Burroughs

MEDIUM SYSTEMS

REFERENCE MANUAL

Burroughs
MEDIUM SYSTEMS

INPUT/OUTPUT SUBSYSTEMS
and
DATA COMMUNICATIONS

REFERENCE MANUAL

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INTRODUCTION

The Burroughs Medium Data Processing Systems offer a totally integrated hardware/program products design that incorporates monolithic, solid-state circuitry and high-speed disk capabilities, along with years of experience in the art of machine/man interface to create an unparalleled system for the dollar investment involved. The basic differences in the Medium Data Processing Systems are internal speed, maximum peripheral component capacity, and maximum memory capacity. Because of these slight differences, the statements contained within this manual apply to all Medium Data Processing Systems unless otherwise noted.

The Medium Data Processing Systems are character-oriented toward business and data communications applications. They consist of highly efficient modular hardware/program products, plus a wide range of exceptional peripheral devices that fulfill the sophisticated requirements involved to solve the data gathering and immediate response requirements that confront data processing installations today and in the near future.

This new level of computer responsiveness to business, as well as scientific problems, is available to even the smallest organization with a requirement for electronic data processing. Speed and flexibility are the key words which describe these systems. To support this statement, Burroughs offers:

a. Extremely fast hardware speeds, some measured in billionths of a second.

b. The ability to do many unrelated jobs at the same time in a truly multiprocessing mode and to continue doing them without interruption, even if a rush job is dropped in on the spur of the moment. Multiple compilations of COBOL symbolic programs, along with multiple compilations of FORTRAN, or any other mix, can be accomplished in the same run with operational programs.

c. An unprecedented degree of self-regulation in low cost computer systems.

d. Programming so simple that it can be started by one programmer and finished by another, or divided up between programmers and then integrated by the Operating System.

e. Higher-level programming languages that save time and money as well as improved communication by removing the machine language curtain between those who understand the in-house problem and those who understand the computer.

f. A special suitability to real time, data communications, and time sharing problems.

g. The ability to accommodate the fastest random access disk file on the market in a simple and direct manner.

h. From 4 to 20 input/output channels, all of which may be active simultaneously and still leave ample time free for computation.

It is the purpose of this manual to acquaint the reader with the hardware and associated components inherent in the design of the peripheral and data communication areas of the Medium Data Processing Systems.

For detailed information pertaining to programming features incorporated in these systems, refer to the appropriate Medium System manuals.

SECTION 1
INPUT/OUTPUT SUBSYSTEMS

GENERAL

The Medium Data Processing Systems have been designed to handle a wide range of peripheral units while maintaining a high degree of compatibility with other data processing systems. These peripheral units are logically controlled by the various types of input/output (I/O) channels. The configuration and quantity of peripherals used within a Medium Data Processing System is dependent upon the customer requirements. Because of the modularity of the Medium Data Processing Systems, peripheral configurations can be changed to suit customer data processing requirements without a major reprogramming effort. For the purpose of discussion, the I/O subsystems of the low end of the Burroughs Medium Data Processing Systems product line will be described in terms of two cabinet and three cabinet systems.

TWO CABINET BASIC SYSTEM

The peripheral channels for the two cabinet system are located within the Central Control A and Memory Base A cabinet. Figures 1-1 and 1-2 show views of the internal hardware and a detailed layout of the cabinet, respectively. The maximum number of I/O channels for this system is six. Channel positions 0 through 2 can house either large Type B I/O controls (1 x 85 card locations) or, with an adapter kit, house small Type A controls (1 x 36 card locations). Channel positions 3 through 5 house small I/O controls only.

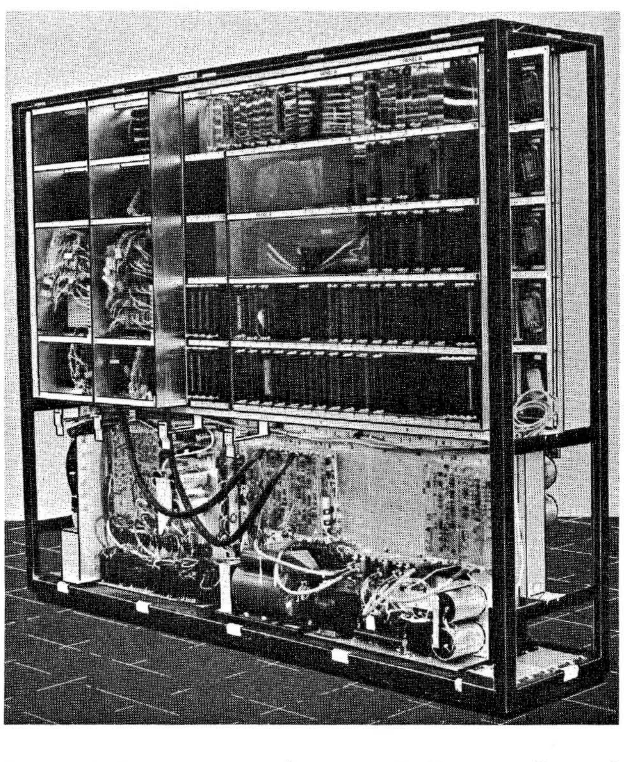

Figure 1-1. Central Control and Memory Base A Cabinet

THREE CABINET BASIC SYSTEM

Peripheral control channels for the three cabinet system are located within the Central Control B cabinet. Figures 1-3 and 1-4 show views of the internal hardware and a detailed layout of the cabinet, respectively. The Central Control B cabinet can accommodate up to 10 I/O controls. Although room is allocated for up to 10 I/O channels, only 8 in any combination of large and small controls can be utilized. The large channel positions, designated 00 through 04, with adapter kits, can house small I/O controls. The section of figure 1-4 labeled CENTRAL CONTROL provides distribution logic between peripheral controls and the central processor. Because of the number of peripheral devices utilizing main memory, a Memory Base B cabinet must be included in the system configuration when using a Central Control B cabinet.

Three cabinet basic systems can utilize up to a maximum of two Central Control B cabinets thus providing the system with the versatility of 16 I/O channels. Referring to figure 1-5, the first cabinet houses control channels 0 through 9, and the second cabinet houses control channels 10 through 19, however, a maximum of only 16 positions can be used.

B 3700/B 4700 CONFIGURATION

Peripheral control channels for both the B 3700 and B 4700 Medium Data Processing Systems are located within Central Control B cabinets as shown in figure 1-5.

Either a B 3700 or a B 4700 System can use up to a maximum of two Central Control B cabinets thus providing each of these systems with the versatility of 20 I/O channels. Referring to figure 1-5, the first cabinet houses control channels 00 through 09, and the second cabinet houses control channels 10 through 19.

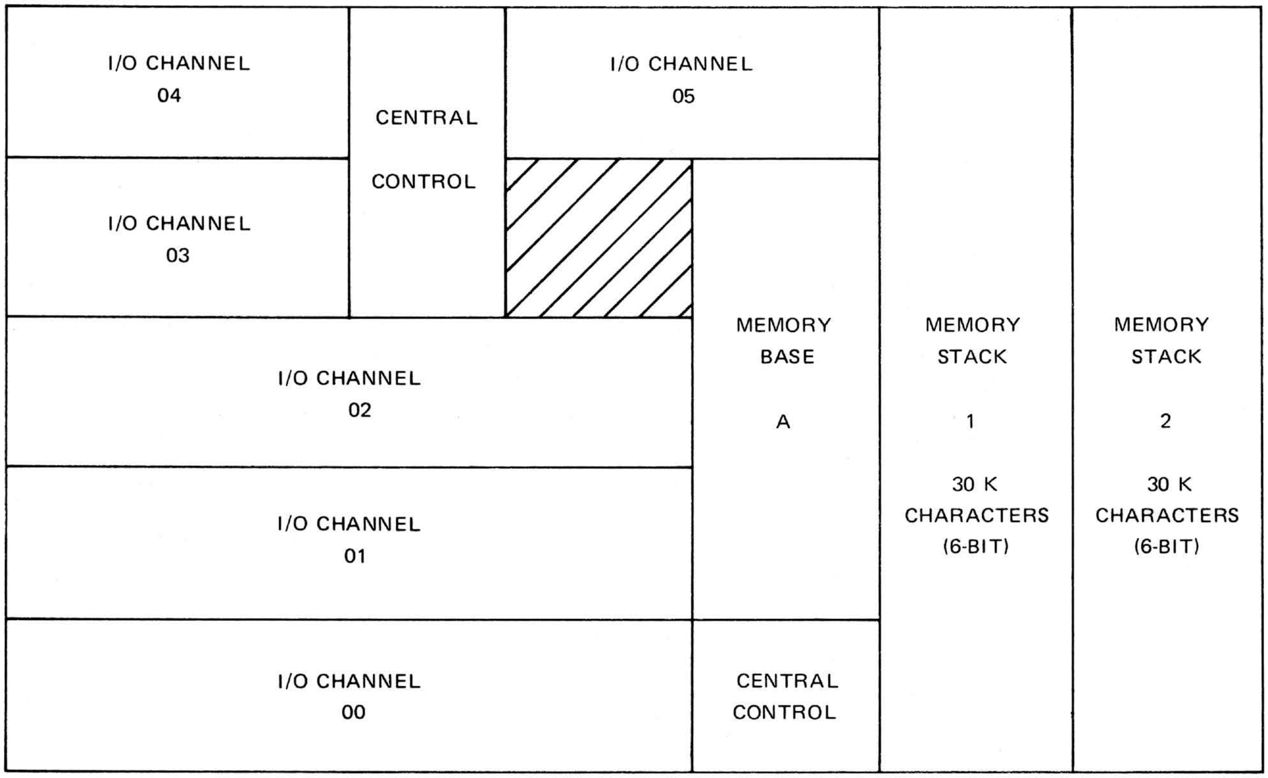

Figure 1-2. Two-Cabinet System Peripheral Control Channel Configuration

Because of the number of peripheral devices utilizing memory, a Memory Base B cabinet must be included in the system configuration of both these systems when using a Central Control B cabinet. Figure 1-6 shows a fully-paneled view of the cabinet.

INPUT/OUTPUT CONTROL TYPES

There are two basic types of input/output controls available for use on the Medium Data Processing Systems: Type A (small) and Type B (large).

The Type A controls (1 x 36 card positions) are used for the more basic and slower peripheral units. These controls are located in channel positions 03 through 05 of the Central Control A cabinet and positions 05 through 09 of the Central Control B cabinet. If these controls are used in the second Central Control B cabinet, they are located in positions 15 through 19 (figure 1-5).

The Type B controls (1 x 85 card positions) are used for the more complex and higher speed peripheral units. These controls are located in channel positions 00 through 02 in the Central Control A cabinet and positions 00 through 04 in the Central Control B cabinet. If these controls are used in the second Central Control B cabinet, they are located in positions 10 through 14 (figure 1-5).

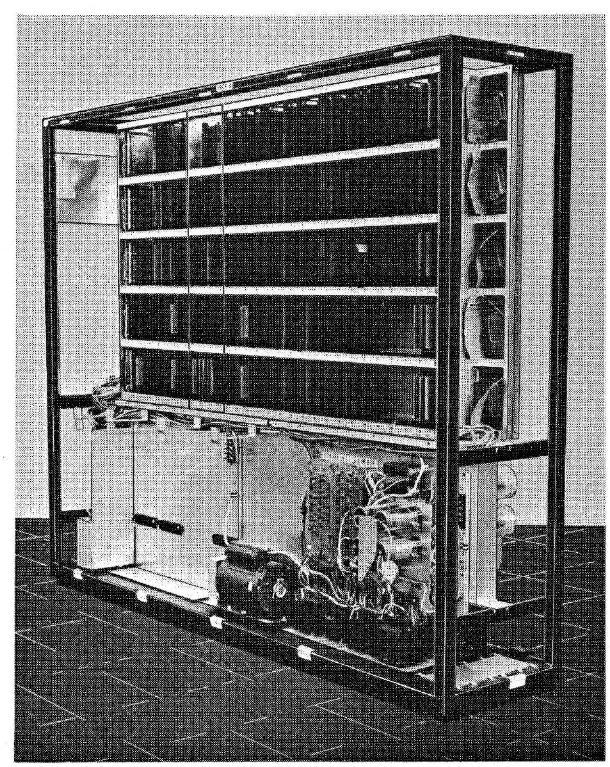

Figure 1-3. Central Control B Cabinet

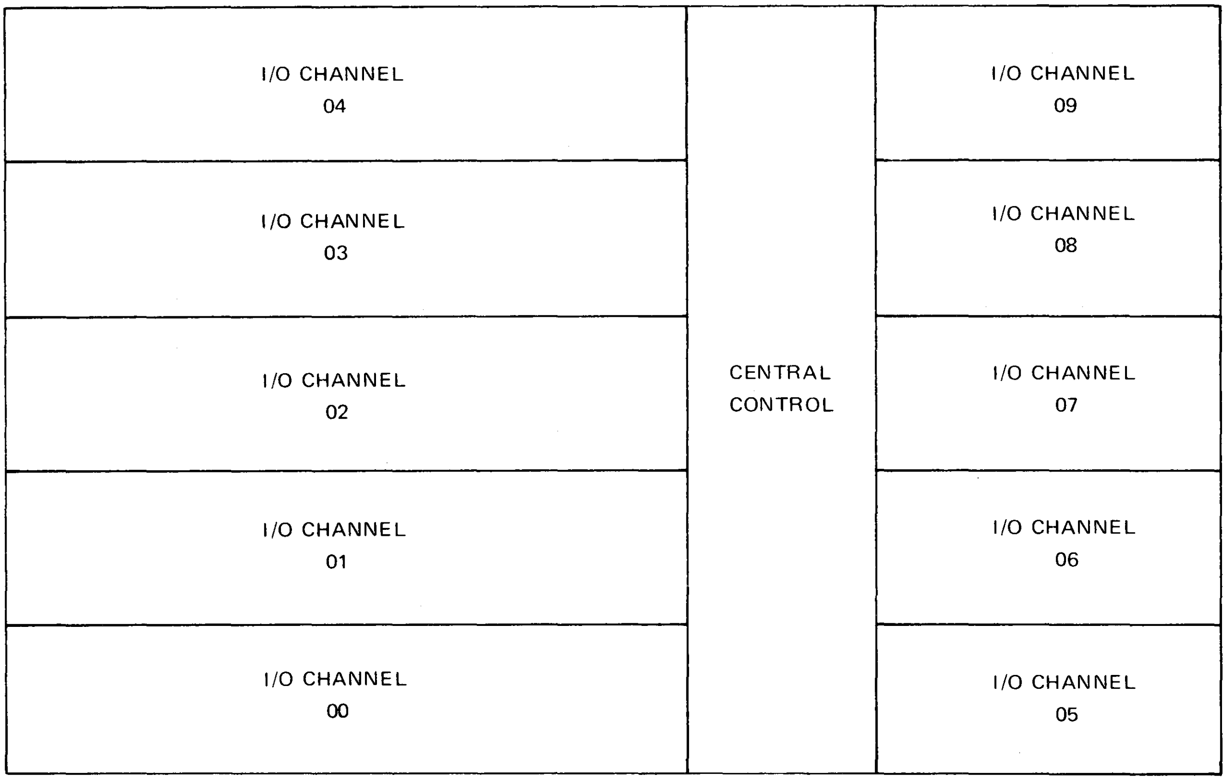

Figure 1-4. Three Cabinet System Peripheral Control Channel Configuration

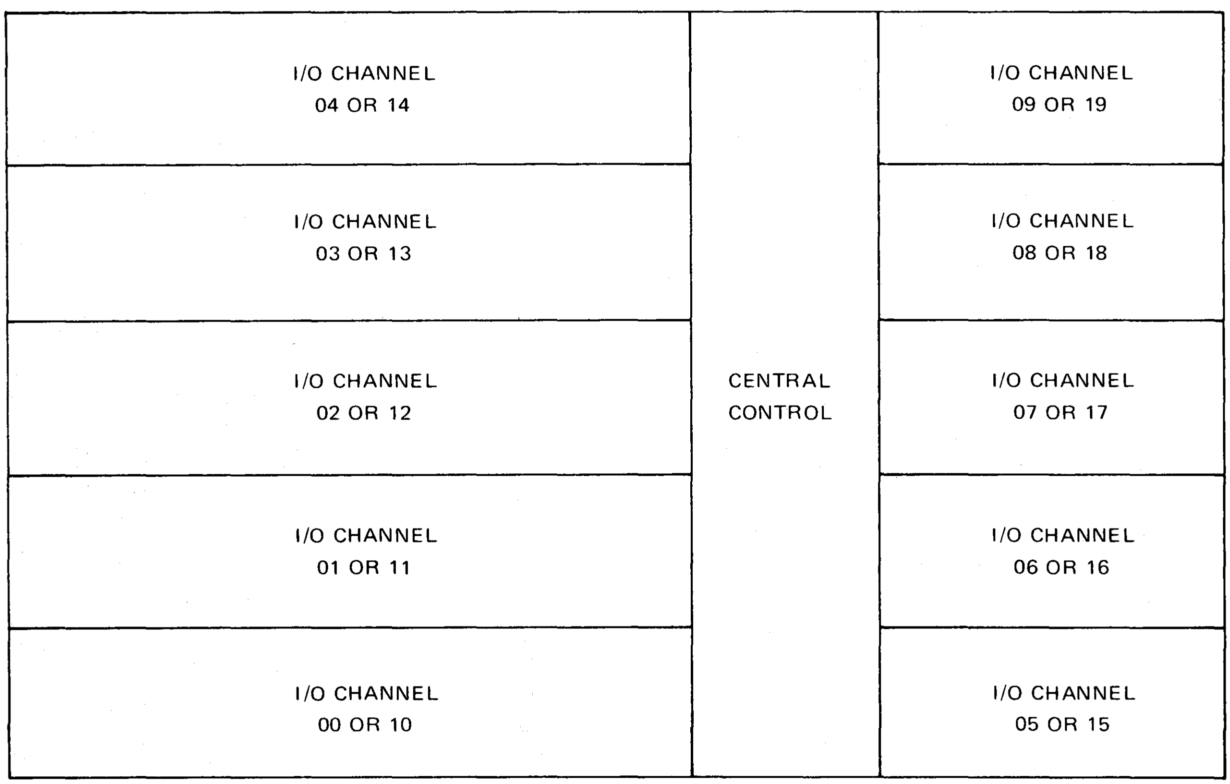

Figure 1-5. Three Cabinet System Peripheral Control Channel Configuration for Two Central Control Cabinets

If customer requirements dictate, the small 1 x 36 Type A controls can, with an adapter kit, be positioned into a large 1 x 85 Type B control channel.

The large number of peripheral control types available on the Medium Data Processing Systems make these systems extremely versatile.

Table 1-1, Peripheral Control Types, lists the various peripheral controls along with their associated types and type numbers. The numbers refer to controls utilized on the various systems. For example, B 4240 and B 4380-1 reflect controls utilized on the B 4700 Systems. B 3240 and B 3380-1 are used on the B 3700 systems.

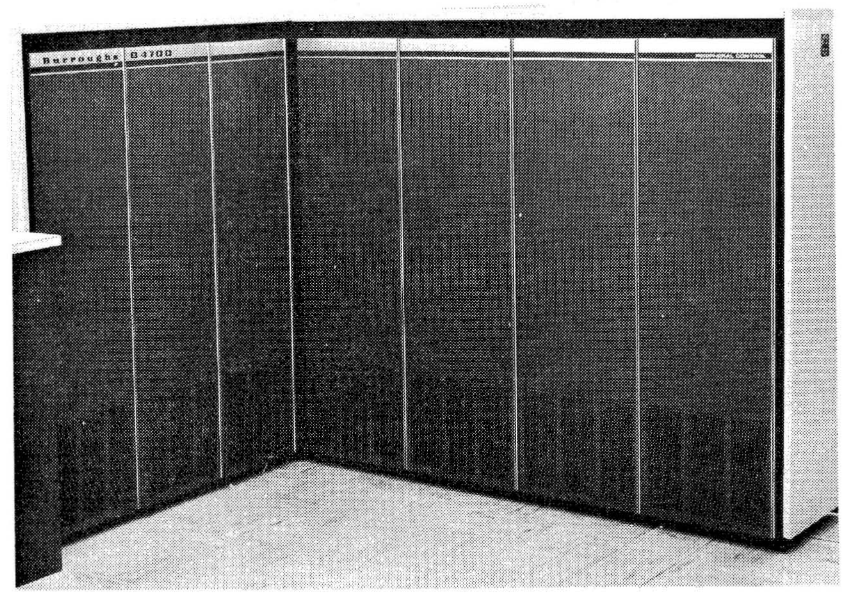

Figure 1-6. B 3700/B 4700 Central Control B Cabinets

Table 1-1. Peripheral Control Types

Control	Type	B 2500	B 3500	B 2700	B 3700	B 4700
Card Reader Control	(A) Small	B 2110	B 3110	B 2110-2	B 3110-2	B 4110
Card Punch Control	(A) Small	B 2212	B 3212	B 2212-2	B 3212-2	B 4212
Buffered Printer Control	(A) Small	B 2240	B 3240	B 2240-1	B 3240-1	B 4240
Unbuffered Printer Control	(A) Small	B 2242	B 3242	B 2242-1	B 3242-1	B 4242
Paper Tape Reader Control	(A) Small	B 2120	B 3120	B 2120-2	B 3120-2	B 4120
Paper Tape Punch Control	(A) Small	B 2220	B 3220	B 2220-2	B 3220	B 4220
Magnetic Tape Cluster Control	(B) Large					
9-Track NRZ		B 2381-11	B 3381-11	B 2381-21	B 3381-21	B 4381-11
9-Track PE		B 2381-12	B 3381-12	B 2381-22	B 3381-22	B 4381-12
9-Track Dual NRZ		B 2381-14	B 3381-14	B 2381-24	B 3381-24	B 4381-14
9-Track Dual PE		B 2381-15	B 3381-15	B 2381-25	B 3381-25	B 4381-15
9-Track Dual NRZ/PE		B 2381-16	B 3381-16	B 2381-26	B 3381-26	B 4381-16
7-Track Control Adapter		B 2680-1	B 3680-1	B 2680-1	B 3680-1	B 4680-1
Magnetic Tape Control 7-Track NRZ	(B) Large	B 2391-1 B 2391-3 B 2391-4	B 3391-1 B 3391-3 B 3391-4	B 2391-11 B 2391-13 B 2391-14	B 3391-11 B 3391-13 B 3391-14	B 4391-1 B 4391-3 B 4391-4
Magnetic Tape Control 9-Track NRZ	(B) Large	B 2393-1 B 2393-3	B 3393-1 B 3393-3	B 2393-11 B 2393-13	B 3393-11 B 3393-13	B 4393-1 B 4393-3
Magnetic Tape Control 9-Track PE	(B) Large (B) Large	B 2393-2	B 3393-2	B 2393-12	B 3393-12	B 4393-2 B 4395-5

Table 1-1. Peripheral Control Types (Cont)

Control	Type	B 2500	B 3500	B 2700	B 3700	B 4700
Disk File Controls:						
Systems Memory Control	(B) Large	B 2371	B 3371	B 2371-1	B 3371-1	B 4371
Disk File Control	(B) Large	B 2373	B 3373	B 2373-1	B 3373-1	B 4373
Combination Control	(B) Large	B 2375	B 3375	B 2375-1	B 3375-1	B 4375
Disk Pack Control:						
Single	(B) Large	B 2380-1	B 3380-1	B 2380-3	B 3380-1	B 4380-1
Dual	(B) Large	B 2380-2	B 3380-2	B 2380-2	B 3380-2	B 4380-2
Single						B 4383-1
Dual						B 4383-2
Reader Sorter:	(A) Small	B 2130	B 2130	B 2130-6	B 3130-6	B 4130
MICR	(A) Small	B 2130-1	B 3130	B 2130-7	B 3130-7	B 4130-1
OCR/MICR	(A) Small	B 2130-2	B 3130-2	B 2130-8	B 3130-8	B 4130-2
Tape Listers	(A) Small	B 2244	B 3244	B 2244-1	B 3244-1	B 4244
Supervisory Printer	(A) Small	B 2340	B 3340	B 2340-1	B 3340-1	B 4340
Data Communications:						
Data Communications Processor	(B) Large			B 2352	B 3352	B 4352
Single Line Control	(B) Large	B 2351	B 3351	B 2351-2	B 3351-2	B 4351
Multiline Control	(B) Large	B 2353	B 3353	B 2353-1	B 3353-1	B 4353
Terminal Control	(A) Small	B 2350-1	B 3350-1			

ADDRESS MEMORY

The address memory section of the Medium Data Processing Systems is a modular array of storage registers that share a common memory address register. The logic for address memory is located in the central processor cabinet of each of the systems. The primary use of these storage registers is to contain core memory addresses that are used by both the processor and the input/output channels.

The basic address memory provided with each system consists of 24 six-digit words as shown in figure 1-7. Eight of these words (1 through 8) are reserved for use by the processor while the remaining 16 words are utilized by eight input/output channels. The input/output section of address memory is grouped in consecutive word-pairs, that is, two words for each channel. Each of these six-digit words is of sufficient length to contain any absolute address within the core memory configuration.

The first word of the consecutive pair contains the begin address that indicates to the corresponding input/output channel the core memory address to be accessed for information during an input/output operation. The second word of the pair contains the end address that indicates the last core memory address available to the input/output channel.

Address Memory Extension

Since only eight address memory words are provided in the basic configuration of the systems, additional words are available if more input/output channels are required. Up to eight extensions, each containing 12 words, can be incorporated into the system for a total expansion of up to 120 words. This number provides address memory for the 20 maximum input/output channels and provides an area that is required for the multi-line control. Figure 1-7 illustrates the complete configuration layout of address memory. Eight of the words are required by the processor and 40 by the 20

PROCESSOR AND I/O CHANNEL ADDRESS MEMORY LOCATIONS

WD48	CHANNEL	19	E.A.	EXTENSION NO. 2
WD47	CHANNEL	19	B.A.	EXTENSION NO. 2
WD46	CHANNEL	18	E.A.	EXTENSION NO. 2
WD45	CHANNEL	18	B.A.	EXTENSION NO. 2
WD44	CHANNEL	17	E.A.	EXTENSION NO. 2
WD43	CHANNEL	17	B.A.	EXTENSION NO. 2
WD42	CHANNEL	16	E.A.	EXTENSION NO. 2
WD41	CHANNEL	16	B.A.	EXTENSION NO. 2
WD40	CHANNEL	15	E.A.	EXTENSION NO. 2
WD39	CHANNEL	15	B.A.	EXTENSION NO. 2
WD38	CHANNEL	14	E.A.	EXTENSION NO. 2
WD37	CHANNEL	14	B.A.	EXTENSION NO. 2
WD36	CHANNEL	13	E.A.	EXTENSION NO. 1
WD35	CHANNEL	13	B.A.	EXTENSION NO. 1
WD34	CHANNEL	12	E.A.	EXTENSION NO. 1
WD33	CHANNEL	12	B.A.	EXTENSION NO. 1
WD32	CHANNEL	11	E.A.	EXTENSION NO. 1
WD31	CHANNEL	11	B.A.	EXTENSION NO. 1
WD30	CHANNEL	10	E.A.	EXTENSION NO. 1
WD29	CHANNEL	10	B.A.	EXTENSION NO. 1
WD28	CHANNEL	09	E.A.	EXTENSION NO. 1
WD27	CHANNEL	09	B.A.	EXTENSION NO. 1
WD26	CHANNEL	08	E.A.	EXTENSION NO. 1
WD25	CHANNEL	08	B.A.	EXTENSION NO. 1
WD24	CHANNEL	07	E.A.	INPUT/OUTPUT CHANNEL USE
WD23	CHANNEL	07	B.A.	INPUT/OUTPUT CHANNEL USE
WD22	CHANNEL	06	E.A.	INPUT/OUTPUT CHANNEL USE
WD21	CHANNEL	06	B.A.	INPUT/OUTPUT CHANNEL USE
WD20	CHANNEL	05	E.A.	INPUT/OUTPUT CHANNEL USE
WD19	CHANNEL	05	B.A.	INPUT/OUTPUT CHANNEL USE
WD18	CHANNEL	04	E.A.	INPUT/OUTPUT CHANNEL USE
WD17	CHANNEL	04	B.A.	INPUT/OUTPUT CHANNEL USE
WD16	CHANNEL	03	E.A.	INPUT/OUTPUT CHANNEL USE
WD15	CHANNEL	03	B.A.	INPUT/OUTPUT CHANNEL USE
WD14	CHANNEL	02	E.A.	INPUT/OUTPUT CHANNEL USE
WD13	CHANNEL	02	B.A.	INPUT/OUTPUT CHANNEL USE
WD12	CHANNEL	01	E.A.	INPUT/OUTPUT CHANNEL USE
WD11	CHANNEL	01	B.A.	INPUT/OUTPUT CHANNEL USE
WD10	CHANNEL	00	E.A.	INPUT/OUTPUT CHANNEL USE
WD09	CHANNEL	00	B.A.	INPUT/OUTPUT CHANNEL USE
WD08	SECOND TIMER WORD			PROC. LOGIC USE
WD07	FIRST TIMER WORD			PROC. LOGIC USE
WD06				PROC. LOGIC USE
WD05	D1 8 4 2 1, D2 8 4 2 1, D3 8 4 2 1, D4 8 4 2 1, D5 8 4 2 1, D6 8 4 2 1			PROC. LOGIC USE
WD04				PROC. LOGIC USE
WD03	INSTRUCTION C ADDR.			PROC. LOGIC USE
WD02	INSTRUCTION B ADDR.			PROC. LOGIC USE
WD01	INSTRUCTION A ADDR.			PROC. LOGIC USE

MULTILINE EXTENSION ADDRESS MEMORY ADAPTER LOCATIONS

WD84	ADAPTER	37	E.A.	EXTENSION NO. 5	WD120	ADAPTER	55	E.A.	EXTENSION NO. 8
WD83	ADAPTER	37	B.A.	EXTENSION NO. 5	WD119	ADAPTER	55	B.A.	EXTENSION NO. 8
WD82	ADAPTER	36	E.A.	EXTENSION NO. 5	WD118	ADAPTER	54	E.A.	EXTENSION NO. 8
WD81	ADAPTER	36	B.A.	EXTENSION NO. 5	WD117	ADAPTER	54	B.A.	EXTENSION NO. 8
WD80	ADAPTER	35	E.A.	EXTENSION NO. 5	WD116	ADAPTER	53	E.A.	EXTENSION NO. 8
WD79	ADAPTER	35	B.A.	EXTENSION NO. 5	WD115	ADAPTER	53	B.A.	EXTENSION NO. 8
WD78	ADAPTER	34	E.A.	EXTENSION NO. 5	WD114	ADAPTER	52	E.A.	EXTENSION NO. 8
WD77	ADAPTER	34	B.A.	EXTENSION NO. 5	WD113	ADAPTER	52	B.A.	EXTENSION NO. 8
WD76	ADAPTER	33	E.A.	EXTENSION NO. 5	WD112	ADAPTER	51	E.A.	EXTENSION NO. 8
WD75	ADAPTER	33	B.A.	EXTENSION NO. 5	WD111	ADAPTER	51	B.A.	EXTENSION NO. 8
WD74	ADAPTER	32	E.A.	EXTENSION NO. 5	WD110	ADAPTER	50	E.A.	EXTENSION NO. 8
WD73	ADAPTER	32	B.A.	EXTENSION NO. 5	WD109	ADAPTER	50	B.A.	EXTENSION NO. 8
WD72	ADAPTER	31	E.A.	EXTENSION NO. 4	WD108	ADAPTER	49	E.A.	EXTENSION NO. 7
WD71	ADAPTER	31	B.A.	EXTENSION NO. 4	WD107	ADAPTER	49	B.A.	EXTENSION NO. 7
WD70	ADAPTER	30	E.A.	EXTENSION NO. 4	WD106	ADAPTER	48	E.A.	EXTENSION NO. 7
WD69	ADAPTER	30	B.A.	EXTENSION NO. 4	WD105	ADAPTER	48	B.A.	EXTENSION NO. 7
WD68	ADAPTER	29	E.A.	EXTENSION NO. 4	WD104	ADAPTER	47	E.A.	EXTENSION NO. 7
WD67	ADAPTER	29	B.A.	EXTENSION NO. 4	WD103	ADAPTER	47	B.A.	EXTENSION NO. 7
WD66	ADAPTER	28	E.A.	EXTENSION NO. 4	WD102	ADAPTER	46	E.A.	EXTENSION NO. 7
WD65	ADAPTER	28	B.A.	EXTENSION NO. 4	WD101	ADAPTER	46	B.A.	EXTENSION NO. 7
WD64	ADAPTER	27	E.A.	EXTENSION NO. 4	WD100	ADAPTER	45	E.A.	EXTENSION NO. 7
WD63	ADAPTER	27	B.A.	EXTENSION NO. 4	WD99	ADAPTER	45	B.A.	EXTENSION NO. 7
WD62	ADAPTER	26	E.A.	EXTENSION NO. 4	WD98	ADAPTER	44	E.A.	EXTENSION NO. 7
WD61	ADAPTER	26	B.A.	EXTENSION NO. 4	WD97	ADAPTER	44	B.A.	EXTENSION NO. 7
WD60	ADAPTER	25	E.A.	EXTENSION NO. 3	WD96	ADAPTER	43	E.A.	EXTENSION NO. 6
WD59	ADAPTER	25	B.A.	EXTENSION NO. 3	WD95	ADAPTER	43	B.A.	EXTENSION NO. 6
WD58	ADAPTER	24	E.A.	EXTENSION NO. 3	WD94	ADAPTER	42	E.A.	EXTENSION NO. 6
WD57	ADAPTER	24	B.A.	EXTENSION NO. 3	WD93	ADAPTER	42	B.A.	EXTENSION NO. 6
WD56	ADAPTER	23	E.A.	EXTENSION NO. 3	WD92	ADAPTER	41	E.A.	EXTENSION NO. 6
WD55	ADAPTER	23	B.A.	EXTENSION NO. 3	WD91	ADAPTER	41	B.A.	EXTENSION NO. 6
WD54	ADAPTER	22	E.A.	EXTENSION NO. 3	WD90	ADAPTER	40	E.A.	EXTENSION NO. 6
WD53	ADAPTER	22	B.A.	EXTENSION NO. 3	WD89	ADAPTER	40	B.A.	EXTENSION NO. 6
WD52	ADAPTER	21	E.A.	EXTENSION NO. 3	WD88	ADAPTER	39	E.A.	EXTENSION NO. 6
WD51	ADAPTER	21	B.A.	EXTENSION NO. 3	WD87	ADAPTER	39	B.A.	EXTENSION NO. 6
WD50	ADAPTER	20	E.A.	EXTENSION NO. 3	WD86	ADAPTER	38	E.A.	EXTENSION NO. 6
WD49	ADAPTER	20	B.A.	EXTENSION NO. 3	WD85	ADAPTER	38	B.A.	EXTENSION NO. 6

Figure 1-7. Address Memory Configuration

maximum input/output channels available on the largest systems. The remaining 72 address memory words (49 through 120) are reserved for the multi-line adapters of the data communications system.

Address Memory Limitations

Several limitations and requirements in assigning groups of address memory must be observed. The following is a list of these limitations:

a. Of the standard 24 words provided by the system, 12 of these words must be assigned to positions 1 through 12 as shown in figure 1-7. The second group of 12 and all 12-word extensions are assigned to other positions equal to 1 through 12, modulo 12 (that is, positions 13 through 24, 25 through 36, 37 through 48, etc.).

b. When Central Control B cabinets are used in the system configuration, words 9 through 12 (figure 1-7) are assigned to the two lower B channels in the first Central Control B cabinet. Words 13 through 24 are assigned to the three upper B channels and the three lower A channels in the first Central Control B cabinet. Words 25 through 36 are assigned to the two upper A channels in the first Central Control B cabinet and to the four lower B channels in the second Central Control B cabinet. Words 37 through 48 are assigned to the remaining B channel and the five A channels in the second Central Control B cabinet.

c. Words 49 through 120 are allocated for multi-line adapters.

d. When the central control and memory base cabinet is used in the system configuration, the initial 24 words must be assigned to positions 1 through 24. Words 9 through 12 (figure 1-7) are assigned to the two lower B channels, and words 13 through 20 are assigned to the remaining B channel and the three A channels.

THREE CABINET BASIC SYSTEM INTERFACE

Figure 1-8 illustrates the interfacing logic lines that interconnect the various cabinets comprising the three cabinet basic system. Logic levels

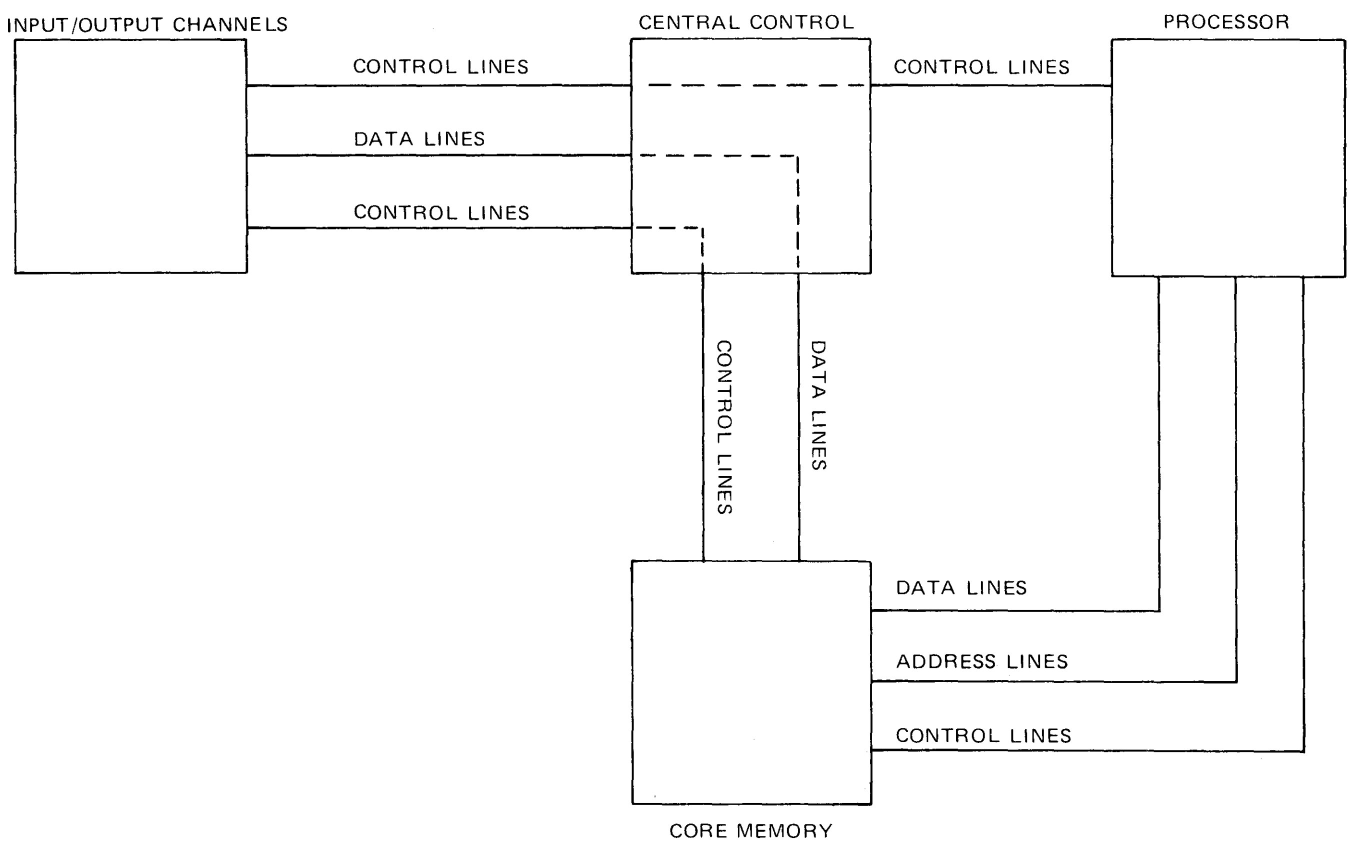

Figure 1-8. Three Cabinet Basic System Interface

are generated in each of the input/output channels and are then sent to be combined with central control logic. From central control these levels are distributed to either the processor or the core memory cabinet. There are also logic levels which are generated within the processor and core memory cabinets. These levels are then routed over the interfacing lines to the central control where they are distributed to the individual input/output channels. Logic levels (figure 1-8), are never passed directly between the input/output channels and the processor.

B 3700/B 4700 INTERFACE

Figure 1-9 illustrates the interfacing logic lines that interconnect the various cabinets comprising the B 3700/B 4700 Data Processing Systems. Logic levels are generated in each of the input/output channels and are then sent to the peripheral control through interframe jumpers. From the peripheral control, these levels are routed to the processor cabinet and from there to the core memory cabinet. Logic levels are also generated by the core memory and the processor. These levels are routed from the processor, over the interfacing lines, to the peripheral control where they are distributed, through interframe jumpers, to the individual input/output channels.

INPUT/OUTPUT (I/O) DESCRIPTOR

The input/output (I/O) area of all Medium Data Processing Systems consists of the input/output channels and their associated exchanges and the peripheral units. Although the initiation on any specified input/output operation is accomplished by the processor, it is the input/output control that controls the executing operations.

The input/output operation can be executed simultaneously with a concurrent processor operation and a previously initiated input/output operation on other input/output channels.

The type of input/output operation to take place (i.e., read, write, etc.) is obtained by the input/output descriptor that is transferred to the input/output control during the initiation by the processor.

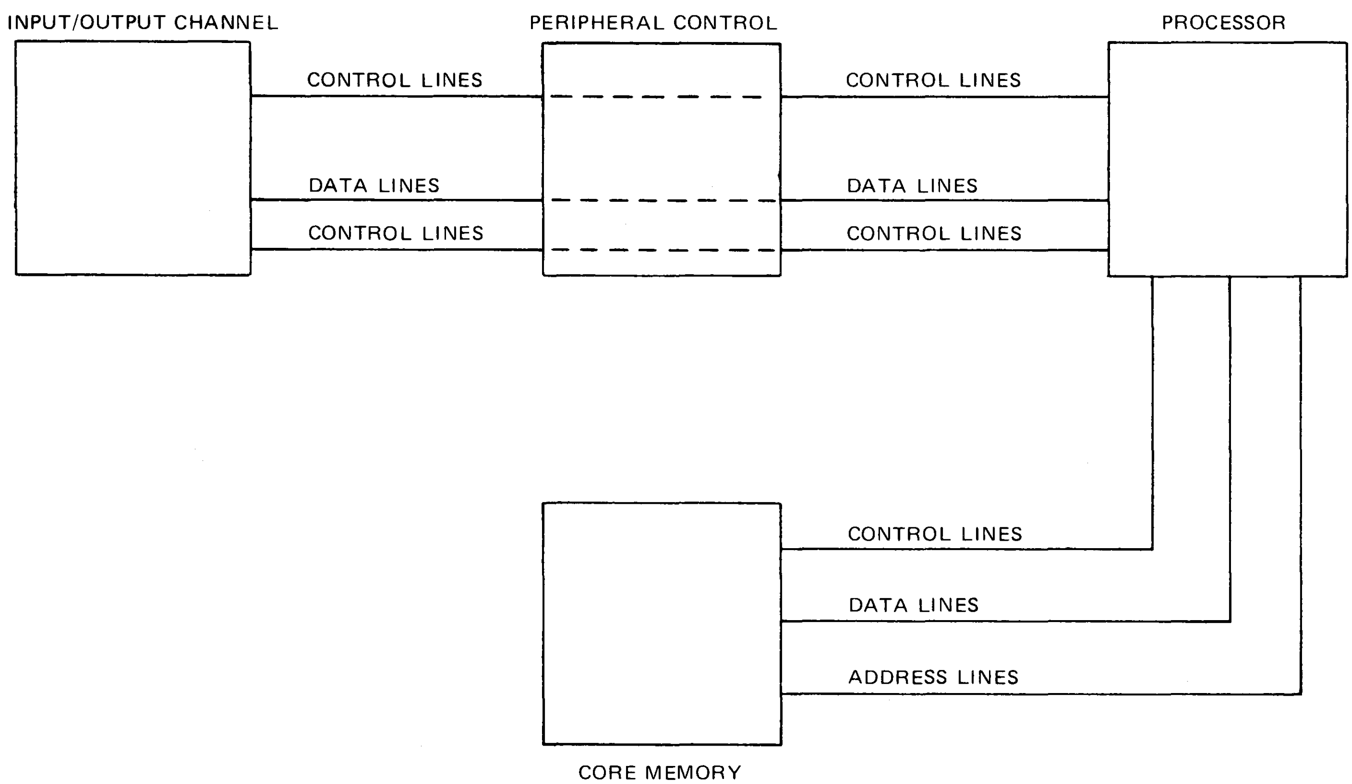

Figure 1-9. B 3700/B 4700 Interface

As an input/output operation is initiated by the processor, the specified control receives and stores the I/O descriptor. This control then executes the desired operation as outlined by the configuration of the I/O descriptor.

The I/O descriptor consists of a variable number of six-digit syllables. Depending upon the required input/output operation, most descriptors contain from one to three syllables.

Descriptor Format

The format for the I/O descriptor is shown in figure 1-10. Digits D1 and D2, located within syllable 1, always specify the type of input/output operation to be performed. Digits D3 through D6, also located within syllable 1, are referred to as variant digits in that they specify what the various options the specific input/output operations can incorporate.

Syllable 2 contains the address of the most significant digit (MSD) of the input or output core memory buffer area. This buffer is referred to as the beginning address (see figure 1-10) and must be synchronized as modulo-4. It must begin at a word boundary.

Syllable 3 contains the address of the least significant digit plus 1 (LSD+1) of the input or output core memory buffer area. This buffer area is referred to as the ending address (see figure 1-10) and is actually the address of the first digit in the field immediately following this buffer area. This ending address must be synchronized modulo-2 (even) for all I/O descriptors except for the magnetic tape, the disk file, the reader sorter and the lister controls, which require modulo-4 synchronization since word transfer is required.

The most significant address and the least significant address plus 1 represent the maximum memory boundary limits of a record being transmitted. The length of the record may or may not utilize the entire area within this limit. But, an attempt to exceed this limit causes termination of data transmission to that area. For

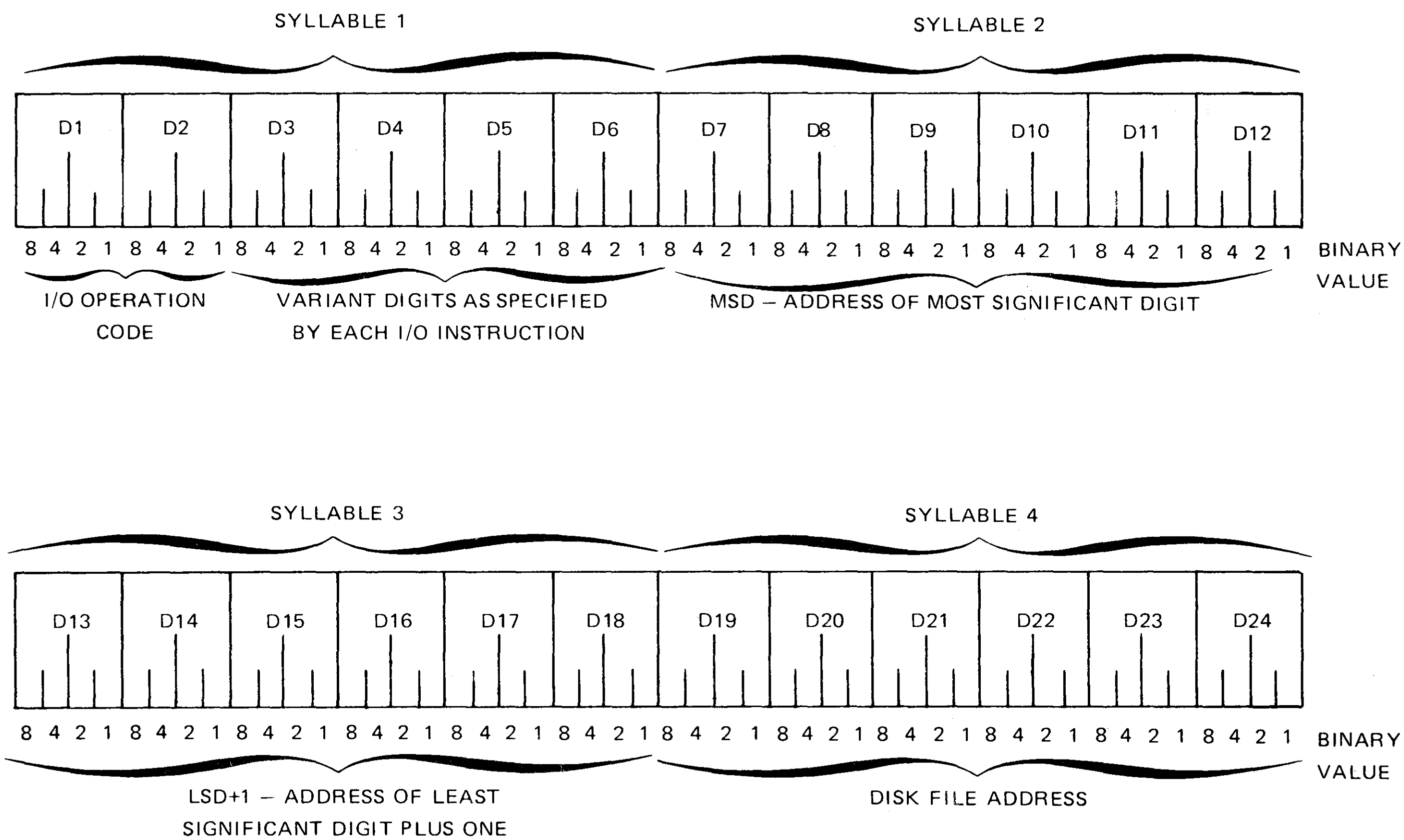

Figure 1-10. I/O Descriptor Syllable Format

instance, punch cards may be read into an area greater than 80 characters (i.e., with an MSD and LSD+1 greater than 80 characters apart), or they may be read into an area of less than 80 characters. For example, the record area defined in a particular object program reflects 40 characters in a card reader record. Data within columns 1 through 40 of the punch card are stored in the record area of core memory allocated by MSD and LSD+1. Although the card reader continues to read columns 41 through 80, data within these columns is inhibited from entering core memory. This feature prevents other record areas from being overwritten and destroyed by the extra data and allows for conservation of core memory buffer area allocations.

Syllable 4 is used only for disk file descriptors and contains the disk address.

INPUT/OUTPUT CONTROLS AND DESCRIPTORS

The following is a description of the various controls and associated I/O descriptors utilized within Medium Data Processing Systems.

Card Reader Control

The card reader I/O control executes the card reader I/O descriptors as initiated by the processor. Card reading is terminated by reaching the ending address, or when 80 columns of information have been transferred to main memory. The control automatically supplies blanks in the case of short (incomplete) cards that, unless terminated by the ending address, are stored in core memory.

The card reader control signals the central control or the processor (depending on the Medium Data Processing System) to automatically translate BCL code, used within the control, to EBCDIC code used within the remainder of the system. As one BCL character is received from one card column of the punched card, one 8-bit EBCDIC character is stored in core memory.

When reading EBCDIC code, 256 card-hole combinations are valid, including the combination for the EBCDIC ? character. When reading BCL code, 63 card-hole combinations are valid, excluding the combination for the BCL ? character.

Card Reader I/O Descriptors

The various card reader descriptors are shown in table 1-2. The following is a description of each of the descriptors.

CARD READ BCL

A card is read into ascending memory locations beginning with the location specified by the A address (digits 7 through 12) and continuing to, but not including, the terminal location specified by the B address (digits 13 through

Table 1-2. Card Reader I/O Descriptors

Operation	Op Code	Digits 3-6	Digits 7-12	Digits 13-18	Digits 19-24
Card Read BCL	20	RRRR	Begin	End	
Card Read Binary	21	RRRR	Begin	End	
Card Read EBCDIC	22	RRRR	Begin	End	
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			
R denotes bit positions reserved for future expansion.					

18). The contents of each card column occupies one alpha-numeric character position in core memory.

CARD READ BINARY

A card is read into ascending core memory locations beginning with the location specified by the A address and continuing to, but not including, the location specified by the B address. The contents of each card column are divided into two 6-bit characters. The upper 6-bit character is stored in the memory location specified by the A address. The lower 6-bit character is stored in the memory location specified by the A address plus 2, and so forth, for each column. The unassigned high-order bits of each 8-bit character are cleared during this operation.

CARD READ EBCDIC

A card is read into ascending core memory locations beginning with the location specified by the A address and continuing to, but not including, the terminal location specified by the B address. The contents of each card column occupies one alphanumeric 8-bit character position in core memory.

INPUT REQUEST ENABLE

When the control is able to receive data from the card reader, the control returns a result descriptor indicating that an operation is complete, the card reader is ready, and the START pushbutton on the card reader is depressed.

INPUT REQUEST DISABLE

This descriptor makes the control insensitive to any condition the card reader may present.

TEST

This descriptor returns a result descriptor, indicating that the test operation is complete and the card reader is ready (operation complete), or the card reader is not ready (operation not complete or exception), as appropriate.

Card Punch Control

The card punch I/O control executes card punch I/O descriptors and contains an EBCDIC/EBCDIC card-code translator required to translate card-code EBCDIC to INTERNAL EBCDIC. The card punch control can signal the central control or the processor (depending on the Medium Data Processing System) to automatically translate EBCDIC to BCL when transferring data from core memory to the input/output control. The Input/output control contains one and only one of the following translators in addition to the standard EBCDIC/EBCDIC card-code translator:

a. BCL/ITC card code.

b. BCL/BULL card code.

c. BCL/BCL card code.

Information is transferred to the punch from the control bit-serially for each punch position, with 12 separate 80 bit-serial transfers to the punch to punch a complete card. Transfer of a given row within a card consists of 40 bit-pairs of information.

To allow punching to be terminated from a desired column of a card to the end of that card, two codes are provided: one in EBCDIC and one in Binary as follows:

Card Code	Code
EBCDIC	1100 1111 (CF)
Binary	1XXXXXX (X represents any value)

Bit information that is required by a card that is terminated at any area other than at column 80 is supplied by the I/O control. When required, by the use of an object program, the control is capable of punching binary information. When a punch check, access, or memory error is detected during the punching of a card, the punching of that card is completed and the next card is punched. Both cards are sent to the error stacker and the card punch remains in the ready condition.

Card Punch I/O Descriptors

The various card punch descriptors are shown in table 1-3. Programmatic stacker selection is accomplished by the value of S in descriptor position D3. The stacker selection also depends upon the type of card punch being utilized. The B 9210 has one stacker to which all cards are

Table 1-3. Card Punch I/O Descriptors

Operation	Op Code	Digits 3 -6	Digits 7-12	Digits 13-18	Digits 19-24
Card Punch BCL	23	SRRR	Begin		
Card Punch Binary	24	SRRR	Begin		
Card Punch EBCDIC	25	SRRR	Begin		
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			
S denotes stacker values.					
R denotes bit positions reserved for future expansion.					

routed regardless of the value of S, or whether or not a punch-detected error exists. The error stacker of the B 9211, B 9212, and B 9213 receives cards only as a result of a punch-detected error. For these three card punch units values of S equal to 0 or 2 cause cards to be routed to the normal stacker while an S value of 1 routes cards to the auxiliary stacker as shown below:

Value of D3	Action
0	Normal stacker for all card punches.
1	Normal stacker for B 9210 or auxiliary stacker for B 9211, B 9212, and B 9213.
2	Normal stacker for B 9210 and B 9211 or error stacker for B 9212 and B 9213.

The error stacker is also selected by the control when an error is detected. The following paragraphs describe each descriptor.

CARD PUNCH BCL

A card is punched from ascending memory locations beginning with the location specified by the A address. Punching is terminated by the EBCDIC code 1100 1111 (CF) or the punching of 80 columns. During punching, the BCL/BCL translator (which is in reality a EBCDIC to BCL) is enabled and one of the three optional card-code translators is required to complete the data transfer.

CARD PUNCH BINARY

A card is punched from ascending memory locations beginning with the location specified by the A address. Punching is terminated by the code 1XXXXXX (X represents any value) or the punching of 80 columns. The contents of each card column are divided into two 6-bit characters. The upper 6-bit character is accessed from the memory location specified by the A address. The lower 6-bit character is accessed from the location specified by the A address plus 2, and so forth, for each column. The two high-order bits of each 8-bit character are not used except as a delimiter and must otherwise be set to zero.

CARD PUNCH EBCDIC

A card is punched from ascending memory locations beginning with the location specified by the A address. One column is punched for each EBCDIC character, and 80 columns are always punched. If the data that is to be punched is of a quantity insufficient to fill the entire 80 columns, blanks must be used to fill the remaining space in memory.

INPUT REQUEST ENABLE

When the control is able to receive data from the card punch, the control returns a result descriptor indicating that an operation is complete and the card punch is ready.

INPUT REQUEST DISABLE

This descriptor makes the control insensitive to any condition the card punch may present.

TEST

A result descriptor is returned indicating a completed operation (operation complete and no punch checks), a not ready condition, or a punch check, as appropriate.

Buffered Line Printer Control

The buffered line printer control executes I/O operations on the buffered printer. It signals the central control or the processor (depending on the Medium Data Processing System) to automatically translate EBCDIC to BCL information as it is transferred from core memory to the buffered line printer control. The EBCDIC code 1100 1111 (CF) in the data stream is translated by the EBCDIC/BCL translator to 1000 0000 (hexadecimal 80). When the buffered printer control detects code 80, memory accesses are terminated and the remaining positions in the printer buffer are filled with blanks.

The buffered printer control contains a one-character buffer which receives information from core memory a character at a time and transfers information to the line printer a character at a time. At the time the buffer within the buffered line printer is full, transfer or paper motion takes place. The control is capable of loading the printer buffer while paper motion is occurring in response to a previous descriptor. After this paper motion is completed, the printer can print the information in the buffer.

Unbuffered Line Printer Control

The unbuffered line printer control executes I/O operations on the unbuffered line printer. It signals the central control or the processor (depending on the Medium Data Processing System) to automatically translate EBCDIC to BCL information as it is transferred from core memory to the unbuffered line printer control. The EBCDIC code 1100 1111 (CF) in the data stream is translated by the EBCDIC/BCL translator to 1000 0000 (hexadecimal 80). When the unbuffered printer control detects code 80, memory accesses are terminated and the remaining positions in the line of print are left blank.

The unbuffered line printer control contains a two-character buffer which receives information from core memory, through the translator, two characters at a time. The control transfers information bit-serially to the column storage latches in the unbuffered printer, one bit for each column. These bits are then returned to the control to determine whether or not they have been received by the printer. If the returned bits do not compare with those transmitted, a bit transfer error exists. The control transfers information bit-serially to the printer column buffer for each comparison. A 1 bit indicates a true comparison and a 0 bit indicates a false comparison. The printer must receive this comparison information for all columns.

Overprinting shall not occur and replicated sets of graphics are not acceptable. The control requires that 64 unique codes, which provide positioning information, be received from the printer during each drum revolution. A counter, required to keep count of the number of graphics remaining to be printed, is contained in the control. The initial count of this counter is a function of the number of positions on the drum. The length of the printed line is a function of the delimiter code 1100 1111 (CF) in the data stream. The code for blanks in the data stream is EBCDIC code 0100 0000 (40).

The printer control incorporates a quick-release feature that terminates data scanning and enables paper motion as soon as all nonblank characters are printed, thus gaining absolute speed over short lines of print.

Line Printer I/O Descriptors

The I/O descriptors, as used on both the buffered and unbuffered line printers, are shown in table 1-4. The descriptors are explained in the following paragraphs.

Table 1-4. Line Printer I/O Descriptors

Operation	Op Code	Digits 3-6	Digits 7-12	Digits 13 - 18	Digits 19 - 24
Printer Write	10	SUNN	Begin		
Printer Skip	11	SUNN			
Input Request Enable	35	RURR			
Input Request Disable	97	RRRR			
Test	99	RURR			

R denotes bit positions reserved for future expansion.

S denotes spacing requirements.

U denotes the unit number.

N denotes the skip-to-channel number in the carriage-control tape.

PRINTER WRITE

A line of data is printed from ascending memory locations beginning with the location specfied by the A address. The length of the printed line is determined by the EBCDIC delimiter code 1100 1111 (CF) in the data stream or by the number of printer columns, either 120 or 132, whichever is encountered first. Spacing or skipping as specified by descriptor digits D3, D5, and D6 takes place after printing, and skipping takes precedence over spacing. Print characters that are not assigned a bit code are translated as the EBCDIC ? character. Coding for the variant digits D3, D4, D5, and D6 is as follows:

Digit	Value	Operation
D3	0	No space
D3	1	Single space
D3	2	Double space
D4	-	Not used
D5 and D6	00	No skip
D5 and D6	01 through 11	Skip to channel nn (determined by 01 through 11)

PRINTER SKIP

The number of lines specified by the variant digits D3, D5, and D6 are spaced. The variant digit coding is the same as that outlined for the printer write. Skipping takes precedence over spacing.

INPUT REQUEST ENABLE

The control returns a result descriptor indicating that the operation is complete and that the printer is ready.

INPUT REQUEST DISABLE

The control is made insensitive to any condition the printer may present.

TEST

A result descriptor is returned indicating that the operation is complete (the printer is ready) or that the printer is not ready, as appropriate.

Paper Tape Punch Control

The paper tape punch control can fetch one character per memory access. BCL codes are transferred from the I/O control to the paper tape punch, one character at a time. Within the

Table 1-5. Paper Tape Punch I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Paper Tape Write	48	RRVR	Begin	End	
Paper Tape Punch Leader	49	RRRR	Begin	End	
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			

V indicates a variant of the Op Code.

R denotes bit positions reserved for future expansion.

paper tape punch, a code translator permits the translation of BCL to a single frame code by means of a removable plugboard. By use of this plugboard, Teletype codes can also be translated. An optional output code translator is available that provides the versatility of translating BCL code to any 5-, 6-, 7-, or 8-channel paper tape punch code.

Paper Tape Punch I/O Descriptors

The various paper tape punch descriptors are shown in table 1-5.

PAPER TAPE WRITE

A record is punched on the paper tape punch from ascending memory locations beginning at the location specified by the A address and continuing to, but not including, the terminal address specified by the B address. Digit 5 is a variant digit with two operational values (1 and 2) that are described as follows:

Digit 5 Value	Description
1	If the variant digit contains a value of 1, the EBCDIC/BCL translator is enabled. The I/O control terminates the operation when the delimiter code (1000 0000) is detected. This code is not sent to the paper tape punch. The seventh bit from memory is ignored, forced to zero, and an even parity bit is sent on the eighth line. The BCL/BCL translator is enabled to complete the data transfer.
2	If the variant digit contains a value of 2, the I/O control sends all eight bits received from memory to the paper tape punch. Parity is neither generated nor sent to the paper tape punch.

PAPER TAPE PUNCH LEADER

A record consisting of all holes is punched on the paper tape punch. The number of these characters is determined by the A and B addresses.

INPUT REQUEST ENABLE

The paper tape punch control returns a result descriptor indicating that the operation is complete and the paper tape punch is ready.

INPUT REQUEST DISABLE

The paper tape punch control is made insensitive to any condition that the paper tape punch may present.

TEST

The status of the designated paper tape punch is tested and a result descriptor is returned.

Paper Tape Reader Control

The paper tape reader control can store one character per memory access. BCL codes are transferred from the paper tape reader to the paper tape reader control one character at a time. An optional code translator is available that provides the versatility of translating BCL code to any 5-, 6-, 7-, or 8-level code.

Paper Tape Reader I/O Descriptors

The various paper tape reader descriptors are shown in table 1-6.

PAPER TAPE READ

A record is read from the paper tape reader into ascending memory locations beginning at the locations specified by the A address and continuing to, but not including, the terminal address specified by the B address. Digit 5 is a variant digit with three operational values (0, 1, and 2) that are described as follows:

Digit 5 Value	Description
0	If the variant digit contains a value of 0, only the least significant seven bits of the eight bits received from the paper tape reader, together with the high-order zero bit, are stored in memory. The parity error line from the paper tape reader is monitored.
1	If the variant digit contains a value of 1, the eight bits received from the paper tape reader are transferred to memory through the BCL/EBCDIC translator. However, the translator ignores the two most significant bits. The parity error line from the paper tape reader is monitored and the BCL paper tape code/BCL code in the reader is enabled.
2	If the variant digit contains a value of 2, the eight bits received from the paper tape reader are transferred to memory. The parity error line from the reader is ignored.

PAPER TAPE SPACE

The paper tape is spaced forward the number of characters specified by the A and B addresses unless terminated by the end-of-tape condition. This I/O descriptor requires no memory space.

Table 1-6. Paper Tape Reader I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Paper Tape Read	40	RRVR	Begin	End	
Paper Tape Space	41	RRRR	Begin	End	
Paper Tape Backspace	43	RRRR	Begin	End	
Paper Tape Rewind	47	RRRR			
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			

V indicates a variant of the Op Code.

R denotes bit positions reserved for future expansion.

PAPER TAPE BACKSPACE

The paper tape is backspaced the number of characters specified by the A and B addresses unless terminated by the beginning-of-tape condition. This I/O descriptor requires no memory space.

PAPER TAPE REWIND

The paper tape is rewound to the beginning of tape.

INPUT REQUEST ENABLE

The paper tape reader control returns a result descriptor that indicates the operation is complete and that the paper tape reader is ready.

INPUT REQUEST DISABLE

The paper tape reader control is made insensitive to any condition that the paper tape reader may present.

TEST

The status of the designated paper tape reader is tested and a result descriptor is returned.

Console Printer Control

The console printer control (supervisory printer) is used to control the supervisory printer (SPO) unit. The control contains a bidirectional translator that translates from EBCDIC to USASCII code. All USASCII codes received from the console printer unit that have no equivalent EBCDIC code become the NULL code (0000 0000). Similarly, all EBCDIC codes sent to the console printer that have no equivalent USASCII code become the USASCII code 1011 1111 (BF), which represents the USASCII question mark.

Information between the console printer and the console printer control is transferred bit-serially, whereas information between the console printer control and core memory is transferred a character at a time.

Console Printer I/O Descriptors

The various console printer I/O descriptors are shown in table 1-7.

READ

Upon receipt of a read descriptor, the console printer automatically generates a signal to await an input message from the system operator. The message being typed onto the keyboard is read into ascending core memory locations beginning with the location specified by the A address and continuing until the end-of-text (EXT) code is detected, but is not to extend beyond the terminal address specified by the B address. The USASCII EXT code is 1000 0011 (83).

WRITE

A message is typed onto the console printer from ascending memory locations beginning with the location specified by the A address and continuing until the EXT code is detected, but is not to extend beyond the terminal address specified by the B address.

Table 1-7. Console Printer I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Read	32	RRRR	Begin	End	
Write	34	RRRR	Begin	End	
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			
R denotes bit positions reserved for future expansion.					

INPUT REQUEST ENABLE

This descriptor is valid only if the console printer unit is idle, that is, its reading and writing operations are not in progress. The console printer control is sensitive to the USASCII enquiry (ENQ) code from the keyboard. This code is 1000 0101 (85). When the control receives this code, a result descriptor is generated and the interrupt flip-flop is set. The ENQ character is not stored in memory.

INPUT REQUEST DISABLE

This descriptor is valid only if the console printer control is input-request-enabled. The control is made insensitive to any input from the keyboard, that is, the control is placed in an idle state.

TEST

A result descriptor is returned to indicate that the operation is complete.

Reader Sorter Controls

Three types of reader sorter controls are utilized on the Medium Data Processing Systems: the sorter reader control, the reader sorter control II, and the reader sorter control III. Each control is described in the paragraphs that follow.

SORTER READER CONTROL

The sorter reader control is designed to interface to the B 100 series of reader sorter peripheral units. This control is capable of reading documents encoded in E-13B or CMC-7 MICR (Magnetic Ink Character Recognition) code, with a single read head, and sorting these documents into either a 13 or 16 pocket array.

The information transferred from the reader sorter unit to the sorter reader control is in a 4-bit binary code. Therefore, in order for this information to be stored in memory, it must first be translated into 8-bit EBCDIC code. Refer to table 1-8.

Although the maximum number of readable MICR characters on a single document is less than 60, 100 character spaces (200 digits) of memory must be allocated for a storage field. This field is referred to as the input buffer. Blank characters (EBCDIC code 0100 0000) are inserted in the information flow after the last character to fill the 100 character input buffer.

The sorter reader control utilizes non-revolving or non-alternating input buffering (the two terms are synonomous). As information is read from each document in the reader sorter unit, it is placed in memory within the input buffer. From this location, the information awaits positioning into the final memory address location specified by the B address in the I/O descriptor. Once placed into the final memory location, the information from the next document is placed into the same input buffer and the procedure repeats itself.

READER SORTER CONTROL II

Reader sorter control II is designed to interface to the B 9134 series of reader sorter peripheral units. This control is capable of reading documents encoded in E-13B or CMC-7 MICR code, with a single read head, and sorting these documents into a 4 through 32 pocket array.

Information transferred from the reader sorter unit to the reader sorter control is in a 4-bit binary code. Therefore, in order for this information to be stored in memory, it must first be transferred into 8-bit EBCDIC code. Refer to table 1-8.

Reader sorter control II utilizes both non-alternating and alternating input buffering. The non-alternating mode of operation is identical to that explained previously under the sorter reader control section.

Alternating or revolving input buffering (the two terms are synonomous) allocates two 100-character input buffer areas in memory. Information from one document is routed to one buffer area while information from the next document is routed to the second buffer area, and so on. This type of operation allows a greater amount of time for the information to be relocated within memory, which results in reducing the possibility of transfer errors.

Table 1-8. Translation of 4-Bit MICR Code into EBCDIC Code

SORTER		INTERNAL EBCDIC		OUTPUT (EBCDIC)	
SORTER SYMBOL	SORTER CODE 8 4 2 1	INAF 8 4 2 1	INBF 8 4 2 1	STANDARD GRAPHIC	LISTER GRAPHIC
BLANK	- - - -	0 1 0 0	0 0 0 0	BLANK	BLANK
0	0 0 0 0	1 1 1 1	0 0 0 0	0	0
1	0 0 0 1	1 1 1 1	0 0 0 1	1	1
2	0 0 1 0	1 1 1 1	0 0 1 0	2	2
3	0 0 1 1	1 1 1 1	0 0 1 1	3	3
4	0 1 0 0	1 1 1 1	0 1 0 0	4	4
5	0 1 0 1	1 1 1 1	0 1 0 1	5	5
6	0 1 1 0	1 1 1 1	0 1 1 0	6	6
7	0 1 1 1	1 1 1 1	0 1 1 1	7	7
8	1 0 0 0	1 1 1 1	1 0 0 0	8	8
9	1 0 0 1	1 1 1 1	1 0 0 1	9	9
AMOUNT (S1)	1 0 1 0	0 1 1 1	1 0 1 1	#	.
TRANSIT (S2)	1 0 1 1	0 1 1 1	1 1 0 0	@	X
ON-US (S3)	1 1 0 0	0 1 1 1	1 0 1 0	:	,
HYPHEN (S4)	1 1 0 1	0 1 1 0	0 0 0 0	-	-
CAN'T READ	1 1 1 1	0 1 0 1	1 1 0 0	*	*

Alternating mode is advantageous if the system is extremely busy with other peripheral devices. When using non-alternating input buffering, the information in the buffer area cannot be placed into the desired memory address before the succeeding document is read. In this case, the information from the succeeding document overrides and destroys the information presently in the input buffer. If this happens, information that indicates the pocket in which the previous document should have been placed cannot be returned to the reader sorter unit. The document is subsequently routed to the reject pocket.

Sorter Reader/Reader Sorter Control II I/O Descriptors

The various sorter reader/reader sorter control II I/O descriptors are described in tables 1-9 and 1-10.

START FLOW READ

This descriptor establishes the end address of the input buffer, starts the feeder mechanism and the reader sorter unit, and reads and stores the data received from the first item. Read in-

Table 1-9. Sorter Reader I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Start Flow Read	62	RVRC	*	End	
Demand Read	63	RVRC	*	End	
Pocket Select	60	NNRV			
Pocket Light	64	NNRR			
Count Batch Number Plus One	66	RRRR			
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			

R denotes bit positions reserved for future expansion.

V denotes bits used for reading control (refer to text).

C denotes bits used for MICR checking control in check mode (refer to text).

N denotes the pocket select units and tens digits.

* denotes a modulo-4 condition, that is, an address less than End but not equal to 0.

formation is stored in descending memory locations starting with the location specified by the B address minus two. EBCDIC blanks (code 0100 0000) are stored in memory following the last information character read until a total of 100 characters are stored in the input buffer. Digit 4 is a variant digit with one operational value described as follows:

Digit 4 Value	Description
0	If the variant digit 4 contains a value of 0, MICR reading takes place.
1 - 5	These bit positions are reserved for future expansion.

A second variant digit, digit 6, specifies MICR checking controls and is used only in checking mode. This variant determines the amount of read information in which can't read errors are reported and whether or not formatting and validity checking shall occur. The various values of digit 6 and associated descriptors are as follows:

Digit 6 Value	Description
0	If the variant digit contains a value of 0, all fields of the item are read and checked, up to a maximum document data length of 7.75 inches.
1	If the variant digit contains a value of 1, the can't read conditions are checked up until the time the second S2 (transit) character is detected. However, the reading of the item continues until the end of the item.
2	If the variant digit contains a value of 2, the read operation is terminated at the detection of the second S2 character.

Table 1-10. Reader Sorter Control II I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Start Flow Read	62	RVRC	*	End	
Demand Read	63	RVRC	*	End	
Pocket Light	64	NNRR			
Pocket Select	60	NNRV			
Count Batch Number Plus One	66	RRRR			
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			

* denotes a modulo-4 condition, an address less than End but not equal to 0.

R denotes bit positions reserved for future expansion.

V denotes bits used for the selection of alternating or non-alternating input buffering (refer to text).

C denotes bits used for MICR checking control (refer to text).

N denotes the pocket select units and tens digits.

Digit 6 Value	Description
4	If the variant digit contains a value of 4, the data is formatted and any error conditions in the amount and transit fields are reported.
5	If the variant digit contains a value of 5, both variant values 1 and 4 are performed as previously described.
6	If the variant digit contains a value of 6, both variant values 2 and 4 are performed as previously described.

DEMAND READ

This descriptor causes a single item to be fed and read before a result descriptor is returned for that item. The variant digits for this descriptor are identical to those described for the flow read.

POCKET SELECT

The pocket select descriptor informs the reader sorter unit of the pocket where the previously read item is to be placed. The pocket select number is received and stored by a binary counter within the reader sorter until chute selection time. This descriptor is the only valid operation that can be executed while the reader sorter unit is in flow mode. Variant digits 3 and 4 indicate the pocket number where the item read is to be place. Variant digit 6, if equal in value to any odd number (1, 3, or 5), stops the feeder mechanism.

POCKET LIGHT

This descriptor transmits the pocket number of the lamp to be illuminated to the binary register of the reader sorter and sets the indicate latch. This latch remains the same until the next descriptor is initiated.

COUNT BATCH NUMBER PLUS ONE

This descriptor causes the digit advance mechanism in the endorser assembly of the reader sorter to be upcounted each time the descriptor is executed. This descriptor is invalid unless the feeder is off and no items are in the feed area of the reader sorter unit.

INPUT REQUEST ENABLE

The reader sorter returns a result descriptor that indicates the START pushbutton is pressed and the reader sorter unit is ready.

INPUT REQUEST DISABLE

The reader sorter control is made insensitive to any condition that the reader sorter unit may present.

TEST

This descriptor interrogates the status of the reader sorter unit and returns the appropriate result descriptor.

Reader Sorter Control III

The reader sorter control III incorporates the entire capability of the reader sorter control II in addition to the capabilities listed in the following paragraphs.

The reader sorter control III is designed to perform with two separate read heads and to handle the Optical Character Recognition (OCR) code. The dual read operation minimizes the possibility of errors due to the dual, inherent checking capabilities of two heads.

The two read heads can be combined as follows:

a. MICR and MICR.

b. MICR and OCR.

c. OCR and OCR.

These combinations are in addition to the configuration of one MICR or one OCR read head.

Reader Sorter Control III I/O Descriptors

The I/O descriptors utilized in the sorter reader and reader sorter II controls are used in the reader sorter control III along with those listed in table 1-11.

SET DELAY

This descriptor provides a time delay from the time the leading edge of the document reaches the read head until the read head is enabled to read the document. This delay is set to provide delays in tenths of inches on the document so that undesired information is not processed.

Table 1-11. Reader Sorter Control III I/O Descriptors

Operation	OP Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Set Delay	61	RVDD			
Start and Demand Read	62 and 63	RVFF	A*	B*	

R denotes bit positions reserved for future expansion.

V denotes variant bits.

D denotes amounts of delay in tenths of inches from leading edge of the document.

F denotes format control values.

* The A address is the second station buffer end address that must be modulo-4 and less than the ending address (A).

The B address is the first station buffer end address that must be modulo 4 and greater than the second station address.

The functions of the variant bit used in this descriptor are described as follows:

Descriptor Bit Value	Description
0	First station delay, non-revolving buffer.
1	First station delay, revolving buffer.
2	Second station delay, non-revolving buffer.
3	Second station delay, revolving buffer.

START AND DEMAND MODES

For the reader sorter control III, the following variant combinations are utilized. Also, refer to table 1-11.

Descriptor Bit Value	Description
0	First station delay, non-revolving buffer.
1	First station delay, revolving buffer (start flow read operation only).
2	Second station read, non-revolving buffer.
3	Second station delay, revolving buffer (start flow read operation only).
4	Dual read, non-revolving buffer (demand read operation only).
5	Dual read, revolving buffer (start flow read operation only).

Disk File Control

Disk file controls are utilized within the Medium Data Processing Systems. The control types (Systems Memory, Disk File, and Disk File Combination) can be used interchangeably with any system.

All disk file peripheral units are classified as head-per-track disk. This method requires no mechanical head movement and thus provides optimum read and write access time.

The disk file control can store or fetch two 8-bit characters (one word) per memory access. To ensure that valid information is transferred from the control unit to the disk file unit, a longitudinal parity character is generated for all characters located within a disk segment.

Disk File Exchanges

Four types of basic disk file exchanges can be utilized within the Medium Data Processing Systems: 1 x 2 exchange, 2 x 10 exchange, 4 x 10 exchange, and the 4 x 20 exchange extension. The basic exchange contains the appropriate control and EU adapters. Additional adapters are available. A maximum of four control adapters and 20 EU adapters can be accommodated for each exchange.

1 X 2 DISK FILE EXCHANGE

This exchange provides the capability of addressing up to two systems memory units or disk file electronics units using a single control. This exchange is an integral plug-in part of the disk file control.

2 X 10 DISK FILE EXCHANGE

This modular exchange provides the capability of interfacing up to ten systems memory units or disk file electronics units to either one or two disk file controls. One disk file exchange adapter must be installed in the 2 x 10 exchange for each attached disk file electronics unit or systems memory unit.

4 X 10 DISK FILE EXCHANGE

This exchange provides the capability of interfacing up to ten systems memory units or disk file electronics units to any one of four controls. Priority resolution is not utilized in that the first systems memory or disk file electronics unit that requires an access is the first to be recognized. Asynchronous requests from the controls are permitted and are serviced at least every 10 microseconds.

4 X 20 DISK FILE EXCHANGE EXTENSION

This modular exchange extension provides the capability of interfacing an additional ten systems memory or disk file electronics units to any one of four controls connected to the 4 X 20 exchange.

Disk File and Systems Memory I/O Descriptors

The various disk file and systems memory I/O descriptors are described in table 1-12 and in the following paragraphs.

DISK FILE WRITE

Information is written onto the disk file from ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the ending address specified by the B address. The information is written onto the disk in areas referred to as segments. If the information is of such length that it does not completely fill a segment, NULL characters are written after the data to fill the remaining spaces.

If the variant digits (VV), digits 5 and 6, are equal to 8, the write occurs in the maintenance segment portion of the disk.

DISK FILE READ

Data is read from the disk file into ascending memory locations specified by the A address and continuing to, but not including, the terminal address specified by the B address.

DISK FILE CHECK

This operation is essentially the same as the read operation except that it does not store or change any data in memory.

TEST

This operation tests the status of the designated unit.

Disk-Pack Drive Control

The disk-pack drive subsystem is a high speed, modular storage system. It includes the host interface control located in the peripheral control cabinet, the disk-pack drive controller and the dual disk-pack drive, both of which are located in the disk-pack cabinet, and the interfacing cable.

Data is transferred bit-serially between the disk-pack controller and the disk-pack drive unit, whereas it is transferred bit parallel between the controller and the host control. The controller synchronizes the interface between the controller and the system and the disk-pack drives.

Table 1-12. Disk File and Systems Memory Control I/O Descriptors

Operation	Op Code	Digits 3-6	Digits 7-12	Digits 13-18	Digits 19-24
Disk File Write	50	UFVV	Begin	End	File address
Disk File Read	51	UFVV	Begin	End	File address
Disk File Check	52	UFVV	Begin	End	File address
Test	99	URRR			

R denotes bit positions reserved for future expansion.

U denotes the electronics unit number to be selected.

F denotes the density of storage (bits per inch) on the disk.

V denotes variant values of the operation (OP) code.

The disk-pack drive subsystem can be configured with a dual controller with two disk-pack controls for simultaneous read/write and seek.

Disk-Pack Drive I/O Descriptors

The various disk-pack drive I/O descriptors are shown in table 1-13. The begin and end address specified in table 1-13 must be synchronized modulo-4 (word-synchronized). The file address (digits 19 through 24) designates a particular track and sector on a disk and is the starting point for all operations having that file address.

WRITE

Information is written onto the disk pack from the begin address up to, but not including, the end address starting at the designated file address. Partial-sector writes require the use of null characters to fill in the remaining portion of the sector (code 0000 0000). The following is a list of variants used in the write operation. These variant digits, designated as F, S and V, are expressed by bit value rather than by digit or decimal value. For example, S4 represents the 4 bit of the S variant (digit 4); V2 represents the 2 bit of the V variant (digit 6).

Table 1-13. Disk-Pack Drive I/O Descriptors

Operation	Op Code	Digits 3-6	Digits 7-12	Digits 13-18	Digits 19-24
Write	50	USFV	Begin	End	File address
Read	51	USFV	Begin	End	File address
Initialize	56	USFV	Begin	End	File address
Verify	57	USFV	Begin	End	File address
Relocate	58	USFN	Begin	End	File address
Test	99	RRRR			
Report	53	Reserved file protect memory descriptors			
Unlock	54				
Clear	55				
On Line Test	59	UVRR	Begin	End	File address

R denotes bit positions reserved for future expansion.

U denotes bits designating disk-pack drive units 1 through 16.

N denotes the address of the spare sector on disk surface 0.

F denotes the type of format.

S, V } bits are defined in the operation where they are used.

Variant Digit	Value	Description
F1	0	Standard format.
F1	1	Single-sector-per-track format.
S1	0	An unconditional seek is initiated (refer to note 3).
S1	1	Conditional seek is initiated (refer to notes 1 and 2).
S2	1	The automatic restore function is disabled following a seek error condition.
S4	1	Upon completion of a write operation, the controller automatically executes a parity check on all sectors written.
V4	1	Reserved for file protect memory.
V8	1	The EBCDIC to ASCII translator is enabled (refer to note 4).

NOTES:

1. Execution of a conditional command is not initiated if the drive is seeking when selected.

2. The execution of a conditional command differs depending upon whether or not a seek operation is required. If a seek command is not required (no head movement is required to reach the specified address), the entire command function is unconditionally executed. If a seek (head movement) is required, the controller initiates the seek operation and disregards the remainder of the operation.

3. Execution of an unconditional portion of a command is initiated following the required seek.

4. The EBCDIC to ASCII translator is enabled by the controller activating the line on the central control/I/O control interface.

READ

Information is read from the selected file address into the begin address of memory up to, but not including, the end address. A partial sector read results in the termination of data transfer, but the controller release waits for completion of the total sector read. Variant digits used in the read operation are described as follows:

Variant Digit	Value	Description
S1	1	Conditional seek is initiated (refer to notes 1 and 2 under Write variants).
S1	0	Unconditional seek is initiated (refer to note 3 under Write variants).
S4	1	The binary address (three bytes of address plus parity) field only is read into memory beginning at the begin address. Only one address is read and this address is the actual address field recorded on the disk pack for the sector specified by the file address (as altered by the F variant). In the case of a previously-designated unusable sector, the address field returned contains all ones.
S4	0	A normal read is initiated.
S2	1	The automatic restore function is disabled following a seek error condition.

Variant Digit	Value	Description
S8	1	Error correction is disabled.
F1	0	Standard format.
F1	1	Single sector-per-track format.
V1		Reserved for file protect memory.
V2		
V8	1	The EBCDIC to ASCII translator is enabled (refer to note 4 under Write variants).
F8		
F4		Indicates spare sector (1 through 5) on the designated cylinder, (if S4=1).
F2		

INITIALIZE

The controller writes sector addresses and gaps in all tracks starting with the index on the track of the designated address. The controller also writes a test data pattern consisting of all zeros. The variant digits used in the initialize operation are described as follows:

Variant Digit	Value	Description
V1	0	Initialize the entire disk pack.
V2	0	
V1	1	Initialize the designated cylinder.
V2	1	Initialize the designated track.

Variant Digit	Value	Description
V4	1	Include the writing of data in each sector as specified at the begin address. Do not write the test data pattern. Refer to note 1.
F1	0	Standard format.
F1	1	Single sector-per-track format.
S1	1	Conditional seek is initiated (refer to notes 1 and 2 under Write variants).
S1	0	Unconditional seek is initiated (refer to note 3 under Write variants).
S2	1	The automatic restore function is disabled following a seek error condition.

NOTES

1. For the V4 variant, a 16-bit data pattern can be specified that is repeated throughout the data field.

VERIFY

The controller reads and checks for address errors, data errors (if specified), and parity errors. The verification of sectors begins with the sector specified by the file address, as altered by the F variant, and continues through the entire track, cylinder, or pack. The positions of the sectors are verified by counting from the index on each track.

The binary coded decimal (BCD) address of the detected error(s) is reported back between the begin and end memory addresses or, if the V4 variant is equal to 1, between the begin address plus 14 bytes in the buffered interface and the end address. The variants used in the verify operation are described as follows:

Variant Digit	Value	Description
V1 V2	0 0	The entire pack is verified with termination on the first encountered error. A maximum of one address can be reported.
V1	1	The designated cylinder is to be verified with termination on the first encountered error.
V1 V2	0 1	The designated track is to be verified with termination on the first encountered error.
V4	1	Data bits are verified by comparison with the 16-bit data pattern beginning at the begin address, comparison repeated for each 16 bits of data. Check bits are verified by regeneration of error detection bits and a comparison is made.
V4 V8	0 1	Verifies test data pattern written on initialization.
S2	1	The automatic restore function is disabled following a seek error condition.
F1	0	Standard format.
F1	1	Single sector-per-track format.
S1	1	Conditional seek is initiated.
S1	0	An unconditional seek is initiated.
F2 F4 F8		Indicates spare sectors (1 through 5) on the designated cylinders.

NOTES.

1. The data fields of relocated sectors are compared with the test data pattern if either V4 = 1 or V8 = 1. If neither V4 = 1 or V8 = 1, the data fields of all sectors are checked for correct parity.

RELOCATE

The controller flags the address of the unusable sector with an error configuration and rewrites this address on head 0 in the same cylinder specified by the N variant. Both the original address field and the relocated address field are located by counting from the index on the respective track. The spare sectors are relocated in reverse order, that is, the last (number 5) first, then 4, and so on. Once a spare is relocated, that spare cannot be relocated again. The variants used in the relocate operation are described as follows:

Variant Digit	Value	Description
N	1 - 5	These values indicate spare sectors 28 through 32, respectively, on the designated track.
F1	0	Standard format.
F1	1	Single sector-per-track format.
S1	1	Conditional seek is initiated.
S1	0	An unconditional seek is initiated.
S2	1	The automatic restore function is disabled following a seek error condition.

TEST

The controller returns an appropriate result descriptor indicating the type of disk pack accessed, the controller type, and the number of the assigned processor (in a shared system configuration), and the write lockout condition of the drive. The single variant as used in this operation is described as follows:

Variant Digit	Value	Description
V1	1	The disk-pack drive is taken off-line for the removal of the disk pack. To establish an off-line condition for the disk-pack drive, the disk pack controller must activate both drive bus line 2 and the head tag line.

ON-LINE TEST

This operation is the same as the TEST operation except the controller receives a begin, end, and file address, all of which are ignored.

File Protect Memory

File protect memory is a feature rather than a control that is used whenever two or more computer systems are utilizing the same disk file system through a 4 x 10 or 4 x 20 exchange. This feature provides record interlock protection, so that if one system is updating the disk file, the disk file record is locked out from all other systems until it is released by the system initiating the lock. Requests from other systems to a locked disk file address (record) are stored in the file protect memory circuitry in sequential order of requests. At the time the record is available (unlocked), the record is made available to the first requestor, and the second requestor is then moved up in the file protect memory stack. File protect memory control adapters have a memory size of 16 words of 40 bits each of storage.

File Protect Memory I/O Descriptors

The various file protect memory I/O descriptors are listed in table 1-14. The following paragraphs give a brief description of each of the I/O descriptors.

WRITE

Data is written onto the disk file from ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the end location specified by the B address. The variants used in the write operation are described as follows:

Variant Digit	Value	Description
V	0	Unlocks the lock bit at the completion of a successful write
V	1	The write takes place on the appropriate maintenance segment and is terminated after writing one segment. The unlock takes place on the address given in the descriptor. It is not the maintenance segment address.
V	4	Do not unlock

READ

Data is read from the disk file into ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the end location specified by the B address. A complete segment need not be read, but it is checked for correct parity. The variants used in the read operation are described as follows:

Variant Digit	Value	Description
V	0	The file address is not locked nor is the contention bit affected.
V	1	Same as V=0 except that the maintenance segment is accessed.

Variant Digit	Value	Description
V	2	If the file address is locked, the appropriate contention bit is set. If the file address is unlocked, the appropriate contention bit is cleared, and the file address is unlocked.
V	3	Same as V=2 except the read takes place on the appropriate maintenance segment and is terminated after reading one segment. The file address sent to the file protect memory is given in the descriptor. It is not the maintenance segment address.
V	4	Fast lock operation. This operation is the same as V = 2 except that disk is not accessed.

CHECK

The check operation is the same as the read operation except that memory is not accessed. All the read variants that apply are given above.

REPORT

A report operation is used to access file protect memory to obtain information about locked or contended-for addresses and to transfer this information to memory. Information can also be transferred from the lock memory register in the control. A file address would be placed in this register by file protect memory during a

Table 1-14. File Protect Memory I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Write	50	UFRV	Begin	End	File address
Read	51	UFRV	Begin	End	File address
Check	52	UFRV	Begin	End	File address
Report	53	RRRV	Begin	End	RRRRRR
Unlock	54	UFNV	Begin	End	File address
Clear	55	UFNV	Begin	End	File address
Test	99	UURR			

R denotes bit positions reserved for future expansion.

V denotes variant digits.

N denotes file address to be unlocked.

F denotes the most significant digit (MSD) address.

U denotes unit number.

previous access if the file address is unlocked and contended for. The variants used in the report operation are described as follows:

Variant Digit	Value	Description
V	0	Long report. Bits 1 through 40 of the file protect memory address word are transferred to memory, either locked or contended for.
V	2	Fast report. Transfer the file address memory from the lock memory register in the control starting at the descriptor begin address word and continuing up to, but not including, the end address word. In a previous access, with the lock bit reset and the system contention bit set, an address is placed into the lock memory register. With the exception of report and the second access of write, a prior access places an address into the lock memory register if the lock bit is reset and the contention bit is set.
V	4	Short report. Data is read from file protect memory into memory starting at the descriptor begin address word and continuing up to, but not including, the end address word. This data consists of bits 9 through 40 of a file protect memory word that has its lock bit reset and the contention bit set. If no such word is present, no information is transferred. The disk is not accessed.

UNLOCK

In this operation, the disk file electronics unit is not accessed. The variants used in the unlock operation are described as follows:

Variant Digit	Value	Description
V	0	Unlock the file address specified.
V	2	Unlock all file addresses for the system(s) as specified by the N variant. The coding for the N variant is as follows:

N Variant	System Number
1	0
2	1
4	2
8	3

CLEAR

This operation clears specified contention bits. The variants used in the clear operation are described as follows:

Variant Digit	Value	Description
V	0	Clear the contention bit(s) for the specified file address and system. The specified system is determined by the N variant as shown in the unlock operation.
V	2	Clear the contention bit(s) in the specified system for all file addresses.

TEST

This operation tests the status of the designated unit and returns the appropriate result descriptor. The test descriptor does not request the file protect memory.

Lister Control

The lister control is capable of handling one master alphanumeric lister and two alphanumeric slave listers. Data is transferred to the lister serially by character and in parallel by bit. The control must enable the EBCDIC/BCL translator in order to print and can load the lister buffer while paper motion is occurring in response to a previous space or print descriptor.

Lister I/O Descriptors

The various lister I/O descriptors are shown in table 1-15. If unspecified variant bits are used in the following I/O descriptors, a continuous busy status is detected from the lister unit.

LISTER PRINT

Two print operations are utilized on the lister unit: the multiprocessing mode (master/slave/slave) using three lister tapes, and the normal mode (6-tape/6-tape) using two lister tapes. In either mode, data is printed on the lister from ascending memory locations beginning at the location specified by the A address and continuing to, but not including, the end location specified by the B address. The A and B addresses must define a memory buffer area of 44 characters.

In multiprocessing mode, the first 22 characters of information are printed on both the master tape, selected by the master tape select switch located on lister unit 1 (master unit), and the detail tape on the unit specified by the variant digit D3 and tape specified by D4. For example, if digit D3 = 3 and digit D4 = 5, the master tape would always be printed on the master lister unit and tape selected by the master tape select switch. The detail tape would be printed on the second slave unit (since D3 = 3 designates the second slave unit) and the tape utilized on that unit would be number 5 (since D4 = 5). The second 22 characters would be printed on the multiprocess tape as specified by the variant digits D5 and D6.

In the normal mode of operation, character positions 1 through 22 are printed only on the master lister unit on the master tape. Detail information, characters 23 through 44, are printed on the unit and tape as specified by variant digits D5 and D6. Single spacing occurs after printing.

Table 1-15. Lister Control I/O Descriptors

Operation	OP Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Lister Print	70	UTUT	Begin	End	
Lister Space	71	UTUT			
Lister Skip	72	UTUT			
Lister Slew	73	UVUT			
Input Request Enable	35	RRRR			
Input Request Disable	97	RRRR			
Test	99	RRRR			

R denotes bit positions reserved for future expansion.

V denotes a variant.

U denotes a unit number.

T denotes a tape number.

The printing of the tape designated by variant digits D3 and D4 is possible only with the B 9244-1 Tape Lister Unit.

The coding for the various variant digits used in the multiprocessing mode of operation is given below:

Variant Digit	Value	Description
3	0	Suppress print on both the master and detail tape.
3	1 - 3	Unit designator for the detail tape as shown below: 1=Master tape unit 2=First slave unit 3=Second slave unit
4	1 - 6	Tape designator for detail information, character positions 1 through 22.
5	0	Suppress print on multiprocess tape.
5	1 - 3	Unit designator for multiprocess tape.
6	1 - 6	Tape designator for multiprocess information, character positions 23 through 44.

The coding for the various variant digits used in the normal mode operation is given below:

Variant Digit	Value	Descriptor
3	0	Master tape print suppress.
3	1 - 3	Unit designator for master tape, character positions 1 through 22.
4	0	This digit must be equal to 0.
5	0	Suppress detail tape print.
5	1 - 3	Unit designator for detail tape.

Variant Digit	Value	Description
6	1 - 6	Tape designator for detail information, character positions 23 through 44.

LISTER SPACE AND LISTER SKIP

The space and skip descriptors are designed to function with one another. The space descriptor, operation (OP) code 71 permits a single space while the skip descriptor, OP code 72 permits a skip of 15 spaces (2.5 inches). The single space and the 15 space skip operations are automatic with their associated descriptors unless otherwise specified. The lister spaces six lines per inch.

For the master/slave/slave combination, a skip/space operation is performed on both the master tape on unit number 1 and the tape on the unit designated by variant digits D3 and D4. Digit D3 designates the unit, and D4 designates the tape on that unit. If D3 is equal to zero, skipping and spacing on both the master tape on unit number 1 and the tape designated by digit D4 is inhibited.

For the 6-tape/6-tape combination, digit D4 must be equal to zero, and skipping and spacing operations on the master tape on the unit specified by digit D3 are performed. If D3 is equal to zero, skipping and spacing of the master tape are inhibited. An additional tape on an additional unit can be designated by variant digits D5 and D6.

If variant digits D3 and D5 are both equal to zero within the same lister descriptor, then that descriptor is invalid. The variant digits used in both the space and skip operations are described as follows:

Variant Digit	Value	Descriptor
3	0	In normal mode, inhibits spacing and skipping on the master tape.

Variant Digit	Value	Description
3	0	In the multiprocessing mode, inhibits spacing and skipping on both the master tape and the detail tape specified by variant digit D4.
3	1 - 3	In the multiprocessing mode, space and skip the master tape and designate the tape unit for the detail tape (refer to variant digit D4).
3	1 - 3	In normal mode, space and skip the master tape.
4	0	In the normal mode, this digit must be equal to zero.
4	1 - 6	In the multiprocessing mode, this digit designates the detail tape.
5	0	The space and skip operations on the tape designated by variant digit D6 are inhibited.
5	1 - 3	The tape unit is designated for the tape designated by variant digit D6.
6	1 - 6	In the normal mode, this digit designates the detail tape.
6	1 - 6	In the multiprocessing mode, this digit designates the multiprocess tape.

LISTER SLEW

This operation causes the lister to slew 10 inches as designated by variant digits D3 through D6. For the 6-tape/6-tape combination, the D3 variant digit is valid only when it is equal to 3. Variant digits D5 and D6 are utilized only on the 18-tape lister units and must otherwise be equal to zero. The various variant digits used in the lister slew operation are described as follows:

Variant Digit	Value	Description
3	1	Slews all tapes on lister unit number 1.
3	2	Slews all tapes on lister unit number 2.
3	4	Slews all tapes on lister unit number 3.
3	3	Slews all tapes on lister units 1 and 2.
3	5	Slews all tapes on lister units 1 and 3.
3	6	Slews all tapes on lister units 2 and 3.
3	7	Slews all tapes on lister units 1, 2, and 3.
4	0	Allows slew on the master tape.
4	1	Inhibits the slew on the master tape.
5	0	In normal mode, this digit must be equal to zero.
5	0	In the multiprocessing mode, tape slew is not inhibited.
5	1 - 3	In the multiprocessing mode this designates the tape unit to be used with the tape designated by variant digit D6.
6	0	In normal mode, this variant digit must be equal to zero.

Variant Digit	Value	Description
6	1 - 6	In the multiprocessing mode, inhibits the slew of the designated tape.

INPUT REQUEST ENABLE

The control returns a result descriptor indicating that the operation is complete if and when the lister unit is in a ready condition.

INPUT REQUEST DISABLE

The control is made insensitive to any condition the lister unit may present.

TEST

The status of the lister unit is checked.

Magnetic Tape 7- and 9-Track Controls

Magnetic tape 7- and 9-track controls are utilized on all Medium Data Processing Systems. The controls along with associated tape exchanges are described in the paragraphs that follow.

Magnetic Tape 7-Track Control

The magnetic tape 7-track non-return-to-zero (NRZ) control is designed to function at one of three optional inch-per-second (IPS) rates: 45 IPS, 90 IPS, and 120 IPS. Each of these speeds can function at any of the three following densities (bits-per-inch): 200 BPI, 556 BPI, and 800 BPI.

The magnetic tape 7-track control, utilizing a 6-bit character and a parity bit, requires the use of a BCL (6-bit code)/EBCDIC (8-bit code) translator that is located in the central control or the processor depending on the Medium Data Processing Systems.

During a write operation, information is transferred from memory to the tape control, two characters at a time, where it is then sent to the write circuitry located within the tape unit. The write circuitry then places the data onto the tape.

During a read operation, information on the tape is read by the tape unit and sent to the tape control. As the tape control acquires two characters from the tape unit, the characters are written into memory.

A maximum of six free-standing 7-track transports (tape units) can be used on the control without the use of the optional 2 x 10 exchange. The 2 x 10 exchange provides for a maximum of 10 free-standing 7-track transports (tape units) and concurrent and independent reading and/or writing to any two different tape units.

Magnetic Tape 7-Track I/O Descriptors

The various magnetic tape 7-track I/O descriptors are shown in table 1-16. The following paragraphs give a brief description of these descriptors.

REWIND

This descriptor causes a designated tape to rewind tape onto the supply reel until the tape is positioned at the load point. The coding for the various variant digits used in the rewind operation is as follows:

Variant Digit	Value	Description
3	Any	Not used.
4	0 - 9	Unit designation.
5	Any	Not used.
6	Any	Not used.

READ FORWARD

A record is read from the designated unit into ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the end location specified by the B address. The reading is terminated by the inter-record gap or the A and B addresses being equal, whichever comes first. If the inter-record gap is sensed first, the delimiter character (code 1100 1111) is stored in

Table 1-16. Magnetic Tape 7-Track I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Rewind	01	RURR			
Read Forward	02	FUVR	Begin	End	
Read Backward	03	FUVR	Begin	End	
Erase	04	FURR	Begin	End	
Write	06	FUVR	Begin	End	
Space Forward	08	FUNN			
Space Backward	09	FUNN			
Test	99	RURR			

R denotes bit positions reserved for future expansion.

F denotes density.

U denotes tape unit number.

V denotes operation code variant.

N denotes amount of spacing.

memory positions following the last information character. The variant digits used in the read forward descriptor are described as follows:

Variant Digit	Value	Description
3	0	800 BPI, even parity.
3	1	800 BPI, odd parity.
3	2	556 BPI, even parity.
3	3	556 BPI, odd parity.
3	4	200 BPI, even parity.
3	5	200 BPI, odd parity.
3	8	Unit selected, even parity.
3	9	Unit selected, odd parity.
4	0 - 9	Unit designation.
5	0	No translation.
5	4	BCL/EBCDIC translation.
5	8	Count information, but inhibit transfer to memory (NO-OP read).
6	Any	Not used.

READ BACKWARD

A record is read from the designated unit into descending memory locations beginning at the location specified by the B address minus four and continuing to, but not including, the location specified by the A address while the tape is moving in the reverse direction. Reading is terminated by detection of an inter-record gap or the A and B addresses being equal, whichever comes first. If the inter-record gap is detected first, the delimiter character (code 1100 1111) is stored in memory positions preceding the last information character stored. The variant digits used in the read backward operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the read forward operation.
4	0 - 9	Unit designation.
5	0, 4, 8	Refer to the values of variant digit 5 in the read forward operation.
6	Any	Not used.

ERASE

Tape is erased in a forward direction on the designated tape unit. The number of characters erased is the same as the number of characters that would be written for the same A and B addresses. No memory space is used for this operation. However, memory cycle time is used. A delimiter does not terminate this operation. The variant digits used in the erase operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the forward read operation.
4	0 - 9	Unit designation.
5	0	No translation.
5	Any	Not used.
6	Any	Not used.

WRITE

A record is written in a forward direction on the designated unit from ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the end location specified by the B address, or until a delimiter is encountered, whichever comes first. The variant digits used in the write operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the read forward operation.
4	0 - 9	Unit designate.
5	0	No translation.
5	4	EBCDIC/BCL translation.
6	Any	Not used.

SPACE FORWARD

This descriptor causes tape to move forward on the designated unit until the number of records specified by variant digits D5 and D6 are spaced over. The operation is terminated if a tape mark record is encountered. The variant digits used in the space forward operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the read forward operation.
4	0 - 9	Unit designation.
5, 6		Number of records to be spaced, from 00 to 100.

SPACE BACKWARD

The tape moves backward on the designated tape unit until the number of records specified by variant digits D5 and D6 are spaced over. The operation is terminated if a tape mark record is encountered or the beginning-of-tape (BOT) is encountered. The variants for this operation are the same as the space forward operation previously discussed.

TEST

The test descriptor checks the status of the designated tape unit. The variant digits used in the test operation are described as follows:

Variant Digit	Value	Description
3	Any	Not used.
4	0 - 9	Designated tape unit.
5	Any	Not used.
6	Any	Not used.

Magnetic Tape 9-Track Control

The magnetic tape 9-track non-return-to-zero (NRZ) control is designed to function at one of three optional inch-per-second (IPS) rates: 45 IPS, 90 IPS, and 120 IPS. Any of these speeds can function at either of the following two densities (bits-per-inch): 200 bits-per-inch (BPI) or 800 BPI.

The magnetic tape 9-track control, utilizing an 8-bit character and one parity bit, does not require the use of a translator.

For each 9-track NRZ control, a cyclic redundancy character (CRC) adapter is required. This adapter is used to correct an erroneous tape read where a bit pick-up or drop-out is confined to a single track. Controlled by the Master Control Program (MCP) and variants in the tape read descriptor, the CRC adapter can be used only with a 9-track, 800 BPI, odd-parity tape descriptor.

During a write descriptor, information is transferred from memory, two characters at a time, into the tape control. It is then sent to the tape unit to be written onto tape.

During a read operation, information on the tape is read by the tape unit and then transferred to the tape control. As the tape control acquires two characters from the tape unit, these characters are written into memory.

Read and write retries are not automatic in the tape controls but are programmatic by the MCP. Transfers into memory are terminated in all cases where input operations attempt to exceed memory locations incremented beyond the ending address.

A maximum of six free-standing 9-track transports can be used on the control without the use of the optional 2 x 10 exchange. This 2 x 10 exchange provides for a maximum of 10 free-standing 9-track transports (tape units) and concurrent and independent reading and/or writing to any two different tape units.

Magnetic Tape 9-Track I/O Descriptors

The various magnetic tape 9-track I/O descriptors are shown in table 1-17. The following paragraphs give a brief description of each of these descriptors.

REWIND

This descriptor causes a designated tape unit to rewind tape onto the supply reel until the tape is positioned at the load point. The variant digits used in the rewind operation, and their coding, are described as follows:

Variant Digit	Value	Description
3	Any	Not used.
4	0 - 9	Unit designation.
5	Any	Not used.
6	Any	Not used.

READ FORWARD

A record is read from the designated tape unit into ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the location specified by the B address. The reading is terminated by the inter-record gap, or the A and

B addresses being equal, whichever comes first. The variant digits used in the read forward operation are described as follows:

Variant Digit	Value	Description
3	0	800 BPI, even parity (used for maintenance only).
3	1	800 BPI, odd parity and CRC.
3	4	200 BPI, even parity (used for maintenance only).
3	5	200 BPI, odd parity.
3	8	Density as selected by transport unit, even parity.
3	9	Density as selected by transport unit, odd parity.
4	0 - 9	Unit designation.
5	8	Inhibit information, transfer to memory.
6	8	CRC correction. Bits 1, 2, and 4 indicate the track that is to be corrected.

READ BACKWARD

A record is read from the designated tape unit into descending memory locations beginning at the location specified by the B address minus four and continuing to, but not including, the location specified by the A address while the

Table 1-17. Magnetic Tape 9-Track I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Rewind	01	RURR			
Read Forward	02	FUVT	Begin	End	
Read Backward	03	FUVT	Begin	End	
Erase	04	FURR	Begin	End	
Write	06	FUVR	Begin	End	
Space Forward	08	FUNN			
Space Backward	09	FUNN			
Test	99	RURR			

R denotes bit positions reserved for future expansion.

F denotes density.

U denotes tape unit number.

V denotes operation code variant.

T denotes a track on the tape.

N denotes amount of spacing.

tape is moving in the reverse direction. Reading is terminated by the detection of an inter-record gap, or the A and B addresses being equal, whichever comes first. The variant digits used in the read backward operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the read forward operation.
4	0 - 9	Unit designation.
5	8	Inhibits information transfer to memory.
6	8	CRC correction. Bits 1, 2, and 4 indicate the track that is to be corrected.

ERASE

Tape is erased in a forward direction on the designated tape unit. The number of characters erased is the same as the number of characters that would be written for the same A and B addresses. No memory space is used for this operation. However, memory cycle time is used. The variant digits used in the erase operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the read forward operation.
4	0 - 9	Unit designation.
5	Any	Not used.
6	Any	Not used.

WRITE

A record is written in a forward direction on the designated tape unit from ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the end location specified by the B address. The variant digits used in the write operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the read forward operation.
4	0 - 9	Unit designation.
5	2	Record tape mark.
6	Any	Not used.

SPACE FORWARD

This descriptor causes the tape to move forward on the designated tape unit until the number of records specified by variant digits D5 and D6 are spaced over, or until a tape mark is detected, whichever comes first. The variant digits used in the space forward operation are described as follows:

Variant Digit	Value	Description
3	0 - 9	Density and parity variant. Refer to the values of variant digit 3 in the read forward operation.
4	0 - 9	Unit designation.
5, 6		Number of records to be spaced, from 00 to 100.

SPACE BACKWARD

The tape moves backward on the designated tape unit until the number of records specified by variant digits D5 and D6 are spaced over, or until a tape mark is detected. The variants for this operation are the same as for the space forward operation previously discussed.

TEST

The test descriptor checks the status of the designated tape unit. The variant digits used in the test operation are described as follows:

Variant Digit	Value	Description
3	Any	Not used.
4	0 - 9	Unit designation.
5	Any	Not used.
6	Any	Not used.

Magnetic Tape 7- and 9-Track Cluster Controls

The Medium Data Processing Systems have available a magnetic tape cluster unit that contains two, three or four separate tape transports. On any of the transports, the following units can be interchanged in any combination within the cluster:

a. 7-Track NRZ and 9-Track NRZ.

b. 9-Track NRZ and 9-Track PE.

The PE designation denotes phase encoding type tape transports.

If two types of transports are utilized in a common cluster unit, two types of associated tape I/O controls must be interfaced to the cluster. To accommodate this interface, a 2 x 8 exchange is an integral feature of the cluster unit. The I/O controls interface to this exchange in the first cluster unit, designated as the master unit. This interface controls an additional cluster unit, designated as the slave unit, for a total control of eight tape transports. This exchange provides for concurrent and independent reading and/or writing to any two different transports.

The 7- and 9-track controls interfacing to the cluster unit must be operating at 45 IPS.

Phase Encoded 9-Track Tape Control

The phase encoded tape control can interface to a cluster unit or to a phase encoded stand-up tape transport. The transport writes, without the use of a translator, onto 9-track tape at 90 IPS, 120 IPS, and 150 IPS at a density rate of 1600 BPI on the stand-up tape transports and at 45 IPS at 1600 BPI when interfaced to a cluster unit. Of the nine tracks utilized by the phase encoded tape transport, eight of these tracks comprise the character and one track is for parity.

A phase encoded tape transport can house a unit, referred to as a common electronics unit, that provides the tape control with a 1 x 8 exchange. This allows the control to handle up to eight transport units. By placing a second common electronics unit into a second phase encoded tape transport, a 2 x 8 exchange is configured.

Phase Encoded 9-Track I/O Descriptors

The various phase encoded I/O descriptors are shown in table 1-18. The following paragraphs give a brief description of each of these descriptors.

REWIND

This descriptor causes a designated tape to rewind onto the supply reel until the tape is positioned at load point. The coding for the variant digits used in the rewind descriptor is described as follows:

Variant Digit	Value	Description
3	Any	Not used.
4	0 - 9	Unit designation.
5	Any	Not used.
6	Any	Not used.

READ FORWARD

A record is read from the designated tape unit into ascending memory locations beginning

Table 1-18. Phase Encoded 9-Track I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Rewind	01	RURR			
Read Forward	02	FUVR	Begin	End	
Read Backward	03	FUVR	Begin	End	
Erase	04	FURR	Begin	End	
Write	06	FUVR	Begin	End	
Space Forward	08	FUNN			
Space Backward	09	FUNN			
Test	99	RURR			

R denotes bit positions reserved for future expansion.

F denotes density.

U denotes tape unit number.

V denotes operation code variant.

N denotes amount of spacing.

with the location specified by the A address and continuing to, but not including, the location specified by the B address. The reading is terminated by the inter-record gap, or the begin/end addresses begin equal. The variant digits used in the read forward descriptor are described as follows:

Variant Digit	Value	Description
3	7	1600 BPI with odd parity.
3	9	Density as selected by the transport, odd parity, 1600 BPI is typical.
4	0 - 9	Unit designation.
5	8	Inhibits the transfer of information to memory.
6	Any	Not used.

READ BACKWARD

A record is read from the designated tape unit into descending memory locations beginning with the location specified by the B address minus four and continuing to, but not including, the location specified by the A address. Reading is terminated by the inter-record gap, or the A and B addresses being equal. The variant digits used in the read backward descriptor are described as follows:

Variant Digit	Value	Description
3	7	1600 BPI with odd parity.
3	9	Density as selected by the transport, odd parity, 1600 BPI is typical.
4	0 - 9	Unit designation.

Variant Digit	Value	Description
5	8	Inhibits the transfer of information to memory.
6	Any	Not used.

ERASE

Tape is erased in a forward direction on the designated unit. The number of characters erased is the same as the number of characters that are written for the same A and B addresses. Memory cycles are allowed, but information is inhibited from entering memory. The variant digits used in the erase descriptor are described as follows:

Variant Digit	Value	Description
3	7	1600 BPI with odd parity.
3	9	Density as selected by the transport, odd parity, 1600 BPI is typical.
4	0 - 9	Unit designation.
5	Any	Not used.
6	Any	Not used.

WRITE

A record is written in a forward direction on the designated tape unit from ascending memory locations beginning with the location specified by the A address and continuing to, but not including, the location specified by the B address. The variant digits used in the write descriptor are described as follows:

Variant Digit	Value	Description
3	7	1600 BPI with odd parity.
3	9	Density as selected by the transport, odd parity, 1600 BPI is typical.
4	0-9	Unit designation.
5	2	Record the tape mark.
6	Any	Not used.

SPACE FORWARD

This descriptor causes the tape to move forward on the designated tape unit until the number of records specified by variant digits D5 and D6 are spaced over, or until a tape mark is detected. The variant digits used in the space forward descriptor are described as follows:

Variant Digit	Value	Description
3	7	1600 BPI with odd parity.
3	9	Density as selected by the transport, odd parity, 1600 BPI is typical.
4	0-9	Unit designation.
5 6		Number of records to be spaced.

SPACE BACKWARD

This descriptor causes the tape to move backward on the designated unit until the number of records specified by variant digits D5 and D6 are spaced over, or until a tape mark is detected. The variant digits for this operation are the same as those used for the space forward operation.

TEST

This descriptor checks the status of the designated tape unit. The variant digits used in the test descriptor are described as follows:

Variant Digit	Value	Description
3	Any	Not used.
4	0 - 9	Unit designation.

Variant Digit	Value	Description
5	Any	Not used.
6	Any	Not used.

INPUT/OUTPUT RESULT DESCRIPTORS

An input/output (I/O) result descriptor is generated by the various I/O controls for each operation performed. This result descriptor informs the system of the success or failure encountered in the execution of the designated control. This descriptor is transferred from the control and stored in a fixed location of reserved memory associated with the channel housing that control. Refer to figure 1-6. Bit 1 is the most significant bit (MSB) of the 16-bit result descriptor.

Result descriptor bits 1 and 2 are standard for all descriptors. Bit 1 indicates that the I/O operation is complete, and bit 2 indicates that an exception condition exists. The specific exception conditions for the various controls are described as follows:

Control	Descriptor Bits	Description
Card reader	3	Card reader not ready.
	4	Memory access error.
	4 and 6	Validity error.
	7 - 12	Not used.
	13 - 16	Unit number (equal to 0).
Card punch	3	Card punch not ready.
	4	Punch check or parity error.
	4 and 6	Memory parity error.
	5	Not used.
	7	Punch identification (test operation only).
	8 - 12	Not used.
	13 - 16	Unit number (equal to 0).
Paper tape reader	3	Paper tape reader not ready.
	4	Parity or access rate error.
	4 and 6	Tape parity error.
	5	End-of-tape or beginning-of-tape.
	7	Incomplete record.
	8 - 12	Not used.
	13 - 16	Unit number (equal to 0).

Control	Descriptor Bits	Description
Paper tape punch	3	Paper tape punch not ready.
	4	Memory parity error.
	5	End-of-tape or beginning-of-tape.
	6	Not used.
	7	Stop code.
	8 - 12	Not used.
	13 - 16	Unit number (equal to 0).
Console printer	3	Console printer not ready.
	4	Parity error.
	7	Input (keyboard) error.
	8	Memory access error.
Lister	3	Lister not ready.
	4	Error.
	5	Low paper or end of paper.
	6	Memory parity error.
	7	Print check.
	8 - 12	Not used.
	13 - 16	Unit number (equal to 0).
Unbuffered printer	3	Unbuffered printer not ready.
	4 and 5	Bit transfer error.
	4 and 6	Memory parity error.
	4 and 7	Code parity error.
	8	Low paper.
	9	Channel 12 punch on the format tape is detected. If the executed descriptor has skip information in it, bit is not turned on.

Control	Descriptor Bits	Description
Sorter reader	3	Sorter reader not ready.
	4	Memory access error.
	5	Flow stopped.
	6	Too-late-to-pocket select.
	3 and 5	Sorter stop, full pocket, empty hopper, jam.
	4, 5, and 7	End-of-file (input request enabled).
	4 and 7	Can't read or unencoded document.
	4 and 8	Third transit symbol (double document).
	4, 7, 10 and 11	Unencoded item (if the MICR checking control variant is equal to 4, 5, or 6).
	4 and 10	Amount field error (if the MICR checking control variant is equal to 4, 5, or 6).
	4 and 11	Transit field error (if the MICR checking control variant is equal to 4, 5, or 6).
	5 and 7	Control ticket.
	9	Not used.
	12	Buffer identification (equal to 0).
	13 - 16	Unit number (equal to 0).
Reader sorter control II	3	Reader sorter control II not ready.
	4	Memory access error.
	5	Document flow stop.
	6	Too-late-to-pocket select.
	7	Can't read, blank document, sorter jam, control ticket.
	8	Mis-sort or double document detected.
	9	Not used.
	10	Invalid amount field.
	11	Invalid transit field.

Control	Descriptor Bits	Description
Reader sorter control II (cont.)	12	Buffer identification.
	3 and 5	Sorter not ready and flow stopped (jam or mis-sort).
	3, 5, and 7	Sorter not ready and flow stopped (jam).
	3, 5, 7 and 8	Sorter not ready and flow stopped (mis-sort).
	4, 5, and 6	Too-late-to-read and flow stopped.
	4 and 7	Can't read or unencoded document (if the MICR checking control variant is equal to 0, 2, 4, or 6).
	4 and 7	On-us field error (if the MICR checking control variant is equal to 1, 3, 5, and 7).
	4 and 10	Amount field error (if the MICR checking control variant is equal to 1, 3, 4, 5, 6, and 7).
	4 and 11	Transit field error (if the MICR checking control variant is equal to 4, 5, 6, and 7).
	5 and 6	Too-late-to-pocket select and flow stopped.
	5 and 7	Control ticket and flow stopped.
	5, 7, and 8	Double document detected with control ticket and flow stopped.
	13 - 16	Not used.
Reader sorter control III	3	Reader sorter control III not ready.
	4	Memory access error.
	5	Document flow stopped.
	6	Too-late-to-pocket select.
	7	Control ticket, sorter jam, mis-sort, station A MICR read error, station A OCR can't read.
	8	Mis-sort or double document detected.
	9	Not used.
	10	Invalid amount field (station A MICR) or memory access error (station A OCR).
	11	Invalid transit field (station A MICR).
	12	Buffer identification.

Control	Descriptor Bits	Description
Reader sorter control III (cont.)	13	Memory access error (station B).
	14	Read error (station B MICR) or can't read (station B MICR).
	15	Invalid amount field (station B MICR) or memory access error (station B OCR).
	16	Invalid transit field (station B MICR).
	3 and 5	Flow stopped and sorter not ready.
	3, 5, and 7	Sorter jammed, not ready and flow stopped.
	3, 5, 7, and 8	Mis-sort, sorter not ready, and flow stopped.
	4, 5, and 6	Too-late-to-read and flow stopped.
	4 and 7	Read error (station A MICR).
	4 and 7	Unencoded document (station A OCR).
	5 and 6	Too-late-to-pocket select and flow stopped.
	5 and 7	Control ticket detected and flow stopped.
	5, 7, and 8	Double document with control ticket detected and flow stopped. Control ticket is rejected.
	13 and 14	Read error (station B MICR).
	13 and 14	Unencoded document (station B OCR).
Buffered printer	3	Buffered printer not ready.
	4 and 6	Memory parity error.
	4 and 7	Print error.
	5	End-of-page.
7-track magnetic tape	3	Magnetic tape not ready.
	4	Memory access error (read, write, and erase operations).
	4 and 6	Memory parity error (write or erase).
	4, 7, and 8	Tape parity error (read, write or space).
	5	End-of-tape or beginning-of-tape.
	6	Write lockout (write or test) or end-of-file (read or space).

Control	Descriptor Bits	Description
7-track magnetic tape (cont.)	7	Incomplete record (read).
	8	Attempt to exceed maximum address (read).
	10	Non-present option required.
	11	Rewinding.
	12	Spacing six feet of blank tape.
	13 - 16	Tape unit number (binary values of 0 through 9 with 0 designating tape unit 10).
	7 and 8	Density switch (test). Switch positions are as follows:

INB2F	INB1F	Switch Position
0	0	800 BPI
0	1	556 BPI
1	0	200 BPI

Control	Descriptor Bits	Description
9-track magnetic tape	3	Magnetic tape not ready.
	4	Memory access error (read, write, or erase).
	4 and 6	Memory parity error (write or erase).
	4, 7, and 8	Tape parity error (read, write, or space).
	5	End-of-tape or beginning-of-tape.
	6	Write lockout (write or test) or end-of-file (read or space).
	7	Record shorter than allocated memory (read).
	7 and 8	Density switch (test). Switch positions are as follows:

INB2F	INB1F	Switch Position
0	0	800 BPI
0	1	556 BPI
1	0	200 BPI

Control	Descriptor Bits	Description
	8	Record longer than allocated memory (read).
	9	CRC correction is possible. INC bits 4, 2, and 1 indicate which track is in error, as follows:

INC 4, 2, and 1 count	0	1	2	3	4	5	6	7
TRACK IN ERROR	1	2	3	4	5	6	7	8

Control	Descriptor Bits	Description
	10	Non-present option required.

Control	Descriptor Bits	Description
9-track magnetic tape (cont.)	11	Rewinding.
	12	Spacing of six feet of blank tape.
	13 - 16	Tape unit number (binary value of 0 through 9 with 0 designating tape unit 10).
Phase encoded	3	Magnetic tape not ready.
	4	Memory access error (read, write, or erase).
	4 and 6	Memory parity error (write or erase).
	4, 7, and 8	Tape parity error (read, write, or space).
	5	End-of-tape or beginning-of-tape.
	6	Write lockout (write or test) or end-of-file (read or space).
	7	Record shorter than allocated memory (read).
	7 and 8	Density switch (test). Switch positions are as follows:

INB2F	INB1F	Switch Position
1	1	1600 BPI

Control	Descriptor Bits	Description
	8	Record longer than allocated memory (read).
	10	Non-present option required.
	11	Rewinding.
	12	Spacing of six feet of blank tape
	13 - 16	Tape unit number (binary value of 0 through 9 with 0 designating tape unit 10).
Disk file	3	Disk file not ready.
	4	Memory access error (write, read, or check). If file protect memory is used, report if variant digit V is equal to 0.
	4 and 6	Memory parity error (write).
	4 and 6	Read parity error (read or check).
	5	After three seconds, the electronics unit is still busy (write, read, check, or test).
	6	Write lockout (write).

Control	Descriptor Bits	Description
Disk file (cont.)	7 and 8	Density switch (test). Switch positions are as follows:

INB2F	INB1F	Control Type
0	0	Control I or V
0	1	Control II
1	0	Control III

Descriptor Bits	Description
9	A previously requested locked file address, now unlocked, is contained in a control register and can be read through the report V = M descriptor (write, read, check, or clear).
10	File protect memory is full; however, the address is not inserted (read or check).
11	File address locked prior to operation (write, read, check, unlock, or clear).
12	Time out (write, read, or check).
13 and 14	Disk file identification (test). Refer to the table below:

IND2F	IND1F	Peripheral Unit Type
0	0	Disk file 1A
0	1	Disk file 1A-2 and/or Systems Memory
1	0	Disk file 1C-1 and/or 1C-3
1	1	Disk file 1C-2 and/or 1C-4

Descriptor Bits	Description
15 and 16	Data processor identification. Refer to the table below:

IND2F	IND1F	Processor Identification
0	0	1
0	1	2
1	0	3
1	1	4

AUXILIARY CABINETS

Medium Data Processing Systems auxiliary cabinets are capable of housing any combination of adapters, exchanges and/or extensions that are listed below, up to a maximum of five in a cabinet.

a. Terminal unit exchange

b. Disk file exchange — 2 x 10

c. Disk file exchange — 4 x 10

d. Disk file exchange/extension, 4 x 20

e. Magnetic tape exchange

f. Multi-line extension

g. File protect memory

Two types of auxiliary cabinets are available: dependent and independent. The difference between the two types of cabinets is merely the method in which power and power control signal cables are routed.

PERIPHERAL SWITCH

The peripheral switch unit, figure 1-11 is used to expand the capability of multiple processor installations by allowing the various peripherals to be switched between the associated processors in the system. This unit can be connected between any two or three processors used in Medium Data Processing Systems configurations.

Figure 1-11. Peripheral Switch Unit

Since customer configurations differ as to switching requirements, each peripheral switch is, in effect, customized to customer requirements. In planning for or modifying a peripheral switch, the following items must be considered:

a. The peripheral switch unit cannot be used to switch the following units:

(1) A magnetic tape cluster or a 1600 BPI phase encoded magnetic tape unit.

(2) Disk file or disk pack units.

(3) Data Communications single line controls and multi-line controls.

b. All models of the line printer can be switched.

c. A maximum of six magnetic tape units can be placed in a single string.

d. The total cable length between the processor and the peripheral switch unit cannot exceed the length that is currently specified for that unit. Refer to the associated technical manual.

e. Magnetic tape units connected to an exchange cannot be placed in a string. Each unit must be tied directly to the exchange.

SECTION 2

DATA COMMUNICATIONS

SCOPE

This section describes the data communications network used with Medium Data Processing Systems.

DATA COMMUNICATIONS CONTROL UNITS

The following data communications controls can be used on the Medium Data Processing Systems:

a. Single Line Control.

b. Multi-Line Control.

c. Standard Terminal Control.

The single line control (SLC) and the multi-line control (MLC) are functionally equivalent, except that the single line control services one communication line, whereas the multi-line control services a number of communications lines on a time-shared basis.

The single line control and the multi-line control can be adapted to accommodate a variety of data sets and remote terminals. The following are representative of the remote terminals that can be used:

a. Another Medium Data Processing System on dialed or leased lines.

b. B 9350 typewriter on dialed, leased, or directly connected lines.

c. American Telephone and Telegraph (A.T.&T.) 8A1 Selective calling Station (Model 35) on leased lines.

d. A.T.&T. 83B3 Selective Calling Station (Model 28) on leased lines.

e. Teletypewriter Model 33 or 35 on TWX network.

f. IBM 1050 on TWX, dialed, or leased lines.

g. IBM 1030 on leased or direct connect lines.

h. Univac DCT-2000 on dialed or leased lines.

i. Burroughs Input and Display System on dialed, leased, or direct lines.

j. TC 500 or TC 700 on dialed, leased, or direct connect lines.

k. B 300, B 500, and B 5500 on dialed or leased lines.

l. Friden 7311 on dialed or leased lines.

m. B 606/TC 700 on mixed line.

n. TU 100 on switched or leased lines.

o. TU 500 on switched or leased lines.

The primary function of the standard terminal control (STC) is to operate with the Burroughs proprietary terminals that conform to the Burroughs Standard Communication Procedures. In addition, the STC is designed for intercommunications between all Medium Data Processing Systems in either ASCII or EBCDIC code.

No translation is provided for any code by the controls. However, the Audio Line Adapter translates BCL code to an 8-bit EBCDIC code. Code translation is performed by tables stored in the MCP.

SINGLE LINE CONTROL

The single line control (SLC) is a 1 x 85 card position data communications input/output (I/O) control that provides a single line of communications between a Medium Data Processing System and a minimum of one terminal station. Since the SLC is a half-duplex I/O control, it is capable of sending and receiving messages, but not simultaneously.

Terminal Compatibility

Two types of SLC controls are available: model II and model III. Both controls can be adapted to accommodate a variety of terminal units.

The SLC model II does not operate in transparent mode. All line adapters can be used with the model II, except for the following:

a. B 2500/B 2700/B 3500/B 3700/B 4700.

b. DCT-2000.

c. B 606 - TC 700.

d. Touch-Tone. ®

The single line control model III accepts all line adapters, except for the following:

a. B 606 - TC 700.

b. Touch-Tone. ®

Line Adapters

The line adapter is a block of input/output logic consisting of plug-in card sets that provide an interface between the SLC and the terminal unit. All line adapters are field installable and field interchangeable. Through the use of the line adapter, many types of data sets and terminal devices can be used. The data set interfaces the transmission lines to both the system and the terminal device. Also, it provides each terminal device with a carrier on which to place the data flow. The line adapter furnishes the SLC with certain characteristic information to allow the control to recognize the type of remote terminal device to which it is communicating. The essential characteristics supplied by the line adapter are as follows:

a. Character length.

b. Number of required start and stop bits.

c. Whether the operation is synchronous or asynchronous.

d. Type of line control.

e. Type of error control.

f. Control code sensitivity.

Although many variations of a particular adapter type are available, only one variation can be used at a time. The variation is dependent upon the type of remote terminal device being utilized. The line adapter consists basically of four separate circuit cards that are described as follows:

® Registered Service Mark of the A.T.&T. Company.

Card Type	Purpose
Data set control card	Contains control logic for the desired adapter.
Data set data card	Used for the generation of special control terms.
Data set level changer card	Used to change the various logic levels from the data set to the logic levels required by the adapter.
Data set timer card	Required by each adapter to allow the adapter to function at the proper bit-transfer rate (bits-per-second).

Automatic Calling Adapter

The automatic calling adapter requires the use of two additional plug-in circuit cards: the dial level changer card and the dial data card.

When used in conjunction with an automatic calling unit (ACU) and any switched line adapter, the automatic calling adapter provides an automatic calling feature. The automatic calling adapter sends dial digits to the ACU in a 4-bit format that the ACU utilizes to dial the desired telephone number. Once this number is reached and is answered with the proper signal, the ACU turns the phone line over to the adapter. The only function of the ACU and the adapter is to place the call.

There are three types of automatic calling adapters in use, which depend on the type of telephone system in use. The three systems are as follows:

a. Adapter A is utilized with telephone systems that are capable of accepting dial digits immediately upon presentation of the first PND (present next digit) level to the ACU adapter. The A.T.&T. telephone system is an example of this type.

b. Adapter B is used with telephone systems that require a maximum of a one second delay upon acceptance of the dial digits. An independent telephone system is an example of this type.

c. Adapter C is used with British telephone systems and interfaces to specifications of British Post Office document "Technical Guide No. 8."

A configuration for a switch line operation, utilizing an automatic calling adapter, is shown in figure 2-1.

Transmission Codes

Transmission codes vary for the different types of remote terminals utilized. The various code types used in the Medium Data Processing Systems for data communications are as follows:

a. The 8-bit **E**xtended **B**inary **C**oded **D**ecimal **I**nterchange **C**ode (EBCDIC) is the standard internal code used on the Medium Data Processing Systems and is programmatically selectable. The EBCDIC code is used when transferring information between two medium systems.

b. The other programmatically selectable code that the processor uses is the **U**nited **S**ates of **A**merica **S**tandard **C**ode for **I**nformation **I**nterchange (USASCII). This code is an 8-bit extension of the standard 7-bit ASCII code with an eighth bit added to provide a parity bit. The character set consists of 128 characters of which 34 are control characters.

c. The BAUDOT code is used by the Teletype Model 28 teletypewriter. Five bits are used to represent a character, which gives a total binary count of 32 character variations. Since this number of characters is insufficient to meet the requirements of the alpha and numeric characters, a special code, designated the shift code, is used to indicate whether the incoming character is a letter or a figure.

d. PTTC/6 is required to interface to the IBM 1050 terminal.

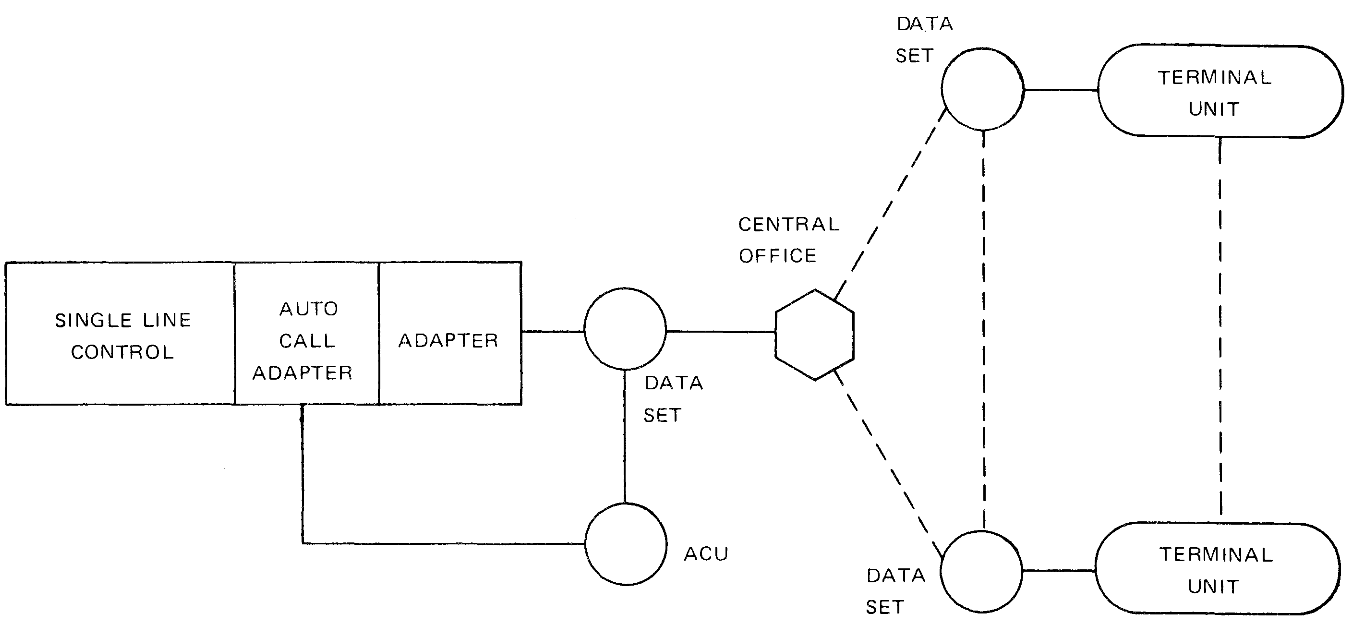

Figure 2-1. Switch Line Configuration with Automatic Calling Operation

Modes of Operation

The single line control is capable of operating in two different modes: asynchronous and synchronous. Refer to figure 2-2.

ASYNCHRONOUS OPERATION

Asynchronous mode of operation means that the two or more communicating devices are not synchronized with one another. The sending device transmits information at any time and the receiving device then synchronizes on that information.

Information transmitted in the asynchronous mode has a start bit preceding each character and at least one stop bit at the end of each character. The receiving device becomes synchronized on the start bit and expects the remaining bits to follow in a prescribed interval of time until the stop bit arrives indicating the end of the character. The advantage of the asynchronous mode of operation is that it allows transmission from irregular devices. However, transmission of the start and stop bits increases the time of transmission and thereby decreases the actual data transmission rate.

SYNCHRONOUS OPERATION

Synchronous mode of operation means that two or more communicating devices are synchronized with each other and, in some way, share a common clock. This clock can be generated by a device external to both devices, such as the telephone company data sets.

In synchronous operation there are no start or stop bits, but rather a synchronous (sync) character that establishes time-coordination between the transmitting and receiving stations. The USASCII code for this character is 16. The sync characters are provided programmatically, and the minimum number of these characters required is dependent upon the specifications of the particular terminal. Prior to receiving the sync character, the receiving station is not sensitive to any other code. When the control receives and recognizes a sync character, it becomes "in sync" with the controlling clock. Once the sync characters are sent, the information follows in a continuous stream, the last bit of a character being followed one bit time later by the first bit of the succeeding character. This stream continues until an end code is sensed, which normally ends the

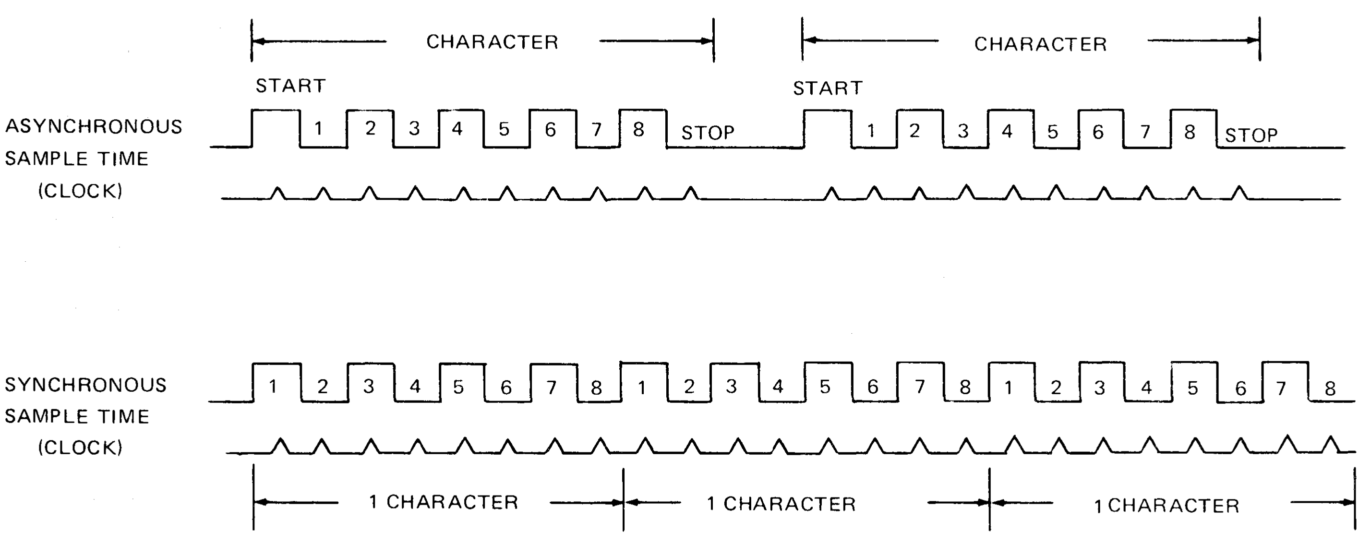

Figure 2-2. Clock-to-Character Relationship

operation. The sync characters are not counted in the block check character (BCC) and are not stored in memory. Also, they are ignored in the transparent mode of operation. The synchronous mode yields a higher data transmission rate.

Line Types

Two categories of transmission lines are available for use by the customer: dedicated and dialed. Each of the types can be further subdivided as follows:

a. Dialed and switched lines.

b. Dedicated, leased, and private lines.

The dial lines can be further subdivided into two separate categories:

a. Voice.

b. Teletypewriter exchange.

The voice lines are suitable for transmission of speech, digital and analog data, and facsimile. The frequency range of these lines is generally between 300 and 3000 Hertz.

On the dialed and switched lines (synonomous), operations are involved in interconnecting circuits in order to establish a temporary communications channel between the two channels. Operations are normally point-to-point, and the amount of billing is based upon the amount of usage.

On the dedicated, leased, and private lines (synonomous), a communication line is provided for the exclusive use of a particular customer on a contract basis, that is, billing is on a monthly basis whether or not the services are used. Multiple point operation is normally used, and the type of transmission is of better quality than that of the dialed and switched lines.

Direct connect is a method in which a remote terminal device is interfaced to the central system. This particular method does not incorporate the use of data sets but consists of a cable from the device to the system.

Configurations for the leased, switched, and direct connect lines are shown in figures 2-3, 2-4, and 2-5.

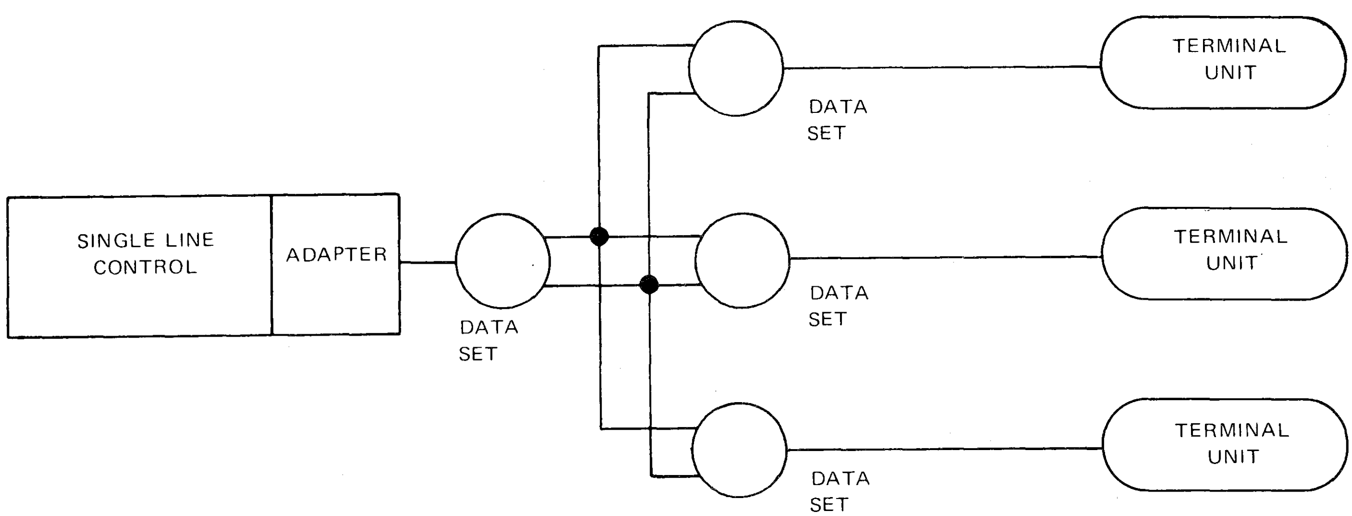

Figure 2-3. Lease Line Configuration

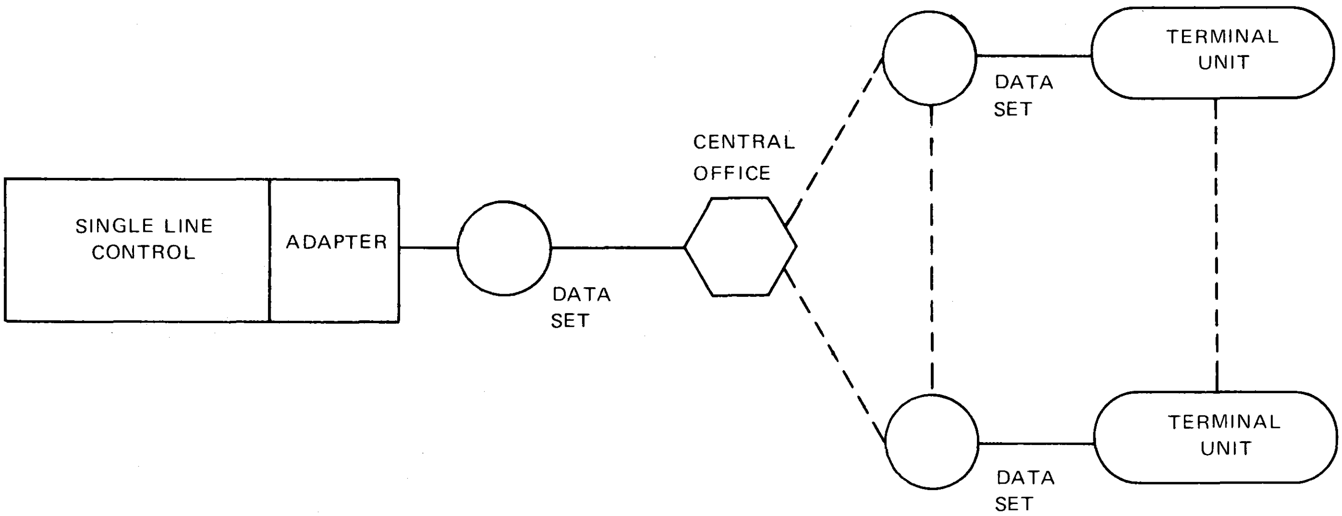

Figure 2-4. Switch Line Configuration

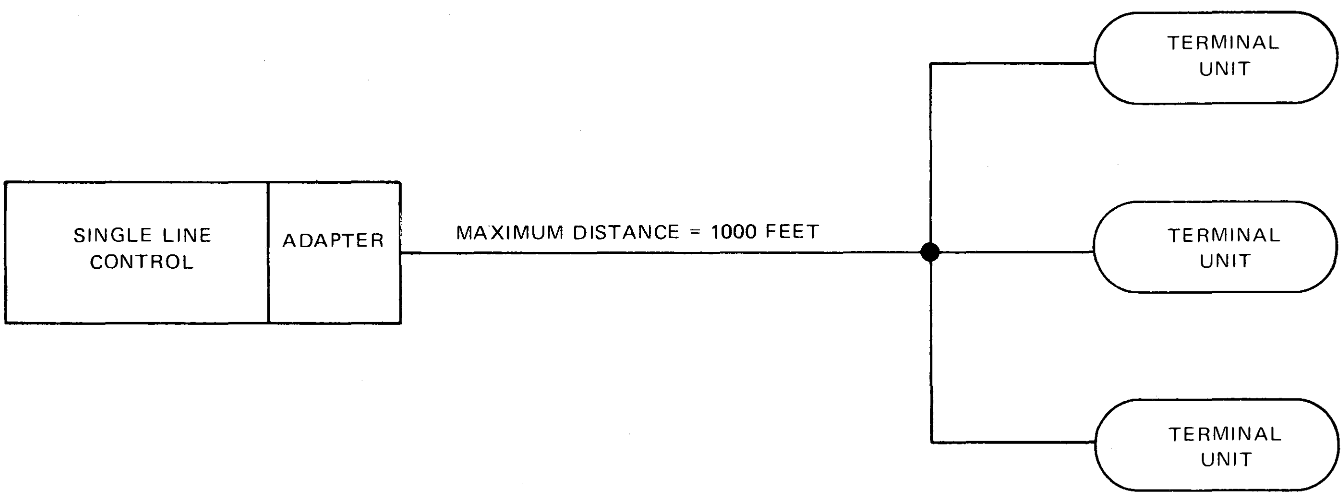

Figure 2-5. Direct Connect Configuration

Data Set Compatibility

The data communications subsystem provides the capability of operating with the following data sets:

Table 2-1. Data Set Compatibility

Line Type	Line Conditioning	Baud Rate	Usage
	1005	≤ 75 BPS	Relay
	1006	≤ 150 BPS	WE 816A
Telephone company private lines	3002	≤ 1000 BPS	WE 103A, WE 103F, WE 202D, WE 403D5, WE 403F3, STELMA 1BRS/1BRS-1, and 1CRS/1CRS-1
	3002 C1	≤ 1200 BPS	TA 212, TA 713, and WE 202D
	3002 C2	≤ 1800 BPS	TA 282, TA 783, and WE 202D
	3002 C4	≤ 2400 BPS	TA 734, and WE 201B1
	3002 CA	≤ 4800 BPS	TA 733
	TWX		WE 103A, and WE 811B
	DATA-PHONE®		WE 103A, WE 103E, WE 202C, WE 201A3, WE 403E3, and WE 403D5
Telephone company switched lines	Wide Area Telephone Service (WATS)	Normal direct distant dialing	WE 103A, WE 103E, WE 202C, WE 201A3, WE 403E3, and WE 403D5
	Class D	≤ 180 BPS	WE 103F
Western Union private lines	Class E	≤ 2400 BPS	WE 202D, WE 201A3, and WE 201B1
	Class F (point-to-point only)	≤ 2400 BPS	WE 202D, WE 201A3, and WE 201B1
International leased lines	Telephonic	≤ 1200 BPS	WE 202D, TA 713 and TA 212
		1200	B.P.O. Datel 1C5, and S.E.L. type GH-2011 model 5
	Voice Grade	≤ 2400	TA 734, TA 774
	TRAFFIC "T" or C1	≤ 4800	TA 733, TA 773
International switched lines	Telephonic	≤ 1200	WE 202C

Optional Data Set Services

The data communications subsystem of the Medium Data Processing Systems does not provide, at the present time, operation with the data set services listed below. However, these services have been considered in the basic planning and can be implemented as the need requires on a Customer Engineering Request (CER) basis.

Table 2-2. Optional Data Set Services

Line Type	Channel Type	Baud Rate	Usage
Telephone company private lines	Schedule 1 Channel	≤ 45 BPS	Relay
	Schedule 2 Channel	≤ 57 BPS	Relay
	Telepac A2 Channel	≤ 40,800 BPS	WE 301B
AUTODIN			MIL 188B
Western Union private lines	Class A Channel	≤ 50 BPS	Relay
	Class B Channel	≤ 57 BPS	Relay
	Class C Channel	≤ 75 BPS	Relay
Western Union switched lines	TELEX	≥ 50 BPS	WU 12150
	Broadband exchange	600 BPS	WU 1601-A
	Broadband exchange	1200 BPS	WU 2121-A
	Broadband exchange	2400 BPS	WU 2241-A
	Broadband exchange	5000 BPS	WU 3051-A
	Broadband exchange	10,000 BPS	WU 30101-A
	Broadband exchange	30,000 BPS	WU 3301-A
International leased lines	Telegraphic	≥ 50 BPS	Relay
International switched lines	TELEX	≥ 50 BPS	WU 12150

In addition to the optional data set services listed above, there are certain parallel data sets that can be made available upon CER request. The sets are as follows:

a. WE 401A

b. WE 401B

c. WE 401E

d. WE 401J

e. WE 402C

f. WE 402D

Input/Output (I/O) Descriptors

INSTRUCTION FORMAT

The various I/O descriptors utilized in the single line control consist of a variable number of 6-digit syllables as shown in figure 2-6.

Digits 1 through 6 specify the type of operation to be performed (OP code), the adapter on which the OP code is to be performed, and the options (variants) available for the operation.

If a memory address is required, then syllables 2 and 3 are utilized along with syllable 1. Syllable 2 contains six digits and is the A or beginning address. Syllable 3 also contains six digits and is the B or ending address. These two syllables specify a memory buffer area used for the storage of data that is to be transmitted or received by the single line control. These addresses are always absolute.

The various single line control I/O descriptors are shown in table 2-3.

Of the variant field (digits D3 through D6), only digits D5 and D6 are used to provide variant values. Therefore, digits D5 and D6 are further broken down as shown in figure 2-7.

The functions of these variant bit numbers are described as follows:

Variant Bit Number	Description
1	A dial number is accessed from memory starting at the locations specified by the A address. The dial number must be in a 4-bit format. The dial field must be terminated by the end-of-number (EON) code. This code is 1100. The total number of digits accessed in the dial field must be even and, if necessary, a filler digit must be added after the EON code. The EON code is not transferred to the automatic calling unit. Information to be written or received starts in the field following the control code, or the filler digit. If an unconditional cancel operation is in progress, the phone line is disconnected and the input requests are ignored.
2	A read-to-control or a write-to-control descriptor operates in a continuous stream mode.
3	Write-to-control flip to read-to-control (WC/RC). This variant is used during a write operation only.
4	Write-to-control flip to read-transparent (WC/RT). This variant is used during a write operation only.
5	The first code received or sent is considered to be text and is used in the generation of the longitudinal parity character (LPC). The start-of-text function is preset.
6	Inhibits the end-of-text (ETX) character from being transmitted. This variant is used during a write operation only.
7	The time-out feature is inhibited. However, if this variant is used with operation code 39, a break is made. A break is a method of stopping incoming data without disconnecting the phone line.
3 and 4	Polling operation (WC/RC/WC/RC...).

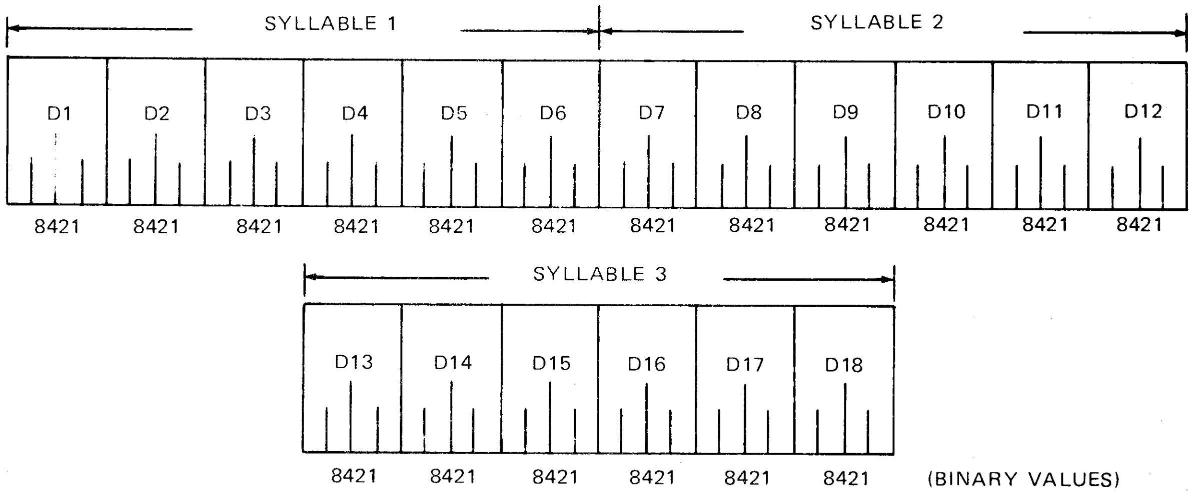

Figure 2-6. Syllable Instruction Format

The following table and paragraphs describe the various descriptors.

Table 2-3. Single Line Control I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Buffer empty	31	UURR	Begin	End	
Read-to-control	32	UUVV	Begin	End	
Write transparent/read-to-control	33	UUVV	Begin	End	
Write-to-control	34	UUVV			
Input request enable	35	UURR			
Conditional cancel	37	UURR			
Unconditional cancel	39	UUVV			
Test	99	UURR			
R denotes bit positions reserved for future expansion.					
V denotes variant bits.					
U denotes adapter number (this number is equal to 0 for SLC).					

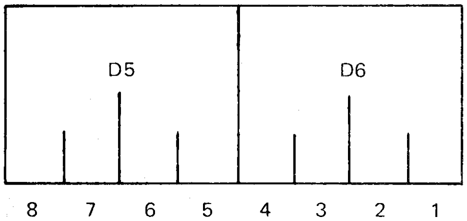

Figure 2-7. Variant Digit Configuration

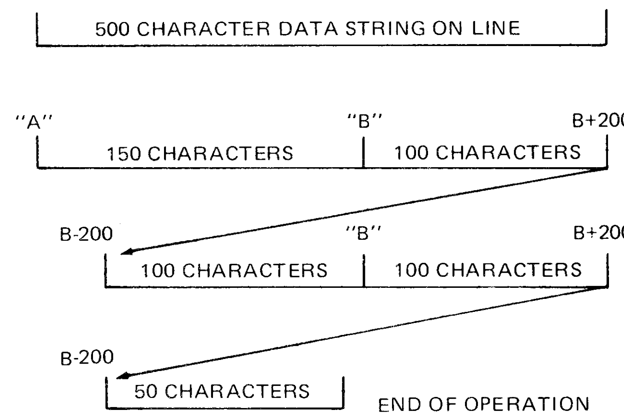

Figure 2-8. Stream Mode Operation

BUFFER EMPTY

This descriptor flags a 100-character buffer that is available to the single line control when operating in stream mode. The buffer lies between the B−200 address and the B address, or between the B address and the B+200 address (figure 2-8).

WRITE-TO-CONTROL

Transmits information from ascending memory locations to a remote device. The information begins at the location specified by the A address and continues until a control code denoting the end-of-text (ETX) is detected. Information must not be in the ending location specified by the B address. Variant bits are used independently and in combination as described below. All digits not defined must be equal to zero. All of the other bit numbers and combinations not listed below are invalid or undefined and not applicable to the single line control. Variant bits that can be used during the write operation are as follows:

Variant Bit Number	Detail Description
2	Stream mode is permitted only for a write-to-control or read-to-control descriptor. All other descriptors are invalid for this operation. The A address and the B address of the I/O descriptor must define at least a 100-character (200-digit) buffer area. A 100-character buffer area is used before and after the B address. The B address is used as a reference point defining two buffer areas. Buffer area 1 is from memory location B-200 up to, but not including, location B. Buffer area 2 is from memory location B up to, but not including, memory location B+200. The initial transmission and/or storage of data continues until the location specified by the B+200 address. Subsequent transmission and/or storage of data is from/to the memory locations defined by buffers 1 and 2. These two buffers are hardware-forced when operating in stream mode by incrementing and decrementing the A and B addresses. Figure 2-8 illustrates the operation of stream mode.

Variant Bit Number	Detail Description
3	The remote terminal device is written to from ascending memory locations beginning with the location specified by the A address and continuing until a control code denoting ETX is detected. Then, the remote device is read from and into ascending memory locations beginning with the locations following the control code that terminates the write. Continue the read until a control code denoting ETX is detected but not including the end location specified by the B address. Each portion of the message that is written and/or read must be terminated by a control code.
4	The remote terminal device is written to from ascending memory locations beginning with the location specified by the A address and continuing until a control code denoting ETX is detected. The remote device is read from and into ascending memory locations beginning at the location following the control code that terminates the write and continuing until, but not including, the end location specified by the B address. When reading in the transparent mode of operation, everything is stored in memory including the control codes. Since end codes cannot be sensed, information ending before reaching the end address causes a timeout to occur. This variant bit is not applicable to the SLC model II.
6	The control code denoting the ETX character is not transmitted, the end-of-transmission (EOT) function is ignored, and the longitudinal parity character is not generated or sent.
3 and 4	Each polling address contained in memory must be delimited by a control code denoting ETX or by a control code denoting a response when not preceded by an STX function code. Detection of the control code delimiting the poll address terminates the write-to-control operation and flips to a read-to-control operation for the response. A negative response is not stored in memory but terminates the read-to-control and flips back to the write-to-control operation for continuation of the polling. A positive response is stored in memory following the code that terminated the write-to-control operation. The read-to-control operation is then terminated in the normal manner. The exhaustion of the poll list is determined by an ETX code immediately following the code delimiting the last poll address. Polling information cannot start with an ETX code.

WRITE TRANSPARENT/READ-TO-CONTROL

The remote terminal device is written to from ascending memory locations beginning with the locations specified by the A address and continuing until, but not including, the end location specified by the B address. The data is then read into ascending memory locations starting at the B address and continuing until a control code denoting ETX is detected but not into the locations specified by the B address plus 200 (B+200). When writing in the transparent mode, everything in memory is sent to the terminal. The single line control is insensitive to any control codes until the end address is reached. This descriptor is not valid on SLC model II.

READ-TO-CONTROL

The data in the remote terminal device is read from and into ascending memory locations beginning with the location specified by the A address and continuing until a control code denoting ETX is detected but not into the end location specified by the B address. The complete message that is read must be terminated by the receipt of the control code.

INPUT REQUEST ENABLE

On switched lines, this descriptor disconnects any existing phone connection and allows the SLC to recognize ring indicators from other dial stations. On leased lines or direct connect lines, the SLC simulates an "on hook" condition by setting itself up to recognize only an enquiry (ENQ) character. The SLC must receive and recognize an input request character before it completes the operation. The ENQ character varies with the various adapters.

CONDITIONAL CANCEL

This descriptor cancels a prior descriptor if an operation is not in progress (SLC is in a "not busy" state) and ignores input requests from the remote devices. The variant bits are reserved and are not used. The cancel can take place during the time period following the write portion but prior to the read portion of a flip command.

UNCONDITIONAL CANCEL

This descriptor cancels a prior descriptor unconditionally. If variant bit 1 is set, the phone line is disconnected and input requests are ignored. If variant bit 7 is set, a break is transmitted to the remote station. These two variant bits must be used individually and cannot be combined.

TEST

This descriptor checks the adapter for a ready or busy condition. The variant bits are reserved and are not used with this descriptor. The conditions that are checked with this descriptor are as follows:

a. Ready — If the adapter is found ready, a channel result descriptor is stored with the adapter identification number indicated in bits 8 through 12.

b. Not ready — If the adapter is found not ready, an adapter card is missing or there is a problem with a data set, the proper result descriptor is set.

c. Busy — If the adapter is found busy, operation in progress, or if the SLC is in a local state, there is no result descriptor stored. However, an invalid descriptor bit is set.

Result Descriptors

A result descriptor is generated for each of the various adapters utilized within the single line control for each operation performed. This descriptor is stored in a fixed location of reserved memory that is reserved for the particular channel being used.

Result descriptor bits 1 and 2 are standard for all descriptors. Bit 1 indicates that the I/O operation is complete and bit 2 indicates that an exception condition exists. The designations for the remaining bits of the result descriptor are as follows:

Descriptor Bits	Description
3	Single line control adapter not ready.
4	Data parity error.
4 and 6	Break detected.
5	Abandon call and retry.
6	Cancel complete.
7	End-of-transmission.
8	Attempt to exceed maximum address.
9	Time out.
10 and 11	Memory parity error.
12	Carrier loss.
13	Stream end-of-text.

MULTI-LINE CONTROL

The multi-line control (MLC) (figure 2-9), is a data communications I/O control that provides up to 36 lines of communications between a Medium Data Processing System and remote terminal stations. Only one MLC is allowable on a single system. Space is available within the MLC itself to accommodate up to four line adapters. If customer needs necessitate more than four line adapters, a multi-line extension is required. The multi-line extension (MLE) provides additional space for up to eight line adapters and up to four of these extensions can be utilized on a single system. Since the MLC operates in half-duplex mode, it can transmit and receive, but not simultaneously.

Three models of the MLC and three models of the MLE are available for use on medium systems: MLC-2, MLC-3 and MLC-5 and MLE-2, MLE-3 and MLE-5. The MLC occupies two large Type B I/O control channel positions and has associated with it reserved memory area for the following:

a. One channel result descriptor. The address equals the channel number multiplied by 20 plus 100.

b. Thirty-six adapter result descriptors. The address equals the adapter number multiplied by 20 plus 480.

c. Two words of address memory for the I/O channel.

d. Seventy-two words of address memory for the adapters.

Line Adapters

Through the use of line adapters, the MLC is able to accommodate a variety of remote terminal devices and data sets. The line adapter is a block of input and output logic, consisting of plug-in card sets that provide an interface between the MLC and the data set.

Line adapters furnish the MLC with certain characteristic information to allow the control to recognize the type of remote terminal device with which it is communicating. The essential characteristics supplied by the line adapter are as follows:

a. Character length.

b. Number of start and stop bits.

c. Whether the operation is synchronous or asynchronous.

d. Type of line control.

e. Type of error control.

f. Control code sensitivity.

MLC-2 AND -3 LINE ADAPTER CARDS

The multi-line controls 2 and 3 consist basically of four plug-in circuit cards that are described as follows:

Card Type	Purpose
Data set control card	Contains the adapter control logics.
Data set data card	Used for the generation of special control terms.
Data set level changer card	Used to change the various logic levels from the data set to the logic levels required by the adapter.
Data set timer card	Since communications can be at different bit-rates (BPS), ranging from 50 bits per second up to 9600 bits per second, a timer card is required for each adapter to allow it to function at its proper speed. This card is also used to produce the adapter identification levels that indicate the type of device being used at the terminal unit.

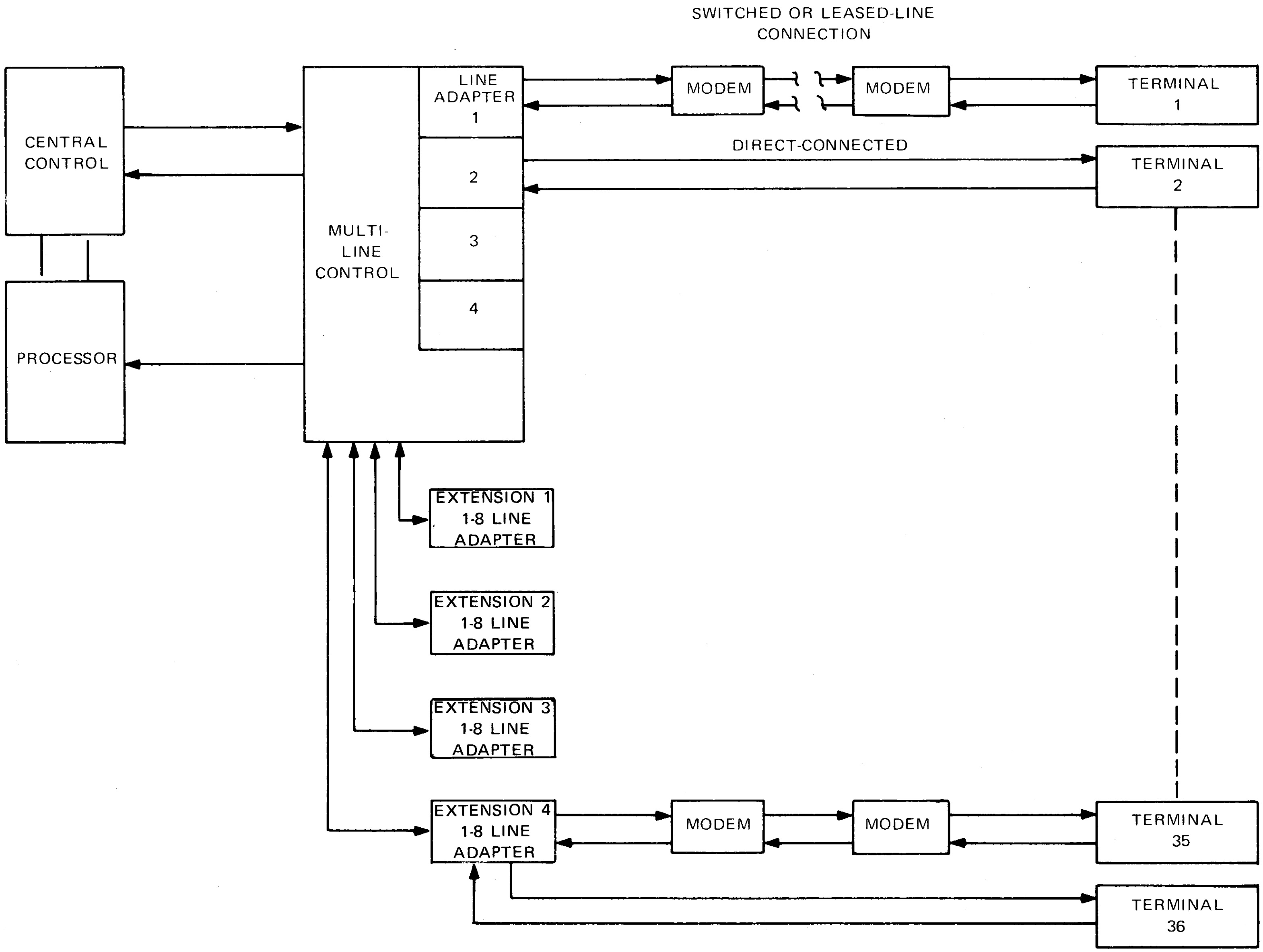

Figure 2-9. Multi-Line Control Block Diagram

MLC-5 LINE ADAPTER CARDS

Multi-line control model 5 basically consists of three plug-in circuit cards that are described as follows:

Card Type	Purpose
D/C logic adapter card	This adapter actually consists of two cards: logic A and logic B. These cards serve the same function as the data set data card and the data set control card that is used in the MLC-2 and MLC-3 controls.
Timer adapter card	Provides adapter identification levels, control functions, and proper clock speed control for the terminal unit on that line
Level changer adapter card	Handles levels to and from the data sets. If the direct-connect method is being used, signals are handled directly to and from a terminal.

MLC Line Adapter Types

Table 2-4 describes the line adapters that can be utilized by the multi-line control. This list also contains the remote terminal type and associated data set type.

Table 2-4. MLC Line Adapter Types

Adapter Type	Terminal Type	Data Set Type
TWX	Model 33 or 35 Teletype	811B
8A1	Model 35 Teletype	816A
B 9350	B 9350 Teletype	Direct connect, 103A or 103F
IBM 1050	IBM 1050	103 A or 103 F
IBM 1030	IBM 1030	202 D
DCT 2000	Univac DCT 2000	201A or 201B
B 2500/B 2700/B 3500/ B 3700/B 4700	B 2500/B 2700/B 3500/B 3700/ B 4700	201A or 201B
Touch-Tone® voice response	Voice Response, Touch-Tone® telephone	403E3 or 403D5
Standard synchronous	B 9352, B 9353, DC 1000 or TD 700	201A, 201B
Standard asynchrounous	B 9352, B 9353, DC 1000, TC 500, TD 700, TU 500, TU 900	202C, 202D, TA713 or TA783
Standard asynchrounous direct	B 9352, B 9353, DC 1000, TC 500, TD 700	None
7311	Friden 7311	103A or 103F
83B3	Model 28 Teletype Selective Calling Station	None
TC 500 (CCITT)	TC 500	202C,202D,TA211,TA212 or TA713
Mixed TC 700/B 606	TC 700,B 606	TA231, +A232
TU 100	TU 100	103A, 103F

Automatic Calling Adapter

The automatic calling adapter, which is used on all three models of the MLC, requires the use of two additional plug-in circuit cards: the dial level changer card and the dial data card.

When used in conjunction with an automatic calling unit (ACU) and any switched line adapter, the automatic calling adapter provides an automatic calling feature. The automatic calling adapter sends dial digits to the ACU in a 4-bit format that the ACU utilizes to dial the desired telephone number. Once this number is reached and is answered with the proper signal, the ACU turns the phone line over to the adapter. The only function of the ACU and the adapter is to place the call.

There are three types of automatic calling adapters in use, which depend on the type of telephone system in use. The three systems are as follows:

a. Adapter A is utilized with telephone systems that are capable of accepting dial digits immediately upon presentation of the first PND (present next digit) level to the ACU adapter. The A.T.&T. telephone system is an example of this type.

b. Adapter B is used with telephone systems that require a maximum of a one second delay upon acceptance of the dial digits. An independent telephone system is an example of this type.

c. Adapter C is used with British telephone systems and interfaces to specifications of British Post Office document "Technical Guide No. 8."

A configuration for a switch line operation, utilizing an automatic calling adapter, is shown in figure 2-10.

Transmission Codes

Transmission codes vary for the different types of remote terminals utilized. The various code types used in the Medium Data Processing Systems for data communications are as follows:

a. The 8-bit **E**xtended **B**inary **C**oded **D**ecimal **I**nterchange **C**ode (EBCDIC) is the standard internal code used on the Medium Data Processing Systems and is programmatically selectable. The EBCDIC code is used when transferring information between two medium systems.

b. The other programmatically selectable code that the processor uses is the **U**nited **S**tates of **A**merica **S**tandard **C**ode for **I**nformation **I**nterchange (USASCII). This code is

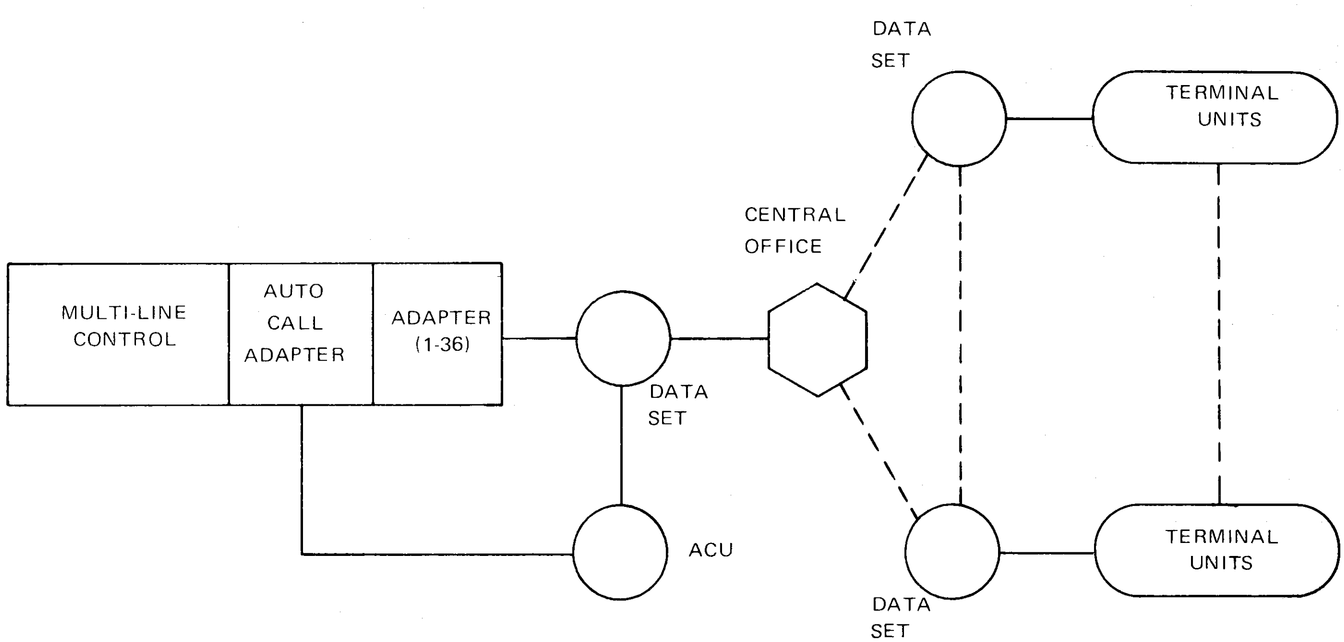

Figure 2-10. Switch Line Configuration with Automatic Calling Operation

an 8-bit extension of the standard 7-bit ASCII code with an eighth bit added to provide a parity bit. The character set consists of 128 characters of which 34 are control characters.

c. The BAUDOT code is used by the Teletype Model 28 teletypewriter. Five bits are used to represent a character, which gives a total binary count of 32 character variations. Since this number of characters is insufficient to meet the requirements of the alpha and numeric characters, a special code, designated the shift code, is used to indicate whether the incoming character is a letter or a figure.

d. PTTC/6 is required to interface to the IBM 1050 terminal.

Modes of Operation

The multi-line control is capable of operating in two modes: asynchronous and synchronous.

ASYNCHRONOUS OPERATION

Asynchronous mode of operation means that the two or more communicating devices are not operating in synchronization with one another. The sending device transmits information at any time and the receiving device then synchronizes on that information.

Information transmitted in the asynchronous mode (see figure 2-2) has a start bit preceding each character and at least one stop bit at the end of each character. The receiving device synchronizes on the start bit and the remaining bits follow within prescribed time intervals until the stop bit arrives, indicating the end of the character.

The transmission line from the data set or remote terminal device is maintained in the marking state when the system is in an idle state. If the line goes to the spacing condition for one-half of a bit time, caused by an incoming start bit, the line adapter expects information to follow and samples the line at the prescribed time interval. At sample time, if the line is in the spacing state, it is recognized as the absence-of-a-bit. If, however, the line is sampled and found to be in the marking state, it is recognized as the presence-of-a-bit.

SYNCHRONOUS OPERATION

Synchronous type of communications means that the communicating devices are in synchronization with one another and, in some way, share a common timing circuit (clock). This clock can be generated by a device external to both devices, such as a data set.

In synchronous operation, shown in figure 2-2, the first character is the only one that is preceded by the start bit. When the control receives and recognizes the synchronous character, it becomes "in sync" with the incoming data. Once the synchronous character is recognized, the information to follow is sent in a continuous stream, the last bit of a character to be followed one bit-time later by the first bit of the succeeding character. This stream continues until the end code is sensed, which normally ends the operation.

The synchronization characters are not generated by the hardware, but are provided programmatically. The quantity of these characters must be sufficient to allow proper synchronization. Usually four of these characters are utilized.

The synchronization characters are not counted in the block check character (BCC) and are not stored in memory.

Line Types

Two categories of transmission lines are available for use by the customer: dedicated and dialed. Each of the types can be further subdivided as follows:

a. Dialed and switched lines.

b. Dedicated, leased, and private lines.

The dial lines can be further subdivided into two separate categories:

a. Voice.

b. Teletypewriter exchange.

The voice lines are suitable for transmission of speech, digital and analog data, and facsimile. The frequency range of these lines is generally between 300 and 3000 Hertz.

On the dialed and switched lines (synonomous), operations are involved in interconnecting circuits in order to establish a temporary communications channel between the two channels. Operations are normally point-to-point and the amount of billing is based upon the amount of usage.

Table 2-5. Data Set Compatibility

Line Type	Line Conditioning	Baud Rate	Usage
Telephone company private lines	1005	$\leq$ 75 BPS	Relay
	1006	$\leq$ 150 BPS	WE 816A
	3002	$\leq$ 1000 BPS	WE 103E, WE 103F, WE 202D, WE 403D5, WE 403F3, STELMA 1BRS/ 1BRS-1, 1CRS/1CRS-1, and WE 816A
	3002 C1	$\leq$ 1200 BPS	TA 212, TA 713, and WE 202D
	3002 C2	$\leq$ 1800 BPS	TA 282, TA 783, and WE 202D
	3002 C4	$\leq$ 2400 BPS	TA 734, and WE 201B1
	3002 C4	$\leq$ 4800 BPS	TA 733
Telephone company switched lines	TWX		WE 103A, and WE 811B
	DATA-PHONE ®		WE 103A, WE 103E, WE 202C, WE 201A3, WE 403E3, and WE 403D5
	Wide Area Telephone Service (WATS)	Normal direct distance dialing	WE 103A, WE 103E, WE 202C, WE 201A3, WE 403E3, and WE 403D5
Western Union private lines	Class D	$\leq$ 180 BPS	WE 103F
	Class E	$\leq$ 2400 BPS	WE 202D, WE 201A3, and WE 201B1
	Class F (point-to-point only)	$\leq$ 2400 BPS	WE 202D, WE 201A3, and WE 201B1
International leased lines	Telephonic	$\leq$ 1200BPS	WE 202D, TA 713 and TA 212
		1200	B.P.O. Datel 1C5, and S.E.L. type GH-2011 model 5
International switched lines	Telephonic	$\leq$ 1200	WE 202C

On the dedicated, leased, and private lines (synonomous), a communication line is provided for the exclusive use of a particular customer on a contract basis, that is, billing is on a monthly basis whether or not the services are used. Multiple point operation is normally used, and the type of transmission is of better quality than that of the dialed and switched lines.

Direct connect is a method in which a remote terminal device is interfaced to the central system. This particular method does not incorporate the use of data sets but consists of a cable from the device to the system.

Configurations for the leased, switched, and direct connect lines are shown in figures 2-3, 2-4, and 2-5.

Data Set Compatibility

The data communications subsystem provides the capability of operating with the data sets listed in table 2-5.

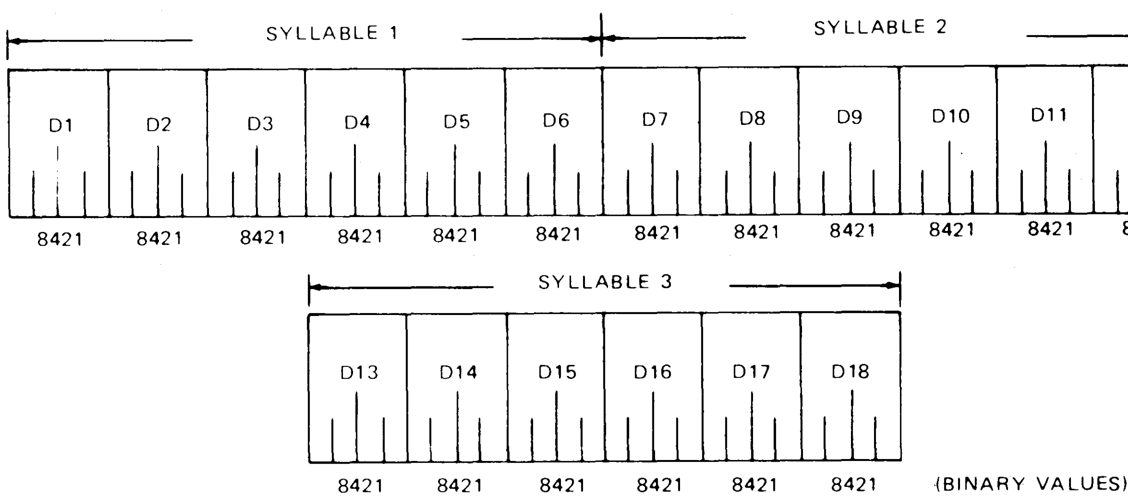

Figure 2-11. Syllable Instruction Format

Table 2-6. Multi-Line Control I/O Descriptors

Operation	Op Code	Digits 3 - 6	Digits 7 - 12	Digits 13 - 18	Digits 19 - 24
Buffer empty	31	UURR			
Read-to-control	32	UUVV	Begin	End	
Write transparent/Read-to-control	33	UUVV	Begin	End	
Write-to-control	34	UUVV	Begin	End	
Input request enable	35	UURR			
Conditional cancel	37	UURR			
Prepare to read address	38	UURR			
Unconditional cancel	39	UUVV			
Test	99	UURR			

R denotes bit positions reserved for future expansion.
V denotes variant digits.
U denotes adapter number.

Input Output (I/O) Descriptors

INSTRUCTION FORMAT

The various I/O descriptors utilized in the multi-line control consist of a variable number of 6-digit syllables as shown in figure 2-11.

Digits 1 through 6 specify the type of operation to be performed (OP code), the adapter on which the OP code is to be performed, and the options (variants) available for the operation.

If a memory address is required, then syllables 2 and 3 are utilized along with syllable 1. Syllable 2 contains six digits and is the A or beginning address. Syllable 3 also contains six digits and is the B or ending address. These two syllables specify a memory buffer area used for the storage of data that is to be transmitted or received by the multi-line control. These addresses are always absolute.

The various multi-line control I/O descriptors are shown in table 2-6.

The I/O descriptors are described in the paragraphs that follow.

BUFFER EMPTY

This descriptor flags a 100-character buffer that is available to the multi-line control when operating in stream mode. The buffer lies between the B-200 address and the B address, or between the B address and the B+200 address.

READ-TO-CONTROL

The data in the remote terminal device is read from and into ascending memory locations beginning with the location specified by the A address and continuing until a control code denoting ETX is detected but not into the end location specified by the B address. The complete message that is read must be terminated by the receipt of the control code.

WRITE TRANSPARENT/READ-TO-CONTROL

Information from ascending memory locations is written to the remote terminal device, beginning with the locations specified by the A address and continuing until, but not including, the end location specified by the B address. The data is then read into ascending memory locations starting at the B address and continuing until a control code denoting ETX is detected but not into the locations specified by the B address plus 200 (B+200). When writing in the transparent mode, everything in memory is sent to the terminal. The multi-line control is insensitive to any control codes until the end address is reached.

WRITE-TO-CONTROL

Transmits information from ascending memory locations to a remote device. The information begins at the location specified by the A address and continues until a control code denoting the end-of-text (ETX) is detected. Information must not be in the ending location specified by the B address. Variant bits are used independently and in combination as described below. All digits not defined must be equal to zero.

Of the variant field (digits D3 through D6), only digits D5 and D6 will be used to provide variant values. Therefore, D5 and D6 is further broken down as shown in figure 2-12.

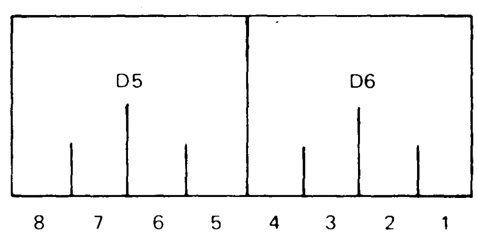

Figure 2-12. Variant Digit Configuration

The functions of these variant bit numbers are shown below:

Table 2-7 contains variant digit bit configurations as utilized by the multi-line control. Refer to figure 2-12 for bit pattern.

FLIP TO READ-TO-CONTROL. When the V variants indicate a write-to-control flip to read-to-control, information from ascending memory locations is written to the remote device, beginning with the location specified by the A address. Writing is continued until a control code that denotes the end-of-text (ETX) is detected.

Data is then read from the remote device into ascending memory locations, beginning with the location following the control code that terminated the writing. Reading continues until a control code that denotes the end-of-text is detected, but reading does not continue into the ending location specified by the B address. Each portion of the message that is written and read must be terminated by a control code.

FLIP TO READ TRANSPARENT. When the V variants indicate a write-to-control flip to read transparent, information from ascending memory locations is written to the remote device, beginning with the location specified by the A address. Writing continues until a control code that denotes the end-of-text is detected.

Variant Bit Number	Description
1	A dial number is accessed from memory starting at the locations specified by the A address. The dial number must be in a 4-bit format. The dial field must be terminated by the end-of-number (EON) code. This code is 1100. The total number of digits accessed in the dial field must be even and, if necessary, a filler digit must be added after the EON code. The EON code is not transferred to the automatic calling unit. Information to be written or received starts in the field following the control code, or the filler digit. If an unconditional cancel operation is in progress, the phone line is disconnected and the input requests are ignored.
2	Stream mode is permitted only for a write-to-control or read-to-control descriptor. All other descriptors are invalid for this operation. The A address and the B address of the I/O descriptor must define at least a 100-character (200-digit) buffer area. A 100-character buffer area is used before and after the B address. The B address is used as a reference point defining two buffer areas. Buffer area 1 is from memory location B-200 up to, but not including location B. Buffer area 2 is from memory location B up to, but not including, memory location B+200. The initial transmission and/or storage of data continues until the location specified by the B+200 address. Subsequent transmission and/or storage of data is from/to the memory locations defined by buffers 1 and 2. These two buffers are hardware forced when operating in stream mode by incrementing and decrementing the A and B addresses. Figure 2-8 illustrates the operation of stream mode.
3 and 4	Not used.
5	The first code received or sent is considered to be text and is used in the generation of the longitudinal parity character (LPC). The start-of-text function is preset.
6	Not used.
7	The time-out is inhibited. If, however, this variant is used with operation code 39, a break is made. A break is a method of stopping incoming data without disconnecting the phone line.

Table 2-7. Variant Digit Bit Configurations

Variant Digit Bits				Description
8	4	3	2	
0	0	0	0	Write-to-control (WC)
0	0	0	1	Write-to-control (stream mode)
0	0	1	0	Write-to-control flip to read-to-control (WC/RC)
0	0	1	1	Invalid or undefined
0	1	0	0	Write-to-control flip to read transparent (WC/RT)
0	1	0	1	Invalid or undefined
0	1	1	0	Polling (WC/RC/WC/RC)
0	1	1	1	Recirculating polling
1	0	0	0	Write-to-control except the selected Touch-Tone ® adapter output tones instead of voice. These tones (tone bus A and tone bus B) are transmitted from 200 to 400 milliseconds.
1	0	0	1	Invalid and undefined
1	0	1	0	Write-to-control (tone) flip to read-to-control (WC (tone)/RC)
1	0	1	1	Invalid and undefined
1	1	0	0	Invalid and undefined
1	1	0	1	Invalid and undefined
1	1	1	0	Invalid and undefined
1	1	1	1	Invalid and undefined

Data is then read from the remote device into ascending memory locations, beginning at the location following the control code that terminated the write. Reading continues until, but not into, the ending location specified by the B address.

POLLING. When the V variants indicate polling, each poll address contained in memory must be delimited by the ending control code character ENQ (enquiry).

Detection of the code that delimits the poll address terminates the write-to-control operation and flips to a read-to-control operation for the response. A negative response code is not stored in memory but terminates the read-to-control and flips back to the write-to-control operation for continuation of a polling.

A positive response is stored in memory following the code that terminated the write-to-control operation. The read-to-control operation is then terminated in the normal manner. The exhaustion of the poll list is determined by an ETX code immediately following the code delimiting the last poll address. Note that polling information cannot start with an ETX code.

A no response condition results in the operation being terminated after a predetermined period.

INPUT REQUEST ENABLE

On switched lines, this descriptor disconnects any existing phone connection and allows the MLC to recognize ring indicators from other dial stations. On leased lines or direct connect lines, the MLC simulates an "on hook" condition by setting itself up to recognize only an enquiry (ENQ) character. The MLC must receive and recognize an input request character before it can complete the operation. The ENQ character varies with the various adapters.

CONDITIONAL CANCEL

This descriptor cancels a prior descriptor if an operation is not in progress, MLC is in a "not busy" state, and ignores input requests from remote devices. The variant bits are reserved and are not used. The cancel can take place during the time period following the write portion but prior to the read portion of a flip command.

PREPARE TO READ ADDRESS

From the address memory locations of the adapter, the A and B addresses are transfered to the address memory locations of the desired channel.

UNCONDITIONAL CANCEL

This descriptor cancels a prior descriptor unconditionally. If variant bit 1 is set, the phone line is disconnected and input requests are ignored. If variant bit 7 is set, a break is transmitted to the remote station. These two variant bits must be used individually and cannot be combined.

TEST

This descriptor checks the adapter for a ready or busy condition. The variant bits are reserved and are not used with this descriptor. The conditions checked with this descriptor are as follows:

a. Ready - If the adapter is found ready, a channel result descriptor is stored with the adapter identification number indicated in bits 8 through 12.

b. Not ready - If the adapter is found not ready, an adapter card is missing or there is a problem with a data set, the proper result descriptor is set.

c. Busy - If the adapter is found busy, operation in progress, or if the MLC is in a local state, there is no result descriptor stored. However, an invalid descriptor bit is set.

Result Descriptors

A result descriptor is generated for each of the various adapters utilized within the multi-line control for each operation performed. This descriptor is stored in a fixed location of reserved memory that is reserved for the particular channel being used.

Result descriptor bits 1 and 2 are standard for all descriptors. Bit 1 indicates the I/O operation is complete and bit 2 indicates that an exception condition exists.

Table 2-8 documents the various result descriptors. It is segmented into two categories: multi-line control result descriptors and adapter result descriptors. If an unsuccessful attempt is made during initialization of the control itself, one or more of the result descriptors listed in the column under Multi-Line Control Result Descriptors is returned. However, if the initialization is successful, and result descriptors incurred are those listed in the column under Multi-Line Adapter Result Descriptors.

STANDARD TERMINAL CONTROL

The standard terminal control (STC) is an input/output device designed for data communications use on all Medium Data Processing Systems. The primary function of the STC is to operate with the Burroughs proprietary terminals that conform to the Burroughs Standard Communication Procedures. In addition, the STC is fully designed for intercommunications between all Medium Data Processing Systems in either ASCII or EBCDIC code.

Physically, the standard terminal control is a small, Type A peripheral control and has associated with it two words of central processor address memory and reserved memory area for one result descriptor.

One code, one interface, and one timer adapter are required in the control. The automatic calling adapter (ACA), described later, is an optional feature. All adapters can be installed in the field.

Table 2-8. Multi-Line Control Result Descriptors

Multi-Line Control Result Descriptors		Multi-Line Adapter Result Descriptors	
Bit	Description	Bit	Description
3	Not ready. The channel is in local mode.	3	Not ready.
4	Adapter is busy. The I/O descriptor is not being accepted.	4	Data error (message or character parity).
		4 and 5	Memory access error.
5 - 12	Reserved	4, 5 and 11	Write data loss.
13 - 16	Equal to 0.	5	Abandon call, and retry. The phone line is disconnected. The line is busy until reenabled.
		6	Cancel complete.
		6 and 7	Write break detect. The phone line is not disconnected.
		7	End of transmission. The phone line is disconnected.
		8	Attempt to exceed maximum address during a read operation. The phone line is not disconnected.
		8 and 11	Identical to 8 except during a write operation.
		9	Time-out. The phone line is not disconnected.
		10 and 11	Write memory parity error. The phone line is not disconnected.

Terminal Compatibility

The STC services one communication line through the use of the data set interface or, for local installation, can be connected through the two-wire direct interface.

DATA SET INTERFACE

The data set interface (DSI) can be used for both synchronous and asynchronous data sets. These data sets are listed as follows:

a. WE-103G.

b. WE-103F.

c. WE-201A.

d. WE-201B.

e. WE-202C.

f. WE-202D.

g. TA 713.

h. TA 783

In the asynchronous mode, timer adapters, all of which are quickly interchangeable in the field, are available at the following rates:

a. 150 BPS.

b. 300 BPS.

c. 600 BPS.

d. 1200 BPS.

e. 1800 BPS.

f. 2400 BPS.

g. 4800 BPS.

h. 9600 BPS.

TWO-WIRE DIRECT INTERFACE

The two-wire direct interface (TDI) is used for local terminal operation. Using the TDI interface, only the asynchronous timer adapter can be used. Figure 2-13 diagrams the two-wire direct interface.

TERMINAL UNITS

The following is a list of remote terminal devices available for use on the standard terminal control:

a. Another Medium Data Processing System.

b. Burroughs Input and Display System.

c. Burroughs Input and Display Terminal.

d. TC 500 Terminal Computer.

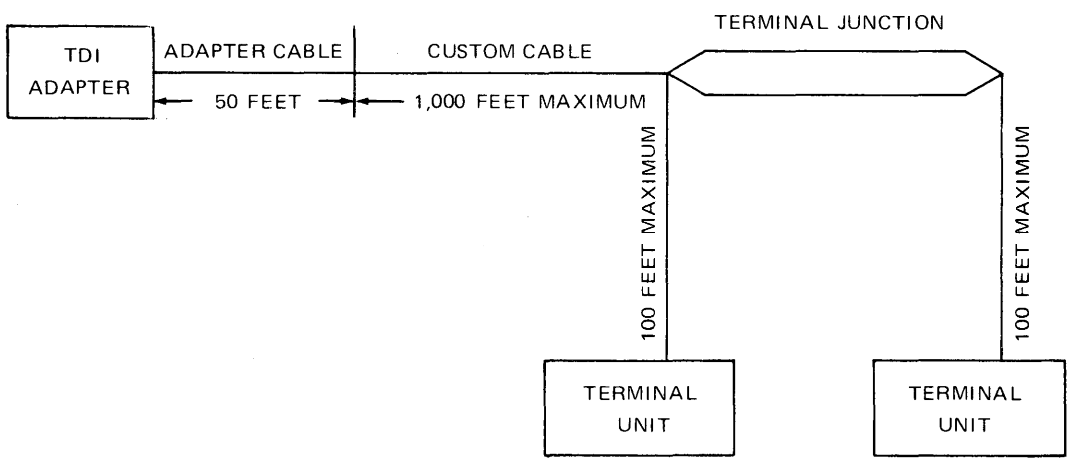

Figure 2-13. Two-Wire Direct Interface

Options

Several options are inherent in the design of the STC, all of which can be exercised by field personnel. Included are the following interfacing options: switch line option, direct connection option and, if neither is utilized, the STC assumes lease line procedures.

Half-duplex and full-duplex options are also available. In full-duplex, data turn around time, time in switching from transmitting to receiving mode, is noticeably improved, thus creating a more efficient means of communication.

The constant carrier option is utilized in the full-duplex mode only. This option allows the associated data set to remain in a constant transmit mode; this, in turn, alleviates the otherwise necessary request-to-send (RTS) and clear-to-send (CTS) delays.

Automatic Calling Unit

The automatic calling unit, described previously in the single line and multi-line sections of this volume, is available for use with the STC.

Standard Terminal Control I/O Descriptors

The various standard terminal control I/O descriptors are shown in table 2-9. The following is a brief description of these I/O descriptors.

READ-TO-CONTROL

Data is read from the remote device into ascending memory locations, beginning with the location specified by the A address and continuing until a control code is detected but not including the end address specified by the B address. The complete message read must be terminated by the receipt of the control code. The digit 5 and 6 variant bits used in this descriptor are shown in figure 2-12. The bits of these two digits are numbered from 1 through 8 as follows:

Variant Bit	Description
8	A dial number is accessed from memory starting at the location given by the A address. The dial number must be in a 4-bit format and must be terminated by the end-of-number (EON) code (1100). The total number of digits accessed in the dial field must be even and, if necessary, a filler digit must be added after the EON code. The information to be written or received starts in the field following the EON code or filler digit, as the case may be.
4	Preset start-of-text (STX). The first code received or sent is considered text and is used to generate the longitudinal parity character (LPC).
2	The time-out feature is inhibited.

WRITE-TO-CONTROL

Data is written to the remote terminal device from ascending memory locations beginning with the location specified by the A address and continuing until a control code denoting end-of-text (ETX) is detected. Information must not be in the ending location specified by the B address. The complete written message must be terminated by an ending control code. The following variant bits are used in this descriptor:

Variant Bit	Description
8	Refer to variant bit 8 of the read-to-control descriptor.
4	Refer to variant bit 4 of the read-to-control descriptor.
3	Deletes the STX control code.
2	Inhibits the time-out feature.

Table 2-10 contains variant digit combinations utilized in the write-to-control descriptor. Refer to figure 2-12 for a layout of variant bits 7, 6, 5, and 1.

Table 2-9. Variant Digit Bit Configuration

Variant Digit Bits 7	6	5	1	Description
0	0	0	0	Write-to-control (WC)
0	0	0	1	Invalid and undefined
0	0	1	0	Write-to-control flip to read-to-control (WC/RC)
0	0	1	1	Invalid and undefined
0	1	0	0	Write-to-control flip to read transparent (WC/RT)
0	1	0	1	Invalid and undefined
0	1	1	0	Automatic polling (WC/RC/WC/RC)
0	1	1	1	Recirculation poll
1	0	0	0	Invalid and undefined
1	0	0	1	Invalid and undefined
1	0	1	0	Invalid and undefined
1	0	1	1	Invalid and undefined
1	1	0	0	Invalid and undefined
1	1	0	1	Invalid and undefined
1	1	1	0	Invalid and undefined
1	1	1	1	Invalid and undefined

FLIP TO READ-TO-CONTROL. When the V variants indicate a write-to-control flip to read-to-control, information from ascending memory locations is written to the remote device, beginning with the location specified by the A address. Writing is continued until a control code that denotes the end-of-text (ETX) is detected.

Data is then read from the remote device into ascending memory locations, beginning with the location following the control code that terminated the writing. Reading continues until a control code that denotes the end-of-text is detected, but reading does not continue into the ending location specified by the B address. Each portion of the message written and read must be terminated by a control code.

FLIP TO READ TRANSPARENT. When the V variants indicate a write-to-control flip to read transparent, information from ascending memory loctions is written to the remote device, beginning with the location specified by the A address. Writing continues until a control code that denotes the end-of-text is detected.

Data is then read from the remote device into ascending memory locations, beginning at the location following the control code that terminated the write. Reading continues until, but not into, the ending location specified by the B address.

POLLING. When the V variants indicate polling, each poll address contained in memory must be delimited by the ending control code character ENQ (enquiry).

Detection of the code that delimits the poll address terminates the write-to-control operation and flips to a read-to-control operation for the response. A negative response code is not stored in memory but terminates the read-to-control and flips back to the write-to-control operation for continuation of a polling.

A positive response is stored in memory following the code that terminated the write-to-control operation. The read-to-control operation is then terminated in the normal manner. The exhaustion of the poll list is determined by an ETX code immediately following the code delimiting the last poll address. Note that polling information cannot start with an ETX code. A no response condition results in the operation being terminated after a predetermined period.

RECIRCULATION POLLING. This polling operation operates in a similar manner to the polling operation previously discussed with one minor exception. The ending code that delimits the poll list must be an end-of-text that is used to advance a counter in the control and not to terminate the polling. An additional EXT character immediately following the EXT character that advanced the counter causes the control to decrement the A

Table 2-10. Standard Terminal Control I/O Descriptors

Operation	Op Code	Digits 3-6	Digits 7-12	Digits 13-18	Digits 19-24
Read-to-control	32	RRVV	Begin	End	
Write-to-control	34	RRVV	Begin	End	
Write transparent/read-to-control	33	RRVV			
Input request enable	35	RRRR			
Unconditional cancel	39	RRVV			
Conditional cancel	37	RRRR			
Test	99	RRRR			

R denotes bit positions reserved for future expansion.

V denotes variant bits.

address by 100 N, where N is the value of the counter. The timer is simultaneously cleared and polling continues. Since the counter is able to advance up to a count of four, up to four 50-character poll lists can be used repetitively until a positive response is returned or a cancel is received.

The cancel code (ASCII 18) is used to fill character slots in the polling string. Upon detection of this character, it is not transmitted but is discarded. The control then proceeds to the next character in the polling string.

If no response is received from a polling terminal, the control times out in the normal manner.

WRITE TRANSPARENT/
READ-TO-CONTROL

Information from ascending memory locations is written to the remote device, beginning with the location specified by the A address. Writing continues until the ending address, but not into the ending location specified by the B address. Data is then read into ascending memory locations, starting at the B address. Reading continues until a control code that denotes the end-of-text is detected, but not into the location specified by the B address plus 200. Variant bits applicable to this descriptor are 2 and 8, explained previously under write-to-control.

INPUT REQUEST ENABLE

On a dial line, the line is disconnected and the system waits for the RING indicator and data set READY indicator to light. On a leased line, the system waits for an input request ENQ (enquiry) character.

UNCONDITIONAL CANCEL

The prior descriptor is cancelled unconditionally. If a variant bit 8 is present, the phone line is disconnected. Any input request is then ignored. If no operation is in progress, and a switched line connection is not made, the operation is invalid.

CONDITIONAL CANCEL

A conditional cancel descriptor initiated during a standard polling operation is allowed. Depending upon the response of the poll, the following three results are possible:

a. Negative response (NAK). Upon receipt of the NAK response, cancel immediately.

b. Positive response (message). The message is completed upon detection of the ETX character, and the cancel does not occur.

c. No response (time-out). The operation is complete when the time-out occurs; the cancel does not take place.

A conditional cancel descriptor initiated during a write-to-control operation is not executed, the operation is invalid.

A conditional cancel descriptor initiated after a read-to-control operation is started results in one of the following:

a. If no data is received, the cancel is executed.

b. If data is being received, the cancel is not executed. The operation is invalid.

A conditional cancel descriptor initiated after a write-to-control flip to read-to-control (WC/RC), write transparent flip to read-to-control (WT/RC) or write-to-control flip to read transparent (WC/RT) will cancel the read portion of the flip command, provided data has not been received. If data is being received the initiation of the cancel will be invalid.

TEST

The test descriptor tests for a ready or busy condition of the standard terminal control.

Result Descriptors

A result descriptor is generated for each of the various adapters utilized on the STC for each operation performed. This descriptor is stored in a fixed location of reserved memory that is reserved for the particular channel being used.

Result descriptor bits 1 and 2 are standard for all descriptors. Bit 1 indicates the I/O operation is complete, and bit 2 indicates that an exception condition exists.

The various result descriptors of the STC are as follows:

Descriptor Bits	Description
3	Data set or automatic calling unit (ACU) not ready
4	Data error
4 and 5	Data loss (read)
4, 5 and 11	Data loss (write)
5	Abandon call, and retry
6	Cancel complete
8	Attempt to exceed maximum address
9	Time-out
10 and 11	Memory parity error (write)
12	Carrier loss (read)
13-16	Reserved

DATA COMMUNICATIONS PROCESSOR (DCP)

The DCP (B x350) used in conjunction with a Type B I/O channel and DCP control (B x352) relieves the central system of communication overhead and allows the host system to revert to an orderly mode of operation. Along with satisfying the standard interfaces to the communication environment and host CPU, the DCP performs: line control, character/message assembly, code conversion, data and message editing, error control and message buffering. These functions can be easily managed through the use of the DCP Network Definition Language (NDL). NDL efficiently generates a data communication program for the DCP that accommodates the specified communication environment. In addition, programs can be easily and efficiently coded in DC assembly language. A total data communication environment can be increased to 64 lines, expandable from a basic 16 lines in 16-line increments.

The DCP is designed to support Data Communications Subsystems for more than one central system. The internal functional hardware of the DCP consists of the following:

a. Central processor.

b. Memory.

c. Direct memory access.

d. Input/output interface to the DCP control.

e. Peripheral controllers.

Central Processor

The DCP central processor employs parallel arithmetic and parallel word transfers for maximun speed. Accumulator operations such as "add" and "store" are performed with variable word lengths for 8 to 32 bits. The variable word length feature allows a programmer to utilize the precision required rather than fitting the data to the precision of the machine.

The DCP Central Processor can operate in two environments:

a. Environment 1 is interruptable and can perform the following functions:

1. Line control.

2. Message editing and formatting.

3. Interpretation of heading information.

4. Preparation of buffer areas for data receipt or transmission.

b. Environment 2 is non-interruptable and can perform the following functions:

1. Input/output transfers.

2. Storage and retrieval of buffer areas.

3. Checks for control characters.

Each of the environments may be either current or non-current with changes between environments requiring only 1.5 microseconds. The flexibility of the environment is due to the duplication of the registers. Each environment has its own:

a. Accumulator.

b. Program address register.

c. Index register.

Memory

The DCP incorporates a high-speed (1.5 microsecond memory-cycle speed with a 500-nanosecond read-access time) random access memory of modular construction. It is a magnetic core memory with coincident current read and write control. Each memory module has a capacity of 4,096, eight- or nine-bit words. The nine-bit memory uses the ninth bit for parity. The memory is expandable from 16,384 bytes to 32,768 bytes in 4,096 byte increments to support a greater number of lines and terminals, and more complex network functions.

Direct Memory Access Port (DMA)

The DMA port enables high-speed direct memory access to the host central system at a rate of 50,000 bits per second. The DMA also allows peripheral units of the data communications subsystem to interrupt the DCP central processor without disturbing the operational registers; the interrupted program continues at the conclusion of the DMA transfer.

Input/Output Interface to DCP Control of Host Central System, (See Figure 2-14.)

The DCP provides five types of I/O operations:

a. Sense external device (SENS). The status of the DCP control is interrogated by the DCP under program control.

b. Function control (FUNS). A control code is transferred under program control to the DCP control.

c. Byte transfer in (BTIS). A single byte of data is transferred under program control from the DCP control to the least significant eight bits of the current accumulator.

d. Byte transfer out (BTOS). A single byte of data is transferred under program control to the DCP control from the least significant eight bits of the current accumulator.

e. Interrupt. The DCP control transmits an interrupt to the DCP to initiate special program subroutines.

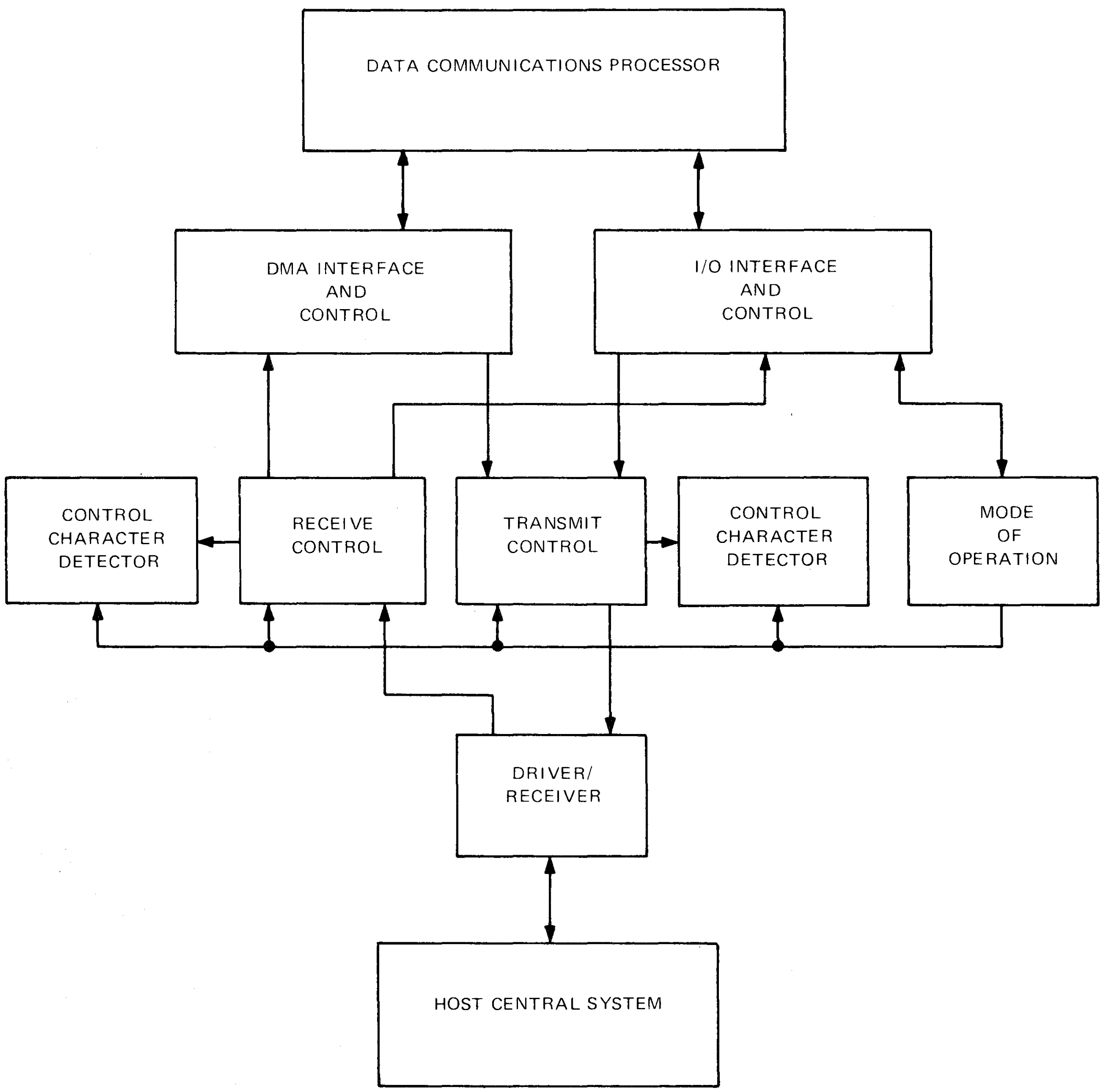

Figure 2-14. DCP I/O Interface

SENSE EXTERNAL DEVICE (SENS) INSTRUCTION DESCRIPTION

I/O Address XXX01100:

SEN 0 — True when the DCP Control requires service by the DCP. The status byte must be interrogated to determine what kind of service. The following conditions cause SEN 0 to sense true.

a. Transmitter needs data.

b. Receiver needs data.

c. Received line break.

d. Byte count overflowed.

e. Transmit complete.

f. Receive complete.

g. Interrupt test.

h. Overflow or underflow.

i. DMA timing error.

SEN 1— Test transmit parity. Parity is generated on accumulator bits 00 through 06. SEN 1 senses true if the calculated parity bit is a one; it senses false if the calculated parity bit is a zero.

SEN 2 — Test R/T oscillator. After enabling the oscillator with test FUN 4, SEN 2 will sense true in 90 μs. SEN 2 senses true every 100 μs thereafter.

SEN 3 — Test data-line. SEN 3 is sensing the transmit serial data stream. A one bit senses true, a zero bit will sense false.

SEN 4 — Test receive parity. Parity is accumulated on data bits 00-06 and compared with data bit 07. Correct parity senses false, incorrect parity senses true.

SEN 5 — Test start bit. SEN 5 senses true when a start bit is detected. SEN 5 continues sensing true until a stop bit (tenth bit) is detected.

FUNCTIONAL CONTROL (FUNS) INSTRUCTION DESCRIPTION

I/O Address XXX01100:

FUN 0 — Initialize. The DCP control is initialized to the idle condition; mode of operation reset, interrupts reset, interrupt enable reset, bit counters set to $F, data line set marking, status conditions reset, BCC generators reset, etc. Console reset performs the same functions as FUN 0.

FUN 1 — Enable interrupts. The DCP control interrupts are enabled. No interrupts are realized unless FUN 1 has been issued.

FUN 2 — Disable interrupts. DCP control interrupts are disabled.

FUN 3— Transfer data byte. The data byte output with BTO 4 is set into the transmit disassembly buffer. An interrupt or DMA request occurs immediately to acquire the second data character.

FUN 4 — Send line break. The transmit data line is set to spacing (zero) for 1 character time. An interrupt occurs after line break is transmitted.

FUN 5 — Send time fill (marks). The transmit data line will be held marking (ones) until FUN 6 is issued. Data interrupts will occur every 100 μs until DCP control is re-initialized or time fill is reset with FUN 6.

FUN 6 — Reset time fill. The time fill mode set with FUN 5 is reset with FUN 6.

FUN 7 — Execute. The mode selected with BTO 5 is executed.

I/O Address XXX01110:

FUN 0 — Transmit test clock. One transmit shift clock occurs whenever FUN 0 is issued in the test mode.

FUN 1 — Receive test clock. One receive shift clock occurs whenever FUN 1 is issued in the test mode.

FUN 2 — Counter test clock. Whenever FUN 2 is issued the DMA address register is incremented and DMA byte counter is decremented by one.

FUN 3 — Interrupt test. FUN 3 will generate a DCP interrupt if the interrupts have been properly enabled.

FUN 4 — Start oscillator test. The 100KC oscillator is enabled in the test mode.

FUN 5 — Error Sync. Whenever an error occurs in the diagnostic and maintenance program FUN 5 is issued. This pulse may be used as an oscilloscope trigger to aid in fault isolation.

BYTE TRANSFER IN (BTIS) INSTRUCTION DESCRIPTION

I/O Address XXX01100:

BTI 0 — Input starting address, bits 00-07. The least significant 8 bits of the 15-bit DMA address register is input to the current accumulator.

BTI1 — Input starting address, bits 08-14. The most significant 7 bits of the 15-bit DMA address register is input to the current accumulator.

BTI2 — Input number of bytes, bits 00-07. The least significant 8 bits of the 15-bit DMA byte counter is input to the current accumulator.

BTI3 — Input number of bytes, bits 08-14. The most significant 7 bits of the 15-bit DMA byte counter is input to the current accumulator.

BTI4 — Input transmit buffer one (test). The data byte output with BTO 4 is input to the current accumulator. Parity has not been inserted at this time, so the input byte is the same as the output byte.

BTI5 — Input transmit buffer two (test). The data byte output with BTO 4 and moved with FUN 3 is input to the current accumulator. Odd/even parity, if selected with BTO 5, resides in bit 7 at this time.

BTI6 — Input receiver assembly buffer (test). The serial data stream generated with test clock FUN 4 appears in buffer one sequentially starting at bit 0. The received parity bit is in bit 7.

BTI7 — Input received data. The data accumulated in the assembly buffer is transferred to the received data buffer during clock ten. The calculated parity indication appears in bit 7 if odd/even parity was selected with BTO 5.

I/O Address XXX01110:

BTI 0 — Input receive block check character. BCC is generated by half adding every character in a register. BCC generation is enabled when the controller is in the DMA mode or by issuing FUN 5.

BTI1— Input transmit block check character. See BTI 0.

BTI2— Input mode of operation (test). The mode of operation output with BTO 5 is input to the current accumulator as a test function.

BTI3— Input R/T bit counters (test). The receive bit counter is input by way of accumulator bits 0-3, the transmit bit counter by way of bits 4-7. Both bit counters initialize to $F. They increment to $0, 1, 2, 3, 4, 5, 6, 7, 8, and $F again. The interrupts and DMA requests are set when count $8 is reached. Both counters may be incremented with test clock FUN 5 after proper selection with BTO 5.

BTI4— Input status. The status of the DCP control is input to the DCP by way of BTI 5. The status bits are reset after being input. The interrupt and sense conditions are also reset with BTI 4. The accumulator bits are coded in the following manner:

Bit 0	Set	Transmit complete
Bit 1	Set	Transmitter needs data
Bit 2	Set	Line break detected
Bit 3	Set	Interrupt test
Bit 4	-	Spare
Bit 5	-	Spare
Bit 6	Set	Receiver needs data
Bit 7	Set	Receive complete

BTI5— Input error status. The error status of the DCP Control is input to the DCP by way of BTI 5. The status functions are reset after BTI 5 inputs the data to the DCP. The accumulator bits are coded in the following manner.

Bit 0	Set	Receive parity error
Bit 1	Set	Transmit parity error
Bit 2	Set	Byte count exceeded
Bit 3	Set	Spare
Bit 4	Set	Spare
Bit 5	Set	DMA timing error
Bit 6	Set	Overflow condition
Bit 7	Set	Underflow condition

BYTE TRANSFER OUT (BTOS) INSTRUCTION DESCRIPTION

I/O Address XXX01100:

BTO 0 — Output starting address, bits 00-07. Loads the least significant 8 bits of the 15-bit DMA address register from the current accumulator.

BTO 1 — Output starting address, bits 08-14. Loads the most significant 7 bits of the 15-bit DMA address register from the current accumulator.

BTO 2 — Output number of bytes, bits 00-07. Loads the least significant 8 bits of the 15-bit DMA byte counter from the current accumulator.

BTO 3 — Output number of bytes, bits 08-14. Loads the most significant 7 bits of the 15-bit DMA byte counter from the current accumulator.

BTO 4 — Output data byte. The current accumulator is output to the DCP control as one byte of data. Zero's must be inserted in the most significant bits if less than 8-bit codes are being transmitted.

BTO 5 — Output mode of operation. The current accumulator is output to the DCP control selected by the current mode of operation. The accumulator bits are coded in the following manner:

Bit 0	Set	Transmit
Bit 1	Set	Receive
Bit 2	Set	Transmit data thru DMA
Bit 3	Set	Receive data thru DMA
Bit 4	Set	Do not send BCC
Bit 4	Reset	Send BCC
Bit 5	Set	Odd parity
Bit 7	Set	Test mode

Peripheral Controllers

The peripheral controllers provide the logic required to interface the DCP with the network terminals. These controllers are "Soft" (programmable) through the terminal interface which permits maximum configuration flexibility without requiring physical modification of the data communication subsystem.

APPENDIX A
EBCDIC, ASCII, AND BCL REFERENCE TABLES

The charts reflected in this appendix define the EBCDIC, ASCII, and BCL code specifications as implemented by Burroughs Corporation for the Medium Data Processing Systems.

Table A-1 and table A-2 show the USASCII X3.4 - 1963 and USASCII X3.4 - 1967 code sets respectively. The major differences in the code sets are in columns 0 and 1 (control characters) and columns 6 and 7 (lower case characters).

Table A-3 is an explanation of all characters and their functions or meanings for both the 1963 and 1967 versions of the USASCII character set. In this presentation, the first entry is the column/row notation in respect to tables A-1 and A-2. The second item is the character as it appears in the two tables, the 1963 version appearing at the top and the 1967 version on the bottom. Following the characters is the name and function of the character, if in fact it is not evident.

When reading tables A-1 and A-2, and using columns and rows; the standard 7-bit character representation, with B_7 the high-order bit and b_1 the low-order bit, is shown below:

EXAMPLE:

The bit representation for the character K positioned in column 4, row 11 is:

$b_7\ b_6 b_5 b_4 b_3 b_2 b_1$
1 0 0 1 0 1 1

The decimal equivalent of the binary number formed by bits b_7, b_6, and b_5, collectively, forms the column number, and the decimal equivalent of the binary number formed by bits b_4, b_3, b_2, and b_1, collectively, forms the row number.

Table A-4 reflects the Extended Binary Coded Decimal Interchange Code (EBCDIC) and is read exactly as tables A-1 and A-2.

Table A-1

USASCII X3.4-1963

b_4	b_3	b_2	b_1	Bits $b_7\,b_6\,b_5$ → / Row ↓ Column →	0 0 0 0	0 0 1 1	0 1 0 2	0 1 1 3	1 0 0 4	1 0 1 5	1 1 0 6	1 1 1 7
0	0	0	0	0	NULL	DC_0	b̸	0	@	P	↑	↑
0	0	0	1	1	SOM	DC_1	!	1	A	Q		
0	0	1	0	2	EOA	DC_2	"	2	B	R		
0	0	1	1	3	EOM	DC_3	#	3	C	S		
0	1	0	0	4	EOT	DC_4	$	4	D	T		
0	1	0	1	5	WRU	ERR	%	5	E	U		
0	1	1	0	6	RU	SYNC	&	6	F	V	UNASSIGNED	UNASSIGNED
0	1	1	1	7	BELL	LEM	' (APOS)	7	G	W		
1	0	0	0	8	FE_0	S0	(	8	H	X		
1	0	0	1	9	HT/SK	S1	)	9	I	Y		
1	0	1	0	10	LF	S2	*	:	J	Z		
1	0	1	1	11	VT	S3	+	;	K	[		↓
1	1	0	0	12	FF	S4	(COMMA) ,	<	L	\		ACK
1	1	0	0	13	CR	S5	-	=	M	]		(1)
1	1	1	0	14	SO	S6	.	>	N	↑		ESC
1	1	1	1	15	SI	S7	/	?	O	←	↓	DEL

(1) Unassigned Control

Table A-2

USASCII X3.4-1967

b_4	b_3	b_2	b_1	Bits $b_7\,b_6\,b_5$ → / Row ↓ Column →	0 0 0 0	0 0 1 1	0 1 0 2	0 1 1 3	1 0 0 4	1 0 1 5	1 1 0 6	1 1 1 7
0	0	0	0	0	NUL	DLE	SP	0	@	P	\`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,		L	\	l	¦
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Table A-3

1963, 1967 USASCII Characters

COLUMN / ROW	CHARACTER: USASCII X3.4 – 1963 / USASCII X3.4 – 1967	NAME/FUNCTION
0/0	NULL / NUL	Null: The all zeros character which may serve to accomplish time fill and media fill.
0/1	SOM	Start of Message: It is used in conjunction with EOA, EOM, and EOT for messages on tapes where the message is to be sent automatically.
	SOH	Start of Heading: A communication control character used at the beginning of a sequence of characters which constitute a machine-sensible address or routing information. Such a sequence is referred to as the "Heading." An STX character has the effect of terminating a heading.
0/2	EOA	End of Address: This character, together with SOM, will be used to define the section of perforated tape in which the call-directing codes of the addressee are contained.
	STX	Start of Text: A communication control character which precedes a sequence of characters that are to be treated as an entity and entirely transmitted through to the ultimate destination. Such a sequence is referred to as "text." STX may be used to terminate a sequence of characters started by SOH.
0/3	EOM	End of Message: It may be used to separate individual messages which are sent in sequence on a single transmission between two stations (see SOM).
	ETX	End of Text: A communication control character used to terminate a sequence of characters started with STX and transmitted as an entity.
0/4	EOT / EOT	End of Transmission: A communication control character used to indicate the conclusion of a transmission which may have contained one or more texts and any associated headings.
0/5	WRU / ENQ	Enquiry: A communication control character used in data communication systems as a request for a response from a remote station. It may be used as a "Who Are You" (WRU) to obtain indentification, or may be used to obtain station status, or both.
0/6	RU	Are You: Use of this character for confirmation type of answer back has been discontinued until a more suitable arrangement can be devised.
	ACK	Acknowledge: A communication control character transmitted by a receiver as an affirmative response to a sender.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	USASCII X3.4 – 1963 / USASCII X3.4 – 1967	NAME/FUNCTION
0/7	BELL / BELL	Bell: A character for use when there is a need to call for human attention. It may control alarm or attention devices.
0/8	FE / BS	Backspace: A format effector that controls the movement of the printing mechanism one print position backward on the same print line.
0/9	HT/SK / HT	Horizontal Tabulation: A format effector that controls the movement of the printing mechanism to the next in a series of predetermined positions along the print line. (Applicable also to the skip function on punched cards.)
0/10	LF / LF	Line Feed: A format effector that controls the movement of the paper one line at a time.
0/11	VT / VT	Vertical Tabulation: A format effector that controls the movement of paper to the next in a series of predetermined print lines.
0/12	FF / FF	Form Feed: A format effector that controls the movement of the printing position to the first predetermined printing line on the next form or page.
0/13	CR / CR	Carriage Return: A format effector that controls the movement of the print mechanism to the first print position on the same print line.
0/14	SO / SO	Shift Out: A control character indicating that the code combinations that follow shall be interpreted as outside of the character set of the standard code table until a Shift In character is reached.
0/15	SI / SI	Shift In: A control character indicating that the code combinations that follow shall be interpreted according to the standard code table.
1/0	DC_0 / DLE	Data Link Escape: A communication control character that will change the meaning of a limited number of contiguously following characters. It is used exclusively to provide supplementary controls in data communication networks.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	CHARACTER	
	USASCII X3.4 – 1963 USASCII X3.4 – 1967	NAME/FUNCTION
1/1 1/2 1/3 1/4	DC_1 DC_2 DC_3 DC_4	Device Controls: DC_1 (X-ON) turns the tape reader ON and DC_3 (X-OFF) turns the tape reader OFF in Models 33 and 35. DC_2 and DC_4 can be used as PUNCH–ON and PUNCH–OFF controls.
	DC_1 DC_2 DC_3 DC_4	Device Controls: Characters for the control of ancillary devices associated with data processing or telecommunication systems, more especially switching devices ON or OFF. (If a single "stop" control is required to interrupt or turn off ancillary devices, DC_4 is the preferred assignment.
1/5	ERR NAK	Negative Acknowledge: A communication control character transmitted by a receiver as a negative response to the sender.
1/6	SYN SYN	Synchronous Idle: A communication control character used by a sychronous transmission system in the absence of any other character to provide a signal from which synchronism may be achieved or retained.
1/7	LEM	Logical End of Media: Used to indicate the end of usable information, as in "End-of-Card".
	ETB	End of Transmission Block: A communication control character used to indicate the end of a block of data for communication purposes. ETB is used for blocking data where the block structure is not necessarily related to the processing format.
1/8	SO	Information Separators.
	CAN	Cancel: A control character used to indicate that the data with which it is sent is in error or is to be disregarded.
1/9	S1	Information Separators.
	EM	End of Medium: A control character associated with the sent data which may be used to identify the physical end of the medium, or the end of the used, or wanted, portion of information recorded on a medium. (The position of this character does not necessarily correspond to the physical end of the medium).
1/10	S2	Information Separator.
	SUB	Substitute: A character that may be substituted for a character which is determined to be invalid or in error.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	CHARACTER: USASCII X3.4 –1963 / USASCII X3.4 – 1967	NAME/FUNCTION
1/11	S3	Information Separator.
	ESC	Escape: A control character intended to provide code extension (supplementary characters) in general information interchange. The Escape character itself is a prefix affecting the interpretation of a limited number of contiguously following characters.
1/12 1/13 1/14 1/15	S4 S5 S6 S7	Information Separators.
	FS GS RS US	File Separator, Group Separator, Record Separator, and Unit Separator: These information separators may be used within data in optional fashion, except that their hierarchical relationship shall be: FS is the most inclusive, then GS, then RS, and US is least inclusive. (The content and length of a File, Group, Record or Unit are not specified.)
2/0	SP	Space: A normally non-printing graphic character used to separate words. It is also a format effector which controls the movement of the printing position, one printing position forward.
	SP	
2/1	!	Exclamation Point.
	!	
2/2	"	Quotation Marks (Diaeresis).
	"	
2/3	#	Number Sign.
	#	
2/4	$	Dollar Sign.
	$	
2/5	%	Percent.
	%	
2/6	&	Ampersand.
	&	
2/7	'	Apostrophe (Closing Single Quotation Mark; Acute Accent).
	'	

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	USASCII X3.4 - 1963 / USASCII X3.4 – 1967	CHARACTER NAME/FUNCTION
2/8	(/ (	Opening Parenthesis.
2/9	) /)	Closing Parenthesis
2/10	* / *	Asterisk
2/11	+ / +	Plus.
2/12	, / ,	Comma (Cedilla).
2/13	- / -	Hyphen (Minus).
2/14	. / .	Period (Decimal Point).
2/15	/ / /	Slant (Slash).
3/0	0 / 0	Figure Zero.
3/1	1 / 1	Figure One.
3/2	2 / 2	Figure Two.
3/3	3 / 3	Figure Three.
3/4	4 / 4	Figure Four.
3/5	5 / 5	Figure Five.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	CHARACTER: USASCII X3.4 – 1963 / USASCII X3.4 – 1967	CHARACTER: NAME/FUNCTION
3/6	6 / 6	Figure Six.
3/7	7 / 7	Figure Seven.
3/8	8 / 8	Figure Eight.
3/9	9 / 9	Figure Nine.
3/10	: / :	Colon.
3/11	; / ;	Semicolon.
3/12	< / <	Less Than.
3/13	= / =	Equals.
3/14	> / >	Greater Than.
3/15	? / ?	Question Mark.
4/0	@ / @	Commercial At.
4/1	A / A	Upper Case Letter A.
4/2	B / B	Upper Case Letter B.
4/3	C / C	Upper Case Letter C.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	CHARACTER: USASCII X3.4 – 1963 / USASCII X3.4 – 1967	CHARACTER: NAME/FUNCTION
4/4	D D	Upper Case Letter D.
4/5	E E	Upper Case Letter E.
4/6	F F	Upper Case Letter F.
4/7	G G	Upper Case Letter G.
4/8	H H	Upper Case Letter H.
4/9	I I	Upper Case Letter I.
4/10	J J	Upper Case Letter J.
4/11	K K	Upper Case Letter K.
4/12	L L	Upper Case Letter L.
4/13	M M	Upper Case Letter M.
4/14	N N	Upper Case Letter N.
4/15	O O	Upper Case Letter O.
5/0	P P	Upper Case Letter P.
5/1	Q Q	Upper Case Letter Q.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	USASCII X3.4 – 1963 / USASCII X3.4 – 1967	NAME/FUNCTION
5/2	R R	Upper Case Letter R.
5/3	S S	Upper Case Letter S.
5/4	T T	Upper Case Letter T.
5/5	U U	Upper Case Letter U.
5/6	V V	Upper Case Letter V.
5/7	W W	Upper Case Letter W.
5/8	X X	Upper Case Letter X.
5/9	Y Y	Upper Case Letter Y.
5/10	Z Z	Upper Case Letter Z.
5/11	[[	Opening Bracket.
5/12	\ \	Reverse Slant,
5/13	]]	Closing Bracket.
5/14	↑ ^	Exponentiation or Up Arrow. Circumflex.
5/15	← _	Replace by or Left Arrow. Underline.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	USASCII X3.4 – 1963 / USASCII X3.4 – 1967	CHARACTER NAME/FUNCTION
6/0		Unassigned.
	'	Grave Accent (Opening Single Quotation Mark).
6/1		Unassigned.
	a	Lower Case Letter a.
6/2		Unassigned.
	b	Lower Case Letter b.
6/3		Unassigned.
	c	Lower Case Letter c.
6/4		Unassigned.
	d	Lower Case Letter d.
6/5		Unassigned.
	e	Lower Case Letter e.
6/6		Unassigned.
	f	Lower Case Letter f.
6/7		Unassigned.
	g	Lower Case Letter g.
6/8		Unassigned.
	h	Lower Case Letter h.
6/9		Unassigned.
	i	Lower Case Letter i.
6/10		Unassigned.
	j	Lower Case Letter j.
6/11		Unassigned.
	k	Lower Case Letter k.
6/12		Unassigned.
	l	Lower Case Letter l.
6/13		Unassigned.
	m	Lower Case Letter m.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	CHARACTER: USASCII X3.4 – 1963 / USASCII X3.4 – 1967	NAME/FUNCTION
6/14		Unassigned.
	n	Lower Case Letter n.
6/15		Unassigned.
	o	Lower Case Letter o.
7/0		Unassigned.
	p	Lower Case Letter p.
7/1		Unassigned.
	q	Lower Case Letter q.
7/2		Unassigned.
	r	Lower Case Letter r.
7/3		Unassigned.
	s	Lower Case Letter s.
7/4		Unassigned.
	t	Lower Case Letter t.
7/5		Unassigned.
	u	Lower Case Letter u.
7/6		Unassigned.
	v	Lower Case Letter v.
7/7		Unassigned.
	w	Lower Case Letter w.
7/8		Unassigned.
	x	Lower Case Letter x.
7/9		Unassigned.
	y	Lower Case Letter y.
7/10		Unassigned.
	z	Lower Case Letter z.
7/11		Unassigned.
	{	Opening Brace.

Table A-3 (cont)

1963, 1967 USASCII Characters

COLUMN / ROW	CHARACTER	
	USASCII X3.4 – 1963 / USASCII X3.4 – 1967	NAME/FUNCTION
7/12	ACK	Acknowledge: A communication control character transmitted by a receiver as an affirmative response to a sender.
	¦	Vertical Line.
7/13		Unassigned Control.
	}	Closing Brace.
7/14	ESC	Mode shift character used to indicate a departure from the standard set of basic characters; e.g., used to shift from upper to lower case letters.
	~	Overline (Tilde; General Accent)
7/15	DEL / DEL	Delete: This character is used primarily to "erase" or "obliterate" erroneous or unwanted characters in perforated tape. (In the strict sense, DEL is not a control character.)

Table A-4

MEDIUM SYSTEMS
EXTENDED BINARY CODED DECIMAL INTERCHANGE CODES (EBCDIC)

CARD, 9-TRACK MAGNETIC TAPE, DISK AND MEMORY* FORMATS

b4	b3	b2	b1	BITS b8 b7 b6 b5 → / COL → / ↓ ROW	0	1	2	3	4	5	6	7	8	9	10 (A)	11 (B)	12 (C)	13 (D)	14 (E)	15 (F)
				b8 b7 b6 b5	0 0 0 0	0 0 0 1	0 0 1 0	0 0 1 1	0 1 0 0	0 1 0 1	0 1 1 0	0 1 1 1	1 0 0 0	1 0 0 1	1 0 1 0	1 0 1 1	1 1 0 0	1 1 0 1	1 1 1 0	1 1 1 1
0	0	0	0	0	NUL 12-0-9-8-1	DLE 12-11-9-8-1	11-0-9-8-1	12-11-0-9-8-1	SP BLANK	& 12	- 11	12-11-0	12-0-8-1	12-11-8-1	11-0-8-1	12-11-0-8-1	PZ (+) 12-0	MZ (!) 11-0	0-8-2	0 0
0	0	0	1	1	SOH 12-9-1	DC1 11-9-1	0-9-1	9-1	12-0-9-1	12-11-9-1	0-1	12-11-0-9-1	a 12-0-1	j 12-11-1	11-0-1	12-11-0-1	A 12-1	J 11-1	11-0-9-1	1 1
0	0	1	0	2	STX 12-9-2	DC2 11-9-2	0-9-2	SYN 9-2	12-0-9-2	12-11-9-2	11-0-9-2	12-11-0-9-2	b 12-0-2	k 12-11-2	s 11-0-2	12-11-0-2	B 12-2	K 11-2	S 0-2	2 2
0	0	1	1	3	ETX 12-9-3	DC3 11-9-3	0-9-3	9-3	12-0-9-3	12-11-9-3	11-0-9-3	12-11-0-9-3	c 12-0-3	l 12-11-3	t 11-0-3	12-11-0-3	C 12-3	L 11-3	T 0-3	3 3
0	1	0	0	4	12-9-4	11-9-4	0-9-4	9-4	12-0-9-4	12-11-9-4	11-0-9-4	12-11-0-9-4	d 12-0-4	m 12-11-4	u 11-0-4	12-11-0-4	D 12-4	M 11-4	U 0-4	4 4
0	1	0	1	5	HT 12-9-5	NL 11-9-5	LF 0-9-5	9-5	12-0-9-5	12-11-9-5	11-0-9-5	12-11-0-9-5	e 12-0-5	n 12-11-5	v 11-0-5	12-11-0-5	E 12-5	N 11-5	V 0-5	5 5
0	1	1	0	6	12-9-6	BS 11-9-6	ETB 0-9-6	9-6	12-0-9-6	12-11-9-6	11-0-9-6	12-11-0-9-6	f 12-0-6	o 12-11-6	w 11-0-6	12-11-0-6	F 12-6	O 11-6	W 0-6	6 6
0	1	1	1	7	DEL 12-9-7	11-9-7	ESC 0-9-7	EOT 9-7	12-0-9-7	12-11-9-7	11-0-9-7	12-11-0-9-7	g 12-0-7	p 12-11-7	x 11-0-7	12-11-0-7	G 12-7	P 11-7	X 0-7	7 7
1	0	0	0	8	12-9-8	CAN 11-9-8	0-9-8	9-8	12-0-9-8	12-11-9-8	11-0-9-8	12-11-0-9-8	h 12-0-8	q 12-11-8	y 11-0-8	12-11-0-8	H 12-8	Q 11-8	Y 0-8	8 8
1	0	0	1	9	12-9-8-1	EM 11-9-8-1	0-9-8-1	9-8-1	12-8-1	11-8-1	0-8-1	8-1	i 12-0-9	r 12-11-9	z 11-0-9	12-11-0-9	I 12-9	R 11-9	Z 0-9	9 9
1	0	1	0	10 (A)	12-9-8-2	11-9-8-2	0-9-8-2	9-8-2	[12-8-2	] 11-8-2	12-11	: 8-2	12-0-8-2	12-11-8-2	11-0-8-2	12-11-0-8-2	12-0-9-8-2	12-11-9-8-2	11-0-9-8-2	12-11-0-9-8-2
1	0	1	1	11 (B)	VT 12-9-8-3	11-9-8-3	0-9-8-3	9-8-3	. 12-8-3	$ 11-8-3	, 0-8-3	# 8-3	12-0-8-3	12-11-8-3	11-0-8-3	12-11-0-8-3	12-0-9-8-3	12-11-9-8-3	11-0-9-8-3	12-11-0-9-8-3
1	1	0	0	12 (C)	FF 12-9-8-4	FS 11-9-8-4	0-9-8-4	DC4 9-8-4	< 12-8-4	* 11-8-4	% 0-8-4	@ 8-4	12-0-8-4	12-11-8-4	11-0-8-4	12-11-0-8-4	12-0-9-8-4	12-11-9-8-4	11-0-9-8-4	12-11-0-9-8-4
1	1	0	1	13 (D)	CR 12-9-8-5	GS 11-9-8-5	ENQ 0-9-8-5	NAK 9-8-5	(12-8-5	) 11-8-5	(US) 0-8-5	' 8-5	12-0-8-5	12-11-8-5	11-0-8-5	12-11-0-8-5	12-0-9-8-5	12-11-9-8-5	11-0-9-8-5	12-11-0-9-8-5
1	1	1	0	14 (E)	SO 12-9-8-6	RS 11-9-8-6	ACK 0-9-8-6	9-8-6	+ 12-8-6	; 11-8-6	> 0-8-6	= 8-6	12-0-8-6	12-11-8-6	11-0-8-6	12-11-0-8-6	12-0-9-8-6	12-11-9-8-6	11-0-9-8-6	12-11-0-9-8-6
1	1	1	1	15 (F)	SI 12-9-8-7	US 11-9-8-7	BEL 0-9-8-7	SUB 9-8-7	| 12-8-7	¬ 11-8-7	? 0-8-7	" 8-7	12-0-8-7	12-11-8-7	11-0-8-7	12-11-0-8-7	DELIMETER 12-0-9-8-7	12-11-9-8-7	11-0-9-8-7	12-11-0-9-8-7

*INTERNAL COLLATING SEQUENCE = $b_8 b_7 b_6 b_5 / b_4 b_3 b_2 b_1$ = 0 0 0 0/0 0 0 0 TO 1111/1111

TABLE A-4 (cont'd)

CONTROL AND SPECIAL CODES

NUL NULL - The all-zeros character which may serve to accomplish time fill and media fill.

SOH START OF HEADING - A communication control character used at the beginning of a sequence of characters which constitutes a machine-sensible address or routing information. Such a sequence is referred to as the "heading." An STX character has the effect of terminating a heading.

STX START OF TEXT - A communication control character which precedes a sequence of characters that is to be treated as an entity and entirely transmitted through to the ultimate destination. Such a sequence is referred to as "TEXT." STX may be used to terminate a sequence of characters started by SOH.

ETX END OF TEXT - A communication control character used to terminate a sequence of characters started with STX and transmitted as an entity.

HT HORIZONTAL TABULATION - A format effector which controls the movement of the printing position to the next in a series of predetermined positions along the printing line. (Applicable also to display devices and the SKIP function on punched cards.)

DEL DELETE - This character is used primarily to "ERASE" or "OBLITERATE" erroneous or unwanted characters in perforated tape. (In the strict sense, DEL is not a control character.)

VT VERTICAL TABULATION - A format effector which controls the movement of the printing position to the next in a series of predetermined printing lines. (Applicable also to display devices.)

FF FORM FEED - A format effector which controls the movement of the printing position to the first predetermined printing line on the next form or page. (Applicable also to display devices.)

CR CARRIAGE RETURN - A format effector which controls the movement of the printing position to the first printing position on the same printing line. (Applicable also to display devices.)

SO SHIFT OUT - A control character indicating that the code combinations which follow shall be interpreted as outside of the character set of the Standard Code Table until a shift in character is reached.

SI SHIFT IN - A control character indicating that the code combinations which follow shall be interpreted according to the Standard Code Table.

DLE DATA LINK ESCAPE - A communication control character which will change the meaning of a limited number of contiguously following characters. It is used exclusively to provide supplementary controls in data communication networks.

DC1
DC2
DC3
DC4 DEVICE CONTROLS - Characters for the control of ancillary devices associated with Data Processing or Telecommunication Systems, more especially switching devices "ON" or "OFF." (If a single "STOP" control is required to interrupt or turn off ancillary devices, DC4 is the preferred assignment.)

NL NEW LINE - A format effector which causes both Carriage Return and Line Feed.

BS BACKSPACE - A format effector which controls the movement of the printing position one printing space backward on the same printing line. (Applicable also to display devices.)

CAN CANCEL - A control character used to indicate that the data with which it is sent is in error or is to be disregarded.

EM END OF MEDIUM - A control character associated with the sent data which may be used to identify the physical end of the medium, or the end of the used, or wanted, portion of information recorded on a medium. (The position of this character does not necessarily correspond to the physical end of the medium.)

FS FILE SEPARATOR
GS GROUP SEPARATOR
RS RECORD SEPARATOR
US UNIT SEPARATOR

These information separators may be used within data in optional fashion, except that their hierarchical relationship shall be: FS is the most inclusive, then GS, then RS, and US is least inclusive. (The content and length of a File, Group, Record, or Unit are not specified.)

LF LINE FEED - A format effector which controls the movement of the printing position to the next printing line. (Applicable also to display devices.)

ETB END OF TRANSMISSION BLOCK - A communication control character used to indicate the end of a block of data for communication purposes. ETB is used for blocking data where the block structure is not necessarily related to the processing format.

ESC ESCAPE - A control character intended to provide code extension (supplementary characters) in General Information Interchange. The escape character itself is a prefix affecting the interpretation of a limited number of contiguously following characters.

ENQ ENQUIRY - A communication control character used in Data Communication Systems as a request for a response from a Remote Station. It may be used as a "WHO YOU ARE" (WRU) to obtain identification, or may be used to obtain Station Status, or both.

ACK ACKNOWLEDGE - A communication control character transmitted by a receiver as an affirmative response to a sender.

BEL BELL - A character for use when there is a need to call for human attention. It may control alarm or attention devices.

SYN SYNCHRONOUS IDLE - A communication control character used by a synchronous transmission system in the absence of any other character to provide a signal from which synchronism may be achieved or retained.

EOT END OF TRANSMISSION - A communication control character used to indicate the conclusion of a transmission, which may have contained one or more texts and any associated headings.

NAK NEGATIVE ACKNOWLEDGE - A communication control character transmitted by a receiver as a negative response to the sender.

SUB SUBSTITUTE - A character that may be substituted for a character which is determined to be invalid or in error.

SP SPACE - A normally non-printing graphic character used to separate words. It is also a format effector which controls the movement of the printing position, one printing position forward. (Applicable also to display devices.)

OTHER CODES

PZ PLUS ZERO
MZ MINUS ZERO

Code 0110 1110, is never obtained from a BCL plus sign; plus zero (PZ) code 1100 0000 prints as a plus sign. Minus zero (MZ) prints as an !. Choice of graphic for PZ and MZ may vary from system to system. The choice of styling (! or I) for graphic code 0100 1111 may also vary from system to system.

DATA COMMUNICATIONS TRANSLATION TABLES

This appendix provides tables for translating Baudot code to EBCDIC code, and PTTC/6 code to EBCDIC code.

BAUDOT TO EBCDIC TRANSLATION TABLE

Baudot		EBCDIC	
Decimal Equivalent	Graphic	Decimal Equivalent	Graphic
00	BLK	00	NULL
01	E	C5	E
02	LF	0A	LF
03	A	C1	A
04	SPACE	40	SPACE
05	S	E2	S
06	I	C9	I
07	U	F4	U
08	CR	0D	CR
09	D	C4	D
0A	R	D9	R
0B	J	D1	J
0C	N	D5	N
0D	F	C6	F
0E	C	C3	C
0F	K	D2	K
10	T	E3	T
11	Z	F9	7
12	L	D3	L
13	W	E6	W
14	H	C8	H
15	Y	E8	Y
16	P	D7	P
17	Q	D8	Q
18	0	D6	0
19	B	C2	B
1A	G	C7	G
1B	FIGS	02	STX
1C	M	D4	M
1D	X	E7	X
1E	V	E5	V
1F	LTRS	7C	@
20	BLK	00	NULL
21	3	F3	3
22	LF	0A	LF
23	-	60	-
24	SPACE	40	SPACE
25	BELL	07	BELL
26	8	F8	8
27	7	F7	7
28	CR	0D	CR
29	$	5B	$
2A	4	F4	4
2B	,	6B	,
2C	7/8	5E	;

BAUDOT TO EBCDIC TRANSLATION TABLE (cont)

Baudot		EBCDIC	
Decimal Equivalent	Graphic	Decimal Equivalent	Graphic
2D	1/4	7D	[
2E	1/8	4F	+
2F	1/2	5C	*
30	5	F5	5
31	"	7F	"
32	3/4	5D	)
33	2	F2	2
34	DIMOND	6F	6
35	6	F6	6
36	0	F0	0
37	1	F1	1
38	9	F9	9
39	5/8	4D	(
3A	&	50	&
3B	FIGS	02	STX
3C	.	4B	.
3D	/	61	/
3E	3/8	6C	%
3F	LTRS	7C	@

PTTC/6 TO EBCDIC TRANSLATION TABLE

PTTC/6		EBCDIC		1050 Standard Card Code
Decimal Equivalent	Graphic	Decimal Equivalent	Graphic	
Lower Case				
00	SPACE	40	SPACE	
01	1	F1	1	1
02	2	F2	2	2
03	3	F3	3	3
04	4	F4	4	4
05	5	F5	5	5
06	6	F6	6	6
07	7	F7	7	7
08	8	F8	8	8
09	9	F9	9	9
0A	0	F0	0	0
0B	= or #	7B	#	8-3
0C	PN	11	DC1	9-4
0D	Rs	14	DC4	9-5
0E	UC	36		9-6
0F	EOT	04	EOT	9-7
10	@	7C	@	8-4
11	/	61	/	0-1
12	S	A2	S	0-2
13	T	A3	T	0-3

PTTC/6 TO EBCDIC TRANSLATION TABLE (cont)

PTTC/6		EBCDIC		1050 Standard Card Code
Decimal Equivalent	Graphic	Decimal Equivalent	Graphic	
14	U	A4	U	0-4
15	V	A5	V	0-5
16	W	A6	W	0-6
17	X	A7	X	0-7
18	Y	A8	Y	0-8
19	Z	A9	Z	0-9
1A	≠	6D	USCOR≠	0-8-2
1B	,	6D	,	0-8-3
1C	BY	24		0-9-4
1D	LF	0A	LF	0-9-5
1E	EOR	17	FTR	0-9-6
1F	PRE	01	SOH	0-9-7
20	-	60	-	11
21	J	91	J	11-1
22	K	92	K	11-2
23	L	93	K	11-3
24	M	94	M	11-4
25	N	95	N	11-5
26	O	96	)	11-6
27	P	97	P	11-7
28	Q	98	Q	11-8
29	R	99	R	11-9
2A	M7	7D	APOS≥	11-0
2B	$	5B	$	11-8-3
2C	RFS	0C	FF	11-9-4
2D	NL	0D	CR	11-9-5
2E	BS	08	BS	11-9-6
2F	IL	00	NULL	11-9-7
30	+ or &	4E	+	12
31	A	81	A	12-1
32	B	82	B	12-2
33	C	83	C	12-3
34	D	84	D	12-4
35	E	85	E	12-5
36	F	86	F	12-6
37	G	87	G	12-7
38	H	88	H	12-8
39	I	89	I	12-9
3A	PZ	50	&	12-0
3B	.	4B	.	12-8-3
3C	PF	12	DC2	12-9-4
3D	HT	09	HT	12-9-5
3E	LC	1A	SS	12-9-6
3F	DEL	FF	DEL	12-9-7
Upper Case 40	SPACE	40	SPACE	

PTTC/6 TO EBCDIC TRANSLATION TABLE (cont)

PTTC/6		EBCDIC		1050 Standard Card Code
Decimal Equivalent	Graphic	Decimal Equivalent	Graphic	
41	>	6E	>	1
42	)	5D	)	2
43	;	5E	;	3
44	SBLANK	4A	CENT	4
45	(	4D	(	5
46	:	7A	:	6
47	"	7F	"	7
48	*	50	*	8
49	[	70	[	9
4A	]	6A	]	0
4B	SEGMRK	7E	=	8-3
4C	PN	11	DC1	9-4
4D	RS	14	DC4	9-5
4E	UC	36		9-6
4F	EOT	04	EOT	9-7
50	DELTA	5F	NOT <	8-4
51	QUES	6F	QUES	0-1
52	S	E2	S	0-2
53	T	E3	T	0-3
54	U	E4	U	0-4
55	V	E5	V	0-5
56	W	E6	W	0-6
57	X	E7	X	0-7
58	Y	68	Y	0-8
59	Z	E9	Z	0-9
5A	GRPMRK	6D	USCOR≠	0-8-2
5B	,	6B	,	0-8-3
5C	BY	24		0-9-4
5D	LF	0A	LF	0-9-5
5E	EOB	17	ETB	0-9-6
5F	PRF	01	SOH	0-9-7
60	BACK/	60	-	11
61	J	D1	J	11-1
62	K	D2	K	11-2
63	L	D3	L	11-3
64	M	D4	M	11-4
65	N	D5	N	11-5
66	O	D6	O	11-6
67	P	D7	P	11-7
68	Q	D8	Q	11-8
69	R	D9	R	11-9
6A	GAMMA	7D	APOS >	11-0
6B	V.BAR	4F	V.BAR←	11-8-3
6C	RES	0C	FF	11-9-4
6D	NL	0D	CR	11-9-5
6E	BS	08	RS	11-9-6
6F	IL	00	NULL	11-9-7

PTTC/6 TO EBCDIC TRANSLATION TABLE (cont)

PTTC/6		EBCDIC		1050 Standard Card Code
Decimal Equivalent	Graphic	Decimal Equivalent	Graphic	
70	<	40	<	12
71	A	C1	A	12-1
72	B	C2	B	12-2
73	C	C3	C	12-3
74	D	C4	D	12-4
75	E	C5	E	12-5
76	F	C6	F	12-6
77	G	C7	G	12-7
78	H	C8	H	12-8
79	I	C9	I	12-9
7A	SQ.RT	6C	%	12-0
7B	.	4B	.	12-8-3
7C	PF	12	DC2	12-9-4
7D	HT	09	HT	12-9-5
7E	LC	1A	SS	12-9-6
7F	DEL	FF	DEL	12-9-7

DATA COMMUNICATIONS CONTROL CODES

The tables in this appendix identify the codes that are used with remote terminals for information interchange with the Medium Data Processing Systems data communications network. Line control procedures and codes vary for each of these terminals. Also listed in the tables are the functions performed by the control and the applicable control code(s) used to generate that particular function.

USASCII X3.4-1967 TRANSMISSION CONTROL CODES

Graphic	Function	Code 7654321
SOH	Start of heading	0000001
STX	Start of text	0000010
ETX	End of text	0000011
EOT	End of transmission	0000100
ENQ	Enquiry	0000101
ACK	Acknowledge	0000110
DLE	Data link escape	0010000
DC1	Device control	0010001
DC2	Device control	0010010
NAK	Negative acknowledge	0010101
SYN	Synchronous idle	0010100
ETB	End of transmission block	0010111
NUL	Null	0000000

ASCII X3.4-1963 TRANSMISSION CONTROL CODES

Graphic	Function	Code 7654321
SOM	Start of message	0000001
EOA	End of address	0000010
EOM	End of message	0000011
EOT	End of transmission	0000100
WRU	Who are you	0000101
RU	Are you	0000110
SYNC	Synchronous idle	0010110
ERR	Error	0010101
ACK	Acknowledge	1111100
DC1	(XON)	0010001
\	Reverse slash	1011100
*	Asterisk	0101010

ASCII A CONTROL CODE FUNCTIONS

Function	Code
Start of text	Any code
End of text	ETX (EOM), DC1 (XON), ENQ (WRU), or EOT (EOT)
End of transmission	EOT (EOT)
Enquiry	ENQ (WRU)

NOTE — Codes in parentheses are 1963 codes.

ASCII B CONTROL CODE FUNCTIONS

Function	Code
Start of text	Any code except * or \
End of text	ETX (EOM) or EOT (EOT)
Response	NONE (ACK)
Negative response	NONE (ACK)
Timing select	SOH (SOM)
	NOTE When SOM is used as start-of-text, the time-out is changed from 5 to 25 seconds.

NOTE

Codes in parentheses are 1963 codes.

ASCII C CONTROL CODE FUNCTIONS

Function	Code
Start of text	SOH (SOM) or STX (EOA)
End of text	ETX (EOM) or ETB (LEM)
Response	ACK (RU), NAK (ERR), EOT (EOT), or ENQ (WRU)
Enquiry	ENQ (WRU)
Syn	SYN (SYNC)

ASCII D CONTROL CODE FUNCTIONS

Function	Code
Start of text	SOH (SOM) or STX (EOA)
End of text	ETX (EOM) or ETB (LEM)
Response	ACK (RU), NAK (ERR), EOT, DC1 or DC2
Enquiry	ENQ (WRU)
Syn	SYN (SYNC)

IBM PTTC/6 TRANSMISSION CONTROL CODES

Function	Code BA8421
EOT (end of transmission)	001111
EOA (end of address – #)	001011
EOB (end of block)	011110
Positive response-polling (#)	001011
Positive response-addressing (.)	111011
Positive response-inquiry (#)	001011
Negative response-polling (-)	100000
Negative response-addressing (-)	100000
Positive ACK-error control (.)	111011
Negative ACK-error control (-)	100000
Upper case	001110
Lower case	111110

PTTC/6 CONTROL CODE FUNCTIONS

Function	Code
Start of text	EOA
End of text	EOB
End of transmission	EOT
Response	. (period) or - (hyphen)
Negative response	- (hyphen)
Upper case shift	U.C.
Lower case shift	L.C.

BAUDOT TRANSMISSION CONTROL CODES

Graphic	Code 54321
M	11100
V	11110
H	10100
S	00101
Figures	11011
Letters	11111

BAUDOT A CONTROL CODE FUNCTIONS

Function	Code
Start of text	Any code but B
End of text (read)	H
End of text (write)	H with a flag bit
Response	V or letters

BAUDOT A CONTROL CODE FUNCTIONS (cont)

Function	Code
Negative response	V
Upper case shift	Figures
Lower case shift	Letters
Enquiry	Letters

NOTE

In addition to the control code sensitivity defined for each adapter, the switched line adapters are sensitive to a 4-bit end-of-number code (1100) when dialing. The EON code is not transferred to the 801A1 ACU.

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