IBM 3274, 3276 Control Unit to Device Product Attachment Information

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Includes base document dated October, 1977, PLUS

Addenda 1 & 2 (entered into base document)
3 - 7 (Addendum 7 covers 3178)
7-Colcr/PS (plus updates #1 & #2)
3299

Effective date of PAI: September, 1983

August 3, 1984

PREFACE

An IBM 3270 Information Display System is composed of selected units from a family of display products. The selection of units and features can be tailored to meet the needs of most alphameric display applications. The 3270 system has three basic categories of units:

Control Unit
Display Station
Printer

This Original Equipment Manufacturer's Information Manual provides information on the interface and Input/Output messages transferred between the control unit and its attached display stations and printers.

The control unit interface is described for the IBM 3274 Control Unit and the IBM 3276 Control Unit Display Station attaching the following devices:

IBM 3278 Display Station, Models 1, 2, 3, and 4
IBM 3287 Printer, Models 1 and 2
IBM 3289 Line Printer, Models 1 and 2
IBM 3179 Color Display Station, Model 1
IBM 3180 Display Station, Model 1

The 3276 Control Unit Display Station and the 3278 Display Station may optionally be equipped with a Selector Light Pen and a Magnetic Slot Reader.

The 3274 Control Unit (using an optional interface) can also attach the following devices:

IBM 3277 Display Station, Models 1 and 2
IBM 3284 Printer, Models 1 and 2
IBM 3286 Line Printer, Models 1 and 2
IBM 3287 Printer, Models 1 and 2
IBM 3288 Printer, Model 2
IBM 3278 Display Station, Models 1, 2, 3, 4 and 5
IBM 3279 Display Station, Models 2A and 3A
IBM 3287 Colour Printer, Models 1C & 2C

Additionally, the 3274 Control Unit using Configuration Support C will attach:

IBM 3279 Colour Display Station, Models 2B and 3B
IBM 3278/79 Display Stations, Models 2 thru 4, with PS feature
IBM 3287 Colour Printer, Models 1C and 2C, with ECSA feature
IBM 3287 Printer, Models 1 and 2, with PS feature

Additionally, the 3274 Control Unit Models 1A, 1C, & 5C using Release 43 of Configuration Support C will attach:

Refer to appropriate product literature for additional devices that attach to the Configuration Support C 3274.

For information on that interface, see the 3271/3272 Control Unit to Device Interface Manual. When using that manual, read "3271" and/or "3272" as "3274". The APL/TEXT feature for those devices is not supported by the 3274.

Not all features mentioned in this manual are available in all configurations. For availablity of features see the IBM 3270 Information Display System Configurator, GA27-2849 or contact your local IBM Sales Representative.

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SECTION 1. TRANSMISSION ARCHITECTURE

1.0 INTRODUCTION

The 3274 Control Unit is used to control and support up to 32 display stations and/or printers. The 3276 Control Unit Display Station is used to control and support up to eight display stations and/or printers. However, the 3276 is supplied with one attached display station. All device functions are controlled by the control unit (3274 or 3276). 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. In addition, status information from the attached devices is monitored and logged.

1.1 GENERAL TRANSMISSION ARCHITECTURE

Data is transmitted from a control unit to a device or device to control unit via 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 3.0 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 contigous. In this case, the sync bit of the next word must directly follow the parity bit of the preceding word with no invervening 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 contigous 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	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 preceding 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 preceding 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.

STATUS WORD TO CONTROLLER (see also paragraph 1.4.2.2)

1	2345	6	7	8	9	10	11	12
SYNC	XXXX	X	0	X	X	0	0	X
BIT	ADDR	(		STATUS	BITS		)	PARITY

OR:

1	2345	6789	10	11	12
SYNC	KEYBOARD		1	0	X
BIT	SCAN	CODE			PARITY

A status word is always sent (in response to a POLL command) from a device 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 activiity requiring service.

This response will be referred to as "all zero" or "clean" response. If bit 11 is set, bits 2-10 are undefined.

DATA WORD TO CONTROLLER (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

1.3.1 Address Bits (2, 3, 4, 5) for a Command to a Device

2345		
000X	0,1	BASE OR KEYBOARD
0010	2	SELECTOR PEN
0011	3	Reserved
0100	4	MAGNETIC SLOT READER
0101	5	Reserved
0110	6	Reserved
0111	7	EXTENSION ATTRIBUTE BUFFER (EAB)
1000	8	Reserved
1001	9	Reserved
1010	A	Reserved
1011	B	CONVERGENNCE FEATURE
1100	C	Reserved
1101	D	Reserved
1110	E	Reserved
1111	F	ESCAPE

1.3.2 Address Bits (2, 3, 4, 5) of Status Word from a Device

0000 BASE UNIT

All other features have the same address bits in a status word response as shown for command words to a device.

1.4 COMMANDS

1.4.1 Device Base Address Read Commands (Bits 5, 6, 7, 8 and 9)

		56789
READ COMMANDS	(XXXX1)	XXX11: Response Parity Checked
56789		XXX01: " Not "

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	Read Extended Terminal ID
11011	Reserved
11101	Reserved
11111	Reserved

Note: Reserved commands. 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.

1.4.2 Read Command Functions (to Base)

1.4.2.1 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:

For Display:	For Printer:
11= Enable keyboard clicker	11= Enable Operation*
01= Disable keyboard clicker	01= Disable Operation*
10= Sound alarm	10= Sound alarm**
00= None of the above	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 accessing adapter RAM as soon as possible (10 msec max), then return "Op. Complete" or other available status, and wait for subsequent controller 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 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 (1.4.3) and Disable (within 100 usecs) by the setting status bit 6 or 9 (Poll response) or POR response (1.4.2.2).

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. Refer to Section 2.0.

**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 of the 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 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 retreived 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 priority of Poll response in the 3278 and 3279 Displays 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

Other devices including those that emulate 3278/3279 Displays, are permitted to establish alternate Poll response priorities.

* 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 returneed 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.

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.

Note: While the base display is busy, the display will suppress all status. See paragraph 1.4.3 Clear Command. Upon completion of the Busy operation, bit 9 will be set in base status.

1.4.2.2 Response to Poll (Status Words)

The status response word from the device base unit is:

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

Bit 1 = Sync Bit

Bits 2, 3, 4, 5 = Base address

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

For Printers: Status Available. This bit is set by the printer when new status is loaded or when status bit 4 is cleared in the printer status register. 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 2.4.

Bit 7 = Spare

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; printer until after the next command from Control Unit.

For Printers: Bit 8 set signifies that a parity error occurred during a search or clear command. Bit 9 will also be set.

Bit 9 = A. A search has been completed.
B. A clear command has been completed.
C. An Insert byte command has been completed. (Display Only)
D. A "Disable" Poll has been completed. (Printer Only)

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 4.4 for specific code points. Non make/break keys will enter scan codes with bit 2=0.

Special status codes are:

2345	6789	DISPLAY: Keyboard overrun
X000	0001	Spare
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. Also, for Printers: Following internal test during which controller communication was suspended for a minimum of five seconds.
X000	0100	Spare
X111	1111	Reserved for control unit use
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 1-20 may contain meaningless

data that should be ignored by the control unit. Refer to paragraph 1.4.4 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 11 is not set by printers.

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

1.4.2.3 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. (Printers will not generate any Feature Poll response.)

SELECTOR PEN STATUS

1	2345	6789	10	11	12
1	0010	X000	0	0	P

Bit 6 = Request Read
Bit 7 = Reserved
Bit 8 = Reserved
Bit 9 = Reserved

MAGNETIC SLOT READER STATUS

1	2345	6789	10	11	12
1	0100	X000	0	0	P

Bit 6 = Request Read
Bit 7 = Reserved
Bit 8 = Reserved
Bit 9 = Reserved

EXTENDED CHARACTER SET (ECS) Status (Display Only)

1	2345	6789	10	11	12
1	0100	X000	0	0	P

Bit 6 = Reserved
Bit 7 = Reserved
Bit 8 = Device Check (EAB parity error)
Bit 9 = Op Complete

Note: Printers will report parity error of EAB by bit 8 in "base" Poll Response or bit 1 of status.

CONVERGENCE FEATURE

This feature does not request Poll service or generate a Poll Response.

1.4.2.4 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.

This command will be no-op'd by the printer.

10101 READ ADDRESS COUNTER LOW

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 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 8 low-order bits of the address counter.

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 ID	Model	0 0 0 P

PRINTER

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

DISPLAY (bit 9=0, bits 6, 7, 8 ≠ 0)

Bits 2, 3, 4, 5 = A/N Keyboard ID

0000	Reserved
0001	APL with numeric lock
0010	TEXT with numeric lock
0011	Reserved
0100	Reserved
0101	APL
0110	TEXT
0111	Reserved
1000	Data Entry 2 with numeric lock
1001	Data Entry 1 with numeric lock
1010	Typewriter with numeric lock
1011	Reserved
1100	Data Entry 2 without numeric lock
1101	Data Entry 1 without numeric lock
1110	Typewriter
1111	No keyboard

Bits 6, 7, 8

000 -	Reserved
001 -	Screen Size 960
010 -	" " 1920
011 -	" " 2560
111 -	" " 3440
101 -	" " Reserved
110 -	" " 3564 (3278 Model 5)
100 -	Escape

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 2.2.5.

Additional Terminal ID definition for Displays attached to a 3274 Control Unit using configuration support C.

New keyboard ID table

Bits 2345	
0000	Reserved
0001	APL, numeric lock
0010	text, " "
0011	Reserved
0100	typewriter, PSHICO, or Overlay, PSHICO
0101	APL
0110	text
0111	APL, PSHICO
1000	data entry 2, num lock
1001	data entry 1, " "
1010	typewriter, " "
1011	Reserved
1100	data entry 2
1101	data entry 1
1110	typewriter
1111	no keyboard

Note: Num lock for PSHICO keyboards handled by controller customization.

	W/O Convergence				W Convergence	
Bits 6,7,8 =	010	011	111	110	010	011
no. characters horz.	80	80	80	132	80	80
no. characters vert.	24	32	43	27	24	32
PEL space horz.(x10-3)in.	14.6	14.6	14.6	11.4	13.5	13.5
PEL space vert.(x10-3)in.	15	15	15	15	18	18
PELs/char horz.	9	9	9	9	9	9
PELs/char vert.	16	16	12	12	12	12

Note: Displays with EAB feature installed will support both Field and Character highlighting. Also, Displays with both EAB and Convergence features will support Field and Character Colour.

Additional Terminal ID definition for Displays attached to a 3274 Control Unit using configuration support D.

Newer keyboard ID table

2345

0000	Keyboard ID in Read Extended Terminal ID
0001	APL, numeric lock
0010	text, numeric lock
0011	Reserved
0100	typewriter, PSHICO, or Overlay, PSHICO
0101	APL
0110	text
0111	APL, PSHICO
1000	data entry 2, num lock
1001	data entry 1, num lock
1010	typewriter, num lock
1011	Reserved
1100	data entry 2
1101	data entry 1
1110	typewriter
1111	no keyboard

Note: Num lock for PSHICO keyboards handled by controller customization.

Bits 6,7,8: Same as Configuration Support C.

00111 READ EXTENDED TERMINAL ID

The 3274 control unit, configuration support D or higher, will issue this command to all "dumb" devices, i.e. those that respond to Read Terminal ID with other than '0000 000 1'. Devices that support this command will return 4 bytes, as defined below, obeying the same rules as Read Multiple. READ EXTENDED TERMINAL ID command does not reset OP Complete and Feature Error status though READ TERMINAL ID command does reset them.

The control unit promises to:

1. Set the device address counter to 'XXX----XX00' prior to issuing this command.

2. No issue this command to devices that respond '0000 000 1' to Read Terminal ID.

3. Not get upset if the device responds TT/AR to this command, unless the device responded '10000XXX000P' to Read Terminal ID.

The device:

1. Must support this command with a 4 byte response if it responded '10000XXX000P' to Read Terminal ID.

2. Is allowed to answer this command with TT/AR if it has provided keyboard ID in bits 2-5 of Read Terminal ID response.

3. Is allowed to advance its address counter while generating the 4 byte response.

The four byte response is defined as follows:

Byte one: Keyboard Information

Bit 0=0: 3278 mode. Scancodes returned to the control unit are exact equivalents of the 3278 keyboard scancodes. Keyboard ID is in bits 2-5 of Read Terminal ID response. (Remainder of Byte one is undefined, need not be zeros.)

Bit 0=1: Native mode. Scancodes returned to the control unit are those defined for the 'Modifiable Keyboard'. Refer to table 4.5.1, page 44.1. Remainder of Byte one defined as:

Bit 1=1: Numeric Lock

Bit 2=1: 'RYO' (Roll Your Own) in effect. Keyboard key functions have been relocated (redefined) via the 'Keyboard Definition Utility' (see User's Guide GA23-0187-0).

Bits 3-7: Modifiable Keyboard ID

Bits 3-7:	Bit 2=0 (no RYO	Bit 2=1 (RYO no)
00000	Reserved	Reserved
00001	Typewriter	Roll A
00010	Data Entry	Roll B
00011	Reserved	Roll C
00100	Reserved	Roll D
00101 thru 11111	Reserved	Reserved

Bytes two and three: Device Type

Devices will return their four digit type number (packed decimal).

Device	Byte two	Byte three
3179	0000 0000	0000 0000
3180	0011 0001	1000 0000

Byte four: Additional ID:

Bit 0=0: IBM Device
Bit 0=1: OEM Device

Bits 1-7: Reserved (Must be zero)

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 - " " " " on

3 Reserved

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

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

6 Spare

7=1 Feature Error Bit ***

8=1 Op Complete**

9=0 - Security key turned on (display on)
9=1 - " " " 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. For Printers: 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. For Printers: Op Complete Poll Status, set as a result of a disable Poll command, may or may not be returned as Read Status Op Complete.

***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.

For Printers: Only bits 4 and 8 are implemented.

1.4.3 Device Base Address Write Commands (Bits 5, 6, 7, 8 and 9)

WRITE COMMANDS (XXXX0)
56789

```
00000     Reserved
00010     RESET
00110     CLEAR
01100     WRITE DATA
01010     LOAD CONTROL REGISTER
  BITS 2  3  4
       0  0  0 = 80 characters per line
       0  0  1 = 40 characters per line (3278 Model 1 only)
       1  0  0 = 102 characters per line (3278 Model 5 only)
       1  1  0 = 132 characters per line (3278 Model 5 only)
       0  1  X = Invalid
       1  X  1 = Invalid
00100     LOAD ADDRESS COUNTER HIGH
10100     LOAD ADDRESS COUNTER LOW
01000     START OPERATION
11010     SPARE
11100     SPARE
01110     INSERT BYTE
11000     SPARE
10000     SEARCH FORWARD
10010     SEARCH BACKWARD
10110     LOAD MASK
11110     Escape
```

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

1.4.3.1 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 sent while no command stored will be lost. TT/AR will occur, except in response to data sent to a busy display.

00010 RESET

A 3274 will send data to displays and printers. A 3276 will send only RESET commands.

For Displays: 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' (Hex '40' in 3278 Mod I) which corresponds to the first chartacter location on the screen. The device will execute the TT/AR sequence. POR Response will be returned to a subsequent Poll.

For Printers: 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 able 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 & 7 must be zero
Byte 1: All bits valid
Bytes 2 thru B: All zero
Bytes C thru 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. The Conf. Supt. C controller, which supports Query and Query Reply, will load X'AA 32 74 CC' to allow a printer to determine when he is attached to an advanced controller (if he cares).

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.)

For Displays: The Mask byte must be reloaded following an Insert Byte command.

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

For 3278 Display, the controller must set the Mask register to X'FF' prior to issuing an Insert command.

00110 CLEAR

The Clear command clears all or part of the printer storage or 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 function 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 (For printers: Low order Address Counter bits equivalent to installed buffer will be zero). Corresponding locations of the EAB will be cleared to nulls (under control of the EAB mask) when the EAB feature is present.

This command may also be used to clear the storage area containing the indicator character codes or printer register space. Exception: 3178 Display does not support this command within the operator indicator area - address X'000' to X'04F'. 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 (clear 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. While Busy, Reset command may be honored or no-op'd at the descretion of the device. While "busy" the Display will inhibit display of the cursor. Display of the cursor will be inhibited until the next Set Address Counter Low Command is received. While the cursor display is thus inhibited, commands to the features may be blocked by base hardware.

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. Printers with 4K base and 4K EAB will meet the 32 msec busy limitation only if no Load Mask (EAB) command preceeded (since last POR Response) the Clear Command. If a Load Mask (EAB) Command preceeded the Clear, "busy" state may approach 64 msec.

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 4.0. The control unit prevents address overflow while writing the device buffer.

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 Spare

3=1 Spare

4=1 Set 480 Character Format. This bit will be set by the control unit when the Application Program has specified that the 960 display is to be set to 480 mode.

5=1 Inhibit Feature Step of I/O Address Counter. When this bit is set the base logic will prevent the address counter from stepping during read and write commands to the features. This allows the controller ucode to read and write the extension attribute buffer at the cursor location without affecting the address counter and the cursor position on the screen. Printers that support the extension attribute buffer (EAB) will implement this command and support bit 5 only.

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. The printer will no-op this command.

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.

01000 START OPERATION

When this command is sent to a printer, the printer will go enabled. 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.

This command will be no-op'd (treated as spare) by the display.

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 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 and Pattern register must be relcaded by the control unit prior to the next Search or Clear command. The extension attribute buffer is also shifted with the contents of the Mask reg being inserted at the initial current address. For 3178 Display, this command will terminate at address X'7D0' if no null or attribute is found.

This command will be no-op'd by the printer.

The address counter must be set to within the Read buffer before issuing CLEAR, SEARCH or INSERT.

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 printers: 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. For 3178 Display, this command will terminate at address X'7D0' if no satisfying bytes are found.

The address counter must be set to within the Read buffer before issuing CLEAR, SEARCH or INSERT.

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). For 3178 Display, this command will terminate at address X'04F' if no satisfying bytes are found.

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. 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.

1.4.4 Device Feature Commands (Bits 6, 7, 8, and 9)

For Displays:

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 to poll response.

1.4.4.1 A/N Keyboard Feature

The keyboard will only respond to a Poll.

1.4.4.2 Selector Pen Feature

0001 POLL (See status response)

0011 READ ROW COUNT

Following a detect the selector pen will respond to this command with a row count (in bit positions 4 to 9) indicating the displayed row in which a detect occurred.

1111 READ SELECTOR PEN FIELD COUNT

Following a detect the response to this command is a count in bit positions 6 through 9 that indicates the Selector Pen field count at the time a detect occurred. (The field counter is reset to zero before the start of each row.) A Selector Pen field is a detectable attribute followed by a designator character.

Note: If either of the above two commands is issued after the Reset command but before a detect, a Feature Bus Timeout will occur.

01X1 READ FEATURE CONFIGURATION

Responds with feature address in bits 2 through 5 if feature is present.

0010 RESET

The Reset command will reset all latches and registers in the addressed device feature and must be sent to re-enable the selector pen for another detect.

1.4.4.3 Magnetic Reader Feature

0001 POLL (See status response.)

0011 READ DATA

The Read Data command is issued to the Magnetic Reader when the poll response word indicates that the Reader has data to send to the control unit. The first data word is sent in response to the first Read command and the (Read-Response) sequence continues until terminated by the control unit. The Magnetic Stripe buffer address counter will increment for each byte of data read from the buffer. The Magnetic Reader will determine when the last significant byte of data (EOM) has been read. EOM will be returned on all subsequent Read Data and/or Read Multiple commands until a Reset or Clear command is received.

If a read Data (or Read Multiple) command is issued after a Clear or Reset command but before a card is read, a Feature error will occur.

1011 READ MULTIPLE

The feature will respond with four successive bytes of data. The same restrictions as for Read Data apply.

01X1 READ FEATURE CONFIGURATION

Responds with feature address in bytes 2 through 5 if feature is present.

0010 RESET (RETRY)

The Reset command is sent following a control unit detected error during the previous Magnetic Read command. The feature is reenabled to the operator, hardware is reset, yellow and green lights extinguished, and the red light turned on.

0110 CLEAR

This command is normally sent to re-enable the feature to the operator. Hardware is reset, the yellow and red lights extinguished, and the green light turned on.

1.4.4.4 EXTENDED CHARACTER SET (ECS) AND PROGRAMMABLE SYMBOL (PS) BUFFERS

The Extended Character Set feature consists of an Extension Attribute Buffer (EAB) and the APL character set.

Note: Read and Write commands to this feature are affected by the setting of bit 5 in the Base Control Register. Refer to the Load Control Register command.

0011 READ DATA (EAB) (Display and Printer) - This command operates the same as the base Read Data Command.

1011 READ MULTIPLE (EAB) (Display Only) - This command operates the same as the base Read Multiple command.

CLEAR (EAB) - This command is not applicable. Refer to the base Clear command.

1100 WRITE UNDER MASK (EAB) (Display and Printer) - The "0" bits in each data byte from the control unit corresponding to the active ("1") bits in the Mask Register are written into the EAB at the address specified by the base I/O Address Counter. The "1" bits in the data byte from the control unit are written into the EAB regardless of the mask bits. The "1" bits in the EAB corresponding to the "0" bits of the mask are not modified.

1010 WRITE ALTERNATE (EAB) (Display and Printer) - Data bytes following this command are written to the base Refresh Buffer and the EAB alternately, starting with the base Refresh buffer. The base I/O Address Counter is stepped after the byte is written into the EAB. The write to the EAB is "under mask" and operates the same as the Write Under Mask command. Any number of bytes of data may follow this command with no error detected if an odd number of bytes is written.

Note: The Write Under Mask and Write Alternate commands have the following restrictions when writing large blocks of data in burst mode to the printers:

1. If updates pass more than 512 bytes, they must be to contiguous storage locations. There is no limit on the size of these updates.
2. If an error results in retransmission of a buffer update, 600 usec must elapse between the termination of the original attempt and the subsequent retry.
3. If the buffer updates are between 257 and 512 bytes in length with multiple address counter settings imbedded in the data, 600 usec must elapse between such updates.
4. Buffer updates between 1 and 256 bytes in length have no restrictions.

0110 LOAD MASK (Display and Printer)

The first data byte following this command will be stored in a register and used to designate the bits that will be cleared in the Extension Attribute Buffer when the base is executing a Clear command. "1" bits in the mask will clear the corresponding bit in the EAB byte as the base hardware clears the matching byte in the refresh buffer. This register must be restored by the controller following an Insert Cmd to the Base.

The Mask register is also utilized by the feature hardware when executing the "Write Under Mask" and "Write Alternate" Commands. See above.

01X1 READ TERMINAL ID (Display only)

Data Bit	Meaning
2 thru 5	Feature present (0111 returned)
6=1	APL ROS installed
7,8,9	Reserved

0010 RESET (Display only)

The RESET command will reset all latches and registers in the addressed device feature.

Note:

The EAB Color Bits 2,3,4 at address 79 (Column 80 in the indicator row) are defined as Color Switch Override Bits.

When any of these bits are set to 1, the display is forced to the state where the Base Color Suppression switch is on (mono position), and the switch is disabled.

When all these bits are set to 0's, the switch is enabled.

CONVERGENCE FEATURE (adr. 1011)

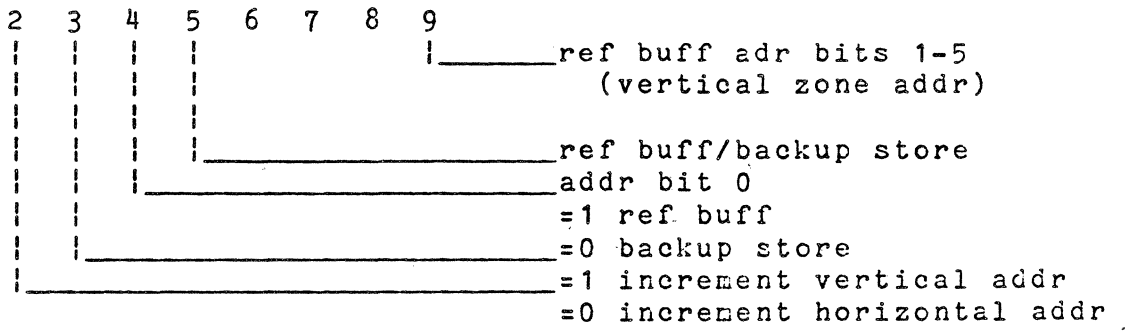
This feature controls the convergence of the colour CRT.

01X1 READ TERMINAL I.D.
Responds with feature address in bits 2 thru 5 if feature is present.

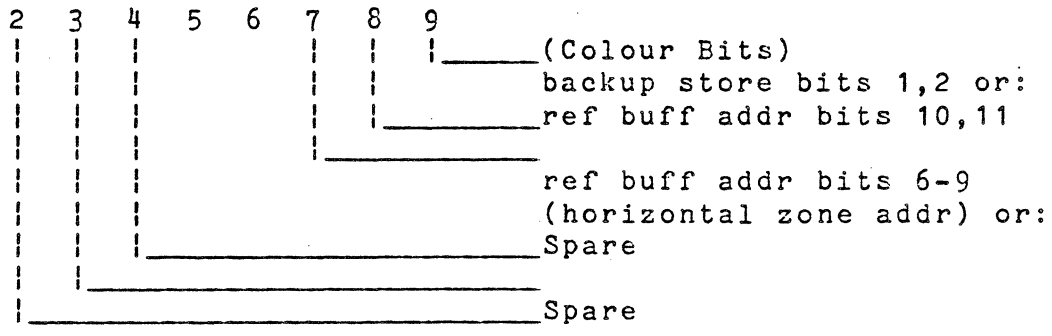
1011 READ STATUS
Bits 2,3,4,5=1011 (feature address)
Bit 6=1 Enabled
Bit 7=1 Colour Default Switch active (monochrome)

0010 Reset
This command will reset the feature status latches and I/O address registers.

0100 Write I/O Address Reg. High
The byte of data sent following this command will be interpreted as shown:
(Only one byte of data will be accepted.)



0110 Write I/O Address Reg. Low
The byte of data sent following this command will be interpreted as shown:
(Only one byte of data will be accepted.)



1100 Write Data
This command will cause the succeeding bytes of data to be loaded into either the reference buffer or the backup store depending on the setting of the select bit in the convergence I/O addr counter (see above).
Data words sent to the Backup Store contain only 3 significant bits, plus parity (a nibble):

```
2345  6789  P
0000  0XXX  P   Data word to Backup Store
XXXX  XXXX  P     "    "   " Reference Buffer
```

A maximum of 64 bytes (128 nibbles) may be sent without overwriting the selected storage.

0011 Read Data
This command will return one byte (nibble) of data from the selected storage.

1011 Read Multiple
This command will return a maximum of four bytes (nibbles) of data from the selected storage, under control of the two least significant bits of the Convergence I/O Address Counter.

Additional ECS Commands for Displays attached to a 3274 Control Unit using configuration support C

Add to Load Mask Cmd: (Display Only)

Also, for Write or Clear (PS): This register will be used to select the 192 Ram symbol set to be updated. Only the three low order bits are meaningful, except when colour feature is installed, in which case bits 4,5 & 6 select the colour plane of the PS specified by bits 7, 8 & 9. The format is identical to Character Attribute - see section 4.2.2.

PS's 2-7 are selected by bits 7,8,9 of Mask register set to b'010'-b'111'. Selection of "base" (b'000') or APL (b'001') or a non-implemented RAM will yield the following:

PS Command:	Device Response:
Write	TT/AR
Clear	TT/AR followed by Op. Complete

If a second data byte follows this command it will be loaded into the Suppress Skip Register. Bits in this register are defined as follows:

Data Bit	Function
2	Suppress Skip - Entire Screen
3	" " PS Font #7
4	" " " " 6
5	" " " " 5
6	" " " " 4
7	" " " " 3
8	" " " " 2
9	" " Pluggable ROS (APL)

The raster skip following a character row will be suppressed whenever one or more of the symbols in that row is displayed from a PS font (or ROS) designated as Suppress Skip.

isplay supports PS, the following commands (to ECS
be honored:

TERMINAL ID

Meaning

Feature present (0111 returned)
Pluggable ROS installed
0 PS Fonts Installed
2 " " "
4 " " "
6 " " "
Reserved

will reset Op Complete status in the feature.

TATUS
ommand is sent by the controller to determine if the
is "busy" (see Clear PS command) or to read the
le ROS ID. Six bits in the response are assigned:

Busy - Other bits are invalid
Not Busy
Op Complete

Pluggable ROS Identifier:

APL/Text

Reserved

Oper. Inds. only

DATA (PS)
rogrammable Font Buffer contains 9 data bits for each
n of storage. The high order bit of the 9 bit byte
isplay in column zero of the character box.
xecutive data words from the controller are combined
one location in the buffer. The second (odd) word
eight low order bits to be loaded in the location as
ed by the I.O. Address counter. The first (even)
ontains the high order bit to be stored in the same
n and is positioned in the low order bit position of
st word from the controller. A data stream of even
d words may be of any length and will load data into
tive locations of the buffer, a store cycle and
g of the base address counter occuring once for each
d pair of data words.

The I/O address counter is used to address the mmable Font buffer when writing (or clearing). The ller must load the I/O address counter with the proper ng address before writing the 32 bytes (16 slices)* of each . The address for the first (top) slice of each symbol be the 7 Lo order bits of the refresh buffer code for that shifted left 4 bit positions (multiplied by sixteen). order address bits will be ignored.

tes (12 slices) sometimes

CLEAR (PS)
This command is used to clear a symbol font buffer. The clear operation starts at the address specified by the address counter and terminates at the end of the 192 symbol programmable font RAM. Op Compl. status will be set in the feature at the end of the operation. It is recommended that the controller set bit 7 in the Control Register prior to issuing this command, and that the controller refrain from sending any commands (except Poll, and Read Status to this feature) to the display while the clear is in process because this command utilizes the Base Address Counter and any commands that alter the contents of the Address Counter may screw up the PS Clear.

The controller ucode is responsible for inhibiting display issuing any write command to a PS font. Refer to 1.4.3 -- ontrol Register command.

SECTION 2. PRINTER CONTROL

2.0 GENERAL

This section defines the additional control provided for printers 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.

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
0011	Read data (EAB)(Adr 0111)	10000	Search Forward
		10010	Search Backward
		01010	Load Control Register
		1100	Write Under Mask (EAB) (Adr 0111)
		0110	Load Mask (EAB)(Adr 0111)
		1010	Write Alternate (EAB) (Adr 0111)

The operation of these commands is described in preceeding sections of this document. 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.

2.1 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
0004-0005	2	Message Length
0006-0009	4	Reserved
000A-000F	6	Terminal ID
Control Unit Output Area		
0010-0011	2	Mode
0012-0013	2	Message Starting Address (MSA)
0014-0015	2	Message Length (ML)
0016-0017	2	Order
0018	1	Maximum Presentation Position (MPP)
0019-002F	23	Reserved
0030-003F	16	Alias Table
0040-0049	10	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.

2.2 PRINTER OUTPUT AREA

2.2.1 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 or loading PS. Reset when enabled. In LU1 mode, printer is allowed to set this bit while executing non-print data, and printing need not complete (but bit 2 must be set anyhow).

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.

ADDRESS (hex)	LENGTH (bytes)	DEFINITION
Printer Output Area		
0000	1	Status
0001	1	Switch Status
0002	1	Key Input Code
0003	1	Sense
0004-0005	2	Message Length
0006-0009	4	Reserved
000A-000F	6	Terminal ID
Controller Output Area		
0010-0011	2	Mode
0012-0013	2	Message Starting Address (MSA)
0014-0015	2	Message Length (ML)
0016-0017	2	Order
0018	1	Maximum Presentation Position (MPP)
0019-002F	23	Reserved
0030-003F	16	Alias Table
0040-0049	10	Reserved
004A-004D	4	Test Message Area
004E-004F	2	Reserved for Control Unit use

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 intc 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, SSA or 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.

2.2.2 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 thru 2=Reserved

Bit 3=0 Colour default switch on-Base colour (Fld Attr)
=1 Colour default switch off-Base colour suppressed

Bit 4=1 Colour cartridge resident (or no cartridge)
=0 Monochrome

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

2.2.3 Input Code

This byte will be loaded by the printer when a switch that initiates host and/or control unit intervention is actuated or timecut/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.

2.2.3.1 More Input Code

X'69' Query Reply
This code indicates that the printer has received a Read Partition Query and the control unit is directed to transmit a canned reply. The reply generated by the control unit will be identical to the LU3 version, and will be limited to Character Set, Hilite, Colour, and Usable Area.

X'6A' Query Reply, extended
Same as above, except that additional response parameters-in structured field format-have been loaded by the printer ucode into the message buffer. The data will start at address X'50' with the length specified in address 0004,0005. A maximum of 256 bytes is allowed.

X'6B' Query Reply, Other
This Input Code is provided for devices that don't conform to the '69' Query Reply criteria. The entire Reply, commencing with the appropriate FM header, will start at address X'50' with the length specified in address 0004,0005. A maximum of 512 bytes is allowed.

Note: A Query Reply input code must only occur with Order Complete and no error status bits (bits 2 and 6 in status req set).

Note also: The printer will return Sense X'02' if the Read Partition Query Structured Field is not the last (or only) SF in the chain. If LIC is not indicated on an otherwise acceptable Read Partition Query Start Op, the printer must 'hold' the Sense or Input Code reply until the next Start Op, and:

1. Return appropriate Query Reply Input Code if this is (or a subsequent) Start Op indicates LIC and the RPQ is still the last SF (null RU case).

2. Return Sense '02' if additional data is received (with or without LIC).

3. Purge the Query Reply if FIC is received prior to LIC.

2.2.4 Sense Data

This byte will be loaded by the printer when the printer has sense data to be sent to a host via a control unit.

When this byte is available, status bits 5 and 2 will also be set.

X'01' Cancel
This code indicates that the Cancel key is depressed by an operator in order to cancel printing. The printer will immediately terminate printing in process. The Cancel key is only active between First Segment of First in Chain and Last Segment of Last in Chain. If a Print Order is in process the printer will return Cancel and Order Complete. If a print order is not in process, the printer will wait for the next Start Print and: If FSFIC, ignore the Cancel; If not FSFIC, abort the print and return Cancel and Order Complete. Controller is responsible for purging remainder of the chain after receiving CANCEL. The next SCS START Print sent to the printer will be FSFIC.

X'02' Invalid Parameter
This code indicates that an invalid control parameter is found in the SNA character stream by the printer.

X'03' Invalid Structured Field
Set only during LU1 FMH Print if the printer detects an invalid SF within a valid FMH.

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. Printers are allowed to return Sense '04' (Sans equipment check) in non-LU1 mode if invalid parameters.

X'05' Illegal PS Selection
Set, in LU1 mode, when byte 6 or 12 of the Load PS Header specifies a non-existant PS Ram or Plane.

X'06' Illegal Alias Selected
Set, in LU1 mode, when an SA (X'28') control code references a PS LCID which does not exist.

X'07' Invalid FMH
Set, in LU1-FMH mode, if the printer doesn't like, or can't hack, the FM Header. (Invalid SF types within a valid FMH are rejected with X'03'.)

2.2.5 Printer ID

These bytes, loaded by the printer, contain the unique device parameters that are significant to the control unit and/or the application program. Definition of these bytes is as follows:

Byte 0C

Bit 0=1 Extension Attribute Buffer Installed
=0 Not Installed

Bit 1=1 APL/3289 Text Print Feature Installed
=0 Not Installed

Note: Bits 0,1=1,1 indicate full APL capability via the Extension Attribute Buffer (a la 3287) and
Bits 0,1=0,1 indicates 3289 "Text Print Feature"
Bit 2=Reserved

Bit 3=1 LU1 EBCDIC feature installed
=0 Not Installed

Bit 4,5 and 6 Logical buffer size:
001= 960
010= 1920
011= 2560
111= 3440
110= 3560 (Mod 5)

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

Additional Terminal ID definition for printers attached to a 3274 Control Unit using configuration support C.

Printer ID bytes have been expanded from '0C' - '0B' - '0F'. Previously defined bits have been preserved for compatibility.

Byte '000B' bits 0-3 Printer 'Type'
='0000' Old Type
='0001' 3287 with Ext. colour and/or PS
='0100' 3268
='0101' 3230
='0111' 3262
='1001' 5210

bits 4-7 Character set ID for font 001
='0000' APL.
all other codes Reserved.

Printer 'Type' definition:

bits 0-3	0001	0100	0101	0111
Type	Matrix	Matrix	Matrix	Non-matrix
MPP	132	132	132	132
MPL	102	127	127	127
PEL space horz (x10-3)in.	10	10	6.25	00
PEL space vert (x10-3)in.	15	15.625	6.25	00
PELs/cell horz	10	10	12	00
PELs/cell vert	8	8	18	00

Note: Printer type 0000, with EAB - same definition as 0001, above. Printer type XXXX, without EAB - Don't Care Condition. (Control Unit will ignore 'type' and highlight ID's)

Printers which do not support APL/TN (48 character belt installed, for instance) are allowed to load ID type '0000', no EAB, prior to POR response.

Note also: Printers of Type 0010 and above will implement an additional byte of ID as follows:

Byte 000A: (other bits reserved, must be zero)

```
bits 0,1,2 = 000   No highlighting supported
           = XX1   b'01' highlight (blink) supported, somehow
           = X1X   b'10' highlight (reverse) supported
           = 1XX   b'11' highlight (underline) supported
bit 3=1 Translate Table Required*
bit 4=1 DCA=L2 Supported
bit 5=1 FMH Subset 4 Supported
bit 6=1 'Local' Save/Restore SF and Query List SF supported
```

*Note: The controller will only test this bit if he (the controller) is configured for EDS.

Note: Printer type 0000, with or without EAB, and
Printer type 0001, without EAB:

DSE/DSC highlighting not supported.

Note also: If Bits 0,1,2 = 1,0,0 and no highlight support indicated (or implied - type 0001) and no colour support indicated (byte '000E, bit 2), then the control unit is prohibited from using - via command - or referencing - via order - the EAB.

```
byte 0C
       bit 2=1        PS installed

byte 0D
                      unchanged (Buffer size)
                      (Note: 4K base buffer req'd for PS)

byte 0E
       bit 0,1        Reserved
       bit 2=1        colour supported
  If bit 0 of byte '0C' is also set (EAB installed),
  then Extended Colour is supported.

       bits 3-7       Reserved
```

byte 0F		PS characteristics
	bits 0-1	single/triple configuration
	00	Reserved
	01	2 PS installed (2 and 3)
	10	4 PS installed (2,3,4,5)
	11	6 PS installed (2,3,4,5,6,7)
	bits 2-7	triple plane addresses by bit:
	1xxxxx	triple installed on PS number 2
	x1xxxx	triple installed on PS number 3
	xx1xxx	triple installed on PS number 4
	xxx1xx	triple installed on PS number 5
	xxxx1x	triple installed on PS number 6
	xxxxx1	triple installed on PS number 7

Byte 0D Buffer Size (Base Buffer)

X'08' = 2048 Buffer
X'10' = 4096 Buffer

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. The EAB, when installed, will be of equal size as the base buffer.

Byte 0E Reserved

Byte 0F Reserved

Note: The control unit is not responsible for testing the validity of combinations of printer ID bits.

2.3 CONTROL UNIT OUTPUT AREA

2.3.1 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:

LU2/3 Mode - The 3270 Data Stream is supported under SNA. (See Section 4.1).

3270 Mode - This mode allows usage of the 3270 Data Stream over BSC and 3272 local channel attachment. (See Section 4.1)

LU1 Mode - This mode allows usage of SCS, DCA-L2 or Structured Field Data Streams. (See Section 4.1.1)

Byte 0:
  bits 0-4=Reserved
  bit 5=0 =For Print Order LU1 mode: SA control code ('28') to be treated as invalid by the printer.
  bit 5=1 =For Print Order LU1 mode: Printer to execute all the control codes he understands
  bit 6 =Reserved

Note: The control unit promises to set Bit 5=1 for Print LU1-FMH.

Byte 1= Bits 0, 1 & 2 = Reserved

Bits 3 and 4
00=Host Direct Print
01=Host Initiated Local Copy (including BSC Copy command)
10=Operator Initiated Local Copy

Note: Either 00 or 01 may be used for BSC Copy command.

Bits 5 thru 7
000=No Mode (Refer to Section 2.3.3 for use of this code)
001=3270 Mode (Control Unit Output Area from X'0010' to X'0018' used)*
101=LU3 Mode (Control Unit Output Area from X'0010' to X'0018' used)*
110=LU1 Mode (Control Unit Output Area from X'0010' to X'0017' used)
For LU1/FMH, Output Area '0030-'003F', also if ID '0000' bit 2 and '000E' bit 3 set.

*The data stream for these two modes appears the same to the printer.

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

Cancel Key - Active only in LU1 mode (see last note under Print Parameter).

Program Attention Keys (PA 1& 2) - Active only in LU1 Mode.

X Print Function - Active in LU3 and 3270 Modes only.

2.3.2 MSA and ML

The Message Starting Address Bytes specify the buffer address where the message buffer starts from the message length Bytes specify the size of the message buffer to be operated on by the printer. In LU1 Mode print data will wrap from the end of the implemented buffer to address X'0050'.

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

2.3.3 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. The following mode changes have unique significance:

any --> No Mode: PA & Cancel keys deactivated, printer SLU enters or remains in receive state. LU1 parameters and any pending PA input will be reset. Unique conditions associated with the previous mode will be reset.

LU1 --> LU3,3270: Previous LU1 parameters saved, PA saved.

any --> LU1: Previous LU1 parameters, if any, restored.

Byte 0 X'01'=Abort
X'02'=System Status Available
X'03'=Print
X'04'=Load PS
X'05'=Load Translate Table

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. The Abort order will be valid during a Load PS order.

The controller is responsible for resetting the aliases for all PS's affected by the Abort. The printer is responsible for executing deferred clears (if any) from previous load PS orders.

System Status Available ('02')

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

X'02' Indicates that the printer SLU enters the send state.

X'03' Indicates that the printer SLU enters the receive state.

Note: Outstanding PA indication will be cleared whenever the printer SLU returns to receive state.

Note: '02' and '03' will only be sent in LU 1 mode.

Print ('03')

Printing of the message buffer specified by the MSA and ML will be performed by the printer. Refer to 4.1.1 for code points. 3270 like print function will take place in any modes other than the LU1 & No Modes. See the 3270 Component Description for 'buffered printer' only. If the message starting address does not contain an attribute character, a backward Search for an attribute must be performed commencing from the end of the current message buffer.

In the LU1 Mode the message buffer contains both control characters (with or without their parameters) and graphic characters. The printer will access I/O codes from the beginning of the message buffer to the end of the message buffer sequentially. A character will be printed if it is a graphic character and the control function will be performed if the control character is supported.

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=1 Extended Order Parameter byte valid
0=0 Extended Order Parameter byte not used: all zero value assumed

Bit 1=1 First Segment of First in Chain

Bit 2=1 Last Segment of Last in Chain

Bit 3= Reserved

Bit 4=1 Print with Extension Attribute Buffer
4=0 Print without Extension Attribute Buffer
2=0 Use EAB value (bits 7,8,9) tc select character set
=1 Use EAB value and EACT to select character set

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)

*Note: MPP does not effect honor of NL, EM and CR. Honor is only defined by Bit 7. FF is honored regardless of Bit 7 setting, but only when it is encountered at the left margin print position. When FF is not honored, a space is printed.

Note: Bits 1 and 2 valid in LU1 mode only. Bits 5,6 & 7 valid in non-LU1 modes only.

Note: Bits 1 & 2 are used to control the operation of the Cancel Key. Cancel is allowed, in LU1 mode, from Start Print of first segment of First Chain until Order Complete on last segment of Last in Chain. Also, the controller must set bits 5 and 6 to 10 (Dualcase) for SCS. See additional note on page 31.1.

2.3.4 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 in all modes except LU1 Mode.

2.3.5 Extended Order Parameter

bits 0 and 1 = Reserved
bit 2=1 Begin Bracket Flag. Valid only in LU1 mode and only if device has indicated support of FMH Subset 4 (bit 5 of ID byte '000A').

Note: The control unit will set bit 2 (to 1) when the outbound RH carries Begin Bracket and first-in-chain (LU1 session only).

bits 3 thru 7 = Reserved

2.4 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 'sybsystem not ready' whenever disable lasts longer than 60 seconds. 'Sybsystem not ready' indication will be turned off when the printer is again enabled.

Note: When bit 4 of the Print Order Parameter is set to 1 (Print Extension Attribute Buffer), bits 1, 2, and 3 are defined as follows:

Bit 1 Reserved
Bit 2 Reserved
Bit 3 = 0 Base buffer codes '01' through '07' are interpreted as control codes regardless of EAB values
Bit 3 = 1 Base buffer codes '01' through '07' are interpreted as control codes when EAB=XXXXX001 (APL)
Code '00' (Null) is valid regardless of any character or field attributes
Character attributes of XXXXX001 select the APL character set. All other character attributes select the base character set. Extended field attributes are ignored. The control unit is not to issue a Start Print with bit 4=1, if the device does not have an EAB (ID byte 0, bit 0).

Additional Definition for Extended LU1 Printers

Print Parameter, FMH Data Stream

Bit 7, previously set to '0' in LU1 mode, will be used to indicate FMH data stream.

Print Order, LU1 mode, FMH, will be loaded only if the printer has indicated support via ID byte '0E', bit 3. SCS mode rules apply, except as noted herein. ASCII is not allowed.

If FIC, the FMH is located at MSA.
If not FIC, the printer will continue processing the data stream. One and only one FMH is allowed per chain, and the first FMH Print Order after a mode change or previous EOC will specify FIC. The control unit promises to perpetuate the FIC bit 7 setting (either '0' or '1') for all print orders in that chain.

If LIC indicated, the printer will return order complete, sense '07' if the data in this chain is insufficient to constitute a valid FMH.

A mode change, FIC Start Op, or abort without a previous LIC Start Op is valid. The printer will termminate any parameter, header, or data processing without generating error status.

Refer to GA23-0061, chapter 1,
for the definition of the FMH1 LU1 Structured Fields.

Load PS ('04')

PS Structured Fields (modified) will be passed to the printer in segments and loaded in the data buffer. Each segment loaded will be stored by the printer upon receiving Start Operation. Synchronization will be achieved by the printer posting status available--order complete. This process will be repeated until all Load PS structured fields are transferred to the printer. Load PS Headers may occur at other than the MSA. The host data stream may contain many Load PS structured fields to multiple PSs or planes in a "scatter load" application, and these structured fields may be concatenated in the buffer for one Start Op. with multiple headers.

The PS buffers will be cleared by the printer before responding POR.

Significant fields in the PCIA are:

- Mode = host direct load, LU 2/3 or 3270
- Message Length = variable
- Message Start Address = variable
- Order = Load PS (x'04')

  Parameters:

  Bit 1 = 1 Beginning of first SF (Load PS Hdr at MSA)

  = 0 Continuation of previous Load PS order, or start of a new SF if previous ended in 'FF', or maybe just 'FF'.

  Other bits are reserved (must be zero)

Note: A load PS order with bit 1 = 1 or any other order will cause the printer to terminate a prior load PS order without forcing error status to be set.

Each load PS order must complete within 2 sec. To maintain subsystem performance, load PS orders containing 3K bytes of data should complete (as far as the control unit is concerned) within one second. The 'Load PS Header' will preceed the slice data. The controller promises not to split up either the header or the character/slices groups when the structured field continues from one buffer load/start op. to the next. The end of the structured field data will be flagged by 'FF' in the n+1 character position.

If a parity error occurs while reading in the header or data, 'data check' status will be set and the load PS order terminated. Deferred clears for previously affected RAMS are not to be lost.

The printers are allowed to terminate with Order Complete/Order Reject, sans Equipment Check, if (when) they detect invalid parameters within the Load PS header, or invalid character addresses or incomplete slice fields within the data. Also, printers are allowed to return Sense '04' in non-LU1 mode if invalid parameters are detected in the Load PS header.

Load PS Header (and data)

BYTE	BIT	CONTENT	MEANING	KEY
0	0	Basic/Ext b'1'	Basic or extended form - Extended form (10 byte hdr)	C
	1	CLEAR b'0' b'1'	Clear PS RAM/Plane - Do Not Clear PS RAM - Clear the PS RAM Specified	P
	2	Skip b'0' b'1'	Skip Suppress - Suppression off - Suppression on	P
	3-7 3 4-7	TYPE b'0' X'5','6'	PS Data Format Type Printer unique type: - Column loading (from left to right hi order bit at top) - Reserved or not supported	C
1		LCID (ALIAS)	Local Coded Graphic Char. Set ID - X'40' thru X'EF' - X'FF' indicates RAM associated with this LCID is free - Others are reserved (X'F0' - X'FE' for ROS sets)	C
2		CHAR	Beginning EBCDIC Code Point X'41' thru X'FE' inclusive	C
3		RAM	PS set RAM number (X'02' - X'07')	C/P

KEY:

C - The controller is responsible for checking the validity of these bits/bytes.

P - These bits/bytes have significance to the printer.

C/P - Both of the above.

BYTE	BIT	CONTENT	MEANING	KEY
4		p-length X'06'	Length of parameters for extended form. This includes the length parameter itself.	C
5	0	APA	=0 All Points available =1 Not all points available	P
	1	CB	=0 LCID compare =1 No LCID compare	C
	2	OB	=0 PS set is KBD selectable =1 PS set is not KBD selectable	C
	3-7	RES	RESERVED (must be zeros)	
6		X	Number of X-units in cell (10)	C
7		Y	Number of Y-units in cell (8)	C
8		X'00'	one byte codes	C
9	0-4	Reserved	Must be zero	
	5-7	Color B'000' B'001' B'010' B'100' Other	Color planes - Single or all planes - Blue - Red - Green - Reserved	C/P

This is the end of header.

BYTE	BIT	CONTENT	MEANING	
n x c+10s		Data	Character (internal code) followed by 10 vertical slices	C/P
last		'FF'	End of structured field	C/P

All LPSs are to be executed and the last LPS to a PS RAM defines the state of that RAM relative to APA, LCID, etc. The last LPS to a triple plane will define APA, etc. for all planes of that PS set.

Description of Printer Significant Bytes:

Byte 0

Bit 0 - specifies extended header.

When bit 1 of byte 0 is set to a 1, any portion of the PS RAM not updated will be cleared prior to executing a print order. If the bit is set to 0, the selected PS RAM is not cleared. Thus characters can be added to an existing character set. For a triple plane set, only the plane(s) indicated is cleared.

Bit 2 (SKIP SUPPRESS) controls the vertical positioning of a line of characters. The next line will be positioned vertically adjacent to the current line, if the current line contains one or more characters from a PS set having SKIP SUPPRESS on.

Byte 2

Successive "characters" (11 byte groups) will be ascending EBCDIC order.

Byte 3

The RAM number indicates the physical RAM to be loaded. Each RAM number is related to an attribute selection key defined for PS. These relations are RAM number 02 thru 07 equate to attribute selection key PS A thru PS F respectively.

Byte 5

The APA bit, when set to a 1 implies that fewer than all points may be displayed or printed to allow a performance gain for specific devices. For example, 3287 NOT APA will attempt to print all characters in one head sweep across the print line, (used with 4 of 7x8 PS font).

Byte 9

For a triple plane PS, if 'PLANES' is omitted, or specified with a value b'000', then for each code point, the character is loaded into each plane of the PS.

For a triple plane PS, if 'PLANES' is specified with a value b'001', b'010', or b'100', then the PS data is loaded into the specified PS plane. Other values are reserved and will be negatively responded to if received by Op-check or X'1003' (by Controller). Controller promises to send only b'000' if the printer ID specifies no triple plane for the RAM designated in byte 3.

Additional Definition for Extended LU1 Printers

If the printer encounters a Load PS header with bits 4-7 of byte 3 containing a X'6' while executing an LU1 mode decompressed as follows:

```
 0    bit    7
|   byte 1   |  2  |   3   |  ...  |   ...   |  ...  |   ...
|Flag| bu 1 |  bu 2  |  bu 3 | bu 4 |  bu 5   |Flag| bu 1 | ...

                                        ...  |  n-1  |  byte n  |
                                    ... | bu 5 | b'1111'| 0-7 1's|
```

(where bu indicates bunch, not bushel)

Each bunch represents two vertical slices, starting at the upper left of the character cell. Each bunch expands to 4 digits of 4 bits each as directed by the variable length flag:

Flag

```
   0 Compare each digit to all zero
  10 Compare each digit to 2nd previous digit, first two to zero
 110 Compare each digit to 4th previous digit, first four to zero
1110 Entire cell is zero
1111 End flag.  Set sense '02' and quit if remainder of byte is
      not padded with 1's.
```

If the first bit of a bunch is '0', every digit in that bunch is to be derived by copying its comparison digit and the bunch terminates following the first bit. If the first bit of a bunch is a '1', the four digits follow.

If the first bit of a digit is a '0', the digit is to be derived by copying its comparison and the digit is terminated following the first bit. If the first bit of a digit is a '1', the four bit value of the digit follows.

Examples:

Compressed Data (Hex representation omitted as data doesn't understand byte boundaries)	Character
b'1110'	blank
b'000000'	blank
b'11000000'	blank
b'10111111111101100110010011100000001100001000000'	fat E

Additional Definition for Extended LU1 Printers

Load Translate Table(s) ('05')

The Conf. Supt. C controller will load this order instead of the initial enable after a POR response if (and only if) the printer has specified "Translate Table Req'd" in Printer ID byte '000A'. Commencing at address X'0050', the controller will load the 191 internal code points corresponding to EBCDIC X'40' thru X'FE'. Commencing at address X'010F' the controller will load the 191 EBCDIC code points corresponding to internal codes X'01' thru X'BF'. The printer will save whichever table he likes and return order complete. The translate table loaded will reflect the language for which the controller is currently customized.

The controller will set:

```
Print parameter = X'00'
           Mode = No
            MSA = X'0050'
             ML = X'017E'
```

The Load Translate Table order must complete within 1 second.

2.3.11 Extension Attribute Correlation Table (EACT)

The EACT, used only in LU 2/3 or 3270 mode when bit 2 of print parameter is set to 1, tells the printer how to correlate PS buffers with the PS address in the EAB buffer. It is updated by the Control Unit for all local copy prints. The EACT is located in the EAB buffer from hex location 10 to 17.

Location	EAB Value	Default Correlation Value
0010	B'xxxxx000'	B'00000000'
0011	001	00000000 if APL/TN not installed 00000001 if APL/TN is installed
0012	010	00000000
0013	011	00000000
0014	100	00000000
0015	101	00000000
0016	110	00000000
0017	111	00000000

Note: If control codes are indicated from the APL character attribute the printer will honor control codes when EAB=b'xxxxx001' regardless of the correlation value for APL graphics. The controller promises not to load correlation values other than b'00000xxx' or to correlate to a non-installed PS set.

2.3.7 Alias Table (Address 0030-003F)

The Alias Table consists of 8 half words, assigned to Base, APL, and PS's 2-7 in ascending order. The even byte contains the Alias (byte 4 of the Load PS hdr.) and the odd byte contains parameter bits (byte 8 of the Load PS hdr.) This table is used by the printer to equate the alias in an SA order to a physical PS ram. It is created by the control unit prior to the first LU1 Start Op of each session. The alias of the Base character set will always by X'00', and the alias of the APL set (if installed) will be X'F1'.

The printer is required to form an "internal" table from the Alias Table at each FIC LU1 Print Order Start Op. whether FMH or not. The printer must update the Alias Table (from his "internal" table) following completion (or termination) of each FMH Start Op, prior to returning Order Complete. The printer is allowed to update the alias table following completion of a non-FMH LU1 Start Op. The alias of a PS will be updated to its new value when the entire Ld PS set header is processed error free. Simultaneously, any other PS set with an identical alias would have its alias "reset" (set to 'FF').

Both the control unit and the printer are required to set the Alias to X'FF' for unassigned or non-installed PS rams when they write (update) the alias table.

Note: The printer is not required to correct mistakes in the parameter bits sent from the host.

2.5 Extended Translate Tables

The following tables, one for each World Trade Language, will be used by printers that support both internal code PS and LU1 (EBCDIC) PS, as a PS set loaded in one mode may be referenced while printing in the other mode.

2.5.1 US, KATAKANA, and CANADIAN FRENCH

U.S. INTERNAL CODE		EBCDIC CODE		KATAKANA INTERNAL CODE	CANADIAN FRENCH INTERNAL CODE
X'10'	--	40	--	X'10'	X'10'
X'0A'	--	41	--	X'6F'	X'0A'
X'0B'	--	42	--	X'70'	X'55'
X'1C'	--	43	--	X'71'	X'1C'
X'1D'	--	44	--	X'72'	X'1D'
X'1E'	--	45	--	X'73'	X'1E'
X'1F'	--	46	--	X'74'	X'1F'
X'2A'	--	47	--	X'75'	X'2A'
X'2B'	--	48	--	X'76'	X'9D'
X'37'	--	49	--	X'77'	X'37'
X'1B'	--	4A	--	X'1C'	X'40'
X'32'	--	4B	--	X'32'	X'32'
X'09'	--	4C	--	X'09'	X'09'
X'0D'	--	4D	--	X'0D'	X'0D'
X'35'	--	4E	--	X'35'	X'35'
X'16'	--	4F	--	X'16'	X'19'
X'30'	--	50	--	X'30'	X'30'
X'38'	--	51	--	X'78'	X'38'
X'39'	--	52	--	X'79'	X'56'
X'3A'	--	53	--	X'7A'	X'51'
X'3C'	--	54	--	X'7B'	X'3B'
X'3E'	--	55	--	X'7C'	X'1B'
X'3F'	--	56	--	X'7D'	X'57'
X'40'	--	57	--	X'0A'	X'52'
X'41'	--	58	--	X'7E'	X'0E'
X'42'	--	59	--	X'0B'	X'42'
X'19'	--	5A	--	X'19'	X'3E'
X'1A'	--	5B	--	X'1D'	X'1A'
X'BF'	--	5C	--	X'BF'	X'BF'
X'0C'	--	5D	--	X'0C'	X'0C'
X'BE'	--	5E	--	X'BE'	X'BE'
X'36'	--	5F	--	X'36'	X'3A'
X'31'	--	60	--	X'31'	X'31'
X'14'	--	61	--	X'14'	X'14'
X'43'	--	62	--	X'0E'	X'75'
X'44'	--	63	--	X'0F'	X'17'
X'45'	--	64	--	X'15'	X'60'
X'46'	--	65	--	X'17'	X'46'
X'47'	--	66	--	X'1B'	X'47'

X'48'	--	67	--	X'1E'	X'48'
X'49'	--	68	--	X'1F'	X'BD'
X'4A'	--	69	--	X'2A'	X'4A'
X'17'	--	6A	--	X'2B'	X'44'
X'33'	--	6B	--	X'33'	X'33'
X'2E'	--	6C	--	X'2E'	X'2E'
X'2F'	--	6D	--	X'2F'	X'2F'
X'08'	--	6E	--	X'08'	X'08'
X'18'	--	6F	--	X'18'	X'18'
X'4B'	--	70	--	X'38'	X'4B'
X'4C'	--	71	--	X'39'	X'7B'
X'4D'	--	72	--	X'3A'	X'76'
X'4E'	--	73	--	X'3B'	X'71'
X'4F'	--	74	--	X'3C'	X'61'
X'50'	--	75	--	X'3D'	X'50'
X'51'	--	76	--	X'3E'	X'77'
X'52'	--	77	--	X'3F'	X'72'
X'53'	--	78	--	X'7F'	X'53'
X'3D'	--	79	--	X'80'	X'3D'
X'34'	--	7A	--	X'34'	X'34'
X'2C'	--	7B	--	X'2C'	X'2C'
X'2D'	--	7C	--	X'2D'	X'2D'
X'12'	--	7D	--	X'12'	X'12'
X'11'	--	7E	--	X'11'	X'11'
X'13'	--	7F	--	X'13'	X'13'
X'54'	--	80	--	X'81'	X'7F'
X'80'	--	81	--	X'40'	X'80'
X'81'	--	82	--	X'41'	X'81'
X'82'	--	83	--	X'42'	X'82'
X'83'	--	84	--	X'43'	X'83'
X'84'	--	85	--	X'44'	X'84'
X'85'	--	86	--	X'45'	X'85'
X'86'	--	87	--	X'46'	X'86'
X'87'	--	88	--	X'47'	X'87'
X'88'	--	89	--	X'48'	X'88'
X'55'	--	8A	--	X'49'	X'0B'
X'56'	--	8B	--	X'82'	X'39'
X'57'	--	8C	--	X'4A'	X'36'
X'58'	--	8D	--	X'4B'	X'7A'
X'59'	--	8E	--	X'4C'	X'7E'
X'5A'	--	8F	--	X'4D'	X'5A'
X'5B'	--	90	--	X'4E'	X'0F'
X'89'	--	91	--	X'4F'	X'89'
X'8A'	--	92	--	X'50'	X'8A'
X'8B'	--	93	--	X'51'	X'8B'
X'8C'	--	94	--	X'52'	X'8C'
X'8D'	--	95	--	X'53'	X'8D'
X'8E'	--	96	--	X'54'	X'8E'
X'8F'	--	97	--	X'55'	X'8F'
X'90'	--	98	--	X'56'	X'90'
X'91'	--	99	--	X'57'	X'91'
X'5C'	--	9A	--	X'58'	X'5C'

X'5D'	--	9B	--	X'83'	X'5D'
X'5E'	--	9C	--	X'84'	X'5E'
X'5F'	--	9D	--	X'59'	X'5F'
X'60'	--	9E	--	X'5A'	X'45'
X'61'	--	9F	--	X'5B'	X'4F'
X'62'	--	A0	--	X'85'	X'62'
X'3B'	--	A1	--	X'37'	X'3C'
X'92'	--	A2	--	X'5C'	X'92'
X'93'	--	A3	--	X'5D'	X'93'
X'94'	--	A4	--	X'5E'	X'94'
X'95'	--	A5	--	X'5F'	X'95'
X'96'	--	A6	--	X'60'	X'96'
X'97'	--	A7	--	X'61'	X'97'
X'98'	--	A8	--	X'62'	X'98'
X'99'	--	A9	--	X'63'	X'99'
X'63'	--	AA	--	X'64'	X'63'
X'64'	--	AB	--	X'86'	X'49'
X'65'	--	AC	--	X'65'	X'65'
X'66'	--	AD	--	X'66'	X'66'
X'67'	--	AE	--	X'67'	X'67'
X'68'	--	AF	--	X'68'	X'68'
X'69'	--	B0	--	X'87'	X'69'
X'6A'	--	B1	--	X'88'	X'6A'
X'6B'	--	B2	--	X'89'	X'6B'
X'6C'	--	B3	--	X'8A'	X'6C'
X'6D'	--	B4	--	X'8B'	X'6D'
X'6E'	--	B5	--	X'8C'	X'6E'
X'6F'	--	B6	--	X'8D'	X'6F'
X'70'	--	B7	--	X'8E'	X'70'
X'71'	--	B8	--	X'8F'	X'4E'
X'72'	--	B9	--	X'90'	X'16'
X'73'	--	BA	--	X'69'	X'73'
X'74'	--	BB	--	X'6A'	X'BC'
X'75'	--	BC	--	X'6B'	X'43'
X'76'	--	BD	--	X'6C'	X'4D'
X'77'	--	BE	--	X'6D'	X'15'
X'78'	--	BF	--	X'6E'	X'9C'
X'0F'	--	C0	--	X'91'	X'5B'
X'A0'	--	C1	--	X'A0'	X'A0'
X'A1'	--	C2	--	X'A1'	X'A1'
X'A2'	--	C3	--	X'A2'	X'A2'
X'A3'	--	C4	--	X'A3'	X'A3'
X'A4'	--	C5	--	X'A4'	X'A4'
X'A5'	--	C6	--	X'A5'	X'A5
X'A6'	--	C7	--	X'A6'	X'A6'
X'A7'	--	C8	--	X'A7'	X'A7'
X'A8'	--	C9	--	X'A8'	X'A8'
X'79'	--	CA	--	X'92'	X'BB'
X'7A'	--	CB	--	X'93'	X'58'
X'7B'	--	CC	--	X'94'	X'4C'
X'7C'	--	CD	--	X'95'	X'7C'
X'01'	--	CE	--	X'01'	X'01'

Additional Definition for Extended LU1 Printers

X'02'	--	CF	--	X'02'	X'02'
X'0E'	--	D0	--	X'96'	X'41'
X'A9'	--	D1	--	X'A9'	X'A9'
X'AA'	--	D2	--	X'AA'	X'AA'
X'AB'	--	D3	--	X'AB'	X'AB'
X'AC'	--	D4	--	X'AC'	X'AC'
X'AD'	--	D5	--	X'AD'	X'AD'
X'AE'	--	D6	--	X'AE'	X'AE'
X'AF'	--	D7	--	X'AF'	X'AF'
X'B0'	--	D8	--	X'B0'	X'B0'
X'B1'	--	D9	--	X'B1'	X'B1'
X'7D'	--	DA	--	X'97'	X'7D'
X'7E'	--	DB	--	X'98'	X'59'
X'7F'	--	DC	--	X'99'	X'54'
X'03'	--	DD	--	X'03'	X'03'
X'04'	--	DE	--	X'04'	X'04'
X'05'	--	DF	--	X'05'	X'05'
X'15'	--	E0	--	X'1A'	X'3F'
X'9A'	--	E1	--	X'9A'	X'9A'
X'B2'	--	E2	--	X'B2'	X'B2'
X'B3'	--	E3	--	X'B3'	X'B3'
X'B4'	--	E4	--	X'B4'	X'B4'
X'B5'	--	E5	--	X'B5'	X'B5'
X'B6'	--	E6	--	X'B6'	X'B6'
X'B7'	--	E7	--	X'B7'	X'B7'
X'B8'	--	E8	--	X'B8'	X'B8'
X'B9'	--	E9	--	X'B9'	X'B9'
X'9B'	--	EA	--	X'9B'	X'9B'
X'9C'	--	EB	--	X'9C'	X'78'
X'9D'	--	EC	--	X'9D'	X'2B'
X'06'	--	ED	--	X'06'	X'06'
X'07'	--	EE	--	X'07'	X'07'
X'9E'	--	EF	--	X'9E'	X'9E'
X'20'	--	F0	--	X'20'	X'20'
X'21'	--	F1	--	X'21'	X'21'
X'22'	--	F2	--	X'22'	X'22'
X'23'	--	F3	--	X'23'	X'23'
X'24'	--	F4	--	X'24'	X'24'
X'25'	--	F5	--	X'25'	X'25'
X'26'	--	F6	--	X'26'	X'26'
X'27'	--	F7	--	X'27'	X'27'
X'28'	--	F8	--	X'28'	X'28'
X'29'	--	F9	--	X'29'	X'29'
X'BA'	--	FA	--	X'BA'	X'BA'
X'BB'	--	FB	--	X'BB'	X'79'
X'BC'	--	FC	--	X'BC'	X'74'
X'BD'	--	FD	--	X'BD'	X'64'
X'9F'	--	FE	--	X'9F'	X'9F'

2.5.2 TABLE 7 COUNTRIES

EBCDIC	'73 US ENGLISH	'76 AUS/GER	'70 AUS/GER	'73 NEW/NOR	'70 NEW/NOR	'73 FIN/SWE	'70 FIN/SWE	'73 FRENCH	'73 ITALIAN	'73S PORTUGAL	'73 SPANISH	'70 SPANISH	'76 UK	'73 BELGIAN	'73 BRAZIL	'73 SPAN SPK	'73 INT'L	'73 JAPAN EIG
41	0A								1B	1B			1B		1B	1B		
42	0B								16	19			16		19	16		
43	1C							2C	2C			1B						1B
44	1D																	15
45	1E									1A	1A							
46	1F			1B		16												
47	2A	3B	17															
48	2B	2D				1B		16	2D									
49	37											3B						3B
4A	1B	70	53	2C	9B	2B	53	38	38	0A	0A		1A	0A	7B	0A	0A	1C
4F	16	19		19		19		19	19	19				19	19		19	
51	38							1B	1B									
53	3A	36		36		36		36	36	36				36	36		36	
54	3C							3B			3B			3B		3B		
55	3E									0E								
5A	19	74	54	1F	9C	1F	9C	2B	4A	0B	0B			0B	1A	0B	0B	
5B	1A		74	BC	BC	BC	BC				1E	1E	1C		BD			1D
5F	36	3A		3A		3A		3A	3A	3A				3A	3A		3A	
64	45									0F					3D			
65	46									17					0F			
67	48							2D	0F					2D				
68	49							0E	0E					0E				
69	4A							0F	16					0F				
6A	17	53	2A	9B		53		4D	4C	46	5F			4D	9D	5F		
70	4B								3B									
71	4C								17									
72	4D							17	3D					17				
73	4E			3B		3B												
74	4F							15	15					15				
75	50	0F	13			0F	13											
78	53	17	1B			17	1B											
79	3D					5B			4D						45			
7B	2C		70	BA	BA	70	70	1C	1C	65	7F	7F			66	7F		
7C	2D	2B	73	BB	BB	73	73	48	2B	66				48	65			
7F	13		50		9A		50					5F						
80	54	0E	19															
90	5B					3D									0E			
9D	5F										17	13				17		

EBCDIC	'73 US ENGLISH	'76 AUS/GER	'70 AUS/GER	'73 DEN/NOR	'70 DEN/NOR	'73 FIN/SWE	'70 FIN/SWE	'73 FRENCH	'73 ITALIAN	'73S PORTUGAL	'73 SPANISH	'70 SPANISH	'76 UK	'73 BELGIAN	'75 BRAZIL	'73 SPAN SPK	'75 INTL	'73 JAPAN ENG
A1	3B	2A		4E		4E		3C	4B	9D	3C		37	3C		3C		37
AC	65									2C					2D			
AD	66									2D					2C			
B7	70	1B	2C			2C	2C											
BA	73	15	2D			2D	2D											
BB	74	16	1A															
C0	0F	50		9A		50		4A	48	45			4A	46				
CC	7B					15								1B				
D0	0E	54		9C		9C		49	49	3E			49	5B				
DC	7F										2C	2C				2C		
E0	15	73				7B		4F	4F	BD			4F					1A
E1	9A			0F	13													
EA	9B			17	1B													
EB	9C			0E	19	0E	19											
EC	9D									3B					17			
FA	BA			16	2C													
FB	BB			2D	2D													
FC	BC			1A	1A	1A	1A											
FD	BD									15					16			

Note: Use US English table as 'base'; i.e. for EBCDIC codes other than listed in the above table and also where blanks appear in the table.

SECTION 3. CONTROL UNIT TO DEVICE INTERFACE

3.0 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 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 3.0 (A) and 3.0 (B).)

The waveforms shown in 3.0 (A) and 3.0 (B) are signals measured across the coax at the transmitting unit (either control unit or device).

The waveforms shown in 3.0 (C) and 3.0 (D) show the signal across the coax at the receiving end of 5000 feet (1,524 metres) of coax.

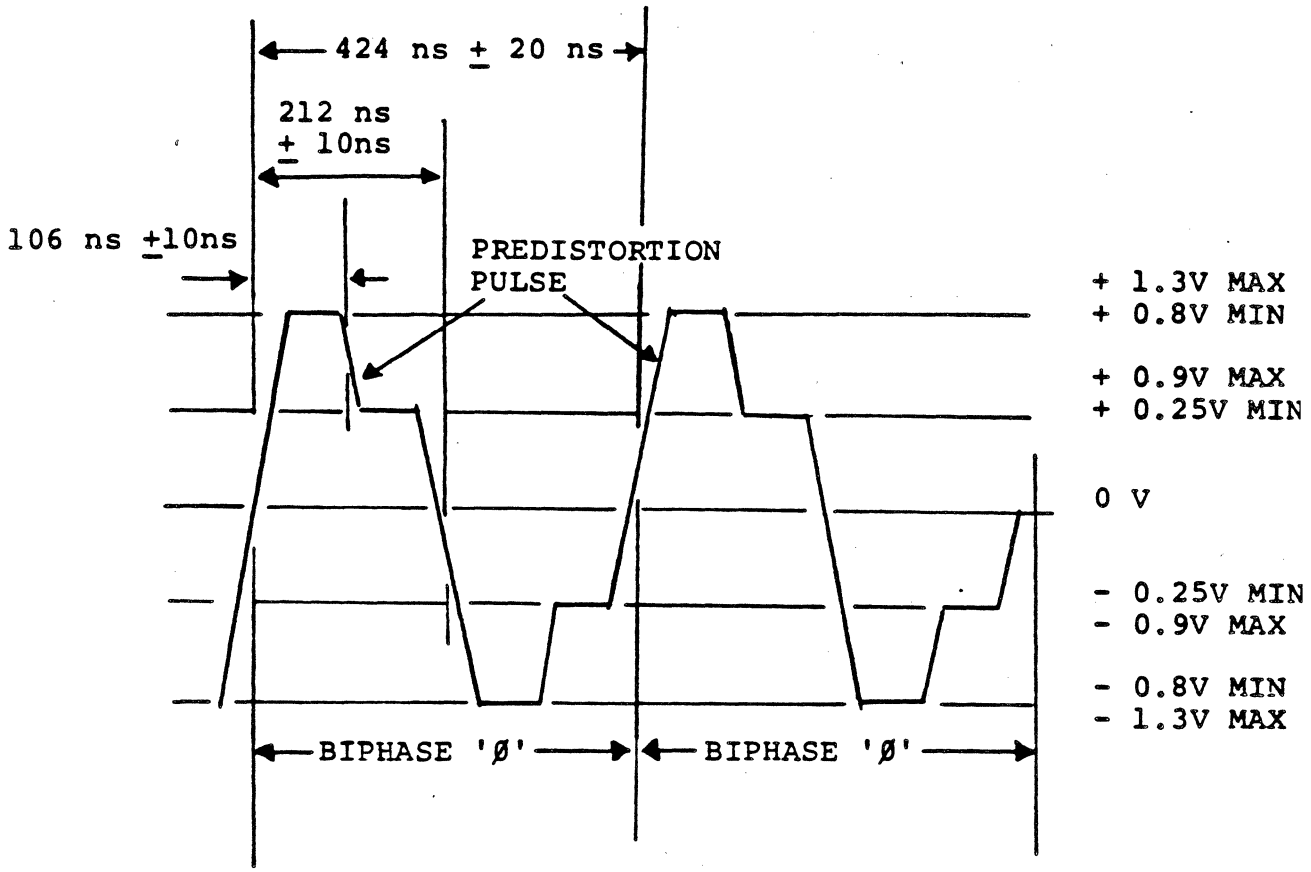


Figure 3.0 (A)

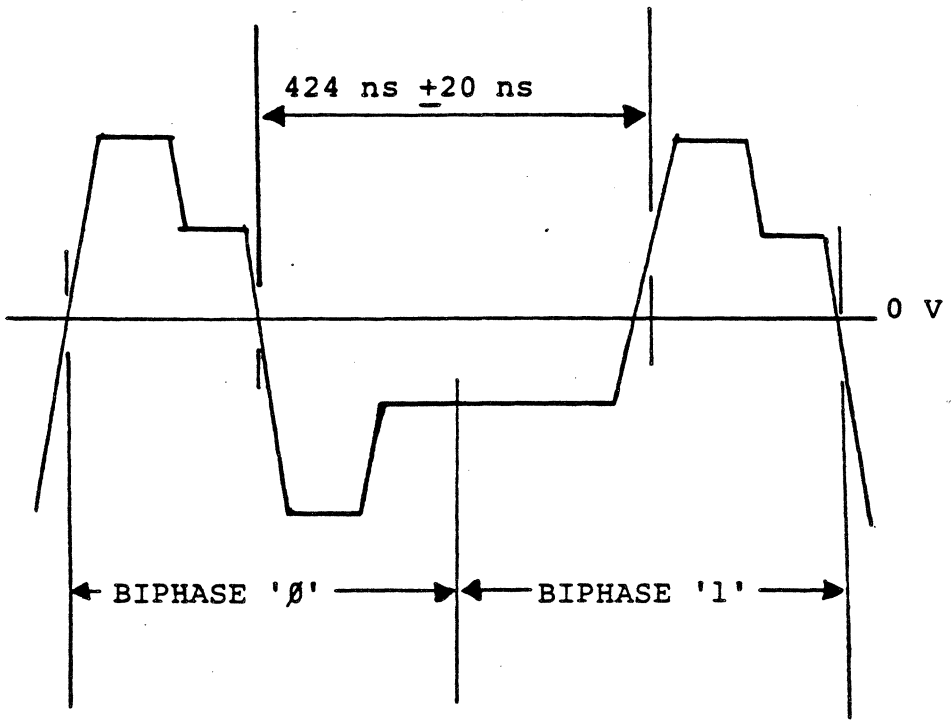


Figure 3.0 (B)

ALL RISE AND FALL TIMES 30 ns MAX.
RISE AND FALL TIMES ARE EXAGGERATED FOR CLARITY.

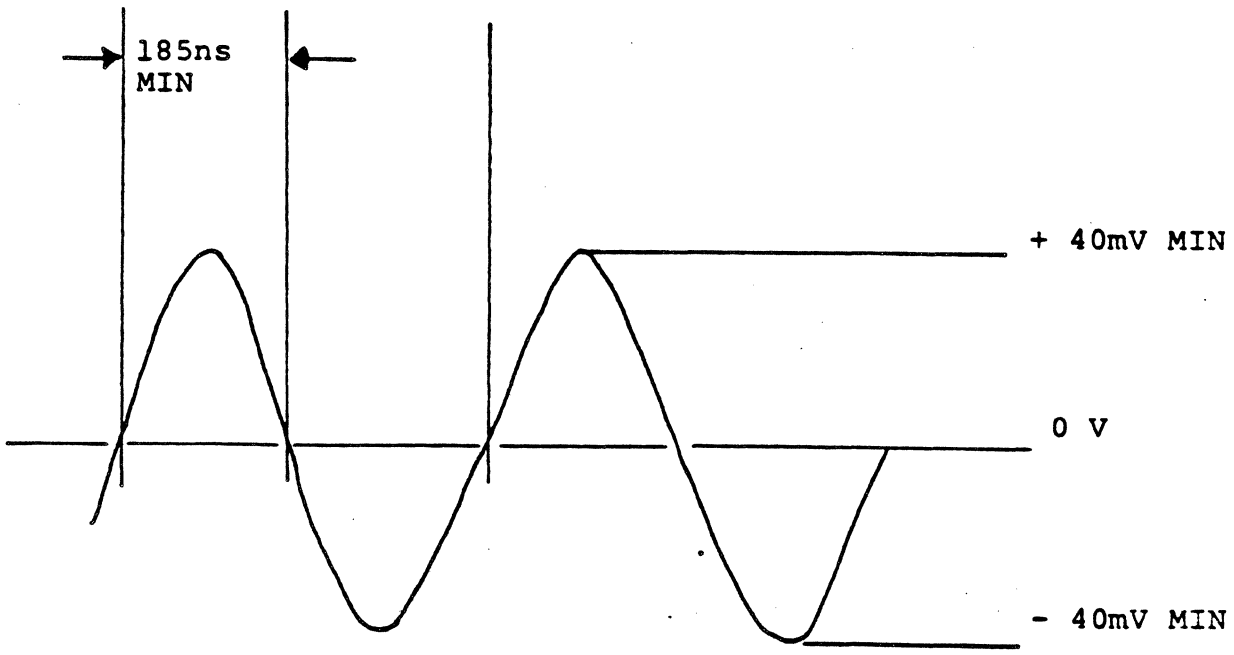


Figure 3.0 (C)

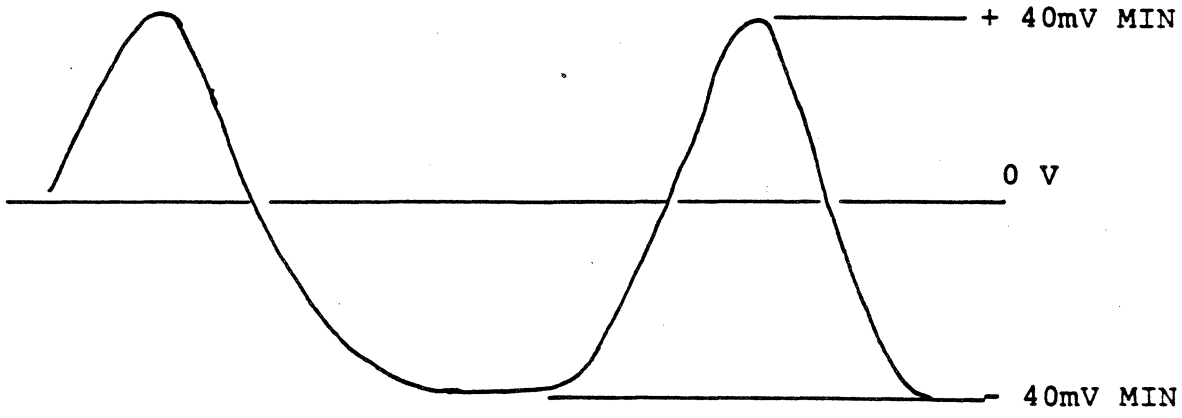


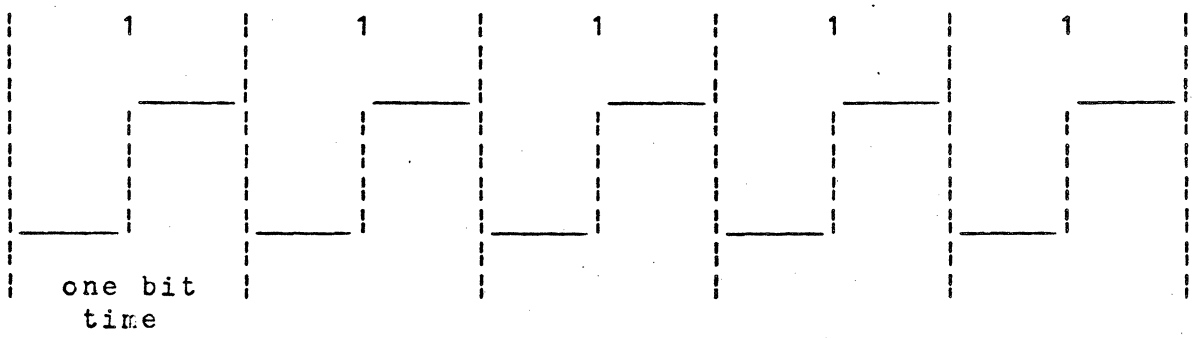
Figure 3.0 (D)

3.1 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.

3.2 LINE QUIESCE PATTERN

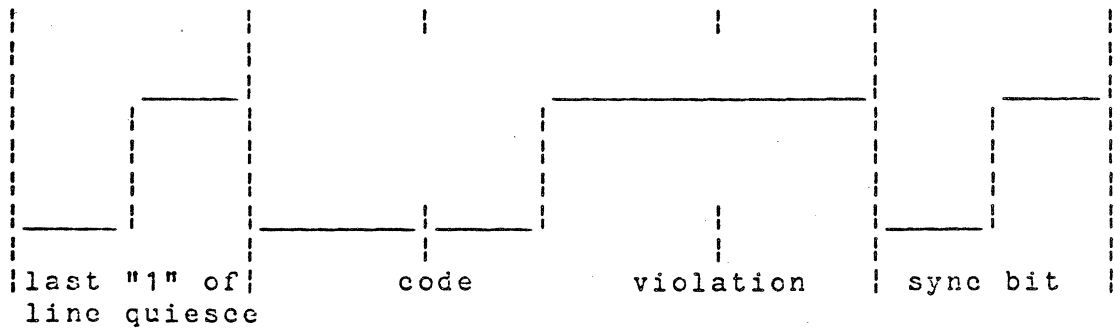
It is necessary to establish an equilibrium switching condition on the line after the null condition of line turn around before valid data can be properly detected at the receiver. Each data sequence from either control unit or device after line turn around will therefore be preceded with the following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



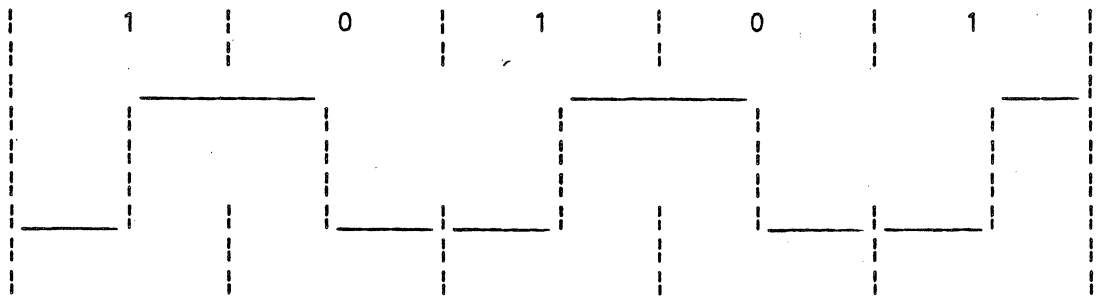
3.3 CODE VIOLATION

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 transmission.

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



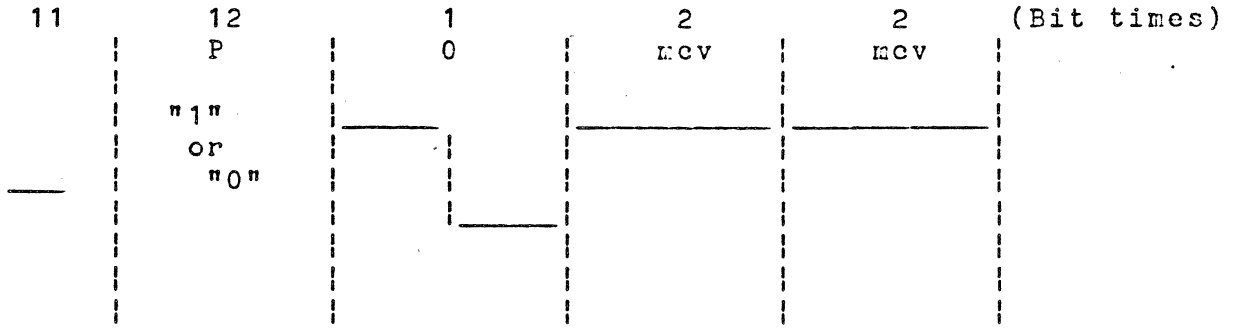
The trailing buffer bit is actually the sync bit of the following data byte. This code violation is unique in that it contains pulse widths (1 1/2 bit pulse widths) not present in normal biphase data (1/2 or 1 bit pulse widths) shown here for comparison.



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.

3.4 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:



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 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.

3.5 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 4. CODE POINTS

4.0 GENERAL

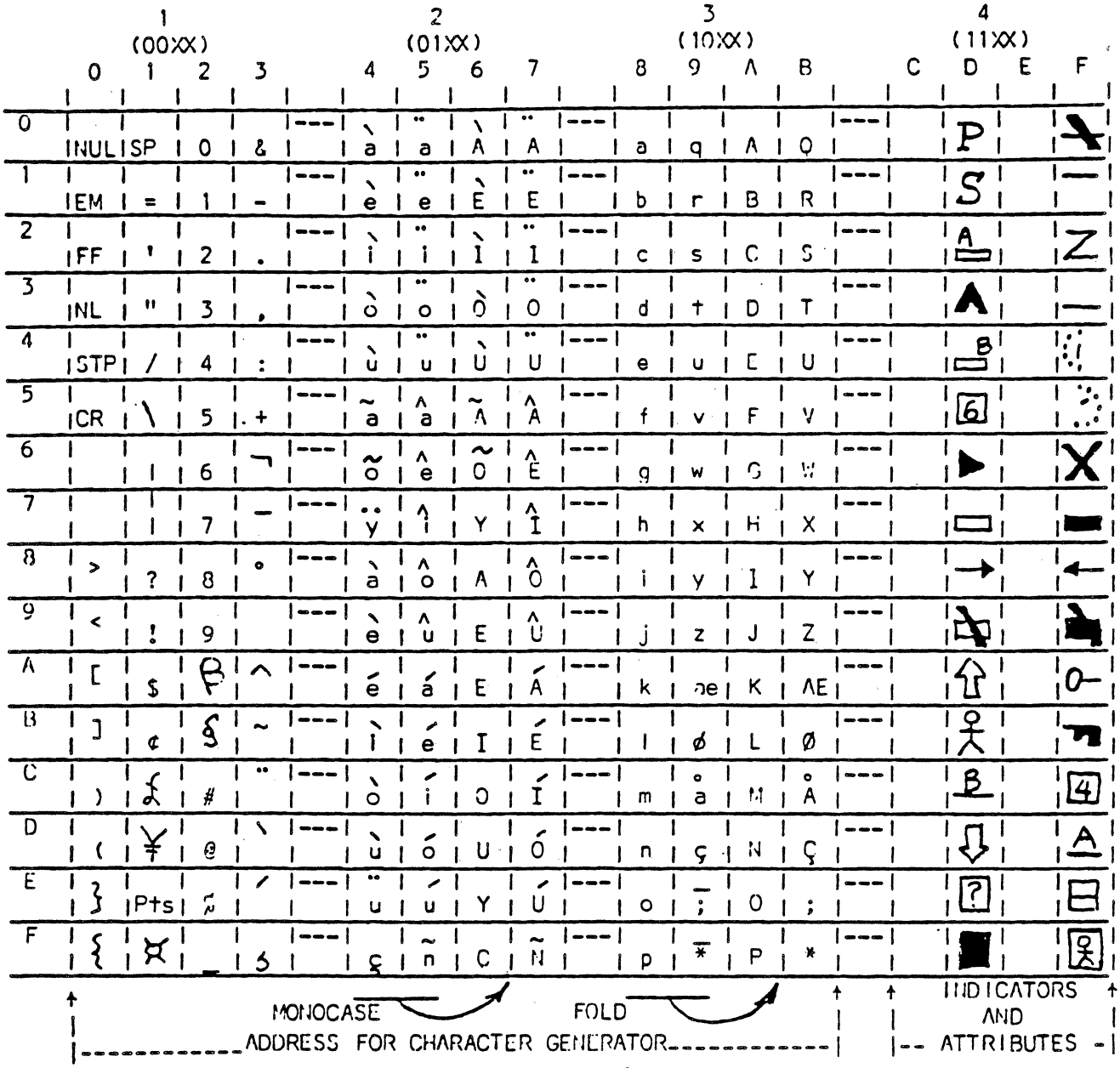
The code points described in this section are transmitted over the coax.

4.1 DEVICE BUFFER CODES

4.1.1 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), EBCDIC LU1 will be sent to printers (see Character Set Reference Manual).

4.1.1.1 Device Buffer Coding



Notes:

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

4.1.1.2 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	L	F
0	NUL	SP	0	&	81	92	A6	42		a	q	^				
1	EM	=	1	¯	82	93	A7	43		b	r	ß				
2	FF	'	2	.	83	94	A8	44		c	s	©				
3	NL	"	3	,	84	95	A9	45		d	t	®				
4	STP	/	4	:	85	96	AA	46		e	u	!				
5	CR		5	+	86	97	AC	47		f	v	£				
6			6	¬	87	98	AD	48		g	w	¢				
7			7	−	88	99	AE	49		h	x	¥				
8	>	?	8		89	9A	AF	51		i	y	[				
9	<	!	9		8A	9D	BA	52		j	z	]				
A		$			8C	9E	BB	53		k		~				
B					8D	9F	BC	54		l		L				
C	)	£	#		8E	A2	BD	55		m		"				
D	(	¥	@	\	8F	A3	BE	56		n		'				
E	}		%		90	A4	BF	58		o	—	?				
F	{		_		91	A5	41	7F		p	¯	P	*			

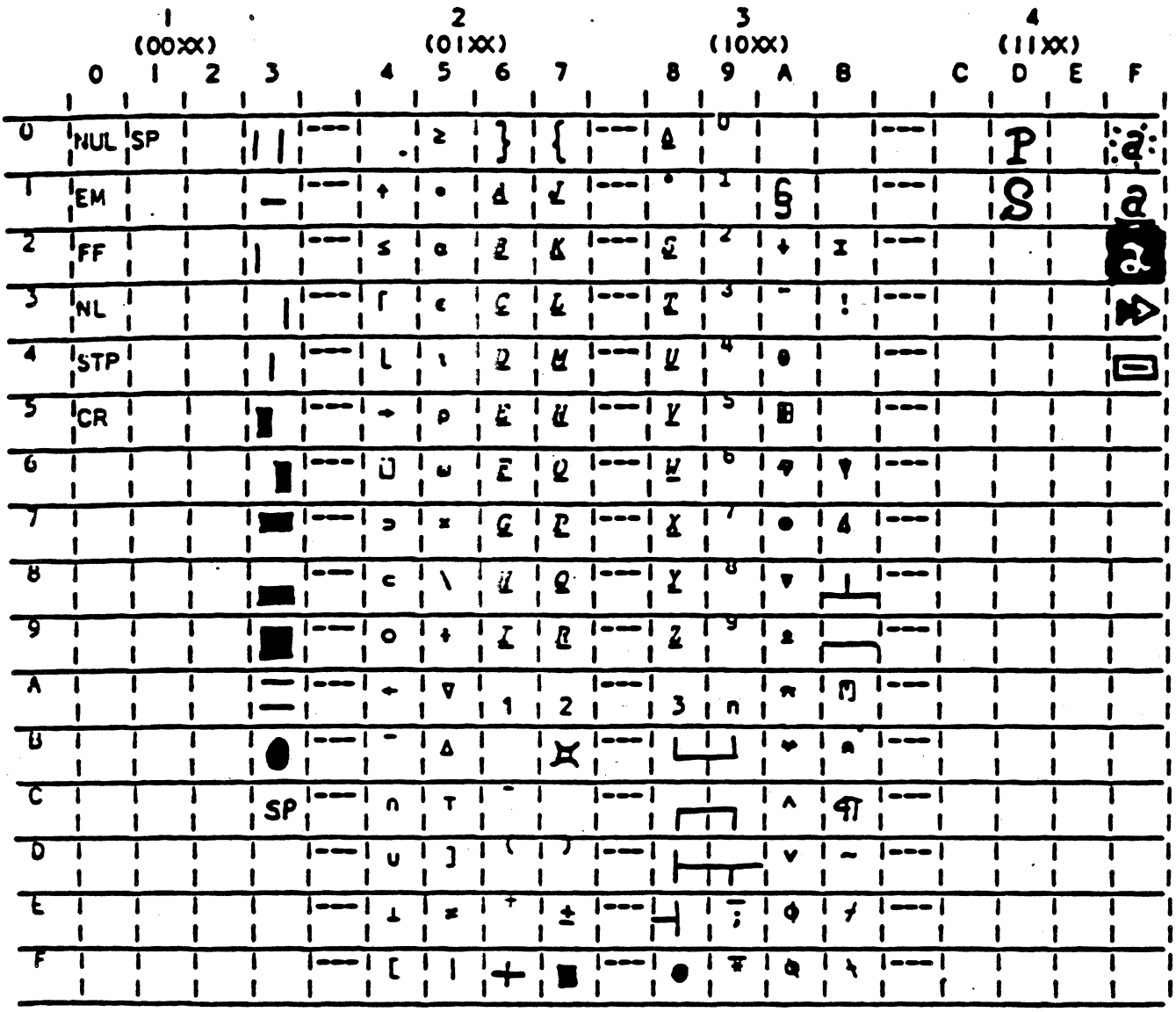
* EBCDIC CODES * — FOR KATAKANA — ADDRESS FOR CHARACTER (SEE ATTR)

* INDICATORS AND ATTRIBUTES *

SAME AS TABLE IV

NOTES: (1) Characters in locations 00 thru 3F display as blank.
(2) Codes Hex 9E and 9F are the Ñ and ñ characters.

4.1.1.3 DEVICE BUFFER CODING FOR APL



INDICATORS
(DISPLAYS ONLY)

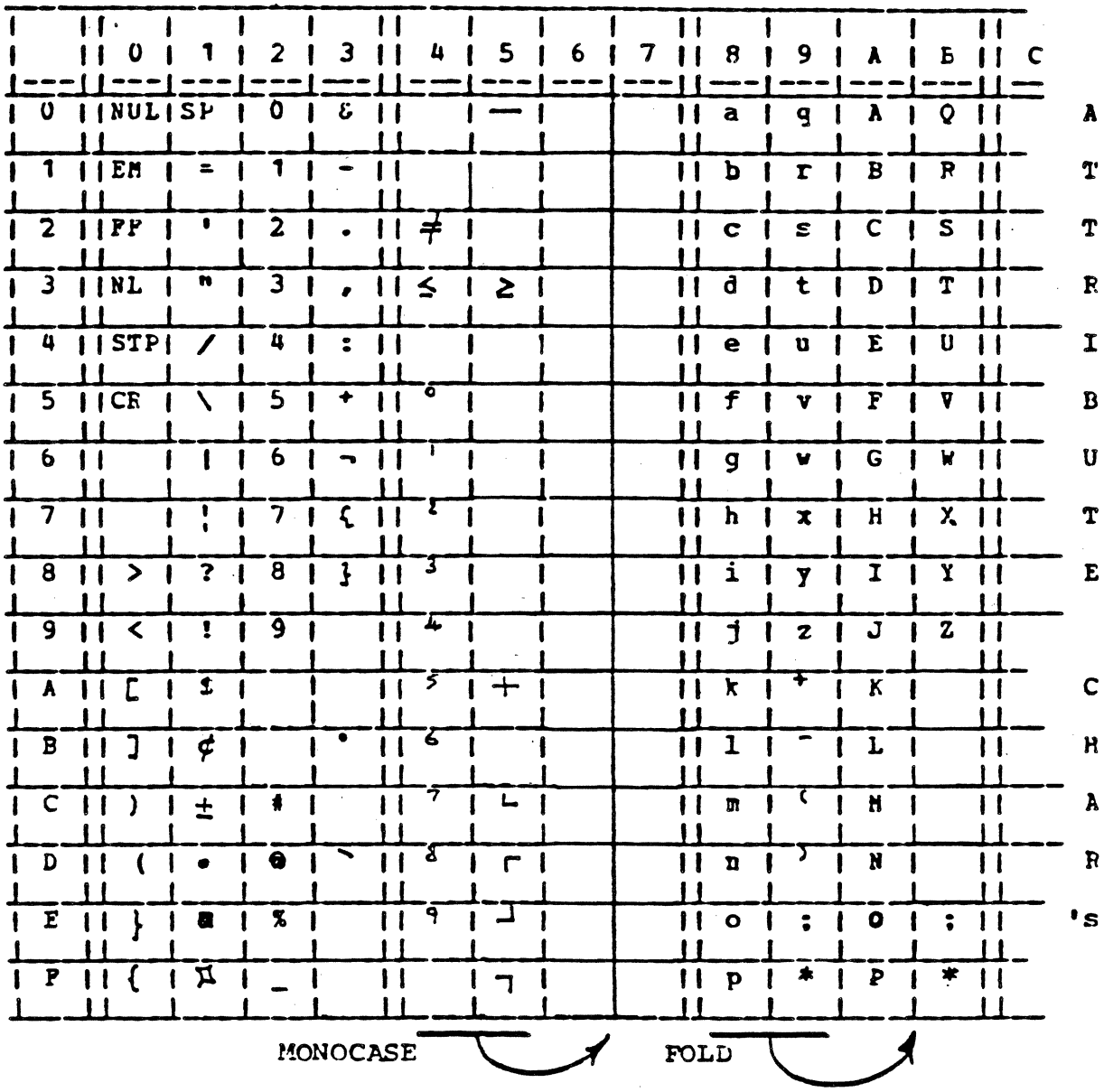
Note 1. Controllers will only transmit valid (filled in) code points. Devices may display/print whatever they please for 'blank' code points between '08' and 'BF'

2. Devices that support a subsed of APL will display/print hyphens for non-supported valid code points.

3. Devices with EAB but no APL/Text feature are required to support (display/print) the following EAB=001 code points: X'31', '3B', '3C', '9E' and '9F'. The display will also support '7F' and the Indicator (4th) quadrant.

Figure 4.1.1.4 BUFFER CODING FOR TN/ENGLISH

(3289 Printer with "Text Print Feature" only)



Note: The TN characters in columns 4,5, and 9 will print in both mono and dualcase modes.

4.1.2 Attribute Codes

An attribute is used to specify the characters 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
```

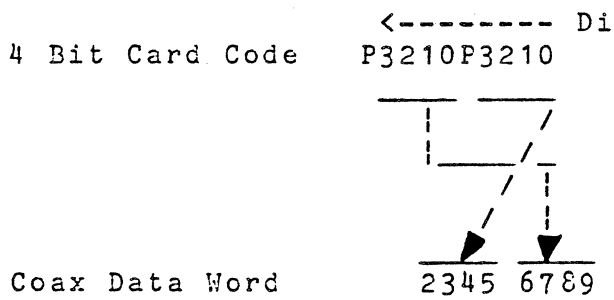
Bit 4	=0	Unprotected
	=1	Protected
Bit 5	=0	Alphanumeric
	=1	Numeric
Bits 4&5	=11	Auto Skip
Bits 6&7	=00	Normal display, nondetectable
	=01	Normal display, detectable
	=10	Bright display, detectable
	=11	Non display nondetectable, nonprint
Bit 8		Reserved. Used only by control unit
Bit 9		Modified Data Tag (MDT)

See paragraph 4.3 for Attribute Extension Codes

4.2 MAGNETIC STRIPE CARD CODES

The following magnetic stripe card codes will be honored by the Magnetic readers and stored by the feature for transmission to the control unit.

Magnetic Stripe characters are transmitted as follows:



For the character set used with Magnetic Readers, see the IBM 3270 Information Display System Description, GA27-2749, or the IBM 3270 Information Display System Character Set Reference, GA27-2837.

4.2.1 Magnetic Stripe Card Code-1, 10 Character (Numeric Only)

CHARACTER	HEX	BIT P3210	REMARKS
0	0	10000	
1	1	00001	
2	2	00010	
3	3	10011	
4	4	00100	
5	5	10101	
6	6	10110	
7	7	00111	
8	8	01000	
9	9	11001	
SPECIAL	A	11010	TRANSLATED, BY CONTROL UNIT, TO EBCDIC '7A
SPECIAL	B	01011	START SENTINEL (SS/RSS)
-------	C	11100	INVALID CHARACTER
SPECIAL	D	01101	FIELD SEPARATOR
------	E	01110	INVALID CHARACTER
SPECIAL	F	11111	END SENTINEL (ES)

4.3 ATTRIBUTE EXTENSION CODES

These code points are transmitted to and from the Extension Attribute Buffer (EAB). See paragraph 1.4.4.4. The EAB provides an additional byte of storage for each location in the main buffer. The EAB byte corresponding to a field attribute in the main buffer is interpreted as an Extended Field Attribute (bytes corresponding to characters are character attributes).

4.3.1 EXTENDED FIELD ATTRIBUTES

```
   DATA WORD BITS:
2 3 4 5  6 7 8 9  10
X X X X  X X X X  P
```

Bits 2,3	Reserved
Bits 4,5,6	Reserved
Bits 7,8,9	Reserved

4.3.2 CHARACTER ATTRIBUTES

```
   DATA WORD BITS:
2 3 4 5  6 7 8 9  10
X X X X  X X X X  P
```

Bits 2,3	Reserved
Bits 4,5,6	Reserved
Bits 7,8,9	Character Generation Selection:

000 Base Character Generator (184 char)
001 APL Character Generator (128 char)
010 through 111 Reserved

4.2.1 EXTENDED FIELD ATTRIBUTES

DATA WORD BITS:

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

Bits 2,3=00 Normal Mode
=01 Blink Character \ Interpreted as
=10 Reverse Video Character / 'normal' by type
=11 Underline Character 0001 printer

Bits 4,5,6 Character Colour
=000 Default to Base Colour
=001 Blue
=010 Red
=011 Pink/black
=100 Green
=101 Turquoise/black
=110 Yellow/black
=111 White/Black (unless tri-plane PS)

Bits 7,8,9 Character Generator Selection:
=000 Base ROS (184 character)
=001 APL ROS (128 character)
=010 PS 2 (191 character)
=011 PS 3 " "
=100 PS 4 " "
=101 PS 5 " "
=110 PS 6 " "
=111 PS 7 " "

4.2.2 CHARACTER ATTRIBUTES

DATA WORD BITS:

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

Bits 2,3=00 Revert to the EFA
=01 Blink Character \Interpreted as
=10 Reverse Video Character/'normal' by type
=11 Underline Character 0001 printer

Bits 4,5,6 Character Colour

=000 Revert to the EFA
=001 Blue
=010 Red
=011 Pink/black (Display/Printer)
=100 Green
=101 Turquoise/black
=110 Yellow/black
=111 White/Black (unless tri-plane PS)

Bit 7,8,9 Character Generator Selection:

=000 Revert to the EFA
=001 APL ROS (128 character)
=010 PS 2 (191 character)
=011 PS 3 " "
=100 PS 4 " "
=101 PS 5 " "
=110 PS 6 " "
=111 PS 7 " "

4.4 Keyboard Layouts

The following charts show the key number assignments for the 75 and 87 key alphanumeric keyboards. The 76 and 88 key typewriter keyboards are identical except for one additional key, number 51A, located on the third row between keys 51 and 52. The layouts of the modifiable keyboards are shown in Figures 4.4.3 and 4.4.4, Page 47.

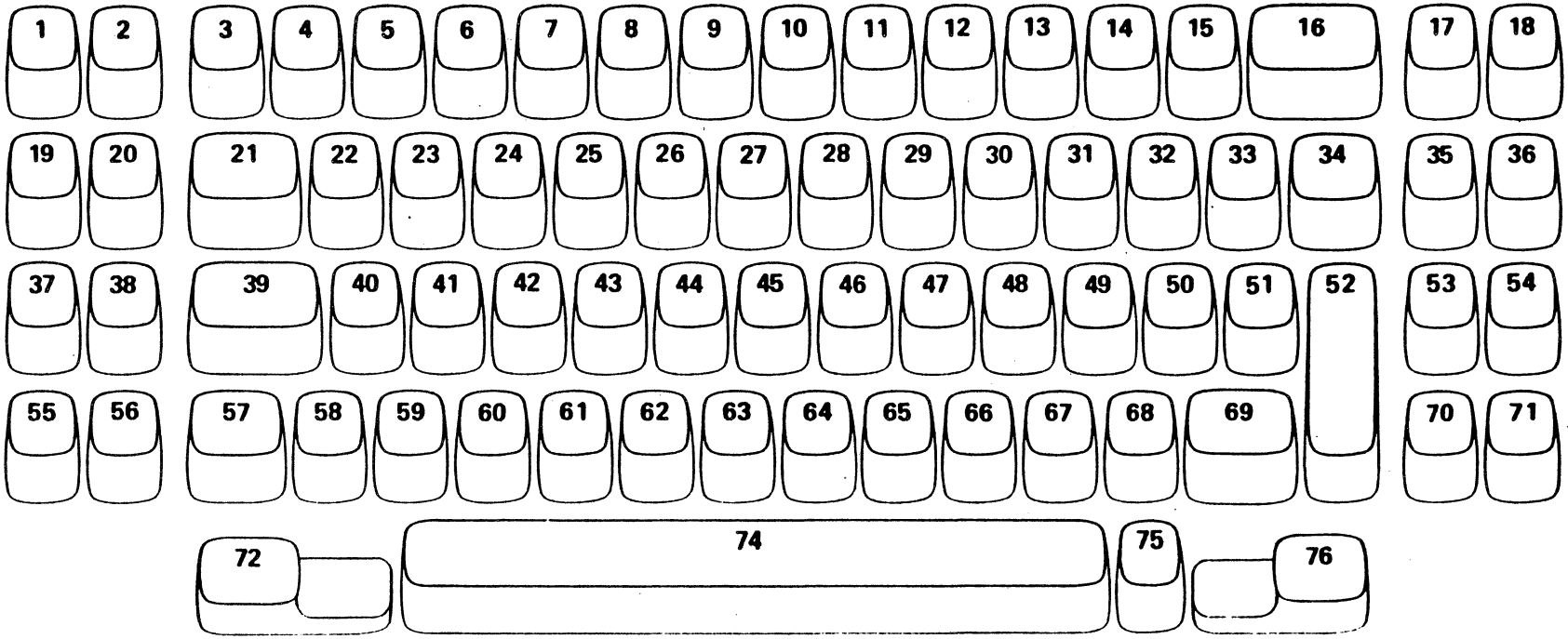
4.5 Keyboard Scan Codes

The following table lists the Scan Codes that are generated by all alphanumeric keyboards (including Katakana) 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. The scan codes are returned by the 122 (124 Katakana) key modifiable keyboards are shown in table 4.5.1, page 44.1. Keys that emit on "break" as well as "make" return "F0" followed by their assigned scan code on "break."

Key # (Coax bit position):	Hex	Scan Code 2345 6789	Key #	Hex	Scan Code 2345 6789
1	50	0101 0000	45	67	0110 0111
2	51	0101 0001	46	69	0110 1001
3	3D	0011 1101	47	6A	0110 1010
4	21	0010 0001	48	6B	0110 1011
5	22	0010 0010	49	7E	0111 1110
6	23	0010 0011	50	12	0001 0010
7	24	0010 0100	51	0F	0000 1111
8	25	0010 0101	51A	1D	0001 1101
9	26	0010 0110	52	08	0000 1000
10	27	0010 0111	53	0E	0000 1110
11	28	0010 1000	54	13	0001 0011
12	29	0010 1001	55	56	0101 0110
13	20	0010 0000	56	57	0101 0111
14	30	0011 0000	57	4D	X100 1101
15	11	0001 0001	58	09	0000 1001
16	31	0011 0001	59	79	0111 1001
17	5F	0101 1111	60	77	0111 0111
18	5E	0101 1110	61	62	0110 0010
19	52	0101 0010	62	75	0111 0101
20	53	0101 0011	63	61	0110 0001
21	36	0011 0110	64	6D	0110 1101
22	70	0111 0000	65	6C	0110 1100
23	76	0111 0110	66	33	0011 0011
24	64	0110 0100	67	32	0011 0010
25	71	0111 0001	68	14	0001 0100
26	73	0111 0011	69	4E	X100 1110
27	78	0111 1000	70	16	0001 0110
28	74	0111 0100	71	1A	0001 1010
29	68	0110 1000	72	34	0011 0100
30	6E	0110 1110	73	NOT USED	
31	6F	0110 1111	74	10	0001 0000
32	1B	0001 1011	75	4F	X100 1111
33	15	0001 0101	76	18	0001 1000
34	35	0011 0101	77	40	0100 0000
35	0C	0000 1100	78	41	0100 0001
36	0D	0000 1101	79	42	0100 0010
37	54	0101 0100	80	43	0100 0011
38	55	0101 0101	81	44	0100 0100
39	4C	X100 1100	82	45	0100 0101
40	60	0110 0000	83	46	0100 0110
41	72	0111 0010	84	47	0100 0111
42	63	0110 0011	85	48	0100 1000
43	65	0110 0101	86	49	0100 1001
44	66	0110 0110	87	4A	0100 1010
			88	4B	0100 1011

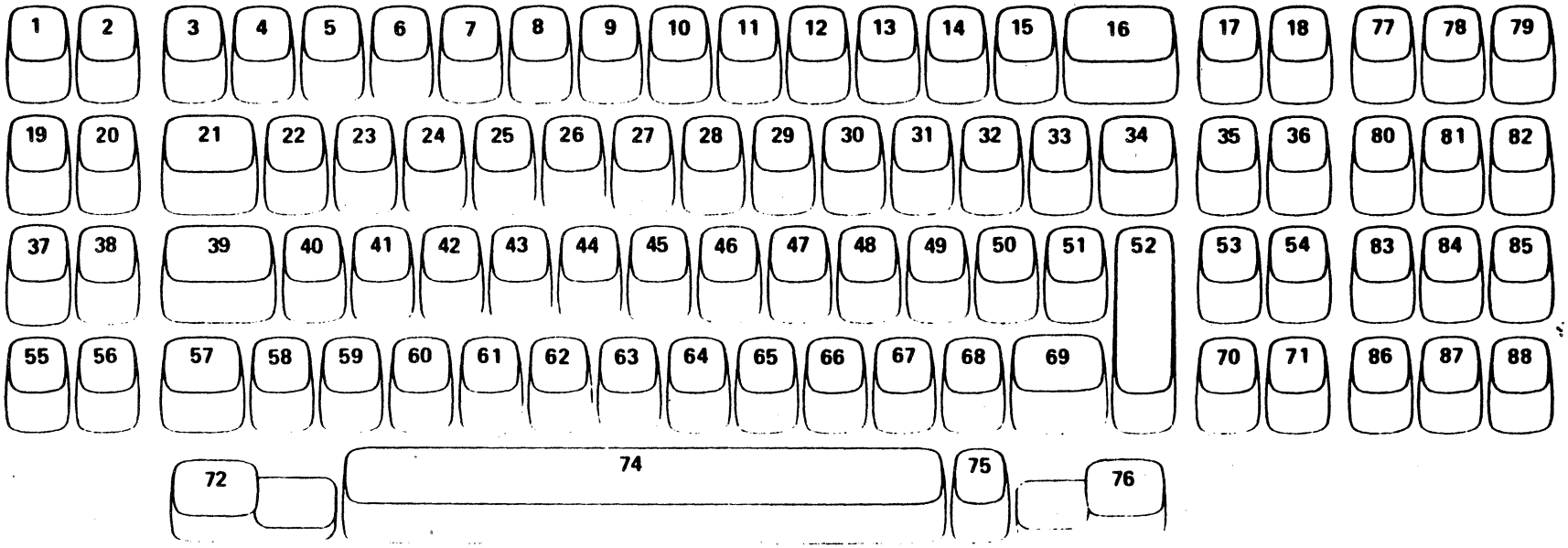
4.5.1 KEY SCAN CODES IN HEX (For both 122 and 124 layouts)

Key	Code	Key	Code	Key	Code	Key	Code	Key	Code
1	0E	33	23	67	0B	103	7A		
2	16	34	2B	68	0A	104	71		
3	1E	35	34	69	09	105	84		
4	26	36	33	70	05	106	7C		
5	25	37	3B	71	04	107	7B		
6	2E	38	42	72	03	108	79		
7	36	39	4B	73	83	109	78		
8	3D	40	4C	74	01	110	07		
9	3E	41	52	75	67	111	0F		
10	46	42	53	76	64	112	17		
11	45	43	5A	78	61	113	1F		
12	4E	44	12	80	6E	114	27		
13	55	45	13	81	65	115	2F		
14	5D	46	1A	82	63	116	37		
15	66	47	22	83	62	117	3F		
16	0D	48	21	84	60	118	47		
17	15	49	2A	85	6F	119	4F		
18	1D	50	32	86	6D	120	56		
19	24	51	31	88	6A	121	5E		
20	2D	52	3A	90	76	122	08		
21	2C	53	41	91	6C	123	10		
22	35	54	49	92	6B	124	18		
23	3C	55	4A	93	69	125	20		
24	43	56	51	94	68	126	23		
25	44	57	59	95	77	127	30		
26	4D	58	11	96	75	128	38		
27	54	60	19	97	73	129	40		
28	5B	61	29	98	72	130	4B		
29	5C	62	39	99	70	131	50		
30	14	64	58	100	7E	132	57		
31	1C	65	06	101	7D	133	5F		
32	1B	66	0C	102	74				



Key 51A For Katakana Only.

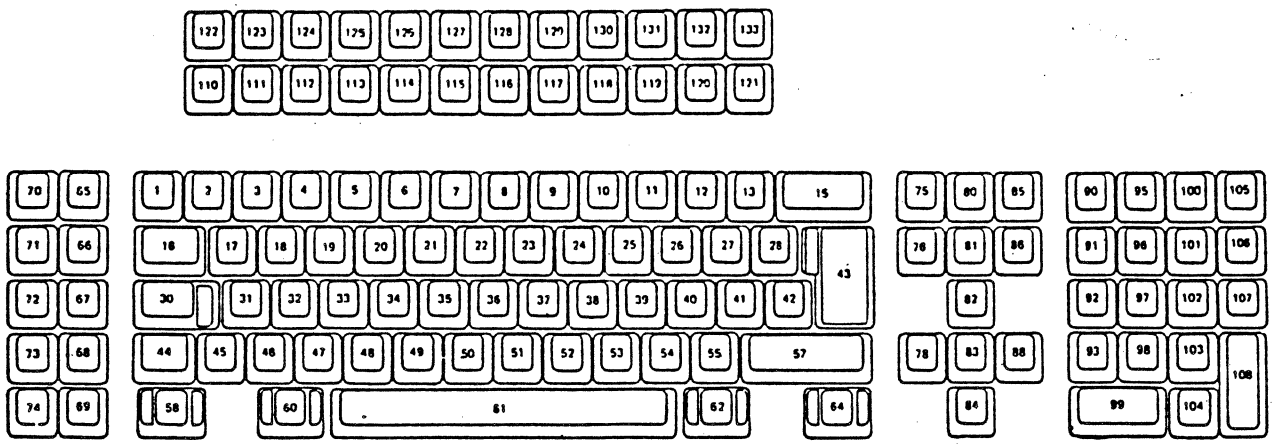
Located between keys 51 and 52.



Key 51A For Katakana Only.

Located between keys 51 and 52.

4.4.3 122 Key Modifiable Keyboard (Typewriter and Data Entry)



4.4.4 124 Key Modifiable Keyboard (Typewriter and Data Entry)