I

SOFTWARE

SPECIFICATION

Document Type: External Reference Specification

Product Name: 731/732 IBM 2780 EMULATION

Product Number: I068*1.1

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731/732 IBM 2780 EMULATION

IDD ARDEN HILLS

APPROVAL SIGNATURES		DATE
PREPARED BY:	J. R. Stockton	5/29/73
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LTR	DESCRIPTION	INITIAL	DATE
	PRE-RELEASE DRAFT		10/25/72
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PAGE	ALL										
REV.											
PAGE	COMPLETE REVISION										
REV.											
PAGE	iii	2-1	3-6	3-29	3-43	F-2	E-2	G-5	H1-H5		
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	Pre-Release Draft		10/25/72	PAGE	ALL									
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				REV.	2	2	2	2	2	2	2	2	2	2
				PAGE	3-34	3-6	3-28	3-35	3-40	E-1	6-5			
				REV.	2	2	2	2	2	2	2			
3	9322 LP Out of Paper	JRS	7/18/73	PAGE	H-2	H-3	H-5							
				REV.	3	3	3							
	Detection			PAGE										
				REV.										
				PAGE										
				REV.										
				PAGE										
				REV.										
				PAGE										
				REV.										

IV

RECEIVED
APR 18 1973
IDD ARDEN HILLS

CONTROL DATA

MEMO

DATE: April 18, 1973

TO: Distribution LOCATION:

FROM: J. D. Grigsby LOCATION: ARH228 EXT: 3667

SUBJECT: Reader/Punch on 73X Batch Terminals

The reader/punch option 730-104 (contrary to the contents of the POD, ERS and IMS) has been removed from the product offering. This option will not be supported or released to the field. If you have any questions, please contact the 73X Batch Controlware Continuation Project.

J. D. Grigsby
J. D. Grigsby
73X Batch Controlware
Continuation Project Manager

JDG:mm

IV

DATE: May 14, 1973

TO: Distribution LOCATION:

FROM: J. D. Grigsby LOCATION: ARH228 EXT: 3667

SUBJECT: 222-2 and 224-2 Peripheral Equipment Support Under 2780

Distribution

IDD
L. D. Ingwerson - ARH252
J. W. Kueck - ARH228
R. L. Stoessel - HØN05U

Please attach this memo to POD no. 248A, Product No. I068*1.0 and to the ERS for Product No. I068*1.0. Also, distribute this memo to the PORB members.

This memo is a notification that contrary to the contents of the POD and ERS, the 2780 product (No. I068*1.0) does not support the 222-2 Line Printer and 224-2 Card Reader as part of the standard product configuration or equipment.

The support of the 200 UT peripherals is being decommitted because the requirement that existed when the POD and ERS were written no longer exists.

Jeffrey D. Grigsby

J. D. Grigsby, Program Manager
Batch Controlware Continuation

JDG:sw

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Section

1.0 SCOPE

This specification describes the external characteristics of the 2780 emulation controlware that resides in the CDC Low/Medium Speed Batch Terminal (L/MSBT-731/732). This controlware employs the Binary Synchronous (Bisync) method of communication, thus allowing the Low/Medium Speed Batch Terminal to communicate with a central 360/370 computer, a 2780 Data Transmission Terminal, or another L/MSBT using 2780 Bisync protocol.

The CDC 2780 emulator allows the use of 2 wire switched or 4 wire leased or privately owned networks, and the use of EBCDIC or ASCII code. The communications scheme is half-duplex with the terminal in either a send or receive mode. In the receive mode, print and punch buffers can be interspersed in the same buffer. A 4-wire (constant carrier) line can be used to reduce line turnaround time.

Maximum transmission speed between a CDC 2780 emulator and an IBM 360/370 is 4800 bps. Maximum transmission speed between two CDC 2780 emulators is 9600 bps.

Change No. 2

2.0 APPLICABLE DOCUMENTS

2.1 Hardware Documents

CDC Specification 16000900, Remote Batch Terminal - Low/Medium Speed

CDC Specification 15539100, CC534 Display Head (80 X 16)

CDC Specification 16004800, CE123 A/B Low Speed Batch Card Reader

CDC Specification 16006900, CE124 A/B 500 CPM Reader

CDC Specification 53574300, CF511 A/B Card Reader/Punch
CDC Specification 50962300, 9322 Line Printer System
CDC Specification 53125500, CL896 A/B 300 LPM Printer 12

CDC Specification 53125200, CL320 A/B 600 LPM Printer

CDC POD No. 244 - 8 Bit Programmable Sync Selector DSA L/MSBT Enhancement

2.2 CDC Software Document

L/MSBT 200 UT Emulation POD (No. 253)

L/MSBT 200 UT Emulation ERS

PL10 Assembler in Fortran (BUCAL) ERS

2.3 IBM Software Documents

IBM 2780 Data Transmission Terminal-Component Description Form A27-3005-3, August 1971

Auerback Data Communications Reports on IBM 2780 Document 6457:01 August 1967

IBM 2701 Data Adapter Unit - Component Description Form A22-6864-2, July 1969

General Information - Binary Synchronous Communications, Form A27-3004

IBM System/360 Disk Operating System, Basic Telecommunication Access Method, File Number 360N-C0-469

The HASP II System (360D-05.1.014) Version 3, Modification Level 1

3.0 DESCRIPTION

3.1 Hardware Configuration

3.1.1 Standard Hardware Configurations

The standard hardware configurations will be offered as saleable products to external customers. The 731-10 {LSBT} and the 732-10 {MSBT} basic terminals include:

- Buffer Controller
- 16K bytes 1.1 usec. memory
- Keyboard/CRT display
- 1.1 MHZ micro drum
- RS232C/CCITT compatible communications interface
- Card Reader
- Line Printer
- Cyclic encoder

731-2780 Emulator

Equipment	
731	Basic Terminal Card Reader Line Printer

732-2780 Emulator

Equipment	
732	Basic Terminal Card Reader Line Printer

The configurations given above correspond to IBM 2780 Model 1.

The 730-104 Card reader/punch is a standard option for both of the above configurations.

The configurations with the 730-104 Card reader/punch option correspond to the IBM 2780 Model 2.

3.2 Transmission Protocol

3.2.1 Features

The CDC 2780 emulator will support IBM Bisync communications protocol as used on the IBM 2780. The communications scheme is half-duplex with the terminal in either a send or receive mode. In the receive mode, print and punch buffers can be interspersed in the same buffer. A 4-wire (constant carrier) line can be used to reduce line turnaround time.

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The following chart lists features of the 2780 terminal and those which will be supported by the CDC 2780 emulator.

FEATURE	IBM 2780		CDC 2780 Emulator	
	Standard	Extra Cost Option	Standard	Not Available
EBCDIC Code	Option		Option	
EBCDIC Transparency		*	*	
ASCII Code	Option		Option	
6-Bit Transcode	Option			*
Line Speeds - 1200 bps	Option			*
- 2000 bps	Option		Option	
- 2400 bps	Option		Option	
- 4800 bps	Option		Option	
Auto Retransmission	*		*	
Transmission Checking (CRC for EBCDIC, VRC/LRC for ASCII)	*		*	
Extended Enquiry Retry	Option		Option	
Contention for line time-outs	Option		Option	
Multiple Record Transmission		*	Option	
Operator Intervention Required	Option		*	
Audible Alarm	Option		*	
Variable Record length for CP, CR by coding EM Character	*		*	
Component selection for CP, LP	*		*	
Auto Turnaround		*	*	
Vertical Forms Control (136 lines)	Note 1		Note 1	
Printer Horizontal Format Cont.		*	*	
Print Line - 80 Characters	*		Note 2	
- 120 Characters		*	Note 2	
- 136 Characters	N/A	N/A	Note 2	
- 144 Characters		*		*
LP Character set - 39	Option			*
- 52	Option			*
- 63	Option		*	
Terminal ID		*		*
Off-line list	*		*	
Dual Communications Interface		*		*
Multi-point line control		*		*
Synchronous Clock		*		*
Off-line DSA Test	*		*	
Auto Answer/Disconnect		*		*

Note 1: CDC 2780 Emulator performs forms control with software while IBM 2780 has a control tape.

Note 2: Print line is variable from 80 to 136 characters per line.

The Auto Turnaround feature works as follows: When reading cards and auto turnaround is selected (via a keyboard command), if a blank card is read an ETX will be sent. The punch must then be manually made ready before punching will start.

The IBM 2780 has a maximum transmission block size of 400 characters. The CDC 2780 emulator will have a variable block size with a normal value of 400 characters per block. The maximum is 400 characters per block. If the value is changed it must be consistent with the terminal or CPU to which it must communicate.

The 2780 normally sends two records per block and with the multiple record feature can send 7 records per block. The number of records per block in the CDC 2780 emulator is variable up to a maximum of 7 records per block. The normal value will be 7 records per block. When communicating with an IBM CPU or 2780, only 2 or 7 records per block can be specified and the choice must be consistent with that of the CPU or 2780. Other values may be used when communicating with another CDC 2780 emulator.

The CDC 2780 emulator will operate with:

1. An IBM 2780 Model 1, 2, 3, and 4.
2. A central IBM 360/370 program supported by:
   - OS/MVT or MFT/HASP II/RJE
3. Another CDC 2780 emulator.

The CDC 2780 emulator should communicate with other competitors 2780 emulation terminals as well as other IBM system software that supports 2780 (such as OS/RJE, DOS/POWER/RJE, OS-DOS/BTAM). These configurations have not been test verified.

In addition to the 2780 features, additional features are available on the CDC 2780 emulator.

1. Software forms control - A number of different forms control tables can be loaded via cards onto the micro-drum (see Appendix E). The operator selects which table is to be used by typing the command FCM on the display along with the form number. Thirty-two (32) forms control tables each with 136 lines can be handled for either 6 or 8 lpi. The maximum number of lines that an IBM 2780 can handle is 132. The line count will not be destroyed by autoloading. Software forms control, is used on the CL896 or CL320 printers but not on the 9322-4 printer which uses a format tape. 2

2. HELP display - This display will provide a quick reference guide on terminal operation for 2780 emulation. The display will: define all keyboard commands and function key settings; list all indicator lights and digital display settings.

3. Feature options defined in B.8 for the 2780 emulator will normally be specified by binary patch cards to the binary deck at install time. Features selected will be displayed at system load/run time.

4. On line card to print - It will be possible to list cards without breaking the connection to another station. A command entered via the keyboard will allow cards to be

command entered via the keyboard will allow cards to be printed on line. When this operation is finished, another keyboard command allows resumption of on line operation. See 3.3.6.4 for details of operation.

3.2.2 Basic Record Formats

The CDC 2780 emulator uses line control characters in the following basic record formats to control the contention for the line, transmission of data, and termination of transmission. The SYN character is used to establish synchronization between the transmitting and receiving stations. Three successive SYN characters will precede any transmission, and a minimum of two SYN characters are required to obtain synchronization when in receive mode. A PAD character must be transmitted at the end of any transmission. The PAD character must have "1"'s as the lower 4 bits. The character codes are given in Appendix A.

3.2.2.1 Enquiry {ENQ}

The Enquiry record is used when the transmitting station requests permission to send, or, requests repeat of last response.

S	S	E	P
Y	Y	N	A
N	N	Q	D

3.2.2.2 Normal Text Block

The normal text block contains data sent by the transmitting station.

S	S	S		U	b	b			U	b	b				E	b	b	P
Y	Y	T	Text	S	c	c		Text	S	c	c		...	Text	T	c	c	A
N	N	X			c	c				c	c				B	c	c	D

The STX character signals the start of the text. The Unit Separator {US} character signals the end of a record in the middle of a

transmission block. The Unit Separator is an IUS in EBCDIC. The End of Transmission Block (ETB) follows the last record in a block. An End of Text (ETX) replaces the ETB in the last block in the message.

The ETB and ETX characters cause checking with a line turnaround and a response. If retransmission is required, the whole block is retransmitted.

Block Check Characters (bcc) are accumulated for each record at both the transmitting and receiving station. The accumulation is initiated by, but does not include the first STX or SOH (START OF HEADER) character. All characters (except SYN) following the first STX, to and including the end of record character, are part of the accumulation. The receiving terminal compares the received check character with the one it has accumulated, and if the accumulations are different, an error has occurred.

The method of accumulating the check character depends on the code being used:

EBCDIC - A 16-bit cyclic accumulation performed by hardware uses the polynomial $X^{16} + X^{15} + X^2 + 1$. This check character is sent as two eight-bit bytes.

ASCII - An eight-bit cyclic accumulation performed by software is an odd parity character on the record. In ASCII transmissions there will be only one eight-bit bcc sent at the end of a record. In addition to this LRC {longitudinal redundancy check} character, there is an odd-parity VRC {vertical redundancy check} on each character.

3.2.2.3 Transparent Text Block

A Data Link Escape (DLE) character must precede a control character that is to be recognized as a control character and not as transparent data.

A control character is treated as data unless it is preceded by a DLE; thus all 256 possible bit combinations in the EBCDIC code are allowed to be used as data. The extra DLE is not included in the bcc accumulation.

Transparent-text-mode operation is initiated by a machine generated DLE STX sequence, and terminated by a DLE character that is followed by a record or block character (US, ETB, or ETX). In transparent operation, two SYN characters must be transmitted following transmission of a US record-check sequence.

Component selection and printer Horizontal Format control will not operate with transparent text. Component selection must be executed while operating in normal mode; however, once the selection has been made it remains in effect for subsequent transparent blocks of text.

S	S	D	S				D	U	b	b	S	S	D	S				D	U						D	E	b	b	P	
Y	Y	L	T		T	e	L	S	c	c	Y	Y	L	T		T	e	L	S	.	.	.		T	e	L	T	c	c	A	
N	N	E	X		x	t	E		c	c	N	N	E	X		x	t	E		.	.	.		x	t	E	B	c	c	D	

A change from transparent text to normal text, or vice versa, can occur only after a block-checking sequence (ETB, ETX).

3.2.2.4 Positive Acknowledgement

ACK0 is the receiving stations response to an initial ENQ and every subsequent, correctly received, even numbered block.

ACK 1 is the response to a correct odd numbered block.

The responses are different in EBCDIC and ASCII (both are two eight bit characters).

Code	ACK0	ACK1
EBCDIC	DLE (Hex 70) 01110000	DLE (Hex 61) 01100001
ASCII	DLE 0	DLE 1

The ASCII responses will be used in the illustrations unless otherwise specified.

```
S  S  D     P
Y  Y  L  0  A
N  N  E     D

S  S  D     P
Y  Y  L  1  A
N  N  E     D
```

3.2.2.5 Negative Acknowledgement

The Negative Acknowledgement (NAK) is the receiving terminal's response to an incorrect data block, e.g., improper format or bad block check character. It is used as a not-ready-to-receive signal if selected to receive a transmission. It is also used as a response to a temporary text delay (see 3.2.2.9).

```
S  S  N  P
Y  Y  A  A
N  N  K  D
```

3.2.2.6 Wait for Acknowledgement

The Wait for Acknowledgement {WACK} is the CPU's response to a good block when it is not ready to receive another block. The terminal replies with an ENQ to each WACK and the CPU continues sending WACK's until it is ready to continue. Then the CPU sends the appropriate acknowledgement to the previous good block. The CPU may also send an EOT {End Transmission} in response to the terminal's ENQ. Upon restarting, the terminal should begin with the following text block, since the WACK response indicates that the previous block was correctly received by the CPU.

The WACK sequences are:

EBCDIC code DLE,

ASCII code DLE;

The terminal does not transmit the WACK.

SYN	SYN	DLE	;	PAD

3.2.2.7 Reverse Interrupt

The Reverse Interrupt {RVI} is a response by the CPU to a good block when the CPU wants to send a high priority message. The terminal ends its transmission and can then receive a message.

SYN	SYN	DLE	@	PAD	{EBCDIC}

SYN	SYN	DLE	<	PAD	{ASCII}

3.2.2.8 End of Transmission

An End of Transmission (EOT) is sent 1) by the transmitting terminal when there is no more data to transmit, 2) by the transmitting terminal after n unsuccessful retries to transmit a block (where n is an installation parameter with default of 15), and 3) by the receiving terminal in response to a data block if the output equipment is not ready. An error occurs if an EOT is detected within a text record by the receiving station, and a NAK is sent.

S	S	E	P
Y	Y	O	A
N	N	T	D

3.2.2.9 Temporary Text Delay

A Temporary Text Delay (TTD) is sent if the transmitting terminal is unable to send the next block of data within two seconds after the response to the previous block is received (e.g., if the card reader is not ready).

S	S	S	E	P
Y	Y	T	N	A
N	N	X	Q	D

3.2.2.10 Component Selection/Printer Format Control

The character following an ESC character is used for component selection and to control vertical spacing and skipping on the printer. An ESC followed by a 4 selects the punch.

S	S	S	E	
Y	Y	T	S	4 Text ...
N	N	X	C	

An ESC and the following characters selects the printer and initiates a carriage spacing or skipping operation:

ASCII	EBCDIC	carriage operation after printing
ESC Q	ESC /	single space
ESC R	ESC S	double space
ESC S	ESC T	triple space
ESC A	ESC A	skip to channel 1
ESC B	ESC B	skip to channel 2
ESC C	ESC C	skip to channel 3
ESC D	ESC D	skip to channel 4
ESC E	ESC E	skip to channel 5
ESC F	ESC F	skip to channel 6
ESC G	ESC G	skip to channel 7
ESC H	ESC H	skip to channel 8

Selection codes can be changed in the middle of a transmission block.

Spacing and skipping operations are performed after all of the data following the ESC sequence is printed, the same as for the 2780. Double space, triple space, or skip operations are not retained beyond one record (that is, the carriage reverts back to normal single spacing). However, printer selection is retained and no further selection is required until selection of the punch is desired.

```
S S S E          U b b E          U b b       E b b
Y Y T S A Text S c c S R Test S c c Text T c c
N N X c ↑        c c c ↑          c c         B c c
```

select printer, skip to ch. 1 after printing

print line, double space

print line single space (default)

In component selection, if there is no selection, or if there is illegal selection, or if the device selected is not ready an error condition (see Table 3.3-6) is displayed on the CRT. If the terminal has no card punch, component selection is ignored. Component selection must be made in a non-transparent record.

For vertical spacing on the printer in transparent text, single spacing is assumed on illegal codes; in non-transparent text an error is given on illegal codes. Illegal printer data characters are ignored and blanks appear in their place.

Horizontal Tab (HT) Control

The HT control character is used with the Printer Horizontal Format Control special feature. This feature is similar to the Tab function on a typewriter. The HT character is used in three ways:

1. When the HT character follows the ESC character at the beginning of a record, it signifies that the remainder of the record is a printer horizontal format control record that is to be stored by the receiving terminal.

2. When an HT character appears within a printer horizontal format control record, it causes a tab stop to be set for the printer. Each HT character within the horizontal format control record sets up a tab stop, thereby establishing the horizontal format control for the printing of subsequent records. Spaces occupy positions in the horizontal format control record not occupied by HT characters. Any character

other than an HT is ignored. The format record is retained in storage until a new format is received, a card is read, or a card is punched. The format record is not destroyed by reautoloading.

3. When the HT character appears within subsequent records, it causes the data following the HT character to be printed, starting at the next tab stop that was set by the preceding horizontal format control record. If no horizontal format control record exists, the record is truncated at the HT character.

3.2.3 Message Sequences

This section describes and gives examples of message sequences between two stations using Bisync protocol.

3.2.3.1 Contention for the Line

A terminal, ready to transmit, must first determine that the remote unit is able to receive. This request to transmit is

made by the transmission of an ENQ. On receipt of the ENQ, a remote unit will respond with DLE 0 if it is ready to receive data, or with NAK if it is not ready to receive data.

Any response other than DLE 0 or NAK to a request to transmit will result in a retransmission of the ENQ.

If a negative reply to an ENQ occurs, the ENQ will be repeated until a positive reply occurs, or until n enquiries have been sent, where n is an installation parameter with a default value of 15. If the reply to the nth ENQ is still negative, an EOT is sent. In a point-to-point configuration, one terminal can be designated the primary terminal and the other the secondary terminal {see "Timeout Controls" section 3.2.4 of this manual}. In a terminal-to-CPU operation, the terminal is normally the primary terminal. {Note - some CPU operating systems may act as the primary terminal.} A primary terminal is the terminal that will transmit data first if both stations try to initiate transmission at the same time.

A primary terminal will wait one second for a response to its ENQ before retransmitting the ENQ.

A secondary station will wait three seconds for a response to its ENQ before sending ENQ again. If the secondary station receives an ENQ as a response to its ENQ, it will respond as if it had never tried to initiate transmission--i.e., with DLE 0 or NAK, depending on its readiness to receive. However, it will initiate the request for transmission of its data after it

receives an EOT from the primary terminal. If both stations send ENQ at the same time, neither will respond to the other's bid. The primary station will then gain control of the line with a second ENQ before the secondary's second ENQ. DLE 0 is always the positive reply to a line-bid ENQ. There is no alternation as in the checking procedure. NAK is the negative reply.

After an EOT appears on the line, any ENQ is interpreted as a line bid. Both stations go into text mode with the appearance of an STX on the line. Text mode is maintained until an EOT appears again. In text mode, an ENQ is interpreted as a request for a response to checking.

Examples of contention sequences are:

1. Normal

   Trans - ENQ Text ...

   Rec - ACK0 ...

2. Not Ready to Receive

   Trans - ENQ ENQ n retries ... ENQ EOT

   Rec - NAK NAK ... NAK

3. Double Contention

   Primary - ENQ ←1 sec→ENQ Text ...

   Secondary - ENQ ACK0 ...

4. No Response

   Trans - ENQ←1 or 3 sec → ENQ n retries ... ENQ EOT

   Rec - - - -

3.2.3.2 Normal Transmission

A normal transmission sequence looks like:

Trans - ENQ Text Text Text ...

Rec - ACK0 ACK1 ACK0 ACK1 ...

3.2.3.3 Block Check Error

A negative reply to a block check sequence causes retransmission of the block. In terminal to terminal or terminal to CPU operation, the number of retransmissions n is an installation parameter. If a positive reply occurs for a retransmission, the transmitting terminal goes on to the next block of data it has to send. If the nth retransmission is still unsuccessful, the transmitter ends transmission by sending an EOT.

In CPU to terminal operation, the number of retransmissions is determined by the CPU.

A block checking reply other than the proper DLE response, NAK or EOT will cause the transmitting terminal to send an ENQ. The ENQ will also be sent if no response is received within three seconds. The ENQ is a request to the receiving terminal to repeat the last block checking reply. Failure to receive a usable response after n ENQ's will cause the transmitting terminal to end transmission by sending an EOT.

An example of a block check error in a transmission sequence is:

Trans - ENQ Block 1 Block 2 Block 2 ...

Rec - ACK0 ACK1 NAK ACK0

3.2.3.4 Odd/Even Check

The transmitting and receiving terminals maintain an alternating count of the blocks transmitted and received. The first block of text after a line bid is an odd block; the next block is an even block, and subsequent blocks alternate until an EOT occurs.

The count at the transmitting terminal is changed only after a correct positive reply is received. The count at the receiving terminal is changed just before a positive reply is to be sent to a block-check sequence. The receiving terminal's count will not be changed if the reply is a response to an ENQ.

If the reply and transmitting terminal's counts do not agree, the transmitting terminal will send an ENQ requesting the receiving terminal to repeat the reply. If the reply and transmitting terminal's counts do not compare after n ENQ's the transmitting terminal will end the transmission by sending an EOT.

When a CPU is transmitting to a terminal, the number of ENQ's transmitted by the CPU is under control of the CPU program routine. If the odd/even block count received by the CPU is still incorrect after a predetermined number of ENQ's, the program should branch to an error correction routine.

Examples of sequences where the counts are out of step are:

1. Case 1 - Immed. Reply

Trans - ENQ Block 1 Block 2 ENQ ... ENQ EOT

Rec - ACK0 ACK1 ACK1 ACK1... ACK1

2. Case 2 - Record Missed

Trans - ENQ Block1 Block 2 ENQ Block 2 ...

Rec - ACK0 ACK1 - ACK1 ACK0 ...

3.2.3.5 Text Delay

When the transmitting terminal is unable to send the next block of data within two seconds, the following sequence occurs:

TRANS - ENQ BLOCK 1 ⟵ 2 SEC.⟶TTD ⟵2 SEC.⟶TTD BLOCK 2 ...

REC - ACK0 ACK1 NAK NAK ACK0...

3.2.3.6 Reverse Interrupt

When the terminal is transmitting and the CPU wants to send a high priority message the following sequence occurs:

Trans - ENQ Block1 Block2 Block3 EOT ACK0

Rec - ACK0 ACK1 RVI ACK1 ENQ ...

3.2.4 Timeout Controls

Two or more terminals, in a ready to transmit condition and using the same communication line, can bid for the line simultaneously. When this contention-for-the-line condition occurs, neither terminal recognizes the request of the other{s}. Therefore, timeout controls are provided. These timeout controls are used to establish priority when a contention-for-the-line

condition exists, thereby preventing the transmission line from being tied up unnecessarily under the following conditions:

1. Line Contention Timeout (1 or 3 seconds)

   This timeout is used when operating point-to-point on a contention basis. A primary terminal allows a secondary terminal 1 second to reply to the Enquiry (ENQ) character. The primary terminal automatically retransmits the ENQ character after 1 second.

   A secondary terminal allows a primary terminal 3 seconds to reply to an ENQ character. At the end of this timeout the ENQ character is automatically encoded again and sent to the primary terminal.

   When operating terminal-to-terminal over leased lines, one terminal must be designated the primary terminal and the other the secondary terminal. This enables the primary terminal to gain control of the line if both terminals bid for the line simultaneously. This designation is not necessary when operating terminal-to-terminal over switched (dial) line facilities, since the operators control the priority of the terminals. In a terminal-to-CPU (contention mode) operation, the terminal is normally the primary.

   The CPU will wait for the terminal to send the second ENQ character if the CPU receives an ENQ response to its ENQ character. This condition could exist if both the terminal and the CPU send ENQ characters at approximately the same time.

2. No Response Timeout (3 seconds)

   A transmitting terminal will wait 3 seconds for a response to a block-checking operation. If no reply is received an ENQ is sent to the receiving terminal to solicit the response.

3. Text Delay Timeout (2 seconds)

   If the transmitting terminal does not send the next block of text within 2 seconds after receiving a response for the last text block a TTD sequence is sent.

4. Response Delay Timeout (2 seconds)

   A receiving terminal must respond to a block-checking operation within 2 seconds. If unable to do so, the receiving terminal remains in receive mode and waits for the transmitting terminal to send an ENQ character to solicit the response.

5. Character Synchronization Timeout (3 seconds)

A receiving terminal initiates a three-second timeout upon receiving a sync pattern (SYN SYN). It must receive an STX character or another sync pattern within this time. If none is received, the terminal abandons synchronization and waits for another sync pattern.

Upon receiving an STX character, another three-second timeout is initiated. If a block-end character or a sync pattern is not received within this time, synchronization is abandoned.

3.3 Terminal Operation

Change No. 1

3.3.1 Control Panel

The terminal control panel consists of:

1. Ten switches which are pictured in Figure 3.3-1 and described in Table 3.3-1.
2. Fifteen indicator lights which are pictured in Figure 3.3-2 and whose meaning is given in Table 3.3-2.
3. A three digit decimal digital display generally used to display an error code to go with the indicator light that is currently lit.

The indicator lights and digital display are used to show current error conditions existing in the local I/O devices and on the cummunication lines. Card Reader, Card Punch, and Printer lights are used where appropriate; peripheral option lights are used for general terminal or communication line errors or alerts.

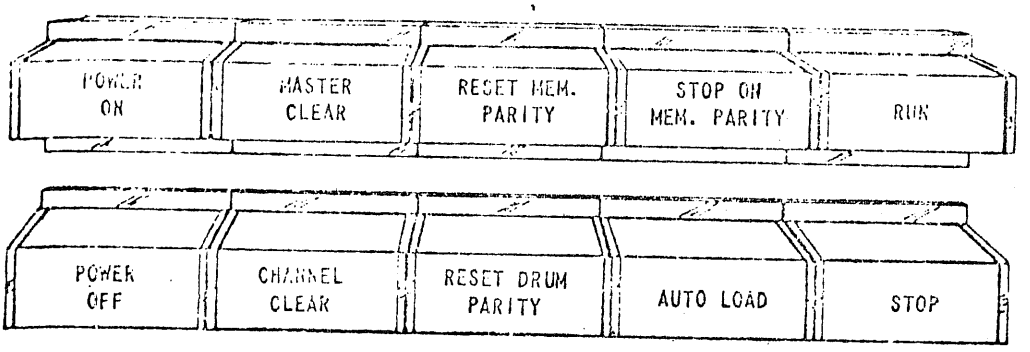


Figure 3.3-1
Terminal Console Switches

TABLE 3.3-1 TERMINAL CONTROL CONSOLE SWITCHES

SWITCH	FUNCTION
POWER ON	Turns on power to Buffer Controller, Display, Micro Drum, Terminal Control Console, and cooling systems. Momentary action, holds set. Lens lighted when power is on.
POWER OFF	Turns off power to above equipment. No Light.
MASTER CLEAR	Stops Buffer Controller operation, clears all addressable registers and their controls, clears memory registers and controls, clears all normal channels, and clears coupler controls.
CHANNEL CLEAR	Clears all input/output channels to zeroes.
RUN	Starts the Buffer Controller. Executes instructions beginning with the address contained in the program address register. Lens lights when controller is running.
STOP	Stops the execution of a Buffer Controller program.
STOP ON MEMORY PARITY FAULT	Stops the Buffer Controller when a parity error is detected in core memory data. Lens lights when switch is depressed.
RESET MEMORY PARITY FAULT SWITCH	Clears the MEMORY PARITY ERROR indicator.
AUTOLOAD	Starts the Buffer Controller loading one track of data from the microdrum into core storage starting at core address zero. Loading is under hardware control.
RESET DRUM PARITY	Clears the DRUM PARITY ERROR indicator.

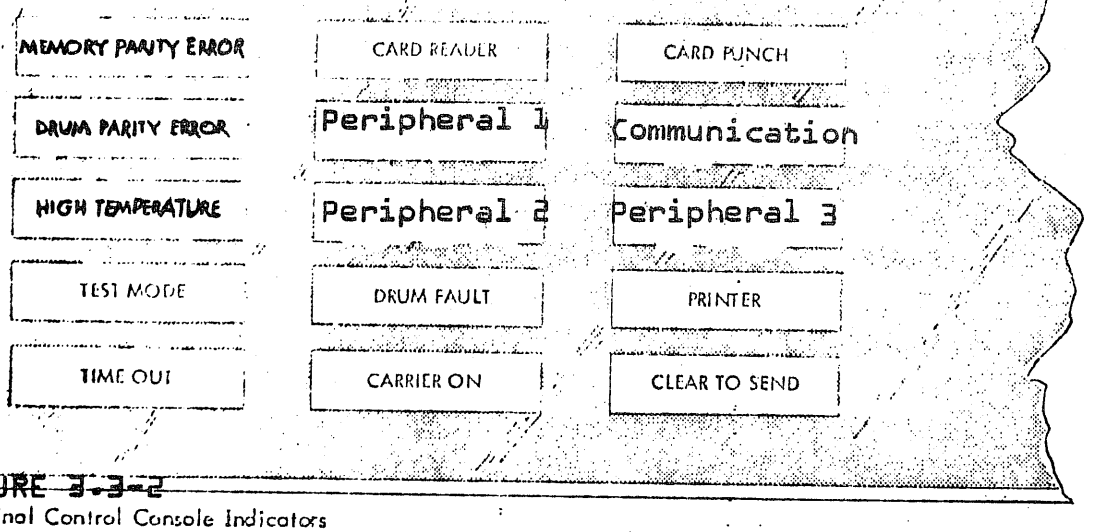


FIGURE 3.3-2
Terminal Control Console Indicators

TABLE 3.3-2 TERMINAL CONTROL CONSOLE INDICATORS

INDICATOR	MEANING
MEMORY PARITY ERROR	Parity error detected in a core memory data word.
DRUM PARITY ERROR	Parity error detected in a microdrum data word.
TEST MODE	The TEST MODE switch in controller is ON, for writing.
TIME OUT	A program or controller malfunction, and execution has stopped.
CLEAR TO SEND	The terminal has received a Clear-To-Send signal from the data set. Ready to send data to central processor.
CARRIER ON	Data Set is sending Carrier On signal to terminal. Data Set has good link to central processor.
TEMPERATURE WARNING	Lights when air temperature of Logic Chassis reaches 105°F ±5°F (40.5°C ±2.8°C). Equipment turns off automatically when temperature reaches 120°F ±5°F (49°C ±2.8°C).
DRUM FAULT	Lights for Drum power error, improper head select, or bad write operation.
CARD READER	Lights when program selects Card Reader.
PRINTER	Lights when program selects Line Printer.
CARD PUNCH	Lights when program selects Card Punch.
COMMUNICATION	Lights when program selects communication
Peripheral 1,2,3	{Not used with this terminal.}

3.3.2 Line Printer

Table 3.3-3 describes the line printer controls. {CL896 and CL3021} 2

TABLE 3.3-3 LINE PRINTER CONTROL FUNCTIONS

CONTROL	TYPE	FUNCTION
POWER ON	Switch/Indicator momentary	Pressed, turns on AC power to the printer. Lights when ON.
POWER OFF	Switch, momentary	Pressed, turns power OFF
STOP/START	Switch/Indicator momentary	Press once, START lights if printer is ready. Press again, STOP lights, printing stops at the completion of the operation. STOP will also light if printer is not ready due to: a. Out of paper. b. Print head failure (hammer fuse blown). c. Interlock switch open.
PAGE EJECT	Switch, momentary	Pressed moves paper to top of next form. Does not work when START is lighted.
Character Phasing	Thumbwheel	Adjusts vertical coverage of printed line. Centers character over print hammer. Range is half a character, up or down.

Table 5-3a describes the controls for the 9322-4 Line Printer.

TABLE 5-3a LINE PRINTER CONTROL FUNCTIONS

CONTROL	TYPE	FUNCTION
POWER ON	Switch/Indicator Momentary	Pressed, turns on AC power to the printer. Lights when on.
POWER OFF	Switch/Non-Indicating momentary contact	Pressed, turns power off.
START	Switch/indicator Momentary	Press once. START lights if printer is ready.
STOP	Switch/indicator Momentary	Pressed, turns on STOP light. Causes printer to stop at end of print cycle.
PAGE EJECT	Switch/non-indicating momentary	Pressed, moves paper to top of form. Works only when printer in STOP mode.
6/8 Line Per Inch	Switch/Indicator	Alternate action allows selection of 6 or 8 line per inch vertical spacing. A lamp indicates mode selected.
SINGLE SPACE	Switch/indicator Momentary	Pressed, moves paper 1 space. Works only when printer in STOP mode.
PAPER FAULT	Indicator	Lights when one of paper tear switches is activated.

3.3.3 Card Reader/Punch

CARD READER OPERATION

To operate the card reader:

a. 410 MSBT. Load the cards into the input hopper and put the START/STOP switch in the START position.

b. Mark II LSBT. Load the cards into the input hopper, depress Clear switch and depress the on-line switch.

c. 730-104. Set READ/PUNCH so that READ is lit. Load the cards into the input hopper and put the START/STOP switch in the START position.

Unless operating in transparent mode an attempt to read a US, ETB, EOT, NAK, or ENQ control character causes an error and reading stops.

CARD PUNCH OPERATION

The 730-104 is rated at a speed of 66 cards per minute. It is run by the Terminal Controller. Controls are shown in Figure 3.3-3 and explained in Table 3.3-4.

For punching operation, POWER, PUNCH, and START must be on (lighted) and the cards must be properly loaded.

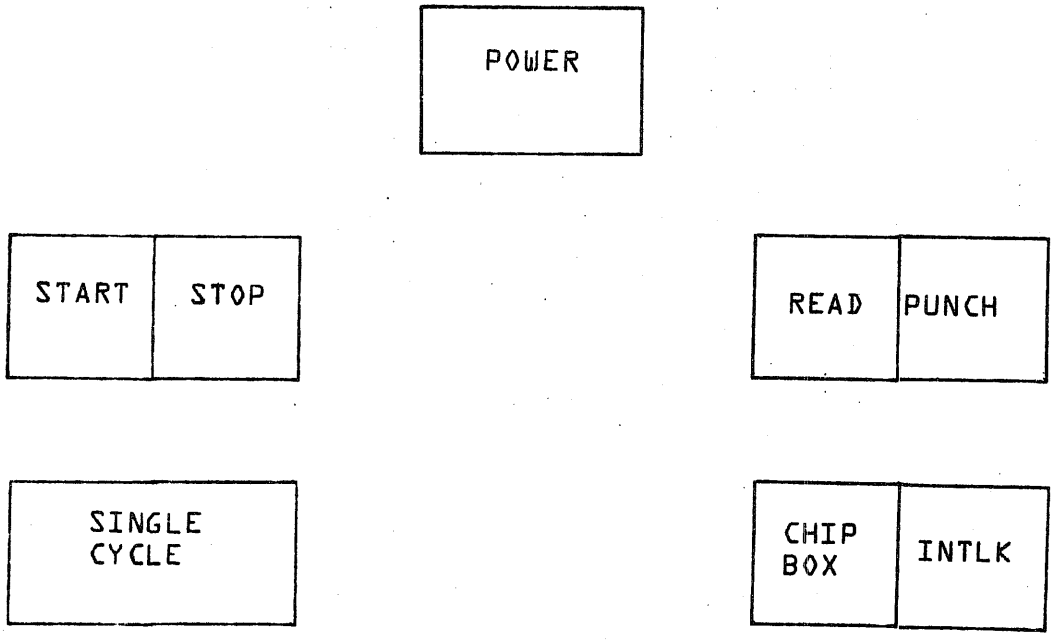


FIGURE 3.3-3
Card Punch
Control Panel

The End of Media (EM) character is used to indicate the end of a record when transmitting records of variable length. If an EM character is punched in the card column following the last column containing data, it prevents further reading of that card. The transmitting terminal then automatically generates and transmits a US or ETB character following the EM character.

As an installation option, if there is no EM character in the record, any trailing blanks can be eliminated and an EM automatically encoded after the data. This compression of trailing blanks improves the transfer rate.

If the punch is selected at the receiving terminal the EM character is punched.

TABLE 3.3-4 OPERATOR CONTROL PANEL CONTROLS AND INDICATORS

SWITCH/INDICATOR TYPE	FUNCTION
POWER Pushbutton indicator, alternate action	Applies and removes power. Indicator is lit when power is applied.
SINGLE CYCLE Pushbutton indicator, momentary action	Initiates a single card cycle and clears error conditions when pressed while START/STOP is in STOP position. If in START position, clears error condition but no cards will cycle.
START/STOP Pushbutton indicator, alternate action	Lights to indicate function initiated by controller. STOP position locks out start initiated by controller.
CHIP BOX Indicator	Lights to indicate the chip box is full or out of place.
INTERLOCK Indicator	Lights to indicate the unit cover is not fully closed.
READ, PUNCH Pushbutton indicator, alternate action	Selects the operation to be performed.

3.3.4 Keyboard

In general, the keyboard is used as a local control device for the purpose of:

1. Selecting terminal operation mode (simulate IBM 2780 mode switch position);
2. Simulating IBM 2780 Operator Panel keys;
3. Operational aids, such as requesting operating instruction on the display.

Keyboard commands are entered in a simple format of a mnemonic followed by a ETX (send) character, or by depressing a function key (F1, F2, ..., F7, F0).

Keyboard input goes to the terminal software and is displayed on the CRT screen, but not sent to the computer. The keyboard is used only for local terminal control.

Table 3.3-5 lists the keyboard entries which are used to simulate 2780 features.

TABLE 3.3-5

Keyboard Commands

Keyboard Entry[1]	Use
RCV	Allow terminal to receive either punch or print output.[2]
PCH	Receive punch output only.[2]
PRT	Receive print output only.[2]
TSM	Transmit card input.[2] Also may receive output after card input finished.
TSP	Works the same as TSM except allows transmission of all EBCDIC characters (ignores control characters in text).[2]
OFF	Allow card-to-print operation while maintaining line connection but no communication activity.[2]
AUTO	Allows terminal to receive punch output immediately after transmitting card data. Stops card reading when a blank card read.[3]
BELL	Used in terminal-to-terminal only. Send BEL character to other terminal. Turn on BELL and audible alarm at other terminal to request voice communication. Only works if terminals connected but idle. The audible alarm is turned off by hitting the reset function key.
FCM, nn *	Load Printer Forms Control Matrix number nn (nn = 1-32) from drum to core. The specified forms table will be used for subsequent printer carriage control. Command is ignored if terminal is in receive mode.
LOCK	Unlock/Lock the Memory Display (for maintenance purposes only). If unlocked, pressing TAB, then CLEAR will bring the BC Memory Display to the CRT. Another TAB, CLEAR will restore display to 2780 operation mode.

* This command is not applicable for 9322-4 Printer.

Keyboard Entry[1]	Use
HELP	Call up basic HELP display.
HELP,n	Call up secondary HELP display (n=1,2,3,4 or 5)

Function Keys	Description
F1	Status - request terminal status on CRT display screen (see Figure 3.3-4).
F2	EOF - Toggle end-of-file key ON/OFF. Causes end of transmission (send ETX) when card hopper goes empty. [3,4]
F4	FCM Load - Used only while terminal is in off-line mode (OFF). Causes cards read to be regarded as Printer FCM data rather than printed. Data is edited for proper FCM format and stored on the drum for later use. Must be pressed each time a new deck of FCM cards is ready to read. [5]
F6	Auxiliary Send - transfer contents of display screen to line printer.
F7	Restart - restart an aborted transmission (INCP or printer/punch not ready).
F0	Release - clears communication error indicators on CRT display and digital display).

1 All keyboard mnemonics are followed by ETX key.

2 Used to simulate 2780 mode switch.

3 Works as a two-way toggle - same entry alternately turns key on/off.

4 EOF works differently with different card readers; sends ETX:
a) When Hopper goes empty or Stacker is full with LSBT Mark II reader;
b) When Hopper goes empty with MSBT 410 reader or 730-104 Reader/Punch

5 FCM load is <u>not</u> applicable when the 9322-4 printer is in use on the LSBT.

3.3.5 Display

The CRT Display is used to:

1. Display keyboard commands as they are entered;
2. Display terminal status on a snap-shot basis upon request. Terminal status is not displayed dynamically, although certain conditions will cause status display to refresh.
3. Display upon request, instructions for operating the 2780 software.

The Display will be used only for local terminal monitoring, not for displaying data received from a remote computer or terminal.

Display Operation

The only Display Operator control is the intensity knob on the lower right corner of the cabinet face. Turning this knob clockwise brightens the display.

The following explanation of cursor movement, format control, transmission control, and extra features will help understanding display/keyboard operation.

Cursor Movement

Cursor is a blinking underline dash that indicates the position of the next symbol to be displayed. Depressing a symbol key on the keyboard erases the cursor and enters the symbol where the cursor used to be. The cursor moves to the next symbol position.

For each operation of a symbol or space bar on the keyboard, the cursor advances one space to the right. If the cursor is at the end of a line, it automatically moves to the first position of the next line.

When the cursor reaches the end of the bottom line, it automatically moves to the first position of the top line. Another symbol entered will replace the existing symbol at that position.

The cursor control keys are used to position the cursor.
SKIP { → } moves the cursor to the right one space. At the end of the line, the cursor will shift to the first position of the next line. At the end of the last line, the cursor will go to the start of the first line.

Backspace { ← } moves the cursor to the left one space At the beginning of the line, it moves to the end of the preceding line. At the beginning of the first line, it moves to the end of the last line.

Cursor Up { ↑ } raises the cursor up one line without changing its horizontal position. On the top line, the cursor will move to the same position in the bottom line.

Cusror Down { ↓ } moves the cursor down one line without changing its horizontal position. On the bottom line, the cursor moves to the same position in the top line.

Format Control

Keys that control the display layout are the NEW LINE, RESET, LINE CLEAR, and CLEAR Keys.

New Line

The NEW LINE Key corresponds to the typewriter Carriage Return. The NEW LINE symbol is displayed as {——}, and shows the end of a line. Entry of this symbol from the keyboard will clear any symbols remaining to the right of the NEW LINE symbol. The cursor advances to the beginning of the next line, as shown previously. If entered in the last line, the cursor moves to the beginning of the top line.

Line Clear

LINE CLEAR works like the NEW LINE function, except that the cursor does not advance. All symbols on the line to the right of the cursor are erased.

Clear

This key is used to erase the entire display. It resets the cursor to the upper left symbol position.

Reset

This key returns the cursor to the top left corner of the roster. No symbols are erased. Entry begins at the first symbol position, replacing existing top line symbols.

3.3.5.1 Terminal Status Display

The status display shows the current terminal status. Among information displayed are: position of the mode switch; position of auto-turnaround and end-of-file keys; line control status - Idle/Transmit/Receive; communication status indicator if terminal is on-line; printer forms table (FCM) currently in use; warning messages indicating any operator action necessary, such as RESTART (F7) required to continue.

The status display is not dynamically repeated, but is updated under certain conditions in which status changes. Figure 3.3-4 shows a sample status.

FIGURE 3.3-4

Sample Status Display

```
* * * C D C   7 3 2   B A T C H   T E R M I N A L   -   2 / 8 0   M O D E * * *

   ***  TERMINAL STATUS  ***

   MODE - -  TSM

   END OF FILE - -  ON              AUTO-TURNAROUND - -  OFF

   LINE CONTROL -  IDLE             PRINTER FCM - 01  *

   CONDITIONS -  RECD LINE

   RESTART REQUIRED
```

* The printer FCM message will not be displayed when the 9322-4 printer is used on the LSBT.

Table 3.3-6 lists how 2780 indicator lights are simulated by messages on the display.

TABLE 3-3-6
STATUS INDICATORS

Indication*	Mode**	Definition
DATA	T	Data check - Invalid character on input card or EOT, ENQ, NAK, ETB, or US on input card in non-transparent mode.
READ	T	Reader Not Ready - Hopper empty on 410 or 430 reader; hopper empty/stacker full on Mark II; if hopper empty, add cards or press EOF key.
RVI	T	Reverse Interrupt - RVI response received from CPU. Watch for high priority message on printer.
RECD	T	Record Check - Odd/Even block count error.
INCP	T	Incomplete transmission - EOT response received {accompanied by alarm}.
WACK	T	Wait for Acknowledgement - WACK sequence received from CPU.
LINE	T	Line check - NAK response, no response, or invalid response.
BELL	R	BEL character received from other terminal {accompanied by alarm}.
BLOK	R	Block Check - bcc error, block format error, ENQ in text, or character sync timeout.
DEVC	R	Device check - device selection error or output device is not ready.
OVRN	R	Overrun - Too many characters or records in block.

* Indicator mnemonic will appear on status display.
** Mode - T = Terminal is in transmit mode;
R = Terminal is in receive mode.

The indicators are cleared:

1. by pressing RELEASE function key (also turns off alarm).
2. by reception of a good ACK0/ACK1 response for RECD, WACK, and LINE indicators.
3. by reception of a good block (retransmission) for BLOK and OVRN.
4. If DEVC is caused by a not ready condition, the output device should be made ready and device error status cleared, in addition to pressing RELEASE.

3.3.6 Special Features

3.3.6.1 Software Forms Control

A number of different forms control tables (FCM) can be loaded via cards onto the micro-drum. The operator can schedule for use any FCM that has been defined on the drum, via the FCM,n command. Autoloading the terminal will not destroy the current FCM or line position. See Appendix E for a description of the forms control matrix card loader. A maximum of 32 forms control tables each with up to 136 lines can be handled.

Software forms control is used only with the CL896 and CL320 printers but not with the 9322-4 printer which uses a format tape and 6/8 line per inch density switch. 2

3.3.6.2 Help Display

To request operating instructions for the CDC 2780 emulator, the operator uses the keyboard entry HELP. The HELP display is not a tutorial but a quick-reference guide to remove the necessity of constant re-use of the operator's guide during operation. It defines all keyboard commands, function key settings, and error indicators. A convenient way to use this display is to call it up once, then dump it to the printer via Aux Send function (see Table 3.3-5).

HELP is actually a series of separate displays, each containing a separate category of instructions. The main display provides

The directory of displays and what to type to display them is as follows:

To Display	Type
a. Basic Information	HELP
b. Keyboard Command Index	HELP,1
c. Keyboard Function Index	HELP,2
d. Mode Switch Usuage	HELP,3
e. Status Display Guide	HELP,4
f. Status Display Error Conditions	HELP,5

3.3.6.3 Selection of Feature Options

Feature options for the 2780 emulator will be specified by Hollerith change cards to the binary deck at install time (before autoload). See Appendix B for format of the Hollerith change cards. Features selected will be displayed at system load/run time. Options and their default values are:

Option	Default
1. ASCII or EBCDIC Transmission Code	EBCDIC
2. Maximum characters per print line (range 80-136)	136
3. Maximum Transmission Block size (Maximum 400)*	400
4. Number Records per block (range 2,7)*	7
5. Primary or Secondary Terminal (1 or 3 second contention timeout)	Primary (1 sec)
6. Transmission Retry Limit (Total of ENQ & Data)	15
7. Control or Constant Carrier	Control
8. Automatic EM to eliminate trailing blanks	off

*Must be consistent with parameter in CPU

3.3.6.4 Off-Line Card to Print

The 2780 Emulator allows the listing of cards without autoloading or breaking line communication. This operation is started by typing OFF and then hitting the ETX key on the keyboard. Then the printer and card reader are made ready and reading and printing should start. Cards will be read and listed until an ETX is encountered. A colon will be substituted for illegal characters and the line will be double spaced. Listing will continue. If the CPU attempts to send output while the terminal is in Off-Line mode, the terminal will send negative responses to all enquiries. When the card-to-print is completed, communication can be returned by putting the terminal in the desired on-line mode (see table 3.3-5).

3.4 System Flow

There are two basic elements to this Software package, a buffer and a scanner. The buffers in the buffer pool are used to accumulate data from the communication line for the output devices and to accumulate data from the input devices to be transmitted to the High Level Processor. The scanner is used to distribute control to the various routines. See Figure 3-4-1.

3.4.1 Buffer Pool

There are two buffers in the buffer pool. A buffer is taken from the pool -

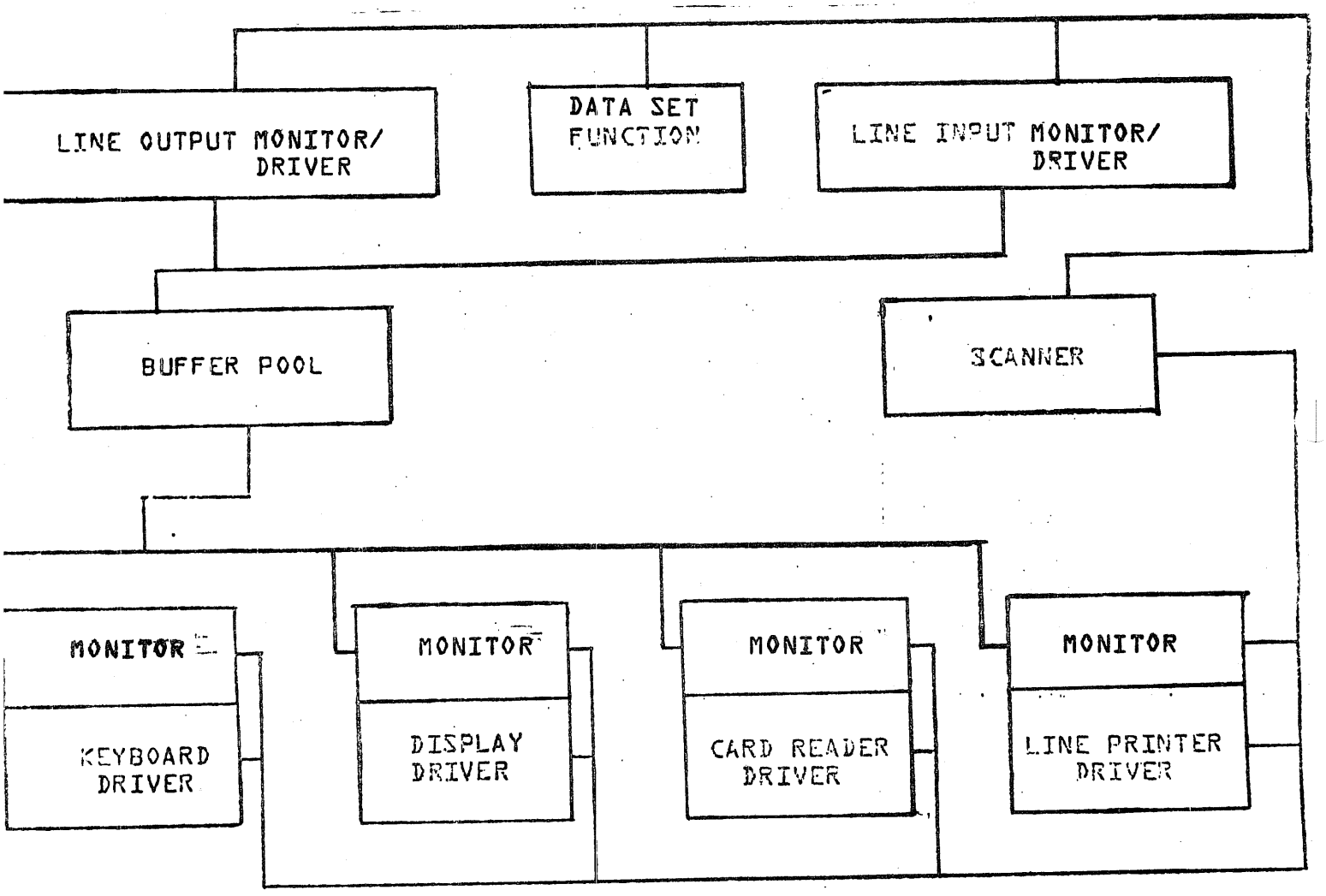
1. When the line input receives a text block. If a buffer is not available, no response is made.
2. When the Card Reader Monitor gains control from the Card Reader Driver. If a buffer is not available, the Card Reader Monitor waits until one is made available.

A buffer is returned to the pool -

1. When the Line Printer {punch} Monitor has completed printing {punching} the data.
2. When a block of data has been transmitted and a positive acknowledge has been received in response.

FIGURE 3.4-1

Block Diagram of Controlware



3.4.2 Scanner

The scanner consists of three parts; an Address Table, a Bit Table, and a Scan Routine. The Scanner has three levels, each having one third of the Address Table and one-third of the Bit Table.

The Address Table is a table of the entry point-addresses of the software routines.

The Bit Table contains a bit position for each address in Address Table.

The Scan Routine scans the Bit Table in search of a bit present. A bit is present in scan level one and scan level three whenever a change occurs in a normal channel bit. A bit is present in scan level two if the corresponding bit is set in the Toggle Mask and set in the Product Mask.

Some of the bits in the Bit Table represent hardware status lines and the remainder of the bits in the Bit Table represent software status. There are two ways bits get set in the Bit Table - a) hardware status line gets set, or b) software routine sets a bit.

Each time the Scan Routine gains control it scans the Bit Table until it finds a bit present. The position within the Bit

Table of the bit detected provides an index into the Address Table.

The following routines have a bit position in the Bit Table and an entry-point address in the Address Table:

1. Line Input Monitor
2. Line Output Monitor
3. Line Function
4. Line Printer Monitor
5. Card Reader Monitor
6. Keyboard Monitor
7. Display Monitor
8. Punch Monitor
9. Time Strobe
10. Line Printer Driver
11. Card Reader Driver
12. Keyboard Driver
13. Display Driver
14. Punch Driver
15. FCM Loader

Each of the devices have drivers that utilize bit positions in the Bit Table. The routines within a driver set and clear each other bits in the Bit Table to perform their respective I/O. However, for the pumpose of this document each driver will be considered one routine with one bit position in the Bit Table.

3.4.2.1 Routine Linkages

Line Input Monitor

The Line Input Monitor will get control from the scanner when its bit is set in the product mask, clear in the toggle mask, and its bit is present on the normal channel. The bit in the product mask is first set by the Initialize routine, and by Time Strobe, Line Output, and Keyboard Monitor routine. The bit on the normal channel is set by the Data Set Adapter when it has a character assembled for input.

The Line Input Monitor routine clears its own bit in the product mask when it completes an input operation. The toggle mask bit is clear at all times.

Line Output Monitor

The Line Output Monitor routine will get control from the scanner when its bit is set in the product mask, clear in the toggle mask, and its bit is set by the Function routine after it puts the line in the send mode. The bit on the normal channel is set by the Data Set Adapter when it is ready to accept a character. The Line Output Monitor routine clears its own bit in the product mask when it completes an output operation.

Line Function

The Function routine will get control from the scanner when its bit is set in the Toggle Mask and Product Mask. The bit in the Toggle Mask is set by the Line Input Monitor routine upon correct receipt of complete message, or by the Time Strobe routine. The Function routine clears its own bit in the Toggle Mask when it completed turning the Communication line around.

Line Printer Monitor

The Line Printer Monitor routine will get control from the Scanner when its bit is set in the Toggle Mask and Product Mask. The bit in the Toggle Mask is set by the Line Input Monitor upon correct receipt of a message for the Printer.

The Line Input Monitor passes a buffer of one or more print records to the Printer Monitor. The Printer Monitor sets up a line of print data. Then sets a bit for the Line Printer Driver in the Toggle Mask and clears its own bit in the Toggle Mask. Upon completion of printing the line of data the Line Printer Driver sets the bit in the Toggle Mask for the Line Printer Monitor and clears its bit in the Toggle Mask. This continues back and forth until all records in the buffer have been printed, at which time the Line Printer Monitor releases the buffer to the pool, and looks to see if there is another buffer of data to be printed. If there is another message to be printed the Line Printer Monitor repeats the process with the new buffer; if not, it clears its bit in the Toggle Mask and does not set any other bits.

Card Reader Monitor

The Card Reader Monitor will get control from the Scanner when its bit is set in the Toggle Mask and Product Mask. The bit in the Toggle Mask is set by the Card Reader Driver after reading a card. The Card Reader Monitor converts the card data and stores it in a buffer from the buffer pool. Then the Card Reader Monitor routine sets the bit for the Card Reader Driver routine in the Toggle Mask and clears its bit in the Toggle Mask. When the buffer is filled with a maximum number of records or characters, the monitor passes the buffer to the Line Output Monitor and takes another buffer from the pool upon receiving

the next card from the Card Reader Driver. This process continues until the last card is read or a card read error occurs, at which time the Card Reader Monitor routine clears its bit in the Toggle Mask and does not set any other bits.

Keyboard Monitor

The Keyboard Monitor routine will get control from the Scanner when its bit is set in the Toggle Mask and Product Mask. The bit in the Toggle Mask is set by the Keyboard Driver upon detection of a function key, or a control key. The Keyboard Monitor interprets Function Keys and alphanumeric commands, then performs the prescribed function. Then it clears its bit in the Toggle Mask. The Product Mask is set at all times.

Display Monitor

The Display Monitor will get control from the Scanner when its bit is set in the Toggle Mask and Product Mask. Then upon preparing some data to be displayed, the Display Monitor routine will set the bit for the Display Driver in the Toggle Mask. Upon completion of displaying the data, the Display Driver routine clears its bits in the Toggle Mask. This continues back and forth until the complete message is displayed at which time the Display Monitor routine clears its bit in the Toggle Mask and does not set any other bits. The Product Mask is set at all times.

3.4.2.2 Routine Functions

Line Input Monitor

The Line Input Monitor routine performs the following functions:

1. Receives all messages received from the communication line one character at a time, including all text data, enquiries and responses, from the other terminal or CPU.
2. Sets 2 sec. timeout (for next transmission block to begin) after receiving response.
3. Toggles odd/even block check responses (ACK1/ACK0) after each good response received.
4. Examines ESC sequences to determine whether each record is for the printer or the punch.
5. Assembles text blocks and pass them to the Punch/Print Monitor in a buffer acquired from the buffer pool. Converts EBCDIC to ASCII if necessary.

Line Output Monitor

The Line Output Monitor routine performs the following functions:

Transmitting Terminal

1. Send line bid sequence (ENQ) to gain control of line.
2. Take buffer of card input passed from card read monitor and transmit it to CPU or terminal. Append appropriate data-line control characters for normal or transparent data. Convert EBCDIC to ASCII.
3. Retransmit blocks if necessary, until correctly received by other end, or until maximum number of retries is exceeded.
4. Compute and transmit block check chars. for each data record - LRC for ASCII, or CRC for EBCDIC.
5. Send EOT, TTD, ETX, or BEL sequence when appropriate.

6. After sending complete message, set appropriate 1, 2, or 3 second timeout, drop out and wait for response.

Receiving Terminal

1. Answer line bid with positive response (ACK0) when ready to receive.
2. Send ACK1/ACK0 response to each block of data correctly received. Toggle ACK1/ACK0 before each response to odd/even numbered block of data.
3. Send NAK response to blocks incorrectly received (e.g. BCC do not agree).
4. When complete response is transmitted, drop out and wait for next block of data.

Line Fucntion

The Function routine turns the communication line around, allowing the terminal to go from receive to transmit mode. If operating under controlled carrier, it waits for carrier to drop before making it ready to transmit.

4.0 GLOSSARY

The following is a list of terms used throughout this document and their definitions:

1. BC - Buffer Controller
2. Bisync - Binary Synchronous Communications Protocol
3. bps - bits per second
4. CPM - cards per minute
5. CRC - cyclic redundancy check
6. CRT - cathode ray tube
7. DSA - Data Set Adapter
8. Line turnaround - Switch the communication line from transmit mode to receive mode, or vice versa.
9. L/MSBT - Low/Medium Speed Batch Terminal
10. LRC - Longitudinal Redundancy check - An odd parity character accumulated for each record.
11. LPM - Lines per minute.
12. VRC - Vertical Redundancy Check - An odd parity bit on each character.
13. 200 UT - 200 User Terminal

APPENDIX A

Code Sets and Code Differences

ASCII Code (HEX)	EBCDIC Code (HEX)	029 Card Code	222-2 Graphic	L/MSBT Graphic
5B	4A	12-8-2	¬	[
2E	4B	12-8-3	.	.
3C	4C	12-8-4	<	<
28	4D	12-8-5	(	(
2B	4E	12-8-6	+	+
21	4F	12-8-7	∧	!
26	50	12	↱	&
5D	5A	11-8-2	↘	]
24	5B	11-8-3	$	$
2A	5C	11-8-4	*	*
29	5D	11-8-5	)	)
3B	5E	11-8-6	;	;
5E	5F	11-8-7	↑	^
2D	60	11	-	-
2F	61	0-1	/	/
2C	6B	0-8-3	,	,
25	6C	0-8-4	%	%
5F	6D	0-8-5	⊏	_
3E	6E	0-8-6	>	>
3F	6F	0-8-7	↓	?
3A	7A	8-2	:	:
23	7B	8-3	≥	#
40	7C	8-4	≠	@
27	7D	8-5	≤	'
3D	7E	8-6	=	=
22	7F	8-7		"
5C	E0	0-8-2		\

ASCII Code (HEX)	EBCDIC Code (HEX)	029 Card Code	222-2 Graphic	L/MSBT Graphic
41	C1	12-1	A	A
42	C2	12-2	B	B
43	C3	12-3	C	C
44	C4	12-4	D	D
45	C5	12-5	E	E
46	C6	12-6	F	F
47	C7	12-7	G	G
48	C8	12-8	H	H
49	C9	12-9	I	I
4A	D1	11-1	J	J
4B	D2	11-2	K	K
4C	D3	11-3	L	L
4D	D4	11-4	M	M
4E	D5	11-5	N	N
4F	D6	11-6	O	O
50	D7	11-7	P	P
51	D8	11-8	Q	Q
52	D9	11-9	R	R
53	E2	0-2	S	S
54	E3	0-3	T	T
55	E4	0-4	U	U
56	E5	0-5	V	V
57	E6	0-6	W	W
58	E7	0-7	X	X
59	E8	0-8	Y	Y
5A	E9	0-9	Z	Z
30	F0	0	0	0
31	F1	1	1	1
32	F2	2	2	2
33	F3	3	3	3
34	F4	4	4	4
35	F5	5	5	5
36	F6	6	6	6
37	F7	7	7	7
38	F8	8	8	8
39	F9	9	9	9
20	40	NO PUNCH	SPACE	SPACE

Control Characters	ASCII Code (HEX)	EBCDIC Code (HEX)	029 Card Code
STX	02	02	12-9-2
ETX	03	03	12-9-3
EOT	04	37	9-7
ENQ	05	2D	0-9-8-5
ACK	06	2E	0-9-8-6
HT	09	05	12-9-5
DLE	10	10	12-11-9-8-1
NAK	15	3D	9-8-5
SYN	16	32	9-2
ETB	17	26	0-9-6
EM	19	19	11-9-8-1
ESC	1B	27	0-9-7
US	1F	1F	11-9-8-7
ACK0	1000	1070	
ACK1	1001	1061	
WACK	103B	106B	
RVI	103C	107C	

The character sets in the 731/732 and 222-2 line printers have differences in the special characters from those in the IBM 2780. The alpha-numeric characters {A-Z, 0-9} are the same for all printers. The special characters for each printer are shown below.

IBM				CDC	
ASCII	EBCDIC			731/732	222-2
63	63	52	39	63	63
¬ !	¬ !			¬ !	[< [
. $ ¬ #	. $ ¬ #	. $ ¬ #	. $ ¬	. $ ¬ #	. $ ¬ ≥
< * % @	< * % @	□ * % @		< * % @	< * % ≠
( ) _ '	( ) _ '	( ) '		( ) ^ '	( ) ↑ ≤
+ ; = [	+ ; = ≠	+ =		+ ; = [	+ ; = ≡
] ? & -	? & -	& -		] ? & -	∨ ↓ ↱ -
/ > \	/ > |	/		/ > \	/ >]

APPENDIX B

TERMINAL INITIALIZATION CONTROLWARE INSTALLATION, INSTALLATION PARAMETERS AND AUTOLOAD

Change No. 1

B.1 TERMINAL INITIALIZATION

Initialization loads the loader to the micro-drum so that it may be used for system installation. Terminal initialization is needed only when the loader tracks of the micro-drum have been destroyed and when system is first installed. Normal installation and use of the system should not destroy the loader track.

B.1.1 Materials Needed for Terminal Initialization

a. Terminal Initialization Paper Tape
b. Terminal Initialization Deck
c. Maintenance Console

B.1.2 Terminal Installation Procedure

a. Disable the write protect feature which allows writing to the loader tracks of the micro-drum.
b. Load the terminal initialization paper tape of the card loader at P=1000 via the maintenance console paper tape reader.
c. Via maintenance console buttons:
   MASTER CLEAR
   CHANNEL CLEAR
   Set P = 1000
   GO
d. Put the Terminal Initialization deck into the card reader and start the card reader.
e. When message 099 appears, loading is complete and the system is ready for controlware installation. If a message other than 099 appears, the loading is aborted.
f. Enable the write protect feature to protect the loader tracks.

B.2 CONTROLWARE INSTALLATION

Change No. 1

Controlware Installation uses the loader on the micro-drum to load the Controlware Installation Deck to the micro-drum. Updated or modified controlware can be installed without doing a Terminal Initialization if the loader on the micro-drum has not been destroyed by hardware failure or non-standard use of the terminal.

B.2.1 Material Needed for Controlware Installation

Controlware Installation Deck

B.2.2 Controlware Installation Procedure*

a. Depress the AUTOLOAD button on the operators console.
b. Load the controlware installation deck into the card reader and start the card reader.
c. When message 099 appears, the system is loaded on the micro-drum. If a message other than 099 appears, the loading is aborted and must be restarted.

B.3 AUTOLOAD

Once the software has been installed on the drum, it can be loaded into the BC by depressing the AUTOLOAD Key on the operator's console. Then depress a function key on the keyboard. The function key picks the system to be loaded.

F0 Diagnostics
F2 IBM 2780 Emulation

B.4 RESTART

Restart and Autoload are synonymous for this product when referring to controlware installation.

* Binary patch cards specifying feature options precede the controlware installation deck. {Format of binary patch cards is specified in Section B.6.3.} See Section B.9 for description of installation parameters for feature options.

B.5 LOADER MESSAGES

Micro Drum

007 Micro drum compare error. The loader has written an overlay to the micro drum and then read it back. It did not match what the loader wrote. Check that write enable board is in place. Run drum diagnostics.

008 Lost in micro drum driver. The 008 is set by the loader on entering the micro drum driver and cleared on exit. If the system hangs with an 008, run drum diagnostics.

Binary Cards

021 Check sum error. The sum of the bytes in the data field of the card (col. 5 thru 80) does not match the card checksum found in cols. 3 and 4. The last card under the card reader is bad or the deck is bad. The card checksum is accumulated while processing the data on the card and then checked at the end of the card processing. An error related to bad Batch overlay structure may be caused by a bad card read and an error generated before the checksum was tested.

022 Card out of sequence or missing. The card sequence number is in column 2. The last card under the read head is the one that caused the error. If the cards are in sequence, then run card reader diagnostics.

027 Deck does not start with EOF EOR. The first card of the deck should have column 1 punched with 11-4-8-9 and the second card of the deck should have column 1 punched with 11-6-8-9.

Link Editor Overlay Structure

031 Bad binary deck. The header generated by the linking loader is in error. Re-assemble.

Batch Overlay Structure

041 Cannot find FFFF. Every overlay header starts with a word of FFFF. Either the header does not start with FFFF or the length of the last overlay processed contained an incorrect length. Re-assemble.

042 Bad header size. The second word of the header must be 4. Re-assemble.

(Change No. 1

043 Batch overlay start address is negative. The fifth word of the overlay header is the base address that overlay was assembled at. The address must be positive. Re-assemble.

044 Bad overlay length. The sixth word of the overlay header is the length of the overlay. The length must be positive and less than the size of a micro drum track. Re-assemble.

045 Batch overlay overflows into patch table.

046 Discontiguous address in header. As far as the assembler is concerned, the batch overlay header is buffer controller code. The header must be assembled as six contiguous words.

Patch Cards

061 Non-hexadecimal digit. All numbers on the patch cards should be hexadecimal. A non-hexadecimal digit has been found on the last card read. This error may also occur while processing the numeric fields of the parameter card {first card of the deck}.

062 Card incomplete. The end of the card was found and there should be more data fields.

063 Number too big. The largest allowable hexadecimal number is FFFF.

065 Patch table overflow. The patch table uses all of core not used by the loader and its fixed length tables. If there is a patch table overflow, then either some patches must be removed or the controlware must be re-assembled to include the patch corrections.

066 Bad patch address. The patch address must be inside the overlay or one word beyond the end of the overlay.

067 Duplicate overlay names. There are two or more batch overlays with the same scan level word. {They probably have different usage words.} Assemble corrections in.

Parameters

071 Bad system number. The system number must be in the range F0 to F8.

Finish

098 Loading complete but more microdrum tracks were used than was set aside for the system. Another system may have been destroyed or the loading of another system may destroy this one.

099 Loading complete.

B.6 Deck Structure for Drum Loader

The data structure for Controlware Installation Deck and for the Terminal Initialization Deck is imbedded in the Buffer Controller Binary Deck produced by the Buffer Controller Link Editor. {See ERS for Buffer Control Assembly Language.} The Batch Overlay Headers are assembled by BUCAL {the Buffer Controller Assembler} as if they are code and only the terminal loader recognizes them as headers.

B.6.1 Card Deck Structure

11-4-8-9 NAME DATE SYSTEM NUMBER {file separator}

Add for binary patching only if needed

11-6-8-9 A {record separator - ASCII follows}

Patch deck

11-6-8-9 BS {record separator - binary follows}

binary controlware deck

11-6-8-9 BS

binary controlware deck

⋮

11-6-8-9 BS

binary controlware deck

11-6-8-9 BS

End of Deck generated by Link Editor

11-4-8-9 {file separator}

B.6.2 Batch Overlays

The batch overlays are imbedded in the data produced by the Link Editor.

Batch Overlay Header

Each overlay must be preceded by a header consisting of the following information:

```
Header Start Con X≠FFFF≠  HEADER IDENT

             Con Header End-Header Start
                 Header Length

             Con Residence Assignment + Scan Level Assignment
                                        or track number

                 Left Byte = Residence Assignment
                 Right Byte = Scan Level Assign or track number

                 If Residence Assignment is 0 or 2,
                 Scan Level = Bit Assignment for the routine
                              in the Overlay Table.

                 If Residence Assignment is hexadecimal 40,
                 Track Number is the track the batch overlay
                 is written on starting with word 0 sector 0.

             Con Use Assignment

                 Bit 0 of this word will be set for all
                 overlays in this product except the Basic
                 Package {Low Core and the Drum Driver}.
                 The multiple overlay feature table will not
                 be used in this product.

Header End   EQU $ Last address of header

             Con Program Start
                 First word address of program

             Con Program End - Program Start
                 Program Length

Program
Start        EQU $ First word address of program
```

The batch overlay code follows. Following the code is another header, an end-of-record, or an end-of-file.

B.6.3 Binary Patching of Controlware

A binary patching feature exists for changing controlware as it is loaded to the micro-drum. The ASCII patch deck is preceded by an end-of-record card with column 1 with rows 11, 6, 8, and 9 punched, and an A in column 2. The patch deck is put into the Controlware Installation deck of the Terminal Initialization deck after the first file separator (11-4-8-9 punch in column 1).

The patch cards are free-field format with a space as a delimiter between fields. All fields are hexadecimal numbers. The fields needed are (in order):

1. Batch Overlay Number - The upper byte of the batch overlay number is the upper byte of the usage word (4th) of the overlay header. The lower byte of the batch overlay number is the lower byte of the third word of the overlay header which contains the scan level and bit assignment.

2. Patch Address - The address of the first word to be patched relative to the start of the batch overlay.

3. Number of Words to be Patched - Hexadecimal count of words to be patched.

4. Patches - One field for each word to be patched.

Each patch card is processed individually and there is no continuation from one card to the next. The patch address may be inside of the overlay or one beyond the end of the overlay, but not more than one word beyond the end.

The number of patches that may be done is dependent on the core space available for the patch table. Take the size of the core minus the size of the loader (about 900 hexadecimal) minus the size of the largest batch overlay to be loaded gives the size of the patch table. Each patch takes 3 words.

EXAMPLE: F01B BF 1 6B0D

F0 is the upper byte of the usage word.
1B is the scan level and bit assignment.
BF is the address of the first word to be patched.
1 indicates 1 word to be patched.
6B0D is the new word for location BF in F01B.

B.7 Micro Drum Structure

Track 0 and 1 Controlware loader
Tracks 2 thru F Diagnostics system
Tracks 10 thru 2F Primary system

For each system on the drum except the controlware loader, the systems have the same format:

1st track - Overlay tables
2nd track - Basic package
3rd track - Message track
Remaining tracks - system overlays

B.7.1 Basic Package Track

The basic package track is the part of the system loaded by the controlware loader starting at word 0. Execution of the basic package is started at word 0. The basic package must find and load its overlay table by getting the track number from the universal parameter table and deciding for itself which subsystem to load.

The basic package is identified in the overlay header by zero in the usage word.

B.7.2 Message Track

The message overlay is identified by X'FFFF' in the usage word of the header.

B.7.3 Overlay Table Track

The overlay table track contains several overlay tables. Each overlay table represents a subsystem. When an overlay is written to the drum, the usage word in the header is checked. If bit 0 is set, the overlay track and sector address is put in the first overlay table. If bit 1 is set, the information is put in the second overlay table. If bit 2 is set, the 3rd table, etc.

B.7.3.1 Overlay Tables

Each overlay table is 128 words long. There are 4 scan levels, 16 bits per scan level, and 2 words per overlay entry. 4*16*2=128. The first 2 words of the table are for bit 0 of the first scan level. The second 2 words are bit 1 of the first scan level. Words 127 and 128 are for the last bit of the 4th scan level.

The contents of each entry are as follows:

Location of overlay on drum:

Word 1 Left Byte = Head Number
Right Byte = Sector Number

Word 2 Left 11 Bits = Length
Right 5 Bits = Residence Assignment

Resident Assignment is = 2 or 0. Other Resident Assignments may be used for other Batch Subsystem products.

B.7.3.2 CHECKSUM and DATE

A system checksum and a build date are put in the first 4 overlay tables in place of the overlay 3F {Bit F of the 4th scan level}.

The system checksum is generated by the Loader after patching has been done by adding all of the words of the overlays and the overlay headers together and adding the number of overlays. The date is obtained from the file separator card at the start of the controlware deck. The date is displayed by the controlware on autoload.

B.8 Loader Parameters

Loader parameters are put on the file separator card (11-4-8-9) at the start of the load deck. The parameters are not supplied by BUCAL and must be punched after the controlware deck is created.

The structure of the file separator card is:

column 1 - 11-4-8-9 punch
1st field - starts in column 2 - name any characters except blank
2nd field - build date - 4 character field with no spaces
1st character - number of month in hex. 1=Jan., A=Oct., C=Dec.
2nd and 3rd character - day of month in decimal
4th character - last digit of year. 3=1973
3rd field - system number F1, F2, ... , F7, F0
Used to designate what function key is used to call the system.

F0	Diagnostics
F1	Mode IV
F2	2780
F3	Mode II
F4	Off-line
F5	
F6	
F7	
F8	Controlware loader - called by autoload button

The fieldsare free-field and are separated by blanks. All parameters must come before column 25. The space after column 25 is a comment field.

B.4 INSTALLATION PARAMETERS

These are entered as changes to the drum during controlware installation. They determine the selection of feature options.

Parameter Description	Default
Transmission code {ASCII/EBCDIC}	EBCDIC
Length of print line {range 80-136 characters}	136
Maximum transmission block size {136-400 chars.}	400
Maximum number of records per block {range 1-7}	7
Primary or Secondary Terminal	Primary
Transmit Retry Limit {range 1-30}	15
Send EM on every card {i.e. drop trailing blanks}	Off {send full card}
Controlled or constant carrier	Controlled

To select option values other than the stated default value, prepare patch loader cards as follows {see B.6.3 for full discussion of Patch Loader}:

23E	n	1	X

where: 23E = constant that must appear in all Installation Option patches;

n = Option Number

1 = constant - means one option per card.

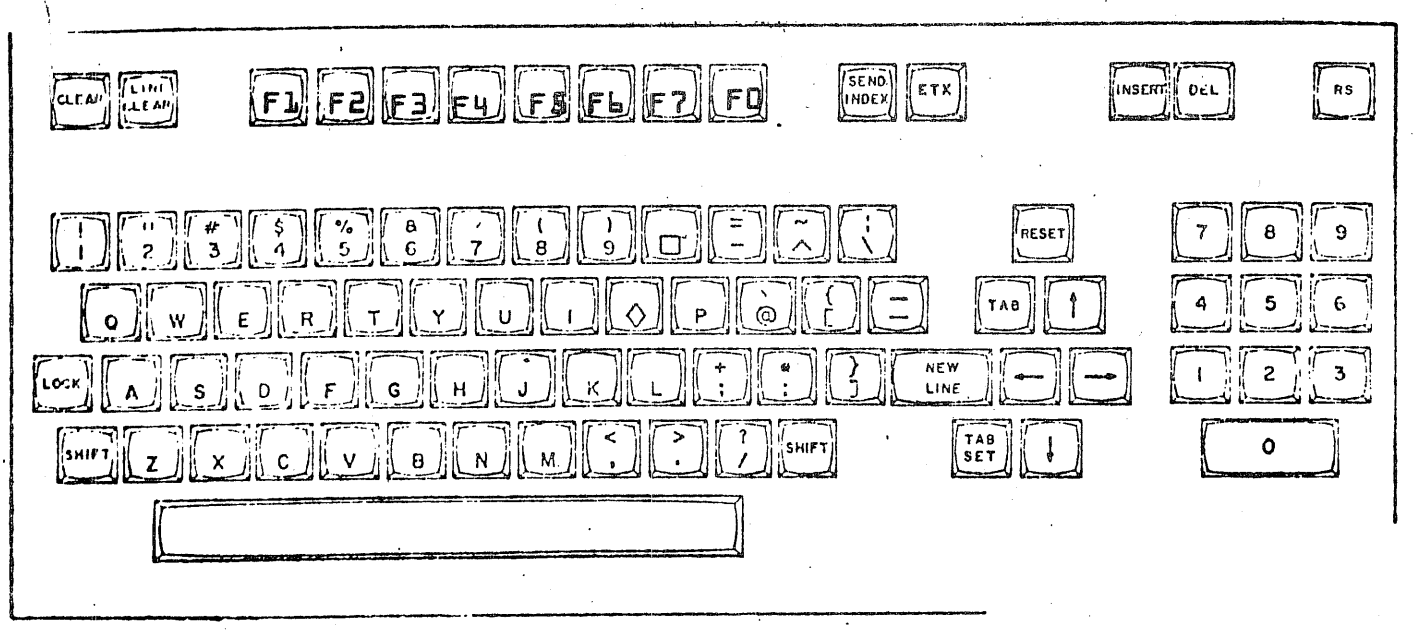
X = Value of Option in Hexadecimal {see Table below}

Option	Option Number {n}	Option Value {X}
Maximum characters per Trans. Block	1	*
Maximum records per Trans. Block	2	*
Select ASCII Transmission code	3	0
Transmit Retry Limit	4	*
Secondary Terminal	5	1
Print Line Length	6	*
Constant Carrier	7	1
Select EM Option	8	1

* Select desired value in Hexadecimal.

APPENDIX C

KEYBOARD



731/732 Keyboard

Explanation of Keyboard Keys

Alphanumeric Keys {48}	Entering data messages to the controller.
Edit and Control Keys {12}	
CLEAR	Clears entire message. Entry point returns to top line, left end.
LINE CLEAR	Clears only the present line. Clears from present position to end of line and leaves cursor where it was.
SEND INDEX	Not used.
ETX	End of Text. Sends completed message to Buffer Controller.
INSERT	Not used.
DEL	Not used.
RS	Not used.
NEW LINE	Same as typewriter carriage return. Next symbol will be inserted at the left hand end of the next line down.
TAB	Used to toggle from 2780 mode to Memory mode use of CRT Display. Move from one display mode to the other by pressing TAB, CLEAR. Only works if Memory Display is unlocked.
TAB SET	Not used
LINE UP {↑}	For changes. Next symbol is entered at same spacing, one line up. Old symbol is replaced by new symbol entered.
LINE DOWN {↓}	Same as { }, but new symbol is entered one line down.
SHIFT LEFT {←}	Same as backspace on a typewriter. Entry shifts left one space.

Explanation of Keyboard Keys
{continued}

SHIFT RIGHT {→}	Same as space forward on a typewriter. Entry shifts right one space.
Control Keys	
Space Bar	Same as typewriter. Enters a blank space.
SHIFT {2 Keys}	Sets uppercase when depressed.
LOCK	Locks the SHIFT key to uppercase. Replaces when SHIFT key is again depressed.
Numeric Keys {0 ... 9}	Enters control codes to operate terminal.
Function Keys {8}	See Table 3.3-5.

APPENDIX D

TEMPORARY FIX FACILITY

TEMPORARY FIX FACILITY

To allow field changes (small temporary fixes without reassembling) it is necessary to have a map of the controlware on the drum. When it has been determined what area on the drum is going to be modified, the changes can be made using the following procedure:

1. Enter LOCK on keyboard, followed by ETX key.
2. Depress the TAB key.
3. Depress the Clear key.
4. Key in S5,00XX (XX = Drum track address of data to be read).
5. Depress New Line key.
6. S6, will appear on the screen.
7. Key in GGHH (GG = Starting sector address of data to be read, HH = Starting word address of data to be read).
8. Depress New Line key.
9. S7, will appear on the screen.
10. Key in JJJJ (JJJJ = Starting word address of where data is going to be written into the Buffer Controller Memory).
11. Depress New Line key.
12. S8, will appear on the screen.
13. Key in KKKK (KKKK = Length of the data transfer, in words).
14. Depress New Line key.
15. The right hand side of the display must begin with address 0.
16. Depress F0 key.
17. The data is in core beginning at location JJJJ as defined in statement 10 above.

18. Depress Clear key.

19. Display the area in the Buffer Controller core that is going to be modified by using the following procedure:

    a. Key in RRRR (RRRR is address to be displayed).

    b. Depress New Line key.

        1. The screen will appear with RRRR as the first address displayed.

    c. It is possible to change only the left half of the screen by preceding the RRRR (paragraph 19 (a) above) with a "<" character. The right half of the screen can be changed by preceding the RRRR (paragraph 19 (a) above) with a ">" character.

        1. Example: Key in RRRR and depress New Line; the first address displayed will be RRRO and the screen to the right of second column of *'s will remain unchanged.

20. Depress the Clear key.

21. Key in STTTT,VVVV (TTTT = Address to be modified, VVVV = Modified contents of TTTT).

22. Depress New Line key.

23. Continue steps 20, 21 and 22 until all modifications are made.

    a. TTTT will be incremented by one each time the New Line key is depressed automatically so it is not necessary to depress the Clear key and key in STTTT, if contiguous locations are modified.

24. Write the modified program back on the drum using the following procedure:

    a. Depress the Clear key.

b. Key in S5,0XX (XX = Drum track address where data is to be written). Extreme care must be exercised to assure that the modified program does not extend into another program area on the drum. If the modified program is written in a different area on the drum than it was removed from, the overlay tables must be changed to reflect the new location on the drum.

c. S6, will appear on the screen.

d. Key in GGHH (GG = Starting sector address of where data is to be written. HH = Starting word address of where data is written).

e. Depress New Line key.

f. S7, will appear on the screen.

g. Key in JJJJ (JJJJ = Starting word address of where data is going to be read from in the Buffer Controller Memory).

h. Depress New Line key.

i. S8, will appear on the screen.

j. Key in KKKK (KKKK = Length of the data transfer, in words).

k. Depress New Line key.

l. The right hand side of the display must begin with address 0.

m. Depress F0 key.

n. Depress Autoload key.

o. Depress F2 key.

p. The modified system is executing.

APPENDIX E

PRINTER FORMS CONTROL MATRIX LOADER FOR THE CL896 AND CL320 PRINTERS

B. FORMS CONTROL MATRIX FORMAT AND LOADER

Change No. 2

1.0 GENERAL

The FCM loader is an off-line utility which transfers user defined format control matrices from card to drum for subsequent on-line use.

This utility is only required if the CL896 and CL320 printers are used. The 9322-4 printer used on the LSBT does not require a FCM table since the 9322-4 printer uses a format tape. 2

2.0 FCM CARD DESCRIPTION

The first card of an encoded FCM has the following structure:

Columns 1-3: The hollerith characters "FCM". This serves as a label for operator identification and acts as a password to insure that intentional FCM's, not random bit patterns, are installed as FCM's.

Columns 4-5: A right justified decimal number used to identify this FCM. {For the 731/732 this value is required to be in the range 1 to 32}. Leading blanks are treated as zeros.

Column 6: FCM card sequence number. For the first card, it must be "1".

Columns 7-9: Number of lines per page, right justified. This decimal value gives the length of the FCM and determines the number of cards needed. {For the 731/732, this value cannot exceed 136.} Leading blanks ignored.

Column 10: 6 or blank = 6 lpi; 8 = 8 lpi

Columns 11-12: Reserved for future CDC use.

Columns 13-20: Comment field available for user definition.

Columns 21-80: First sixty lines of the FCM. Each column contains one line of the FCM.

As many cards as needed may be used to describe the FCM. All subsequent cards have the following structure:

Columns 1-3: The characters "FCM".

Columns 4-5: The FCM number, which must agree with that on card 1.

Column 6: The FCM card sequence number. The cards must be in strict ascending order.

Columns 7-20: Comment field available for user definition.

Columns 21-80: Next sixty lines of the FCM. If less than sixty lines of the FCM remain, they must be left justified; the rest of the card is ignored.

3.0 PREPARATION OF AN FCM

The FCM is layed out on paper in a form identical with the printer motion control tape that it replaces.

EXAMPLE:

Line \ Level	12	11	10	9	8	7	6	5	4	3	2	1
1					1	1	1	1	1	1	1	1
2												
3												1
4					1					1		
5									1		1	
6							1					
7					1		1			1	1	

The table below is transferred directly to the FCM cards in 60 line blocks. Level 1 is punched in row 12 {+}, level 2 in row 11 {-}, level 3 in row 0, level 4 in row 1, etc.

EXAMPLE: {using the previous example}

Column		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Level	Row	F C M 0 1 1 7 A S A M P L E
1	12	1
2	11	1 1 1 1
3	0	1 1 1
4	1	1 1
5	2	1 1
6	3	1 1
7	4	1
8	5	1 1 1
9	6	
10	7	
11	8	
12	9	

4.0 LOADING PROCEDURE

1. Enter OFF then press ETX on keyboard to put 2780 Emulator in OFF line mode.
2. Push F4 to initiate the FCM loader routine.
3. Place one or more sets of FCM cards in the reader and start the reader. The FCM loader will transfer the FCM's to unprotected area of the drum unless errors are detected. Any existing FCM with a number matching one of those being loaded will be replaced by the new FCM.
4. Errors may occur in loading, either on the card reader, or in the FCM cards themselves. See Appendix F for both types of error codes.

APPENDIX F

ERROR CODES

ERROR CODES

The following is a list of all error codes used in the CDC 2780 emulation software.

1. Printer

   a. CL896 and CL320 Printers

XX2	NOT READY {STOP}
XX4	SYNC ERROR
XX8	PAPER RUN AWAY
X1X	PAPER FAULT
X2X	DRUM LATCH SWITCH
X4X	HAMMER FUSE or 29 VOLT FAULT
X8X	ILLEGAL CHARACTER CODE

   b. 9322-4 Printer

XX1	FAIL TO COMPLETE
XX2	NOT READY {blown hammer driver, vertical paper driver, ribbon driver fuse, drum gate open, format gate interlock open, paper tear, dropout of any print head voltage, out of paper, or STOP.
XX4	UNASSIGNED
XX8	TRANSMISSION PARITY ERROR
X1X	UNASSIGNED
X2X	UNASSIGNED
X4X	UNASSIGNED
X8X	ILLEGAL CHARACTER CODE

2. Card Reader

   a. MARK II

XX2	NOT READY
XX4	STROBE COUNT ERROR
X1X	DARK CHECK FAIL
X2X	LIGHT CHECK FAIL
1XX	READ HEAD JAM
2XX	MOTOR OFF
4XX	HOPPER EMPTY or STACKER FULL
8XX	HOPPER FEED JAM

   b. 410/430

XX1	CLUTCH MALFUNCTION
XX2	NOT READY {STOP}
XX4	COLUMN COUNT ERROR {CARD SLIP}
XX8	SKEW ERROR or SKEW TEST FAILURE
X1X	DARK CHECK FAIL
X2X	LIGHT CHECK FAIL
X4X	0 SWITCH MALFUNCTION
X8X	321 SWITCH MALFUNCTION
1XX	READ STATION JAM/EXIT JAM
2XX	MOTOR OFF/INTERLOCK MODE ERROR
4XX	STACKER FULL or HOPPER EMPTY
8XX	FAIL TO FEED

4. BG300 DRUM

XX1	HEAD SELECT FAULT
XX2	POWER FAULT
XX4	DRUM FAULT
X1X	DRUM BLOCK ERROR

5. Communication Line Error Bits

a. Transmitting

8X1	NAK Response Received
8X2	Invalid Response
8X4	No Response
8X8	EOT Response (Incomplete Transmission)
81X	WACK Response
82X	Odd/Even Block Check Error
84X	-
88X	RVI Received from CPU*
9XX	-

b. Receiving

XX1	ENQ in Text (STX...ENQ)
XX2	Char. overflow (400/block or 170/record)
XX4	Record overrun (7 rec./block)
XX8	Device Selection Error
X1X	BCC Error
X2X	Character Sync. Timeout
X4X	Block Format Error
X8X	RVI Received from CPU*
1XX	-
2XX	-
4XX	-

* RVI Indicator status retained thru end of transmission and subsequent reception.

6. Off-Line Error Codes (No Indicator Light-Digital Code Only)

a. Autoload Errors

101	Wrong Function Key
102	Terminal Configuration Error
103	Peripheral Configuration Error

b. FCM Load Errors

150	FCM Password missing
151	Illegal FCM number
152	Inconsistent FCM number

b. FCM Load Errors (Continued)

153 Card Sequence Error
154 Illegal Line Count
155 Invalid Line Density

APPENDIX G

ERROR RECOVERY

This terminal uses two methods of announcing errors. The Terminal Control Console lights an indicator light and displays a three digit error code. The display screen shows errors involving communications on the "conditions" line of the status display. The two basic types of errors are mechanical device errors and communication errors. Mechanical device errors are announced for the Line Printer, Card Readers, Card Reader/Punch, Microdrum, and Terminal Controller. Communication errors are shown for both transmitting (reading cards) and receiving (printing or punching).

Table G-1 shows the Status Display error indicators, and explains the corrective action taken by the terminal operator.

In all cases, the indicated action should be taken after the terminal has returned to IDLE line control mode. IF in TRAN or RECV mode, recovery attempts are being made.

In addition to errors listed on the "CONDITIONS" line of the Status Display, the message, "RESTART REQUIRED" may appear below it. This indicates that there may have been data in the I/O or Communication Buffers at the time the indicated error occurred. The proper recovery procedure is always:

1. To correct any mechanical malfunction that may have occurred
2. To depress the Release Key (F0 key)
3. To depress the Restart Key (F7)

Table G-2 shows the Terminal Control Console error indicators, and lists the corrective action taken by the terminal operator. In the case of mechanical errors, repairs or adjustments may have to be done by a Control Data Customer Engineer. If more than one device has an error, the errors will alternate at two second intervals. The X's in table G-2 indicate that the digit could be any other number listed for that digit position (e.g., if we have a 002 error and a 010 error on the same device, this would appear as a 012). In addition, if we have a 010 and a 040 error on the same device this would appear as a 050.

TABLE G-1

STATUS DISPLAY ERROR CONDITIONS

ERROR WORD	LINE CONTROL STATUS	CAUSE	OPERATOR CORRECTIVE ACTION
DATA	T	Invalid punch code on card just read.	Inspect card in read station for improper punching. Correct card. Place corrected first in line before read station. Start Card Reader.
READ	T	Card reader not ready.	Check digital error code, take action indicated in Table G-2 Start card reader.
RVI	T	RVI received from Central.	Automatic recovery. Wait for print message from Central.
RECD	T	Odd/even block count error. EOT sent.	Automatic Recovery attempted. If accompanied by "RESTART REQUIRED" message, press F0, F7.
WACK	T	Received WACK response Waiting for acknowledgement.	Automatic recovery. Wait for Central.
INCP	T	Incomplete transmission {EOT response received} Accompanied by "RESTART REQUIRED".	Depress F0, F7 keys.
LINE	T	1} No response received 2} NAK response received 3} Invalid response rec'd. Accompanied by "RESTART REQUIRED".	Depress F0, F7 Keys.

continuation of Table G-1
Status Display Error Conditions

ERROR WORD	LINE CONTROL STATUS	CAUSE	OPERATOR CORRECTIVE ACTION
BELL	R	BEL character received.	Pick up data set phone. Talk to other operator.
BLOK	R	1. Block check char. error. 2. Block format error. 3. Lost synchronization, or 4. ENQ in text, of received text block.	Automatic recovery. Transmitting station may restart.
DEVC	R	1. Output device {printer or punch} selection was invalid or missing. or 2. Device not ready.	1. Transmitting station must correct selection, or receiving station may select Punch or Print Mode {enter PCH or PRT}. 2. Make device ready and depress F0,F7
OVRN	R	Character overrun or record in received record.	Automatic recovery. Transmitting station must correct and restart.

NOTE: T indicates transmitting mode; R indicates receiving mode.

TABLE G-2

TERMINAL CONTROL CONSOLE ERROR DISPLAYS

DEVICE INDICATED	ERROR CODE	FAULT	OPERATOR CORRECTIVE ACTION
PRINTER {CL896 and CL302}	XX2	Not Ready {Stopped}.	Check for X1X, X2X, X4X conditions. Correct the fault, then restart.
	XX4	Sync Error.	Automatic recovery, but print line may be duplicated.
	XX8	Paper Runaway.	1. Power off and restart or reauto-load. 2. Call CE
	X1X	Paper Fault {empty or torn}.	Replace paper.
	X2X	Drum Arm Panel not latched.	Close Panel securely.
	X4X	Hammer Fuse blown or Power Supply Fault.	Call Customer Engineer
CARD READER* {LOW SPEED}	XX2	Not Ready.	Check for conditions below and start the card reader.
	XX4	Strobe Count Error.	Call Customer Engineer if this persists.
	X1X	Dark Check Failed.	1. Clean card path. 2. Restart 3. Call CE
	X2X	Light Check Failed	1. Clean card path 2. Restart 3. Call CE
	1XX	Card Jam at Read Head	Clear Card jam.
	2XX	Motor Off	1. Restart 2. Call CE
	4XX	Hopper Empty or Stacker Full.	Load or unload cards.
	8XX	Card Jam at Hopper.	Clear card jam.

* To clear card reader error indicators, depress CLEAR with ONLINE not lit.

Change No. 2

DEVICE INDICATED	ERROR CODE	FAULT	OPERATOR CORRECTIVE ACTION
PRINTER (9322-4)	XX1	Fail to complete	Indicates printer driver has been inactive for 1 second and has stopped in middle of processing a print line. Indicates a software or hardware error. To continue press start.
	XX2	Not Ready (blown hammer driver, vertical paper drive or ribbon driver fuse, drum gate open, paper tear, drop out of any print head voltage, out of paper, or stop)	Check for obvious errors such as drum gate open, paper tear etc. and if can not find error call a C.E. When error fixed restart it.
	XX4	Transmission parity error	1. Try again by pressing START switch.* 2. If fails on next line then call a C.E. * Each time this error occurs a line of data will be lost. This error indicates a hardware malfunction.
	X8X	Illegal character code	Indicates the printer driver received an illegal character. When this message is received the line has been printed with space codes replacing any illegal characters.

2

continuation of Table G-2
Terminal Control Console Error Displays

DEVICE INDICATED	ERROR CODE	FAULT	OPERATOR CORRECTIVE ACTION
CARD READER* (MEDIUM SPEED)	XX1	Clutch Fault.	Call CE.
	XX2	Not Ready (Stopped)	Depress START, then correct other faults displayed.
	XX4	Column Count Error. (Card Slipped).	Clean Card Path**
	XX8	Skew Error or Skew Test Failed.	Clean Card Path**
	X1X	Dark Check Failed.	Clean Card Path**
	X2X	Light Check Failed.	Clean Card Path**
	X4X	0^{o} Switch Fault.	Call CE.
	X8X	321^{o} Switch Fault.	Call CE.
	1XX	Card Jam at Read Station or Exit station.	Clear Card Jam**
	2XX	Motor Off (due to Open Interlock, or control failure).	Clear the error. Restart.
	4XX	Stacker Full or Hopper Empty.	Load or unload cards.
	8XX	Card Feed Failed	1. Restart 2. Clean Card Path, expecially Picker Knives.
CARD PUNCH	010	Non-blank card	Make sure only blank cards are in the input hopper.***
	020	Compare Error	Remove offset cards in stacker and restart.***

continuation OF Table G-2
Terminal Control Console Error Displays

DEVICE INDICATED	ERROR CODE	FAULT	OPERATOR CORRECTIVE ACTION
CARD PUNCH	040	Chip Box Full	Empty chip box and restart.***

* To clear card reader error indicators depress SINGLE CYCLE.

** 1. Remove cards from input hopper.
2. Depress STOP and then depress SINGLE CYCLE twice.
3. Move last two cards from stacker to input hopper.
4. Replace cards in input hopper.
5. Depress START.

*** After correcting condition depress single cycle to clear card punch error. Then depress F0 and F7 function keys to restart.

DEVICE INDICATED	ERROR CODE	FAULT	OPERATOR CORRECTIVE ACTION
DRUM FAULT and/or DRUM PARITY ERROR	XX1	Head Select Fault.	Call CE.
	XX2	Power Supply Fault.	Call CE.
	XX4	Drum Fault.	Call CE.
	X1X	Parity Error in Transferred Data.	Restart. Call CE.

continuation of Table G-2
Terminal Control Console Error Displays

DEVICE INDICATED	ERROR CODE	FAULT	OPERATOR CORRECTIVE ACTION*
COMM. ERROR {Communications Error}	8X1	NAK Response Received	see "LINE", Table G-1
	8X2	Invalid Response Received	see "LINE", Table G-1
	8X4	No Response Received	see "LINE", Table G-1
	8X8	EOT Response Received {Incomplete Transmission	see "INCP", Table G-1
	81X	WACK Response Received	see "WACK", Table G-1
TRANSMITTING	82X	Odd/Even Block Count Error	see "RECD", Table G-1
	88X	RVI Received from Central	see "RVI", Table G-1
	XX1	ENQ in Text	see "BLOK", Table G-1
	XX2	Character Overflow {400 per block; 170 per record}	see "OVRN", Table G-1
RECEIVING	XX4	Record Overrun {more than selected record limit}	see "OVRN", Table G-1
	X1X	Block Check Character Error	see "BLOK", Table G-1
	X2X	Character Synchronization Time out	see "BLOK", Table G-1
	X4X	Block Format Error	see "BLOK", Table G-1
	X8X	RVI Received from Central	see "RVI", Table G-1

MEMORY PARITY ERROR.	Call CE.
DRUM PARITY ERROR.	Call CE.
HIGH TEMPERATURE.	Clean Power Cabinet and Controller Cabinet air filters.
TEST MODE.	Indicates maintenance personnel working.
TIME OUT.	Call CE.

* All digital communication status indicators involve attempts at automatic recovery. Take no action before checking Status Display. Depress F1 key to assure current status.

APPENDIX H

DESCRIPTION OF THE MOTION CONTROL FUNCTION TABLE AND FORMAT CONTROL TAPE FOR THE 9322-4 PRINTER

General Information

The Motion Control Function Table {MCFT} and Format Control Tape {FCT} shown are the standard ones for the LSBT 9322-4 printer. These are for use with eleven {11} inch paper and six {6} or eight lines per inch {LPI} density.

The page eject is performed by a skip to level 1 {top of form}. "Form" is defined as the print area between perforations of a physical page.

The FCT may be implemented to satisfy the needs of the user.

The 6/8 LPI switch must be set to 6 LPI position when using a 6 line per inch FC tape and 8 lines per inch when using an 8 LPI FC tape.

Formatting will be restricted to the page or form boundary, since a punch for bottom of form is required in channel 2 line 0 for out of paper to be detected properly.

Change No. 3

MOTION CONTROL FUNCTION TABLE

CHARACTER		
EBCDIC	ASCII	ACTION AFTER PRINTING
/	Q	Single Space
S	R	Double Space
T	S	Triple
A	A	Skip to Level 1
B	B	Skip to Level 3
C	C	Skip to Level 4
D	D	Skip to Level 5
E	E	Skip to Level 6
F	F	Skip to Level 7
G	G	Skip to Level 8
H	H	Skip to Level 9

Any other character received by the Line Printer will be treated as a single space function.

Level 1 is top of form.

Level 2 is defined as bottom of form and activates the auto-perforation mechanism in the hardware. Line 0 must be punched for out of paper to be activated properly.

Level 3 - double spacing

Level 4 - triple spacing

Level 5 - quadruple spacing

Level 6 - quintuple spacing

Level 7 - sextuple spacing

Level 8 - septuple spacing

Level 9 - octuple spacing

Levels 10-12 - unused and undefined by 2780

Example: {11 inch form with 6 LPI FC tape}

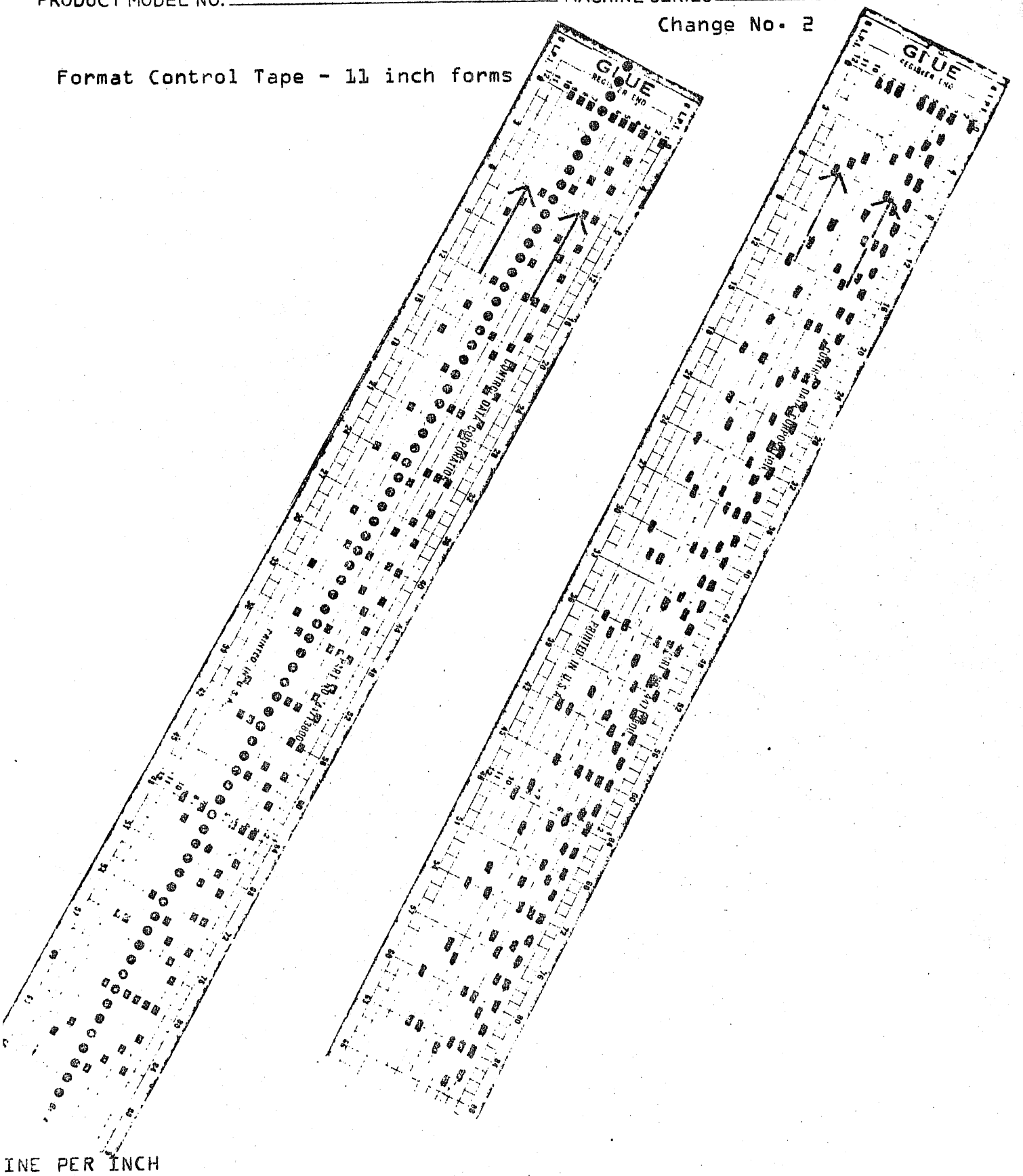
Assume that the last line printed was line number 51 and no spacing occured after printing. The printing action which follows is determined by the carriage control character as shown below.

Carr. Ctl. Char.	Meaning	Action
A	Page eject	Eject {skip to level 1 without printing}
E	Skip to Level 6	Print and skip to line 55
B	Skip to level 3	Print and skip to line 52

DOCUMENT CLASS ERS PAGE NO. H-5
PRODUCT NAME 731/732 IBM 2780 EMULATION
PRODUCT MODEL NO. 1068*1-1 MACHINE SERIES 730

Change No. 2

Format Control Tape - 11 inch forms



INE PER INCH

8 LINE PER INCH