Attachment Information Manual

for

Display/Printer Adapter

for

4300 System

(June 26, 1979)
(September, 1981)

PREFACE

This Product Attachment Information document provides information on the interface and Input/Output from the 4300 System Display/Printer Adapter to the 3278 Model 2 or 3279 Model 2A Display Station, 3278 Model 2A or 3279 Model 2C Operator Display Console, 3287 Models 1, 2, or 1C, 2C Printer, the 3289 Model 4 Line Printer, and 3262 Model 1 Printer.

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C O N T E N T S

SECTION 1. TRANSMISSION ARCHITECTURE

1.0 INTRODUCTION

The 3278-2A Operator Display Console, 3278-2 Display Station, 3287-1/2 Printer, 3262-1 Printer and 3289-4 Line Printer may attach to the 4300 System via a display/printer adapter referred to hereafter as the control unit or control unit/adapter. All device functions are controlled by the control unit. Commands provide for Read, Write and physical operation of the attached devices. Separate buffers in the display terminals and printers receive, hold or transmit data and commands.

1.1 GENERAL TRANSMISSION ARCHITECTURE

Data is transmitted from a control unit to a device or device to control unit by a single coax line, per device. The coax type is RG62AU with a maximum length of 1.5 kilometers. Data is transmitted as serial bits using a binary dipulse technique. (See paragraph 5.0 for coax transmission protocol.)

Data is transmitted over the coax at a bit rate of 2.3587 MHz in the following format:

Twelve (12) bits are assembled to form one (1) twelve (12) bit word for transmission in either direction over the coax. The first bit of the twelve (12) bit word is used to delimit successive words from the control unit and is always a "one (1)" bit and will be referred to as the "Sync bit". The last bit of each twelve (12) bit word is the parity bit that will maintain even parity when added to the preceeding eleven (11) bits.

Word groups of twelve (12) bits each may be contiguous. In this case, the SYNC bit of the next word must directly follow the parity bit of the preceding word with no intervening pad bits. A word from the control unit to the device (display or printer) may be either a command or a data word. Each Write type command will cause a Transmission Turnaround/Auto Response (TT/AR) following the last word of

each group of contiguous words sent from the control unit, and the device responds with clean status (bits 1 and 12) if the word(s) was (were) received without a Transmit Check. A word from a device in response to a Read type command may be either data or a status word. The device must begin response (data, status or TT/AR) within 5.5 microseconds after receiving the ending sequence from the control unit (both read and write type commands). The 5.5 usec. is measured from the end of the last bit time of the received ending sequence to the beginning of the first bit time of the transmitted starting sequence.

The 12 bit command word from the control unit to a device contains address bits and a command code. The address portion of the command word is three bits in length (Bits 2, 3, 4) when addressed to the device base unit and four bits in length (Bits 2, 3, 4, 5) when addressed to a feature of the base unit. This provides five bits for command codes (Bits 5, 6, 7, 8 and 9) to the base unit and four bits (Bits 6, 7, 8, and 9) for command code to a feature. Reserved bits in all commands and responses must be zero.

1.2 WORD FORMATS

COMMAND WORD TO BASE UNIT:

1	234	56789	10	11	12
SYNC	000	XXXXX	0	1	X
BIT	ADDR.	CMND	*	CMND	Parity

*Bit 10 is reserved.

COMMAND WORD TO FEATURE:

1	2345	6789	10	11	12
SYNC	XXXX	XXXX	X	1	1
BIT	ADDR.	CMND.	*	CMND.	Parity

* Bit 10 is a parity bit (odd) for the preceeding 8 bits.

DATA WORD TO BASE UNIT OR FEATURE (Bit 2 is most significant):

1	2345	6789	10	11	12
SYNC	XXXX	XXXX	X	0	0
BIT	DATA	WORD	*	Data	Parity

* Bit 10 is a parity bit (odd) for the preceeding 8 bits.

Data words of less than 8 significant bits will be right justified (by the control unit) and the high-order bits set to zero.

DATA WORD TO CONTROL UNIT (Bit 2 is most significant):

1	2345	6789	10	11	12
SYNC	XXXX	XXXX	P	0	P
BIT	DATA	WORD	*		Parity

* Bit 10 = Parity bit (odd) for the eight bit (2 through 9) data word for Read Data and Read Mult. commands to the Base address, and any Read command (with bit 8 set to 1) sent to a feature.

Data words of less than 8 significant bits will be right justified (by the device) and the high order bits set to zero.

1.3 ADDRESS BIT ASSIGNMENTS

Bits 2345	
0000	Base Unit

SECTION 2. DISPLAY CONTROL

2.0 GENERAL

This section defines the commands and control provided for the display.

2.1 COMMANDS

2.1.1 Device Base Address Read Commands

READ COMMANDS (XXXX1)
56789

00001	POLL
00011	READ DATA
00101	READ ADDRESS COUNTER HIGH
10101	READ ADDRESS COUNTER LOW
01001	READ TERMINAL I.D.
10001	POLL/ACK
10011	Reserved
01101	READ STATUS (Security key and other switches)
11001	Reserved
01011	READ MULTIPLE
10111	Reserved
01111	Reserved
00111	Reserved
11011	Reserved
11101	Reserved
11111	Reserved

Note: In response to Reserved Read commands the display will return an all zero data word with bad parity (bits 2 through 10 all zero) regardless of bit 8 in the Read command.

2.1.2 Read Command Functions (to Base)

2.1.2.1 00001-POLL and 10001-POLL/ACK

The poll command (Hex 1) does not use the address portion of the command word for address. Bits in address portion are assigned as follows:

Bits 2 and 3 are encoded as follows:

11= Enable keyboard clicker
01= Disable keyboard clicker
10= Sound alarm
00= None of the above

Bit 4= Reserved
Bit 5= ACKnowledge last input message to control unit.

1	2	3	4	5	6	7	8	9	10	11	12
SYNC	X	X	0	X	0	0	0	1	0	1	P
BIT	(see above)				(Poll cmnd)						

Bit 10= Reserved

The response word to a poll is a one word status response. The Poll Response is returned for any combination of bits 2, 3, and 4 in the Poll command. Since the poll is not addressed to the base unit or any feature, a priority for response is established by having the base unit respond with its status. If a non-zero status word is sent to the control unit, the device will anticipate receiving a Poll/ACK to acknowledge the acceptance of the first status word and cause the device to respond with "clean" status and reset the previously returned status bits. Upon receipt of the clean status response the control unit may issue another Poll, without the ACK bit, and the device will respond with the second status word. If the second poll does not have the ACK bit on, the device will respond with the first status word again even though higher priority status may have become available. Reset and Read Terminal ID commands sent to a device after it has returned non-zero status but before the status was ACKnowledged will cause certain status bits to be reset. Refer to Reset and Read Terminal ID commands.

Note: 'OP complete' status, and 'Feature Error' status, can also be retrieved by the 'Read Status' command. OP Complete status, or Feature Error status, will be reset by the 'Read Terminal ID' command, as well as the Poll, Poll/ACK sequence described above.

Note: The Control Unit must issue the Poll/ACK command with bits 2, 3 and 4 set to zero.

The Poll command is received and decoded in the base logic. The priority of Poll response is:

0 Feature Error (Bit 11)
1 POR complete Special status code.
2 Base Status (Bits 6,8,9) *
3 Keyboard (including keyboard overrun) Scan Code
4 Any other Feature Status

* Multiple bits of base status may be returned in a poll response. If a base status Bit is returned and not ack'd, the same bit will be returned in the next poll response. Other base status bits will not be returned until the control unit ack's the original returned status.

Exception: The Display will add bit 9 to previously returned base status bits if an OP Complete condition occurs and a poll is received prior to receipt of a Poll/ACK.

Note: While the base display is busy, the display will suppress all status. See paragraph 2.1.3 Clear Command. Upon completion of the Busy operation, bit 9 will be set in base status.

2.1.2.2 Response to Poll (Status Words)

A status word is always sent in response to a Poll command from a display that has power on and has completed its POR sequence. A response of all zeros except for bits 1 and 12 indicates that there are no error conditions to be reported and no operator activity requiring service. This response will be referred to as "all zero" or "clean" response. If bit 11 is set, bits 2-10 are undefined.

The status response word from the device base unit is:

1	2345	6	7	8	9	10	11	12
SYNC BIT	0000 ADDR	STATUS TRANS	SPARE 0	DEVICE CHK	OP CPLT	KYBD IND	FEAT. ERROR	PARITY BIT

Bit 1 = SYNC Bit

Bits 2, 3, 4, 5 = Base address

Bit 6 = Status transition has occurred. Refer to Read Status command.

Bit 7 = Reserved

Bit 8 = Parity error has been detected in storage. When ack'd, display will not respond with another Device Check until after the next Write Data, Clear, or Reset command.

Bit 9 will also be set.

Bit 9 = A. A Search command has been completed.
B. A Clear command has been completed.
C. An Insert Byte command has been completed.

Bit 10 = 1 Redefines bits 2 through 9 as being a keyboard code or additional base status.
Keyboard scan codes will be entered with Bit 2 the make/break bit, and Bit 3 the high order bit of the 7 bit scan code. See Section 6.0 for specific code points. Non make/break keys will enter scan codes with bit 2=0.

Special status codes are:

2345 6789

X000 0000 DISPLAY: Keyboard overrun.
X000 0001 Reserved
0000 0010 Power On Reset (POR) response.
Device has powered on since last Poll.
This code is sent only in response to a Poll received after a power on (or Reset command) sequence is complete.

X000 0100 Reserved
X111 1111 Reserved
1000 0010 Reserved

Bit 11 = Feature Error Bit.
This bit will be returned when a feature error is set. This bit will be reset by Poll/ACK or Read Terminal ID. When bit 11=1, bits 2-10 may contain garbage and should be ignored by the control unit. Refer to paragraph 2.1.4 for additional description of the Feature Error Bit.

While set, the features are blocked. ACK will only reset the Feature Error Bit, other base status pending will not be reset.

Bit 12 = Parity Bit - maintains even parity of the preceeding eleven (11) bits.

2.1.2.3 Feature Poll Response

Individual Status Bits will be returned until ack'd by a subsequent Poll. Following receipt of the ACK, the feature will not return the same status bit until positive action (Read, Reset, Clear, etc.) has been taken to service the status.

2.1.2.4 Other Read Commands (to Device Base)

Each of these commands will cause the device to return one or more Data Words. The ending sequence will follow the 12th (P) bit of the last response word.

00011 READ DATA

The read data command will cause the addressed device to respond with one data word from storage at the current I/O address counter value. The address counter steps up (increments) once at the completion of the command.

01011 READ MULTIPLE

This command will cause the device to respond with one or more data words from storage beginning at the current I/O address counter value. The read will terminate (with ending sequence) when the two low order bits of the I/O address counter step to 00. A maximum of four bytes will be returned.

10101 READ ADDRESS COUNTER LOW

This command will cause the device to respond with one data word. Bits 2 thru 9 of the data word contain the present value of the 8 low order bits of the address counter.

00101 READ ADDRESS COUNTER HIGH

This command will cause the device to respond with one data word. Bits 2 through 9 of the data word contain the present value of the high order bits of the address counter (right justified).

01001 READ TERMINAL I.D.

This command causes the device to respond with one data word.

Note: This command will reset OP Complete and Feature Error status (bits 9 and 11 in Poll Response).

The format of the response data word is as follows:

DISPLAY

1	2 3 4 5	6 7 8	9	10	11	12
Sync Bit	Keyboard I.D.	Model	0	0	0	P

Bits
2345

0000 Reserved
1000 Data Entry 2 with Numeric Lock
1001 Data Entry 1 with Numeric Lock
1100 Data Entry 2 without Numeric Lock
1101 Data Entry 1 without Numeric Lock
1010 Typewriter Numeric Lock
0010 Reserved
1110 Typewriter
0110 Reserved
1111 No Keyboard
1011 Reserved

Bits
678

000- Reserved
001- Reserved
010- Screen Size 1920
011- Reserved
111- Reserved
101- Reserved
110- Reserved
100- Escape

01101 READ STATUS

This command will cause the device to respond with one data word as follows:

Bit

2=0 Mono Case switch turned off
2=1 Mono Case switch turned on

3 Reserved

4=1 Not Busy* (Refer to Clear command)

5=0 Security key turned off
5=1 Security key turned on

6 Reserved

7=1 Feature Error Bit ***

8=1 OP Complete**

9=0 Security key turned on (display on)
9=1 Security key turned off (display blanked)

5&9=0,0 - Security key not installed.
5&9=1,1 - Invalid code.

*Other bits are valid only when bit 4=1.

**Set when OP. Complete set in base status. Reset when ACK received to OP Complete poll status (Poll/ACK sequence) or Read Terminal ID Command received.

***Set when Feature Error Bit is set in base status. Reset when ACK received to Feature Error poll status (Poll/ACK sequence) or Read Terminal ID command received.

Transitions of bits 2,3, or 5 and 9 will cause the display to return bit 6 in Poll Response.

2.1.3 Device Base Address Write Commands

WRITE COMMANDS (XXXX0)
56789

00000	Reserved
00010	RESET
00110	CLEAR
01100	WRITE DATA
01010	LOAD CONTROL REGISTER
00100	LOAD ADDRESS COUNTER HIGH
10100	LOAD ADDRESS COUNTER LOW
01000	Reserved
11010	Reserved
11100	Reserved
01110	INSERT BYTE
11000	Reserved
10000	SEARCH FORWARD

10010 SEARCH BACKWARD
10110 LOAD MASK
11110 Escape

Note: The Reserved and Escape Write commands will reset the previous command, unless busy. If no other command or data word directly follows the Reserved command, TT/AR takes place.

2.1.3.1 Write Command Functions (to Base)

Note: Many of the Write Commands are defined as being followed by one (or more) bytes of data. The device will execute the command following receipt of the data byte. If a second command is received instead of the data byte for the first command, the first command is lost and the second command sequence started. This operation applies to Base and Feature commands. Write type commands will remain active until reset by the next command (including Poll) except while busy. Refer to Clear command. Data Data sent while no command stored will be lost. TT/AR will occur, except in response to data sent to a busy display.

00010 RESET

The Reset command (whether followed by data or not) will cause a partial POR sequence in the display. Base and feature storage will not be cleared. The Mask Register will not be altered. The I/O Address Counter will be set to Hex '50' which corresponds to the first character location on the screen. The device will execute the TT/AR sequence. POR Response will be returned to a subsequent Poll.

The device must be capable of accepting two or more successive Reset commands (without intervening Poll commands) and respond with a single POR response to a subsequent Poll. Prior to returning POR response the device is allowed to terminate communication with the control unit.

10110 LOAD MASK

This command will cause the device to load the following data byte into the "Mask" register. The mask will be used in conjunction with subsequent Search and Clear commands. "1" bits in the mask will specify the bits in the buffer to be compared with the pattern byte. A mask of all "0" bits will prohibit a pattern test from being satisfied and cause the Clear command to terminate at address 0 and a Search Forward command to terminate at address 0 (or the first address encountered with bad parity).
The Mask byte must be reloaded following an Insert Byte command.

00110 CLEAR

The Clear command clears all or part of the regen. buffer in the addressed device to nulls. A byte of data, called the pattern byte, is transmitted following the Clear command. The device uses the pattern, in conjunction with the previously loaded mask, to terminate the clear function. The address counter is used to indicate the point at which the Clear functon starts. All locations including the starting address up to but not including the location containing the byte that satisfies the pattern and mask are tested and cleared. Upon completion the address counter will be pointing to the satisfying location. The command will terminate at address 0 (without clearing address zero) if no match occurs.

This command may also be used to clear the storage area containing the indicator character codes. The Clear operation will not terminate prematurely if a buffer parity error is detected. Device Check will be set (if not inhibited due to a previous parity error) if a parity error is detected. Upon completion of the command the Operation Complete bit (bit 9) will be set in the poll response status word. Prior to setting OP Complete the device will be busy. Poll response while busy will be the Auto Response (clean response). Commands

other than Poll and Reset sent to a device while the base is busy will be no-op'd. TT/AR will occur, except following data, chained or unchained, sent after a Write type command to a display. Busy also applies to Search and Insert commands.

To prevent control unit timeout, the busy state of the device must not exceed 32 msec. To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Clear Pattern byte, unless the operation is completed and OP complete is posted in the poll status.

The address counter must be set to an address within the Read buffer before issuing Clear, Search, or Insert commands.

01100 WRITE DATA

The Write Data command will cause the device to accept all following data words for storage until another command is received. The data will be loaded at the location indicated by the address counter. The address counter will step up once for each data word received and stored. Codes for specific characters and attributes are defined in Section 6.0.

01010 LOAD CONTROL REGISTER

This command will cause the device to load the following Data Word into the Device Control Register (double line transfer). The Control Register will be set to all zeros by POR and the Reset command, but otherwise not altered by the device. The Control Register bits are defined as follows:

Bit

2=1 Reserved
3=1 Reserved
4=1 Reserved
5=1 Reserved
6=1 Inhibit Display. When this bit is set, the display screen, except for the cursor and indicator row, will be blanked.
7=1 Inhibit Cursor Display. When this bit is set, the cursor will not be displayed.
8=1 Reverse Image Cursor. This bit will cause the cursor to be displayed as a reversed image of the associated character box.
9=1 Blink Cursor. This bit will cause the cursor to blink.

8&9=0 Normal Cursor.

10100 LOAD ADDRESS COUNTER LOW

This command, followed by one data word, will load the 8 bits of the data word into the 8 low order bits of the address counter. This command will enable cursor display (at the screen location associated with the value in the address counter) if the cursor had previously been blanked due to a busy condition.

00100 LOAD ADDRESS COUNTER HIGH

This command, when followed by one data word, will load the data word into the high order bits of the address counter.

01110 INSERT BYTE

This command will cause the display to accept the following data word and place it in the buffer storage at the location indicated by the current value of the address counter. The original contents of the storage location is shifted one location ahead. This sequence is continued for each successive location until a null character or

attribute is found, or the I/O address counter steps to zero (in which case the character that formerly resided in the last addressable location of storage will be lost). Only one data word may follow this command. During the time that shifting takes place, the display will be busy. Refer to Clear command. OP Complete is set when this command is completed. At this time the address counter is pointing to the last character moved unless the command terminated at an attribute, in which case the address counter will be pointing to the attribute and the character which was located ahead of the attribute will be permanently lost. The insert operation will not terminate prematurely if a buffer parity error is detected. Upon completion of this command the Mask register must be reloaded by the control unit prior to the next Search or Clear command.

The address counter must be set to within the Read buffer before issuing Clear, Search, or Insert command.

10000 SEARCH FORWARD

This command, when followed by a "pattern" data byte, will cause the device to search each buffer storage location starting at the current value of the address counter until a byte that satisfies the mask and pattern is found. The address counter will contain the value of the address in storage of the first satisfying byte found. If no satisfying bytes are found, the Search command will terminate at address 0. To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Pattern Byte, unless the operation is completed and OP complete is posted in the Poll status.

The address counter must be set to within the Read buffer before issuing Clear, Search, or Insert command.

10010 SEARCH BACKWARD

This command operates in a similar manner as the above Search command. If no satisfying bytes are found, the search will terminate one location past address zero (all address bits implemented set to 1).

To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Pattern Byte, unless the operation is completed and OP complete is posted in the Poll status.

Note: The two Search commands will indicate completion of the operation by setting bit 9 in the status response word to a Poll command. While the search is in progress the display will be busy. Refer to Clear command. A buffer parity error detected during a search memory cycle will cause the search to terminate. The address counter will be pointing to the location containing the byte with bad parity. OP Complete (bit 9) will be set, and Device Check (bit 8) will be set if not inhibited due to a previous Device Check.

The address counter must be set to within the Read buffer before issuing Clear, Search, or Insert command.

2.1.4 Display Feature Commands

The 'Feature Error' latch is set for the following conditions:

1. A feature does not acknowledge a Write type command or data.
2. A feature does not respond to a Read type command.
3. A feature requesting Poll service does not respond to this Poll.

For case 1, the display will set bit 11 - 'Feature Error', but respond with TT/AR. For case 2, the display will respond

with an 'all zeros' data word with bad parity (bit 10=0). (The 'all zeros' data word will actually contain the 9 bit byte from the feature and may be non-zero if the addressed feature, or one of the other features, is malfunctioning.) The feature error bit will be set. For case 3, Bit 11 returned in Poll response.

SECTION 3. 3287 PRINTER CONTROL

3.0 GENERAL

This section defines the commands and control provided for the 3287 Printer.

The commands recognized by the printer are:

READ		WRITE	
00001	Poll	10110	Load Mask
10001	Poll/ACK	00010	Reset
00011	Read data	01100	Write data
00101	Read Adr. Cntr. Hi	00100	Load Adr. Cntr. Hi
10101	Read Adr. Cntr. Lo	10100	Load Adr. Cntr. Lo
01001	Read Terminal Id	01000	Start Operation
01101	Read Status	00110	Clear
		10000	Search Forward
		10010	Search Backward

Other commands, including all commands to other than the base address, are invalid. Invalid read type commands will return an all zeros data word (with bad parity - Bit 10) and invalid Write type commands will (may) reset the previous command. If no other command or data word directly follows the invalid Write command, TT/AR take receipt of the ending sequence. Invalid commands include printer no-op commands. Commands other than Poll, Reset and Start Operation (Abort Order) will be treated as invalid while the printer is enabled or busy.

Control is provided by means of preassigned register space in the printer buffer in conjunction with a subset of the above described coax commands for reading and writing this buffer.

3.1 COMMANDS

3.1.1 Device Base Address Read Commands

READ COMMANDS (XXXX1)
56789

00001	POLL
00011	READ DATA
00101	READ ADDRESS COUNTER HIGH
10101	READ ADDRESS COUNTER LOW
01001	READ TERMINAL I.D.
10001	POLL/ACK
10011	Reserved
01101	READ STATUS (Security key and other switches)
11001	Reserved
01011	Reserved
10111	Reserved
01111	Reserved
00111	Reserved
11011	Reserved
11101	Reserved
11111	Reserved

Note: In response to the Reserved Read commands the device will return an all zero data word with bad parity (bits 2 through 10 all zero) regardless of bit 8 in the Read command.

3.1.2 Read Command Functions (to Base)

3.1.2.1 00001-POLL and 10001-POLL/ACK

The Poll command (Hex 1) does not use the address portion of the command word for address. Bits in address portion are assigned as follows:

Bits 2 and 3 are encoded as follows:

11 = Enable Operation*
01 = Disable Operation*
10 = Sound alarm**
00 = None of the above

* A "Special Poll" to the printer to control the half-duplex operation of the printer.
"Disable Operation" will cause the printer to stop internal operations as soon as possible (10 msec max), return "Op. Complete," and wait for subsequent control unit commands. The Printer will 'No-Op' the disable Poll if the printer is already disabled.
"Enable Operation" will revert the printer to internal operation. The printer will continue the operation in process prior to the "disable."
Enable Operation must be sent upon completion of Control Unit command sequences to allow new status to be presented to the control unit. The maximum disable time will not normally exceed 60 seconds. The printer must not load (or add) any Poll status (except POR response) after becoming disabled. The device must be capable of accepting successive enable or disable polls. The control unit must not send 'enable' (or Start OP Command) while waiting for a response to a previous 'disable'. If 'disable' state occurs prior to completion (or termination) of an order, the control unit is not allowed to alter the control unit output area or load a new order, except 'Abort'. If Abort order is loaded, Start Op, rather than Enable, must be sent.

Note: The printer is also Enabled by Start OP and Reset commands and Disabled (within 100 usecs) by the setting status bit 6, or 9 (Poll response) or POR response.

Note: Prior to disabling, the printer will set the printer Address Counter to '0000'.

To allow for control unit error recovery, the printer must appear enabled to the control unit immediately (within 20 usec) upon receiving the 'Enable' Special Poll.

Exception: The printer must no-op the 'Enable' function if the Poll Response register is non-zero.

** The Sound Alarm Poll will not alter the Enable/Disable state.

Bit 4= Reserved
Bit 5= Acknowledge last input message to control unit.

1	2	3	4	5	6	7	8	9	10	11	12
SYNC	X	X	0	X	0	0	0	1	0	1	P
BIT	(see above)					(Poll cmnd)					

Bit 10 = Reserved

The response word to a Poll is a one word status response. The Poll Response is returned for any combination of bits 2, 3, and 4 in the Poll command. Since the Poll is not addressed to the base unit or any feature, a priority for response is established by having the base unit respond with its status. If a non-zero status word is sent to the control unit, the device will anticipate receiving a Poll/ACK to acknowledge the acceptance of the first status word and cause the device to respond with "clean" status and reset the previously returned status bits. Upon receipt of the clean status response the control unit may issue another Poll, without the ACK bit, and the device will respond with the second status word. If the second Poll does not have the ACK bit on, the device will respond with the first status word again even though higher priority status may have become available. Reset and Read Terminal ID commands sent to a device after it has returned non-zero status but before the status was acknowledged will cause certain status bits to be reset. Refer to Reset and Read Terminal ID commands.

Note: 'Op complete' status can also be retrieved by the 'Read Status' command. OP Complete status will be reset by the 'Read Terminal ID' command, as well as the Poll, Poll/ACK sequence described above.

Note: The Control Unit must issue the Poll/ACK command with bits 2, 3 and 4 set to zero.

Multiple bits of base status may be returned in a Poll response. If a base status bit is returned and not ack'd, the same bit will be returned in the next Poll response. Other base status bits will not be returned until the control unit ack's the original returned status.

Exception: The Printer is allowed to add base status bits to previously returned base status. If there is no base or feature status to send, an all zero Poll response is sent from the base unit indicating that service is not required at the device.

3.1.2.2 Response to Poll (Status Words)

A status word is always sent in response to a Poll command from a printer that has power on and has completed its POR sequence. A response of all zeros except for bits 1 and 12 indicates that there are no error conditions to be reported and no operator activity requiring service. This response will be referred to as "all zero" or "clean" response. If bit 11 is set, bits 2-10 are undefined.

The status response word from the printer base unit is:

1	2345	6	7	8	9	10	11	12
SYNC BIT	0000 ADDR	STATUS TRANS	SPARE 0	DEVICE CHK	OP CPLT	SPEC STATUS	FEAT. ERROR	PARITY BIT

Bit 1 = SYNC Bit

Bits 2, 3, 4, 5 = Base address

Bit 6 = Status Available. This bit is set by the printer when new status is loaded or, before setting this bit, the printer will set the Address Counter to 0000. After setting this bit the printer will go disabled. The Control Unit is responsible for reading status (address 0000) prior to sending enable. This bit is also set (and the above sequence occurs) periodically to test the communication link. Refer to Section 3.5

Bit 7 = Reserved

Bit 8 = Parity error occurred during a Search or Clear command. When ack'd, printer will not respond with another Device Check until after the next command from the Control Unit.

Bit 9 will also be set.

Bit 9 = A. A Search command has been completed.
B. A Clear command has been completed.
C. A 'Disable' Poll has been completed.

Bit 10=1 Defines bits 2 through 9 as being additional base status.

Special status codes are:

2345 6789

X000 0000 Reserved
X000 0001 Reserved
0000 0010 Power On Reset (POR) response. Device has powered on since last Poll. This code is sent only in response to a Poll received after a power on (or Reset command) sequence is complete. Following internal test of printer during which controller communication was suspended for a minimum of five seconds. See Reset command.
X000 0100 Reserved
X111 1111 Reserved
1000 0010 Reserved

Bit 11 = Feature Error Bit. Not set by printer.

Bit 12 = Parity Bit - maintains even parity of the preceeding eleven (11) bits.

3.1.2.3 Other Read Commands (to Device Base)

Each of these commands will cause the device to return one or more Data Words. The ending sequence will follow the 12th (P) bit of the last Response word.

00011 READ DATA

The Read Data command will cause the addressed device to respond with one data word from storage at the current I/O address counter value. The address counter steps up (increments) once at the

completion of the command.

10101 READ ADDRESS COUNTER LOW

This command will cause the device to respond with one data word. Bits 2 thru 9 of the data word contain the present value of the 8 low order bits of the address counter.

00101 READ ADDRESS COUNTER HIGH

This command will cause the device to respond with one data word. Bits 2 thru 9 of the data word contain the present value of the high order bits of the address counter (right justified).

01001 READ TERMINAL I.D.

This command causes the device to respond with one data word.

Note: This command will reset OP Complete status (bit 9 in Poll Response).

The format of the response data word is as follows:

PRINTER

1	2 3 4 5	6 7 8	9	10	11	12
Sync	0 0 0 0	0 0 0	1	0	0	P
bit	(	Printer			)	

Printer (bits 2 through 8 = 0, bit 9=1)

Terminal ID of a printer will be obtained by reading address '000C' of the printer buffer. Refer to paragraph 3.3.5.

01101 READ STATUS

This command will cause the device to respond with one data word as follows:

Bit	
2	Not set by printer
3	Reserved
4=1	Not Busy* (Refer to Clear command)
5	Not set by printer
6	Reserved
7	Not set by printer
8=1	OP Complete**
9	Not set by printer

* Other bits are valid only when
Bit 4 = 1.
Bit 4=0 when Busy or Enabled.

** Set when Op. Complete set in base status. Reset when ACK received to OP Complete Poll status (Poll/ACK sequence) or Read Terminal ID Command received. OP Complete Poll Status, set as a result of a disable Poll command, may or may not be returned as Read Status OP Complete.

3.1.3 Device Base Address Write Commands

3.1.3.1 Write Command Functions (to Base)

Note: Many of the Write Commands are defined as being followed by one (or more) bytes of data. The device will execute the command following receipt of the data byte. If a second command is received instead of the data byte for the first command, the first command is lost and the second command sequence started. Write type commands will remain active until reset by the next command (including Poll) except while busy. Refer to Clear command. Data ent while no command stored will be lost. TT/AR will occur.

00010 RESET

In a printer the Reset command will terminate any operation in process and cause the printer to respond to a Poll with the POR complete status code. The printer will then be ale to accept and execute any valid command (i.e. the printer will be disabled). The message buffer will not be cleared, and the control unit output area will be cleared. The Address Counter will be set to '0000', and the Mask and Control Register will be reset. The following portion of the Printer Output Area will be initialized:

Byte 0: All bits except 4 and 7 must be zero.
Byte 1: All bits valid.
Bytes 2 through B: All zero.
Bytes C through F: Terminal ID bytes initialized.

To allow for control unit error recovery, the printer must appear enabled to the control unit immediately (within 20 usec) upon receiving the Reset command.

Note: Following Control Unit initialization of the printer (Read Term. ID, Load Address Counter, Read Data, etc.), the Control Unit must send 'Enable' Poll before sending a Start OP command to allow the printer to complete its' initialization. Also,' the Control Unit will write a 4 character test message, X'AA 32 74 AA' or X'AA 32 76 AA', beginning at printer address X'004A', prior to sending the first enable poll. This sequence is required after all POR responses.

Note: POR Complete will not be returned if the reset (either Command, Power On, or operator initiated) 'failed', that is, if the printer has Equipment Check set in its status word.

The device must be capable of accepting two or more successive Reset commands (without intervening Poll commands) and respond with a

single POR response to a subsequent Poll. Prior to returning POR response the device is allowed to terminate communication with the control unit.

10110 LOAD MASK

This command will cause the device to load the following data byte into the "Mask" register. The mask will be used in conjunction with subsequent Search and Clear commands.
"1" bits in the mask will specify the bits in the buffer to be compared with the pattern byte. A mask of all "0" bits will prohibit a pattern test from being satisfied and cause the Clear command to terminate at address 0* and a Search Forward command to terminate at address 0 (or the first address encountered with bad parity). (*For printers, low order Address Counter bits equivalent to installed buffer will be zero.)

The Mask byte must be reloaded following a Start Print order.

00110 CLEAR

The Clear command clears all or part of the printer storage in the addressed device to nulls. A byte of data, called the pattern byte, is transmitted following the Clear command. The device uses the pattern, in conjunction with the previously loaded mask, to terminate the clear function. The address counter is used to indicate the point at which the Clear functon starts. All locations including the starting address up to but not including the location containing the byte that satisfies the pattern and mask are tested and cleared. Upon completion the address counter will be pointing to the satisfying location. The command will terminate at address 0 (without clearing address zero) if no match occurs. (Low order Address Counter bits equivalent to installed buffer will be zero.)

This command may also be used to clear the storage area containing the printer register space. The Clear operation will not terminate prematurely if a buffer parity error is detected. Device Check will be set (if not inhibited due to a previous parity error) if a parity error is detected. Upon completion of the command the Operation Complete bit (bit 9) will be set in the Poll response status word. Prior to setting OP Complete the device will be busy. Poll response while busy will be the Auto Response (clean response). Commands other than Poll and Reset sent to a device while the base is busy will be NO-OP'd. TT/AR will occur.

To prevent control unit timeout, the busy state of the device must not exceed 32 msec. To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Clear Pattern byte, unless the operation is completed and OP complete is posted in the Poll status.

The address counter must be set to within the Read buffer before issuing Clear or Search command.

01100 WRITE DATA

The Write Data command will cause the device to accept all following data words for storage until another command is received. The data will be loaded at the location indicated by the address counter. The address counter will step up once for each data word received and stored. Codes for specific characters and attributes are defined in Section 6.0.

10100 LOAD ADDRESS COUNTER LOW

This command, followed by one data word, will load the 8 bits of the data word into the 8 low order bits of the address counter.

00100 LOAD ADDRESS COUNTER HIGH

This command, when followed by one data word, will load the data word into the high order bits of the address counter.

01000 START OPERATION

When this command is sent to a printer the printer will go enabled. Upon Upon completion (or termination) of the operation (as specified in the 8 bit order register) the printer will return Status Available in Poll Response. Order Complete Status will be set. To prevent control unit timeout, the device must complete the operation, except for Print Order, within 500 milliseconds (excluding the duration of any intervening disable time). While the printer is enabled, the printer must treat as invalid any command other than Poll, Reset and Start operation (Abort Order). The printer will switch to the disabled state when Status Available is set.

To allow for control unit error recovery, the printer must appear enabled to the control unit immediately (within 20 usec) upon receiving the Start OP Command. Upon receiving the Start OP Command, the printer must test the Poll Response Register (bits 6,8,9,&10) for zero. If zero, the order will be executed; if non-zero, the printer must ignore the Start Operation command and remain disabled. TT/AR will occur.

10000 SEARCH FORWARD

This command, when followed by a "pattern" data byte, will cause the device to search each buffer storage location starting at the current value of the address counter until a byte that satisfies the mask and pattern is found. The address counter will contain the value of the address in storage of the first satisfying byte found. If no satisfying bytes are found, the Search command will terminate at address 0. (For the low order

address counter bits equivalent to installed buffer will be zero.) To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Pattern Byte, unless the operation is completed and OP complete is posted in the Poll status.

The address counter must be set to within the Read buffer before issuing Clear or Search command.

10010 SEARCH BACKWARD

This command operates in a similar manner as the above Search command. If no satisfying bytes are found, the search will terminate one location past address zero (all address bits implemented set to 1).

To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Pattern Byte, unless the operation is completed and OP complete is posted in the Poll status.

Note: The two Search commands will indicate completion of the operation by setting bit 9 in the status response word to a Poll command. While the search is in progress the display will be busy. Refer to Clear command. A buffer parity error detected during a search memory cycle will cause the search to terminate. The address counter will be pointing to the location containing the byte with bad parity. OP Complete (bit 9) will be set, and Device Check (bit 8) will be set if not inhibited due to a previous Device Check.

The address counter must be set to within the Read buffer before issuing Clear or Search command.

3.2 PRINTER REGISTER SPACE

The first 80 bytes of the printer buffer are used as

register space to store control information. The first sixteen bytes are used for printer output to the control unit. The next 64 bytes are used for control unit orders and instructions to the printer. Protocol prohibits the Control Unit and the Printer from altering each others' Output Area (except at POR time).
The assignment is:

ADDRESS (hex)	LENGTH (bytes)	DEFINITION
Printer Output Area		
0000	1	Status
0001	1	Switch Status
0002	1	Key Input Code
0003	1	Sense
0004-000B	8	Reserved
000C-000F	4	Terminal ID
Control Unit Output Area		
0010-0011	2	Mode
0012-0013	2	Message Starting Address
0014-0015	2	Message Length
0016-0017	2	Order
0018	1	Maximum Presentation Position (MPP)
0019-0049	49	Reserved
004A-004D	4	Test Message Area
004E-004F	2	Reserved for Control Unit use

Note: For the printer Register Space Bit definitions, Bits 0-7 correspond to Interface Data Word Bits 2-9.

3.3 PRINTER OUTPUT AREA

3.3.1 Status

The Status Bits are defined as follows:

Bit 0 Reserved
Bit 1 Data Check
Bit 2 Order complete
Bit 3 Equipment Check
Bit 4 Intervention Required
Bit 5 Sense Data Available
Bit 6 Input Code Available
Bit 7 Switch Transition (Valid)

- Data Check
  Bit 1 Set, with Order Complete, when the printer detects a parity check in the message buffer (not Register Space) while printing. Reset when enabled.

- Order Complete

  Bit 2 Set when the order, as specified in the two byte

  Order Register, has been completed or terminated. Reset when the printer is enabled.*

- Equipment Check
  Bit 3 Set when a printer detects a 'Permanent Error' condition. Cleared by a successful POR. A permanent error results when the printer detects a parity error or invalid parameter in the control unit output area (Printer Register space). If invalid parameter, Status Bit 5 will also be set, and Sense code '04' - Order Reject will be loaded.

- Intervention Required
  Bit 4 Set, after a device determined delay, when an operator recoverable (without POR response) condition occurs. Reset when the above condition is removed.

  Note: The control unit is not allowed to alter the printer print buffer or the Control

Unit Output Area after receiving IR,OC status, until receiving IR cleared status.

- Sense Data Available
  Bit 5 Set when new sense data is loaded into the sense byte and reset when the printer is enabled.*

- Input Code Available
  Bit 6 Set when new input code is loaded into the input code byte and reset when the printer is enabled.*

- Switch Transition
  Bit 7 Set when any valid transition of the applicable switches on the printer operator panel occurs and reset when the printer is enabled.*
  New status of the operator panel switches is stored in the switch status byte.

  * (Provided Poll Response is all zero. Refer to Start OP command.)

  The Status Available Bit (in Poll Response) is set when any of the above status bits are set or when Intervention Required is reset. Transition of two or more status bits may occur for one Status Available Poll Response.

  Defined combinations of status bits are:

Status Bits	Occurance
2	Print, Abort Order with Print Order successfully completed.
1,2	Data Check while printing. Print completes.
2,3	Printer Register Space Check following Start OP Command.
4	IR condition while idle.
3	EC condition while idle.
2,4	Print Order terminated due to IR condition.

- 2,5 Print Order terminated due to Sense condition.
- 2 Print Order terminated by an Abort Order.
- 2,3 Print Order terminated due to Equipment Check.
- 2,3,5 Print Order terminated due to invalid parameter in Control Unit Output Area.

Multiple failures or other undefined error conditions may result in other combinations of Status Bits being generated.

The print operation in process will be terminated whenever Equipment Check, Intervention Required, or Sense Data Available are set.

3.3.2 Switch Status

This byte contains the current status of certain operator panel switch positions. Whenever positions of MONO/DUAL Case, SINGLE/DOUBLE INDEX and 8/6 LPI switches are altered by an operator the Status Bit 7 (Switch transition) is set and new switch status is loaded into this byte.

Bit 0 through 4=Reserved

Bit 5=1= MONO/DUAL SW in DUAL position
=0= MONO/DUAL SW in MONO position
Bit 6=1= SINGLE/DOUBLE SW in DOUBLE position
=0= SINGLE/DOUBLE SW in SINGLE position

Bit 7=1= 8/6 SW in 8 LPI position
=0= 8/6 SW in 6 LPI position

3.3.3 Input Code

This byte will be loaded by the printer when a switch that initiates host and/or control unit intervention is actuated or timeout/no PA's installed condition occurs. The following four input codes are defined for the printer:

X'50' = Attention
X'5F' = PA 1
X'5E' = PA 2
X'5D' = No PA Keys Available/Actuated

Attn is allowable only in Printer SLU Receive state.
Attn does not terminate the order in process or alter the printer SLU (Secondary Logical Unit) send/receive state.

PA1, PA2, and No PA are allowable only in printer SLU send state. Printer SLU will assume receive state upon disabling and returning the Input Code. No
PA code may be sent after timeout in send state.

3.3.4 Sense Data

This byte will be loaded by the printer when the printer has sense data to be sent to a host by a control unit. When this byte is available, status bit 5 will also be set.

X'01' Cancel

Not supported by the control unit.

X'02' Invalid Parameter

Not supported by the control unit.

X'03' Reserved

X'04' Order Reject

Set when printer detects an invalid order or parameter in the Control Unit Output Area. Status bits 2,3 (and 5) will be set.

3.3.5 Printer ID

This byte, loaded by the printer, contains the unique device parameters that are significant to the control unit and/or the application program. Definition of this byte is as follows:

Byte 0

Bit 0,1,2 and 3 = Reserved

Bit 4,5 and 6 Logical buffer size:

001 = Reserved
010 = 1920
011 = Reserved
111 = Reserved

Bit 7=1 = Printer (Unit ID)
=0 = Other (Unit ID)

Byte 1 Buffer Size

X'08' = 2048 Buffer
X'10' = Reserved

Byte 1 will be set to the equivalent value of the high order byte when the size of the printer buffer installed (plus 1) is counted in 2 byte binary format.

Byte 2 Reserved

Byte 3 Reserved

3.4 CONTROL UNIT OUTPUT AREA

3.4.1 Mode (2 bytes)

The mode bytes define in which data stream mode the Subsystem is operating. The mode remains in effect until overlayed with a new mode. The modes are defined as follows:

3270 Mode - This mode allows usage of the 3270 Data Stream. (See Section 6.0).

Byte 0 = Reserved

Byte 1 = Bits 0, 1 and 2 = Reserved

Bits 3 and 4
00 = Host Direct Print
01 = Reserved
10 = Operator Initiated Local Copy

Bits 5 through 7
000 = No Mode (Refer to Section 3.4.3 for use of this

code)

001 = 3270 Mode (Control Unit Output Area from X'0010' to X'0018' used)

101 = Reserved

110 = Reserved

The validity of the control unit output area and implemented functions vary among modes. The dependencies are summarized below:

Cancel Key - Not supported

Program Attention Keys (PA 1 & 2) - Not supported

X Print Function - Active in 3270 Mode

3.4.2 MSA and ML

The Message Starting Address Bytes specify the buffer address where the message buffer starts from and the message Length Bytes specify the size of the message buffer to be operated on by the printer.

If ML = zero for Start Print order, the printer will suppress any printing and return order complete.

3.4.3 Order

Two bytes are used as the order bytes to specify what operations will be performed by the printer. The first byte contains an order and its parameters are specified in the second byte if applicable. Order complete status will be set upon completion of the operation. The order will remain loaded until overwritten by the next order. The order will be examined and executed following a Start OP Command, providing there is no pending Poll Response Status. Refer to Start OP Command.

The printer must test the mode byte prior to executing the order.

Byte 0 X'01' = Abort
X'02' = System Status Available
X'03' = Print

Byte 1 Parameters for Orders

Abort ('01')

This order causes the printer to terminate the print order in process. No parameters are available for this order. Following receipt of this order the device must respond with one, and only one, Order Complete. The printer will ignore an abort order (and remain enabled) if no print operation is in process. The control unit may only send this order following a 'Start Print' Start Operation and prior to receiving Order Complete. The control unit may not change the Mode when sending this order.

System Status Available ('02')

X'00' May be used by control unit to indicate Mode change.

X'02' Reserved

X'03' Reserved

Print ('03')

Printing of the message buffer specified by the MSA and ML will be performed by the printer.

If No Mode is specified, printer will suppress any printing. Order complete will be returned.

The following parameters are defined for the print order:

Bit 0 = Reserved

Bit 1 = Reserved

Bit 2 = Reserved

Bit 3 = Reserved

Bit 4 = Reserved

Bit 5 & 6 Dual/Monocase
00 = Machine Default as configured
01 = Monocase
10 = Dualcase

Bit 7=1 = Ignore NL, EM and CR and print space for them
=0 = Honor NL, EM and CR (3270 non line length format)

3.4.4 Maximum Presentation Position (MPP)

The MPP specifies the maximum print position per line. If zero, print full width as determined by hardware. The MPP byte is loaded by the control unit.

3.5 PRINTER RECOVERY AND OPERATOR PANEL

While idle, and Enabled (with no Equipment Check pending), the printer will run a timer and periodically (10-60 sec.) disable and return 'status available' (bit 6 Poll Response). The control unit will read the status register, compare the contents with the previously returned status, and re-enable the printer. The printer will indicate 'subsystem not ready' whenever disable lasts longer than 60 seconds. 'Subsystem not ready' indication will be turned off when the printer is again enabled.

SECTION 4. 3289 and 3262 PRINTER CONTROL

4.0 GENERAL

This section defines the commands and control provided for the 3289 Model 4 Printer and 3262 Model 1.

The commands supported by the 3289 Model 4 and 3262 Model 1 printer are categorized as being in one of two groups of commands. The first group, referred to in the following paragraphs as Control Unit Attachment Commands, are transmitted between the control unit and the printer as command words. The second group of commands, referred to as Printer Operation Commands, are transmitted from the control unit to the printer as data words and are loaded in preassigned buffer space (printer register space) at location X'0000'.

The commands supported by the printer are:

Control Unit Attachment Commands

Read Commands

Bits 56789	
00001	Poll
10001	Poll/ACK
00011	Read Data
01101	Read Status

Write Commands

00010	Reset
01100	Write Data
00100	Load Address Counter High
10100	Load Address Counter Low
01000	Start Operation

Printer Operation Commands

Carriage Control Commands

Hex Code	
00	No Operation
01	Skip to Channel 1
02	Skip to Channel 2
03	Skip to Channel 3
04	Skip to Channel 4
05	Skip to Channel 5
06	Skip to channel 6
07	Skip to Channel 7
08	Skip to Channel 8
09	Skip to Channel 9
0A	Skip to Channel 10
0B	Skip to Channel 11
0C	Skip to Channel 12
0D	Space 1 Immediate
0E	Space 2 Immediate
0F	Space 3 Immediate

Print Commands

10	Write No Space
11	Write Skip to Channel 1
12	Write Skip to Channel 2
13	Write Skip to Channel 3
14	Write Skip to Channel 4
15	Write Skip to Channel 5
16	Write Skip to Channel 6
17	Write Skip to Channel 7
18	Write Skip to Channel 8
19	Write Skip to Channel 9
1A	Write Skip to Channel 10
1B	Write Skip to Channel 11
1C	Write Skip to Channel 12
1D	Write Space 1
1E	Write Space 2
1F	Write Space 3

Initialize and Diagnose Com

20	Fold
21	Unfold
22	Allow Data Check
23	Block Data Check
24	Load Forms Control Buffer
25	Read Forms Control Buffer
26	Load Universal Character Set Buffer
27	Read Universal Character Set Buffer
28	Set Command Reject
29	Check Read
2A	Reset Sense
2C	Read Printer Model

Control of the printer, including the printer operation commands, is provided by the Printer Register Space.

4.1 CONTROL UNIT ATTACHMENT COMMANDS

4.1.1 Read Commands

00001 POLL

The Poll command does not use the address portion of the command word for address. Bits in the address portion are assigned as follows:

Bits
234

010 Disable printer
110 Enable printer

Upon receipt of the Poll command, the printer will provide a Poll Response in the following format:

1	2	3	4	5	6	7	8	9	10	11	12
SYNC	0	0	0	0	X	0	X	X	X	0	P
Bit Addr.	0	0	0	0							

Bit 6 - Status Available
Bit 8 - Not Ready

Bit 9 - Operation Complete
Bit 10 - Additional Base Status

A response of all zeros except for bits 1 and 12 indicates a clean status with no error conditions to be reported or operator activity requiring service.

10001 POLL/ACK

The Poll/ACK command indicates that the control unit acknowledges the receipt of the previous Poll Response. If any bits were set for the previous response, they are reset and a clean status returned. Response to this command will be accomplished within 5 usec.

00011 READ DATA

The Read Data command causes the printer to respond with one byte of data from the Printer Register Space (paragraph 4.3) at the location specified by the Printer Address Counter. The counter will advance by one at the completion of the Read operation.
Response to this command will be within 5 usec.

01101 READ STATUS

The Read Status command requires the printer to respond with one data word in the following format:

1	2 3 4	5 6 7	8	9	10	11	12
SYNC	0 0 1	0 0 0	X	0	0	0	P
Bit	*		**				

* Bit 4=1 not busy
=0 busy
** OP Complete bit; valid only when Bit 4=1.

Response to this command will be within 5 usec.

4.1.2 Write Commands

00010 RESET

The Reset command will terminate any operation in process and cause the printer to be reinitialized. Prior to returning the POR response, communications with the control unit is t

01100 WRITE DATA

The Write Data command will cause the printer to store all successive data words in the printer buffer until another command is received. The data to be stored in the buffer will be loaded in the Printer Register Space (paragraph 4.3) at the location indicated by the Printer Address Counter. The counter is incremented by one for each data word received and stored.

00100 LOAD ADDRESS COUNTER HIGH

This command will load the data byte from the next data word received into the high order 8 bits of the Printer Address Counter.

10100 LOAD ADDRESS COUNTER LOW

This command will load the data byte from the next data word received into the low order 8 bits of the Printer Address Counter.

01000 START OPERATION

When this command is received, it indicates that a printer operation command (paragraph 4.2) has been placed in byte 0 of the Printer Register Space (paragraph 4.3). The printer will perform the indicated operation and set the appropriate Poll Response bits for a response to the next Poll command. From the time that the Start Operation command is received until the Poll Response is returned, commands other than Poll or Reset will

be treated as invalid.
TT/AR will occur.

4.2 PRINTER OPERATION COMMANDS

These commands are sent to the Printer as one byte of data and are loaded in the Printer Register Space location X'0000' (see paragraph 4.3). Any commands other than those described in the following paragraphs will set OP Complete and Status Available in the Poll Response.

4.2.1 Carriage Control Commands

X'00' NO-OP

This command will place the printer in the Enabled and Idle state and set OP Complete in the Poll Response.

X'01' - X'0C' SKIP TO CHANNEL X (WHERE X IS 1 THROUGH 12)

This command will cause the printer to search the Forms Control Buffer for a channel match. If the carriage is already at the specified channel, the command is suppressed unless the previous command was Write Without Spacing. Upon completion of the operation, the printer will set OP Complete and, if any errors, will also set Status Available in the Poll Response.

X'0D' - X'0F' SPACE X IMMEDIATE (WHERE X IS 1 THROUGH 3)

This command will cause the printer to advance the forms either 1, 2, or 3 spaces. Upon Upon completion of the operation, the printer will set OP Complete and, if any errors or unusual conditions occur, will set Status Available in the Poll Response.

4.2.2 Print Commands

X'10' WRITE NO SPACE

This command will cause the printer to obtain 132 bytes of data from Printer Register Space locations X'0001 through X'0084' and print a No line index will be performed. Upon completion of the print operation, the printer will set OP Complete, and, if any errors, will set Status Available in the Poll Response.

X'11' - X'1C' WRITE SKIP TO CHANNEL X (WHERE X IS 1 THROUGH 12)

This command will cause the printer to obtain 132 bytes of data from Printer Register Space locations X'0001' through X'0084' and print a line. Prior to printing, the printer will search the Forms Control Buffer for a channel match. A line index will be performed for each increment of the forms control buffer following printing. If no channel match is found, printing is suppressed, and no carriage movement occurs. Upon Upon completion of the operation, the printer will set OP Complete, and if any errors, will set Status Available in the Poll Response.

X'1D' - X'1F' WRITE SPACE X (WHERE X IS 1 THROUGH 3)

This command will cause the printer to obtain 132 bytes of EBCDIC data from Printer Register Space locations X'0001' through X'0084' and print a line. At the completion of the print operation, the forms will be advanced either 1, 2, or 3 spaces.
Upon completion of the operation, the printer will set OP Complete and, if any errors or unusual conditions occur, will set Status Available in the Poll Response.

4.2.3 Initialize and Diagnose Commands

X'20' FOLD

This command will cause the printer to ignore bit positions 0 and 1 of the EBCDIC code during the

translate and compare function. In all cases characters in quadrant 4 are checked first for a match. If an unprintable character is encountered, the characters in quadrants 3 and 2 are checked for a printable character. If no match is found, a space (X'40') prints and a Data Check may be indicated.

After the Fold command executes, folding continues until the Unfold command is received or the printer power is turned off. No Poll Response bits are set.

X'21' UNFOLD

This command will cause the printer to discontinue folding data for successive print operations. No Poll Response bits are set.

X'22' ALLOW DATA CHECK

This command will cause the printer to reset the Block Data flag if on. The printer will then indicate Print Check if unprintable characters are encountered during subsequent print operations. No Poll response bits are set.

X'23' BLOCK DATA CHECK

This command will set a flag to cause the printer to ignore invalid print data and continue printing. All unprintable characters print as blanks. No Poll Response bits are set.

X'24' LOAD FORMS CONTROL BUFFER

This command will cause the printer to obtain 256 bytes of data from Printer Register Space, starting at location X'0100' and move it to the printer's Forms Control Buffer (FCB). The data will be checked for valid channel codes, presence of end-of-sheet indicator, presence of a channel 1 code, and a count greater than 256 bytes. Upon

completion of the operation, the printer will set OP Complete and, if any errors, will set Status Available in the Poll Response.

X'25' READ FORMS CONTROL BUFFER (FCB)

This command causes the printer to move the 256 bytes of data in the Forms Control Buffer to Printer Register Space locations X'0100' through X'01FF'. The printer remains in the disabled state. Upon completion of the data move, the printer will set OP Complete in the Poll Response.

X'26' LOAD UNIVERSAL CHARACTER SET BUFFER (USCB)

This command will cause the printer to obtain 256 bytes of data from Printer Register Space, starting at location X'0200', and move it to the printer's Character Set Buffer to be used as a translate table for EBCDIC print data. The USCB remains loaded until it is reloaded or power is turned off. Upon completion of the operation, the printer sets OP Complete and, if any errors occur, will set Status Available in the Poll Response.

X'27' READ UNIVERSAL CHARACTER SET BUFFER (USCB)

This command causes the printer to move the 256 bytes in the printer's Universal Character Set Buffer into Printer Register Space locations X'0200' through X'02FF' leaving the printer in the disabled state. Upon completion of the data move, the printer sets OP Complete in the Poll Response.

X'28' SET COMMAND REJECT

This command causes the printer to reset previous status and dynamic sense data in Printer Register Space (locations X'0090' and X'00C0 - X'00D7'). The printer will then set command reject in the sense data and return to the enabled state. No Poll Response bits are set.

X'29' CHECK READ

This command causes the printer to move the current address of the forms control buffer (FCB) pointer to Printer Register Space location X'0091' and the printer remains in the disabled state. No Poll Response bits are set.

X'2A' RESET SENSE

This command will cause the printer to reset all dynamic sense bytes at Printer Register Space locations X'00C0' through X'00D7'. No Poll Response bits are set and the printer remains in the Enabled state.

X'2C' READ PRINTER MODEL

This command will cause the printer to load the printer model bits at Printer Register Space location X'0092' and go to the disabled state. No Poll Response bits are set.

4.3 PRINTER REGISTER SPACE

The first 1024 bytes of the printer buffer are used as register space to store control information between the control unit and the printer. The assignments are as follows:

ADDRESS (hex)	LENGTH (bytes)	DEFINITION
0000	1	Printer Operation Commands
0001	132	EBCDIC Print Data
0085	11	Reserved
0090	1.	Status
0091	1	Forms Control Buffer Address
0092	1	Printer Model
0093	45	Reserved
00C0	24	Sense Data
00D8	40	Reserved
0100	256	Forms Control Buffer (FCB)

0200	256	Universal Character Set Buffer (USCB)
0300	256	Reserved

4.4 STATUS

One byte of Status is maintained in Printer Register Space location X'0090' in the following format:

Bit 0 = Reserved
Bit 1 = Reserved
Bit 2 = Reserved
Bit 3 = Reserved
Bit 4 = Device Ready
Bit 5 = Device End (Not set by 3289 Printer)
Bit 6 = Unit Check
Bit 7 = Unit Exception

The reserved bits must be zero. The remaining bits are defined in the following paragraphs.

4.4.1 Device Ready

The Device Ready bit is set by the printer to indicate that the printer has changed from the not ready state to the ready state. This bit is set provided that no error exists when transferring the Start/Stop switch to Start, when entering single-cycle mode, and after the POR response has been accepted by the control unit. It is also set if the Check Reset switch results in resetting an error condition with the Start/Stop switch in the Start position.

4.4.2 Device End

The Device End bit is not set by the printer since the control unit interprets OP Complete in the Poll Response to be device end.

4.4.3 Unit Check

The Unit Check bit is set for any of the errors defined in sense bytes 0 - 3. Unit Check is also set for other unuaual conditions such as stop key, cover interlock, end of forms, forms jam, or any conditions requiring program or operator

intervention. Detection of a channel 9 code in the Forms Control Buffer during carriage space operations or write and space also cause setting of Unit Check. The setting of Unit Check causes Status Available to be returned with OP Complete in the Poll Response. Manual space or skip commands do not set Unit Check.

4.4.4 Unit Exception

The Unit Exception bit is set when a channel 12 code is detected in the Forms Control Buffer during a Space or a Write and Space command. The setting of Unit Exception causes Status Available to be returned with OP Complete in the Poll Response.

SECTION 5. CONTROL UNIT TO DEVICE INTERFACE

5.0 GENERAL

The Control Unit to Device Interface is a single wire coaxial cable (coax) interface using type RG62AU coaxial cable with serial by bit data transferred in either direction but in only one direction at a time. The control unit operates as a master, and the attached device operates as a slave. Each device attached directly to the control unit receives and sends data addressed only to that device.

Bits on the coax appear as positive and negative going pulses. Binary data is phase encoded such that a 212 nanosecond (ns) up-level followed by a 212 ns down-level, represents a binary 0. Similarly, a 212 ns down-level, followed by a 212 ns up-level, represents a binary 1. A predistortion pulse is generated for every transition from an up-level to a down-level or vice versa (see waveforms in 5.0 (A) and 5.0 (B).).

The waveforms shown in 5.0 (A) and 5.0 (B) are the signals measured across the coax at the transmitting unit (either control unit or device).

The waveforms shown in 5.0 (C) and 5.0 (D) show the signal across the coax at the receiving end of 5000 feet (1 524 metres) of coax.

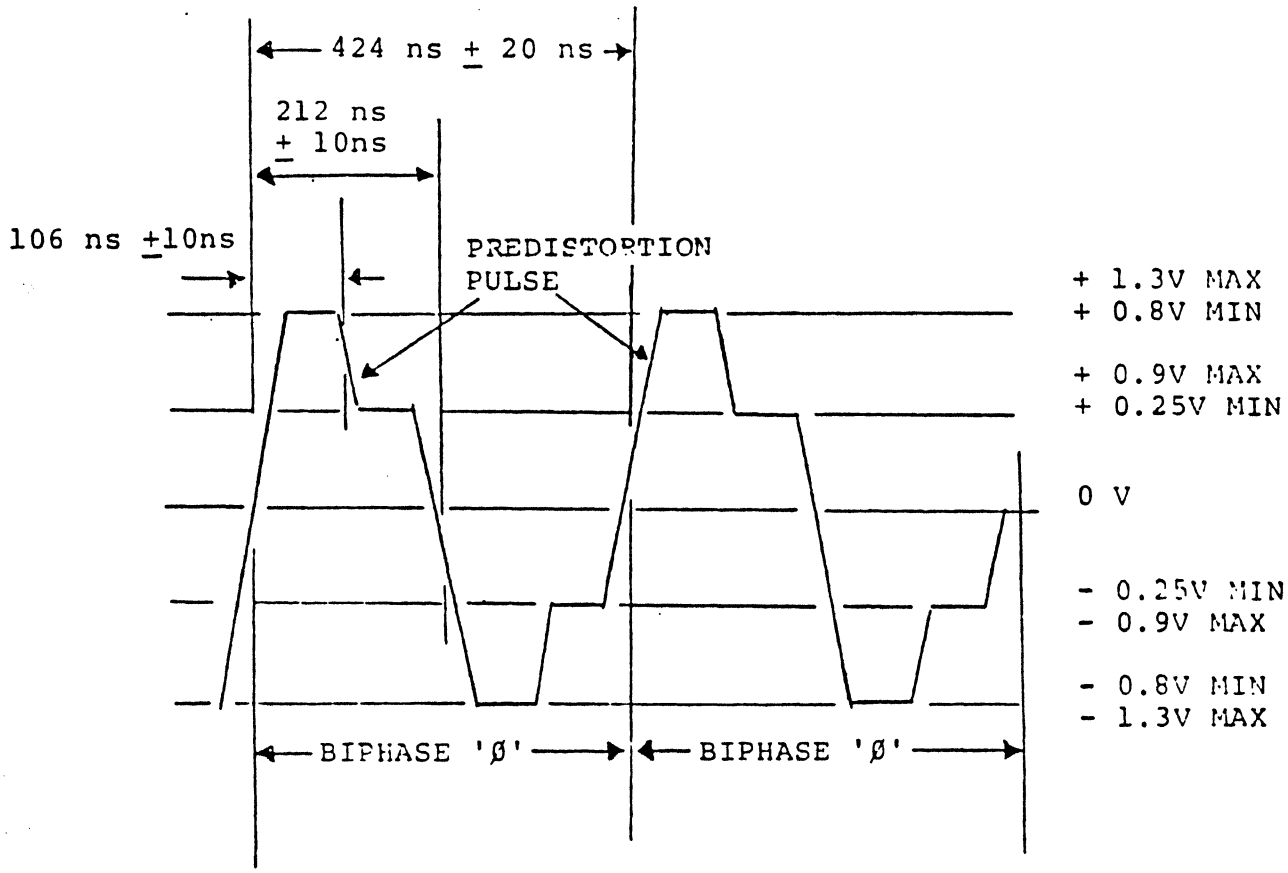


Figure 5.0 (A)

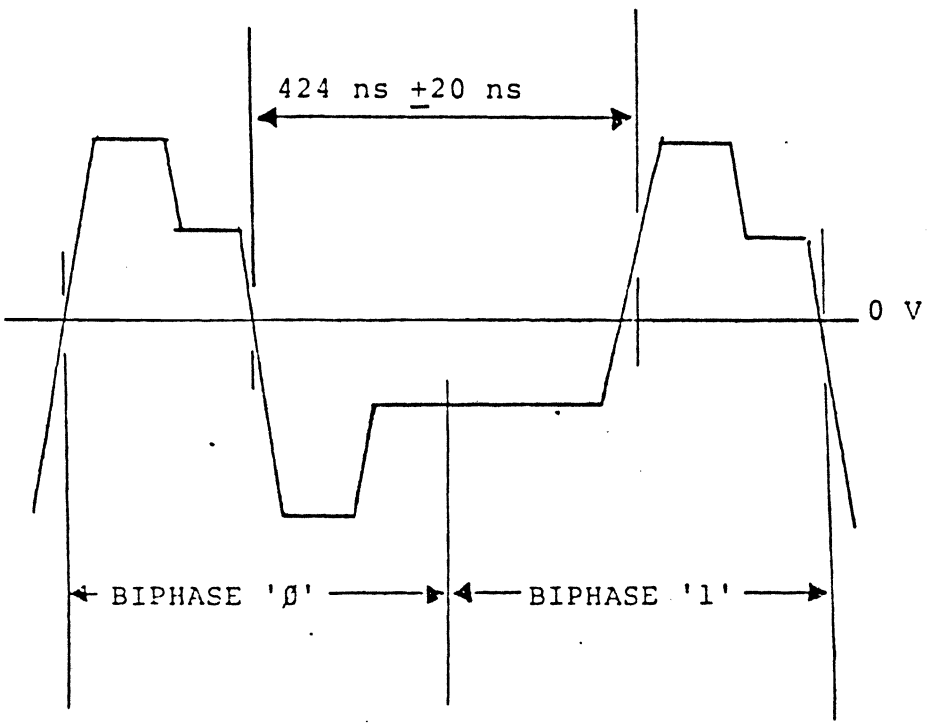


Figure 5.0 (B)

All rise and fall times 30 ns max. Rise and fall times exaggerated for clarity.

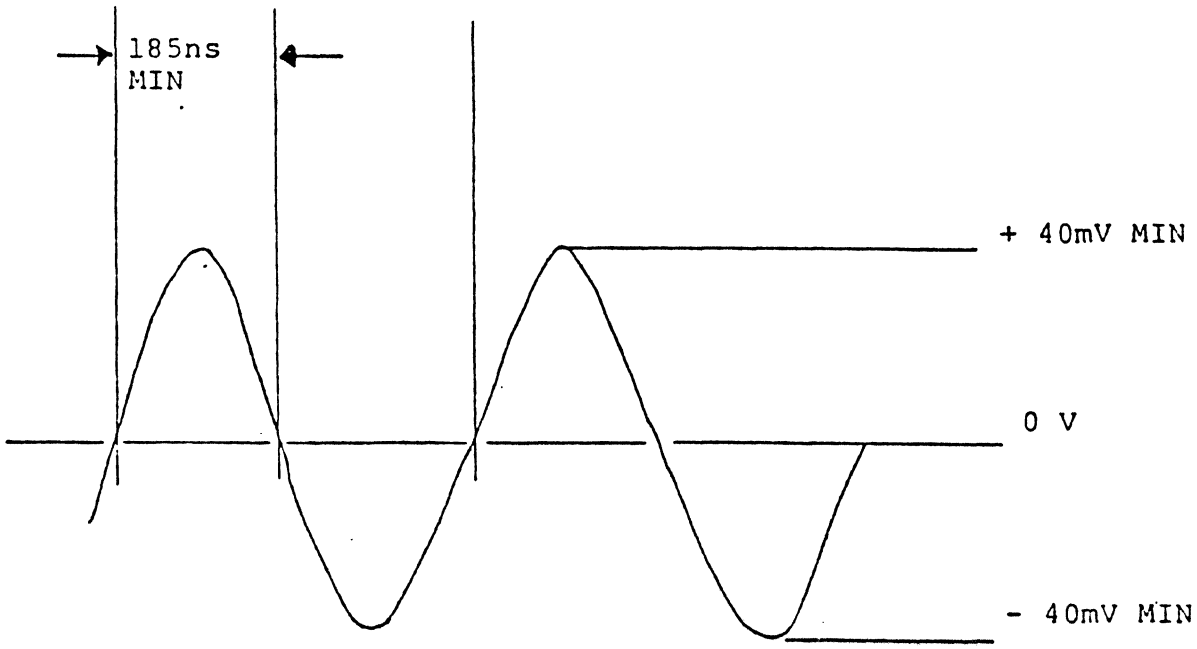


Figure 5.0 (C)

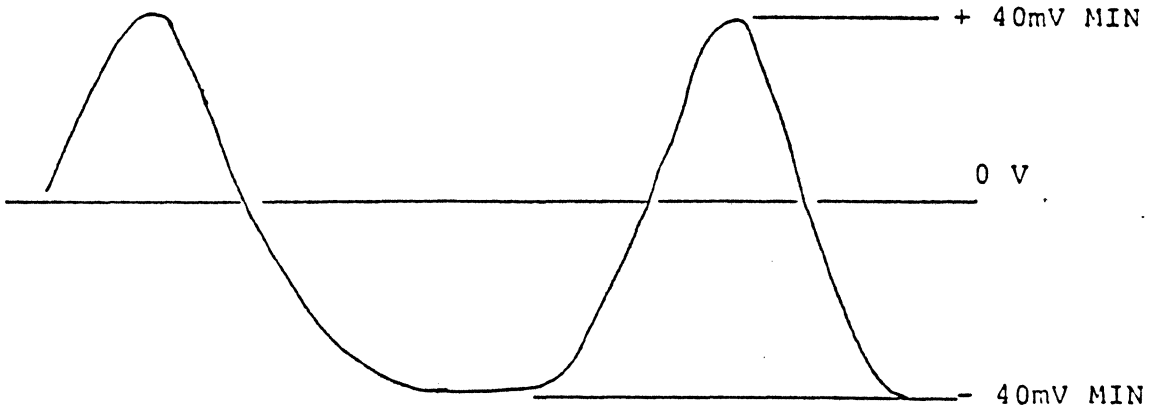


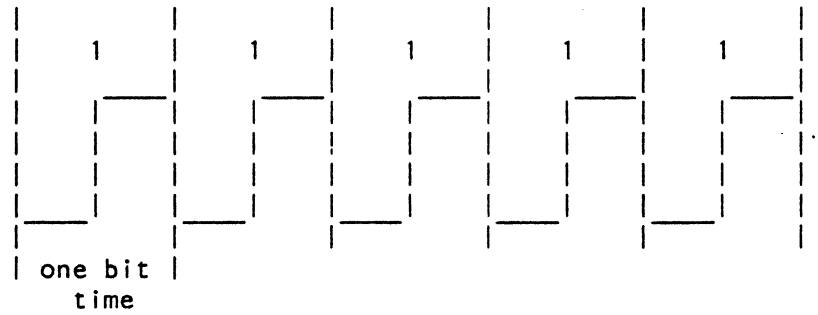
Figure 5.0 (D)

5.1 COAX TRANSMISSION PROTOCOL

The dipulse technique is utilized to provide a voltage transition of the coax at mid-bit time. Prior to valid data being transmitted, the coax must be conditioned to ensure that bit and byte synchronization may be achieved. This requires the transmission of a line quiesce and code violation pattern.

5.2 LINE QUIESCE PATTERN

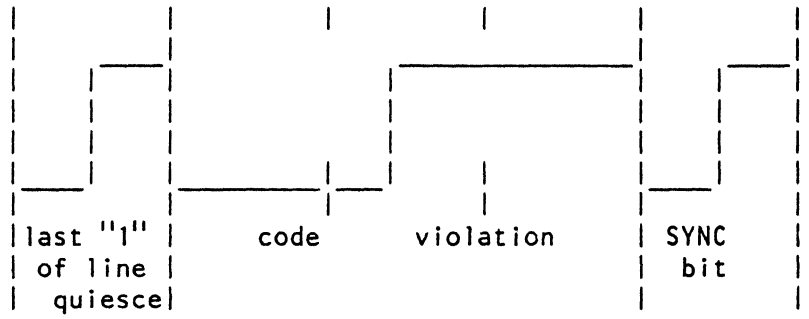
It is necessary to establish an equilibrium switching condition on the line after the null condition of line turn around before valid data can be properly detected at the receiver. Each data sequence from either control unit or device after line turn around will therefore be preceded with the following 5 bit biphase encoded data.



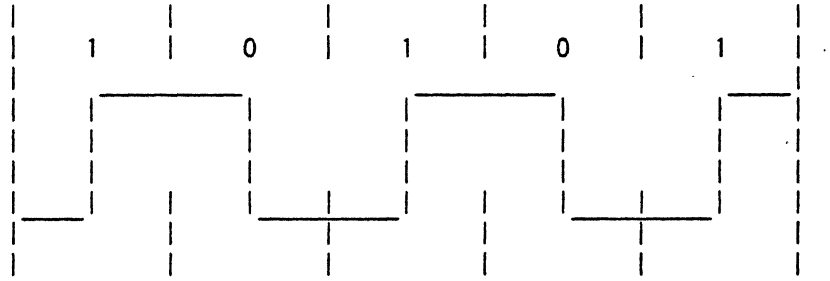
5.3 CODE VIOLATION

A code violation will follow the line quiesce pattern to differentiate between the quiesce pattern and the start of the valid data following the code violation. This is necessary because, due to varying line lengths, it is not possible to predict when the received data will become valid. However the code violation will be received properly thus providing a reference mark for start of transmission.

A unique balanced code violation sequence containing leading and trailing buffer bits to eliminate history dependence on adjacent data would appear as follows:



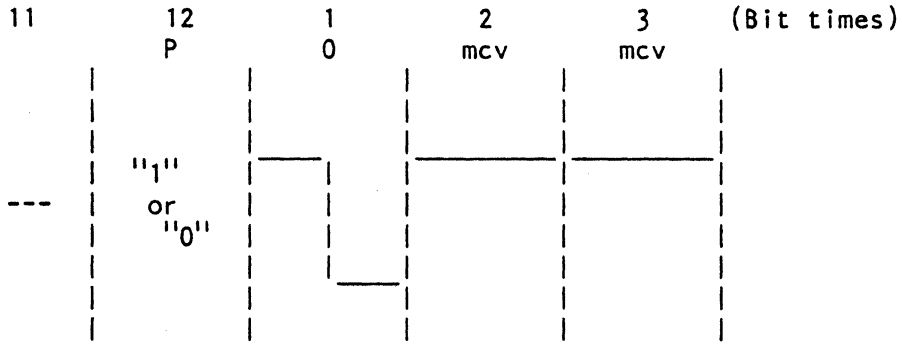
The trailing buffer bit is actually the SYNC bit of the following data byte. This code violation is unique in that it contains pulse widths (1 1/2 bit pulse widths) not present in normal biphase data (1/2 or 1 bit pulse widths) shown here for comparison.



Note that each bit has mid-bit transition. Thus, once decoded, this code violation provides, in addition to a reference mark for start of transmission, a definition of bit boundaries.

5.4 TRANSMISSION TERMINATION SEQUENCE (MINI-CODE VIOLATION - MCV)

In order that the receiver demodulation logic is reset at the end of a transmission, so that a subsequent transmission may be properly demodulated, a special termination sequence is used:



Last Data Byte

Ending Sequence

The last byte of data transmitted shall have 12 bits followed by a three bit Ending Sequence. The preceding 12 bit word is as previously defined (starting with Sync and ending with a parity bit). The The first bit of the Ending Sequence shall be a zero followed by two bit times without a mid-bit transition. (These are referred to as minicode violations.) The first minicode violation is always used to reset the receiver logic. The second merely guarantees that the line does not discharge and generate a spurious clock pulse while the logic is detecting the first MCV. The zero in the first bit position allows for discriminating a Transmit Check condition generated as a result of invalidly padded zero bits between bytes from a normal ending sequence.

5.5 TRANSMIT CHECK

A Transmit Check is defined as follows:

1. A 0 in the SYNC bit location not followed by the mini code violation.

2. The loss of mid bit transition detected at other than normal ending sequence time.

3. A transmission parity error (bit 12 not being even).

When a Transmit Check is sensed in the device, the device

will cease accepting data and all commands and suppress the TT/AR. The stored command, if any, will not be reset. Normal operations will resume upon receipt of the next Line Quiesce/Code Violation.

The control unit will also test the same three conditions and provide for error recovery. Control units that only implement 1 byte Read commands need not perform the complete ending sequence test (Item 1 above).

SECTION 6. CODE POINTS

6.0 GENERAL

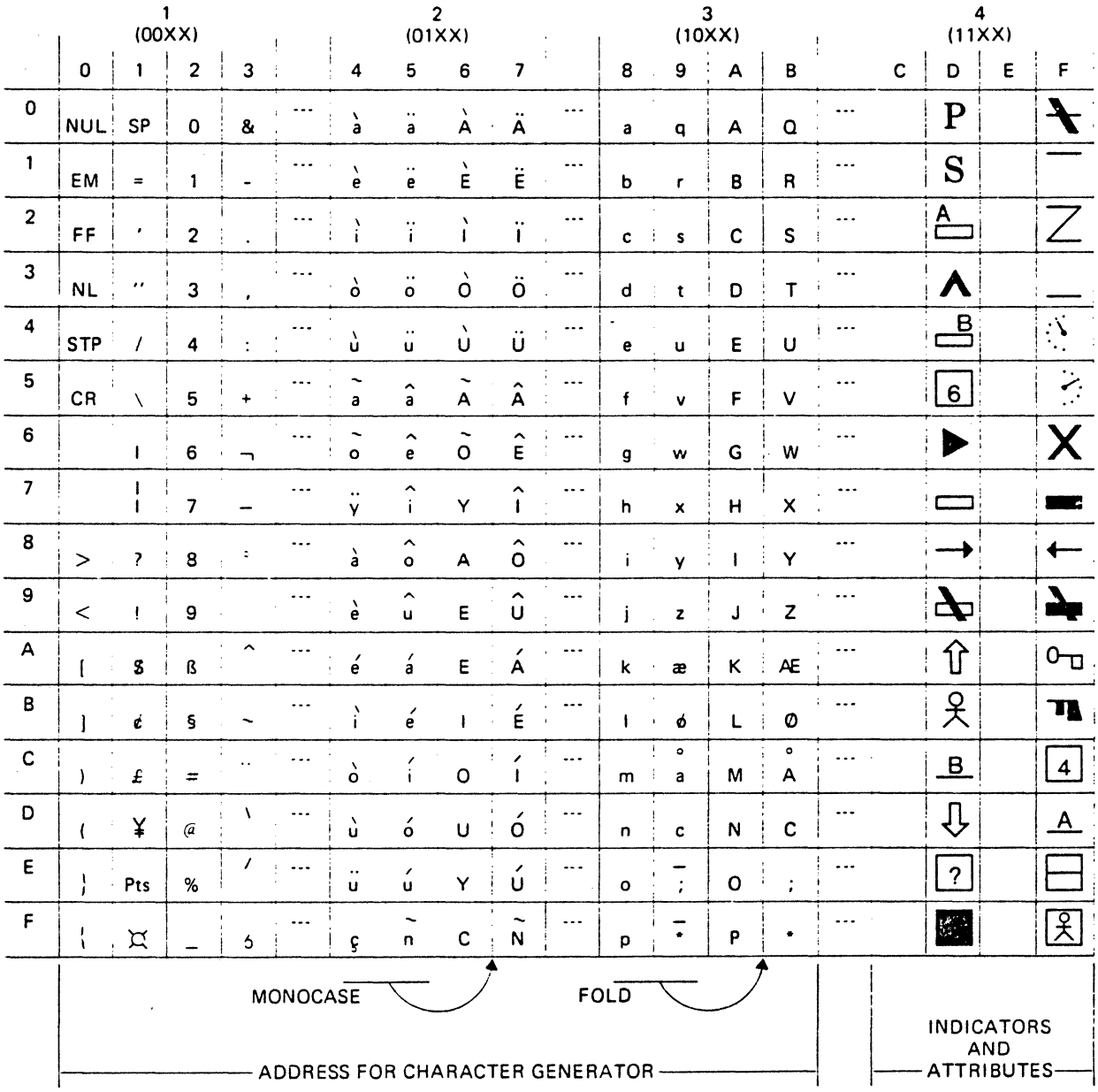
The code points described in this section are transmitted over the coax.

6.1 DEVICE BUFFER CODES

6.1.1 Character Codes

The following character codes are sent to display regeneration buffers and to printer "print" buffers. In addition to "internal code" (see following tables).

6.1.1.1 Device Buffer Coding



NOTES:
(1) Characters in locations 00 thru 07 display as blank.
(2) Codes Hex 9E and 9F are the PM and DUP characters.
(3) Lower case character in columns 4 & 5 and 8 & 9 fold to upper case characters, columns 6 & 7 and A & B, when the Display ist in the Monocase Mode.
(4) Printers are required to support only those graphics that are defined asl valid, in KGD 0379-XX-66F, for that particular language.

6.1.1.2 Device Buffer Coding for Katakana (and Japan English)

	1 (00XX)					2 (01XX)					3 (10XX)					4 (11XX)			
	0	1	2	3		4	5	6	7		8	9	A	B		C	D	E	F
0	NUL	SP	0	&	---	81	92	A6	42	---	a	q	A	Q	---		P		
1	EM	=	1	–	---	82	93	A7	43	---	b	r	B	R	---		S		
2	FF	'	2	.	---	83	94	A8	44	---	c	s	C	S	---		A		
3	NL	"	3	,	---	84	95	A9	45	---	d	t	D	T	---				
4	STP	/	4	:	---	85	96	AA	46	---	e	u	E	U	---		B		
5	CR		5	+	---	86	97	AC	47	---	f	v	F	V	---		6		
6		ı	6	¬	---	87	98	AD	48	---	g	w	G	W	---				
7		ı ı	7	–	---	88	99	AE	49	---	h	x	H	X	---				
8	>	?	8		---	89	9A	AF	51	---	i	y	I	Y	---				
9	<	!	9		---	8A	9D	BA	52	---	j	z	J	Z	---				
A		S			---	8C	9E	BB	53	---	k		K		---				
B					---	8D	9F	BD	54	---	l		L		---				
C	)	£	=		---	8E	A2	BD	55	---	m		M		---		B		4
D	(	¥	@	\	---	8F	A3	BE	56	---	n		N		---				A
E	¦		%		---	90	A4	BF	58	---	o	¯ ;	O	;	---		?		
F	¦		:	_	---	91	A5	41	7F	---	p	¯ *	p	*	---				

EBCDIC CODES —FOR KATAKANA—

INDICATORS AND ATTRIBUTES

ADDRESS FOR CHARACTER GENERATOR

NOTES: (1) Characters in locations 00 thru 07 display as blank.

(2) Codes Hex 9E and 9F are the PM and DUP characters.

6.1.2 Attribute Codes

An attribute is used to specify the characteristics of the "field" (characters) that follows in the buffer. Each attribute occupies a location in the print buffer and displays (prints) as a blank.

DATA WORD BITS:

```
2 3 4 5   6 7 8 9   10
1 1 X X   X X X X   P
```

Bit 4=0 Unprotected
=1 Protected

Bit 5=0 Alphameric
=1 Numeric

Bits 4&5=11 Auto skip

Bits 6&7=00 Normal display, nondetectable
=01 Normal display, detectable
=10 Bright display, detectable
=11 Non display, nondetectable, nonprint

Bit 8 Reserved. Used only by control unit.

Bit 9 Modified Data Tag (MDT).

Additional use of bits 2, 4, and 5 when color is installed:

Bit 2 4 5	Base Color Switch Set to 0000	Base Color Switch Set to 00
0 0 X	Green	Green
1 0 X	Blue	Green
0 1 0	Red	White
1 1 0	White	White
X 1 1	Non display	

X = ignored

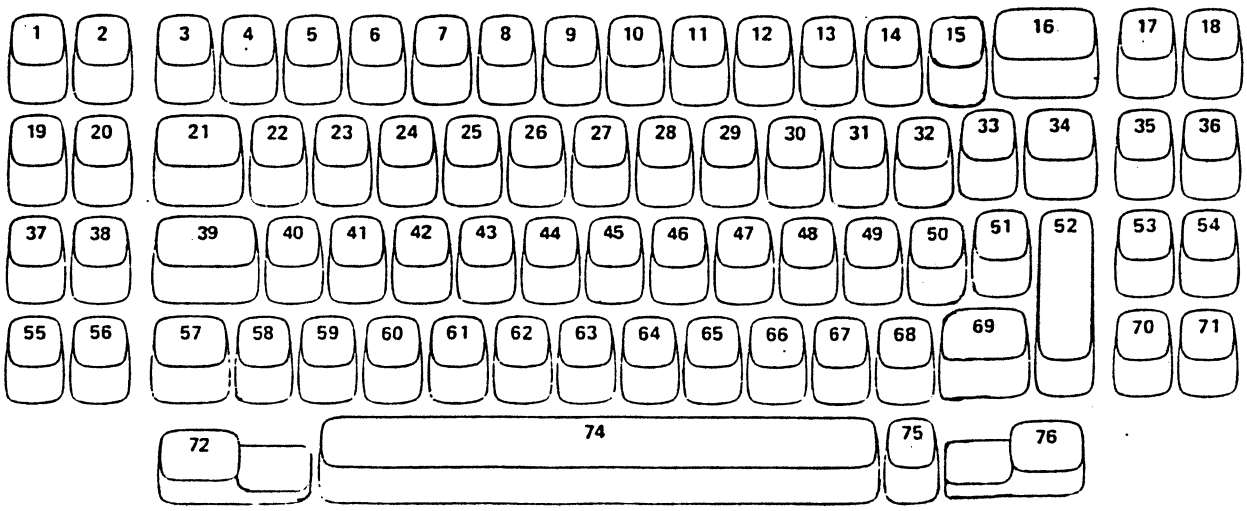
6.2 KEYBOARD SCAN CODES

The following table lists the Scan Codes that are generated by all alphanumeric keyboards that have 88, or fewer, keys. The keys that generate both make and break codes are shown with an 'X' in scan code bit 2, the make/break bit. This bit is a zero on make, one on break on the coax.

6.3 KEYBOARD LAYOUTS

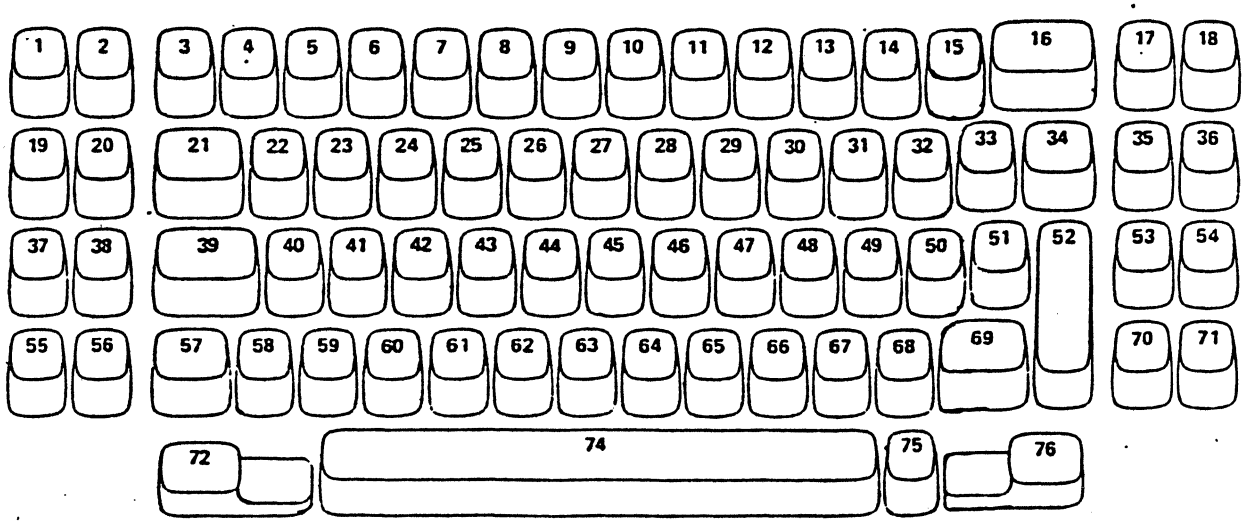
The following chart shows the key number assignments for the 75 and 76 key alphanumeric keyboards. The layout of the 75-key keyboard is shown in 6.3.1. The 76 key typewriter keyboard is identical except for one additional key, number 51A, located on the third row between keys 51 and 52.

51A, located on the third row between keys 51 and 52.



Key # (Coax bit position):	Hex	Scan Code 2345 6789	Key #	Hex	Scan Code 2345 6789
1	50	0101 0000	39	4C	X100 1100
2	51	0101 0001	40	60	0110 0000
3	3D	0011 1101	41	72	0111 0010
4	21	0010 0001	42	63	0110 0011
5	22	0010 0010	43	65	0110 0101
6	23	0010 0011	44	66	0110 0110
7	24	0010 0100	45	67	0110 0111
8	25	0010 0101	46	69	0110 1001
9	26	0010 0110	47	6A	0110 1010
10	27	0010 0111	48	6B	0110 1011
11	28	0010 1000	49	7E	0111 1110
12	29	0010 1001	50	12	0001 0010
13	20	0010 0000	51	0F	0000 1111
14	30	0011 0000	51A	1D	0001 1101
15	11	0001 0001	52	08	0000 1000
16	31	0011 0001	53	0E	0000 1110
17	5F	0101 1111	54	13	0001 0011
18	5E	0101 1110	55	56	0101 0110
19	52	0101 0010	56	57	0101 0111
20	53	0101 0011	57	4D	X100 1101
21	36	0011 0110	58	09	0000 1001
22	70	0111 0000	59	79	0111 1001
23	76	0111 0110	60	77	0111 0111
24	64	0110 0100	61	62	0110 0010
25	71	0111 0001	62	75	0111 0101
26	73	0111 0011	63	61	0110 0001
27	78	0111 1000	64	6D	0110 1101
28	74	0111 0100	65	6C	0110 1100
29	68	0110 1000	66	33	0011 0011
30	6E	0110 1110	67	32	0011 0010
31	6F	0110 1111	68	14	0001 0100
32	1B	0001 1011	69	4E	X100 1110
33	15	0001 0101	70	16	0001 0110
34	35	0011 0101	71	1A	0001 1010
35	0C	0000 1100	72	34	0011 0100
36	0D	0000 1101	73	NOT USED	
37	54	0101 0100	74	10	0001 0000
38	55	0101 0101	75	4F	X100 1111
			76	18	0001 1000

6.3.1 75-Key Keyboard



APPENDIX A. OPERATOR CONTROL PANEL (OCP) TO 3278-2A (or 3279-2C) CABLE INTERFACE DESCRIPTION

OCP CONNECTOR PIN #	SIGNAL NAME	FUNCTION	INACTIVE V	INACTIVE I	ACTIVE V	ACTIVE I
3	OCP Power On	Unused				
8	IML	With IML depressed, Pin 8 should float. With IML not depressed, Pin 8 should have 24 V source.	F1	0MA	+24V	28MA
2	O.C.P. Pwr.	Unused				
7	Pwr In Process	This pin remains at gnd until all pwr. is completed in the H.S. Then it floats with a REV biased collector base jct.	+24V	0MA	.5V	10MA
5	Pwr. Comp. Ind	When Pwr. is sequenced totally on the H.S. pulls this line to gnd. and causes the Pwr. comp Ind. to glow. When Pwr. is in process of coming up, this line floats.	+24V	0MA	.5V	20MA