	10	EMP. NUMBER	CARD
CST						03	B	20	NAME	READ
CST						03	C	50	ADDRESS	AREA

Figure 5-3. Defining Card Read Area

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE	REF	SIZE	CONSTANTS	REMARKS
CST						11	A	10	$, . -	MASK
CST						11	B	4	FICA	FICA CØNSTANT

Figure 5-4. Coding Constant Data and Mask

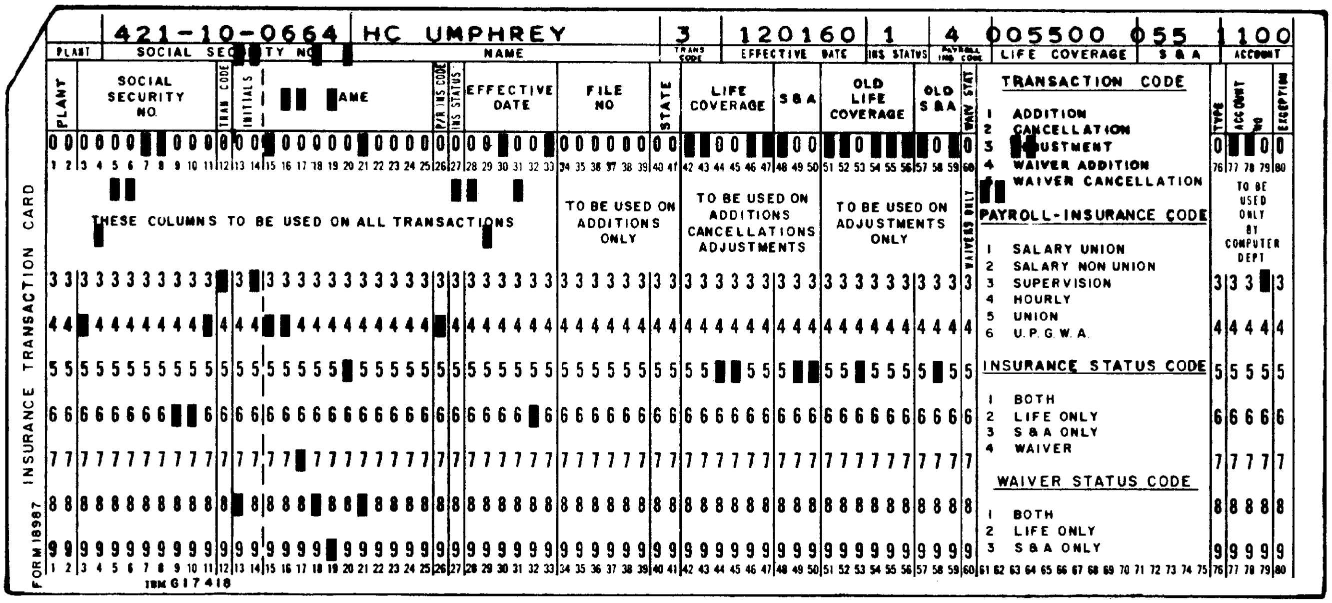


Figure 5-5. Input Card

SOC SEC NO	NAME	INS AMT
421 10 0664	HC UMPHREY	$ 5,500
257 50 8186	ME GROFFLIN	$ 12,500
563 40 8418	JB BAXTER	$ 17,000

Figure 5-6. Sample Report

5-27. The basic approach to a problem of this nature is to set up the card read-in area. This is done by using constants (CST) which accomplish two things:

a. Reserve 80 positions of storage for a card read-in area.

b. Assign symbolic addresses to the fields which will be referenced in the program.

5-28. Figure 5-8 illustrates the three constants needed to properly identify the card read area. The first constant, 02B, is 11 characters long; the first two positions represent the first two card columns which are not used in preparing the report. When referencing the social security number, the programmer will address it by the symbolic address 02B2. (In this case, 02 is the page number, B is the particular line on the page, and 2 is the first character position). The employee number is found at 02C1. The constant shown on the coding form is 30 characters in length; the first 12-positions will be assembled as a constant, and the remaining 18-positions will be reserved (as blanks). The insurance amount, which is located in the first five positions, is addressed as 02D; the other positions of the constant represent the 34 remaining, and unused, card columns.

Op	M	N	A Address	B Address	C Address	Page	Ref	Size	Constants	Remarks
HDG						02				CARD READ AREA
CST						02	B	11	X————X	SØC SEC NØ
CST						02	C	30	X——————X	EMP NAME
CST						02	D	39	X———X	INS. AMØUNT

Figure 5-7. Card Read Area

5-29. After establishing the card read-in area, the programmer normally sets up the output areas which may consist of either punch, print, or magnetic tape areas. In the sample problem, two output areas are required, one for heading printing and one for body printing. Figure 5-8 illustrates the manner in which these print areas may be coded. In order to reduce the number of symbolic references used, each constant includes the number of spaces between print positions.

5-30. The third step of the basic approach is the coding of other constants (such as masks) and work areas for accumulation or temporary storage. All that is required in the sample problem is a mask for the insurance amount field (figure 5-8). Figure 5-9 illustrates one manner in which this problem may be coded. Provisions have been made to stop processing when the last card of the file has been processed and to skip to and head a new sheet on page overflow.

Op	M	N	A Address	B Address	C Address	Page	Ref	Size	Constants	Remarks
HDG						02				OUTPUT AREAS
CST						02	F	14	XXX XX XXXX	SØC. SEC. NØ
CST						02	G	23	XX X————X	EMP NAME
CST						02	H	83	X————X	INS. AMØUNT
CST						02	J	14	SØC SEC NØ	HEADING LINE DATA
CST						02		24	NAME	
CST						02		82	INS AMT	
CST						02	M	9	# , -	MASK

Figure 5-8. Printer Output Area

Op	M	N	A Address	B Address	C Address	Page	Ref	Size	Constants	Remarks
PRT	2		02J			01	A			PRINT HEADING LINE
CRD		1		01N	02B	01	B			READ CARD
TFR		3	02B2		02F	01				SPLIT SØC. SEC. NØ
TFR		2	02B5		02F4	01				TØ FØRMAT FØR
TFR		4	02B7		02F7	01				PRINTING
TFR		2	02C1		02G	01				SPLIT INITIALS FROM LAST
TFR		11	02C3		02G3	01				NAME FØR PRINTING
MSK	6		02D	02M	02H	01				EDIT AMØUNT FIELD
PRT	1		02F	01L		01				PRINT - SINGLE SPACE
BRU			01B			01				TO READ NEXT CARD
SKP	0	1		*		01	L			SKIP TØ NEXT PAGE ØN
BRU			01A			01				ØVERFLØW TØ PRINT HDG
HLT	9	9				01	N			END ØF JØB HALT

Figure 5-9. Program Coding

5-31. There are many different approaches to problems of this nature and, as the problems become more complex, the number of workable solutions is greatly increased, depending only on the ingenuity and training of the programmer. In the paragraphs that follow, more advanced programing techniques are presented to enable the programmer to code programs in a more flexible manner.

CODING TECHNIQUES

5-32. In addition to the conventional methods of programing in the assembly language described previously, the B 200 Series Basic Assembler provides additional coding techniques. The reader should study the techniques in the order of their presentation since some interrelation exists between them.

Machine Language

5-33. The machine-language technique allows coding in machine language whenever it is useful. This feature pertains to the M, N, A, B, and C fields. The letter M in the first column of these fields informs the assembler that the following character(s) in the field are to be assembled in the program exactly as they appear on the coding form (figure 5-10).

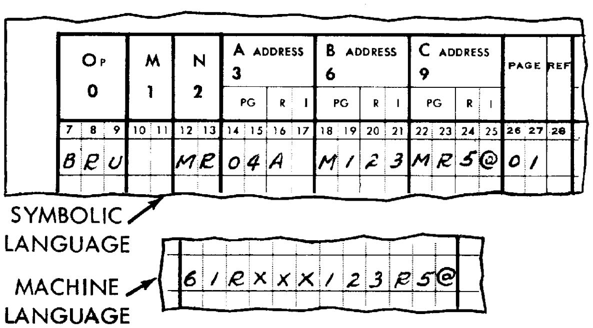


Figure 5-10. Machine Language Coding

Character Addressing

5-34. The advantage of character addressing is that it permits maximum use of storage. Data, such as constants, masks, or control symbols, may be packaged into unused portions of the instruction, or several small constants can be arranged in one constant field.

5-35. Normal addressing consists of the symbolic address PAGE and REF inserted in the A, B, or C address. This manner of addressing is quite acceptable, however, it requires that each entry addressed be assigned a separate symbolic address and be coded on a separate line of the coding form. Frequently a need arises for short constants such as numerals 1, 2, 3, etc. Under standard coding and addressing techniques, this would require a constant to be set up for each numeral. With special techniques such as character addressing, valuable storage positions are saved by using data already in memory. For the purpose of illustration, assume that the words TAX and NET PAY are needed on a printed report. They might be coded as shown in figure 5-11.

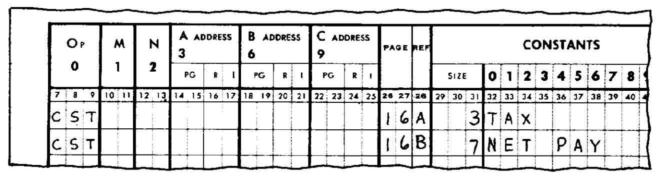


Figure 5-11. Standard Addressing

5-36. As illustrated, this method requires an individual REF symbol for each constant. To reduce the number of references, character addressing can be utilized as shown in figure 5-12. In this manner, NET PAY is identified by the symbolic address 16A and the TAX by the symbolic address 16A7. The numeral 7 designates character position 7 of the field 16A. The M and N variants, in referencing commands, will determine the number of characters used.

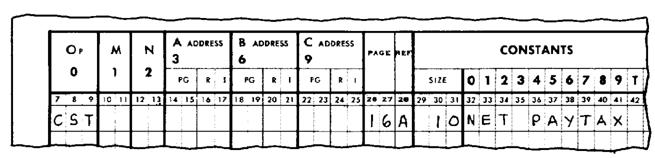


Figure 5-12. Character Addressing of Constants

5-37. In figure 5-13, 01J is a three-position accumulator to which the digit 1 is added. By means of character addressing, the M variant, which specified field length, is also used as a number to be added.

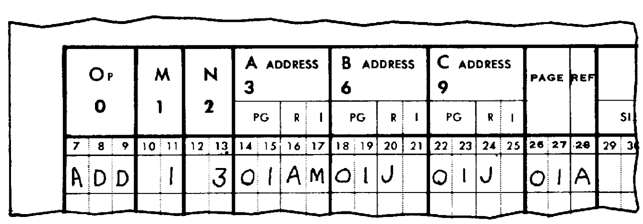


Figure 5-13. Character Addressing of Instructions

5-38. Character addressing may be done using either of the following methods although, for uniformity in keypunching, alphabetic referencing is preferred whenever possible:

CONSTANT	0	1	2	3	4	5	6	7	8	9	10	1
or	Op	M	N	A1	A2	A3	B1	B2	B3	C1	C2	C3
INSTRUCTION	0	1	2	3	4	5	6	7	8	9	T	E
ADDRESSED AS						or						
	0	M	N	A			B			C	T	E

Note: T = Ten, E = Eleven

5-39. The character address has no effect upon the number of characters to be used since the M and N variants determine the actual number of characters used. If the information desired begins in the MSD position, only the PAGE and REF are used as the address. Fields beginning in other than the MSD position require use of PAGE, REF, and I.

5-40. The I position of the addresses may also be used to increment symbolic addresses by increments of 12. Assume during assembly that the symbolic address 05A was assigned to location 040. A later address of 05AJ would be assigned to 050, 05AK would be assigned 060, and 05AL would be assigned 070. The characters J, K, and L increment the symbolic address by 12, 24, and 36 characters respectively. By using the J, K, and L feature, it is often possible to save references if the words or instructions desired are within three lines of a referenced entry. The only letters permitted for incrementing by multiples of 12 are J, K, and L.

Literals

5-41. A literal is data which remains inviolate in memory and may be referenced by more than one instruction. The purpose of the literal is to allow the referencing of the data without the programmer setting it up separately as a constant. A literal is entered on the same line as the instruction entry which refers to it. This is accomplished by placing an asterisk (*) in the first column of the address field and placing the data to be referenced (left-justified) in the CONSTANTS field. For example, it may be desirable to test a character located at 18A5 for zero. This can be done under normal addressing by setting up a constant of zero at some other address, for example, 40C1 (figure 5-14). By using a literal, the same thing could be accomplished without setting up a separate constant of zero (figure 5-15). During assembly, the constant zero would be stored and its machine-language address would be inserted in the B address portion of the compare instruction.

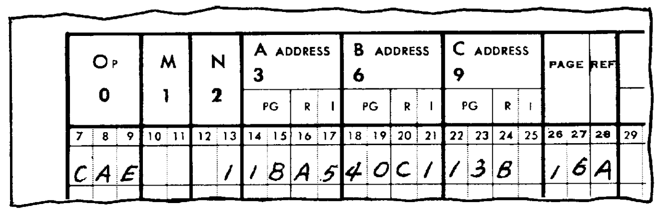


Figure 5-14. Testing for Zero Using A Constant

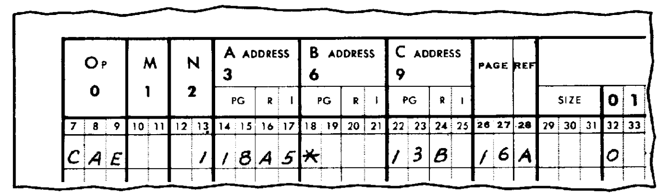


Figure 5-15. Testing for Zero Using A Literal

5-42. Only one literal, up to 12 characters in length, may be used for each entry. A total of 200 literal characters may be assigned in any one program. If a literal is coded which duplicates any portion of the previously assigned literals no additional characters will be assigned. Size is not required for literals. The assembly program determines size by referencing the M and N entries on the line where each literal appears. During assembly, literals will be assigned memory addresses starting at the next available character after the basic program. Literals cannot be assigned to a C address since by its very nature a literal is something that remains constant throughout a program. If a literal was coded in a C address, its value could be changed in the course of running since the C address is always used as a "put down" or store address. In addition to the C address restriction, there are some instructions (MSK and TFR) in which a literal cannot be used. For example, the Mask instruction cannot use a literal in the B field because it is impossible for the assembler to determine the length of a literal required as a mask. Literals cannot be used in program overlays.

Fall-Through

5-43. When using the branch instruction, it is often desirable to proceed to the next instruction in sequence according to one or more of three conditions. With conventional addressing, the next instruction would be referenced and then addressed normally by the branch conditional instruction (figure 5-16).

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE	REF
BRC			11B	11B	11R	11	
XXX	X	X	XXX	XXX	XXX	11	B

Figure 5-16. BRC Instruction with Conventional Addressing

5-44. The use of the fall-through technique eliminates this needless referencing. A fall-through is set up by placing a hyphen (-) in the first column of an address field (figure 5-17). The presence of the hyphen instructs the assembler to insert the address of the next entry into the address field in which the hyphen is located. The fall-through feature may be used in any of the three address fields and on all instructions.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE	REF
BRC			-	-	11R	11	
XXX	X	X	XXX	XXX	XXX	11	

Figure 5-17. BRC Instruction Using Fall-Through

Self-Addressing

5-45. It is sometimes desirable for an instruction to refer to itself. With normal addressing this is easily accomplished if the particular instruction is referenced by PAGE and REF. Figures 5-18 illustrates the transfer of a 7 to symbolic location 16J. Again, to eliminate needless referencing and to conserve memory, the self-addressing feature has been provided.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE	REF
TFR		1	01AB	M7	16J	01	A

Figure 5-18. Self-Addressing Using PAGE and REF

The presence of an asterisk (*) in the third column (R) of any of the three address fields will cause the assembler to insert the assigned machine address of that instruction into the address field containing the asterisk (figure 5-19). This example illustrates how the character 7 (in this case, the op code for the TFR instruction) is stored in symbolic location 16J. The use of self-addressing in conjunction with encrementing enables an instruction to refer to a character within itself.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE
TFR		1	*		16J	
			or			
TFR		1	*0		16J	
			or			
TFR		1	*Ø		16J	

Figure 5-19. Self-Addressing Using Self-Addressing Feature

Address-Of

5-46. Frequently the actual machine language address of an instruction is needed in the program as constant data. The presence of an A in the first column of any address field will cause the assembler to assign the machine address of the symbolic address written in the last three columns of the field as a literal. Figure 5-20 illustrates this feature. In this example, assume that the symbolic address 14F was assigned to an actual machine address of T60 during assembly. In the example, the literal which was set up (T60) will be compared with the contents of the symbolic address 35N, *not* the first three characters of the contents of memory starting at the machine address. If the literal (T60) was assigned a machine address of X17, then X17 would be the resulting machine language A address of the CAE instruction. The literal set up as a result of using the address-of feature is included in the total number of literal characters (200) which can be assigned for any one program, and all rules for literals, described in 5-41 and 5-42 apply.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE	REF
CAE		3	A14F	35N	11R	09	

Figure 5-20. Coding of Address—Of

Special Addressing With Incrementing

5-47. Both fall-through and self-addressing techniques can be further complemented by the use of the J, K, and L feature discussed previously. Figure 5-21 illustrates the updating of the field in symbolic address 15R by the constant 1 stored in symbolic location 14C. If the BRC instruction AAA branch is executed, 15R will be updated by 3. If the BBB branch is executed, 15R will be updated by 2; and if the CCC branch is executed, 15R will be updated by 1. Figure 5-22 illustrates the use of fall-through with K and L incrementing. In this example, with the BRC instruction, if the AAA branch is executed, a 3 will be added to 15R. If the BBB branch is executed, 15R will be updated by 2; if the CCC branch is executed, 15R will be updated by 1.

OP 0 (7-9)	M 1 (10-11)	N 2 (12-13)	A ADDRESS 3 (14-17)	B ADDRESS 6 (18-21)	C ADDRESS 9 (22-25)	PAGE (26-27)	REF (28-29)
BRC			*J	*K	*L	01	
ADD	1	3	14C	15R	15R	01	
ADD	1	3	14C	15R	15R	01	
ADD	1	3	14C	15R	15R	01	

Figure 5-21. Field Updating Using Conventional Addressing

OP 0 (7-9)	M 1 (10-11)	N 2 (12-13)	A ADDRESS 3 (14-17)	B ADDRESS 6 (18-21)	C ADDRESS 9 (22-25)	PAGE (26-27)	REF (28-29)
BRC			-	- K	- L	01	
ADD	1	3	*N	15R	15R	01	
BRU			- K			01	
ADD	1	3	*M	15R	15R	01	
ADD	1	3	*M	15R	15R	01	

Figure 5-22. Field Updating Using Special Addressing with Incrementing

PSEUDO AND MACRO INSTRUCTIONS

5-48. Psuedo and macro instructions are an important feature of most assemblers. These two types of instructions are written in the same general manner as normal machine instructions; however, their effect on the assembler program is quite different.

Pseudo Instructions

5-49. In addition to the machine operation codes, certain pseudo instructions are provided to control the assembly process. Pseudo instructions are not assembled as a part of the finished program, however, they are printed in the listing for future reference during assembly. These instructions are used to regulate machine address assignment and to indicate the end of input to the assembly program. Machine address assignment is accomplished by the use of a location counter which is incremented every time an entry is assembled. The normal increment is 12 because each instruction requires 12 positions of storage. At the beginning of the assembly routine, the location counter is automatically set to 000; and normal assignment of instruction locations will begin at 000, then 010, 020, etc. It is possible for the programmer to regulate the setting of the location counter by use of the pseudo instructions described below.

5-50. SET LOCATION COUNTER (SLC). This instruction permits setting the location counter to any desired value, at any time, during the assembly of the program. SLC is entered in the OP field and the value to which the location counter is to be set is placed in the second, third, and fourth columns of the A ADDRESS field (columns 15, 16, and 17). The page and line number is written in the PAGE and LINE fields; no other fields are required (figure 5-23). It should be noted that if memory locations are out of sequence due to an SLC instruction setting the memory location counter backwards, an error message will be printed; and the assembler program will continue assembling output cards, with five instructions per card, beginning at the location which is out of sequence. These cards can be used in place of normal autoload cards only if the following conditions are met:

a. Exactly five words per card must be indicated in column 64. Column 65 must be zero.

b. The machine address, punched in columns 61 through 63, must end in either 00 or 50.

5-51. A full 4800 characters will not necessarily be produced. When using some special purpose versions of the assemblers, only a listing will be produced beginning at the location that is out of sequence.

OP 0 (7-9)	M 1 (10-11)	N 2 (12-13)	A ADDRESS 3 (14-17)	B ADDRESS 6 (18-21)	C ADDRESS 9 (22-25)	PAGE (26-27)	REF (28-29)
SLC			A60			14	

Figure 5-23. SLC Coding

5-52. ADJUST LOCATION COUNTER (ALC). This instruction permits the programmer to advance the units and tens position of the location counter during assembly. It is sometimes desirable to have a group of instructions or constants assembled and stored starting at a modulus location. To accomplish this, ALC is entered in the OP field. If both the units and tens positions are to be adjusted, the desired settings are entered in the third and fourth columns of the A ADDRESS field (columns 16 and 17). If only the units position is to be adjusted, the desired setting is entered in the fourth column of the A ADDRESS field and the third column is left blank. The page and line numbers are written in the PAGE and LINE fields. No other fields are required. If the location counter units/tens position(s) equal the ALC coding, 16 in this example (figure 5-24), it will not be advanced.

OP 0	M 1	N 2	A ADDRESS 3 (PG R I)	B ADDRESS 6 (PG R I)	C ADDRESS 9 (PG R I)	PAGE	REF
7 8 9	10 11	12 13	14 15 16 17	18 19 20 21	22 23 24 25	26 27	28
ALC			16			03	

Figure 5-24. ALC Coding

5-53. Both SLC and ALC are useful when assembling service routines which rely on certain memory locations for proper operation.

5-54. OVERLAY (OVR). This instruction allows the setting of the location counter to any desired value, either machine actual (M in the most significant position of the A field) or symbolic (figures 5-25 and 5-26). When this OP Code is detected during assembly, the balance of the first 4800 characters will be produced in autoload form, including any literals used. The Overlay routine will then be assembled in autoload form, beginning at the location specified.

OP 0	M 1	N 2	A ADDRESS 3 (PG R I)	B ADDRESS 6 (PG R I)	C ADDRESS 9 (PG R I)	PAGE	REF
7 8 9	10 11	12 13	14 15 16 17	18 19 20 21	22 23 24 25	26 27	28
ØVR			MB50			01	

Figure 5-25. Machine Language OVR Pseudo Coding Overlay Beginning at Memory Location B50

OP 0	M 1	N 2	A ADDRESS 3 (PG R I)	B ADDRESS 6 (PG R I)	C ADDRESS 9 (PG R I)	PAGE	REF
7 8 9	10 11	12 13	14 15 16 17	18 19 20 21	22 23 24 25	26 27	28
ØVR			06A			01	

Figure 5-26. Symbolic OVR Pseudo Coding Overlay Beginning at the Memory Location Assigned to 06A

5-55. Overlays will be best utilized where a program exceeds memory, or when it becomes desirable to reserve memory for future use. For example, Initializing routines and End-of-Job routines could be assigned to the same memory locations. The End-of-Job routine could then be loaded in for execution by a program loading subroutine. Another use of Overlay would be in a tape system where various transaction code subroutines could be assigned to the same memory location. The subroutines could be kept on tape and called into memory as required. Literals cannot be used in Overlay routines.

5-56. Multiple Overlay routines can be used. The location counter setting is coded in the A field. All Overlays must start in or at a location with a least significant digit (LSD) of zero. The Overlay routine should be placed immediately preceding the END card. If an AAR subroutine is required in the main body of the program, the Overlay routine must be placed after it. If the AAR subroutine is required only for the Overlay, it may be included as part of the Overlay routine itself.

5-57. END-OF-PROGRAM (END). This instruction identifies the end of the program to be assembled. END is entered in the OP field and the page and line number are entered in the PAGE and LINE Fields (figure 5-27). No other fields are required for this instruction. The END card must be the last card of each program to be assembled.

OP 0	M 1	N 2	A ADDRESS 3 (PG R I)	B ADDRESS 6 (PG R I)	C ADDRESS 9 (PG R I)	PAGE	REF
7 8 9	10 11	12 13	14 15 16 17	18 19 20 21	22 23 24 25	26 27	28
END						99	

Figure 5-27. END Coding

Macro Instructions

5-58. The assembly program allows the use of two macro instructions. Macro instructions are generative in nature; that is, they consist of only one symbolic entry. However, when operated on by the assembly program, they generate multiple instructions in the resulting machine language or assembled program.

5-59. LINK (LNK). Often a particular subroutine, which is to be used several times throughout the main routine, is coded with the main program. The subroutine is coded only once and the control entry LNK allows it to be entered from any point in the program with an automatic exit back to the instruction following the entry. LNK is coded in the OP field of the coding form and the address of the first instruction of the subroutine is coded in the A ADDRESS field as shown in figure 5-28.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE REF
LNK			16A			07

Figure 5-28. LNK Coding

5-60. Whenever LNK is executed by the assembler program, it generates two instructions in the main routine which provide entry to the subroutine and set up the correct exit from the subroutine. In order to use the LNK feature, the subroutine should include at least two branching instructions. The first instruction of the subroutine must be a BRU instruction. The last executed instruction in the subroutine must transfer control to the first instruction of the subroutine. The LNK instruction generates two instructions to the assembled program. The first instruction transfers the address of the symbolic instruction following the LNK to the BRU instruction (A Address) which is located at the beginning of the subroutine. The second instruction generated from the LNK entry will transfer control to the second instruction of the subroutine. Figure 5-29 illustrates a subroutine which updates a line counter in a print area, prints a line, skips to a new page if overflow is sensed, and transfers control back to the main program. The M in 16AA indicates a reference provision from another source.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE REF
BRU			M			16A
ADD	1	3	*M	11C	11C	16
PRT	1		11C	- J		16
BRU			16A			16
SKP		1				16
BRU			16A			16

Figure 5-29. Sample Subroutine

5-61. ADDRESS ARITHMETIC (AAR). Address arithmetic is a subroutine technique for modifying an address in any one of the three address fields. This is accomplished by placing AAR in the OP field, the symbolic address of the address to be modified into the A ADDRESS field, the number of digits (increment) by which the address is to be modified into the B ADDRESS field, and the symbolic address where the result is to be stored into the C ADDRESS field (figure 5-30). Both A and C addresses may be the same.

OP 0	M 1	N 2	A ADDRESS 3	B ADDRESS 6	C ADDRESS 9	PAGE REF
AAR			01BC	M012	01BC	16A

Figure 5-30. AAR Coding

5-62. In this example, the C address of the instruction in symbolic location 01B will be incremented by 12. This increment value must be identified as machine language (M is the most significant position of the B field). If the value is variable and is to be modified by the program, assign a reference to the AAR instruction. This reference will be assigned by the assembler to the linkage instruction in such a manner that the increment can be modified by transferring a new three-digit value into PPRB where PPR is the page and reference assigned to the AAR instruction.

5-63. When the assembler encounters the AAR op code, it sets up a two-instruction linkage to an address modification subroutine which must be included in the symbolic deck by the programmer. The three-instruction linkage consists of a NOP, TFR, and BRU. Each time AAR is encountered, the program is linked to the *same* address modification routine which consists of 30 instructions and constants. When using AAR in a program, be sure to allow for the two-instruction linkage and the 30-instruction subroutine when allocating storage. The 30-instruction routine must start in a location ending in 00. This takes place automatically due to the ALC 00 instruction in the subroutine. As stated previously, when the AAR instruction is used, the linkage will be set up automatically. However, the AAR symbolic cards (figure 5-33) must be placed in the program being assembled. If an Overlay (OVR) instruction is used, the AAR subroutine must precede it unless it is to be a part of the Overlay routine only.

NOTE

When using the macro instruction LNK and AAR, the PAGE, REF, REMARK, and LINE fields will appear repetitively for each of the automatically generated linkage instructions.

SPECIAL ENTRY

5-64. SYMBOLIC ADDRESS ENTRY (SAD). This instruction allows the programmer to use the M and N fields together as a four-character field. The combined M and N field may then be coded in the same manner as the A, B, and C fields (figure 5-31). All coding techniques applicable to the A, B, and C fields (e.g., machine language, figures 5-31 and 5-32) can be applied to the M and N fields combined. This will be useful in setting up tables of addresses.

NOTE

Literals cannot be used with SAD in any of the four fields (M and N, A, B, or C).

OP 0 (7–9)	M 1 (10–11)	N 2 (12–13)	A ADDRESS 3 (14–17)	B ADDRESS 6 (18–21)	C ADDRESS 9 (22–25)	PAGE REF (26–28)
SAD	O/	AA	O6B2	O5S	O1B4	O1A

Figure 5-31. Symbolic SAD Pseudo Coding

OP 0 (7–9)	M 1 (10–11)	N 2 (12–13)	A ADDRESS 3 (14–17)	B ADDRESS 6 (18–21)	C ADDRESS 9 (22–25)	PAGE REF (26–28)
SAD	MT	3O	MS1O	MO13	MZ17	O1A

Figure 5-32. Machine Language SAD Pseudo Coding

```
PROGRAM NO. SR050
OP. MM NN AAAA BBBB CCCC PGR SIZ CONSTANTS... REMARKS..................... LN.

HDG                      BB                   MODEL 0                        01
HDG                      BB                   ADDRESS ARITHMETIC ROUTINE     02
HDG                      BB                   SEMI-RELOCTABLE                03
HDG                      BB                   LINKAGE PROVIDED BY AAR INST   04
HDG                      BB                   360 CHAR-5 REFERENCES          05
HDG                      BB                   ENTER AT BBB                   06
ALC        00            BB                                                  07
NOP                      BBB                  AAR CONSTANTS                  08
TFR     2 BBBM      BBEA BB                   STORE RETURN ADDRESS           09
TFR     3 BBBC      BBDC BB                   STORE LOCATION OF ANSWER       10
TFR     3 BBBB      BBEB BB                   STORE INCREMENT                11
TFR     3 BBBA      -  A BB                   STORE LOCATION OF DATA         12
TFR     3 M***      BBBA BB                   STORE DATA TO BE MODIFIED      13
CAU     1 BBB5 BBD7   *L BB                   TEST FOR @                     14
ADD  4  2 BBE5 BBFT BBE5 BB                   ADD 11 FOR UNITS POSITION      15
BRU         *K           BB                   SKIP NEXT INSTRUCTION          16
ADD  4  1 BBE5 BBB5 BBE5 BB                   ADD UNITS POSITION             17
DIV  4  2 BBE5 BBF1 BBET BB                   COMPUTE NUMBER OF WORDS        18
CAU     1 BBE7   *N   *L BB                   TEST FOR # OR @                19
ADD  1  1 -  8 BBE8 -  5 BB                   MODIFY TRANSFER FOR # OR @     20
TFR     1   *B M#@6 BBE8 BB                   STORE # OR @                   21
TFR     1 BBE8      BBC7 BB                   STORE LOW ORDER DIGIT          22
ADD  2  3 BBB3 BBE9 BBC4 BB                   INCREASE MIDDLE DIGIT          23
CZE     1 BBBA   *M BBC  BB                   TEST FOR NO ZONE               24
CZE     1 BBBA BBFK   *L BB                   TEST FOR NEGATIVE              25
BRC         *L   *K -    BB                   TEST COMPARISON INDICATORS     26
ADD  1  1 BBC4   *M BBC4 BB                   ADD 1                          27
ADD  1  1 BBC4   *M BBC4 BB                   ADD 1                          28
ADD  1  1 BBC4   *M BBC4 BB                   ADD 1                          29
TFR     1 BBF       BBC5 BBC                  HIGH ORDER DIGIT FROM TABLE    30
TFR     3 BBC5 M#@  M*** BBD                  STORE NEW ADDRESS              31
BRU       M**0      M5   BBE                  BRANCH TO RETURN               32
CST                      BBF  12 012345678911                                33
CST                      BB   12 +ABCDEFGHI                                  34
CST                      BB   12 ×JKLMNOPQR                                  35
CST                      BB   12  /STUVWXYZ                                  36
CST                      BB   12 0123456789                                  37
```

Figure 5-33. AAR Routine

SECTION 6

TIMING CONSIDERATIONS

GENERAL

6-1. The Input/Output (I/O) and processing abilities of the B 200 Series Systems are used to the greatest advantage when applicable timings are considered during the development of the program. Because of the buffering of selected peripheral units, timing, while important, normally is not a critical factor. This section provides information for the calculation of the Input/Output and internal processing times.

TIMING INPUT/OUTPUT OPERATIONS
B 102/B 103 Sorter-Reader

6-2. Under program control, the sorter-reader operates in either demand or flow mode. In demand mode, or buffered flow mode, information is stored in input buffer number 2 upon executing a Control Sorter instruction and remains there until read into storage by a Sorter-Reader instruction (SRD). The demand-type of feeding does not require close timing.

6-3. In unbuffered flow mode, information is read directly into core storage. This continuous type of operation requires close system timing in order to achieve maximum use of the available time and for maintaining proper operation.

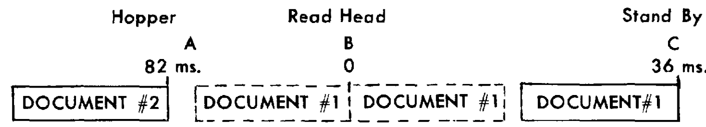
Demand Mode (B 102 Only)

6-4. In demand mode, the program must contain one Sorter-Reader-Demand (#-SRD) and Control Sorter (C-CTL) instruction for every item. The transfer time of 84 characters from buffer to core storage requires 2.0 ms.

6-5. A Control Sorter instruction is executed in 120 microseconds (μs.). Following a Control Sorter instruction to pocket select and demand feed next document, the buffer is refilled in 150 ms.

6-6. A Control Sorter instruction is always the first sorter-reader instruction in a program which utilizes the B 102 as an input device. The following is the minimum sorter-reader program timing (worst case) and sequence of operation when in demand mode operation:

DEMAND MODE



a. Control Instruction—This instruction feeds the first document from the hopper; reads it into buffer number 2 and places it in the standby station.

b. Sorter-Read Instruction—This instruction transfers the contents from input buffer number 2 (first document) to memory.

c. Control Instruction—This instruction selects the pocket and reads the second document into input buffer number 2. No hardware timing restrictions are involved.

d. Sorter-Read Instruction—This instruction transfers the contents from buffer number 2 to memory for the second document.

e. Repeat Control and Read instructions (c and d).

f. The Document is fed to the read head in 82 ms., to the leading edge of the document. It is read in 15 ms., placing the trailing edge at point B and is placed in standby in 21 ms. (leading edge).

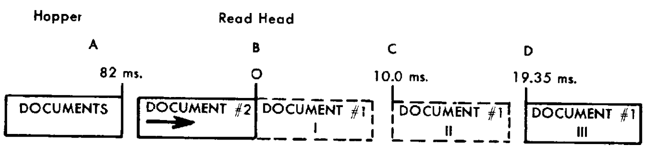
g. The pocket must be selected before the next read instruction is given. Pocket selection can be made at the programmer's option.

h. It requires 2 ms. processing time to unload the buffer and 2.5 ms. processing time to reload the buffer (40 μs. per access, 63 accesses). The 2.5 ms. is maximum buffer access time during processing of the preceding document.

Flow Mode

6-7. In flow mode, information can be read from documents directly into core storage. Reading will stop after reading the ending transit number symbol of the Transit Field or after 7¾ inches of document has passed the read head of the sorter-reader. The stop read at the ending transit number symbol must be programed. If it is not programed, reading will automatically stop after 7¾ inches of document length. The following is the minimum program timing and sequence of operation of the sorter-reader when in unbuffered flow mode operation worst case condition:

UNBUFFERED FLOW MODE



a. Control Instruction (start flow)—This instruction begins feeding documents from the hopper.

b. Sorter-Read Instruction—This instruction reads the document directly into memory. The instruction must be initiated before the document reaches point B after leaving point A. (See document #2.)

c. Control Instruction (PS)—This instruction selects the pocket and must be given between points B and C.

d. Sorter-Read Instruction—This instruction reads the document directly into memory and must be initiated before the next document reaches the read head, point B (See document #1, III, and document #2).

e. Repeat Control (PS) and Read instruction (c and d).

f. Processing time of 82 ms. is available from the leading edge of the document at point A to the leading edge of the document at point B on the *first document only.* (See steps a and b).

g. The central processor is required during the actual reading of the entire document—15 ms.

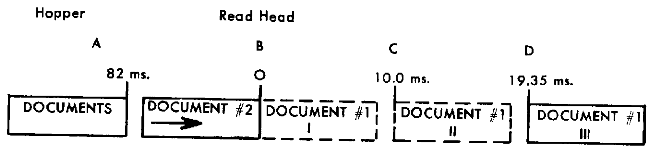
h. Processing time is available from the trailing edge of the document at point B (document #1-I) to the trailing edge of the document at point D (document #1-III)—19.35 ms. When the trailing edge of document #1-III is at point D, the leading edge of document #2 is at point B, ready to read.

i. The pocket must be selected before or when it reaches point C which is 10.0 ms. after leaving point B. (See document #1-II and document #1-I).

j. The available processing time after selection of a pocket is the total processing time (19.35 ms.) minus the time used through pocket select (maximum of 10 ms.).

6-8. The minimum program timing (worst case) and sequence of operation of the sorter-reader when in the buffered flow mode operation is as follows:

BUFFERED FLOW MODE



a. Control Instruction (start buffered flow)—This instruction begins feeding documents and fills input buffer number 2 from first document.

b. Read Instruction—This instruction transfers the contents of input buffer number 2 to memory. If the instruction is given before the first document is completely read into buffer number 2, internal processing will be inhibited.

c. Control Instruction (PS)—This instruction selects the pocket before the first document reaches point C and fills input buffer number 2 with second document.

d. Read Instruction—This instruction transfers the contents of the second document in input buffer number 2 to memory. If the instruction is initiated before document is completely read into input buffer number 2, internal processing will be inhibited.

e. Repeat Control and Read instruction (steps c and d).

f. The central processor is required for 2 ms. during buffer unload in b and d above.

g. The Control instruction for pocket selection must be given before the document in process reaches point C (document I-II); therefore, 10 ms. — 2 ms. (unload buffer) or 8 ms. after reading, the complete document is available for pocket selection.

h. Internal processing can take place for a total of 30.35 ms.

   1. 19.35 ms. from point B (trailing edge) to point D (trailing edge) minus 2 ms. for buffer reload.
   2. 15 ms. while loading buffer with information from next document (leading edge at point B to trailing edge at point B) minus 2.0 ms. for character transfer to the input buffer (buffer access time).

i. Buffer access time is dependent upon number of characters read at 40 μs. per character.

j. Magnetic tape operations must take place before refilling of the input buffer begins (between trailing edge at point B and trailing edge at point D). Normally, a tape operation should take place immediately following pocket select. On this basis, the time available for magnetic tape operations ranges from 9.35 ms. to 17.23 ms. (a-b).
   1. Total time between documents (19.35 ms.).
   2. Processing time used through pocket select (including 2 ms. for buffer unload and 0.120 ms. for actual pocket selection).

k. When reading from or writing onto magnetic tape during MICR operations, provision must be made to handle the additional 50 ms. required for travel time from load point to first record. This can be accomplished either by using header labels which are written or read before starting flow or by programing a stop flow before execution of the first magnetic tape operation. (figure 6-1).

N = Number of characters per millisecond which can be transferred to or from tape (excluding start/stop time) these are:

B 421 : High Density—50
Low Density—18

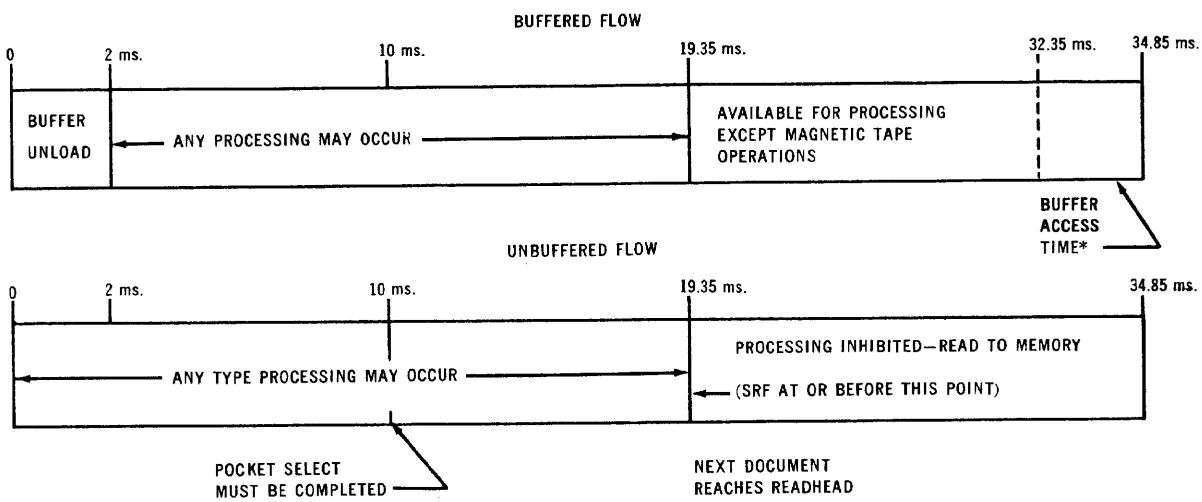
B 422 : High Density—66.6
Low Density—24

P = Total time used for pocket select including 2 ms. for buffer unload and 0.120 ms. for execution of the pocket select instruction, as well as all time required to determine correct pocket selection via the longest possible routing.

S = Start time for magnetic tape: Applicable times are:

B 421 : Write 6.7 ms.
Read 6.7 ms.

B 422 : Write 6.85 ms.
Read 6.85 ms.



*Buffer access time actually occurs throughout the read to buffer process (48 accesses x 40 μs. — 2 ms.). Net effect is that total processing time equals 30.35 ms. No additional time should be added to individual instructions for buffer access.

Figure 6-1. Magnetic Tape Operation When Using Sorter-Reader

1. The maximum block size for each MICR-to-magnetic tape program can be computed as follows:

$$R = N \frac{(19.35 - P - S)}{C}$$

where:

R = Number of records per block (result truncated to largest whole number).

C = Number of characters per record.

19.35 = total time between documents in which magnetic tape operations may take place.

Examples:

a. Assumption: Minimum time used for pocket select P = 2.12 ms., N = 50, B 421, S = 6.7 ms., C = 25

$$R = \frac{N\,(19.35 - P - S)}{C}$$

$$R = \frac{50\,(19.35 - 2.12 - 6.7)}{25}$$

R = 21 records per block.

b. Assumptions: Maximum time used for pocket select P = 10 ms., N = 50, (B 421), S = 6.7 ms., C = 25

$$R = \frac{N\,(19.35 - P - S)}{C}$$

$$R = \frac{50\,(19.35 - 10.0 - 6.7)}{25}$$

R = 5 records per block.

NOTE

For magnetic tape operations utilizing unbuffered flow mode, the following differences must be considered:

a. No buffer unload time is required; therefore, the total time available for magnetic tape operations will be increased by 2 ms.

b. However, since the read is directly to memory, total processing time will be 13 ms. (less 15 ms. for read, less 2 ms. for buffer access time.)

6-9. A composite timing chart (figure 6-2), illustrates the timing available for computation on various size documents. There will be instances when all the documents being processed are identical in size; however, normally intermixed size documents will be processed. To prevent rejection of minimum size documents, it is recommended that timing be calculated on the basis of a minimum size document.

Document Length	Total Document Time Between Leading Edges (A)	Tolerance for Sorter-Reader Slippage (B)	Effective Document Time	Time to Read: Through 7¾"	Time to Read: Through Transit Number Symbol
5¾"	38.3 ms.	2.8 ms.	35.5 ms.	19.4 ms.	14.4 ms.
6"	40.0 ms.	3.0 ms.	37.0 ms.	19.4 ms.	14.4 ms.
6½"	43.3 ms.	3.3 ms.	40.0 ms.	19.4 ms.	14.4 ms.
7"	46.6 ms.	3.6 ms.	43.0 ms.	19.4 ms.	14.4 ms.
7½"	50.0 ms.	4.0 ms.	46.0 ms.	19.4 ms.	14.4 ms.
7¾"	51.6 ms.	4.2 ms.	47.4 ms.	19.4 ms.	14.4 ms.
8"	53.3 ms.	4.3 ms.	49.0 ms.	19.4 ms.	14.4 ms.
8½"	56.6 ms.	4.7 ms.	51.9 ms.	19.4 ms.	14.4 ms.
9"	60.0 ms.	5.0 ms.	55.0 ms.	19.4 ms.	14.4 ms.
9½"	63.3 ms.	5.3 ms.	58.0 ms.	19.4 ms.	14.4 ms.

Figure 6-2. Sorter-Reader Composite Timing Chart

(A) This figure represents the amount of time available between Sorter-Read-Flow instruction for each given size of document. The formula used is shown below.

Length of Document in inches x 6⅔ ms.

(B) This figure represents the tolerance time which has been established for slippage in feeding of documents by the sorter-reader. It is calculated as follows:

(Length of Document in inches x ⅔ ms.) 1 ms.

NOTE

Computation times can not be directly related to document lengths. Items, especially those in poor condition, may occasionally overlap while entering the feeder. The acceleration station will separate these documents; but when this process does not result in a minimum of 7¾ inches between the trailing edge of one document and the leading edge of the next document, the items in the feed will be rejected and the sorter-reader will shut down. This separation process will result in a minimum available computation time of 19.35 ms. per item. Although this time may be increased slightly when processing documents greater than 6½ inches in length, a higher incidence of rejected items will often result.

CARD READER TIMING

6-10. Each of the card readers used in a B 200 Series is a demand-feed unit controlled by an electromagnetic clutch which feeds cards upon receiving a feed signal from the central processor. The two input buffers are used by the card readers.

6-11. The B 123 Card Reader may be used with the B 200 Series in place of either a B 122 or B 124 Card Reader. The characteristics of the B 123 are identical to the B 124 Card Reader with the exception of operating speed. The B 123 is designed to read cards at a speed of 475 cards per minute, which results in a time of 126 ms. per card. The time available for processing is 126 ms. minus 2.0 ms. (buffer unload time) minus 3.2 ms. (buffer access time) or 120.8 ms.

6-12. The associated input buffer of the central processor stores the characters as they are serially transferred from the card reader. Immediately upon executing a Card Read instruction, the contents of the 80-character input buffer are transferrred to memory; and the next card is moved past the read station, reading 80 characters into the buffer. Buffer to memory transfer requires 2 ms. Forty microseconds of central processor time are required as each character is read by the card reader and transferred to the buffer (buffer access time). All cards require an 80-character cycle. When card reader time exceeds internal processing time (input bound), available internal processing time can be used for multiprocessing.

B 122 Card Reader Timing

6-13. The B 122 Card Reader is a 200 cpm card reader that requires 300 ms. per card cycle. Internal processing can take place during the buffer reload time. The time available for processing would then be 300 ms. minus 2 ms. (buffer unload time) minus 40 μs. per character (80 characters or 3.20 ms. for a total of 294.8 ms.). The 320 ms. is considered buffer access time (figure 6-3).

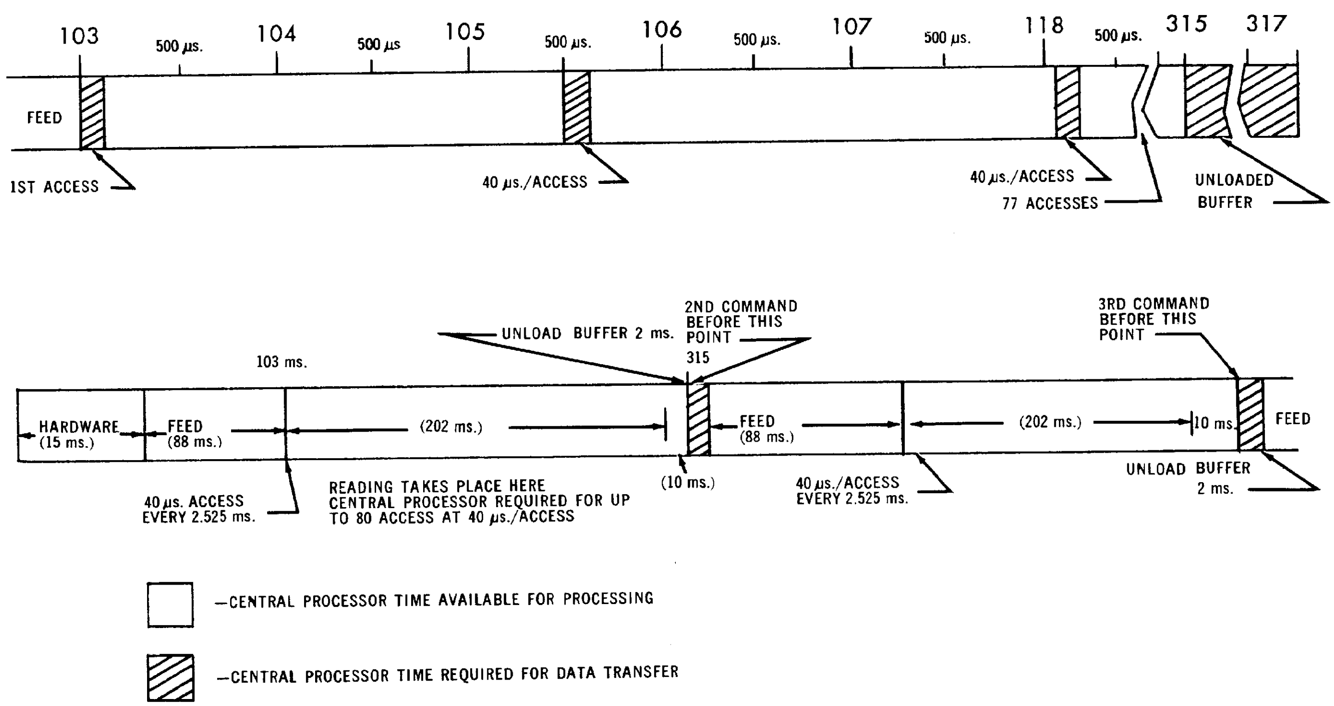


Figure 6-3. B 122 Card Reader Timing Example

6-14. In order to maintain the card reader input speed of 200 cards per minute, it is necessary to issue a second Card Read instruction within 300 ms. of the first Card Read instruction.

6-15. If the internal processing time between Card Read instructions is less than 294.8 ms., the 200 card-per-minute rate will be maintained. If the internal processing time between Card Read instructions is greater than 294.8 ms. and less than 309.8 ms. (hardware requires an additional 15 ms.), the effective reading rate is 190.4 cards-per-minute. When the time between Card Read instructions exceeds 315 ms. (this includes buffer transfer and buffer access time), the effective reading rate may be determined by dividing the total number of ms. processing time, plus buffer transfer and buffer access time, into 60,000 ms. (1 minute). The quotient will represent the actual speed, expressed in cards-per-minute, of the card reader.

B 124 Card Reader Timing

6-16. The B 124 Card Reader is an 800 card-per-minute reader which requires 75 ms. for each card cycle. Internal processing can take place during the buffer reload time. The time available for processing would then be 75 ms., minus 2 ms. (buffer unload time) minus 40 μs. (80 characters) or 3.2 ms. for a total of 69.8 ms. The 3.2 ms. is considered as buffer access time (figure 6-4).

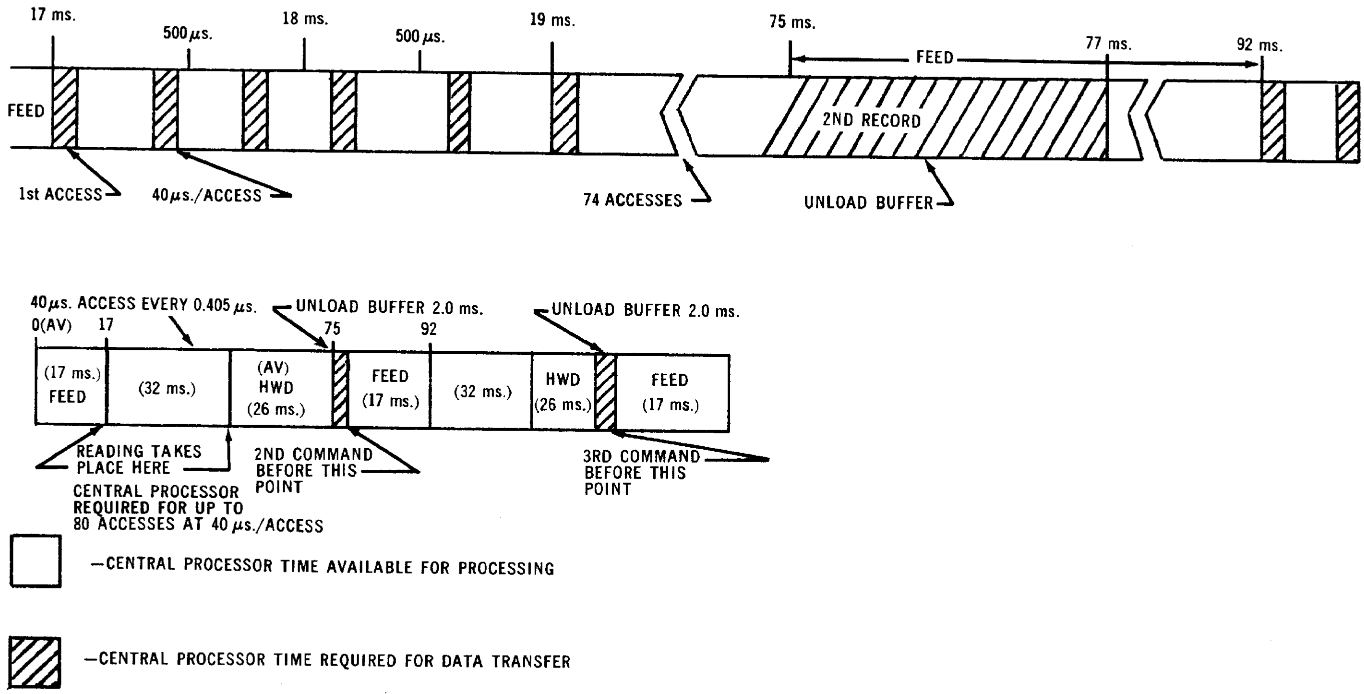


Figure 6-4. B 124 Card Reader, Timing Example

6-17. In order to maintain the rated input speed of 800 cards-per-minute, it is necessary to issue a second Card Read instruction within 75 ms. of the first Card Read instruction. If the internal processing time between Card Read instructions exceeds 69.8 ms., the effective reading rate may be determined by dividing the total number of ms. in internal processing time, plus buffer transfer (2 ms.) and buffer access time (3.2 ms.), into 60,000 ms. (1 minute). The quotient will represent the actual speed, expressed in cards per minute, of the card reader.

CARD PUNCH TIMING

6-18. Either a B 303 or B 304 Card Punch can be used in a B 200 Series configuration. A row buffer is supplied with both punches; therefore, one card row (80 bits) is punched at one time. This requires a total of 12 punch cycles to completely punch one card. When the punch instruction is executed, the central processor output buffer is loaded. The card will pass through the punch station and successive card rows will be punched from 12 to 9. Internal processing will take place during the punching of the card except for buffer load time and buffer access time. The output buffer is always interlocked for the duration of a card cycle.

6-19. When the punch time exceeds internal processing time (output bound), available processing time can be used for multiprocessing.

6-20. It should be noted that magnetic tape instructions may be given after the last punch cycle. For example, during the final 46.0 ms. on the B 303 Card Punch and during the final 30.8 ms. on the B 304 Card Punch.

B 303 Card Punch Timing

6-21. The B 303 Card Punch is a 100 card-per-minute punch which requires 600 ms. per card cycle. It is operated by a 14-tooth clutch which requires 50 ms. in addition to the 600 ms. when internal processing. Buffer transfer and buffer access cannot be accomplished within the 600 ms. card cycle (figure 6-5).

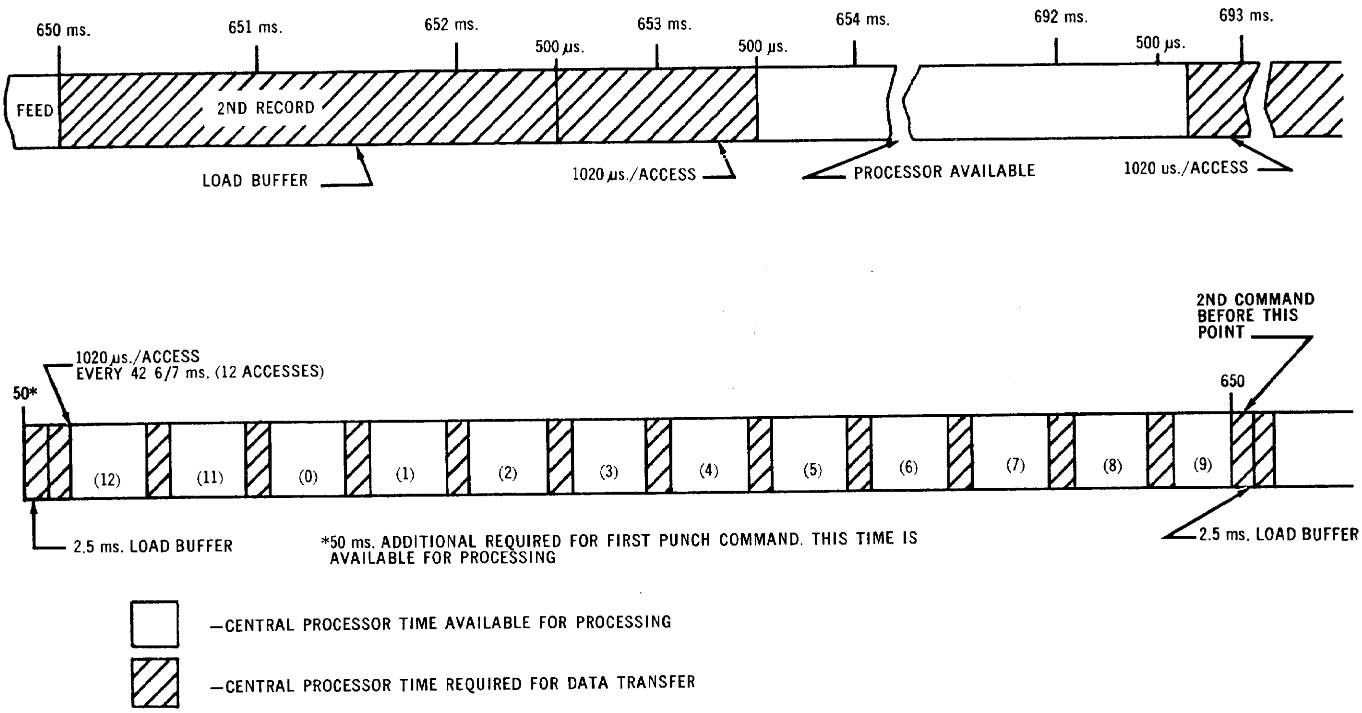


Figure 6-5. B 303 Card Punch, Timing Example

6-22. If the internal processing time between Card Punch instructions is less than 600 ms. minus 2.5 ms. (buffer load time), minus 1020 µs. for each row (12 rows) or 12.24 ms. for a total of 585.26 ms., the 100 cpm punching rate will be maintained. The 12.24 ms. represents buffer access time per-card-cycle. If internal processing is greater than 585.26 ms., an additional 50 ms. is required by the punch unit. The effective punching rate is 92.3 cpm when internal processing requires between 585.26 ms. and 635.26 ms. When internal processing is greater than 635.26 ms., the effecting punching rate may be determined by dividing the total number of ms. in internal processing time plus buffer load (2.5 ms.) and buffer access time (12.24 ms.) into 60,000 ms. (1 minute). The quotient will represent the actual speed, expressed in cards-per-minute, of the card punch.

6-23. In some applications, the system may be output bound. That is, the time required to punch a card exceeds the buffer load time, plus internal processing time, plus buffer access time. In such a case, the total job time will be the number of cards to be punched, divided by the effective punching rate.

B 304 Card Punch Timing

6-24. The B 304 Card Punch is a 300 card-per-minute card punch which requires 200 ms. per-card-cycle. It is operated by a 1-tooth clutch; therefore, 400 ms. is required if the buffer load time plus internal processing; plus buffer access time exceeds 200 ms. If the internal processing time between Card Punch instructions is less than 200 ms. minus 2.5 ms. (buffer load time) minus 1020 µs. (12 rows) or 12.24 ms. for a total of 185.26 ms., the 300 cpm rate will be maintained. The 12.24 ms. represents buffer access time per-card-cycle. If internal processing is greater than 185.26 ms. or less than 385.26 ms., the effective punching rate is 150 cpm (figure 6-6).

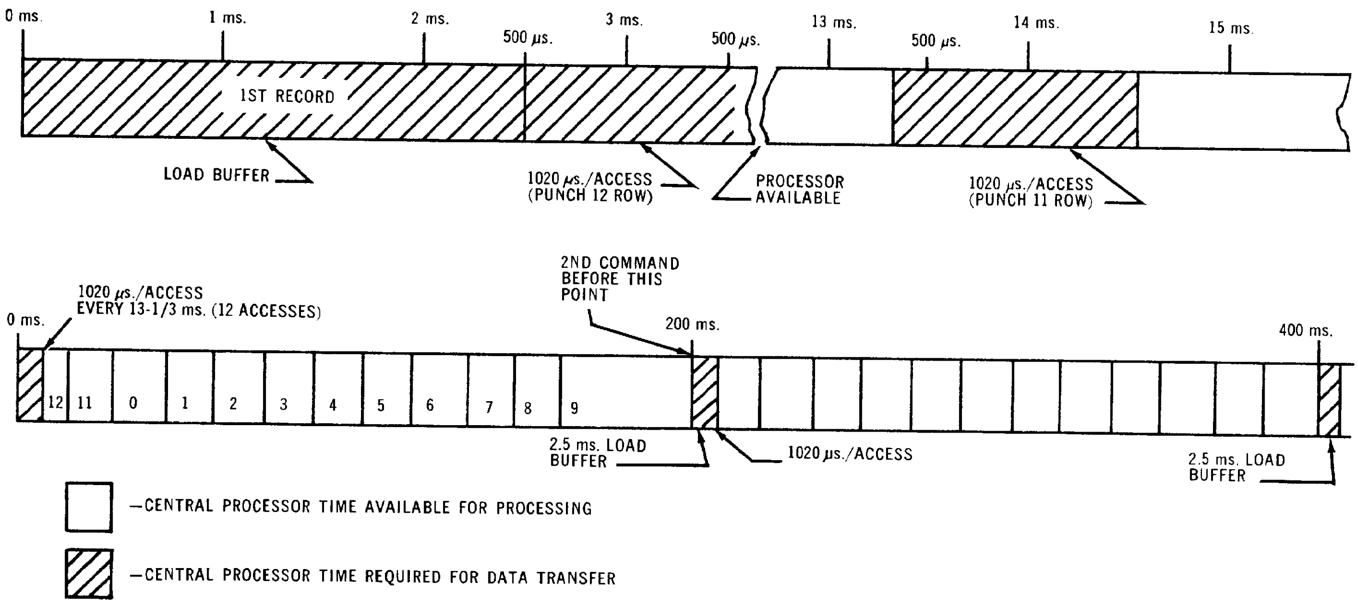


Figure 6-6. B 304 Card Punch, Timing Example

6-25. When internal processing in greater than 385.26 ms., the effective punching rate may be determined by dividing the total number of ms. in internal processing time, plus buffer load time (2.5 ms.), plus buffer access time 12.24 ms. into 60,000 ms. (1 minute). The quotient will represent the actual speed, expressed in cards-per-minute of the card punch.

B 320 LINE PRINTER

3-26. The B 320 Line Printer may be used with the B 200 Series in place of a B 321 Line Printer. The B 320 is physically and operationally identical to the B 321. However, the B 320 is designed to operate at speeds of up to 475 lines per minute when single spacing and 450 lines per minute when double spacing. Internal processing time is available for the entire print cycle except during buffer load time. The print cycle for the B 320 when printing at 475 lines per minute requires 126.3 ms. This time, minus 1.3 ms. (buffer load time) or 125 ms. is available for processing.

B 321 LINE PRINTER

6-27. The speed of the B 321 Line Printer is 700 lines-per-minute when single spacing, or 650 lines-per-minute when double spacing. Internal processing time is available for the entire print cycle, except during printer buffer load time.

6-28. The execution of the Print instruction causes the print buffer, located in the print unit, to be filled with data in 1.3 ms. As soon as the buffer is filled, a line will be printed. The buffer will remain interlocked for the duration of the print cycle. Buffer access time is not required because the printer contains its own buffer.

6-29. Double spacing and skipping after printing will interlock the print mechanism for additional time, but will not prevent a succeeding Print instruction from reloading the buffer if it is issued during the execution of the spacing or skipping operation. However, the central processor will be interlocked from the time the buffer is loaded, until the paper motion of the preceding command is completed.

6-30. If processing time (including buffer load time) exceeds 85.7 ms., the effective rate of printing may be calculated by dividing the total number of ms. processing time into 60,000 ms. (1 minute). The quotient will be the actual number of lines printed per minute (plus skipping time).

B 326 MULTIPLE TAPE LISTER

6-31. A B 326 Multiple Tape Lister may be used in a B 200 Series in place of either a B 322 or B 323 Multiple Tape Lister. The physical characteristics are identical to that of the B 322 and B 323. The only difference is that the B 326 is designed to operate at a speed of up to 1250 lines per minute. The print cycle requires 48 ms. However, 47.3 ms. is available for other processing since the only processor time necessary is the time to load the buffer which requires 0.7 ms. per line.

B 322 & B 323 MULTIPLE TAPE LISTER

6-32. The B 322 and B 323 Multiple Tape Listers have a maximum speed of 1600 lines-per-minute. The 37.5 ms. print cycle allows 36.8 ms. for internal processing.

6-33. The execution of the Print instruction causes the print buffer, located in the Lister, to be filled with data in 0.7 ms. As soon as the buffer is filled, a line will be printed with the buffer remaining interlocked for the duration of the print cycle. Since the Lister contains its own buffer, buffer access time is not required.

6-34. Skipping after printing will interlock the print mechanism for an additional 100 ms., but will not prevent a succeeding Print instruction from reloading the buffer if it is issued during the execution of the skipping operation.

6-35. If processing time (including buffer load time) exceeds 37.5 ms., the effective rate of printing may be calculated by dividing the total number of ms. processing time into 60,000 ms. (1 minute). The quotient will be the actual number of lines printed-per-minute.

B 421 MAGNETIC TAPE UNIT

6-36. The B 421 Magnetic Tape Unit permits reading and writing of data at either of two densities and speeds. They are:

50,000 characters-per-second at 555.5 characters-per-inch (50KC), or

18,000 characters-per-second at 200.0 characters-per-inch (18KC).

6-37. For 50KC, the transfer time per-character is 0.02 ms. and 0.056 ms. for the 18KC rate. To determine the time required to read or write a record, the length of the record (number of characters plus 4.2) is multiplied by the character transfer rate (0.02 or 0.056 ms.). The product is then added to the time required to start tape movement, which is 6.7 ms. The resulting sum is the total time required to read or write the record. This same method of timing applies to Magnetic Tape Write and Erase instructions. Backspace requires 26.0 ms. if it follows a Write instruction and 11.2 ms. if it follows any other instructions.

6-38. Rewinding a tape requires 60 microseconds of central processor time, after which the rewinding is accomplished independently of the central processor. Total rewind time for a 2400 ft. reel is 90 seconds. This permits internal processing to continue while the tape is rewinding unless, of course, the tape unit being rewound is referenced by another instruction before the rewind operation is complete.

6-39. Magnetic tape instructions (rewind excluded) are not buffered and their execution times are to be considered as part of the total processing time. To calculate the total job time, the following factors are considered:

a. Tape Read + internal processing + Tape Write. The resulting sum, when divided into 60,000 ms. (1 minute), will express the number of records processed per-minute.

b. Dividing this quotient into the total number of records to be processed will give the total job time in minutes.

6-40. When a magnetic tape application utilizes short records, it is often advisable to pack, or combine, several such short records into one longer record. By so doing, the start time (6.7 ms.) normally required for each of the individual records is now considered only once per group, as this group of packed records will read in as one record. For example: to read 10 records of 30 characters each, requires 7.36 ms. per-record or a total of 73.6 ms. total tape read time; however, if these same 10 records were combined into one record, the total time required to read in this record would be 12.76 ms. Using this simple technique can result in a considerable saving of tape time.

6-41. On various applications the size of the magnetic tape file may require two or more reels of magnetic tape. Under this condition, and when the system being used has tape storage units not in normal use during the run, it is advantageous, from the job time and tape handling aspects, to mount the first reel on one unit and the second reel on another unit. When the end of the first reel is encountered during the processing run, the program (if so coded) will begin processing the tape from the second unit, while the first reel is being rewound. Then the third reel can be mounted in place of the first reel and the procedure repeated when the end of the second tape is encountered. This procedure of flip-flopping, either by manually changing the unit designate number or by a self-modifying program, will reduce the over-all job time on applications which utilize large magnetic tape files.

B 422 MAGNETIC TAPE UNIT

6-42. The B 422 Magnetic Tape Unit is designed to read and write at two speeds, 24,000 characters per second or 66,600 characters per second. Transfer time when reading or writing at 24,000 characters per second, is 0.041 ms. per character. When reading or writing at 66,600 characters per second, the transfer time is 0.015 ms. per character. The turn around time or the time to reverse the direction of the tape drive is 10.0 ms. Start time to begin reading or writing is 6.85 ms. Timing for the B 422 can be calculated in the same manner as described for the B 421.

B 423 MAGNETIC TAPE UNIT

6-43. The B 423 Magnetic Tape Unit may be used with the B 200 Series in place of either a B 421 or B 422 Magnetic Tape Unit. The B 423 Magnetic Tape Unit operates at a speed of 24,000 characters per second only. Timing for the B 423 may be obtained by referring to the B 422 Magnetic Tape unit timing information.

B 141 PAPER TAPE READER

6-44. The B 141 Paper Tape Reader can read punched paper tape at speeds of either 500 or 1000 characters-per-second. Fanfold tape, whether in strips or in reels, must be read at 500 characters-per-second.

6-45. The start time for the B 141 is 5 ms. and stop time is 1 ms. (oiled or non-oiled tape). The B 141 stops on the stop character or between characters at both high or low speeds. After the last character has been read, the B 141 requires 20 ms. stop stabilization time (this includes the 1 ms. stop time), prior to executing another command. A command given in less than 20 ms. waits for the 20 ms. time interval. If a broken tape condition occurs, the tape reel motors are automatically turned off. The total time between Paper Tape Reads is 25 ms. This includes the 20 ms. stop stabilization time, plus the 5 ms. start time (figure 6-7).

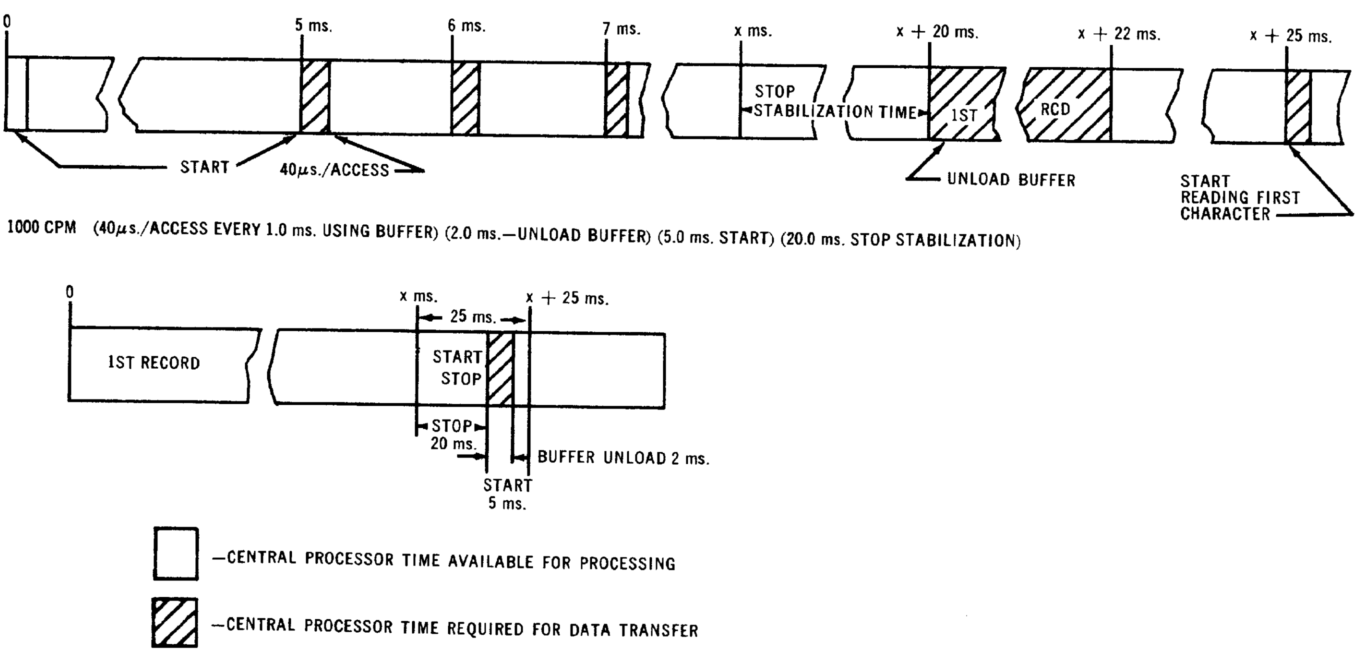


Figure 6-7. B 141 Paper Tape Reader Timing Example

B 341 PAPER TAPE PUNCH

6-46. The B 341 Paper Tape Punch punches at a speed of 100 characters-per-second, 10 characters-per-inch. Through means of an output code translator, the translator allows translation of BCL code to any 6, 7, or 8-level code, in up to 64 different characters. The B 341 Paper Tape Punch automatically shuts off if it has not punched paper tape within one second. If a punch command is given while the paper tape punch is off, it will take less than one second before punching commences, after it is turned on (figure 6-8).

6-47. If the B 341 Paper Tape Punch has not been turned off, it will take approximately 10 ms. before punching commences.

DISK FILE AND DATA COMMUNICATION

6-48. The disk file and data communication system is used with either the B 273 or B 283 System. The disk file has an average access time of 20 ms. and a maximum access time of 40 ms. Usually, the disk file functions fall into two categories: One involves locating and then reading or writing data only. The other involves locating, reading, and the writing back of data on the file. The total time for these typical processing cycles are listed in table 6-1 and 6-2.

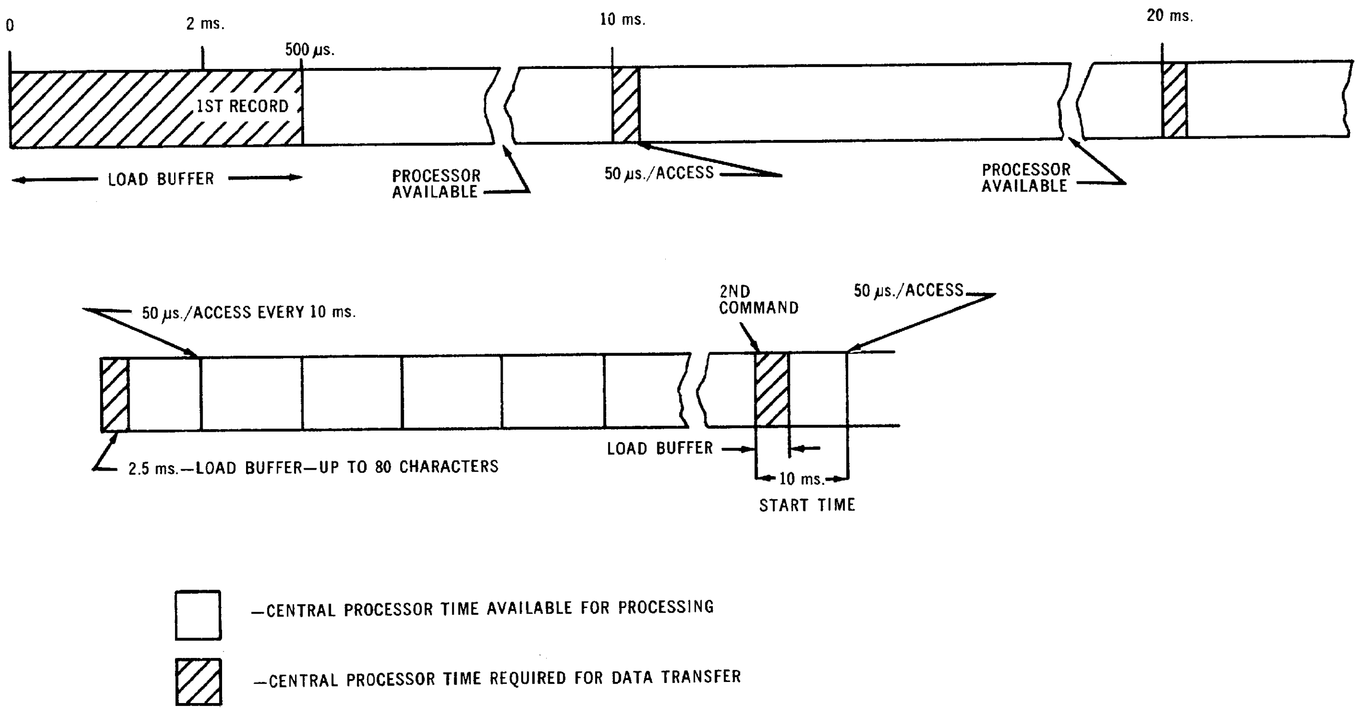


Figure 6-8. B 341 Paper Tape Punch Timing Example

TABLE 6-1
Locate and Read or Write

OPERATION	TIME	EXPLANATION
Locate 240-character data segment.	20.0 ms.	Latency time only.
Read and transfer 240 char. to core memory. (Write and transfer 240 chars. to disk storage.)	2.4 ms.	Data is now available for processing, inquiry reply, printing, punching, magnetic tape writing, etc.
TOTAL CYCLE TIME	22.4 ms.	

TABLE 6-2
Locate, Read, Process, Write Back

OPERATION	TIME	EXPLANATION
Locate 240-character segment.	20.0 ms.	Latency time only.
Read & transfer 240 chars. to core memory.	2.4 ms.	Data is now available for processing.
Process data.	37.6 ms.	This is latency period while disk revolves to original data location. Data is manipulated and a write command is issued during this time. Printing, punching, magnetic tape writing, etc., can occur during this latency.
Write updated information.	2.4 ms.	Information has been written back on disk and system is free for next transaction or storage access.
TOTAL CYCLE TIME	*62.4 ms.	

NOTE

This cycle would be extended and another full revolution (40 ms.) added if the optional read check operation is performed. The central processor is free to perform functions both during disk revolution and read check time.

Data Communication

6-49. A maximum of fifteen teletype and/or typewriter units can be attached to one data communication control unit. Only one data communication control unit can be attached to a B 273 or B 283 System. One teletype terminal unit with a 120 or 240-character buffer can be connected to up to 399 teletype stations. The minimum data transfer rate is 30 KC between the terminal buffer and the central processor. The central processor replys are terminated by a group mark. Typewritten station inquires are terminated by pressing the END-OF-MESSAGE key. All teletype inquires are terminated by "bb" sequence.

B 495 Supervisory Printer

6-50. The B 495 Supervisory Printer uses a modified electric typewriter as an input/output device which can be field installed. The print format is 10 characters-per-inch horizontally, and six lines-per-inch vertically. The B 495 operates at the rate of 10 characters-per-second.

APPLICATION TIMING

6-51. Punch card and magnetic tape applications to be processed on a B 200 Series System will fall into one of the following categories:

a. Required processing time is less than or equal to the available processing time.
b. Required processing time is greater than the available processing time.

6-52. When processing can be accomplished within the time available on input/output instructions, the timing of the application will be based on the rated speed of the slowest input or output unit. In figure 6-9, timing is shown for an application which reads one card, then prints a line and punches a card before reading another card. Processing of this application will be at the rate of 300 transactions-per-minute, which is the speed of the punch unit involved.

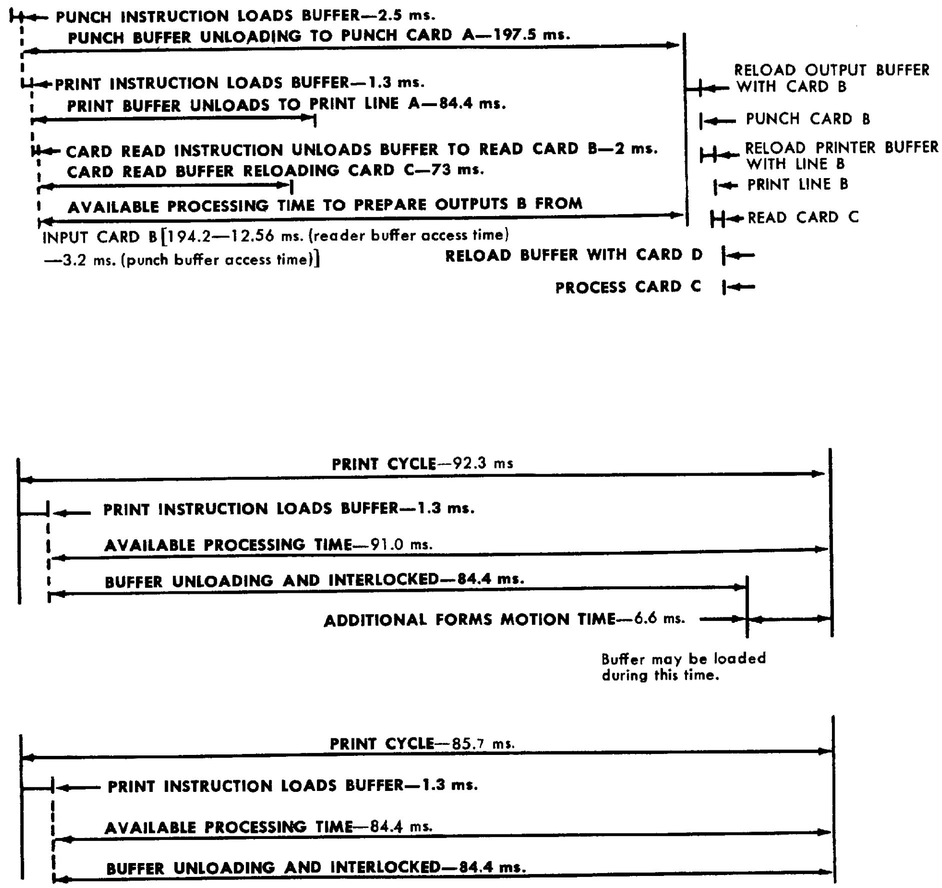


Figure 6-9. Application Timing Example

6-53. When required processing time exceeds available processing time, the method of determining total job time changes. To accurately determine the total processing time required on a given application, it will be necessary to compute the time on every instruction in the routine and compare this to the available buffered processing time. The processing time is multiplied by the number of repetitions and the product, when converted from milliseconds to minutes, will be the job time required.

INSTRUCTION TIMINGS

6-54. Since all of the systems in the B 200 Series are character oriented, the time required to execute most instructions will vary depending on the number of characters involved. A complete timing chart of the instructions used is included in the appendices.

SECTION 7

INPUT/OUTPUT MEDIA AND FORMS DESIGN

GENERAL

7-1. Input/Output Media refers to the means by which information is entered into the computer and the means by which results of processing are obtained from the computer. Input media takes the form of punched cards, punched paper tape, magnetic tape, MICR documents, etc. The output media resulting from computation includes punched cards, punched paper tape, magnetic tape, and printed forms.

7-2. This section describes the various forms of input/output media used by the B 200 Series. The media in the B 200 Series consists of the following:

a. 80-Column Cards
b. Paper Tape
c. Magnetic Tape
d. MICR Documents
e. Printed Forms

PUNCH CARD STOCK

7-3. The punch card peripheral units are capable of processing the following types of card stock:

B 122 Card Reader:	80 columns, standard thickness.
B 123 or B 124 Card Reader:	Either 80-, 66-, 60-, or 51-column cards of either standard or postcard thickness.
B 303 Card Punch:	80-column cards of either standard or postcard thickness.
B 304 Card Punch:	80-column cards of either standard or postcard thickness.

Number Of Columns

7-4. Up to 80 columns can be punched on the maximum-length card.

Card Description

7-5. The cards used with the B 200 Series have edges which must be free from creases and free of fuzz and particles which might affect electrical contacts. However, the B 124 Card Reader will read metalized cards.

Card Size

7-6. The length of an 80-column punched card at any point parallel to the bottom edge is 7.375 inches. The width of the card when measured at any point is 3.250 inches. The cards can have one or more corners cut at a 60° angle to the top or bottom edge of the card.

Punched Hole Size and Location

7-7. The size of the punched hole is approximately 0.125 inches high and 0.055 inches wide. The holes punched in the 80th column are centered on a line 0.251 inches from the right end of the card. Other columns of holes appear at 0.087 inch intervals. In each case, the tolerance for location is ±.007″ with the right end of the card as the reference point. Holes can appear in any 12 locations in each vertical column. The uppermost punching position is centered 0.250 inches from the upper edge of the card. Lower punching positions occur at 1/4-inch intervals.

Notched Cards

7-8. Cards can be notched (on the verifying machine) along the top and right edges to indicate errors or good verification, respectively. The notches resemble a half-moon and are punched over the error, or on the right edge of the card to indicate a correctly verified card. The card-correct notch is located between rows 0 and 1. Card-error is located on top of the column in error.

PUNCHED PAPER TAPE

7-9. There are five types of paper tape that can be used with the B 341 Paper Tape Punch and B 141 Paper Tape Reader. They are: oiled paper tape, dry paper tape, polyester film tape (i.e., mylar or metalized mylar), fanfold paper tape, and vulcanized fiber paper tape.

Paper Tape Size

7-10. The widths of the paper tape that can be handled on the B 341 and B 141 are 11/16, 7/8, and 1 inch.

Roll

7-11. The paper tape is put up in rolls of one continuous length without splice, joint, seam, or tear. The outside diameter of the roll is not less than 7-7/8 inches nor greater than 8-1/8 inches. The weight of the rolls, including the core, is 17 ounces for 11/16-inch wide tape. The roll is wound on a fiber core having a wall thickness between 1/8 and 3/16 inch and approximately the width of the tape being wound. The inner end of the tape must be glued to the core and the outer end to the adjacent layer in a manner as not to render useless more than two layers of tape at each end.

Paper Stock and Characteristics

7-12. The paper stock is composed of 100 percent bleached chemical wood pulp coated with a light-grade, paraffin base lubricating oil which is free from acids and as nearly odorless as commercially possible. The oil content is not less than 12 percent or more than 22 percent based on the weight of the deoiled paper, which is 49 pounds per 500 sheets, 24 by 36 inches. The thickness of the oiled paper is 0.0040 inches. The average folding endurance, machine direction (parallel to the direction of travel through the paper tape reader) per ½-inch is at least 75 double folds or 90 double folds under 1 kilogram tension.

Strength

7-13. The paper tape has an average tensile strength of at least 30 pounds machine direction, 20 pounds cross direction, per inch of width. The tearing resistance of unoiled paper is at least 80 grams machine direction.

MAGNETIC TAPE

7-14. The magnetic tape used with the B 421, B 422, and B 423 tape units is a Heavy-Duty Mylar tape. The main difference between Mylar and Heavy-Duty tape is wearability. Mylar tape is actually a standard tape with a wear factor of 1. Heavy-Duty Mylar tape has a wear factor of 15. The standard Mylar tape deteriorates rapidly (oxide flakes off, etc.) and is not recommended for the use on these units. Burroughs Mylar tape is a Heavy-Duty Mylar tape which has an improved binder between the ferromagnetic coating and the base material.

Physical Characteristics

7-15. The width of the magnetic tape used on the tape units is 0.5 inches with an approximate length of 2400 feet. The total thickness of the tape is 2.0 mils. The tape is wound on a 10½ inch reel and shipped in a plastic box which is dustproof, prevents motion of the reel inside the box, supports the reel at the hub, and has a positive lock.

Tape Life

7-16. The tape life is 15,000 useful passes or one year, whichever occurs first. The number of useful passes is defined as the number of times any portion of the tape moves past the head in either direction without permanent error occuring as a result of wear or defects in the tape base or oxide materials. An error is defined as a system stop resulting in failure to read or write.

MICR CHARACTERS AND SPECIFICATIONS

7-17. The B 270, Improved B 270, and the B 273 Systems can accept input in the form of MICR (Magnetic Ink Character Recognition) documents which are read by the B 102, B 103, B 106, or B 107 Sorter-Reader. Fourteen magnetic ink characters, which conform to the standards established by the American Bankers Association (refer to ABA Publications 147 and 149), can be recognized by the sorter-reader. These characters consist of the 10 digits, 0 through 9 and four special symbols: Amount symbol, Dash symbol, Transit Number or Routing symbol, and an On-Us symbol. The 14 characters which are referred to as E13B type font are illustrated in figure 7-1.

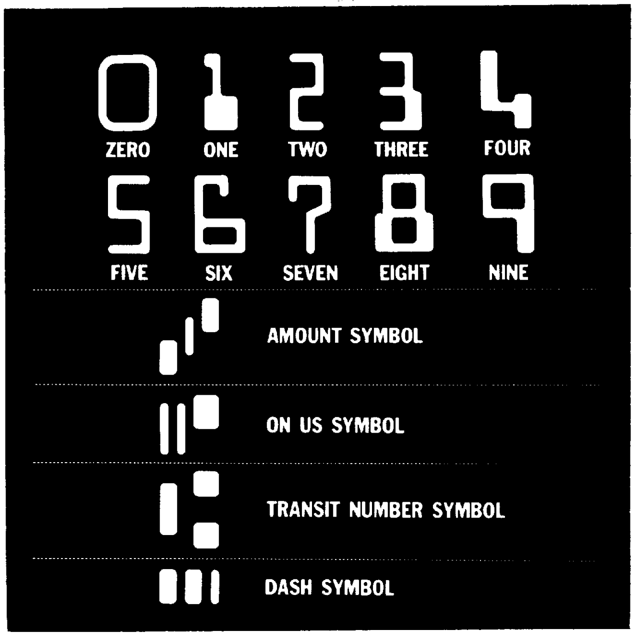


Figure 7-1. E13B Type Font Characters

7-18. Figure 7-2 illustrates a sample paper check encoded with the specifications set forth in ABA Publication 147. The location of the Amount and Transit Number fields in relation to the common or reference edge of the document is included in the illustration, along with the arrangement of 43 spaces intended for the character positions.

7-19. A field is defined as the space between a defined start and finish symbol which is sufficient to permit the encoding of the maximum number of characters required for identification and processing. This definition includes all possible variations; from a full distinct grouping such as the Amount Field, to the transaction code group in the "On-Us" Field.

Field Location Specifications

7-20. The following specifications are included to serve in understanding the encoded information, its grouping into fields, the starting and ending symbols, and the normal contents of the fields.

7-21. THE AMOUNT FIELD (Figure 7-3).

Boundaries: 1/4″ and 1-7/8″ from the right reference edge with the first (or right) symbol located 5/16″ plus or minus 1/16″ from the reference edge.

Characters: 10 digits bracketed with two Amount Field symbols.

Contents: Amount of items with leading zeros.

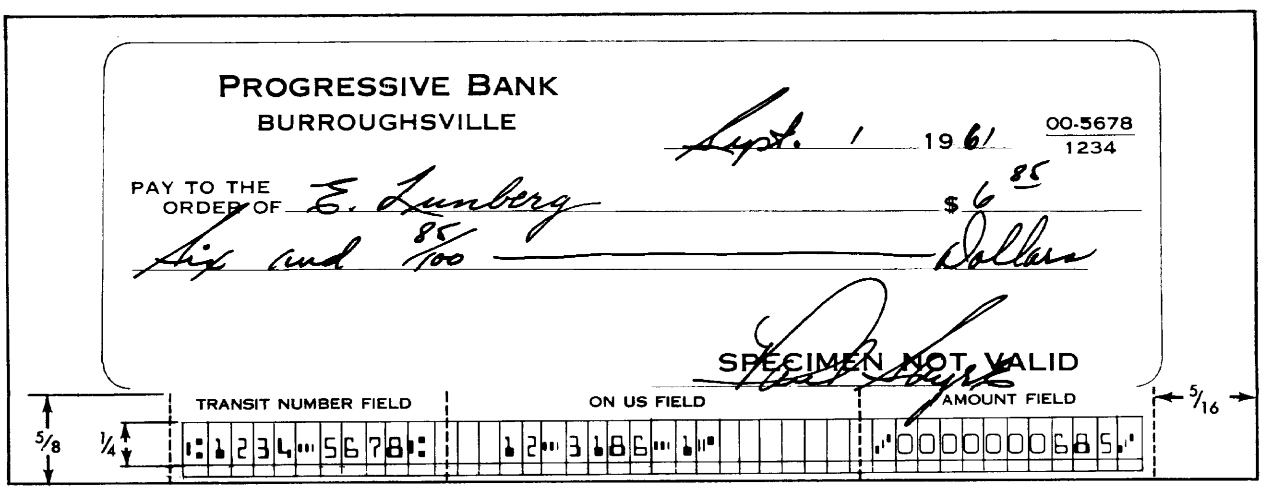


Figure 7-2. Sample Paper Check Encoding

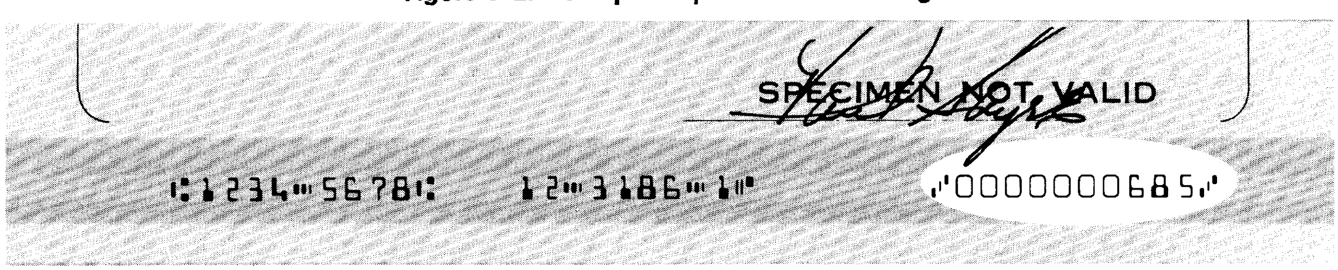


Figure 7-3. Amount Field Encoding

7-22. THE ON-US FIELD (Figure 7-4).

Boundaries: 1-7/8″ and 4-1/4″ from the right reference edge.

Characters: 19 spaces, of which 18 are normally usable due to tolerance requirements between pre-printed and post-printed encoded information. When the contents of the On-Us Field are printed separately (Account Number and Transaction Code), each printing has a tolerance of plus or minus 1/16″ on the horizontal plane. The result is 1/8″ (one space) being used for the total tolerance. When On-Us data is printed simultaneously with the amount, it may appear immediately adjacent to the left Amount Symbol; and when On-Us data is printed simultaneously with the Transit Number data, it may appear immediately adjacent to the right Transit Number Symbol.

Contents: Usually Account Number and Transaction Code.

7-23. THE TRANSIT NUMBER FIELD (Figure 7-5).

Boundaries: 4-1/4″ and 5-3/4″ from the reference edge, with the right edge of the ending symbol located 5-9/16″, plus or minus 1/16″ from the reference edge.

Characters: Two groups of 4 digits each, separated by the Dash Symbol and bracketed by 2 Transit Number Symbols.

Contents: Transit Number and ABA Number.

7-24. THE AUXILIARY ON-US FIELD (Figure 7-6).

Boundaries: 5-3/4″ to left border of check which exceeds 6″ length; up to 7-3/4″.

Characters: As many as can be bracketed between the ending symbol of the Transit Number Field, and the ending symbol of the Auxiliary On-Us Field, not to exceed 16 characters. The On-Us Field Symbol is used as an ending symbol in this field.

Contents: Optional.

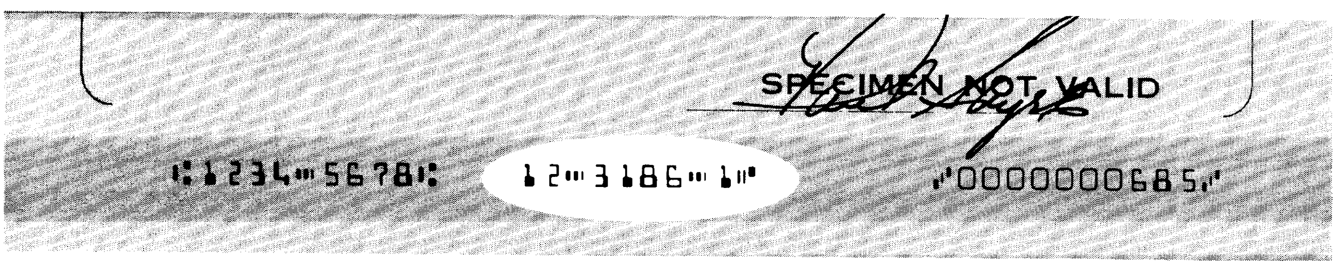


Figure 7-4. On-Us Field Encoding

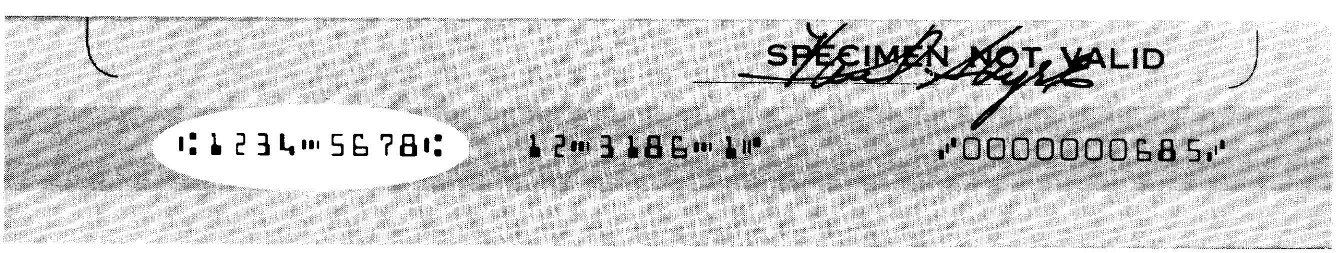


Figure 7-5. Transit Number Field Encoding

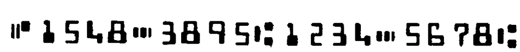


Figure 7-6. Auxiliary On-Us Field Encoding

Paper Specifications

7-25. Check size specifications which are shown on page 40 of the Bank Management Publication 147 prepared by the ABA, are as follows:

	MAXIMUM	MINIMUM
LENGTH	8-3/4″	6″
WIDTH	3-2/3″	2-3/4″

7-26. The sorter-reader specifications for all documents are determined by the ability of the equipment to handle paper of varying sizes at satisfactory effective speed. The tolerances are less restrictive than those stated above since they apply to internal documents as well as checks. All documents must fall within the following specifications if the sorter-reader is to sort them properly.

	MAXIMUM	MINIMUM
UNIFORM SIZE		
LENGTH	9-1/2″	5-3/4″
WIDTH	4-1/4″	2-1/2″
LENGTH TO WIDTH RATIO	3:1	1.6:1
INTERMIXED SIZE		
LENGTH	9-1/16″	5-15/16″
WIDTH	4-1/16″	2-11/16″
LENGTH TO WIDTH RATIO	3:1	1.6:1

7-27. The sorter-reader has been designed to handle a maximum document thickness of .0075″ to a minimum thickness of .0040″. However, acceptable maximum and minimum document thickness cannot be defined in terms of thickness alone. Instead, the thickness is related to the following paper characteristics:

	24 lb.		20 lb.	
	MACHINE	CROSS	MACHINE	CROSS
STIFFNESS	2.7	1.3	1.9	.9
TENSILE STRENGTH	8.0	4.0	5.9	3.4
TEAR STRENGTH	55	62	45	53
BURST	35	35	28	28

a. Stiffness—The bending moment of 1/5 of a gram applied to a 1-1/2 inch wide specimen at a 5 centimeter test length flexing it to an angle of 15 degrees measured in the Machine (M) and cross machine (C) direction.

b. Tensile Strength—The force in kilograms required to tear a single sheet of paper 43 millimeters from an initial tear measured in the machine and cross machine directions. (Normally, four sheets are torn at a time to obtain any one reading.)

c. Bursting Strength—The hydrostatic pressure in pounds per square inch required to rupture the paper when the pressure is applied at a controlled rate through a rubber diaphragm of circular area 1.20 inches in diameter.

WORD FORMATTING OF MICR INFORMATION IN STORAGE

7-28. The magnetic ink characters on documents processed by the Sorter-Reader are either transferred to input buffer No. 2 and then to core storage (demand mode or buffered flow mode) or directly to core storage (unbuffered flow mode). In all cases, a minimum of 84 characters of information are stored in seven fields, each consisting of 12 characters.

7-29. Any character will initiate reading and is stored in the least significant digit position of the input area (CCC + 83). Normally this will be the beginning Amount symbol. If a symbol other than the Amount symbol is read, a read error condition will result. The 10 digits of the amount field are stored starting in the second least significant digit position. The second Amount symbol signals the end of the amount field and is stored in the most significant digit position to complete the first 12-character field of storage.

7-30. Storage of data continues, starting in the least significant digit position of the next storage field to the left, until the next symbol is sensed, at which time that symbol is stored in the next position. The remaining positions, if any, of that 12-character field are blanked out. Storage continues in this manner, until either the ending Transit symbol in the Auxiliary On-Us Field is sensed and stored or all the information on the document has been stored, depending on the Sorter-Reader instructions. If less than seven fields of information are encoded on a document or less than seven fields of information are read on a document, the remaining 12-character fields are blanked out.

7-31. To illustrate the formatting of MICR information in core storage, two examples are presented below. The Sorter-Read instruction used is:

O	M	N	AAA	BBB	CCC
#	0	4	400	300	144

7-32. Figure 7-7 illustrates a document on which the On-Us and Transit Number Field information has been pre-encoded. The contents of core storage after reading is shown in figure 7-8. Note that the dashes on the document are ignored as data. Character positions from 144 through 176 are blank.

7-33. Figure 7-9 illustrates a document that is post-encoded; that is, the account number in the On-Us Field has been encoded after the document is received. The contents of core storage after reading is shown in figure 7-10.

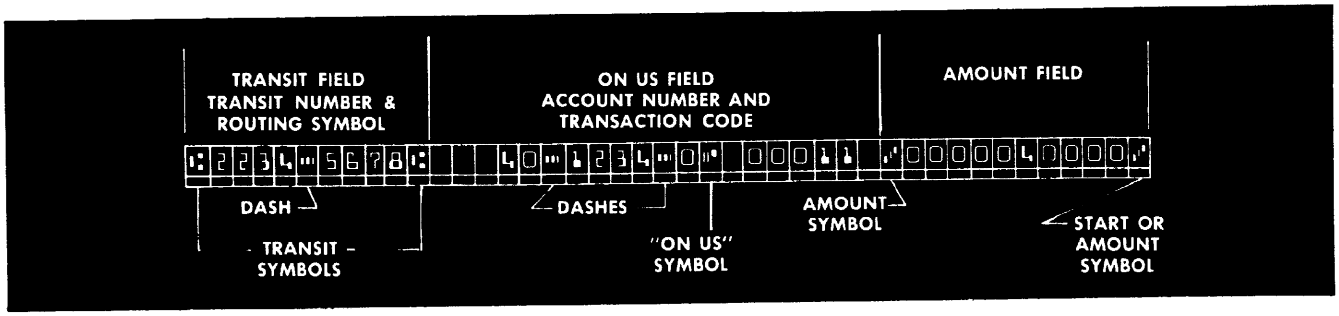


Figure 7-7. Pre-encoded MICR Document

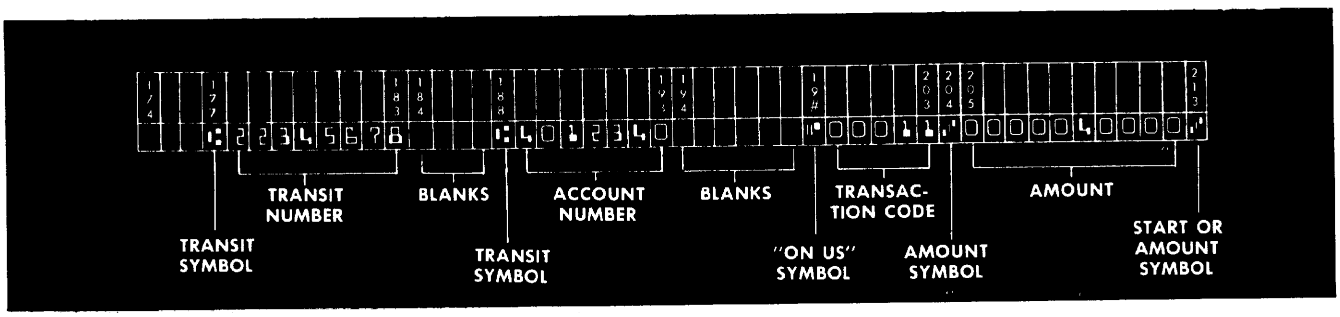


Figure 7-8. Contents of Storage for Pre-encoded Document

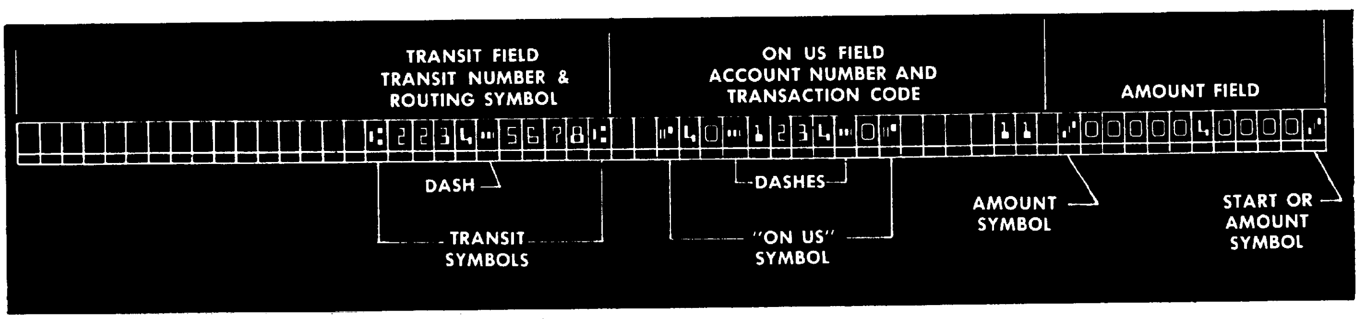


Figure 7-9. Post-encoded MICR Document

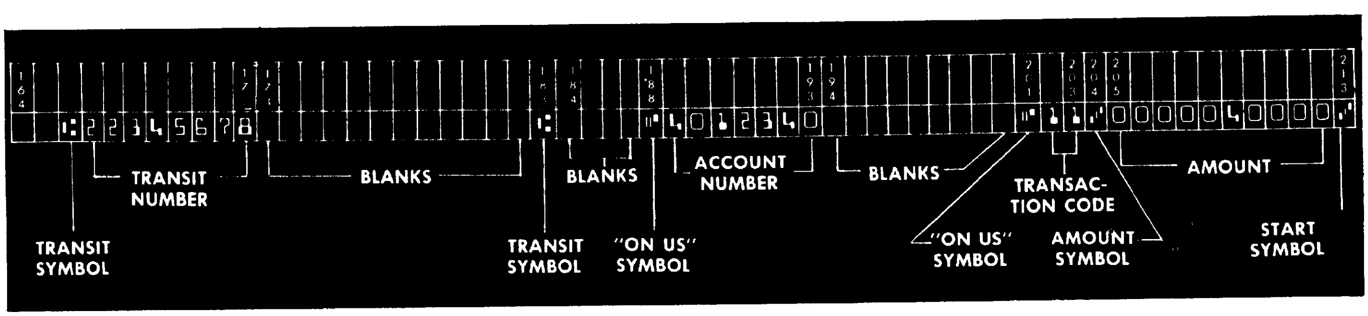


Figure 7-10. Contents of Storage for Post-encoded Document

LINE PRINTER

Forms Construction

7-34. Forms designed for the line printer should conform to specifications contained in the supply specifications for Burroughs Line Printers.

Paper Weight

7-35. To obtain the best copy on a single-part form, 15 lb. paper, or heavier, should be used. Multiple-part forms, up to four, may consist of a 15 lb. first copy with remaining copies in lightweight paper of 12 lbs. or less. Additional copies, up to 6, require 12 lb. paper throughout. The number of copies can be increased by using premium papers and carbons. 150 lb. continuous tabulating card stock can also be processed.

7-36. CARBON WEIGHT. 9 lb. Sulphite.

Forms Dimensions

7-37. Forms with a width from 5 to 20 inches including perforated margins may be used with the printer. The printer will accommodate forms up to 22 inches in length (fold to fold).

MULTIPLE TAPE LISTER

7-38. The listing tapes are each 2½ inches wide. Fanfold paper is used and margins are not punched.

7-39. Forms used on the B 322 should conform to the following standards:

THICKNESS	LENGTH	NO. OF PARTS
.003″ to .0035″	Continuous Form 8½″ Fan Fold	1 or 2 carbons required

7-40. The forms hopper will hold in excess of 800 feet of a 2-part form. Individual stackers will permit stacking of at least 150 feet of continuous forms.

APPENDIX A

MODEL 0 INSTRUCTION LIST

OPERATION	OP CODE		M VARIANT			N VARIANT			AAA ADDRESS FUNCTION	BBB ADDRESS FUNCTION	CCC ADDRESS FUNCTION	COMPARISON INDICATORS
	SYM	M/L	SYM	M/L	FUNCTION	SYM	M/L	FUNCTION				
ARITHMETIC INSTRUCTIONS												
ADD	ADD	1	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	ADDEND	AUGEND	SUM	CONDITIONED
SUBTRACT	SUB	2	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	MINUEND	SUBTRAHEND	DIFFERENCE	CONDITIONED
MULTIPLY	MUL	3	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	MULTIPLICAND	MULTIPLIER	PRODUCT	CONDITIONED
DIVIDE	DIV	4	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11	1-@	BBB LENGTH	DIVIDEND (BEFORE) REMAINDER (AFTER)	DIVISOR	QUOTIENT	CONDITIONED
CONTROL INSTRUCTIONS												
COMPARE FOR =												
ALPHABETIC	CAE	5	b or 0	0	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	BRANCH	CONDITIONED
ZONE	CZE	5	b or 0	1	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	ADDRESS IF	CONDITIONED
NUMERIC	CNE	5	b or 0	2	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	AAA:BBB EQUAL	CONDITIONED
COMPARE FOR ≠												
ALPHABETIC	CAU	5	b or 0	4	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	BRANCH	CONDITIONED
ZONE	CZU	5	b or 0	5	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	ADDRESS IF	CONDITIONED
NUMERIC	CNU	5	b or 0	6	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	AAA:BBB UNEQUAL	CONDITIONED
BRANCH												
CONDITIONAL	BRC	6	b or 0	0	MODIFY OP CODE	b or 0	b or 0	RESERVED FOR EXPANSION	LOW BRANCH	EQUAL BRANCH	HIGH BRANCH	NOT AFFECTED
UNCONDITIONAL	BRU	6	b or 0	1	MODIFY OP CODE	b or 0	b or 0	NO INTERROGATION OF THIRD S_2 OR RE-	BRANCH TO	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
(102 103 ONLY)	BRU	6+	b or 0	1	MODIFY OP CODE	1	1	INTERROGATE FOR THIRD S_2	BRANCH TO	BRU ON THIRD S_2	AVAILABLE TO PROGRAMER	NOT AFFECTED
NO-OPERATION	NOP	b,0	b	b	AVAILABLE TO PROGRAMER	b	b	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
HALT	HLT	9	0-9	0-9	IDENTIFICATION	0-11	0-@	IDENTIFICATION—SR	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
EDITING INSTRUCTIONS												
TRANSFER	TFR	7	0, 1	0-9	M/L = NUMBER OF WORDS SYM = HUNDREDS ①	0-99	0-@	M/L & SYM BOTH = ① NO. CHARACTERS	FROM ADDRESS	AVAILABLE TO PROGRAMER	TO ADDRESS	NOT AFFECTED
MASK	MSK	8	1-11, 12	1-@, 0 or b	AAA LENGTH	b	b	RESERVED FOR EXPANSION	FROM ADDRESS	THROUGH MASK	TO ADDRESS	SET TO EQUAL
CARD INPUT/OUTPUT INSTRUCTIONS												
CARD READ	CRD	#	b	b	RESERVED FOR EXPANSION	1, 2	1, 2	BUFFER NUMBER	AVAILABLE TO PROGRAMER	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
CARD PUNCH	PCH	@	b	b	RESERVED FOR EXPANSION	b	b	RESERVED FOR EXPANSION	OUTPUT ADDRESS	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
PRINTED OUTPUT INSTRUCTIONS												
PRINT												
ON PRINTER	PRT	A	0-2	0-2	FORMS SPACING	0-11	0-@	SKIP TO CHANNEL	OUTPUT ADDRESS	PG O'FLOW BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
ON LISTER	PRL	A	0, 1, 15	0, 1, ≥	MASTER TAPE SELECTION	1-11, 12, 15 ②	1-@, 0, ≥	DETAIL TAPE NO.	OUTPUT ADDRESS	OUT-OF-PAPER BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
SKIP SPACE												
ON PRINTER	SKP	B	0-2	0-2	FORMS SPACING	0-11	0-@	SKIP TO CHANNEL	AVAILABLE TO PROGRAMER	PG O'FLOW BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
ON LISTER	SKL	B	0, 2, 4, 9, 14	0, 2, 4, 9, >	SKIP MASTER AND/OR DETAIL ④	1-11, 12, 15	1-@, 0, ≥	DETAIL TAPE NO.	AVAILABLE TO PROGRAMER	OUT-OF-PAPER BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
			1, 7, 15	1, 7, ≥	SPACE MASTER AND/OR DETAIL	③						
SORTER-READER INSTRUCTIONS												
SORTER READ												
DEMAND	SRD	#	b or 0, 1	b or 0, 1	VALIDITY CHECK	D	6	DEMAND FEED	CANT READ	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
FLOW	SRF	#	b or 0, 1	b or 0, 1	VALIDITY CHECK	E	4	ALL FIELDS	BRANCH ADDRESS			
						T	5	THROUGH TRANSIT				
						B	6	BUFFERED FLOW READ				
CONTROL SORTER	CTL	C	P	0	POCKET SELECT (PS)	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			D	2	DEMAND FEED & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			S	4	STOP FLOW (SPF) & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			C	6	START FLOW (STF) & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			B	7	STF & PS—BUFFERED	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			I	8	INCREASE BATCH COUNTER BY 1 (B 103)	b	b	RESERVED FOR EXPANSION	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED

① SYM—Number of characters expressed in hundreds, tens, and units
M/L—Number of characters expressed in number of words and remaining characters

② N = 1 Not permissible when M = 1 or 15
N = 7 Not permissible when M = 0 or 15

③ N = 1 Not permissible when M = 1 or 2
N = 7 Not permissible when M = 0 or 7

④ M = 4 Skip all non-master tapes } optional on B 322 Lister
M = 9 Skip all tapes } standard on B 323 Lister

APPENDIX A (cont)

OPERATION	OP CODE SYM	OP CODE M/L	M VARIANT SYM	M VARIANT M/L	M VARIANT FUNCTION	N VARIANT SYM	N VARIANT M/L	N VARIANT FUNCTION	AAA ADDRESS FUNCTION	BBB ADDRESS FUNCTION	CCC ADDRESS FUNCTION	COMPARISON INDICATORS
MAGNETIC TAPE INSTRUCTIONS												
READ TAPE	TRD	D	b	1	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	READ ERROR BRANCH	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
WRITE TAPE	TWR	D	b	2	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	OUTPUT ADDRESS	EOT BRANCH	WRITE ERROR BRANCH	SET TO EQUAL
ERASE TAPE	TER	D	b	3	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	PSEUDO RECORD ADDRESS	EOT BRANCH	AVAILABLE TO PROGRAMER	SET TO EQUAL
BACKSPACE TAPE	BSP	D	b	4	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	SET TO EQUAL
REWIND TAPE	RWD	D	b	5	MODIFY OP CODE	1-6	1:6	UNIT NUMBER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	SET TO EQUAL
MACRO INSTRUCTIONS												
LINK	LNK		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	TO SUB-ROUTINE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
ADDRESS ARITHMETIC	AAR		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	LOCATION TO BE MODIFIED	MODIFIER (MODULES 10 10 12)	RESULT ADDRESS	NOT APPLICABLE
PSEUDO INSTRUCTIONS												
SET LOCATION COUNTER	SLC		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	MACHINE ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
ADJUST LOCATION COUNTER	ALC		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	MODULUS MACHINE ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
OVERLAY	OVR		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	SET TO ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
END ASSEMBLY	END		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
SYMBOLIC ADDRESS	SAD		HIGH ORDER SYMBOLIC ADDRESS POSITIONS			LOW ORDER SYMBOLIC ADDRESS POSITIONS			SYMBOLIC ADDRESS	SYMBOLIC ADDRESS	SYMBOLIC ADDRESS	NOT APPLICABLE
HEADING	HDG		HEADING INFORMATION									NOT APPLICABLE
CONSTANT	CST		CONSTANT DATA									NOT APPLICABLE

APPENDIX B

IMPROVED MODEL 0 INSTRUCTION LIST

OPERATION	OP CODE SYM	OP CODE M/L	M VARIANT SYM	M VARIANT M/L	M VARIANT FUNCTION	N VARIANT SYM	N VARIANT M/L	N VARIANT FUNCTION	AAA ADDRESS FUNCTION	BBB ADDRESS FUNCTION	CCC ADDRESS FUNCTION	COMPARISON INDICATORS
ARITHMETIC INSTRUCTIONS												
ADD	ADD	1	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	ADDEND	AUGEND	SUM	CONDITIONED
SUBTRACT	SUB	2	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	MINUEND	SUBTRAHEND	DIFFERENCE	CONDITIONED
MULTIPLY	MUL	3	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	MULTIPLICAND	MULTIPLIER	PRODUCT	CONDITIONED
DIVIDE	DIV	4	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11	1-@	BBB LENGTH	DIVIDEND (BEFORE) REMAINDER (AFTER)	DIVISOR	QUOTIENT	CONDITIONED
CONTROL INSTRUCTIONS												
ADDRESS MODIFICATION	ADM	J	b	b	RESERVED FOR EXPANSION	b	b	RESERVED FOR EXPANSION	THE MODIFIER (THE QUANTITY NOT ITS ADDRESS)	ADDRESS OF THE ADDRESS TO BE MODIFIED	AVAILABLE TO PROGRAMER	NOT AFFECTED
COMPARE FOR =												
ALPHABETIC	CAE	5	b or 0	0	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	BRANCH ADDRESS IF AAA:BBB EQUAL	CONDITIONED
ZONE	CZE	5	b or 0	1	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
NUMERIC	CNE	5	b or 0	2	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
COMPARE FOR ≠												
ALPHABETIC	CAU	5	b or 0	4	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	BRANCH ADDRESS IF AAA:BBB UNEQUAL	CONDITIONED
ZONE	CZU	5	b or 0	5	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
NUMERIC	CNU	5	b or 0	6	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
BRANCH												
CONDITIONAL	BRC	6	b or 0	0	MODIFY OP CODE	b or 0	b or 0	RESERVED FOR EXPANSION	LOW BRANCH	EQUAL BRANCH	HIGH BRANCH	NOT AFFECTED
UNCONDITIONAL	BRU	6	b or 0	1	MODIFY OP CODE	b or 0	b or 0	NO INTERROGATION OF THIRD S_2	BRANCH TO	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
(102/103 ONLY)	BRU	6+	b or 0	1	MODIFY OP CODE	1	1	INTERROGATE FOR THIRD S_2	BRANCH TO	BRU ON THIRD S_2	AVAILABLE TO PROGRAMER	NOT AFFECTED
NO-OPERATION	NOP	b, 0	b	b	AVAILABLE TO PROGRAMER	b	b	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
HALT & BRANCH	HLT	9	0-9	0-9	IDENTIFICATION AND BRANCHING	0-11	0-@	IDENTIFICATION—SR	BRANCH TO (5)	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
EDITING INSTRUCTIONS												
TRANSFER	TFR	7	0, 1	0-9	M/L = NUMBER OF WORDS SYM = HUNDREDS (1)	0-99	0-@	M/L & SYM BOTH = (1) NO. CHARACTERS	FROM ADDRESS	AVAILABLE TO PROGRAMER	TO ADDRESS	NOT AFFECTED
TRANSFER ZONE	TFZ	P	0, 1	0-9	M/L = NUMBER OF WORDS SYM = HUNDREDS (1)	0-99	0-@	M/L & SYM BOTH = (1) NO. CHARACTERS	FROM ADDRESS	AVAILABLE TO PROGRAMER	TO ADDRESS	NOT AFFECTED
MASK	MSK	8	1-11, 12	1-@, 0 or b	AAA LENGTH	b	b	RESERVED FOR EXPANSION	FROM ADDRESS	THROUGH MASK	TO ADDRESS	SET TO EQUAL
CARD INPUT/OUTPUT INSTRUCTIONS												
CARD READ	CRD	#	b	b	RESERVED FOR EXPANSION	1, 2	1, 2	BUFFER NUMBER	AVAILABLE TO PROGRAMER	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
CARD PUNCH	PCH	@	b	b	RESERVED FOR EXPANSION	b	b	RESERVED FOR EXPANSION	OUTPUT ADDRESS	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
PRINTED OUTPUT INSTRUCTIONS												
PRINT												
ON PRINTER (4)	PRT	A	0-2, 4-6	0-2, 4-6	FORMS SPACING	0-11	0-@	SKIP TO CHANNEL	OUTPUT ADDRESS	PG O'FLOW BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
ON LISTER	PRL	A	0, 1, 15	0, 1, ≥	MASTER TAPE SELECTION	1-11, 12, 15 (2)	1-@, 0, ≥	DETAIL TAPE NO.	OUTPUT ADDRESS	OUT OF PAPER BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
SKIP SPACE												
ON PRINTER (4)	SKP	B	0-2, 4-6	0-2, 4-6	FORMS SPACING	0-11	0-@	SKIP TO CHANNEL	AVAILABLE TO PROGRAMER	PG O'FLOW BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
ON LISTER	SKL	B	0, 2, 4, 9, 14	0, 2, 4, 9, >	SKIP MASTER AND/OR DETAIL (6)	1-11, 12, 15	1-@, 0, ≥	DETAIL TAPE NO.	AVAILABLE TO PROGRAMER	OUT OF PAPER BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
			1, 7, 15	1, 7, ≥	SPACE MASTER AND/OR DETAIL		(3)					

(1) SYM—Number of characters expressed in hundreds, tens and units
M/L—Number of characters expressed in number of words and remaining characters

(2) N = 1 Not permissible when M = 1 or 15
N = 7 Not permissible when M = 0 or 15

(3) N = 1 Not permissible when M = 1 or 2
N = 7 Not permissible when M = 0 or 7

(4) M = 0-2 For printer I
M = 4-6 For printer II

(5) Branch address when M variant contains 2 bit (2, 3, 6, 7)

(6) M = 4 Skip all non-master tapes } Optional on B 322 Lister
M = 9 Skip all tapes } Standard on B 323 Lister

APPENDIX B (cont)

OPERATION	OP CODE SYM	OP CODE M/L	M VARIANT SYM	M VARIANT M/L	M VARIANT FUNCTION	N VARIANT SYM	N VARIANT M/L	N VARIANT FUNCTION	AAA ADDRESS FUNCTION	BBB ADDRESS FUNCTION	CCC ADDRESS FUNCTION	COMPARISON INDICATORS
SORTER-READER INSTRUCTIONS												
SORTER READ DEMAND	SRD	#	b or 0, 1	b or 0, 1	VALIDITY CHECK	D	6	DEMAND FEED	CAN'T READ	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
FLOW	SRF	#	b or 0, 1	b or 0, 1	VALIDITY CHECK	E	4	ALL FIELDS	BRANCH ADDRESS			
						T	5	THROUGH TRANSIT				
						B	6	BUFFERED FLOW READ				
CONTROL SORTER	CTL	C	P	0	POCKET SELECT (PS)	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			D	2	DEMAND FEED & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			S	4	STOP FLOW (SPF) & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			C	6	START FLOW (STF) & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			B	7	STF & PS—BUFFERED	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			I	8	INCREASE BATCH COUNTER (B 103)	b	b	RESERVED FOR EXPANSION	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
MAGNETIC TAPE INSTRUCTIONS												
READ TAPE	TRD	D	b	1	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	READ ERROR BRANCH	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
WRITE TAPE	TWR	D	b	2	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	OUTPUT ADDRESS	EOT BRANCH	WRITE ERROR BRANCH	SET TO EQUAL
ERASE TAPE	TER	D	b	3	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	PSEUDO RECORD ADDRESS	EOT BRANCH	AVAILABLE TO PROGRAMER	SET TO EQUAL
BACKSPACE TAPE	BSP	D	b	4	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	SET TO EQUAL
REWIND TAPE	RWD	D	b	5	MODIFY OP CODE	1-6	1-6	UNIT NUMBER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	SET TO EQUAL
PAPER TAPE INSTRUCTIONS												
PAPER TAPE READ	PRD	F	1	1	BUFFERED MODE	1, 2	1, 2	BUFFER NUMBER	PARITY ERROR BRANCH ADDRESS	EOT BRANCH ADDRESS	INPUT ADDRESS	NOT AFFECTED
			2	2	UNBUFFERED MODE	1, 2	1, 2	BUFFER NUMBER		EOT BRANCH ADDRESS	INPUT ADDRESS	NOT AFFECTED
PAPER TAPE SPACE FORWARD	PSF	F	b	4	MODIFY OP CODE	1, 2	1, 2	BUFFER NUMBER	AVAILABLE TO PROGRAMER	EOT BRANCH ADDRESS	AVAILABLE TO PROGRAMMER	NOT AFFECTED
									AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	BOT BRANCH ADDRESS	NOT AFFECTED
PAPER TAPE SPACE BACKWARD	PSB	F	b	&	MODIFY OP CODE	1, 2	1, 2	BUFFER NUMBER				
PAPER TAPE WRITE	PWR	E	1	1	PUNCH ALL HOLES	b	b	RESERVED FOR EXPANSION	OUTPUT ADDRESS	EOT BRANCH ADDRESS	NOT READY	NOT AFFECTED
			2	2	BUFFERED MODE	b	b		OUTPUT ADDRESS	EOT BRANCH ADDRESS	BRANCH ADDRESS	NOT AFFECTED
PAPER TAPE REWIND	PRW	F	b	8	MODIFY OP CODE	1, 2	1, 2	BUFFER NUMBER	AVAILABLE TO PROGRAMER	NOT READY BRANCH ADDRESS	BOT BRANCH ADDRESS	NOT AFFECTED
MACRO INSTRUCTIONS												
LINK	LNK		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	TO SUB-ROUTINE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
ADDRESS ARITHMETIC	AAR		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	LOCATION TO BE MODIFIED	MODIFIER (MODULES 10 10 12)	RESULT ADDRESS	NOT APPLICABLE
PSEUDO INSTRUCTIONS												
SET LOCATION COUNTER	SLC		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	MACHINE ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
ADJUST LOCATION COUNTER	ALC		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	MODULUS MACHINE ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
OVERLAY	OVR		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	SET TO ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
END ASSEMBLY	END		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
SYMBOLIC ADDRESS	SAD		HIGH ORDER SYMBOLIC ADDRESS POSITIONS			LOW ORDER SYMBOLIC ADDRESS POSITIONS			SYMBOLIC ADDRESS	SYMBOLIC ADDRESS	SYMBOLIC ADDRESS	NOT APPLICABLE
INSERT GROUP MARK	IGM		GENERATOR 1—CHARACTER GROUP MARK									
HEADING	HDG		HEADING INFORMATION									NOT APPLICABLE
CONSTANT	CST		CONSTANT DATA									NOT APPLICABLE

APPENDIX C

B 263/B 273/B 283 INSTRUCTION LIST

OPERATION	OP CODE SYM	OP CODE M/L	M VARIANT SYM	M VARIANT M/L	M VARIANT FUNCTION	N VARIANT SYM	N VARIANT M/L	N VARIANT FUNCTION	AAA ADDRESS FUNCTION	BBB ADDRESS FUNCTION	CCC ADDRESS FUNCTION	COMPARISON INDICATORS
ARITHMETIC INSTRUCTIONS												
ADD	ADD	1	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	ADDEND	AUGEND	SUM	CONDITIONED
SUBTRACT	SUB	2	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	MINUEND	SUBTRAHEND	DIFFERENCE	CONDITIONED
MULTIPLY	MUL	3	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11, 12	1-@, 0 or b	BBB LENGTH	MULTIPLICAND	MULTIPLIER	PRODUCT	CONDITIONED
DIVIDE	DIV	4	1-11, 12	1-@, 0 or b	AAA LENGTH	1-11	1-@	BBB LENGTH	DIVIDEND (BEFORE) REMAINDER (AFTER)	DIVISOR	QUOTIENT	CONDITIONED
CONTROL INSTRUCTIONS												
ADDRESS MODIFICATION	ADM	J	b	b	RESERVED FOR EXPANSION	b	b	RESERVED FOR EXPANSION	THE MODIFIER (THE QUANTITY, NOT ITS ADDRESS)	ADDRESS OF THE ADDRESS TO BE MODIFIED	AVAILABLE TO PROGRAMER	NOT AFFECTED
COMPARE FOR =												
ALPHABETIC	CAE	5	b or 0	0	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	BRANCH ADDRESS IF AAA:BBB EQUAL	CONDITIONED
ZONE	CZE	5	b or 0	1	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
NUMERIC	CNE	5	b or 0	2	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
COMPARE FOR ≠												
ALPHABETIC	CAU	5	b or 0	4	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO	BRANCH ADDRESS IF AAA:BBB UNEQUAL	CONDITIONED
ZONE	CZU	5	b or 0	5	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
NUMERIC	CNU	5	b or 0	6	MODIFY OP CODE	1-11, 12	1-@, 0 or b	AAA & BBB LENGTH	FIELD COMPARED	FIELD COMPARED TO		CONDITIONED
BRANCH												
CONDITIONAL	BRC	6	b or 0	0	MODIFY OP CODE	b or 0	b or 0	RESERVED FOR EXPANSION	LOW BRANCH	EQUAL BRANCH	HIGH BRANCH	NOT AFFECTED
UNCONDITIONAL	BRU	6	b or 0	1	MODIFY OP CODE	b or 0	b or 0	NO INTERROGATION OF THIRD S_2	BRANCH TO	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
(102/103 ONLY)	BRU	6‡	b or 0	1	MODIFY OP CODE	1	1	INTERROGATE FOR THIRD S_2	BRANCH TO	BRU ON THIRD S_2	AVAILABLE TO PROGRAMER	NOT AFFECTED
NO-OPERATION	NOP	b, 0	b	b	AVAILABLE TO PROGRAMER	b	b	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
HALT AND BRANCH	HLT	9	0-9	0-9	IDENTIFICATION AND BRANCHING	0-11	0-@	IDENTIFICATION—SR	BRANCH TO ⑤	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
EDITING INSTRUCTIONS												
TRANSFER	TFR	7	0, 1	0-9	M/L = NUMBER OF WORDS SYM = HUNDREDS ①	0-99	0-@	M/L & SYM BOTH = ① NO. CHARACTERS	FROM ADDRESS	AVAILABLE TO PROGRAMER	TO ADDRESS	NOT AFFECTED
TRANSFER ZONE	TFZ	P	0, 1	0-9	M/L = NUMBER OF WORDS SYM = HUNDREDS ①	0-99	0-@	M/L & SYM BOTH = ① NO. OF CHARACTERS	FROM ADDRESS	AVAILABLE TO PROGRAMER	TO ADDRESS	NOT AFFECTED
MASK	MSK	8	1-11, 12	1-@, 0 or b	AAA LENGTH	0, 1, 2	0, 1, 2	FISCAL STANDARD, FISCAL INVERTED, OR ALPHANUMERIC	FROM ADDRESS	THROUGH MASK	TO ADDRESS	SET TO EQUAL
CARD INPUT/OUTPUT INSTRUCTIONS												
CARD READ	CRD	#	0, 1	0, 1	HALT OR BRANCH	1, 2	1, 2	BUFFER NUMBER	M = 0 AP, M = 1 BUSY OR NOT READY BRANCH	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
CARD PUNCH	PCH	@	0, 1, 2	0, 1, 2	PUNCH BCL BULL OR ICT CODES	b	b	RESERVED FOR EXPANSION	TRANSFER FROM ADDRESS MSD	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
PRINTED OUTPUT INSTRUCTIONS												
PRINT ON PRINTER ④	PRT	A	0-2, 4-6	0-2, 4-6	FORMS SPACING	0-11	0-@	SKIP TO CHANNEL	OUTPUT ADDRESS	PG O'FLOW BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
SKIP/SPACE ON PRINTER ④	SKP	B	0-2, 4-6	0-2, 4-6	FORMS SPACING	0-11	0-@	SKIP TO CHANNEL	AVAILABLE TO PROGRAMER	PG O'FLOW BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
ON LISTER	SKL	B	0, 2, 4, 9, 14 1, 7, 15	0, 2, 4, 9, > 1, 7, ≥	SKIP MASTER AND/OR DETAIL ⑥ SPACE MASTER AND/OR DETAIL	1-11, 12, 15 ③	1-@, 0, ≥	DETAIL TAPE NO.	AVAILABLE TO PROGRAMER	OUT OF PAPER BRANCH	AVAILABLE TO PROGRAMER	NOT AFFECTED
PRINT ON SUPERVISORY PRINTER	SPO	Q	1	1	PRINT	b	b	RESERVED FOR EXPANSION	SOURCE ADDRESS MSD	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
SUPERVISORY PRINTER READ	SPR	Q	2	2	READ	b	b	RESERVED FOR EXPANSION	AVAILABLE TO PROGRAMER	BRANCH ON INPUT MESSAGE	DESTINATION ADDRESS MSD	NOT AFFECTED
PRINT ON LISTER	PRL	A	0, 1, 15, 7, 2, 14	0, 1, ≥ 7, 2, >	PRINT MASTER AND/OR SUPPRESS PRINT ON MASTER AND BRANCHING	1-12, 15 ②	0-@, ≥	DESIGNATES DETAIL SUB-UNIT AND/OR SUPPRESS DETAIL DESIGNATION	TRANSFER FROM ADDRESS MSD	BRANCHING ADDRESS ON OUT OF PAPER	WHEN M = 7, 2, OR 14, BRANCH ADDRESS ON PRINT ERROR WHEN M = 0, 1, OR 15—AVAILABLE TO PROGRAMER	NOT AFFECTED
SORTER READER INSTRUCTIONS												
SORTER-READ DEMAND	SRD	#	b or 0, 1	b or 0, 1	VALIDITY CHECK	D E T B	6 4 5 6	DEMAND FEED ALL FIELDS THROUGH TRANSIT BUFFERED FLOW READ	CAN'T READ BRANCH ADDRESS	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
FLOW	SRF	#	b or 0, 1	b or 0, 1	VALIDITY CHECK							
CONTROL SORTER	CTL	C	P	0	POCKET SELECT (PS)	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			D	2	DEMAND FEED & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			S	4	STOP FLOW (SPF) & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			C	6	START FLOW (STF) & PS	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			B	7	STF & PS—BUFFERED	0-9, X, Y, R	0-9, #, @, ≥	SELECT POCKET	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED
			I	8	INCREASE BATCH COUNTER BY 1 (B 103)	b	b	RESERVED FOR EXPANSION	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	NOT AFFECTED

① SYM—Number of characters expressed in hundreds, tens, and units
M/L—Number of characters expressed in number of words and remaining characters

② N = 1 Not permissible when M = 1 or 15
N = 7 Not permissible when M = 0 or 15

③ N = 1 Not permissible when M = 1 or 2
N = 7 Not permissible when M = 0 or 7

④ M = 0-2 For printer I
M = 4-6 For printer II

⑤ Branch Address when M variant contains 2 bit (2, 3, 6, 7)

⑥ M = 4 Skip all non-master tape } Optional on B 322 Lister
M = 9 Skips all tapes } Standard on B 323 Lister

APPENDIX C (cont)

OPERATION	OP CODE SYM	OP CODE M/L	M VARIANT SYM	M VARIANT M/L	M VARIANT FUNCTION	N VARIANT SYM	N VARIANT M/L	N VARIANT FUNCTION	AAA ADDRESS FUNCTION	BBB ADDRESS FUNCTION	CCC ADDRESS FUNCTION	COMPARISON INDICATORS
MAGNETIC TAPE INSTRUCTION												
MAG. TAPE MEMORY WRITE	MWR	D	8	8	MEMORY DUMP	1-6	1-6	UNIT DESIGNATE	TRANSFER FROM ADDRESS MSD	BRANCH ON END-OF-TAPE	BRANCH ADDRESS ON WRITE ERROR	SET TO EQUAL
MAG. TAPE WRITE BINARY	BWR	D	10	#	BINARY WRITE	1-6	1-6	UNIT DESIGNATE	TRANSFER FROM ADDRESS MSD	" " " " "	BRANCH ADDRESS ON WRITE ERROR	SET TO EQUAL
MAG. TAPE READ BINARY	BRD	D	9	9	BINARY READ	1-6	1-6	UNIT DESIGNATE	BRANCH ADDRESS ON READ ERROR	BRANCH ADDRESS ON END-OF-FILE (TAPE MARK)	STORE ADDRESS MSD	SET TO EQUAL
READ TAPE	TRD	D	b	1	MODIFY OP CODE	1-6	1-6	UNIT DESIGNATE	READ ERROR BRANCH	EOF BRANCH	INPUT ADDRESS	SET TO EQUAL
WRITE TAPE	TWR	D	b	2	MODIFY OP CODE	1-6	1-6	UNIT DESIGNATE	OUTPUT ADDRESS	EOT BRANCH	WRITE ERROR BRANCH	SET TO EQUAL
ERASE TAPE	TER	D	b	3	MODIFY OP CODE	1-6	1-6	UNIT DESIGNATE	PSEUDO RECORD ADDRESS	EOT BRANCH	AVAILABLE TO PROGRAMER	SET TO EQUAL
BACKSPACE TAPE	BSP	D	b	4	MODIFY OP CODE	1-6	1-6	UNIT DESIGNATE	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	SET TO EQUAL
REWIND TAPE	RWD	D	b	5	MODIFY OP CODE	1-6	1-6	UNIT DESIGNATE	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	SET TO EQUAL
PAPER TAPE INSTRUCTIONS												
PAPER TAPE READ	PRD	F	1	1	BUFFERED MODE	1, 2	1, 2	BUFFER NUMBER	PARITY ERROR BRANCH ADDRESS	EOT BRANCH ADDRESS	INPUT ADDRESS	NOT AFFECTED
			2	2	UNBUFFERED MODE	1, 2	1, 2	BUFFER NUMBER		EOT BRANCH ADDRESS	INPUT ADDRESS	NOT AFFECTED
PAPER TAPE SPACE FORWARD	PSF	F	b	4	MODIFY OP CODE	1, 2	1, 2	BUFFER NUMBER	AVAILABLE TO PROGRAMER	EOT BRANCH ADDRESS	AVAILABLE TO PROGRAMER	NOT AFFECTED
PAPER TAPE SPACE BACKWARD	PSB	F	b	&	MODIFY OP CODE	1, 2	1, 2	BUFFER NUMBER	AVAILABLE TO PROGRAMER	AVAILABLE TO PROGRAMER	BOT BRANCH ADDRESS	NOT AFFECTED
PAPER TAPE REWIND	PRW	F	b	8	MODIFY OP CODE	1, 2	1, 2	BUFFER NUMBER	AVAILABLE TO PROGRAMER	NOT READY BRANCH ADDRESS	BOT BRANCH ADDRESS	NOT AFFECTED
PAPER TAPE WRITE	PWR	E	1	1	PUNCH ALL HOLES	b	b	RESERVED FOR EXPANSION	OUTPUT ADDRESS	EOT BRANCH ADDRESS	NOT READY BRANCH ADDRESS	NOT AFFECTED
			2	2	BUFFERED MODE	b	b		OUTPUT ADDRESS	EOT BRANCH ADDRESS	NOT READY BRANCH ADDRESS	NOT AFFECTED
DISK FILE INSTRUCTIONS												
DISK FILE WRITE	DFW	K	0	0	WRITE	1-9, 0 (0=10)	1-9, #	NUMBER OF DATA SEGMENTS	MSD OF DISK FILE ADDRESSING WORD	MSD OF MEMORY LOCATION CONTAINING DATA TO BE WRITTEN	BRANCH ON DESIGNATED STORAGE UNIT NOT READY	NOT AFFECTED
DISK FILE READ	DFR	K	2	2	READ	1-9, 0 (0=10)	1-9, #	NUMBER OF DATA SEGMENTS	MSD OF DISK FILE ADDRESSING WORD	MSD OF MEMORY LOCATION CONTAINING DATA TO BE READ	BRANCH ON DESIGNATED STORAGE UNIT NOT READY	NOT AFFECTED
DISK FILE CHECK	DFC	K	4	4	READ CHECK	1-9, 0 (0=10)	1-9, #	NUMBER OF DATA SEGMENTS	MSD OF DISK FILE ADDRESSING WORD	AVAILABLE TO PROGRAMER	BRANCH ON DESIGNATED STORAGE UNIT NOT READY	NOT AFFECTED
DISK FILE INTERROGATE	DFI	K	8	8	INTERROGATE	b	b	RESERVED FOR EXPANSION	BRANCH ON DISK FILE CONTROL UNIT BUSY	BRANCH ON ERROR (AFTER A DFR OR DFC HAS BEEN EXECUTED). PARITY ERROR OR READ ERROR	BRANCH ON INVALID ADDRESS OR AN ATTEMPT TO ADDRESS BEYOND THE MAXIMUM POSSIBLE ELECTRONIC UNIT ADDRESS, OR WRITE LOCKOUT	NOT AFFECTED
DATA COMMUNICATION INSTRUCTIONS												
DATA COMMUNICATION READ	DCR	L	2	2	READ INQUIRY	1-15	1-≥	DESIGNATES TERMINAL UNIT NUMBER	AVAILABLE TO PROGRAMER	BRANCH ON BUSY OUTPUT READY OR IDLE	STORE ADDRESS MSD	NOT AFFECTED
DATA COMMUNICATION WRITE	DCW	L	4	4	WRITE INQUIRY	1-15	1-≥	DESIGNATES TERMINAL UNIT NUMBER	TRANSFER ADDRESS MSD	BRANCH ON BUSY INPUT READY OR IDLE	AVAILABLE TO PROGRAMER	NOT AFFECTED
DATA COMMUNICATION INTERROGATE	DCI	L	1	1	INTERROGATE INQUIRY READY	0-1-15	0, 1-≥	0 = INQUIRY CONTROL UNIT DESIGNATED TERMINAL NUMBER 1-15 = DESIGNATED TERMINAL UNIT NUMBER	BRANCH ON INPUT READY	TERMINAL UNIT NUMBER STORE	BRANCH ON OUTPUT READY	NOT AFFECTED
MACRO INSTRUCTIONS												
LINK	LNK		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	TO SUB-ROUTINE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
ADDRESS ARITHMETIC	AAR		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	LOCATION TO BE MODIFIED	MODIFIER (MODULUS 10 10 12)	RESULT ADDRESS	NOT APPLICABLE
PSEUDO INSTRUCTIONS												
SET LOCATION COUNTER	SLC		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	MACHINE ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
ADJUST LOCATION COUNTER	ALC		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	MODULUS MACHINE ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
OVERLAY	OVR		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	SET TO ADDRESS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
END ASSEMBLY	END		NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
SYMBOLIC ADDRESS	SAD		HIGH ORDER SYMBOLIC ADDRESS POSITIONS			LOW ORDER SYMBOLIC ADDRESS POSITIONS			SYMBOLIC ADDRESS	SYMBOLIC ADDRESS	SYMBOLIC ADDRESS	NOT APPLICABLE
INSERT GROUP MARK	IGM		GENERATOR 1—CHARACTER GROUP MARK									
HEADING	HDG		HEADING INFORMATION									NOT APPLICABLE
CONSTANT	CST		CONSTANT DATA									NOT APPLICABLE

APPENDIX D

MODEL 0 CENTRAL PROCESSOR

INSTRUCTION LIST

INSTRUCTION	SYMBOLIC	PAGE
ADD	**ADD**	4-10
BRANCH CONDITIONAL	**BRC**	4-14
BRANCH UNCONDITIONAL	**BRU**	4-15
CARD READ	**CRD**	4-3
CARD PUNCH	**PCH**	4-3
COMPARE ALPHABETIC, BRANCH ON EQUAL	**CAE**	4-16
COMPARE ALPHABETIC, BRANCH ON UNEQUAL	**CAU**	4-17
COMPARE NUMERIC, BRANCH ON EQUAL	**CNE**	4-17
COMPARE NUMERIC, BRANCH ON UNEQUAL	**CNU**	4-18
COMPARE ZONE, BRANCH ON EQUAL	**CZE**	4-16
COMPARE ZONE, BRANCH ON UNEQUAL	**CZU**	4-18
CONTROL SORTER	**CTL**	4-8
DIVIDE	**DIV**	4-13
HALT	**HLT**	4-19
MAGNETIC TAPE BACKSPACE	**BSP**	4-9
MAGNETIC TAPE ERASE	**TER**	4-9
MAGNETIC TAPE READ	**TRD**	4-8
MAGNETIC TAPE REWIND	**RWD**	4-9
MAGNETIC TAPE WRITE	**TWR**	4-8
MASK	**MSK**	4-20
MULTIPLY	**MUL**	4-12
NO OPERATION	**NOP**	4-19
PRINT ON LISTER	**PRL**	4-5
PRINT ON PRINTER	**PRT**	4-4
SKIP ON LISTER	**SKL**	4-6
SKIP ON PRINTER	**SKP**	4-4
SORTER-READER DEMAND	**SRD**	4-7
SORTER-READ FLOW	**SRF**	4-7
SUBTRACT	**SUB**	4-11
TRANSFER	**TFR**	4-20

APPENDIX E

IMPROVED MODEL 0 CENTRAL PROCESSOR INSTRUCTION LIST

INSTRUCTION	SYMBOLIC	PAGE
ADD	**ADD**	4-10
ADDRESS MODIFICATION	**ADM**	4-23
BRANCH CONDITIONAL	**BRC**	4-14
BRANCH UNCONDITIONAL	**BRU**	4-15
CARD READ	**CRD**	4-3
CARD PUNCH	**PCH**	4-3
COMPARE ALPHABETIC, BRANCH ON EQUAL	**CAE**	4-16
COMPARE ALPHABETIC, BRANCH ON UNEQUAL	**CAU**	4-17
COMPARE NUMERIC, BRANCH ON EQUAL	**CNE**	4-17
COMPARE NUMERIC, BRANCH ON UNEQUAL	**CNU**	4-18
COMPARE ZONE, BRANCH ON EQUAL	**CZE**	4-16
COMPARE ZONE, BRANCH ON UNEQUAL	**CZU**	4-18
CONTROL SORTER	**CTL**	4-8
DIVIDE	**DIV**	4-13
HALT AND BRANCH	**HLT**	4-22
MAGNETIC TAPE BACKSPACE	**BSP**	4-9
MAGNETIC TAPE ERASE	**TER**	4-9
MAGNETIC TAPE READ	**TRD**	4-8
MAGNETIC TAPE REWIND	**RWD**	4-9
MAGNETIC TAPE WRITE	**TWR**	4-8
MASK	**MSK**	4-20
MULTIPLY	**MUL**	4-12
NO OPERATION	**NOP**	4-19
PAPER TAPE BACKSPACE	**PSB**	4-26
PAPER TAPE READ	**PRD**	4-25
PAPER TAPE REWIND	**PRW**	4-26
PAPER TAPE SPACE FORWARD	**PSF**	4-26
PAPER TAPE WRITE	**PWR**	4-25
PRINT ON LISTER	**PRL**	4-5
PRINT ON PRINTER	**PRT**	4-22
SKIP ON LISTER	**SKL**	4-6
SKIP ON PRINTER	**SKP**	4-23
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APPENDIX F

B 263/273/283

CENTRAL PROCESSOR INSTRUCTION LIST

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SUBTRACT	**SUB**	4-11
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TRANSFER ZONE	**TFZ**	4-24

APPENDIX G

MODEL 0 and IMPROVED MODEL 0 INSTRUCTION TIMING

OPERATION	CLASS	EXECUTION TIME	UNIT
		INPUT/OUTPUT INSTRUCTIONS	
CARD READ	**C**	2.0 ms. unload buffer	ms.
CARD PUNCH	**C**	2.5 ms. load buffer	ms.
PRINT ON DRUM PRINTER	**C**	1.31 ms. + .03 ms. if branch is required	ms.
PRINT ON LISTERS	**C**	0.61 ms. + .03 ms. if branch is required	ms.
SKIP DRUM PRINTER	**B**	50 μs. + 30 μs. if branch is required	μs.
SKIP LISTER	**B**	60 μs. + 30 μs. if branch is required	μs.
CONTROL SORTER	**B**	120 μs. except for change of mode	μs.
SORTER-READ	**C**	2 ms. demand or buffered flow 14.4-19.4 ms. unbuffered flow	ms.

B 421

MAGNETIC TAPE OPERATIONS	CLASS	TRANSPORT RELEASED AT	NEW TAPE COMMAND CAN BE ACCEPTED AT	UNIT
READ	**A**	6.7 + h(n)	13.8 + h(n)	ms.
WRITE	**A**	6.7 + h(n)	12.9 + h(n)	ms.
ERASE	**A**	6.65 + h(n)	12.8 + hn	ms.
REWIND	**A**	60 μs. (2400 reel of tape can be rewound in 90 seconds (320 inches per second).		μs.
BACKSPACE	**A**	Backspace following write 26.0 + hn	Backspace following other command. 11.2 + hn	μs.

B 422

MAGNETIC TAPE OPERATIONS	CLASS	TRANSPORT RELEASED AT	NEW TAPE COMMAND CAN BE ACCEPTED AT	UNIT
READ	**A**	6.85 + h(n)	11.05 + h(n)	ms.
WRITE	**A**	6.85 + h(n)	11.05 + h(n)	ms.
ERASE	**A**	15.60 + h(n)	19.80 + h(n)	ms.
REWIND	**A**	Same as 421		
BACKSPACE	**A**	Time to reverse direction of tape drive 10.0 + h(n)		ms.

NOTE

If at a load point, add 50 milliseconds (average), or 55 milliseconds (maximum) to the time.

OPERATION	CLASS	EXECUTION TIME	UNIT
		ARITHMETIC INSTRUCTIONS	
ADD	B	10 [4 + 4 (M + N) + 5L] (no decomplement) 10 [4 + 4 (M + N) + 6L] (with decomplement) L = Longer or M + N If M and N = 5, T = 138 μs. per digit	μs. μs.
SUBTRACT	B	10 [4 + 4 (M + N) + 5L] (no decomplement) 10 [4 + 4 (M + N) + 6L] (with decomplement)	μs.
MULTIPLE	B	[3 + 6N + (16 + B_i) MN] 10 If M and N = 5, and B = 5, Avg. T = 1.116 ms/digit.	μs.
DIVIDE	B	10 [(M + 1) + (M-N) [18 + Q_i (10N + 6) + 10N] (If M = 5, N = 2, Q_i = 5, T = 5.1 ms. total)	μs.
		CONTROL INSTRUCTIONS	
COMPARE	B	10 (4 + 10N) Without Branch 10 (7 + 10N) With Branch	μs.
BRANCH	B	70 μs.	μs.
HALT	B	40 μs. to 1 second (1 second for VRC)	μs.
NO-OP	B	40 μs.	μs.

B 263/273/283

EXECUTION TIME

OPERATION	CLASS	EXECUTION TIME	UNIT
		INPUT/OUTPUT INSTRUCTIONS	
PRINT ON SUPERVISORY PRINTER	A	10 characters per second	Sec.
SUPERVISORY PRINTER READ	A	49 μs.	μs.
PRINT ON LISTERS	C	0.61 ms. + 30 μs. if branch is required	ms.
SKIP LISTER	B	60 μs. + 30 μs. if branch is required	μs.
DISK FILE OPERATION			
DISK FILE INTERROGATE	B	80 μs.	μs.
DISK FILE READ	A	20 ms. + 100KC average access (Access ranges from 84 to 154 KC)	ms.
DISK FILE WRITE	A	20 ms. + 100 KC average access (Access ranges from 84 to 154 KC)	ms.
DISK FILE READ CHECK	B	240 μs.	μs.

DATA COMMUNICATION OPERATIONS	CLASS	EXECUTION TIME	UNIT
DATA COMMUNICATION INTERROGATE	B	150 μs.	μs.
DATA COMMUNICATION READ	A	100 μs. + message at 30 KC transfer rate	μs.
DATA COMMUNICATION WRITE	A	100 μs. + message at 30 KC transfer rate	μs.
		EDITING INSTRUCTIONS	
TRANSFER*	C	10 [10 + 2 (12M + N)]	μs.
TRANSFER	C	10 [4 + 8 (12M +N)]	μs.
TRANSFER ZONE	C	10 [10 + 3 (12M + N)]	μs.
MASK	B	10 [12 + (12M + 8n)] n = number of ($), (,) and (.) inserts	μs.
*ADM	C	130 μs.	μs.

*Improved Model 0 and B 263/273/283 only.

SYMBOL	EXPLANATION
M	M Variant or number of positions in AAA field.
N	N Variant value or number of positions in BBB field.
L	Longer of M and N.
B	Average Value of digits in the number stored in BBB field.
CLASS A	Commands which allow no buffer access.
CLASS B	Commands which allow buffer access and in which execute time equals command time plus BAT.

	B 421		B 422	
	200	555.5	200	555.5
h =	.055 ms.	.020 ms.	.041 ms.	.015 ms.

n = number of characters.

CLASS C These commands if encountered during buffer access require an additional command modification time. If buffer access occurs during an Improved Model 0 or B 263, B 273/B 283 Transfer command, an additional 70 μs. per access is required. All other Class C commands require an additional 30 μs. per buffer access if encountered.

NOTE

All times involving the processor should by multiplied by 0.6 to obtain times for B 263/273/283 Systems.

To aid in determining the process time of a record, five timing tables are provided in this appendix. These tables list the approximate timing for the following operations:

a. Compare (table G-1).
b. Arithmetic (table G-2)
c. Transfer (tables G-3 and G-4; Model 0 and Improved Model 0 processor respectively).
d. Mask (table G-5).

TABLE G-1

Compare Instruction Timing

Number of Characters	Time in Milliseconds	Number of Characters	Time in Milliseconds
1	.14	7	.74
2	.24	8	.84
3	.34	9	.94
4	.44	10	1.04
5	.54	11	1.14
6	.64	12	1.24

NOTE

All times should be multiplied by 0.6 to obtain times for the B 263/273/283 Systems.

TABLE G-2

Arithmetic Instruction Timings

Number of Characters		Time in Milliseconds			Number of Characters		Time in Milliseconds			Number of Characters		Time in Milliseconds		
AAA	BBB	Add or Subtract	Multiply	Divide	AAA	BBB	Add or Subtract	Multiply	Divide	AAA	BBB	Add or Subtract	Multiply	Divide
1	1	.17	.30		6	3	.70	3.99	6.91	8	6	1.00	10.47	8.25
2	1	.26	.51	1.11	7	3	.79	4.62	9.20	9	6	1.09	11.73	12.34
3	1	.35	.72	2.20	8	3	.88	5.25	11.49	10	6	1.18	12.99	16.43
4	1	.44	.93	3.29	9	3	.97	5.88	13.78	11	6	1.27	14.25	20.52
5	1	.53	1.14	4.38	10	3	1.06	6.51	16.07	12	6	1.36	15.51	24.61
6	1	.62	1.35	5.47	11	3	1.15	7.14	18.36	7	7	.95	10.74	
7	1	.71	1.56	6.56	12	3	1.24	7.77	20.65	8	7	1.04	12.21	4.77
8	1	.80	1.77	7.65	4	4	.56	3.63		9	7	1.13	13.68	9.46
9	1	.89	1.98	8.74	5	4	.65	4.47	2.94	10	7	1.22	15.15	14.15
10	1	.98	2.19	9.83	6	4	.74	5.31	5.83	11	7	1.31	16.62	18.84
11	1	1.07	2.40	10.92	7	4	.83	6.15	8.72	12	7	1.40	18.09	23.53
12	1	1.16	2.61	12.01	8	4	.92	6.99	11.61	8	8	1.08	13.95	
2	2	.30	.99		9	4	1.01	7.83	14.50	9	8	1.17	15.63	5.38
3	2	.39	1.41	1.72	10	4	1.10	8.67	17.39	10	8	1.26	17.31	10.76
4	2	.48	1.83	3.41	11	4	1.19	9.51	20.28	11	8	1.35	18.99	15.96
5	2	.57	2.25	5.10	12	4	1.28	10.35	23.17	12	8	1.44	20.67	21.25
6	2	.66	2.67	6.79	5	5	.69	5.58		9	9	1.21	17.01	
7	2	.75	3.09	8.48	6	5	.78	6.63	3.55	10	9	1.30	19.47	5.99
8	2	.84	3.51	10.17	7	5	.87	7.68	7.04	11	9	1.39	21.36	11.88
9	2	.93	3.93	11.86	8	5	.96	8.73	10.53	12	9	1.48	23.25	17.77
10	2	1.02	4.35	13.55	9	5	1.05	9.78	14.02	10	10	1.34	21.63	
11	2	1.11	4.77	15.24	10	5	1.14	10.83	17.51	11	10	1.43	23.73	6.60
12	2	1.20	5.19	16.93	11	5	1.23	11.88	21.00	12	10	1.52	25.83	13.09
3	3	.43	2.10		12	5	1.32	12.93	24.49	11	11	1.47	26.10	
4	3	.52	2.73	2.33	6	6	.82	7.95		12	11	1.56	28.41	7.21
5	3	.61	3.36	4.62	7	6	.91	9.21	4.16	12	12	1.60	30.99	

TABLE G-3

Transfer Instruction Timing

(Model 0 Processor)

Number of Characters	Time in Milliseconds	Number of Characters	Time in Milliseconds	Number of Characters	Time in Milliseconds
1	.12	41	3.32	81	6.52
2	.20	42	3.40	82	6.60
3	.28	43	3.48	83	6.68
4	.36	44	3.56	84	6.76
5	.44	45	3.64	85	6.84
6	.52	46	3.72	86	6.92
7	.60	47	3.80	87	7.00
8	.68	48	3.88	88	7.08
9	.76	49	3.96	89	7.16
10	.84	50	4.04	90	7.24
11	.92	51	4.12	91	7.32
12	1.00	52	4.20	92	7.40
13	1.08	53	4.28	93	7.48
14	1.16	54	4.36	94	7.56
15	1.24	55	4.44	95	7.64
16	1.32	56	4.52	96	7.72
17	1.40	57	4.60	97	7.80
18	1.48	58	4.68	98	7.88
19	1.56	59	4.76	99	7.96
20	1.64	60	4.84	100	8.04
21	1.72	61	4.92	101	8.12
22	1.80	62	5.00	102	8.20
23	1.88	63	5.08	103	8.28
24	1.96	64	5.16	104	8.36
25	2.04	65	5.24	105	8.44
26	2.12	66	5.32	106	8.52
27	2.20	67	5.40	107	8.60
28	2.28	68	5.48	108	8.68
29	2.36	69	5.56	109	8.76
30	2.44	70	5.64	110	8.84
31	2.52	71	5.72	111	8.92
32	2.60	72	5.80	112	9.00
33	2.68	73	5.88	113	9.08
34	2.76	74	5.96	114	9.16
35	2.84	75	6.04	115	9.24
36	2.92	76	6.12	116	9.32
37	3.00	77	6.20	117	9.49
38	3.08	78	6.28	118	9.48
39	3.16	79	6.36	119	9.56
40	3.24	80	6.44	120	9.64

TABLE G-4

Transfer Instruction Timing

(Improved Model 0 Processor)

Number of Characters	Time in Milliseconds	Number of Characters	Time in Milliseconds	Number of Characters	Time in Milliseconds
1	.12	41	.92	81	1.72
2	.14	42	.94	82	1.74
3	.16	43	.96	83	1.76
4	.18	44	.98	84	1.78
5	.20	45	1.00	85	1.80
6	.22	46	1.02	86	1.82
7	.24	47	1.04	87	1.84
8	.26	48	1.06	88	1.86
9	.28	49	1.08	89	1.88
10	.30	50	1.10	90	1.90
11	.32	51	1.12	91	1.92
12	.34	52	1.14	92	1.94
13	.36	53	1.16	93	1.96
14	.38	54	1.18	94	1.98
15	.40	55	1.20	95	2.00
16	.42	56	1.22	96	2.02
17	.44	57	1.24	97	2.04
18	.46	58	1.26	98	2.06
19	.48	59	1.28	99	2.08
20	.50	60	1.30	100	2.10
21	.52	61	1.32	101	2.12
22	.54	62	1.34	102	2.14
23	.56	63	1.36	103	2.16
24	.58	64	1.38	104	2.18
25	.60	65	1.40	105	2.20
26	.62	66	1.42	106	2.22
27	.64	67	1.44	107	2.24
28	.66	68	1.46	108	2.26
29	.68	69	1.48	109	2.28
30	.70	70	1.50	110	2.30
31	.72	71	1.52	111	2.32
32	.74	72	1.54	112	2.34
33	.76	73	1.56	113	2.36
34	.78	74	1.58	114	2.38
35	.80	75	1.60	115	2.40
36	.82	76	1.62	116	2.42
37	.84	77	1.64	117	2.44
38	.86	78	1.66	118	2.46
39	.88	79	1.68	119	2.48
40	.90	80	1.70	120	2.50

TABLE G-5

Mask Instruction Timing

Number of Characters		Time in Milliseconds	Number of Characters		Time in Milliseconds	Number of Characters		Time in Milliseconds
AAA	BBB*		AAA	BBB*		AAA	BBB*	
1	0	.24	10	1	1.40	10	3	1.56
2	0	.36	11	1	1.52	11	3	1.68
3	0	.48	12	1	1.64	12	3	1.80
4	0	.60	2	2	.52	4	4	.92
5	0	.72	3	2	.64	5	4	1.04
6	0	.84	4	2	.76	6	4	1.16
7	0	.96	5	2	.88	7	4	1.28
8	0	1.08	6	2	1.00	8	4	1.40
9	0	1.20	7	2	1.12	9	4	1.52
10	0	1.32	8	2	1.24	10	4	1.64
11	0	1.44	9	2	1.36	11	4	1.76
12	0	1.56	10	2	1.48	12	4	1.88
1	1	.32	11	2	1.60	5	5	1.12
2	1	.44	12	2	1.72	6	5	1.24
3	1	.56	3	3	.72	7	5	1.36
4	1	.68	4	3	.84	8	5	1.48
5	1	.80	5	3	.96	9	5	1.60
6	1	.92	6	3	1.08	10	5	1.72
7	1	1.04	7	3	1.20	11	5	1.84
8	1	1.16	8	3	1.32	12	5	1.96
9	1	1.28	9	3	1.44			

*BBB—Inserts in Mask field ($, .).

APPENDIX H – B 200 INTERNAL CODE

B 200 Print Symbol	B 200 Internal Code							Tab Card Code		
	P	B	A	8	4	2	1	Z		N
Blank	1	1	1	0	0	0	0			
.	0	0	1	1	0	1	0	12	8	3
[	1	0	1	1	0	1	1	12	8	4
(	1	0	1	1	1	0	1	12	8	5
<	1	0	1	1	1	1	0	12	8	6
←	0	0	1	1	1	1	1	12	8	7
&	0	0	1	1	1	0	0	12		
$	0	1	0	1	0	1	0	11	8	3
*	1	1	0	1	0	1	1	11	8	4
)	1	1	0	1	1	0	1	11	8	5
;	1	1	0	1	1	1	0	11	8	6
≤	0	1	0	1	1	1	1	11	8	7
-	0	1	0	1	1	0	0	11		
/	0	1	1	0	0	0	1	0		1
,	1	1	1	1	0	1	0	0	8	3
%	0	1	1	1	0	1	1	0	8	4
=	0	1	1	1	1	0	1	0	8	5
]	0	1	1	1	1	1	0	0	8	6
"	1	1	1	1	1	1	1	0	8	7
#	1	0	0	1	0	1	0		8	3
@	0	0	0	1	0	1	1		8	4
:	0	0	0	1	1	0	1		8	5
>	0	0	0	1	1	1	0		8	6
≥	1	0	0	1	1	1	1		8	7
+	0	0	1	0	0	0	0	12		0
A	1	0	1	0	0	0	1	12		1
B	1	0	1	0	0	1	0	12		2
C	0	0	1	0	0	1	1	12		3
D	1	0	1	0	1	0	0	12		4
E	0	0	1	0	1	0	1	12		5
F	0	0	1	0	1	1	0	12		6
G	1	0	1	0	1	1	1	12		7

APPENDIX H (cont'd)

B 200 Print Symbol	B 200 Internal Code							Tab Card Code		
	P	B	A	8	4	2	1	Z		N
H	1	0	1	1	0	0	0	12		8
I	0	0	1	1	0	0	1	12		9
x	0	1	0	0	0	0	0	11		0
J	1	1	0	0	0	0	1	11		1
K	1	1	0	0	0	1	0	11		2
L	0	1	0	0	0	1	1	11		3
M	1	1	0	0	1	0	0	11		4
N	0	1	0	0	1	0	1	11		5
O	0	1	0	0	1	1	0	11		6
P	1	1	0	0	1	1	1	11		7
Q	1	1	0	1	0	0	0	11		8
R	0	1	0	1	0	0	1	11		9
≠	1	1	1	1	1	0	0	0	8	2
S	0	1	1	0	0	1	0	0		2
T	1	1	1	0	0	1	1	0		3
U	0	1	1	0	1	0	0	0		4
V	1	1	1	0	1	0	1	0		5
W	1	1	1	0	1	1	0	0		6
X	0	1	1	0	1	1	1	0		7
Y	0	1	1	1	0	0	0	0		8
Z	1	1	1	1	0	0	1	0		9
0	1	0	0	0	0	0	0			0
1	0	0	0	0	0	0	1			1
2	0	0	0	0	0	1	0			2
3	1	0	0	0	0	1	1			3
4	0	0	0	0	1	0	0			4
5	1	0	0	0	1	0	1			5
6	1	0	0	0	1	1	0			6
7	0	0	0	0	1	1	1			7
8	0	0	0	1	0	0	0			8
9	1	0	0	1	0	0	1			9
?	1	0	0	1	1	0	0	All Other Codes		

APPENDIX I BCL MAGNETIC TAPE CODE

B 200 Print Symbol	BCL Magnetic Tape Code							B 200 Internal Code							Tab Card Code		
	P	B	A	8	4	2	1	P	B	A	8	4	2	1			
Blank	1	0	1	0	0	0	0	1	1	1	0	0	0	0	Z		N
.	1	1	1	1	0	1	1	0	0	1	1	0	1	0	12	8	3
[	0	1	1	1	1	0	0	1	0	1	1	0	1	1	12	8	4
)	1	1	1	1	1	0	1	1	0	1	1	1	0	1	12	8	5
<	1	1	1	1	1	1	0	1	0	1	1	1	1	0	12	8	6
←	0	1	1	1	1	1	1	0	0	1	1	1	1	1	12	8	7
&	0	1	1	0	0	0	0	0	0	1	1	1	0	0	12		
$	0	1	0	1	0	1	1	0	1	0	1	0	1	0	11	8	3
*	1	1	0	1	1	0	0	1	1	0	1	0	1	1	11	8	4
(	0	1	0	1	1	0	1	1	1	0	1	1	0	1	11	8	5
;	0	1	0	1	1	1	0	1	1	0	1	1	1	0	11	8	6
≤	1	1	0	1	1	1	1	0	1	0	1	1	1	1	11	8	7
-	1	1	0	0	0	0	0	0	1	0	1	1	0	0	11		
/	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0		1
,	0	0	1	1	0	1	1	1	1	1	1	0	1	0	0	8	3
%	1	0	1	1	1	0	0	0	1	1	1	0	1	1	0	8	4
=	0	0	1	1	1	0	1	0	1	1	1	1	0	1	0	8	5
]	0	0	1	1	1	1	0	0	1	1	1	1	1	0	0	8	6
"	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	8	7
#	1	0	0	1	0	1	1	1	0	0	1	0	1	0		8	3
@	0	0	0	1	1	0	0	0	0	0	1	0	1	1		8	4
:	1	0	0	1	1	0	1	0	0	0	1	1	0	1		8	5
>	1	0	0	1	1	1	0	0	0	0	1	1	1	0		8	6
≥	0	0	0	1	1	1	1	1	0	0	1	1	1	1		8	7
+	0	1	1	1	0	1	0	0	0	1	0	0	0	0	12		0
A	1	1	1	0	0	0	1	1	0	1	0	0	0	1	12		1
B	1	1	1	0	0	1	0	1	0	1	0	0	1	0	12		2
C		1	1	0	0	1	1	0	0	1	0	0	1	1	12		3
D	1	1	1	0	1	0	0	1	0	1	0	1	0	0	12		4
E	0	1	1	0	1	0	1	0	0	1	0	1	0	1	12		5
F	0	1	1	0	1	1	0	0	0	1	0	1	1	0	12		6
G	1	1	1	0	1	1	1	1	0	1	0	1	1	1	12		7

APPENDIX I (cont'd)

B 200 Print Symbol	BCL Magnetic Tape Code							B 200 Internal Code							Tab Card Code		
	P	B	A	8	4	2	1	P	B	A	8	4	2	1	Z		N
H	1	1	1	1	0	0	0	1	0	1	1	0	0	0	12		8
I	0	1	1	1	0	0	1	0	0	1	1	0	0	1	12		9
x	1	1	0	1	0	1	0	0	1	0	0	0	0	0	11		0
J	0	1	0	0	0	0	1	1	1	0	0	0	0	1	11		1
K	0	1	0	0	0	1	0	1	1	0	0	0	1	0	11		2
L	1	1	0	0	0	1	1	0	1	0	0	0	1	1	11		3
M	0	1	0	0	1	0	0	1	1	0	0	1	0	0	11		4
N	1	1	0	0	1	0	1	0	1	0	0	1	0	1	11		5
O	1	1	0	0	1	1	0	0	1	0	0	1	1	0	11		6
P	0	1	0	0	1	1	1	1	1	0	0	1	1	1	11		7
Q	0	1	0	1	0	0	0	1	1	0	1	0	0	0	11		8
R	1	1	0	1	0	0	1	0	1	0	1	0	0	1	11		9
≠	1	0	1	1	0	1	0	1	1	1	1	1	0	0	0	8	2
S	0	0	1	0	0	1	0	0	1	1	0	0	1	0	0		2
T	1	0	1	0	0	1	1	1	1	1	0	0	1	1	0		3
U	0	0	1	0	1	0	0	0	1	1	0	1	0	0	0		4
V	1	0	1	0	1	0	1	1	1	1	0	1	0	1	0		5
W	1	0	1	0	1	1	0	1	1	1	0	1	1	0	0		6
X	0	0	1	0	1	1	1	0	1	1	0	1	1	1	0		7
Y	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0		8
Z	1	0	1	1	0	0	1	1	1	1	1	0	0	1	0		9
0	0	0	0	1	0	1	0	1	0	0	0	0	0	0			0
1	1	0	0	0	0	0	1	0	0	0	0	0	0	1			1
2	1	0	0	0	0	1	0	0	0	0	0	0	1	0			2
3	0	0	0	0	0	1	1	1	0	0	0	0	1	1			3
4	1	0	0	0	1	0	0	0	0	0	0	1	0	0			4
5	0	0	0	0	1	0	1	1	0	0	0	1	0	1			5
6	0	0	0	0	1	1	0	1	0	0	0	1	1	0			6
7	1	0	0	0	1	1	1	0	0	0	0	1	1	1			7
8	1	0	0	1	0	0	0	0	0	0	1	0	0	0			8
9	0	0	0	1	0	0	1	1	0	0	1	0	0	1			9
?	0	0	0	0	0	0	0	1	0	0	1	1	0	0	All Other Codes		

APPENDIX J – BCL PAPER TAPE CODE

B 200 Print Symbol	BLC Paper Tape Code							B 200 Internal Code							Tab Card Code		
	C		B	A	8	4	2	1	P	B	A	8	4	2	1			
Blank		0	0	1	0	0	0	0	1	1	1	0	0	0	0			
.		1	1	0	1	0	1	1	0	0	1	1	0	1	0	12	8	3
[		1	1	1	1	1	0	0	1	0	1	1	0	1	1	12	8	4
(		1	1	0	1	1	0	1	1	0	1	1	1	0	1	12	8	5
<		1	1	0	1	1	1	0	1	0	1	1	1	1	0	12	8	6
←	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	12	8	7
&		1	1	1	0	0	0	0	0	0	1	1	1	0	0	12	—	—
$		1	0	1	1	0	1	1	0	1	0	1	0	1	0	11	8	3
*		1	0	0	1	1	0	0	1	1	0	1	0	1	1	11	8	4
)		1	0	1	1	1	0	1	1	1	0	1	1	0	1	11	8	5
;		1	0	1	1	1	1	0	1	1	0	1	1	1	0	11	8	6
≤		1	0	0	1	1	1	1	0	1	0	1	1	1	1	11	8	7
—		1	0	0	0	0	0	0	0	1	0	1	1	0	0	11	—	—
/		0	1	1	0	0	0	1	0	1	1	0	0	0	1	0	1	
,		0	1	1	1	0	1	1	1	1	1	1	0	1	0	0	8	3
%		0	1	0	1	1	0	0	0	1	1	1	0	1	1	0	8	4
≠		0	1	1	1	1	0	1	0	1	1	1	1	0	1	0	8	5
[		0	1	1	1	1	1	0	0	1	1	1	1	1	0	0	8	6
″		0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	8	7
#		0	0	0	1	0	1	1	1	0	0	1	0	1	0	—	8	3
@		0	0	1	1	1	0	0	0	0	0	1	0	1	1	—	8	4
:		0	0	1	1	0	1	0	0	0	0	1	1	0	1	—	8	5
>		0	0	0	1	1	1	0	0	0	0	1	1	1	0	—	8	6
≥		0	0	1	1	1	1	1	1	0	0	1	1	1	1	—	8	7
+		1	1	1	1	0	1	0	0	0	1	0	0	0	0	12		
A		1	1	0	0	0	0	1	1	0	1	0	0	0	1	12	1	
B		1	1	0	0	0	1	0	1	0	1	0	0	1	0	12	2	
C		1	1	1	0	0	1	1	0	0	1	0	0	1	1	12	3	
D		1	1	0	0	1	0	0	1	0	1	0	1	0	0	12	4	
E		1	1	1	0	1	0	1	0	0	1	0	1	0	1	12	5	
F		1	1	1	0	1	1	0	0	0	1	0	1	1	0	12	6	
G		1	1	0	0	1	1	1	1	0	1	0	1	1	1	12	7	

B 200 Symbol Symbol	C	B	A	8	4	2	1	B 200 Internal Code P	B	A	8	4	2	1	Tab Card Code		
H	1	1	0	1	0	0	0	1	0	1	1	0	0	0	12	8	
I	1	1	1	1	0	0	1	0	0	1	1	0	0	1	12	9	
x	1	0	0	1	0	1	0	0	1	0	0	0	0	0	11	0	
J	1	0	1	0	0	0	1	1	1	0	0	0	0	1	11	1	
K	1	0	1	0	0	1	0	1	1	0	0	0	1	0	11	2	
L	1	0	0	0	0	1	1	0	1	0	0	0	1	1	11	3	
M	1	0	1	0	1	0	0	1	1	0	0	1	0	0	11	4	
N	1	0	0	0	1	0	1	0	1	0	0	1	0	1	11	5	
O	1	0	0	0	1	1	0	0	1	0	0	1	1	0	11	6	
P	1	0	1	0	1	1	1	1	1	0	0	1	1	1	11	7	
Q	1	0	1	1	0	0	0	1	1	0	1	0	0	0	11	8	
R	1	0	0	1	0	0	1	0	1	0	1	0	0	1	11	9	
≠	0	1	0	1	0	1	0	1	1	1	1	1	0	0	0	8	2
S	0	1	1	0	0	1	0	0	1	1	0	0	1	0	0	2	
T	0	1	0	0	0	1	1	1	1	1	0	0	1	1	0	3	
U	0	1	1	0	1	0	0	0	1	1	0	1	0	0	0	4	
V	0	1	0	0	1	0	1	1	1	1	0	1	0	1	0	5	
W	0	1	0	0	1	1	0	1	1	1	0	1	1	0	0	6	
X	0	1	1	0	1	1	1	0	1	1	0	1	1	1	0	7	
Y	0	1	1	1	0	0	0	0	1	1	1	0	0	0	0	8	
Z	0	1	0	1	0	0	1	1	1	1	1	0	0	1	0	9	
0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	—	0	
1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	—	1	
2	0	0	0	0	0	1	0	0	0	0	0	0	1	0	—	2	
3	0	0	1	0	0	1	1	1	0	0	0	0	1	1	—	3	
4	0	0	0	0	1	0	0	0	0	0	0	1	0	0	—	4	
5	0	0	1	0	1	0	1	1	0	0	0	1	0	1	—	5	
6	0	0	1	0	1	1	0	1	0	0	0	1	1	0	—	6	
7	0	0	0	0	1	1	1	0	0	0	0	1	1	1	—	7	
8	0	0	0	1	0	0	0	0	0	0	1	0	0	0	—	8	
9	0	0	1	1	0	0	1	1	0	0	1	0	0	1	—	9	
?	0	0	0	1	1	0	1	1	0	0	1	1	0	0	All Other Codes		

APPENDIX K – B 200 ICT CODE

ICT Print Symbol	B 200 Internal Code							ICT Tab Card Code		
	P	B	A	8	4	2	1			
Blank	1	1	1	0	0	0	0	—	—	—
.	0	0	1	1	0	1	0		1	7
'	1	0	1	1	0	1	1	12	8	4
(	1	0	1	1	1	0	1	12	8	5
¼	1	0	1	1	1	1	0		1	3
←	0	0	1	1	1	1	1	12	8	7
&	0	0	1	1	1	0	0		0	1
£	0	1	0	1	0	1	0	11	8	3
*	1	1	0	1	0	1	1	11	8	4
)	1	1	0	1	1	0	1	11	8	5
½	1	1	0	1	1	1	0		1	6
10	0	1	0	1	1	1	1		12	
-	0	1	0	1	1	0	0		1	4
/	0	1	1	0	0	0	1		1	5
,	1	1	1	1	0	1	0	0	8	3
%	0	1	1	1	0	1	1		1	2
=	0	1	1	1	1	0	1	0	8	5
¾	0	1	1	1	1	1	0		1	9
11	1	1	1	1	1	1	1		11	
#	1	0	0	1	0	1	0	—	8	3
@	0	0	0	1	0	1	1		1	8
:	0	0	0	1	1	0	1	—	8	5
>	0	0	0	1	1	1	0	—	8	6
<	1	0	0	1	1	1	1	—	8	7
+	0	0	1	0	0	0	0	12	0	
A	1	0	1	0	0	0	1	12	1	
B	1	0	1	0	0	1	0	12	2	
C	0	0	1	0	0	1	1	12	3	
D	1	0	1	0	1	0	0	12	4	
E	0	0	1	0	1	0	1	12	5	
F	0	0	1	0	1	1	0	12	6	
G	1	0	1	0	1	1	1	12	7	

APPENDIX K (cont'd)

ICT Print Symbol	B 200 Internal Code							ICT Tab Card Code		
	P	B	A	8	4	2	1			
H	1	0	1	1	0	0	0	12	8	
I	0	0	1	1	0	0	1	12	9	
x	0	1	0	0	0	0	0	11	0	
J	1	1	0	0	0	0	1	11	1	
K	1	1	0	0	0	1	0	11	2	
L	0	1	0	0	0	1	1	11	3	
M	1	1	0	0	1	0	0	11	4	
N	0	1	0	0	1	0	1	11	5	
O	0	1	0	0	1	1	0	11	6	
P	1	1	0	0	1	1	1	11	7	
Q	1	1	0	1	0	0	0	11	8	
R	0	1	0	1	0	0	1	11	9	
≠	1	1	1	1	1	0	0	0	8	2
S	0	1	1	0	0	1	0	0	2	
T	1	1	1	0	0	1	1	0	3	
U	0	1	1	0	1	0	0	0	4	
V	1	1	1	0	1	0	1	0	5	
W	1	1	1	0	1	1	0	0	6	
X	0	1	1	0	1	1	1	0	7	
Y	0	1	1	1	0	0	0	0	8	
Z	1	1	1	1	0	0	1	0	9	
0	1	0	0	0	0	0	0	—	0	
1	0	0	0	0	0	0	1	—	1	
2	0	0	0	0	0	1	0	—	2	
3	1	0	0	0	0	1	1	—	3	
4	0	0	0	0	1	0	0	—	4	
5	1	0	0	0	1	0	1	—	5	
6	1	0	0	0	1	1	0	—	6	
7	0	0	0	0	1	1	1	—	7	
8	0	0	0	1	0	0	0	—	8	
9	1	0	0	1	0	0	1	—	9	
?	1	0	0	1	1	0	0	All Other Codes		

APPENDIX L – BULL CODE

Bull Print Symbol	B 200 Internal Code							Bull Tab Card Code		
	P	B	A	8	4	2	1			
Blank	1	1	1	0	0	0	0	—	—	—
.	0	0	1	1	0	1	0	11		
¼	1	0	1	1	0	1	1	9	7	5
(	1	0	1	1	1	0	1	9	8	0
<	1	0	1	1	1	1	0	12	8	6
o̲	0	0	1	1	1	1	1	9	7	0
CR	0	0	1	1	1	0	0	9	8	5
$	0	1	0	1	0	1	0	9	7	12
*	1	1	0	1	0	1	1	12		
)	1	1	0	1	1	0	1	9	8	1
⅓	1	1	0	1	1	1	0	9	8	6
½	0	1	0	1	1	1	1	9	8	4
-	0	1	0	1	1	0	0	9	8	2
/	0	1	1	0	0	0	1	9	7	
,	1	1	1	1	0	1	0	9	8	11
%	0	1	1	1	0	1	1	9	7	4
=	0	1	1	1	1	0	1	9	8	
&	0	1	1	1	1	1	0	0	8	6
"	1	1	1	1	1	1	1	9	7	3
#	1	0	0	1	0	1	0	9	8	12
@	0	0	0	1	0	1	1	9	7	11
:	0	0	0	1	1	0	1	9	7	1
>	0	0	0	1	1	1	0	11	8	6
¾	1	0	0	1	1	1	1	9	7	6
+	0	0	1	0	0	0	0	9	8	3
A	1	0	1	0	0	0	1		7	11
B	1	0	1	0	0	1	0		7	0
C	0	0	1	0	0	1	1		7	1
D	1	0	1	0	1	0	0		7	2
E	0	0	1	0	1	0	1		7	3
F	0	0	1	0	1	1	0		7	4
G	1	0	1	0	1	1	1		7	5

APPENDIX L (cont'd)

BULL PRINT SYMBOL	B 200 INTERNAL CODE							BULL TAB CARD CODE	
	P	B	A	8	4	2	1		
H	1	1	0	1	0	0	0	7	6
I	1	1	1	1	0	0	1	8	12
x	1	0	0	1	0	1	0	7	2
J	1	0	1	0	0	0	1		11
K	1	0	1	0	0	1	0		0
L	1	0	0	0	0	1	1		1
M	1	0	1	0	1	0	0		2
N	1	0	0	0	1	0	1		3
O	1	0	0	0	1	1	0		12
P	1	0	1	0	1	1	1		4
Q	1	0	1	1	0	0	0		5
R	1	0	0	1	0	0	1		6
Ø	0	1	0	1	0	1	0		12
S	0	1	1	0	0	1	0		11
T	0	1	0	0	0	1	1		0
U	0	1	1	0	1	0	0		1
V	0	1	0	0	1	0	1		2
W	0	1	0	0	1	1	0		3
X	0	1	1	0	1	1	1		4
Y	0	1	1	1	0	0	0		5
Z	0	1	0	1	0	0	1		6
0	0	1	0	0	0	0	0		0
1	0	0	0	0	0	0	1		1
2	0	0	0	0	0	1	0		2
3	0	0	1	0	0	1	1		3
4	0	0	0	0	1	0	0		4
5	0	0	1	0	1	0	1		5
6	0	0	1	0	1	1	0		6
7	0	0	0	0	1	1	1		7
8	0	0	0	1	0	0	0		8
9	0	0	1	1	0	0	1		9
?	0	0	0	1	1	0	1	All Other Codes	

INDEX

INDEX (CONT)

INDEX (CONT)

INDEX (CONT)