

**5250 Information Display System
to System/36, System/38, and Application System/400
System Units
Product Attachment Information**

October 1989

Preface

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References to Other IBM Manuals

For information on physical planning (including detailed cabling and switch setting), and for information on system limitations, see *IBM 5250 Information Display System Planning and Site Preparation Guide*, GA21-9337, *IBM System/36 Information Directory*, SC21-9015, *Attaching Work Station and Communication Cables to the AS/400*, SA21-9957, *Planning Guide - 9404*, GA21-9914, and *Planning Guide - 9406*, GA21-9913.

For information concerning the IBM Cabling System, see *Using the IBM Cabling System with Communication Products*, GA27-3620, and the *IBM Cabling System Planning and Installation Guide*, GA27-3361.

For information concerning Telephone Twisted Pair cabling, see *IBM 5299 Terminal Multiconnector Model 3 Planning, Setup, and Maintenance Guide*, GA27-3729.

IBM System/36 Systems Reference Manual, SC21-9020, contains information about work stations. This information includes:

- The physical characteristics of the work station; that is, a description of the keys, switches, lights, and indicators.
- The operational characteristics of the work stations; that is, the function of the keys, the operator aids, and the work station modes.

IBM System/36 Functions Reference Manual, SA21-9436, contains information about work stations, printers, and data streams.

IBM System/38 Service Guide, SY31-0523, contains information on configuring workstations and printers on the IBM System/38.

Device Configuration Guide, SC21-8106, contains information on configuring twinax workstations and printers on the IBM AS/400.

ASCII Work Station Planning and Configuring - 9404, SC21-9797, and *ASCII Work Station Reference -9404*, SA21-9922, contain information on configuring ASCII workstations and printers on the IBM AS/400.

IBM System/38 Work Station Controller Attachment Theory and Maintenance, SY31-0535, contains information on cabling and device addressing for the IBM System/38.

IBM System/38 Work Station Controller Extended Attachment Theory and Maintenance, SY31-0656, contains information on cabling and device addressing for the IBM System/38 using the extended work station controller.

IBM 5250 Information Display System Functions Reference Manual, SA21-9247 contains information about the following.

- Data streams for 5250 type devices, including the graphics orders for the 5292 model 2
- SNA (Systems Network Architecture) as used in the IBM 5251 Model 12, SDLC (Synchronous Data Link Control), and cabling considerations for attaching work stations to the Cluster Feature of the 5251 Model 12
- information similar to that listed above for the System/36 System Reference manual but for work stations attached to a system via a 5251 Model 12 and a communications link using SNA/SDLC

IBM Systems Network Architecture Concepts and Products manual, GC30-3072 presents an overview of SNA including basic descriptions of terminology, concepts, and scope.

IBM Synchronous Data Link Control General Information manual, GA27-3093 describes the procedures that comprise SDLC. It includes material to familiarize the reader with terminology and concepts of SDLC. This is followed by a catalog of the components of SDLC and representative examples of their uses.

The following contain standards information about attaching ASCII devices to the AS/400 9404 system unit.

- *EIA Standard RS-232C*
- *EIA Standard RS-422A*

- *ANSI X3.4-1977, American National Standard Code for Information Interchange*
- *ANSI X3.64-1979, Additional Controls for Use with ASCII*

IBM Systems Network Architecture Format and Protocol Reference Manual: Architectural Logic, SC30-3112, contains information about SNA that allows development and design of products or programs that function within an SNA network.

The following contain information about attaching an IBM Personal Computer with the 5250 emulation feature to an IBM host system such as the S/36.

- *Enhanced 5250 Emulation Program User's Guide*, G570-2202
- *Enhanced Display Station Emulation Adapter Hardware Maintenance and Technical Reference*, G570-2200
- *5250 Emulation Program User's Guide*, part number 6092654
- *Display Station Emulation Adapter Hardware Maintenance and Technical Reference*, part number 7034652

IBM 4224 Product and Programming Description, GC31-2551, contains information about the 4224 printer and its data stream.

IBM 4234 Printer Product and Programming Manual, GC31-2554, contains information about the 4234 printer and its data streams.

IBM 5262 Printer Model 1 Description, GA24-3975, contains information about the 5262 printer and its data streams.

IBM 4214 Printer Model 2 Product Description, GC31-2582, contains information about the 4214 printer and its data streams.

IBM 5219 Printer Models D01/D02 Programmer's Reference Guide, GA23-1025, contains information about the 5219 printer and its data streams.

IBM 5250 Information Display System Introduction, GA21-9246, is an introduction to the 5250 device family.

For information on the 3180 model 2, see *IBM 3180 Display Station Model 2 User's Guide*, GA21-9469.

For information on using the 3812 printer, see

- *Using the IBM Pageprinter 3812 with an IBM System/36 or System/38*, S544-3343.
- *IBM 3812 Pageprinter Programming Reference*, S544-3268. This manual describes the interface between the 3812 and the IBM PC. It includes descriptions of the primitive commands.
- *Using the IBM S/36 Printer Application Program Interface PRPQ (PRPQ P84073, (5799-BYX))*, shipped with the PRPQ

For information on the IBM 3196 display station, see *IBM 3196 Display Station User's Guide*, GA18-2482.

For information on the IBM 4210 printer, see *IBM 4210 Printer Guide to Operations*, SC31-3783, and *IBM 4210 Printer Product and Programming Description*, SC31-3784. The Product and Programming Description contains information on the printer controls and character sets supported.

For information on the 3197 Display and its associated printers, see

- *IBM 3197 Model D Display Station User's Guide*, GA18-2545.
- *IBM 3197 Model C Color Display Station User's Guide*, GA18-2559.
- *IBM 3197 Model W Display Station User's Guide*, GA18-2790.

For information on the 5209 3270-5250 Link Protocol Converter, see

- *IBM 5209 Model 1 3270-5250 Link Protocol Converter User's Guide*, SA21-9869
- *5209 3270-5250 Link Protocol Converter to Device Product Attachment Information*

For information on the 5208 ASCII-5250 Link Protocol Converter, see

- *IBM 5208 Model 1 ASCII-5250 Link Protocol Converter User's Guide*, SA21-9870.

For information on the 5259 Migration Data Link, see

- *IBM 5259 Migration Data Link User's Guide*, SA21-9551.

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1.0 Physical Characteristics of the Twinaxial Cable

In addition to Twinaxial Cable, the System/36, System/38, and AS/400 also support the IBM Cabling System and Telephone Twisted Pair media in attachment of WSC I/O devices.

For information concerning the IBM Cabling System or the IBM 5299 Terminal Multiconnector for Telephone Twisted Pair cabling and how to use them for Twinaxial Cable Applications, see *Using the IBM Cabling System with Communication Products*, GA27-3620, or *IBM 5299 Terminal Multiconnector Model 3 Planning, Setup, and Maintenance Guide*, GA27-3749.

1.1 Cabling Considerations

- A System Unit is a:
 - 5360, 5362, 5363, or 5364 for System/36
 - 5381 or 5382 for System/38
 - 9404 or 9406 for AS/400
- A maximum of seven work stations may be attached to a port on the System Unit when the Cable Through feature is installed on the workstations (except possibly for the last workstation on the port). The work stations are attached to the System Unit with a twinaxial cable.
- The maximum twinaxial cable length on any system port is 1525 meters (5000 feet).

For Telephone Twisted Pair media, see *IBM 5299 Terminal Multiconnector Model 3 Planning, Setup, and Maintenance Guide*, GA27-3749, for maximum cable lengths.

- The cables cannot be spliced. Instead of splicing, use a quick-disconnect adapter (IBM part number 7362230), Amphenol part number 82-5588, or equivalent. The adapter and the attached cable connectors should be covered with shrink tubing to prevent them from touching ground or some noise source.
- The total number of cable junctions (quick-disconnect adapter and units) installed on a line cannot be more than eleven. This includes the junction at the System Unit. A unit on the line counts as one junction.
- The cable shield must be grounded to the System Unit and to each work station. In addition, the shield continuity must be maintained through the entire line; that is, from the System Unit through the cables, the adapters, and the work stations.

- The polarity of the line must be maintained through the entire line. For line continuity and polarity reversal tests, see *IBM 5250 Information Display System Planning and Site Preparation Guide*, GA21-9337.
- The line must be terminated at the end of the line. For example, if three work stations are attached to the same line (multidrop), the work station farthest from the System Unit would have to be terminated. To terminate the line, attach a 54.9 ohm ($\pm 1\%$) resistor from each conductor to the shield.

In addition to the above considerations, no noise can be put on line that might be interpreted as data when turning power on or off on the work station.

For specifications and physical characteristics of the twinaxial cable, refer to *IBM 5250 Information Display System Planning and Site Preparation Guide*, GA21-9337.

1.1.1 System/36 Cabling Considerations

For correct operation of the work stations, you must consider each of the following for the twinaxial cables. For the System/36, a System Unit is the 5360, 5362, 5363, or 5364.

- Up to six work stations can be locally attached to the 5360 System Unit without the work station expansion feature. With the work station expansion feature, 36 workstations may be locally attached. When the two workstation controller feature is installed, 72 workstations may be locally attached. When the extended input fields feature is selected, 18 workstations may be attached locally with the workstation expansion feature, or 36 with the two workstation controllers feature.
- Up to six work stations can be locally attached to the 5362 System Unit without the work station controller feature. With the work station controller feature, 28 workstations may be locally attached. When the extended input fields feature is selected, three workstations may be attached locally without the work station controller feature, or 18 with the workstation controller feature.
- Up to sixteen work stations can be locally attached to the 5363 System Unit without the work station controller feature. With the work station controller feature, 28 workstations may be locally attached. When the extended input fields feature is selected, nine workstations may be attached locally without the work station controller feature, or 18 with the workstation controller feature.
- Up to sixteen work stations can be locally attached to the 5364 System Unit. When the extended input fields feature is selected, nine workstations may be attached locally.

See *IBM System/36 Planning to Set Up Your Computer*, SA21-9439, for system limitations.

1.1.2 System/38 Cabling Considerations

For the System/38, a System Unit is the 5381 or 5382.

The System/38 has two workstation controllers.

- Work Station Controller (WSC)
- Work Station Controller Extended

The Work Station Controller permits direct connection of Work Station Displays and printers to the System/38. One Work Station Controller supports any combination of printers and displays up to a maximum of 20. The System/38 has a maximum configuration of 4 Work Station Controllers permitting a total of 80 devices to be connected.

See *IBM System/38 Service Guide*, SY31-0523, for information on which devices may be attached to the Work Station Controller. Not all devices that may be attached to the Work Station Controller Extended may be attached to the Work Station Controller.

The Work Station Controller Extended permits direct connection of Work Station Displays and printers to the System/38. One Work Station Controller Extended supports any combination of printers and displays up to a maximum of 32. The System/38 has a maximum configuration of 8 Work Station Controller Extended controllers permitting a total of 256 devices to be connected.

See *IBM System/38 Service Guide*, SY31-0523, for information on which devices may be attached to the Work Station Controller Extended. Not all devices that may be attached to the Work Station Controller may be attached to the Work Station Controller Extended.

1.1.3 AS/400 Cabling Considerations

For the AS/400, a System Unit is the 9404 or 9406.

| *AS/400 Release 1.0*

- | • The 9404 model B10 and B20 has a maximum configuration of 1 work station controller permitting a total of 40 devices to be connected.
- | • The 9406 model B30 has a maximum configuration of 3 work station controllers permitting a total of 120 devices to be connected.
- | • The 9406 model B40 has a maximum configuration of 5 work station controllers permitting a total of 200 devices to be connected.
- | • The 9406 model B50 has a maximum configuration of 8 work station controllers permitting a total of 320 devices to be connected.
- | • The 9406 model B60 has a maximum configuration of 12 work station controllers permitting a total of 480 devices to be connected.

| *AS/400 Release 2.0*

- | • The 9404 model B10 has a maximum configuration of 1 work station controller permitting a total of 40 devices to be connected.
- | • The 9404 model B20 has a maximum configuration of 2 work station controllers permitting a total of 80 devices to be connected.
- | • The 9406 model B30 and B35 has a maximum configuration of 4 work station controllers permitting a total of 160 devices to be connected.

- | • The 9406 model B40 and B45 has a maximum configuration of 6 work station controllers permitting a total of 240 devices to be connected.
- | • The 9406 model B50 has a maximum configuration of 10 work station controllers permitting a total of 400 devices to be connected.
- | • The 9406 model B60 has a maximum configuration of 15 work station controllers permitting a total of 600 devices to be connected.
- | • The 9406 model B70 has a maximum configuration of 20 work station controllers permitting a total of 800 devices to be connected.

See *Planning Guide - 9404*, GA21-9914, and *Planning Guide - 9406*, GA21-9913 for additional information.

1.2 Electrical Interface

All information is transmitted between the work stations and the controller in the System Unit on the twinaxial cable. A one (1) bit on the twinaxial cable appears as a positive-going signal followed by a negative-going signal, and a zero (0) bit appears as a negative-going signal followed by a positive-going signal. See Figure 1 on page 6 for an example of a signal transmitted on the cable.

The transmission bit rate is 1 megahertz ($\pm 2\%$). With this rate, 1 microsecond is required for each bit, and 16 microseconds are required for each frame. For a description of the frame, see 1.3, "Description of Bit Stream" on page 5.

Note: The 3196 display station uses a slightly different transmission bit rate (1.0368 megahertz $\pm 0.01\%$). See 13.0, "3196 Interface" on page 221 for more information. All devices that will be attached to a twinaxial cable that is also attached to a 3196 device must be able to handle the data transmission rate of the 3196.

1.3 Description of Bit Stream

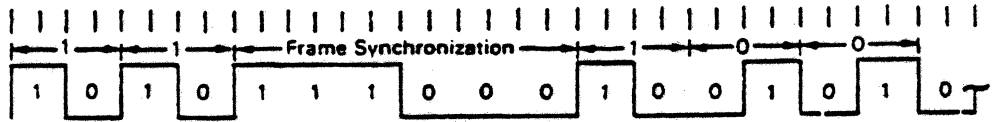
The bit stream is serially transmitted to (or received from) the System Unit; it contains a bit synchronization pattern, a frame synchronization pattern, and a frame. The bit and frame synchronization patterns establish synchronization between the work stations and the system unit, and are transmitted prior to transmitting the first frame. A bit synchronization pattern has a half-bit binary configuration of 1010101010, and a frame synchronization pattern has a half-bit binary configuration of 111000.

The frame is the unit of information used to transmit all data, all commands, and all status between the work stations and the system unit. It is 16 bits long as shown in Figure 3 on page 8 and as described below. Notice that bit 15 is the first bit transmitted.

Bits	Description
15	This is the synchronization bit and it is always active.
14-7	These bits represent a data byte or a status byte from the work stations, or they represent a data byte or a command byte from the system unit. When they are a command byte, bits 7 through 9 are the command modifier.
6-4	These bits represent the work station address unless the frame is the last one transmitted. If the frame is the last one transmitted in a series of frames, these bits are set to 111 to indicate the end of message.
Note: If only 1 frame is sent from the system unit, these bits represent the work station address. If only one frame is sent from the work station, these bits are set to 111.	
3	This is an even parity bit for bits 3 through 15.
2-0	These bits are always set to 000.

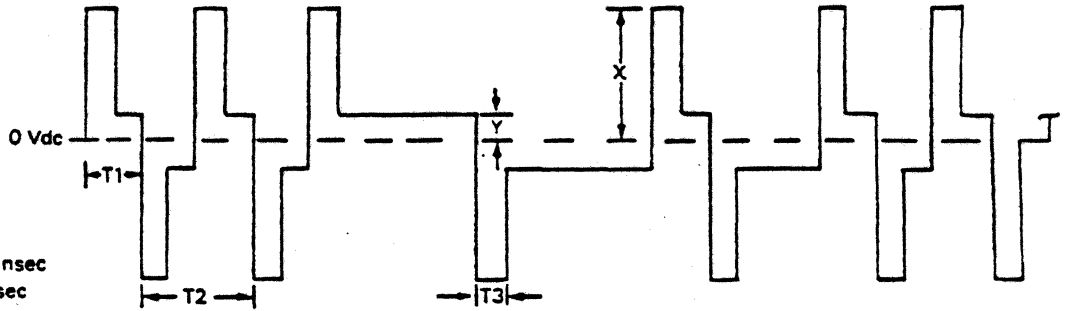
1 division = 250 nsec
Actual bit value

Data to be transmitted
(Half bits)



1 Signal at the driver

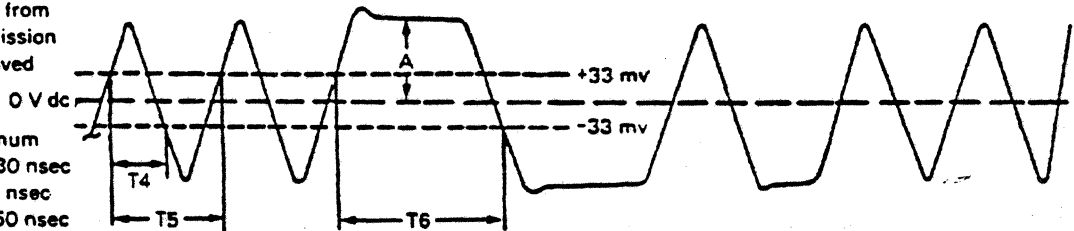
X = 1.6 V dc 20%
Y = 0.32 V dc 20%
X/Y = 5 6%



*T1 = 500 nsec ± 20 nsec
*T2 = 1 μ sec ± 20 nsec
*T3 = 250 nsec ± 20 nsec

2 Resulting signal at the receiver (5000 feet from driver) with transmission time skewing removed

*A = 100 mv minimum
*T4 = 500 nsec ± 30 nsec
*T5 = 1 μ sec ± 30 nsec
*T6 = 1.5 μ sec ± 50 nsec



1 and **2** show the signals when the line is properly terminated. In addition, these signals show signals that were measured differentially when the signal on B was subtracted from the signal on A (see insert for A and B).

*Typical

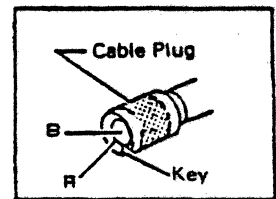


Figure 1. Example of a Typical Transmitted Signal

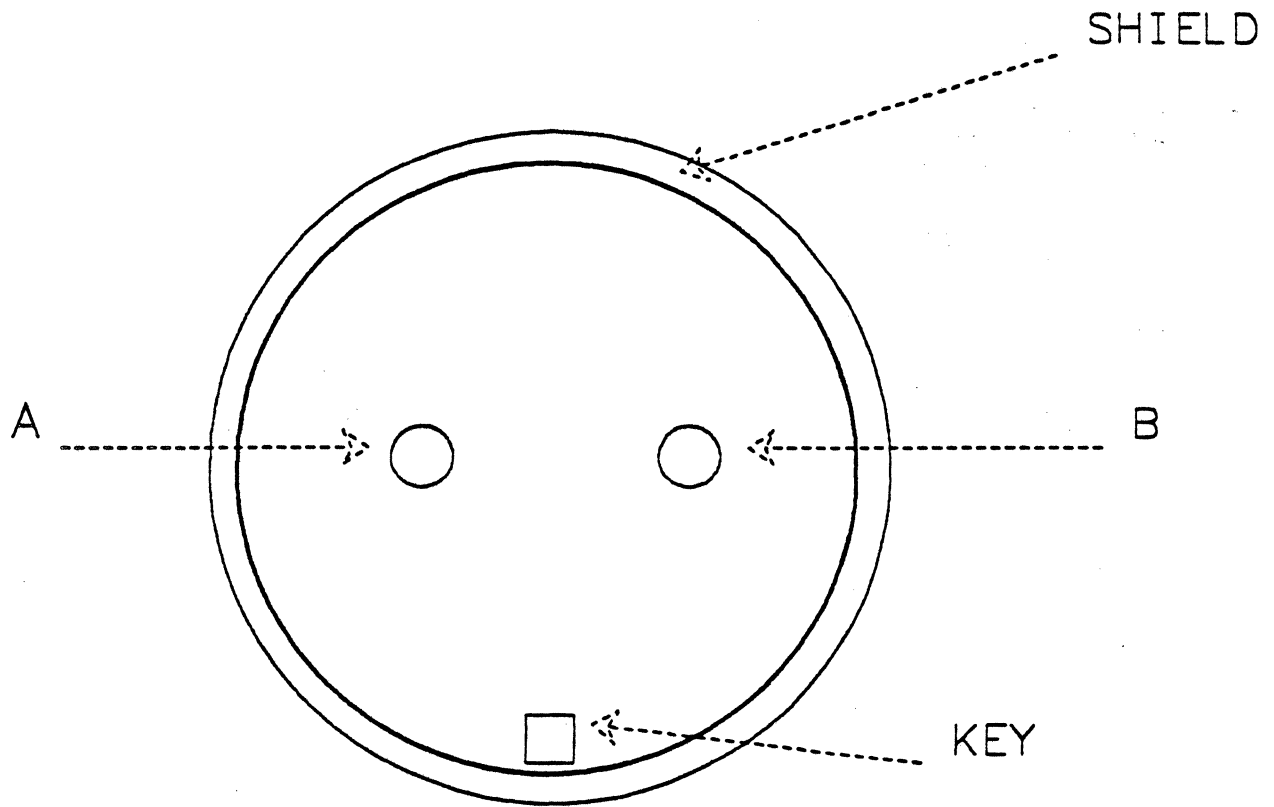


Figure 2. End View of Female Twinaxial Connector

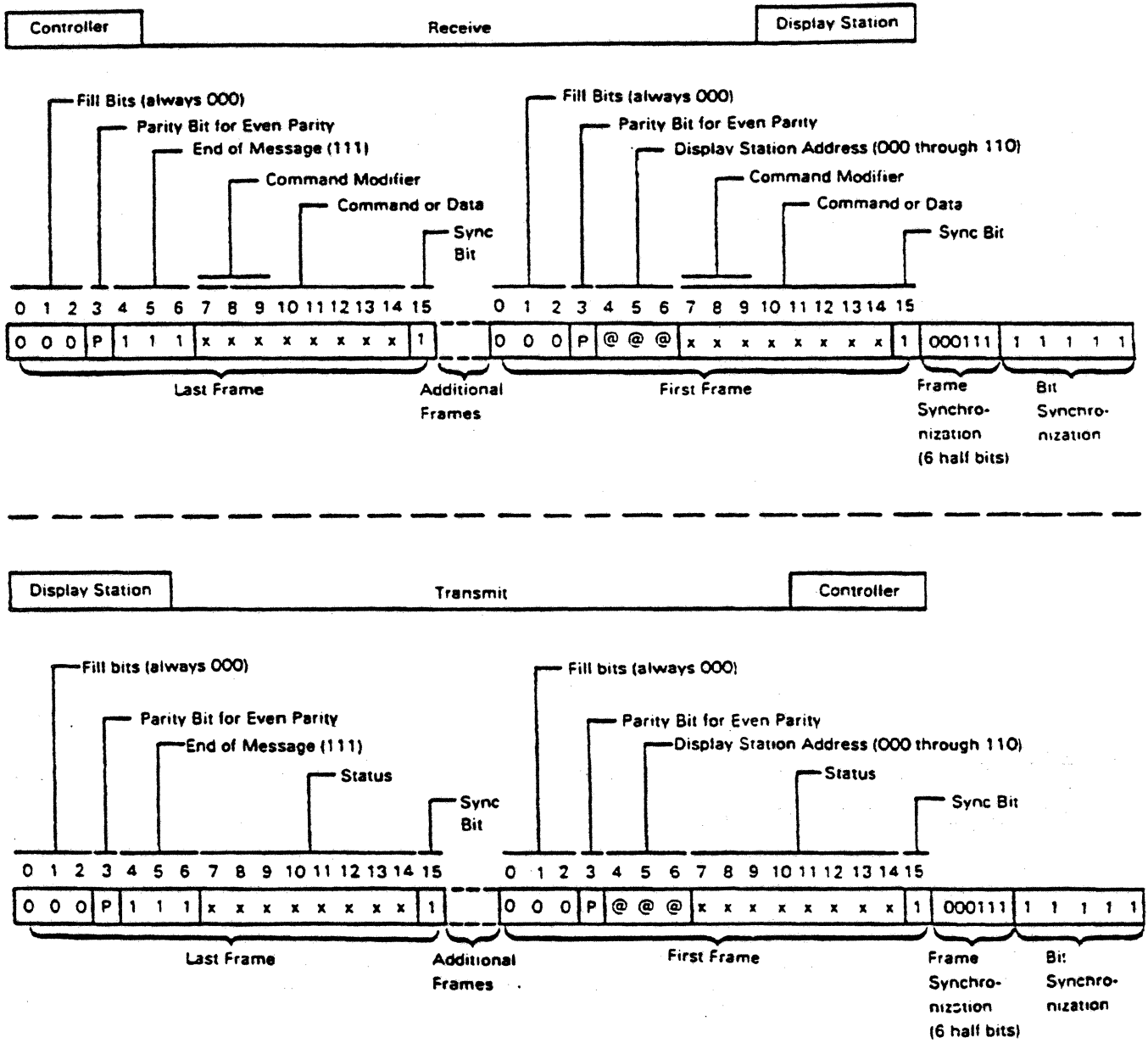


Figure 3. Examples of Frames

1.4 Station Addressing

Each station requires a unique station address. The station address is encoded in bits 4, 5, and 6 of the frame. The address for machines without Cable Through feature is always 000. Addresses 000 to 110 are valid addresses with the Cable Through feature; address 111 is the end of message delimiter.

The first frame from the system following a line turnaround (frame synchronization) must be a command frame. The command frame contains a station address used to select an individual station. Any data frames associated with the command frame are checked for an end of message delimiter.

If bit 14 is off in a command frame and it is the first command following a frame synchronization sequence, no following data or command frames will be processed by a station. This allows single frame commands to be addressed to a specific station.

Commands may be transmitted to a station individually or collectively. Commands with data frames must have the data frames immediately following the command frame, with no frame synchronization sequence between the command and the data. Commands (together with any associated data) may be transmitted with or without intervening frame synchronization sequences. If transmission without intervening frame synchronization sequences is desired, the first command must have associated data (that is, bit 14 of the command frame must be on).

The last frame in a sequence of frames must contain a station address of 111 as the end of message delimiter.

All response frames sent to the host by the station, except the end of message frame, contain the responding station's address.

The address associated with an individual station is selected during the customer setup procedure by setting selector switches on the station when the Cable Through feature is installed. Stations without the Cable Through feature always have a fixed address of 000, unless they are to be attached to the twinaxial cable through a "T-connector". T-connector attached stations have addressing capability.

The display station that is to be the console must be address 000 on port 0 of the S/36 or AS/400. This does not apply to the 5364, as the attached PC is always the console.

The System/38 does not use a workstation as a console, as the console is built into the system unit.

2.0 5251 Model 11 Interface

2.1 Keyboard and Display

The 5251 model 11 is a single keyboard display station that uses logic for control and attachment to the controller in a host system or to other work stations. The 5251 model 11 provides the means of key entry with an interactive display.

This chapter describes the 5251 model 11. It also includes information about other display terminals when the differences are small. Other display terminals also have their own chapters which contain information about their differences from the 5251 model 11.

The 5251 model 999 is a 5251 model 11 with a standard set of features. The 5251 model 999 responds to commands exactly like the 5251 model 11.

The system attachment is an addressable multidrop line using dual signal connector twinaxial cable. The most distant station may be up to 1525 meters (5000 feet) from the host system with twinaxial cable. Each multidrop line can be addressed individually.

Transmission of data and commands is half duplex and is host initiated.

All keyboard and display functions are logically controlled by the system programs for any display station or operator function. The 5251 model 11 provides both an operator and a command interface to the attaching system thus allowing explicit control of the keyboard, display, and features.

The command interface allows the function of fields on the display screen to be controlled. The controlled functions are intensification, image reversal (dark graphic on light background), underlining, column separating, blinking, and non-display. Characters, fields, lines, and the entire regeneration buffer can be accessed.

Key scan codes are delivered to the host on request (Poll command). The display station does not translate key codes into display codes. The scan and display codes are unique to the 5250 display system and do not necessarily conform to EBCDIC standards.

Scan codes are a function of the physical location of the key stem on the keyboard. Therefore, each keyboard arrangement requires a different translate table.

The relationship between the keyboard and the display is through the work station controller. Pressing any key and transmission of its scan code must result in the function described in the *IBM 5251 Display Station models 1 and 11 Operator's Guide*, GA21-9248. Certain other functions of the 5251 model 11 require the using system to issue commands to activate devices and/or respond with commands within a certain amount of time.

Keyboard layouts are shown in

- Figure 4 on page 13
- Figure 5 on page 13
- Figure 6 on page 13
- Figure 7 on page 14
- Figure 8 on page 14

Scan codes for the above keyboard layouts are shown in

- Figure 9 on page 15
- Figure 10 on page 17
- Figure 11 on page 19
- Figure 12 on page 21
- Figure 13 on page 23

The codes for displayable characters are shown in

- Figure 14 on page 25
- Figure 15 on page 26
- Figure 16 on page 27

2.1.1 Scan Codes

Scan codes are a function of the physical location of the key stem on the keyboard. Figure 9 on page 15 shows the 8-bit scan code, the hexadecimal code, and the key position for the keyboards.

When a make/break key is pressed, bit 0 of the scan code is a 0. When a make/break key is released, bit 0 of the scan code is a 1.

A typamatic key repeats its scan code when it is held down for more than 600 milliseconds. The repetition rate is 10 operations per second. The repetition will continue until the key is released or until another key is pressed in addition to the typamatic key. Typamatic keys are a function of the display station; the controller sees only the repetition, as though the user pressed the key repeatedly.

Some keyboards have symbols on the "front face" of some keys (that is, on the front, below the keytop). These symbols are entered by first pressing the shifted HELP key (HELP key with SHIFT held down), then the key with the front face symbol. The shift-HELP sequence must be performed for each front-face symbol that is to be entered.

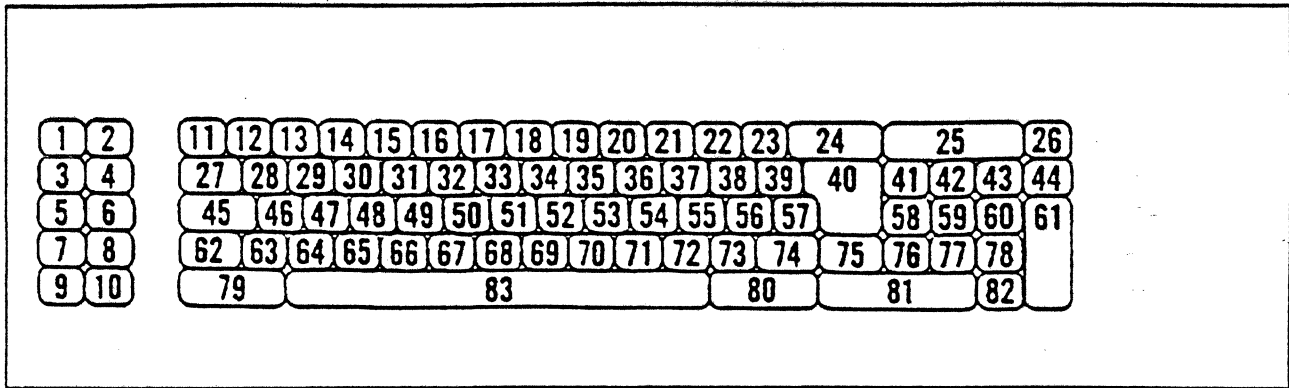


Figure 4. 5251 Model 11 Data Processing Keyboard. See Figure 9 on page 15 for scan codes, make/break keys, and typamatic keys.

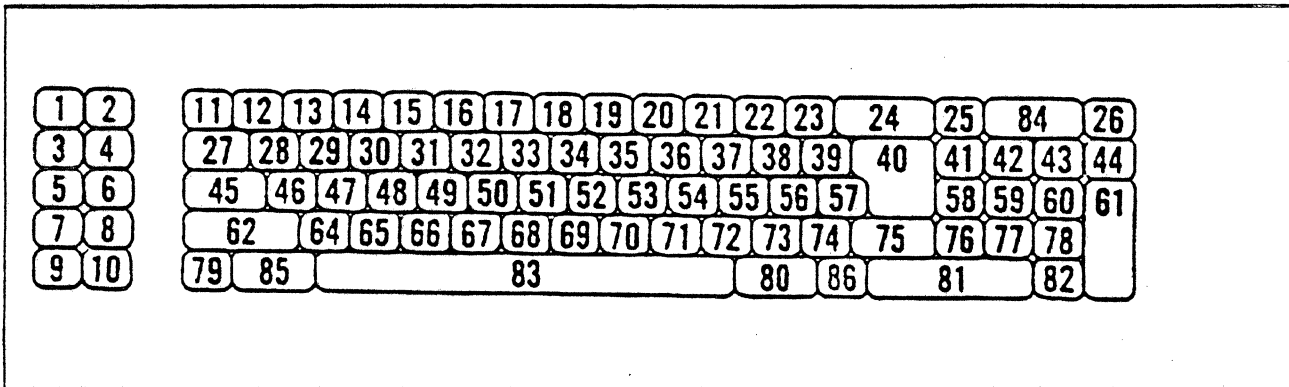


Figure 5. 5251 Model 11 Katakana Data Processing Keyboard. See Figure 10 on page 17 for scan codes, make/break keys, and typamatic keys.

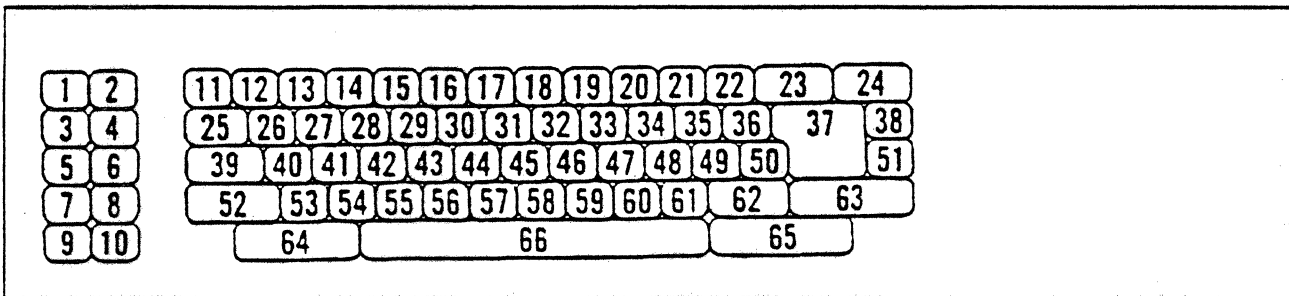


Figure 6. 5251 Model 11 Data Entry Keyboard - 66 key. See Figure 11 on page 19 for scan codes, make break keys, and typamatic keys.

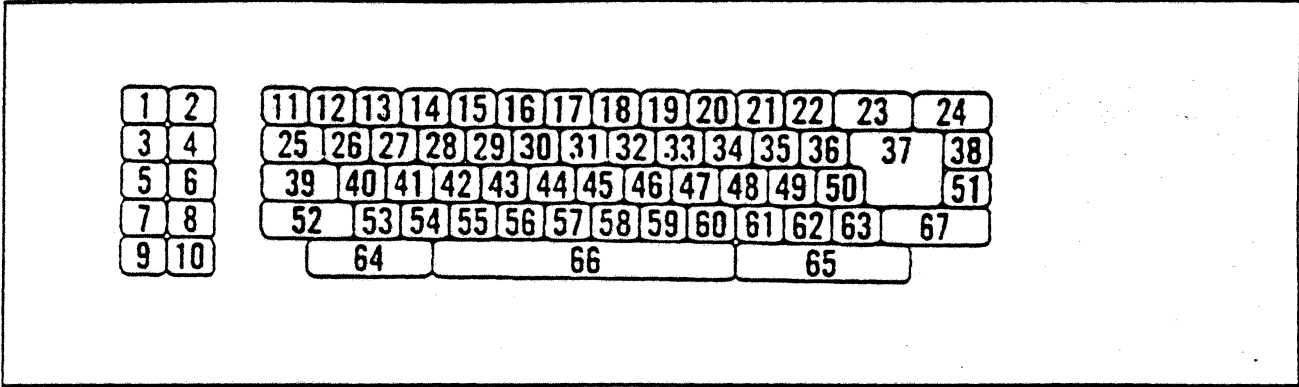


Figure 7. 5251 Model 11 Data Entry Keyboard - 67 key. See Figure 12 on page 21 for scan codes, make break keys, and typamatic keys.

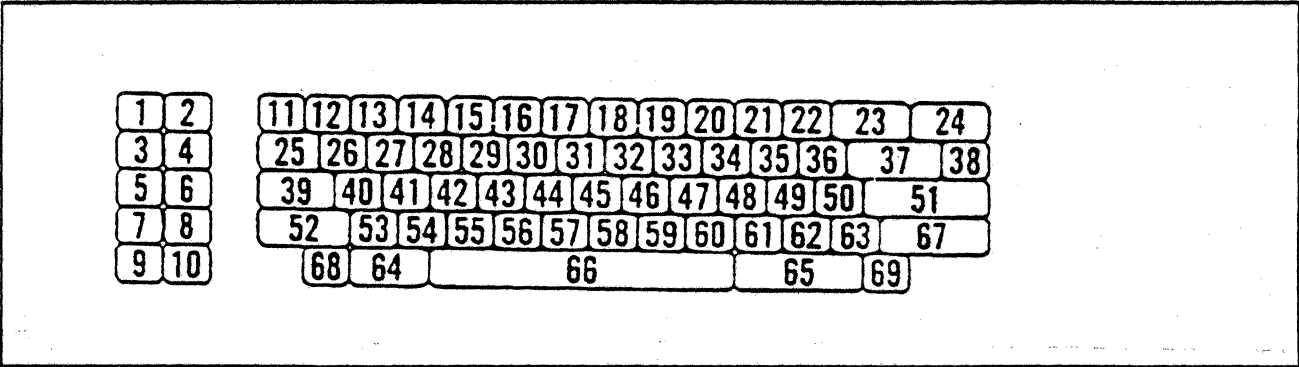


Figure 8. 5251 Model 11 Katakana Data Entry Keyboard. See Figure 13 on page 23 for scan codes, make break keys, and typamatic keys.

Key Position	Hex Scan Code	Binary Scan Code
1	7C	01111100
2	6F	01101111
3	6C	01101100
4	6D	01101101
5	6E	01101110
6	7D	01111101
7	71	01110001 ²
8	70	01110000 ²
9	72	01110010 ²
10	73	01110011 ²
11	3E	00111110 ²
12	31	00110001 ²
13	32	00110010 ²
14	33	00110011 ²
15	34	00110100 ²
16	35	00110101 ²
17	36	00110110 ²
18	37	00110111 ²
19	38	00111000 ²
20	39	00111001 ²
21	3A	00111010 ²
22	3B	00111011 ²
23	3C	00111100 ²
24	3D	00111101 ²
25	4B	01001011 ²
26	4C	01001100 ²
27	20	00100000 ²
28	21	00100001 ²
29	22	00100010 ²
30	23	00100011 ²
31	24	00100100 ²
32	25	00100101 ²
33	26	00100110 ²
34	27	00100111 ²
35	28	00101000 ²
36	29	00101001 ²
37	2A	00101010 ²
38	2B	00101011 ²
39	2C	00101100 ²
40	2D	00101101
41	47	01000111 ²
42	48	01001000 ²
43	49	01001001 ²

Figure 9 (Part 1 of 2). 5250 Model 11 Keyboard Scan Codes - Data Processing

¹ A make-break key

² A typamatic key

Key Position	Hex Scan Code	Binary Scan Code
44	4E	01001110
45	54	*1010100 ¹
46	11	00010001 ²
47	12	00010010 ²
48	13	00010011 ²
49	14	00010100 ²
50	15	00010101 ²
51	16	00010110 ²
52	17	00010111 ²
53	18	00011000 ²
54	19	00011001 ²
55	1A	00011010 ²
56	1B	00011011 ²
57	1C	00011100 ²
58	44	01000100 ²
59	45	01000101 ²
60	46	01000110 ²
61	4D	01001101
62	57	*1010111 ¹
63	0E	00001110 ²
64	01	00000001 ²
65	02	00000010 ²
66	03	00000011 ²
67	04	00000100 ²
68	05	00000101 ²
69	06	00000110 ²
70	07	00000111 ²
71	08	00001000 ²
72	09	00001001 ²
73	0A	00001010 ²
74	56	*1010110 ¹
75	0C	00001100 ²
76	41	01000001 ²
77	42	01000010 ²
78	43	01000011 ²
79	7E	01111110
80	68	01101000
81	40	01000000 ²
82	4A	01001010 ²
83	0F	00001111 ²

Figure 9 (Part 2 of 2). 5250 Model 11 Keyboard Scan Codes - Data Processing

Key Position	Hex Scan Code	Binary Scan Code
1	7C	01111100
2	6F	01101111
3	6C	01101100
4	6D	01101101
5	6E	01101110
6	7D	01111101
7	71	01110001 ⁴
8	70	01110000 ⁴
9	72	01110010 ⁴
10	73	01110011 ⁴
11	3E	00111110 ⁴
12	31	00110001 ⁴
13	32	00110010 ⁴
14	33	00110011 ⁴
15	34	00110100 ⁴
16	35	00110101 ⁴
17	36	00110110 ⁴
18	37	00110111 ⁴
19	38	00111000 ⁴
20	39	00111001 ⁴
21	3A	00111010 ⁴
22	3B	00111011 ⁴
23	3C	00111100 ⁴
24	61	01100001
25	3D	00111101 ⁴
26	4C	01001100 ⁴
27	20	00100000 ⁴
28	21	00100001 ⁴
29	22	00100010 ⁴
30	23	00100011 ⁴
31	24	00100100 ⁴
32	25	00100101 ⁴
33	26	00100110 ⁴
34	27	00100111 ⁴
35	28	00101000 ⁴
36	29	00101001 ⁴
37	2A	00101010 ⁴
38	2B	00101011 ⁴
39	2C	00101100 ⁴
40	2D	00101101
41	47	01000111 ⁴
42	48	01001000 ⁴
43	49	01001001 ⁴

Figure 10 (Part 1 of 2). 5250 Model 11 Keyboard Scan Codes - Katakana Data Processing

³ A make-break key

⁴ A typamatic key

Key Position	Hex Scan Code	Binary Scan Code
44	4E	01001110
45	54	*1010100 ³
46	11	00010001 ⁴
47	12	00010010 ⁴
48	13	00010011 ⁴
49	14	00010100 ⁴
50	15	00010101 ⁴
51	16	00010110 ⁴
52	17	00010111 ⁴
53	18	00011000 ⁴
54	19	00011001 ⁴
55	1A	00011010 ⁴
56	1B	00011011 ⁴
57	1C	00011100 ⁴
58	44	01000100 ⁴
59	45	01000101 ⁴
60	46	01000110 ⁴
61	4D	01001101
62	57	*1010111 ³
64	01	00000001 ⁴
65	02	00000010 ⁴
66	03	00000011 ⁴
67	04	00000100 ⁴
68	05	00000101 ⁴
69	06	00000110 ⁴
70	07	00000111 ⁴
71	08	00001000 ⁴
72	09	00001001 ⁴
73	0A	00001010 ⁴
74	0C	00001100 ⁴
75	56	*1010110 ³
76	41	01000001 ⁴
77	42	01000010 ⁴
78	43	01000011 ⁴
79	53	*1010011 ³
80	68	01101000
81	40	01000000 ⁴
82	4A	01001010 ⁴
83	0F	00001111 ⁴
84	4B	01001011 ⁴
85	7E	01111110
86	52	*1010010 ³

Figure 10 (Part 2 of 2). 5250 Model 11 Keyboard Scan Codes - Katakana Data Processing

Key Position	Hex Scan Code	Binary Scan Code
1	7C	01111100
2	6F	01101111
3	6C	01101100
4	6D	01101101
5	6E	01101110
6	7D	01111101
7	71	01110001 ⁶
8	70	01110000 ⁶
9	72	01110010 ⁶
10	73	01110011 ⁶
11	3E	00111110
12	31	00110001
13	32	00110010 ⁶
14	33	00110011 ⁶
15	34	00110100 ⁶
16	35	00110101 ⁶
17	36	00110110
18	37	00110111 ⁶
19	38	00111000 ⁶
20	39	00111001 ⁶
21	3A	00111010 ⁶
22	3B	00111011 ⁶
23	3C	00111100
24	3D	00111101
25	20	00100000 ⁶
26	21	00100001 ⁶
27	22	00100010 ⁶
28	23	00100011 ⁶
29	24	00100100 ⁶
30	25	00100101 ⁶
31	26	00100110 ⁶
32	27	00100111 ⁶
33	28	00101000 ⁶
34	29	00101001 ⁶
35	2A	00101010 ⁶
36	2B	00101011 ⁶
37	2D	00101101
38	2C	00101100
39	7E	01111110
40	11	00010001 ⁶
41	12	00010010 ⁶
42	13	00010011 ⁶
43	14	00010100 ⁶

Figure 11 (Part 1 of 2). 5250 Model 11 Keyboard Scan Codes - Data Entry 66 Key

⁵ A make-break key

⁶ A typamatic key

Key Position	Hex Scan Code	Binary Scan Code
44	15	00010101 ⁶
45	16	00010110 ⁶
46	17	00010111 ⁶
47	18	00011000 ⁶
48	19	00011001 ⁶
49	1A	00011010 ⁶
50	1B	00011011 ⁶
51	1C	00011100
52	1D	01010111 ⁵
53	01	00000001 ⁶
54	02	00000010 ⁶
55	03	00000011 ⁶
56	04	00000100 ⁶
57	05	00000101 ⁶
58	06	00000110 ⁶
59	07	00000111 ⁶
60	08	00001000 ⁶
61	09	00001001 ⁶
62	0A	00001010 ⁶
63	56	01010110 ⁵
64	69	01101001
65	68	01101000
66	0F	00001111 ⁶

Figure 11 (Part 2 of 2). 5250 Model 11 Keyboard Scan Codes - Data Entry 66 Key

Key Position	Hex Scan Code	Binary Scan Code
1	7C	01111100
2	6F	01101111
3	6C	01101100
4	6D	01101101
5	6E	01101110
6	7D	01111101
7	71	01110001 ⁷
8	70	01110000 ⁷
9	72	01110010 ⁷
10	73	01110011 ⁷
11	3E	00111110
12	31	00110001
13	32	00110010 ⁸
14	33	00110011 ⁸
15	34	00110100 ⁸
16	35	00110101 ⁸
17	36	00110110
18	37	00110111 ⁸
19	38	00111000 ⁸
20	39	00111001 ⁸
21	3A	00111010 ⁸
22	3B	00111011 ⁸
23	3C	00111100
24	3D	00111101
25	20	00100000 ⁸
26	21	00100001 ⁸
27	22	00100010 ⁸
28	23	00100011 ⁸
29	24	00100100 ⁸
30	25	00100101 ⁸
31	26	00100110 ⁸
32	27	00100111 ⁸
33	28	00101000 ⁸
34	29	00101001 ⁸
35	2A	00101010 ⁸
36	2B	00101011 ⁸
37	2D	00101101
38	2C	00101100
39	7E	01111110
40	11	00010001 ⁸
41	12	00010010 ⁸
42	13	00010011 ⁸
43	14	00010100 ⁸

Figure 12 (Part 1 of 2). 5250 Model 11 Keyboard Scan Codes - Data Entry 67 Key

⁷ A make-break key

⁸ A typamatic key

Key Position	Hex Scan Code	Binary Scan Code
44	15	00010101 8
45	16	00010110 8
46	17	00010111 8
47	18	00011000 8
48	19	00011001 8
49	1A	00011010 8
50	1B	00011011 8
51	1C	00011100
52	1D	01010111 7
53	01	00000001 8
54	02	00000010 8
55	03	00000011 8
56	04	00000100 8
57	05	00000101 8
58	06	00000110 8
59	07	00000111 8
60	08	00001000 8
61	09	00001001 8
62	0A	00001010 8
63	0C	00001100 8
64	69	01101001
65	68	01101000
66	0F	00001111 8
67	36	01010110 7

Figure 12 (Part 2 of 2). 5250 Model 11 Keyboard Scan Codes - Data Entry 67 Key

Key Position	Hex Scan Code	Binary Scan Code
1	7C	01111100
2	6F	01101111
3	6C	01101100
4	6D	01101101
5	6E	01101110
6	7D	01111101
7	71	01110001 ¹⁰
8	70	01110000 ¹⁰
9	72	01110010 ¹⁰
10	73	01110011 ¹⁰
11	3E	00111110
12	31	00110001
13	32	00110010 ¹⁰
14	33	00110011 ¹⁰
15	34	00110100 ¹⁰
16	35	00110101 ¹⁰
17	36	00110110
18	37	00110111 ¹⁰
19	38	00111000 ¹⁰
20	39	00111001 ¹⁰
21	3A	00111010 ¹⁰
22	3B	00111011 ¹⁰
23	3C	00111100
24	3D	00111101
25	20	00100000 ¹⁰
26	21	00100001 ¹⁰
27	22	00100010 ¹⁰
28	23	00100011 ¹⁰
29	24	00100100 ¹⁰
30	25	00100101 ¹⁰
31	26	00100110 ¹⁰
32	27	00100111 ¹⁰
33	28	00101000 ¹⁰
34	29	00101001 ¹⁰
35	2A	00101010 ¹⁰
36	2B	00101011 ¹⁰
37	2D	00101101
38	2C	00101100
39	7E	01111110
40	11	00010001 ¹⁰
41	12	00010010 ¹⁰
42	13	00010011 ¹⁰
43	14	00010100 ¹⁰

Figure 13 (Part 1 of 2). 5250 Model 11 Keyboard Scan Codes - Katakana Data Entry

⁹ A make-break key

¹⁰ A typematic key

Key Position	Hex Scan Code	Binary Scan Code
44	15	00010101 ¹⁰
45	16	00010110 ¹⁰
46	17	00010111 ¹⁰
47	18	00011000 ¹⁰
48	19	00011001 ¹⁰
49	1A	00011010 ¹⁰
50	1B	00011011 ¹⁰
51	1C	00011100
52	1D	01010111 ⁹
53	01	00000001 ¹⁰
54	02	00000010 ¹⁰
55	03	00000011 ¹⁰
56	04	00000100 ¹⁰
57	05	00000101 ¹⁰
58	06	00000110 ¹⁰
59	07	00000111 ¹⁰
60	08	00001000 ¹⁰
61	09	00001001 ¹⁰
62	0A	00001010 ¹⁰
63	0C	00001100 ¹⁰
64	69	01101001
65	68	01101000
66	0F	00001111 ¹⁰
67	36	01010110 ⁹
68	33	01010011 ⁹
69	32	01010010 ⁹

Figure 13 (Part 2 of 2). 5250 Model 11 Keyboard Scan Codes - Katakana Data Entry

2.1.2 Displayable Characters

The 5251 model 11 provides the character set shown below. Codes normally displayed as blanks will have the hexadecimal code displayed in Test mode. Nulls (X'00') display as dots in Test mode. X'40' will always display as a blank. X'41' is the required blank for text processing; it displays as a hexadecimal code in Test mode.

First Hex Char	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					&	-	ø	Ø	°	μ	c	|	|	\	0	
1					é	/	É	a	j	~	£	A	J		1	
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	R	C	L	T	3
4					à	è	À	È	d	m	u	f	D	M	U	4
5					á	í	Á	Í	e	n	v	§	E	N	V	5
6					ã	ï	Ã	Ï	f	o	w	¶	F	O	W	6
7					ä	ï	Ä	Ï	g	p	x		G	P	X	7
8					ç	ì	Ç	Ì	h	q	y		H	Q	Y	8
9					ñ	β	Ñ	'	i	r	z		I	R	Z	9
A					[	]	!	:	Λ	ä	i	┌	-	≧	z	3
B					.	\$	,	#	∇	◊	¿	|	◊	◊	◊	◊
C					<	*	%	@	†	∞	∅	κ	ö	ü	Ö	Ü
D					(	)	_	'	≡	5	↑	..	ó	ú	Ó	Ú
E					+	;	>	=	ƒ	℞	ƒ	'	ó	ú	Ó	Ú
F					ı	˘	˙	˚	±	κ	˚	≡	˚	˚	˚	˚

Figure 14. 5251 Model 11 Multinational Character Set. Codes with a first hexadecimal digit of 2 or 3 are reserved for display attributes.

		First Hexadecimal Character															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Second Hexadecimal Character	0					Sp	&	-			ソ					s	0
	1					o	/	/		ア	イ	-		A	J		1
	2					カ	キ			イ	チ	ハ		B	K	S	2
	3					ク	ケ			ウ	ツ	ク		C	L	T	3
	4					コ	ク			エ	テ	マ		D	M	U	4
	5					コ	ク			オ	シ	エ		E	N	V	5
	6					ク	ソ			カ	ジ	ク		F	O	W	6
	7					ク				キ	ニ	メ		G	P	X	7
	8					ク	-			ク	又	モ		H	Q	Y	8
	9					ク				ク	フ	ヤ		I	R	Z	9
	A					ク	リ		:	コ	ノ	リ	レ				
	B					ク	キ	,	#				□				
	C					<	*	%	@	リ		ヨ	フ				
	D					(	)	-	'	シ	ハ	ラ	ソ				
	E					+	;	>	=	ス	ル	リ	"				
	F					リ	フ	ク	"	セ	フ	ル	。				

Figure 15. 5251 Model 11 Katakana Displayable Character Set

For the countries shown below, characters are identical to the multinational character set except as noted.

Hex:	4A	4C	4F	5A	5B	5F	6A	79	7B	7C	A1	C0	D0	E0
U.S. and Canada	c		l	l		7								
Multinational														
Austria/Germany	Ä			Ü			ö			ø	β	ä	ü	ö
Belgium						ù			à	..	é	è	ç	
Brazil	E'		s	ç		ç	ã	õ	ã		õ	é		
Canada (French)	à		'	,		ù				..	é	è	ç	
Denmark/Norway	#		Æ	Å		ø		Æ	Ø	ü	æ	å		
Finland/Sweden	ø		Æ	Å		ö	é	Ä	Ö	ü	ä	å	É	
France	°		ø			ù		£	à	..	é	è	ç	
Italy	°		é			ó	ù	£	ø	l	à	è	ç	
Japan (English)	£		l	l	≠	7					-			s
Portugal		ç				ø		ã	õ	ç	ã	·	ç	
Spain			l		Pts	7	ñ		ñ	7	..			
Spanish-Speaking			l			7	ñ		ñ		..			
United Kingdom	s		l	l	£	7					-			

Figure 16. 5251 Model 11 Modifications to International Character Set

2.1.3 Keyboard Clicker and Audible Alarm

If the clicker is enabled by the controller a click is heard within 30 milliseconds after a key is pressed. A keyboard overrun causes the station to disable the clicker. With the clicker disabled, the 5251 model 11 still responds to keystrokes and indicates keystrokes pending, and overrun. Therefore, the system must not cause display actions for data entry to occur when it has disabled the clicker. The clicker must be enabled to provide a correct operator environment.

The audible alarm is provided by the clicker. When started by the controller, the alarm (clicker) will buzz for about 1 second. The controller should not operate the alarm more than once during any 5 second period.

2.1.4 Display Attributes

2.1.4.1 Field Attributes

The 5251 model 11 uses field attributes to control the manner in which characters are displayed on the screen.

Attribute	Description
X'20'	Normal display
X'21'	Reverse image
X'22'	High intensity
X'23'	Reverse image, high intensity
X'24'	Underscore
X'25'	Underscore, reverse image
X'26'	Underscore, high intensity
X'27'	No display
X'28'	Blink
X'29'	Blink, reverse image
X'2A'	Blink, high intensity
X'2B'	Blink, high intensity, reverse image
X'2C'	Blink, underscore
X'2D'	Blink, underscore, reverse image
X'2E'	Blink, underscore, high intensity
X'2F'	No display
X'30'	Normal display with column separators
X'31'	Reverse image with column separators
X'32'	High intensity with column separators
X'33'	Reverse image and high intensity with column separators
X'34'	Underscore with column separators

Figure 17 (Part 1 of 2). 5251 Model 11 Field Attribute Characters

Attribute	Description
X'35'	Underscore and reverse image with column separators
X'36'	Underscore and high intensity with column separators
X'37'	No display
X'38'	Blink with column separators
X'39'	Blink and reverse image with column separators
X'3A'	Blink and high intensity with column separators
X'3B'	Blink, high intensity, and reverse image with column separators
X'3C'	Blink and underscore with column separators
X'3D'	Blink, underscore, and reverse image with column separators
X'3E'	Blink, underscore, and high intensity with column separators
X'3F'	No display

Figure 17 (Part 2 of 2). 5251 Model 11 Field Attribute Characters

An attribute remains in effect until another attribute is found in the data for the display. An attribute affects the display of characters following the attribute on the line that the attribute is on; the attribute also affects characters on subsequent lines until another attribute is found.

The last attribute found before displaying the last character on the screen does not remain in effect at the start of the screen.¹¹

The character position occupied by an attribute is displayed as a blank in normal mode. In diagnostic mode the hex code of the attribute is displayed.

After power on reset or a reset command, the attributes of normal intensity, non-blink, and non-reverse image are in effect.

The reverse image attribute causes the characters following to be displayed as a dark graphic on a light background (negative image).

If the entire screen has been set for negative image by a Write Control Data command, the reverse image attribute causes a light image on a dark background (positive image).

Additional information is in the "Work Stations" section of *IBM System/36 Functions Reference Manual*, SA21-9243.

¹¹ This is not true for some of the first 5251 model 11 terminals that were made. For this reason, it is suggested that all screens have an attribute byte in row 1, column 1, or in the last character position of the screen, to set the desired attributes.

2.2 Interface

The interface to the IBM 5251 model 11 is a digital interface operating at a bit rate of 1.0 MHz ($\pm 2\%$) over dual conductor twinaxial cable for multidrop network configurations. For information about cable characteristics, bit stream, frame format, and electrical interface, refer to the first section of this document.

2.2.1 Protocols and Synchronization

The keyboard display will never initiate a transaction to or from the attaching system. All such transactions will be explicitly initiated from the attaching system via a command. The flow will be half duplex. Some typical flows are illustrated on the following pages.

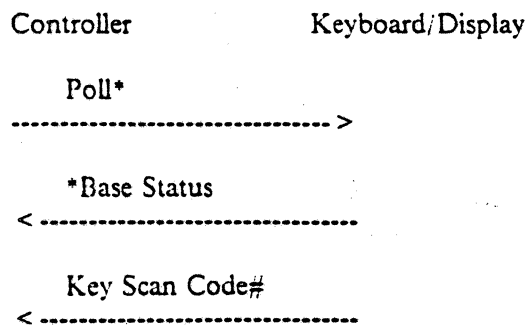
The following legend applies to the illustrations.

* = Frame and bit synchronization and sequences generated by the driver/receiver logic (line turn-around). This conditions the work station to begin receiving a command.

= Data stream termination delimiter, caused by transmission of station address of ones. This terminates a message, and causes the station to expect a synchronization series next.

--> = An arrow indicates the exchange of one 16-bit frame in the indicated direction between the keyboard/display and the attaching system.

Poll for Status



Write Data and Load Cursor

Controller Keyboard/Display

WRTLC*
----->

#DATA
----->

Load*
----->

Value (Bits 0-7)
----->

#Value (Bits 8-15)
----->

Read Registers

Read Registers*
----->

Wait (poll) for nonbusy, no
exception, and no-parity-error
Status response

Activate Read*
----->

*Value (Bits 0-7 of the Address Counter)
<-----

Value (Bits 8-15 of the Address Counter)
<-----

Controller Display Station

Value (Bits 0-7 of the Cursor Register)
<-----

Value (Bits 8-15 of the Cursor Register)
<-----

Value (Bits 0-7 of the Reference Counter)
<-----

Value (Bits 8-15 of the Reference Counter)#

←-----

2.2.2 Frame Characteristics

The frame format for commands and data to or from the IBM 5251 model 11 display station is a fixed 16-bit frame. The general format is as defined below.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Station Address
7-14	command or data
15	Stop bit; always 1.

- Bit 3 is designated as the parity bit and will be set to ensure even parity in each frame. Whenever a line parity error is detected by a station, no further commands will be carried out, and no responses will be made until a valid poll without parity error is received. At that time, a line transmission fault indication will be sent back to the controller as part of the base status.
- Bits 4, 5, and 6 are the physical station address. Valid addresses are 000 to 110, and 111 is the end of message delimiter for the cable. A frame containing the 111 station address causes the station to ignore all following cable line signals until a bit and frame synchronization is detected following a line turn-around.
- Bits 7 through 14 are unique to the type of frame and will be defined later in this document.
- Bit 15 is the least significant digit in the frame and is called a stop bit or sync bit. It is the first bit transmitted on the line and is always set to one.

2.2.3 Addressing and Commands

See 1.4, "Station Addressing" on page 9 for information on addressing stations.

2.2.3.1 Device Addressing

Device addresses are used to select the various logical devices on the station. These may be base devices such as the keyboard or special feature devices such as the Magnetic Stripe Reader. The following addresses are assigned and are encoded in frame bits 7 through 9 (basic format), or bits 7 through 10 (feature format).

Basic Format

000	Base and regeneration buffer
001	Keyboard
010	Indicators

Feature Format

1000	Model
1001	Magnetic Stripe Reader
1010	Light Pen

2.3 Command Matrix

The following matrix represents the valid commands for the IBM 5251 model 11. Also represented in the matrix are the devices which will be affected by a given command.

Only one command may be processed at a time, although several may be put on an internal work queue. Commands are encoded in bits 10 through 14 of the frame (basic format), or bits 11 through 14 of the frame (feature format).

Command frames must be preceded by a line turnaround (bit and frame synchronization sequences) or by another command frame (possibly with intervening data frames) that was preceded by bit and frame synchronization sequences. See 1.4, "Station Addressing" on page 9 for more information.

All command bit patterns not defined below are reserved.

The Device Address is bits 7 through 9 for base format; it is bits 7 through 10 for feature format.

The Command is bits 10 through 14 for base format; it is bits 11 through 14 for feature format.

Command Name	Modifier/ Device Address	Command	Addressed To	Notes
Activate Read	0 0 0	0 0 0 0 0	Base	Device address is specified by preceding command.
Activate Write	0 0 0	0 0 0 0 1	Base	Device address is specified by preceding command.
Clear	0 0 0	1 0 0 1 0	Base	
EOQ Delimiter	0 1 1	0 0 0 1 0	Base	
Exchange	0 0 0	1 0 1 1 0	Base	
Insert Character	0 0 0	0 0 0 1 1	Base	
Load Address Counter	0 0 0	1 0 1 0 1	Base	
Load Cursor Register	0 0 0	1 0 1 1 1	Base	
Load Reference Counter	0 0 0	0 0 1 1 1	Base	
Move Data	0 0 0	0 0 1 1 0	Base	
Poll	X X X	1 0 0 0 0	X X X	See Poll command description for explanation of X's.
Read Data ¹²	1 0 0 1	- 1 0 0 0	MSR	Activate required
Read Data ¹²	1 0 1 0	- 1 0 0 0	Light Pen	Activate required
Read Device ID - base	0 0 0	0 1 1 0 0	Base	Activate required

Figure 18 (Part 1 of 2). Command Matrix for 5251 Commands

¹² These commands use feature format: see 2.4, "Specific Command Formats" on page 37.

Command Name	Modifier/ Device Address	Command	Addressed To	Notes
Read Device ID - key-board	0 0 1	0 1 1 0 0	Keyboard	Activate required
Read Device ID - model ¹²	1 0 0 0	- 1 1 0 0	Model	Activate required
Read Device ID - MSR ¹²	1 0 0 1	- 1 1 0 0	MSR	Activate required
Read Device ID - light-pen ¹²	1 0 1 0	- 1 1 0 0	Light Pen	Activate required
Read Immediate Field	0 0 0	1 1 0 0 1	Base	Activate required
Read Between Limits	0 0 0	1 1 0 1 0	Base	Activate required
Read to End of Line	0 0 0	0 1 0 1 0	Base	Activate required
Read to End of Field	0 0 0	1 1 0 0 0	Base	Activate required
Read Registers	0 0 0	1 1 1 0 0	Base	Activate required
Read Registers	0 1 0	1 1 1 0 0	Indicator	Activate required
Reset	0 0 0	0 0 0 1 0	Base	
Reset ¹²	1 0 0 1	- 0 0 1 0	MSR	
Reset ¹²	1 0 1 0	- 0 0 1 0	Light Pen	
Search Next Attribute	0 0 0	0 0 1 0 0	Base	
Search Next Null	0 0 0	1 0 1 0 0	Base	
Set Mode	0 0 0	1 0 0 1 1	Base	
Write Control Data	0 0 0	0 0 1 0 1	Base	
Write Data and Load Cursor	0 0 0	1 0 0 0 1	Base	
Write Data and Load Cursor	0 1 0	1 0 0 0 1	Indicator	
Write Data	0 0 0	1 1 1 1 0	Base	Activate required
Write Immediate Data	0 0 0	1 1 1 0 1	Base	Activate required

Figure 18 (Part 2 of 2). Command Matrix for 5251 Commands

2.4 Specific Command Formats

All commands pass from the host controller in the System Unit to the IBM 5251 model 11. Data words pass in either direction. Poll response words pass from the IBM 5251 model 11 to the controller.

2.4.1 Command to Keyboard and Base

2.4.1.1 Basic Format

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7,8,9	Base address, Device address, or Command Modifier
10-14	Command
15	Stop bit; always 1.

Figure 19. Basic Format for Commands to Keyboard and Base

2.4.1.2 Feature Format

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7-10	Feature Device Address
11-14	Command
15	Stop bit; always 1.

Figure 20. Feature Format for Commands

2.4.1.3 Data Word To or From Display

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address or End Of Message (111)
7-14	data character
15	Stop bit; always 1.

Figure 21. Data Word To or From Display

The device address field is not required for this format because it follows a command which explicitly addresses the devices.

2.4.2 System Response Time

System response is the time from when the keystroke scan code is first available in the poll response byte until the controller completes the transmission of the last data byte of a write or load command for processing and screen alteration by the display station.

System response is a function of what kind of key is pressed. For acceptable system performance when a key is pressed, the display action must occur within a relatively short time. This time is (in general) a function of the polling frequency to each attached display station and the speed at which, once having sensed an available scan code, the controller reads the scan code, interprets it, and responds with appropriate action.

The display station can store up to 4 keystrokes indefinitely until they are serviced by the controller. This keystroke queue acts as a buffer against high burst rate keying and for the infrequent times when an attached controller is busy with other tasks for extended times.

The polling strategy within a display controller should assure that the probability of exceeding 70 milliseconds from scan code availability to presentation to the workstation for display is less than 0.01 for data keys other than the first character of a field. A station must be polled for keystrokes at least 40 times during any 2 second interval, with no inter-poll time more than 270 milliseconds.

For system response times, once keystrokes have been detected, it is necessary to specify the field environment into which the keystrokes are entered. Assume a worst-case 20 character, alpha-only, right-adjust, check-digit field followed by similar fields of shorter length. For a 4-key sequence, all in the first field, no more than 200 milliseconds shall expire from the Poll command accessing the first key until the Poll command attempting to access a possible 5th key, with all 4 prior data keys completely serviced. If a field boundary is crossed, add 60 milliseconds for field exit processing by the controller. For a field exit key, add 250 milliseconds for response time.

2.4.3 Poll Command (Code = 10000)

This command is sent from the controller to the display and initiates the transfer of one or two poll response bytes. The base status is returned in 45 ± 15 microseconds. The first response time is measured from the time the parity bit is received at the station until the sync bit of the first response frame is transmitted. A frame and bit synchronization sequence precedes this frame.

A keyboard scan code is returned in a following frame after a specified fill delay (see 2.4.25, "Set Mode Command (Code = 10011)" on page 75). If no keystroke has been recognized since the last poll, a scan code of zero is returned. This second response frame is sent only if a Set Mode command has been processed by the station since its last reset (in addition, the 5251 model 11 requires a poll with bit 9 set in order to begin returning two response frames).

The last response frame to a Poll command contains a station address of 111. No fill is sent after this frame.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Station Address
7	Reserved: set to 0
8	Reset line parity error
9	Acknowledge bit (ACK)
10-14	Poll command: 10000
15	Stop bit; always 1.

Figure 22. Poll Command to Display Station

The Poll command solicits an immediate base and keyboard response of status and keyboard data. The command will cause a fixed length two-frame response to be made. The base status is returned first, followed by the keyboard data. At power on time, a single frame response is made containing base status only, until a Set Mode command is executed, and a poll command with frame bit 9 on is received.

No device address is associated with this command, as the base and keyboard always respond to the poll.

Bit 7 is reserved and should be set to 0.

Bits 8 and 9 in the poll frame are defined uniquely for this command. Bit 8 is used to acknowledge and reset the line parity error response bit from the base. This bit is not effective until a nonbusy base status has been received at the controller. Normally, bit 8 should be zero.

Bit 9 is used to acknowledge the last status transmission to allow new status to be sent. If bit 9 is at a 1 value, then updated responses are made whenever they are available. If bit 9 is at a 0 state, then the former response frames are resent, with the exception of real-time status bits. The former response frames may be re-sent any number of times. The real-time status bits are updated at all times.

2.4.3.1 Poll Response to Controller

The first poll response frame is always preceded by a frame synchronization sequence. A fixed length, two frame response will be made to every poll command after a Set Mode command defining interframe fill length and after the first poll command with bit 9 (ACK) set (5251-11 only). Prior to the execution of the Set Mode command, a single frame basic status will be returned only. In either case, the last frame of the response will contain a station address field of all ones designating the last message frame. The first frame in the response contains basic status information. Its format is as follows.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Station Address (or End Of Message (111) for one-frame poll response)
7	Busy
8	Line Parity Error Detected (LP)
9	Reserved
10	Outstanding Status (OS)
11-13	Exception Status
14	Level
15	Stop bit: always 1.

Figure 23. Poll Command Response Byte 1 from Display (Base Response Frame)

2.4.3.1.1 Display Poll Response Bit 7 - Busy:

- 0 = Not Busy (Work Queue Empty)
- 1 = Busy (Work Queue Not Empty or Activate Received)

Bit 7 is a real-time response bit, that is, it is updated continuously and bit 14 of the frame need not be tested first to find if this bit has been updated.

Once the first work queue entry has been received by the station, a Poll command received immediately afterward would have a busy base response status. A nonbusy, no-exception, no-line-parity-error status response must be received before issuing any Activate command.

See 2.7, "Internal Processing Queue" on page 80 for more information.

2.4.3.1.2 Display Poll Response Bit 8 - Line Parity Error:

- 0 = No line parity error detected
- 1 = Line parity error detected

Bit 8 is a real-time response bit. This bit is set immediately when invalid frame parity is detected in a received frame. The parity expected is even parity over bits 3 through 15 of every frame. Since the station address field may be invalid as the result of a parity error, every station that detects the invalid parity frame, regardless of address field content, will indicate the error. Note that in a multidrop environment, several but not necessarily all stations along one cable may "see" the invalid parity frame.

If multiple frames follow a frame synchronization sequence, invalid parity in frames after the first frame will not cause line parity errors in stations other than the one addressed in the first frame.

While the line parity bit is set in a workstation, the station will ignore any commands other than Poll regardless of the parity in the command.

Line parity error mode must be reset by the controller with a Poll command frame that has frame bit 8 on. The station must not be busy when this reset poll command is given. If the station receives this poll while busy, the line parity error bit is not reset. If the line parity error state has been reset by a reset parity poll command, bit 8 will be reset in the response to that particular poll command.

2.4.3.1.3 Display Poll Response Bit 9 - Reserved: Bit 9 is reserved.

2.4.3.1.4 Display Poll Response Bit 10 - Outstanding Feature Status:

- 0 = No outstanding feature status detected
- 1 = Outstanding feature status detected

This bit is never on unless a special feature I/O device is installed and needs attention. Availability of data at the magnetic stripe reader or light pen causes the bit to be set. The bit stays on until all outstanding special feature data or status is readied for transmission to the controller. Receiving and processing a Read Data or Reset command addressed to the device that has outstanding status resets the bit.

2.4.3.1.5 Display Poll Response Bits 11-13 - Exception Status: Bits 11-13 indicate exception status in the station.

Bits			Meaning
11	12	13	
0	0	0	No exception status
0	0	1	Null or attribute error
0	1	0	Invalid activate
0	1	1	Reserved
1	0	0	Invalid command or device address
1	0	1	Input queue or storage overrun
1	1	0	Invalid register value
1	1	1	Power on transition

Figure 24. Exception Status Coding in Poll Command Response

Exception status conditions are indicated in poll responses as soon as they are detected, without changing response levels (see bit 14 description). In testing for the IBM 5251 model 11 exception status, a display controller should wait for a nonbusy response before testing the exception field.

Whenever exception conditions occur, processing of further commands in the command input queue will be discontinued and the queue emptied, in all cases, of the commands remaining in the queue at the time the exception condition was detected. Once an exception condition occurs, only Poll, Set Mode, Reset (to base address) and Write Control Data commands will be processed, until the exception status is reset. In a power on transition status, a Set Mode or base Reset command is processed while a Write Control Data command is not.

To reset nonzero exception status conditions, a Write Control Data command with a reset bit (bit 12) on in the following data frame must be sent. The controller can determine if the reset action occurred by checking for nonbusy status after issuance of the Write Control Data command then noting the absence of the exception status. The power-on transition exception status must be reset with a Set Mode command.

The invalid command or device address exception status is caused when the station receives a command bit combination that is not defined in the command set. This condition also occurs when a device address is associated with a command that is not defined for the selected device. This exception also occurs whenever a valid command that has associated data frames is decoded at a position in the command queue such that not enough queue positions remain to contain all of the following data frames. If the associated data frames actually are received and cannot be stored, an input queue or storage overrun exception will replace the first exception.

The input queue or storage overrun condition occurs when more than 16 commands and associated data frames have been sent, or when an attempt is made to store data beyond the user accessible storage limits.

The power on transition exception condition is returned as the result of the first Poll commands received after power is applied or after processing a base Reset command. When this condition occurs, the base status frame will be the only frame sent in response to a Poll command. A Set Mode command must be received before this condition is reset.

2.4.3.1.6 Display Poll Response Bit 14 - Response Level: Successive Poll commands received before the station has been able to update a complete new response will cause retransmission of former status.

The controller will distinguish new responses from former responses with bit 14. The first response after powering up or resetting will be from level 0. The first two frame responses after receiving a Set Mode command will be from level 1.

While waiting for the Set Mode command to be completed, the display controller should poll with the ACK bit (bit 9) on. The controller may allow level transitions to occur by setting the ACK bit on in the Poll command.

Each time the station receives a Poll command with the ACK bit on, a new response level will be made available after a period ranging from 0 to 225 milliseconds when the station is in a nonbusy state. If a new response level is available for controller access when a Poll command with ACK on is received, the new level will be sent, and bit 14 will be changed from the last Poll response.

Alternatively, if a Poll command is received with ACK off, or a new level is not available, the old level will be sent, and bit 14 will not change since the last Poll command.

Real-time status response bits are not affected by response level transitions.

2.4.3.2 Poll Response Byte 2

The second response frame contains data and status from the keyboard. Its format is as follows.

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	End of Message (111)
7	Make/Break bit
8-14	Key Scan Code
15	Stop bit; always 1.

Figure 25. Poll Response byte 2 (Keyboard Response Frame)

Frame bits 7 through 14 contain a make/break bit and 7 bits of key scan code. The make/break bit will be on whenever the shift lock or shift keys are released, and the shift key scan code will accompany the make/break bit.

If no keystroke is available, bits 7 through 14 will be zeros.

If a keyboard overrun occurs, bits 7 through 14 will be all ones. In the event of an overrun condition, the keystrokes following the last valid scan code could not be stored for user access.

The display station disables the keyboard clicker when an overrun condition occurs at the display station. The clicker will remain disabled until the controller enables it via the Write Control Data command. Keystrokes during an overrun condition will be inaccessible to the controller. When the station is polled and sends the next keystroke to the controller, the overrun condition is terminated until another keystroke is detected that cannot be stored at the station. During a keyboard overrun condition, the station will still respond to commands from the controller; it will just ignore keystrokes until the overrun condition is cleared.

2.4.4 Write Control Data Command (Code = 00101)

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4-6	Station Address
7-9	Device Address (000)
10-14	Write Control Data Command (00101)
15	Stop bit: always 1.

Figure 26. Write Control Data Command

This command is followed by a data frame. The bits in the data frame accompanying the Write Control Data command are used as follows.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	End of Message (111)
7	Cursor Display Control. 0 = Display cursor 1 = Inhibit display of cursor Defaults to 0 upon powering up or resetting.
8	Reserved
9	Cursor Blink Control. 0 = Do not blink cursor 1 = Blink cursor. Defaults to 0 upon powering up or resetting.
10	Reserved. Controllers must set this bit to zero when issuing a Write Control Data command.
11	Background Control. 0 = Normal background 1 = Negative image background Defaults to 0 upon powering up or resetting.
12	Reset Exception Status 0 = Do not reset exception status 1 = Reset exception status.

Figure 27 (Part 1 of 2). Write Control Data Command Response Frame

Bit	Purpose
13	<p>Keyboard Clicker Control</p> <p>0 = Enable keyboard clicker 1 = Disable keyboard clicker.</p> <p>Defaults to 0 upon powering up or resetting.</p>
14	<p>Audible Alarm Control</p> <p>0 = No audible alarm 1 = Turn on audible alarm</p> <p>Alarm will sound for 1 second after a data frame following a Write Control Data command is received with bit 14 on.</p>
15	Stop bit; always 1.

Figure 27 (Part 2 of 2). Write Control Data Command Response Frame

2.4.5 Read Registers Command (Code = 11100)

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address (000)
10-14	Read Registers Command (11100)
15	Stop bit; always 1.

Figure 28. Read Registers to base device address

This command initiates the transfer of six data frames containing the contents of the three control registers, the address counter, the cursor register, and the reference counter in that order. Bits 7 through 14 of each data frame will contain bits of each register. The high order 8 bits of each register are transmitted prior to the low order 8 bits. An Activate command is required before data transfer is initiated.

2.4.5.1 Read Registers to Indicators

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address (010)
10-14	Read Registers Command (11100)
15	Stop bit; always 1.

Figure 29. Read Registers to discrete indicators

When the Read Registers command is addressed to the indicators a diagnostic log out area is returned in the Activate Read response. The length and content of the response is machine dependent. For 5251-11, the response is 6 frames long and formatted as follows:

1. Line Parity Error Count - This frame gives the number of line parity errors that have occurred since the last time the station was powered on or reset. The count value ranges from 0 to 255. This is a wrap-around count (255 back to 0), with no overflow indicated.
2. Exception Condition Count - This frame returns the number of exception conditions posted in the poll responses since powering up or resetting. It does not count the power on transition exception condition. The count value ranges from 0 to 255. This is a wrap-around count (255 back to 0), with no overflow indicated.
3. Last Exception Condition - This frame gives the last exception condition posted in the poll response since powering up or resetting. Power on transition exceptions are not logged. The exception condition bits are returned in frame bits 11, 12, and 13. Bits 7 through 10 and 14 are reserved.

- | 4. Last Command Prior to Exception - This frame records the last command detected as being ready for processing in the queue at the time the last exception condition occurred (operation and power on transition exceptions are excluded). Poll, Activate Read, and Activate Write commands are not recorded.
- | 5. Last Command - This frame contains the last command detected as being ready for processing from the queue.
- | 6. Reserved - This frame is reserved.

| An Activate command is required before data transfer of the 6 frames is initiated.

| A Read Registers command can result in the invalid device address exception condition if a device address other than the base or indicators is presented with the command.

2.4.6 Read Immediate Field Command (Code = 11001)

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4-6	Station Address
7-9	Device Address (000)
10-14	Read Immediate Field Command (11001)
15	Stop bit: always 1.

Figure 30. Read Immediate Field Command

This command sets up for the transfer of a display field of data to the controller. The starting address of the transfer will be contained in two frames following the command frame. The high order address bits are contained in bits 7 through 14 of the first frame to follow, while bits 7 through 14 of the second following frame contain the low order address bits. Data transfer is terminated when the next field attribute is encountered in the regeneration buffer or when the end of the regeneration buffer is reached. The address counter is not changed by this command. An End Of Queue (EOQ) command must follow the Read Immediate Field command. An Activate Read command is required before data transfer is initiated.

The actual data transfer following the associated Activate Read command does not alter the address counter. A Read Immediate Field command can result in the invalid device address exception condition if a device address of other than the base was presented with the command. The invalid register value exception condition will result if the address presented with the command does not lie within the installed storage area.

If the immediate address points to an attribute, a null or attribute exception condition will result.

2.4.7 Read Data Command (Code = -1000)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-10	Feature Address
11-14	Read Data Command (1000)
15	Stop bit; always 1.

Figure 31. Read Data Command

The Read Data command is addressed to the magnetic stripe reader. It initiates the transfer of a 16 byte block of data. An Activate command is needed before data transfer will start. A Read Data command will not result in an invalid device address condition if the address of an uninstalled or undefined feature device is presented with the command. Instead, 16 data bytes of all zeros are returned with no exception condition.

Note that this command is always issued with a feature address, not a base address.

2.4.7.1 Read Data Word for Light Pen

The row address value is returned first, followed by the column address value.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station address
7	Light Pen installed. This bit is 1 if light pen is installed; it is 0 otherwise.
8	Tip switch depressed. If this bit is set to 1 and bits 7-14 do not equal X'FF', the tip switch has been depressed.
9	Reserved
10-14	Row number (0 to 25)
15	Stop bit; always 1.

Figure 32. Read Data Command - First Light Pen Response Frame

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station address
7	Reserved.

Figure 33 (Part 1 of 2). Read Data Command - Second Light Pen Response Frame

Bit	Purpose
8-14	Column number (1 to 84).
15	Stop bit; always 1.

Figure 33 (Part 2 of 2). Read Data Command - Second Light Pen Response Frame

The activity sequence of issuing a Read Data command addressed to the light pen device and waiting for a non-busy, no exception status before issuing an Activate Read will return 16 frames of response from the light pen. The returned frames are composed of 8 pairs of CRT row and column counter values. The first two frames of data returned by the light pen are considered valid data. The remaining frames are ignored.

The values returned will be physical row and column designations independent of model and screen size. The row values returned will range from 0 to 25 since the actual physical display format is 24 displayable lines of data and 2 diagnostic lines. When the row or column value is X'00' or X'FF', this indicates that the pen is not pointing to an illuminated area. The valid column values may range from 1 to 84, due to variations in phosphor. Column values greater than 84 will be ignored. Each column value has a tolerance of 0 to -4 depending on phosphor delays.

The light pen feature will cause the outstanding status bit in the first poll response byte to be turned on when a pre-select condition ("Wandering") occurs, or when the tip switch is depressed. When the outstanding status bit is set on, the sequence of Read Data, Read Activate is sent to the light pen feature and the data returned to the system. Row values of X'FF' cause all data frames to be discarded by the system.

2.4.7.2 Read Data Word for Magnetic Stripe Reader

Bit	Purpose										
0,1,2	Fill bits; always zero.										
3	Parity bit: set for even parity in the frame										
4-6	Station address										
7	MSR installed. This bit is 1 if MSR is installed; it is 0 otherwise.										
8	Error 0 = No error 1 = Reader error										
9	Last 0 = Not the last character 1 = Last character of data										
10	Parity bit for character										
11-14	Character. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Bit</th> <th>Bit Number of MSR Character</th> </tr> </thead> <tbody> <tr> <td>11</td> <td>8</td> </tr> <tr> <td>12</td> <td>4</td> </tr> <tr> <td>13</td> <td>2</td> </tr> <tr> <td>14</td> <td>1</td> </tr> </tbody> </table>	Bit	Bit Number of MSR Character	11	8	12	4	13	2	14	1
Bit	Bit Number of MSR Character										
11	8										
12	4										
13	2										
14	1										

Figure 34 (Part 1 of 2). Read Data Command - MSR Response Frame

Bit	Purpose
15	Stop bit; always 1.

Figure 34 (Part 2 of 2). Read Data Command - MSR Response Frame

This format does not need a device address because it explicitly follows a Read Data command addressed to that device.

When an Activate Read command is received after busy has dropped, 16 data frames containing up to 16 characters are returned. The response is always 16 frames long even if less than 16 characters are to be sent.

If no data is present, the read data word response has all zeros in positions 10 through 14.

Outstanding feature status (bit 10) in the first poll response byte remains on until the first magnetic stripe data character is readied for transmission. This bit cannot be set on by any magnetic stripe reader activity until the last data character is readied or the reader is reset.

A Reset command addressed to the magnetic stripe reader device address clears this bit and all data remaining in the reader.

Valid codes for the MSR feature follow.

Hex	P	8	4	2	1	Character
0	1	0	0	0	0	0
1	0	0	0	0	1	1
2	0	0	0	1	0	2
3	1	0	0	1	1	3
4	0	0	1	0	0	4
5	1	0	1	0	1	5
6	1	0	1	1	0	6
7	0	0	1	1	1	7
8	0	1	0	0	0	8
9	1	1	0	0	1	9
A	1	1	0	1	0	: (or secure data indicator)
B	0	1	0	1	1	% (or start of message indicator)
C	1	1	1	0	0	@
D	0	1	1	0	1	~ (or circumflex)
E	0	1	1	1	0	=
F	1	1	1	1	1	? (or end of message indicator)

Figure 35. MSR feature data codes

The first character sent is the start-of-message character followed by up to 125 message characters, an end of message character, and an LRC character.

The LRC character is calculated by exclusive ORing each MSR data character with an accumulator that is initially zero. When all data characters, including the LRC character have been XORed together the accumulator value should be zero. Bits 7, 8, 9, and 10 are not included in LRC calculations. Data from the MSR card is stored in the MSR attachment logic where it remains until entirely read out or until the MSR receives a Reset command. No new data is accepted until the current data is read out entirely or the MSR is reset.

2.4.8 Read Device ID Command (Code = 01100 and -1100)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Read Device ID Command (01100)
15	Stop bit; always 1.

Figure 36. Read Device ID Command - base

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-10	Feature Address
11-14	Read Device ID Command (1100)
15	Stop bit; always 1.

Figure 37. Read Device ID Command - feature

This command starts the transfer of one data word from the addressed device. The device ID word from the base contains information about the characteristics of the station. Other special feature devices return an ID word with the device characteristics of the installed special feature. If a special feature device is not installed, bits 7 through 14 of the returned frame are zero.

A Read Device ID command to the indicators returns a field of zeros.

Read Device ID command to the model ID should not be sent to printers.

An Activate command is needed before data transfer will start.

2.4.8.1 Base ID Word

The response to a Read Device ID command to the base device address (000) follows:

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	End Of Message (111)
7,8	<p>Model identifier</p> <p>For display terminals:</p> <p>00 = Reserved 01 = 5252 model 1 (supported on the System/38 Work Station Controller only) 10 = 5251 model 1 (supported on the System/38 Work Station Controller only) 11 = 5251 model 11 (all display terminals other than 5251 model 1 and 5252 model 1 return 11 in this field)</p> <p>Printers have a different use for this field.</p>
9,10	<p>Device type identifier</p> <p>00 = Display (for all displays) 01 = Reserved 10 = Printer 11 = Reserved</p>
11-14	<p>0000 = Reserved 0001 = 5251 model 1 or 5252 model 1 (supported on the System/38 Work Station Controller only) 0010 = all displays except 5251 model 1 and 5252 model 1 1000 = Data Transfer Passthru display Remainder = Reserved</p>
15	Stop bit; always 1.

Figure 38. Read Device ID to base device address

2.4.8.2 Model ID Word

The response to a Read Device ID command to the model feature address (1000) follows:

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	End Of Message (111)
7-14	Terminal type identifier
15	Stop bit; always 1.

Figure 39. Read Device ID to model ID word feature address

Bits 7-14 are interpreted as follows. Bit patterns that are not defined below are reserved.

Value	Terminal type
X'00'	5251 model 11, 5251 model 1, or 5252 model 1 (5251 model 1 and 5252 model 1 supported on the System/38 Work Station Controller only)
X'80'	5291 model 1 or 5291 model 2
X'50'	3197 model C
X'40'	5292 model 1 or 3179 model 2
X'41'	5292 model 2
X'42'	3179 model 2 with right-to-left feature
X'24'	3197 model D/model W or 3477
X'20'	3180 model 2
X'10'	3196 or 3476

2.4.8.3 Keyboard ID Word

The response to a Read Device ID command to the keyboard device address (001) follows.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	End Of Message (111)
7-14	Keyboard Type
15	Stop bit; always 1.

Figure 40. Read Device ID Command - Keyboard ID Word

Bits 7 through 14 are defined as follows. Bit combinations not defined below are reserved.

Bits 7-14	Meaning
0000 0000	No keyboard attached
0000 0010	Typewriter (data processing) keyboard
0000 0100	Data Entry Keyboard
0000 0101	Data Entry Keyboard with inverted 10 key option (proof option)
0000 1010	World Trade or Katakana typewriter keyboard
0000 1011	International typewriter keyboard
0000 1100	World Trade or Katakana data entry keyboard
0000 1101	World Trade or Katakana data entry keyboard with inverted 10 key option (proof option)
1000 0010	Enhanced Keyboard (3179-2, 3196, and 3197 only)
1000 1010	Enhanced World Trade Keyboard (3179-2, 3196, and 3197 only)
1000 1100	Enhanced Katakana Keyboard (3179-2, 3196, and 3197 only)

Figure 41. Keyboard ID Word - Response Decoding

2.4.8.4 Feature ID Word (MSR)

The response to a Read Device ID command to the MSR device address follows.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4-6	End Of Message (111)
7	MSR installed. This bit is 1 if MSR is installed; it is 0 otherwise.
8-14	Reserved
15	Stop bit: always 1.

Figure 42. Read Device ID Command - MSR Feature ID Word

2.4.8.5 Feature ID Word (Light Pen)

The response to a Read Device ID command to the Light Pen device address follows.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4-6	End Of Message (111)
7	Light Pen installed. This bit is 1 if Light Pen is installed; it is 0 otherwise.
8-14	Reserved
15	Stop bit: always 1.

Figure 43. Read Device ID Command - Light Pen Feature ID Word

2.4.9 Read Between Limits Command (Code = 11010)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Read Between Limits Command (11010)
15	Stop bit; always 1.

Figure 44. Read Between Limits Command

The Read Between Limits command causes data to be returned from an area in storage delimited by the address counter register and the reference counter register. Transfer starts with the byte pointed to by the address counter and terminates with passage of the byte pointed to by the reference counter.

At termination of data transfer following the associated Activate Read command, the address counter points to the last character transferred plus one position. The reference counter is unchanged.

An exception status results if the register contents are invalid at the time the Read Between Limits command is decoded; such as address counter is greater than the reference counter, or either register points to an invalid address.

An Activate Read command is required before data transfer is initiated.

2.4.10 Read to End of Line Command (Code = 01010)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit: set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Read to End of Line Command (01010)
15	Stop bit; always 1.

Figure 45. Read To End of Line Command

The Read to End of Line command causes data to be returned from an area in storage delimited by the address counter register and the end of the current logical row. Transfer starts with the byte pointed to by the address counter and terminates when the last byte on the current logical row has been transmitted.

At termination of data transfer following the associated Activate Read command, the address counter points to the last character transferred plus one position.

An exception status results if the register contents are invalid at the time the Read to End of Line command is decoded; such as address counter points to an invalid address (not within the presentation space).

An Activate Read command is required before data transfer is initiated.

2.4.11 Read to End of Field Command (Code = 11000)

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Read to End of Field Command (11000)
15	Stop bit; always 1.

Figure 46. Read To End of Field Command

The Read to End of Field command causes data to be returned from an area in storage delimited by the address counter register and the next attribute within the presentation space. Transfer starts with the byte pointed to by the address counter and terminates when the address counter points to an attribute. The attribute will not be transmitted.

At termination of data transfer following the associated Activate Read command, the address counter points to the attribute position.

An exception status results if the register contents are invalid at the time the Read to End of Field command is decoded; such as address counter points to an invalid address (not within the presentation space). An Operation Exception will be indicated if the address counter points to an attribute. An Operation Exception will also be indicated following processing of the Activate Read command if no attributes are found between the location pointed to by the address counter and the end of the presentation space.

An Activate Read command is required before data transfer is initiated.

2.4.12 Reset Command (Code = 00010 Base, -0010 Feature)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Reset Command (00010)
15	Stop bit; always 1.

Figure 47. Reset Command - Base

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-10	Feature Address
11-14	Reset Command (0010)
15	Stop bit; always 1.

Figure 48. Reset Command - Feature

The Reset command may be addressed to a special feature device or to the base.

The Reset command to the base causes the power up diagnostics to be executed. This takes the station off-line (no poll response) for approximately five seconds. If the CE test switch is in the "test" position while executing a Reset command, the station remains off-line and continually re-executes the diagnostics until the switch is returned to the "normal" position.

Reset causes the cursor, address counter, and reference counter to be set to reference the upper left corner display position. However, the apparent actual cursor position after a base reset, or after powering up is the upper right corner.

Once the base reset is completed, a single frame, power on transition status response is made to polls. Additionally, display attributes are set to normal intensity, non-blink, and not reverse image. The regeneration buffer area is cleared to nulls.

A base reset procedure can take place automatically, without the issuance of the Reset command. See the Automatic Reset Procedures section.

Reset commands to the magnetic stripe reader or light pen reset any error status clear any data remaining in the device. A Reset command to the keyboard or indicators causes an invalid device address exception status. A Reset command addressed to an uninstalled or undefined device does not cause an exception status.

A Reset command to the base will reset the magnetic stripe reader and light pen.

2.4.13 Clear Command (Code = 10010)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Clear Command (10010)
15	Stop bit; always 1.

Figure 49. Clear Command

This command clears the addressed device starting from the present value of the address counter to the present value of the reference counter, inclusive. No register values are changed when this command is executed. The clear value will be nulls. An invalid register value exception condition results if the address counter value does not lie within the installed user accessible storage, or if the address counter value is greater than the reference counter value.

2.4.14 Write Data Command (Code = 11110)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Write Data Command (11110)
15	Stop bit; always 1.

Figure 50. Write Data Command

This command is used to initiate a data transfer to the workstation. The first byte of data received is placed at the location pointed to by the Address Counter. Additional bytes are placed in adjacent ascending memory locations. The Address Counter will point to the last byte received plus one following the processing of the Activate Write command.

The Write Data command must be the last command of a queue load.

An Activate Write command must follow the Write Data command after a nonbusy, no-exception status response is made to a Poll command.

The Write Data command can cause an invalid device address exception condition if a device address of other than the base is presented in the command frame. If the Address Counter value does not lie within the installed user accessible storage, an invalid register value exception condition results. If more data frames are transmitted than can be stored in user accessible storage, a storage overrun exception condition results, and excess data is not stored.

2.4.15 Write Immediate Data Command (Code = 11101)

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Write Immediate Data Command (11101)
15	Stop bit: always 1.

Figure 51. Write Immediate Data Command

This command is followed by two data words. The starting address of the transfer is specified by these data words. The high order address bits are contained in bits 7 through 14 of the first frame to follow, while bits 7 through 14 of the second following frame contain the low order address bits.

An End Of Queue (EOQ) command must follow the Write Immediate Data command.

An Activate Write command must follow the Write Immediate Data command after a nonbusy, no-exception status response is made to a Poll command.

The address counter is not affected by this command or the data transfer activity following it.

The Write Immediate Data command can cause an invalid device address exception condition if a device address of other than the base is presented in the command frame. If the immediate address value does not lie within the installed user accessible storage, an invalid register value exception condition results. If more data frames are transmitted than can be stored in user accessible storage, a storage overrun exception condition results, and excess data is not stored.

2.4.16 Write Data and Load Cursor Command (Code = 10001)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Write Data and Load Cursor Command (10001)
15	Stop bit; always 1.

Figure 52. Write Data and Load Cursor Command

This command is followed immediately by one or more data frames. The data is stored at the location contained in the address counter. The address counter is incremented after storage of each data frame. The cursor register is then set equal to the address counter. No Activate Write command is required or allowed between command and data frames.

When more than one frame is to follow the command frame, a binary count value of X'02' up to X'0E' must be sent in the frame following the command frame. A count value of X'01' is optional. Data byte values X'01' through X'0E' cannot be stored as single frames. The number of frames may not exceed command queue storage area remaining at the time the command is issued. This is at most 14 data frames.

This command may cause an invalid device address exception condition if issued to a base format device address not valid for the command. If the address counter value is not within accessible limits, an invalid register value exception condition will occur. The associated data frames will not be stored in either case. If the address counter is incremented beyond accessible limits, a storage overrun exception condition will occur, with data stored through the limiting address.

2.4.16.1 Discrete Indicators Data Word

This data word format is used only with the Write Data and Load Cursor command addressed to indicators. A data word from the controller contains indicator bits as follows.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	End Of Message (111)
7	Message waiting
8	Reserved
9	Keyboard shift
10	Katakana shift
11	Insert mode

Figure 53 (Part 1 of 2). Discrete Indicators Data Word

Bit	Purpose
12	Diacritic indicator
13	Input inhibited
14	Reserved
15	Stop bit; always 1.

Figure 53 (Part 2 of 2). Discrete Indicators Data Word

The System Available light is developed by the display station. As long as the station receives commands addressed to it within any 200 millisecond period, this indicator will stay on.

2.4.17 Load Address Counter Command (Code = 10101)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Load Address Counter Command (10101)
15	Stop bit; always 1.

Figure 54. Load Address Counter Command

This command must be followed by two data words. It causes bits 7 through 14 of the data words to be written in the address counter. Address counter bits 0 through 7 are loaded from the first word; bits 8 through 15 are loaded from the second word.

An invalid address exception condition will occur if the device address is not the base address.

The value of the address counter is not checked for validity when it is loaded.

2.4.18 Load Reference Counter Command (Code = 00111)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Load Reference Counter Command (00111)
15	Stop bit; always 1.

Figure 55. Load Reference Counter Command

This command, followed by two data words, will load the reference counter. Address counter bits 0 through 7 are loaded from the first word; bits 8 through 15 are loaded from the second word. An invalid device address exception condition will occur if the device address field does not contain the base address.

2.4.19 Load Cursor Register Command (Code = 10111)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Load Cursor Register Command (10111)
15	Stop bit; always 1.

Figure 56. Load Cursor Register Command

This command must be followed by two data words. It causes bits 7 through 14 of the data words to be written in the cursor register. Address counter bits 0 through 7 are loaded from the first word; bits 8 through 15 are loaded from the second word.

An invalid address exception condition will occur if the device address is not the base address.

2.4.20 Search Next Attribute Command (Code = 00100)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Search Next Attribute Command (00100)
15	Stop bit; always 1.

Figure 57. Search Next Attribute Command

This command causes the addressed station to search its buffer for the next attribute. The location of the attribute minus one will be in the reference counter when the command is successfully completed. The search starts at the current value of the address counter, proceeding until an attribute is found, or the end of accessible buffer is reached. The address counter is not altered by this command. If no attribute is found, the reference counter is unchanged and a null or attribute error exception status is set.

An invalid device address exception will occur if the device address field does not contain the base address. An invalid register value exception condition is set when the address counter is not within accessible limits.

2.4.21 Search Next Null Command (Code = 10100)

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Search Next Null Command (10100)
15	Stop bit; always 1.

Figure 58. Search Next Null Command

This command will cause the addressed station to search the buffer for the next null (X'00'). The location of the null minus one will be available in the reference counter after a successful search. The search starts at the current value of the address counter, proceeding until a null is found, or the reference counter value is reached. The address counter is not altered by this command. The byte located at the reference counter value is checked for null before the search fails. If no null is found, the reference counter is unchanged and a null or attribute error exception status is set.

An invalid device address exception will occur if the device address field does not contain the base address. An invalid register value exception condition is set when either the address counter or reference counter is not within accessible limits, or when the address counter is greater than the reference counter.

2.4.22 Move Data Command (Code = 00110)

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Move Data Command (00110)
15	Stop bit: always 1.

Figure 59. Move Data Command

This command moves data between limits established by the value of the address counter and the value of the cursor register. The data is moved to the value of the reference counter register. The command acts by reading a byte at the address counter location, moving the byte to the location designated by the reference counter, and then updating the address and reference counters. If the address counter is initially less than or equal to the cursor value, the address counter and reference counter are incremented when updating. When the address counter is greater than the cursor, the address counter and the reference counter are decremented after each transfer.

The Move Data command will terminate after the transfer of the byte stored at the cursor location. When the command terminates, the address counter will be one greater than the cursor register when the address counter was incrementing and will be one less than the cursor register when the address counter was decrementing. In a similar manner, the reference counter will point one position beyond the last position stored upon termination.

If this command is not addressed to the base, an invalid device address exception condition results. If either the address counter, cursor, or reference counter registers contain a value not within accessible limits, an invalid register value exception condition results, and the command is not carried out. The storage overrun exception condition occurs when the reference counter would be updated beyond accessible storage limits. In this case, data has been moved until the exception condition was detected.

2.4.23 Exchange Command (Code = 10110)

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Exchange Command (10110)
15	Stop bit; always 1.

Figure 60. Exchange Command

This command will exchange the data bounded by the address counter and the cursor register inclusive with the data in an area indicated by the reference counter. Data will be exchanged one byte at a time between the locations pointed to by the address counter and the reference counter. After each data exchange, the address counter and reference counter will be updated as follows:

- If the address counter was initially less than or equal to the cursor register, the address counter and the reference counter are incremented by one.
- If the address counter was initially greater than the cursor register, the address counter and reference counter are decremented by one.

The command will terminate after the data stored at the location pointed to by the cursor register has been exchanged and the address counter and reference counter have been updated.

If this command is not addressed to the base, an invalid device address exception condition results. If either the address counter, cursor, or reference counter registers contain a value not within accessible limits, an invalid register value exception condition results, and the command is not carried out. The storage overrun exception condition occurs when the reference counter would be updated beyond accessible storage limits.

2.4.24 Insert Character Command (Code = 00011)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Insert Character Command (00011)
15	Stop bit; always 1.

Figure 61. Insert Character Command

This command is followed by one data frame containing a character to be inserted at the address counter location. The command is processed as follows.

1. The reference value is checked for a valid accessible storage address. If the reference counter value is greater than accessible storage limits, or is less than the address counter value, an invalid register value exception condition results, and no further processing of this command takes place.
2. If the byte in storage at the reference counter address value is not a null (X'00'), then a null or attribute error exception condition occurs, and no further processing of this command takes place.
3. The contents of storage are shifted one position into the next highest storage address in a region delimited from the address counter to the reference counter. The null formerly at the reference counter is overlaid.
4. The character to be inserted is stored at the address counter location.
5. The address counter is incremented by one and then stored into the cursor register.

If the command is addressed to other than the base, an invalid device address exception condition results.

2.4.25 Set Mode Command (Code = 10011)

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Set Mode Command (10011)
15	Stop bit; always 1.

Figure 62. Set Mode Command

This command will cause the display station to accept a mode control word, which must follow the command. This command must be issued before any multiframe response is made by the station.

If this command is addressed to any device other than the base, an invalid device address exception condition results. The mode control word definition follows.

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	End Of Message (111)
7-11	These bits specify, in binary, the number of times an 8-bit zero fill increment is repeated between consecutive frames in response to a Poll or Activate Read command. The maximum value allowed is 30. If 31 is specified, 30 fill frames are transmitted.
12-14	Reserved
15	Stop bit; always 1.

Figure 63. Set Mode Control Word

2.4.26 Activate Commands (Code = 00000, 00001)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Activate Read Command (00000)
15	Stop bit; always 1.

Figure 64. Activate Read Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4-6	Station Address
7-9	Device Address
10-14	Activate Write Command (00001)
15	Stop bit; always 1.

Figure 65. Activate Write Command

An activate command is inserted between a block data transfer (preactivate) command and the data frames following.

A preactivate command is defined as one of the following.

- Read Data (addressed to Magnetic Stripe Reader)
- Read Immediate Field
- Read Limits
- Read Registers
- Read Device ID
- Write Immediate Data

Activate Read (00000) is associated with the Read commands, while Activate Write (00001) is associated with the Write Immediate Data command.

The activate commands themselves do not make use of the device address field. The device is selected by the preactivate command.

Poll commands must be used after preactivate commands to wait for a nonbusy, no-exception status. No other commands, except an End Of Queue command (delimiter) may be sent to a station between the preactivate command and its associated activate. Once a nonbusy and no-exception status is returned, the Activate command can be issued to allow data transfer to proceed.

The reception of an Activate command will cause a busy status to be returned on subsequent polls. An EOQ command (delimiter) or another queue load must be sent following the data transfer to cause a nonbusy status again.

If an Activate Read command is received while still busy or exception status is set, no response is made. If an Activate Write command is received under the same circumstances, no data will be accepted and stored.

2.4.27 End of Queue Delimiter (Code = 01100010)

The EOQ command (delimiter) has the following format.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4-6	Station Address
7-14	End of Queue Delimiter Command (0110001)
15	Stop bit: always 1.

Figure 66. End of Queue Delimiter Command

After this command is sent, only the Poll command will be accepted by the display station until a not-busy status is returned in response to a Poll command.

2.5 Protocol Related Error Procedures

Once a line parity error is detected by a station, that station will not accept any following commands until a status response indicating a line parity fault has been sent and acknowledged by being reset.

2.6 Automatic Reset Procedures

Whenever the system available indicator remains off for more than 2 seconds, and the station is not in power-on transition status, and the Status switch is in the Normal position, a reset procedure is automatically started by the station. When the Status switch is in the Test position, no automatic reset action occurs. When the station is in power on transition status, no further resets occur.

2.7 Internal Processing Queue

Each station keeps a work area large enough to hold up to 16 frames of commands or associated data. Commands and associated data are processed from this queue area on a first in-first out (FIFO) basis. Commands that require a following activate command must be placed last on the queue; no more commands other than Poll or EOQ will be accepted until after the Activate command has been received. Once the Activate command has been received, and the associated data transfer has completed, another string of commands (queue load) can be sent immediately without waiting for a nonbusy status. An end of queue designator at least must be transmitted to cause a nonbusy status to be returned later.

Whenever a nonbusy status is returned, the queue has been emptied and all commands on the queue have been executed; the queue is available again for up to 16 commands and associated data frames.

The queue loading process must be completed by issuing a command that designates the end of queue. This designator could be either a command requiring activation, or an EOQ command (delimiter). Once an EOQ designator has been transmitted, no commands except Poll will be processed, until a not-busy status is returned to a Poll command.

If all 16 queue entries are loaded, no EOQ designator need be issued. However, if all 16 queue locations are loaded, the last frame cannot contain all '1' bits in frame bits 7 through 14.

It is sufficient to terminate all queues with the EOQ command (delimiter), but not necessary after a command requiring activation (except Read Immediate or Write Immediate) is loaded to the queue.

Commands which are queueable:

- Clear
- End of Queue Delimiter
- Insert Character (with 1 data frame)
- Load Address Counter (with 2 associated data frames)
- Load Cursor Register (with 2 associated data frames)
- Load Reference Counter (with 2 associated data frames)
- Move Data
- Read Data
- Read Immediate Field
- Read Limits
- Read Registers
- Read Device ID
- Reset
- Search Next Attribute
- Search Next Null
- Set Mode (with 1 data frame)
- Write Control Data (with 1 data frame)
- Write Data Load Cursor (with associated data frames)
- Write Immediate Data

Commands which must be placed last on the queue:

- End of Queue Delimiter
- Read Data

- Read Limits
- Read Registers
- Read Immediate Field
- Read Device ID
- Write Immediate Data

Once the queue is not empty, a busy status is set. Activate commands, while not stored in the queue, will cause a busy status to be set as well. The station remains busy until an EOQ designator has been processed and status has been updated.

2.8 Registers

Each station contains three control registers that the host controller can access. Each register serves as an address pointer into the buffer. The registers are named the cursor register, the address counter register, and the reference counter register.

The cursor register controls the location of the cursor on the display. The address counter is used in reading data from, and as well as writing data to, the buffer. The reference counter returns attribute or null location values to the controller. The reference counter is also used for moving data from one area of the buffer to another.

Buffer addressing is represented in binary sequential organization. Thus, the upper left display position of a 5251 model 11 is assigned location X'0000', and the lower right position is assigned X'077F'. The number of user accessible storage positions for an IBM 5251 model 11 is 2000. The number of user accessible storage positions for an IBM 5251 model 1 or an IBM 5252 model 1 is 1000. (The 5251 model 1 and the 5252 model 1 are supported on the System/38 Work Station Controller only.)

2.9 Commands and Data to the IBM 5251 model 11

An IBM 5251 model 11 is capable of accepting consecutive 16-bit frames at a 1.0 MHz ($\pm 2\%$) bit rate. The controller may present data frames at any frame rate up to 16 microseconds per frame.

Prior to command transmission, the transmission system must be conditioned to ensure that bit and frame synchronization can be achieved. This requires the transmission of a five-bit line bit synchronization that synchronizes the receiver's clocks to the incoming pulses, and a three-bit frame synchronization pattern that delimits the start of a command message sequence.

No two commands may follow one another closer than 30 microseconds from the transmission of the last bit in the first command, until the first bit of the bit synchronization pattern of the second command. Following the transmission of a Set Mode command frame used to remove power-on transition status, each succeeding command frame must be transmitted within 256 microseconds of the preceding command frame, until an end of queue designator is transmitted.

Similarly, the same requirement is made for each command frame following a Write Control Data command when employed to reset an exception condition. Finally, after transmission of the first command frame into the queue following an Activate command data transfer, each succeeding command frame must be transmitted within 256 microseconds of the preceding command frame, until an end of queue designator is transmitted.

2.10 Responses and Data From an IBM 5251 Model 11

The Poll and Activate Read commands will respond in 45 ± 15 microseconds. The poll or activate read response time is measured from the time the parity bit is received at the station until the sync bit of the first response frame is transmitted. Data transfers from an IBM 5251 model 11 at 1.0 MHz ($\pm 2\%$) data bit rate. The inter-frame interval may be adjusted from zero to approximately 240 microseconds in increments of 8 microseconds with the set mode command.

The station will be capable of responding with the proper scan code available in its status response in no greater than 40 milliseconds after a key is depressed when no other keys are stored in the station.

2.11 Command Execution

When an command requiring an activate command is decoded, an IBM 5251 model 11 will indicate "not busy" within 1 millisecond.

2.12 Performance Measurement

Factors that influence system performance at the IBM 5251 model 11 to controller interface include the following.

1. The time that a station is busy executing a command. This should be minimized for optimum performance.
2. The interpoll interval while waiting for a nonbusy status. This interval should be minimized for optimum performance.
3. The controller reaction time once a nonbusy poll response occurs, such as the time interval until the next command is transmitted. This time should be minimized for optimum performance.
4. Interframe fill time should be minimized.
5. Selection of proper command streams to implement the desired function.
6. Degree to which controller has overlapped processing time with respect to the station. It is recommended that the controller perform concurrent processing with the station by interfacing with other stations or the host while the station is busy.

The performance measurements that follow apply to an IBM 5251 model 11 when the following conditions apply:

1. There is no outstanding feature status from a special feature device.
2. The keyboard does not require servicing (no keystrokes).
3. Host is polling with the Poll frame bit 9 off when waiting for a nonbusy state.

4. The fill count as specified in a Set Mode command is 0.
5. All data frames associated with a command are transmitted within 240 microseconds of command transmission.
6. Any command sent while the station is busy arrives before execution of the prior command is completed.
7. Audible alarm is not in operation, and the station is between system available indicator sample times.
8. No feature microprogram ROS is installed.
9. The status switch is in the Normal position.

The figures given here reflect the **maximum allowable** time taken to execute the various commands once they have arrived in the work queue of the display station. The observed response time may be unacceptable if more than one work station operating at maximum specifications is on the same line to a System Unit.

The following times are given in milliseconds. They represent **maximum allowable** execution times subject to the preceding assumptions. For the first command in a given queue load, add 0.8 milliseconds.

Set Mode	3.0
Reset to Base	1.8, then no response for approximately 4 seconds.
Write Control Data	3.0
Load Address Counter	2.2
Load Reference Counter	2.2
Load Cursor	2.5
Write Data and Load Cursor	3.2 for 1 character stored (2.0 + 1.600N) for N > 1 characters stored addressed to indicators: 4.0
Clear	N is the number of bytes cleared: 2.0 + 0.054N for 1 ≤ N ≤ 36 3.5 + 0.012N for 36 < N ≤ 2128
Search Attribute	1.9 + 0.12N, where N is the number of bytes searched. For each 564 bytes searched, add 2.5.
Search Null	3.3 + 0.15N, where N is the number of bytes searched. For each 676 bytes searched, add 3.7.
Move	5.1 + 0.04N where N is the number of bytes moved
Insert Character	2.4 + 0.020N where N is the number of bytes shifted.
End of Queue (EOQ)	0.75 when accompanied by other commands. 2.3 when sent alone in queue.

Time is measured until a nonbusy poll response is available.

2.12.1 Preactivate Commands

Each preactivate command has two times associated with it. The first value gives the time to decode and execute the preactivate command itself (until busy drops), while the second value is the maximum time that can occur after the Activate command and data transfer have completed, until the station can begin processing the next command. This latter time is referred to as "post-activate recovery" and is dependent upon the preactivate command issued and the length of the data transferred.

2.12.1.1 Time In Milliseconds

Command	Preactivate	Post-Activate Recovery
Read Data (Feature)	9.3	2.4
Read Device ID (Base)	3.4	2.4
Read Device ID (Feature)	9.3	2.4
Read Immediate Field	4.4	2.4
Read Registers	3.0	2.4
Read Limits	4.1	3.0
Write Immediate Data	4.0	2.4

3.0 Printer Interface

For information about physical characteristics of the twinaxial cable, cabling considerations, electrical interface, and description of the bit stream, refer to those topics in 1.0, "Physical Characteristics of the Twinaxial Cable" on page 1.

For a list of the printers supported locally on twinaxial cable, see 3.5.2.1, "Printer ID Word" on page 98.

Throughout the text in this section, information pertaining to the 3812 pertains to the 3816 as well. Therefore, 3812 should be read as "3812 or 3816".

Cable through is a feature on all printers except for the 4210, 4224, 4245, and 3197-attached printers. The 4210, 4224, 4245, and 3197-attached printers use the "T-connector" to connect to twinaxial cable. The T-connector provides cable through function. All supported printers allow their twinaxial cable address to be set, except those that do not have the cable through feature. The 4224 and 4245 have address selection capability.

3.1 Protocols and Synchronization

The printer will never initiate a transaction to or from the attaching controller. All such transactions are explicitly initiated from the attaching controller via a command. The flow is in half duplex. Some typical flows are shown in the charts that follow.

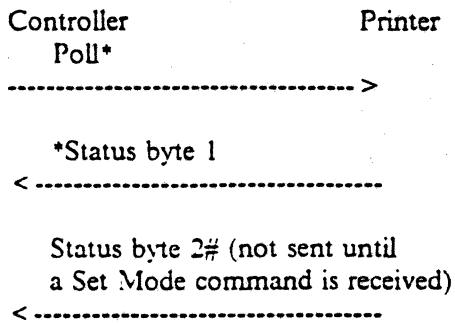
Legend

* = Bit and frame synchronization generated by the driver/receiver logic (line turnaround). This is generated by the controller whenever a new command frame is to be sent. A line turnaround is generated by the printer when a response to the controller is required.

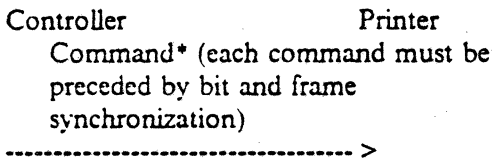
= Data stream termination delimiter identified by the transmission of a printer address of all ones. This terminates a message and conditions the printer to expect a synchronization series next.

--> = Indicates the exchange of one 16-bit frame in the indicated direction between the printer and the controller.

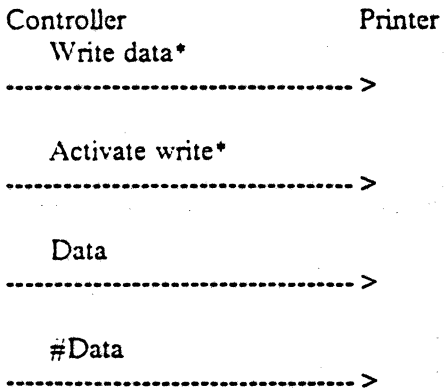
Poll for Status



General Command to Printer



Write Data



Note: Poll commands must be issued and a nonbusy, no-exception status received between the Write and Activate Write commands.

3.2 Frame Characteristics

The frame format for commands and data to or from the printer is a fixed 16-bit frame. The general format follows.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Printer Address
7-14	command or data
15	Stop bit; always 1.

Figure 67. Printer frame format

- Bit 3 is the parity bit and is set to ensure even parity in each frame. When a line parity error is detected by the printer, no more commands are executed, and no responses made until a valid poll without a parity error is received. At that time a line transmission fault indication will be sent to the controller in the printer status byte.
- Bits 4, 5, and 6 are the physical printer address. Valid addresses are 000 to 110. 111 is the end of message delimiter. A frame containing the 111 address causes the printer to ignore all following line signals until a bit synchronization/frame synchronization is detected after a line turnaround.
- Bits 7 through 14 are unique to the type of frame and are defined later.
- Bit 15, the sync bit, is the least significant bit on the line and is always set to 1.

3.3 Addressing and Commands

3.3.1 Printer Addressing

The printer's station address is encoded in bits 4, 5, and 6 of the frame. Printers with the Cable Through feature, or that attach through a "T-connector" and have address selection capability, may have addresses 000 through 110. Printers with neither of the above have an address of 000.

Valid addresses are 000 to 110 and 111 is the end of message delimiter for a given input cable. The first frame following a line turnaround will be a command frame that contains a printer address used to select an individual printer. Any data frame associated with the command frame will be checked for an end of message delimiter.

If bit 14 is off in the command frame, no following data frames will be processed by the printer. This allows single frame commands to be addressed to a specific printer.

The last frame in a sequence of data frames will contain a station address of 111. The intervening data frames need not contain the same address field as the command frame to cause the same printer to remain selected.

All response frames sent to the host by the printer, except the end of message frame, will contain the responding printer's address.

3.4 Commands Matrix

The following matrix shows valid commands for the printer.

Name	Bits 7 through 14
Activate Read	0000 0000
Activate Write	0000 0001
Clear	0001 0010
EOQ Delimiter	0110 0010
Poll	xxxx1 0000
Read Device ID ¹³	0000 1100
Read Status ¹³	1000 1000
Reset	0000 0010
Set Mode	0001 0011
Write Data ¹³	0001 1110
Write Control Data	0000 0101
Read Multibyte ¹³	1000 1010

Figure .68. Printer Command Matrix

Only one command can be processed at a time. Up to sixteen commands and data frames may be placed on an internal work queue.

Command frames must be preceded by a line turnaround (bit and frame synchronization sequences) or by another command frame (possibly with intervening data frames) that was preceded by bit and frame synchronization sequences. See 1.4, "Station Addressing" on page 9 for more information.

¹³ Requires an associated activate command.

3.5 Specific Command Formats

3.5.1 Poll Command

Bit	Purpose
0.1.2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4.5.6	Printer Address
7	Reserved: set to 0
8	Reset line parity error
9	Acknowledge bit (ACK)
10-14	Poll command: 10000
15	Stop bit: always 1.

Figure 69. Printer Poll Command

This command is sent from the controller to the printer and initiates the transfer of two status words per poll. At power on time, a single frame (base status) response is made until a Set Mode command is received by the printer.

Bit 7 should be set to 0.

Bits 8 and 9 are defined uniquely for this command.

Bit 8 is used to acknowledge and reset the line parity error response bit in the first response byte from the printer. This bit is not effective until a not-busy status has been received at the controller. Normally, bit 8 should be 0.

Bit 9 is used to acknowledge the last status transmission to allow new status to be sent. If bit 9 is at a 1 value, updated response frames are sent whenever they become available, except for the real-time status bits.

Real-time response, as used here, means that the response bits change independent of the odd/even response level bit. (See bit 14 in poll response byte 1.) The former response frame can be sent any number of times. All poll response bits are real-time status bits except for Cancel Request and Graphic Check in poll response byte 2.

3.5.1.1 Poll Responses to the Controller

The first poll response frame is always preceded by a line turnaround (bit and frame synchronization patterns). A fixed length, two-frame response is made to every Poll command after a Set Mode command is received by the printer. Before the Set Mode command, only a 1-frame basic status is returned to the controller. In either case, the last frame of the response contains a station address of 111 to designate the last message frame.

The base response frame is returned 45 (± 15) microseconds after reception of the last bit in the Poll command (turnaround). Poll response frame 2 is returned after the fill delay specified by the host in a Set Mode command.

3.5.1.1.1 Poll Response Frame 1 (Base Response Frame): The first frame in the response contains basic status information.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Station Address. If the first response byte is the only one sent, the station address is 111; if both response bytes are sent, the station address in the first frame will be the printer address and the station address in the second frame will be 111.
7	Busy
8	Line parity
9	Unit not available
10	Outstanding status
11-13	Exception status
14	Even/odd response level
15	Stop bit: always 1.

Figure 70. Printer Poll Response Frame 1

3.5.1.1.1.1 Poll Response Bit 7 - Busy Status:

- 0 = Not busy (work queue empty)
- 1 = Busy (work queue not empty or activate received)

Bit 7 is a real-time response bit (it is updated continuously) and bit 14 of the frame need not be tested first to find if this bit has been updated. Once the first work queue entry has been received by the printer, a Poll command received immediately afterward would have a busy base response status. A nonbusy, no-exception, no-line parity error status response must be received before issuing any activate command.

Busy is reset to 0 when all commands have been executed and the queue is available for commands.

3.5.1.1.1.2 Poll Response Bit 8 - Line Parity:

0 = No line parity error detected

1 = Line parity error detected

Bit 8 is a real-time response bit (updated continuously). It is set immediately when invalid frame parity is detected in a frame that has been received. The parity expected is even parity over bits 3 through 15 of every frame. Because the station ID field might be invalid as a result of a parity error, every station that detects the invalid parity frame, regardless of the address field content, indicates an error. In a multidrop environment, several but not necessarily all stations along one cable might detect the invalid parity frame.

Once a line parity error is detected by a station, that station will stop the execution of outstanding commands and will not accept any following commands until a status response indicating a line parity fault has been sent and acknowledged by being reset. This allows the station controller to determine the station's status at the time the line parity error was detected.

The controller can reset bit 8 by issuing a Poll command that has frame bit 8 on. The command will not reset the line parity error bit if the printer is busy when the command is received.

3.5.1.1.1.3 Poll Response Bit 9 - Unit Not Available:

0 = Unit available

1 = Unit not available

If this bit is a 0, it indicates that the printer is available for a customer job (no error conditions have been detected in the printer mechanism, the paper is properly installed, and the Start switch has been pressed). The Ready light on the printer control panel corresponds to the unit available status condition. Bit 9 on corresponds to the Ready light being off. Bit 9 would be a 1 if:

- Power on sequence is complete but the Start switch has not been pressed
- The Stop switch has been pressed
- An end of forms condition has been detected
- A hard printer error was detected
- A graphic error has occurred and the stop on error option is selected
- A Reset command has been received
- A bell control character has been received

Bit 9 is a real-time response bit (updated continuously).

3.5.1.1.1.4 Poll Response Bit 10 - Outstanding Status: If this bit is a 1, outstanding status is available and can be obtained by issuing a Read Status command.

The outstanding status bit is reset by successful completion of the Read Status command. The bit is held off by the printer until a Write Control Data command with the reset outstanding status bit on is received. The Write Control Data command resets the Read Status byte and enables the outstanding status bit in the poll response status.

Bit 10 is a real-time response bit (updated continuously).

Note: This bit is never set for 3197-attached printers. The 3197 can only detect printer hardware errors through the PC parallel interface and will report them to the controller as Unit Not Available.

3.5.1.1.1.5 Poll Response Bits 11-13 - Exception Status Condition: Exception status conditions are indicated in Poll responses as soon as they are detected, without changing response levels (real time bits - see 3.5.1.1.1.6, "Poll Response Bit 14 - Even/Odd Response Level" on page 93).

Bits 11 through 13 are encoded as follows.

11	12	13	Meaning
0	0	0	No exception status
0	0	1	Activate lost (parity)
0	1	0	Invalid activate
0	1	1	(reserved)
1	0	0	Invalid command
1	0	1	Input queue or storage overrun
1	1	0	Reserved
1	1	1	Power on transition

Figure 71. Printer Exception Status Codes

When exception conditions occur, processing of commands in the command queue is stopped and the queue is emptied, without exception, of the commands remaining in the queue when the exception condition was detected. After an exception condition occurs, only the Poll, Set Mode, Reset, and Write Control Data commands will be processed until the exception status is reset. The Write Control Data command will not be processed if the exception status was power-on transition. The Set Mode command will be processed only if the exception status was power-on transition.

Exception status conditions are reset by issuing a Write Control Data command with bit 12 in the 1 state in the data frame that follows the Write Control Data command. The controller can determine if the reset occurred by checking for not-busy status after the Write Control Data command is issued and noting the absence of exception status. If the exception status remains, try the Write Control Data command again. The power-on transition exception status is reset by issuing a Set Mode command.

Invalid activate status is caused by the wrong type of activate command (a Activate Write command following a Read Status command, or a Activate Read command following a Write Data command, or by an activate command being sent without a preceding pre-activate command).

Activate lost status is caused by a line parity error

1. on an input frame from the controller on an Activate. command, or on the data
2. on a Poll command following a Write Data or Read Status command, or immediately following an Activate command
3. any time bad parity occurs on the line after a Write Data or Read Status command has been received and before the associated Activate command has been completely processed.

The controller uses the status to determine the restart point for error recovery procedures. The recovery procedure in the case of a Write command is to resend the entire sequence of Write command, Activate Write command, and the data. For a Read Status command the recovery procedure is to resend the Read Status and Activate Read commands. For error logging and reporting, this bit is combined with bit 8 (line parity check).

The invalid command exception status results when the printer receives a command bit combination that is not defined in the command set. An interval longer than 240 microseconds between frames in multiple-

frame commands (set mode or write control data) might cause invalid command exception status. Any command other than a Poll, Reset, or EOQ between a Read or Write command and its associated Activate command will also cause invalid command exception status.

The input queue or storage overrun condition occurs when more than 16 commands and associated data frames have been sent, or when an attempt is made to store data beyond the user-accessible storage limits.

The power-on transition exception condition is returned as a result of a Poll command received after power is turned on, after processing a Reset command, or after a Test-to-Normal transition of the Status switch. When this condition occurs, the base status frame is the only frame sent in response to a Poll command. A Set Mode command must be received before this condition is reset. After the Set Mode command has been processed, the response is 2 frames long.

3.5.1.1.1.6 Poll Response Bit 14 - Even/Odd Response Level: Successive Poll commands received before the printer has updated a complete new response causes retransmission of the former status.

The controller distinguishes new from former status by using bit 14. The first response after power on is from response level 0.

The controller allows level transitions to occur by setting the ACK bit (bit 9) on in the Poll command. The maximum time for level-switching is 8.16 seconds. If a new response is available for controller access when a Poll command with ACK bit (bit 9) on is received, the new level is sent and bit 14 will be changed from the last poll response. If a Poll command is received with ACK off, or a new level is not available, the old level will be sent and bit 14 will not be changed. The former response status can be sent any number of times.

Real-time status bits are not affected by response level transitions. All poll response bits are real-time status bits except for Cancel Request and Graphic Check in poll response byte 2.

3.5.1.1.2 Poll Response Frame 2

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Station Address. Always 111 to indicate that this is the last message frame.
7	Invalid SCS control code
8	Invalid SCS parameter
9	Receive buffers full
10	Print complete
11	Cancel request
12	Print mechanism not ready (5256 only)
13	End-of-forms
14	Graphic check (unprintable character)
15	Stop bit: always 1.

Figure 72. Printer Poll Response Frame 2

3.5.1.1.2.1 Poll Response Frame 2 Bit 7 - Invalid SCS Control Code:

- 0 = No invalid control code detected
- 1 = Invalid control code detected

When bit 7 is in the 1 state, an invalid control code or an exception condition (EC = 1 or 3) has been detected in the standard character string data stream and the attaching system has specified a terminate condition. This bit is reset upon receipt of a Clear or Reset command.

This bit is a real time bit that is not dependent on the state of bit 14 in the first poll response byte.

3.5.1.1.2.2 Poll Response Frame 2 Bit 8 - Invalid SCS Parameter:

- 0 = No invalid parameter detected
- 1 = Invalid parameter detected

This bit can be active only for the multiple-byte formatting control sequences: print position and format. If the bit is "on", an invalid parameter code or a parameter outside the specified range was detected.

This bit is a real time bit that is not dependent on the state of bit 14 in the first poll response byte.

3.5.1.1.2.3 Poll Response Frame 2 Bit 9 - Receive Buffers Full:

- 0 = Receive buffers are not full
- 1 = Receive buffers are full

When the bit is "on", both input receive buffers are full. No write data can be received until this bit goes "off" indicating that a buffer is available. The bit is used by the controller to determine when data can be sent to the printer.

This bit is a real time bit that is not dependent on the state of bit 14 in the first poll response byte.

3.5.1.1.2.4 Poll Response Frame 2 Bit 10 - Print Complete:

- 0 = Printing is in progress
- 1 = Printing is complete

When this bit is off, the printer is either printing or formatting data to be printed or the printer is unavailable for some other reason.

When the bit is "on", the printer has finished printing all the data that it received (both receive buffers and both print buffers are logically empty).

Detecting the Activate Write command from the controller resets the print complete bit.

In addition to completing the printing of all input data, the power on reset, Clear command, or the Reset command turns on the print complete bit.

This bit is a real time bit that is not dependent on the state of bit 14 in the first poll response byte.

The 4210 sets this bit when it receives the print data, not when it finishes printing the data.

3.5.1.1.2.5 Poll Response Frame 2 Bit 11 - Cancel Request:

- 0 = No cancel request
- 1 = Cancel request

This bit, if on, indicates that the Cancel key on the printer was pressed and requests that the print job in process be cancelled. The only action by the printer is to pass the request to the controller.

The normal response to cancel request is a Clear command that stops printing and clears the receive and print buffers.

Bit 11 is reset by the acknowledgement bit being on in the next Poll command. Also, a Reset command or a power on reset turns off the cancel request.

This bit is dependent on the acknowledge bit (bit 9) of the poll command and on the even/odd response level bit (bit 14) of the first poll response byte. Poll commands without the acknowledge bit set will return the previous value of this bit.

3.5.1.1.2.6 Poll Response Frame 2 Bit 11 - Print Mechanism Not Ready (5256 only):

- 0 = Print mechanism ready
- 1 = Print mechanism is not ready

The bit 12 status condition is caused by a printer voltage being out of tolerance or by a wire check status condition.

A Reset command, a power on reset, or pressing the Stop switch turns off bit 12.

This bit is a real time bit that is not dependent on the state of bit 14 in the first poll response byte.

3.5.1.1.2.7 Poll Response Frame 2 Bit 13 - End-Of-Forms:

- 0 = No end-of-forms condition detected
- 1 = End-of-forms condition has been detected

The bit indicates that an end-of-forms condition has been detected. A Reset command, a power-on reset, or pressing the Stop switch resets bit 13.

This bit is a real time bit that is not dependent on the state of bit 14 in the first poll response byte.

3.5.1.1.2.8 Poll Response Frame 2 Bit 14 - Graphic Check:

- 0 = No graphic check detected
- 1 = Graphic check detected

When this bit is on, an unprintable character was detected in the data stream, and option 3 (which specifies reporting the error status) had been selected by using a set graphic action format control code.

The acknowledgement bit being on in the next Poll command, a Reset command, or a power on reset will reset the graphic check bit.

This bit is dependent on the acknowledge bit (bit 9) of the poll command and on the even/odd response level bit (bit 14) of the first poll response byte. Poll commands without the acknowledge bit set will return the previous value of this bit.

3.5.2 Read Device ID Command (Code = 01100)

This command starts the transfer of one data word from the addressed device. The device ID word from the base contains information about the characteristics of the station. Other special feature devices return an ID word with the device characteristics of the installed special feature. If a special feature device is not installed, bits 7 through 14 of the returned frame are zero. A Read Device ID command to the model ID should not be sent to printers.

An Activate command is needed before data transfer will start.

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	Printer Address
7.8.9	Device Address (000 for base printer)
10-14	Read Device ID Command: 01100
15	Stop bit; always 1.

Figure 73. Printer Read Device ID Command

3.5.2.1 Printer ID Word

The response to a Read Device ID command to the base feature address of a printer device follows.

Bit	Purpose
0.1.2	Fill bits: always zero.
3	Parity bit; set for even parity in the frame
4.5.6	Always 111 (end of transmission)
7-14	device ID
15	Stop bit: always 1.

Figure 74. Printer ID Word

The device ID has the following meaning.

Bits 7 and 8 of the response frame (bits 0 and 1 of the device ID byte) are the printer model ID bits. They have the following meanings.

00	Model 1 (model 2 for 4214 model 2, 4210, and 3197-attached printers in 4214 model 2 emulation mode)
01	Model 2
10	Model 3 (or 4245)
11	Model 4

Bits 9 and 10 of the response frame (bits 2 and 3 of the device ID byte) are the station type bits. They have the following meanings.

00	Display
01	Reserved
10	Printer
11	Reserved

Bits 11 through 14 of the response frame (bits 4 through 7 of the device ID byte) are the printer type bits. They have the following meanings.

0000	5256, 5262 (5262 emulates 5256 model 3), 4245 (in 5256 model 3 emulation mode), or 3197-attached printers (in 5256 model 3 emulation mode).
0001	reserved
0010	reserved
0011	4234
0100	5224 model 1 or model 2
0101	4245 (in native mode)
0110	5224 model 12
0111	reserved
1000	5225 models 1, 2, 3, and 4
1001	reserved
1010	5225 models 11 and 12
1011	4224
1100	4214 model 2, 4210, or 3197-attached printers (in 4214 model 2 emulation mode).
1101	5219 model D, 3812, or 3816

1110 reserved
1111 reserved

Note that displays always return X'C2'.

3.5.3 Write Data Command

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Printer Address
7-14	Write Data Command: 00011110
15	Stop bit: always 1.

Figure 75. Printer Write Data Command

This command causes the printer to store all the data words following the next Activate Write command. The Activate Write command must not be issued until a not-busy, no-exception status response is made to a Poll command. The data frames can follow the activate command immediately.

See 3.5.5.1, "Activate Write Command (0000 0001)" on page 102 for the format of the data frames used to transmit data to the printer.

3.5.4 Write Control Data Command

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	Printer Address
7-14	Write Control Data Command: 00000101
15	Stop bit; always 1.

Figure 76. Printer Write Control Data Command

3.5.4.1 Data Frame for Write Control Data Command

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	End Of Message (111)
7-10	reserved - set to zero
11	All but 4224: reserved - set to zero. On the 4224, <ul style="list-style-type: none"> • 0 = Do not reset outstanding multibyte status flag • 1 = Reset outstanding multibyte status flag
12	Reset Exception Status <ul style="list-style-type: none"> • 0 = Do not reset exception status • 1 = Reset exception status
13	Reset outstanding status <ul style="list-style-type: none"> • 0 = Do not reset outstanding status • 1 = Reset outstanding status
14	reserved - set to zero
15	Stop bit; always 1.

Figure 77. Data Frame for Printer Write Control Data Command

3.5.5 Activate Commands

An Activate Read or an Activate Write command is inserted between a block data transfer command and the data frames that follow it.

The following are block transfer commands.

- Read Status
- Write Data
- Read Device ID

Poll commands must be interjected after the data transfer command to wait for a not-busy, no-exception-status response. Only the End Of Queue delimiter command can be inserted between a block transfer command and its associated activate command.

After a not-busy, no-exception status is returned to the Poll command, the activate command is issued to start the data transfer. When the activate command is received, busy status is returned until the post-activate processing is completed.

If an Activate Read command is received while the printer is busy or has exception status set, no response is made. If an Activate Write command is received under the same circumstances, no data is accepted or stored.

The wrong type of activate command causes invalid activate exception status to be returned.

3.5.5.1 Activate Write Command (0000 0001)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Printer Address
7-14	Activate Write Command: 00000001
15	Stop bit: always 1.

Figure 78. Printer Activate Write Command

This command is used after a Write Data command to transmit the data frames that follow it. The command must not be issued until after a not-busy, no-exception-status response to a Poll command. The Activate Write command resets the print complete bit in poll response byte 2.

3.5.5.2 Data Frame for the Write Data Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	The last data frame contains 111 (end of transmission). All other data frames contain the printer address.
7-14	data byte
15	Stop bit; always 1.

Figure 79. Data Frame for Printer Write Data Command

The data can be any length up to 256 characters (the size of an input buffer). If more data frames are sent than can be stored in the input buffer, the input queue or storage overrun status is returned to the controller. The overrun data is not stored. Two input buffers are used alternately. Data is formatted for printing from one while the other is available to be loaded from the controller. Data from a single Write Data command goes into only one print buffer.

3.5.5.3 Activate Read Command (0000 0000)

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	Printer Address
7-14	Activate Read Command: 00000000
15	Stop bit; always 1.

Figure 80. Printer Activate Read Command

This command may be issued only after a not-busy, no-exception-status response to a Poll command.

This command is used after a Read Status command to cause the response byte to be returned. See 3.5.7, "Read Status Command" on page 106 for the format of the returned data frame.

This command is used after a Read Device ID command to cause the response byte to be returned. See 3.5.2, "Read Device ID Command (Code = 01100)" on page 97 for the format of the returned data frame.

Read Activate is also used to receive data after a Read Multibyte command. See 3.5.10, "Read Multibyte Command" on page 114 for the format of the returned data frame.

3.5.6 Set Mode Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Printer Address
7-14	Set Mode Command: 00010011
15	Stop bit; always 1.

Figure 81. Printer Set Mode Command

The Set Mode command causes the printer to accept one mode control word. The command must be issued before a two-frame response to Poll commands is made by the printer. Only Poll command or a Reset command will be accepted by the printer before the Set Mode command is sent.

Mode Control Data Frame

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address or End Of Message (111)
7-11	Fill Count
12-14	000
15	Stop bit; always 1.

Figure 82. Printer Mode Control Data Frame

The fill count bits, 7 through 11, specify, in binary, the number of times an 8-bit fill increment is repeated between consecutive frames. The maximum value is 30. If 31 is specified, only 30 are transmitted.

Bits 12, 13, and 14 are reserved and should be set to 000.

3.5.7 Read Status Command

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Printer Address
7-14	Read Status Command: 10001000
15	Stop bit: always 1.

Figure 83. Printer Read Status Command

This command starts the transfer of one status word from the printer. The status word contains information about the condition of the printer. An Activate Read command is required before the status word is sent.

Successful completion of the Read Status command resets the outstanding status bit in byte 1 of the Poll response.

3.5.7.1 Read Status Response Frame

The status is reset by a Write Control Data command with bit 13 active.

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	111 (end of transmission)
7-14	Outstanding Status
15	Stop bit; always 1.

Figure 84. Printer Read Status Response Frame

Note: 3197-attached printers (in either 5256 model 3 or 4214 model 2 emulation mode) will never turn on bit 10 in Poll Response Frame 1 and thus will never post an Outstanding Status. The 3197 detects printer hardware errors only through the PC parallel interface and will return Unit Not Available to the controller.

- Bits 7 through 14 - Outstanding status (5256 only)

- Bit 7 = Wire check
- Bit 8 = Slow speed check
- Bit 9 = Fast speed check
- Bit 10 = Emitter sequence check
- Bit 11 = No emitter pulses
- Bit 12 = Overrun error
- Bit 13 = Forms stopped
- Bit 14 = Forms position check

- Bits 7 through 14 - Outstanding status (5262 only)

- Bit 7 = Hammer Fire Check
- Bit 8 = not used
- Bit 9 = Band Synch Check or Print Unit Open
- Bit 10 = Band Up To Speed Check
- Bit 11 = Band Motor Control Check or Thermal Check
- Bit 12 = Ribbon check
- Bit 13 = Carriage Check
- Bit 14 = Paper Clamp Check

- Bits 7 through 14 - Outstanding status (4245 in 5256 model 3 emulation mode only)

- Bit 7 = Hammer Fire Check
- Bit 8 = not used
- Bit 9 = Band Synch Check or Band Image Error
- Bit 10 = Band Up To Speed Check
- Bit 11 = Printer Control Check
- Bit 12 = Ribbon check
- Bit 13 = Carriage Check
- Bit 14 = Forms Check

- Bits 7 through 14 - Outstanding status (5224 only)

X'11' = Machine check
X'31', X'32', X'35', and X'36' = Print check
X'41', X'42', X'45', and X'46' = Forms check
X'81' = Machine check
X'83', X'84', and X'85' = Print check
X'89' = Ribbon check

- Bits 7 through 14 - Outstanding status (4234 only)

X'11' = Print Adapter Timeout
X'38' = Print Adapter Overrun or Emitter Check
X'41' = Forms Jam
X'43' = Forms Driver Check
X'48' = Stepper Motor Timeout
X'81' = Power Supply Failure
X'85' = Hammer Coil Open
X'86' = Hammer Driver Check or Hammer Driver Shorted
X'87' = Coil Protect Check
X'88' = Ribbon Missing, Not Seated, Synch Check, or Driver Check

- Bits 7 through 14 - Outstanding status (5225 only)

X'11' = Machine check
X'31', X'32', X'34', X'35', X'36', X'38', and X'39' = Print check
X'41', X'42', X'43', X'45', X'46', and X'48' = Forms check
X'81' = Machine check
X'83', X'84', and X'85' = Print check
X'86' and X'87' = Machine check
X'88' = Ribbon jam
X'89' = Ribbon check

- Bits 7 through 14 - Outstanding status (5219-D only)

X'11' = Machine check (control processor failure)
X'12' = Machine check (internal communication failure)
X'31' = Escapement failure
X'32' = Print check (selection failure)
X'33' = Print check (hammer/ribbon failure)
X'41' = Forms check (index/automatic sheet feed failure)
X'47' = Paper jam
X'58' = End of ribbon
X'66' = Data stream exception class 1

Class 1 exceptions indicate that a loss of text or textual meaning may result. Most of these errors occur when a printer datastream control has an error; these are noted in 3.6, "Control Character String" on page 116. Other situations are

- Unsupported or unrecognized single byte control
- Text line length exceeds width established by SPPS and automatic new line is not active (SIIF).
- No line ending code in data stream and formatting buffer full - the line is processed as a partial line

X'67' = Data stream exception class 2

Class 2 exceptions indicate that a change from the intended appearance of the text may result. Most of these errors are noted in 3.6, "Control Character String" on page 116. The other condition for a class 2 exception is an attempt to print beyond the page depth with automatic form feed deactivated.

X'68' = Data stream exception class 3

Class 3 exceptions indicate an error in a multibyte control that may have an indeterminate effect on text. These are detailed in 3.6, "Control Character String" on page 116. Another condition that causes class 3 exceptions is an invalid or unsupported multibyte control.

X'69' = Data stream exception class 4

Class 4 exceptions indicate an error in a multibyte control parameter. These errors are detailed in 3.6, "Control Character String" on page 116.

X'81' = Cover unexpectedly opened

- Bits 7 through 14 - Outstanding status (3812 only)

X'11' = Machine check (control processor failure)

X'47' = Paper jam

X'66' = Data stream exception class 1

X'67' = Data stream exception class 2

X'68' = Data stream exception class 3

X'69' = Data stream exception class 4

X'81' = Cover unexpectedly opened

There are "intervention required" status conditions for the 3812 that do not map onto existing 5219-D status byte values. For these conditions, the 3812 will indicate Unit Not Available, but not set the Outstanding Status bit. These conditions are

Out of Toner

Remove Prints

Stop Key Depressed

See the 5219-D Outstanding Status description for an explanation of the various exception classes.

- Bits 7 through 14 - Outstanding status (4214 Model 2 and 4210 only)

X'31', X'32', and X'35' = Print check

- Bits 7 through 14 - Outstanding status (4224 only)

X'1x' Machine Checks

X'3x' Print Checks

X'41' Forms Jam, Paper Insertion Error, or Overcurrent

X'42' No Drive

X'43' Open motor or fuse

X'44' through X'4F' Other forms checks

X'60' Acknowledgement Reply Pending. This means that a Read Multibyte command must be sent to retrieve Acknowledgement Reply data. Reset Outstanding Status in the usual way. The 4224 will not accept any more data until the host acknowledges the reply data by Write Control Data that resets the Outstanding Multibyte Status flag.

X'80' Machine check

X'81' Machine check

X'82' Machine check
X'83' Print check
X'84' Print check
X'85' Print check
X'86' Machine check
X'87' Machine check
X'88' No ribbon installed or ribbon not properly seated
X'89' Ribbon motor overcurrent (possible ribbon jam)

- Bits 7 through 14 - Outstanding status (4245 only)

X'11' = Printer Adapter Check
X'31', X'32', X'34', X'35', X'36' = Print Band Check
X'38' = Hammer Check
X'39' = Printer Control Check
X'41', X'43' = Carriage Check
X'45' = Stacker Check
X'46' = Forms Check
X'83' = Front Gate Open
X'84' = Band Image Error
X'88' = Ribbon Check
X'89' = Near or At Protection Tape End

3.5.8 Reset Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Printer Address
7-14	Reset Command: 00000010
15	Stop bit; always 1.

Figure 85. Printer Reset Command

When the printer receives the Reset command it will

- Finish printing any line that has been started
- Perform an initialization sequence

The Reset command can be issued at any time, but the caution in the note that follows must be observed.

IMPORTANT NOTES

Notes:

- 1. The controller must use this command carefully because the printer error indications are an important part of the printer maintenance philosophy and are used by both the customer and IBM service representative. The Reset command will destroy the printer error indications.*
- 2. A console error message should be displayed and an indicator at the printer turned on so that the operator will know why the printer stopped and that the paper is probably not aligned at the correct starting point.*

3.5.9 Clear Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Printer Address
7-14	Clear Command: 00010010
15	Stop bit; always 1.

Figure 86. Printer Clear Command

This command clears all buffers. No extra forms motion occurs as a result of this command. An indicator turns on if the printer is not ready.

There will be no change to the current line counter and no change to the SHF, SVF, and SGEA formats sent at initialization time.

The 4210 does not clear buffers until after all data in its internal buffers has been printed.

For 3197-attached printers; if CLEAR is received while printing is in progress, printing will continue to the next valid line delimiter. Data in the receive buffers of the 3197 prior to reception of the CLEAR command will be cleared as will the contents remaining after the next valid line delimiter.

3.5.9.1 Clear Command on 4224

For the 4224 printer, Clear does the following.

- Reset all multi-byte 4224 commands across multiple buffer boundaries.
- Does not change character patterns previously loaded.
- Does not change Ready or Forms indication.
- Makes an indication to the operator that a Clear command has been received if the unit is not available (not ready). Pressing Stop on the printer will turn off the Data Cleared indicator.
- Print and Receive buffer handling
 - If Clear is received and printing is not in progress, no more printing will occur. The receive and print buffers will be cleared and the Print Complete bit in Poll Response byte 2 will be set on upon completion of the Clear command processing.
 - If Clear is received while printing is in progress, printing will stop and data in the receive buffers prior to reception of the Clear command will be cleared, as will the contents remaining in all other internal printer buffers queued for printing. The Print Complete bit in Poll Response byte 2 will be set on upon completion of the Clear command processing.
- Print Position

- The current horizontal print position will be changed. The print mechanism will be moved to the left most print reference and will synchronize data received after the Clear command with this horizontal reference.

The host must send a Set Home State 4224 command following the Clear command, before attempting to print any further data. Failure to do so will produce unpredictable results; however, in most cases, an error will be sent to the host via the Acknowledge Reply.

3.5.10 Read Multibyte Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Printer Address
7-14	Read Multibyte Command: 10001010
15	Stop bit; always 1.

Figure 87. Read Multibyte - 4224 Only

This command is for 4224 printers only. It prepares the printer to send 256 bytes of data to the host. The printer will send the data after it receives an Activate Read command.

This command should be used by the host when the host receives Acknowledgement Reply Pending from a 4224.

The data transferred will be formatted as described in *IBM 4224 Product and Programming Description*, GC31-2551. All bytes after the valid reply data will be zeros (X'00'). If the printer has no data to transmit, all 256 bytes will be zero.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Printer Address; '111' for last frame
7-14	data byte
15	Stop bit; always 1.

Figure 88. Read Multibyte Response Frames- 4224 Only

3.5.11 End of Queue Delimiter

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	Printer Address
7-14	End of Queue Command: 01100010
15	Stop bit; always 1.

Figure 89. Printer End of Queue Command

After this command is sent, only the Poll command will be accepted by the printer until a not-busy status is returned in response to a Poll command.

3.6 Control Character String

The printer uses a SNA control character string subset for formatting all data. Protected fields or other non-printable fields must be removed by the controller.

If a control has a list of printers, those are the only printers that the control is valid for.

The controls described in this chapter are not valid for the 4224 printer. *IBM 4224 Product and Programming Description*, GC31-2551, contains information about the 4224 and its data stream.

For the 5219-D and 3812 printers, the exception status values referred to do not mean the exception status value in the poll response. Exception status in this section, for 5219-D and 3812, refers to the exception classes defined in the outstanding status byte. These values are denoted as "EC = value". See 3.5.7.1, "Read Status Response Frame" on page 107 for more information.

When no recovery action is given, the printer's recovery action is to ignore the parameter in error. When a control is sent at an incorrect time, the recovery is to ignore the entire control. When a control has an invalid length field, the recovery is to ignore the entire control.

For printers other than the 5219-D, 3812, and 4224, invalid controls cause an Invalid SCS Control Code condition to be indicated in the poll command response; invalid control parameters cause an Invalid SCS Parameter in the poll command response.

3.6.1 ASCII Transparent (ATRN)

ASCII Transparent (ATRN), X'03nn', is supported *only* on 3197-attached printers. When the ATRN command is received, the 3197 sends the content of the command to the printer without any translation. This command allows direct host system control of the attached printer by using the ASCII data stream. The one byte parameter (nn) is the length of the command and data excluding the first X'03' byte.

3.6.2 Carriage Return (CR)

Carriage Return (CR), X'0D', logically moves the print position horizontally to the effective left margin on the current line. If the current position equals the first print position, the function becomes a no-op. On 5219-D, the print position is moved to the Effective Left Margin. On 3812, the print position is moved two pel to the right of the Effective Left Margin.

3.6.3 New Line (NL)

New line (NL), X'15', logically moves the print position horizontally to the effective left margin and vertically down to the next line. If on the last line of a page, the print position is moved to the effective left margin of the first line of the next page.

3.6.4 Line Feed (LF)

Line Feed (LF), X'25', logically moves the print position vertically down to the next line. If on the last line of the page, the print position is moved to the corresponding print position on the first line of the next page. Line Feed may also be referred to as "index".

3.6.5 Form Feed (FF)

Form Feed (FF), X'0C', moves the print position to the first print line and the first logical print position of the next logical page. The default option for logical page length, if not specified by the Set Vertical Format control code, is 1 line. On the 3812, this causes the current page being defined to be printed.

3.6.6 Print Position (PP)

Print Position (PP), X'34', is a 3-byte format control character sequence that moves the logical print position according to parameter values. Two parameters are specified. One is a function parameter, the other is a value parameter. The function parameter is a single byte and follows the PP code. The value parameter follows the function parameter and consists of a 1-byte binary number. The functions defined by the function parameter are

Absolute move or relative move
Vertical move or horizontal move

Valid parameters for absolute moves are equal to or less than the line or page length. If an Absolute Horizontal Print Position control code with a value less than the current value is detected, the 5256 inserts a Carriage Return control code just before the Absolute Horizontal Print Position control code. It treats the Absolute Horizontal Print Position control code and the succeeding data as if it were a separate new print line.

An Absolute Vertical Print Position control code that is less than the current value results in an advance to the corresponding position on the next page. Specification of an Absolute Horizontal move to the present horizontal position, or the specification of an Absolute Vertical move to the present print line, will result in the function being no-oped.

Valid value parameters for relative moves are those that specify a move to, but not past, the end of the line or page. A zero value is a no-op.

When an absolute move is specified, the value parameter denotes a specific line or column number and the print position is moved to the line or column specified. When a relative move is specified, the logical print position is moved the number of lines or column increments specified relative to the current position.

Synchronization between physical and logical current lines will be done as follows.

- Absolute position is based on the location of the paper when the printer becomes ready after a power on or a Reset command.
- When the printer is stopped with the ready indicator off and with any paper motion switches pressed one or more times, and the start switch is then pressed:

- If the last forms movement resulted from a relative move control code, the next print line will be printed at the present position. The next absolute move control code will put the forms back in sync.
- If the last forms movement was caused by an absolute move control character, the forms are moved to the original absolute position of the next logical page before printing.

The following function parameters and the associated hexadecimal codes are

Absolute horizontal	C0
Absolute vertical	C4
Relative horizontal	C8
Relative vertical	4C

Invalid function or value parameters cause an exception condition (EC = 4) and cause the control to be ignored.

3.6.7 Interchange Record Separator (IRS)

Interchange Record Separator (IRS), X'1E', has the same function as new line (NL).

3.6.8 Index Return (IRT)

Index Return (IRT), X'33', performs the same function as the required new line (RNL) function. This command is valid for the 5219-D and 3812 printers only.

3.6.9 Numeric Backspace (NBS)

Numeric Backspace (NBS), X'36', performs the same function as the backspace (BS) function. This command is valid for the 5219-D and 3812 printers only.

3.6.10 Subscript (SBS)

Subscript (SBS), X'38', causes a downward displacement on the print surface of one-half the single line distance. This command is valid for the 5219-D and 3812 printers only.

On a 5219-D, multiple subscripts (or superscripts) without an intervening return to the baseline will not result in more than one half of single line distance displacement from the nominal baseline. However, the 5219-D will logically track the number of SBS (or SPS) commands encountered. An equal number of SPS and SBS commands will always result in a return to the baseline. If the number of SPS and SBS commands are not equal, a "hanging half index" condition results. All following lines through the end of the page will be offset by one half line from the baseline.

The 3812 can process any number of SBS controls on a line.

If this command does not result in a downward displacement, an exception condition (EC = 1) will be posted. This happens if there are multiple subscript controls on a line or if a subscript control is used on the last physical line of a page.

3.6.11 Indent Tab (IT)

Indent Tab (IT), X'39', moves the print position to the right one tab stop and sets the effective left margin to this position. If no tab stop is encountered to the right of the current horizontal print position, an exception condition (EC = 2) will result, and the print position is moved one space to the right.

This command is valid for the 5219-D and 3812 printers only.

3.6.12 Required Form Feed (RFF)

Required Form Feed (RFF), X'3A', performs the same function as the form feed (FF) control and restores the print position to the left margin. This command is valid for the 5219-D and 3812 printers only.

On the 3812, RFF causes the current page to print.

3.6.13 Null (NUL)

Null (NUL), X'00', is a no-operation. No graphic character is printed and no function is performed in the printer as the result of a null character.

3.6.14 Bell (BEL)

Bell (BEL), X'2F', causes the following.

- All data preceding the BEL will be printed before executing the BEL functions.
- All control characters preceding the BEL will be executed before executing the BEL function.
- Printing will stop.
- Formatting of the print data will cease.
- Ready indicator will turn off.
- "Unit not available" status will be returned in the poll response.
- An attention indicator will turn on.
- An audible alarm will sound if the feature is installed and not disabled by a switch.

The alarm is silenced by activating the stop switch, the start switch, or the cancel switch.

This control is ignored if the environment is word processing (SIC with an si of 1).

The 3812, and the 5219-D in word processing mode, process this command as a NUL.

On the 5219-D, BEL will only be done on the first pass of a line requiring multiple print passes.

On the 4245, the BEL command is not supported and is treated as a no-op.

On 3197-attached printers, the 3197 detects a BEL Command from the host but does not send any printing stop command to the attached printer.

3.6.15 Transparent (TRN)

Transparent (TRN), X'35nn', allows printing characters whose binary representations are between X'00' and X'3F'. This command is valid for the 5224, 5225, 4234, 4214-2, and 5262 printers only.

nn = the number of following bytes that are not to be checked for Printer Data Stream commands.

This command can cause invalid graphic character checks if not used with caution.

Note: The 4210 and 3197-attached printers, though they emulate the 4214-2 in general, do not support this control and will reject it with Invalid SCS Control Code in the next poll response.

3.6.16 Set Attributes (SA)

Set Attributes (SA), X'2843yz', specifies the print speed and number of passes the printer will use to print a given line. This command is valid for the 5224-12 only.

"y" specifies how ideographic characters are to be printed.

- 0 = half speed, 2 passes
- 1 = half speed, 1 pass
- 2 = full speed, 2 passes
- 3 = full speed, 1 pass

"z" specifies how alphanumeric characters are to be printed.

- 0 = full speed, 1 pass
- 1 = full speed, 2 passes
- 2 = half speed, 1 pass
- 3 = half speed, 2 passes

The default value for y and z are 0. Values other than those shown above will cause an invalid Printer Data Stream parameter check to occur.

3.6.17 Shift In (SI)

Shift In (SI), X'0F', causes the printer to print the character pattern loaded at code point X'0F' and then return to alphanumeric (single-byte) mode. The default character pattern is a blank.

This command is valid for 5224 Model 12 and 5225 Models 11 and 12 printers only.

3.6.18 Shift Out (SO)

Shift Out (SO), X'0E', causes the printer to print the character pattern loaded at code point X'0E' and then go into the ideographic (double byte) mode. This will cause the printer to interpret pairs of adjacent bytes as a single double-wide character and print these characters in double character spaces. The default is a blank.

This command is valid for 5224 Model 12 and 5225 Models 11 and 12 printers only.

3.6.19 Horizontal Tab (HT)

Horizontal Tab (HT), X'05', moves the print position to the right one tab stop. If no tab stop is encountered, or if the tab stop encountered is to the left of the current horizontal print position, an exception condition (EC = 2) is posted and the print position is moved to the right by one space.

This command is valid for the 5219-D and 3812 printers only.

3.6.20 Required New Line (RNL)

Required New Line (RNL), X'06', restores the indent level to the left margin and moves the print position to the first position of the next line. This command is valid for the 5219-D and 3812 printers only. On the 3812, this also resets any pending indent level.

3.6.21 Superscript (SPS)

Superscript (SPS), X'09', causes an upward displacement of one-half a single line distance. This command is valid for the 5219-D and 3812 printers only.

On a 5219-D, the resultant position is never more than one-half a single line distance from the nominal baseline. If this control will not result in an upward displacement, an exception condition (EC = 1) will result. This happens if there are multiple superscript controls on a line or if a superscript control is used on the first physical line of a page.

The 3812 can process any number of SPS controls on a line with each moving the print position up one half line.

An SBS control will return an SPS condition to the baseline.

See 3.6.10, "Subscript (SBS)" on page 118 for information on multiple superscripts per line and "hanging half-index" conditions on the 5219-D.

3.6.22 Repeat (RPT)

Repeat (RPT), X'0A', is processed as a no-op. This command is valid for the 5219-D and 3812 printers only.

3.6.23 Backspace (BS)

Backspace (BS), X'16', causes the print position to be moved to the left one space (current font character width). This command is valid for the 5219-D, 3812, and 4234 printers only.

On the 5219-D or 4234, if the current print position and the left limit are separated by less than one character width, the print position is changed to the left margin.

Commands to backspace beyond the left margin result in a no-op on the 4234.

The 3812 ignores the left margin when processing this command.

On the 5219-D, an exception condition results (EC = 2) when an attempt is made to backspace past the leftmost physical print position with the margin released. Attempts to backspace past the left margin result in the print position being set to the left margin, unless the margin is released.

3.6.24 Word Underscore (WUS)

Word Underscore (WUS), X'23', causes the entire word immediately preceding the command in the data stream to be underscored. The word to be underscored is defined as the string of characters preceding the command code back to the first Word Begin delimiter. This command is valid for the 5219-D and 3812 printers only.

The valid Word Begin delimiters follow.

- Backspace
- New line
- Horizontal tab
- Line feed
- Indent tab
- Justify text field
- Form feed
- Required form feed
- Numeric space
- Unit backspace
- Numeric backspace
- Word underscore
- Carriage return
- Interchange record separator
- All four Presentation Position commands
- Underscore graphic
- Required new line
- Space (note: not Required Space)

The 3812 also defines Index Return as a Word Begin delimiter.

3.6.25 Unit Backspace (UBS)

Unit Backspace (UBS), X'1A', when in proportional spacing (PS) mode, causes a backspace of one escapement unit (EU) in width. On the 3812 and 5219-D, this is always 1/60 inch. This command is valid for the 5219-D and 3812 printers only.

When not in proportional spacing mode, the command is a no-operation, except that UBS is always a word delimiter always cancels a line or page boundary, and may define a paragraph boundary.

An exception condition results (EC = 2) when an attempt is made to backspace past the leftmost physical print position with the margin released. Attempts to backspace past the left margin result in the print position being set to the left margin, unless the margin is released.

3.6.26 Switch (SW)

Switch (SW), X'2A', is processed as a no-op. This command is valid for the 5219-D and 3812 printers only.

3.6.27 Substitute (SUB)

Substitute (SUB), X'3F', prints the hyphen graphic. This command is valid for the 5219-D and 3812 printers only.

3.6.28 Space (SP)

Space (SP), X'40', is the standard space graphic. It is included here because it has significance on the 5219-D and 3812 printers. It is a word delimiter, and it can increase in width during formatting.

3.6.29 Required Space (RSP)

Required Space (RSP), X'41', prints the standard space graphic. It is included here because it has significance on the 5219-D and 3812 printers. It is processed like Space (X'40'), but is not recognized as a word delimiter, and it is not increased in width during formatting.

3.6.30 Numeric Space (NSP)

Numeric Space (NSP), X'E1', prints the standard space graphic. It is included here because it has significance on the 5219-D and 3812 printers. It is processed like Space (X'40'), but is not recognized as a word delimiter, and it is not increased in width during formatting.

3.6.31 Format (FMT)

Format (FMT), X'2B', is a data defining character used with a one-byte parameter to define the start of a formatting data stream and a one-byte parameter to define the length of a formatting data stream. The valid format functions (codes starting with X'2B') follow.

3.6.31.1 Set Horizontal Format (SHF)

Set Horizontal Format (SHF), X'2BC1NNHH', sets the maximum print position (MPP). The SHF code itself sets all horizontal formatting controls to their specified value with the default being 132 characters.

A one-byte count (NN) follows the SHF code and counts the number of bytes to the end of the SIIF string, including the count byte. The minimum sequence that can be sent is SHF with a count of one. The maximum allowable count value is two. A count value of zero or a count field with a count greater than two will result in an exception condition (EC = 3).

The first parameter (HH) following the count defines the maximum print position (MPP). A value of zero for HH results in the maximum print position being set to the maximum value. A value of 1 for length (NN) causes the maximum value to be used for maximum print position. An unsupported parameter value results in no change to the maximum print position and an exception condition (EC = 4).

Maximum print position is the print line length. This value defines a line length to be used in place of the physical device line length. Valid values are less than or equal to the physical device length. The MPP default value is the physical device line length, X'84' (132 decimal). The maximum MPP is dependent on the current pitch as follows. The maximum for proportional space printing is 158.

Pitch	Maximum Allowed MPP (decimal)	Printers that allow this value
5	66	4214-2, 4210, 3197-attached printers
10	132	All printers supported
12	158	5219-D, 3812, 4214-2, 4210, 3197-attached printers
15	198	5224, 5225, 5219-D, 3812, 4214-2, 4210, 3197-attached printers
16	220	4214-2, 4210, 3197-attached printers

Figure 90. Maximum Print Position (MPP)

For 5219-D and 3812 printers, receipt of an SHF control activates the auto new line function which may have been previously deactivated by receipt of the SPPS (set presentation page size) control.

The automatic new line function causes a new line operation (functionally equivalent to the NL control) prior to printing any graphic character if the print position for that character would be to the right of the maximum print position.

Page width is recalculated when this command is received. Page width is the line length multiplied by the character distance. A change to the pitch via the SFG or SCD controls may change the maximum print position.

If an SIIF is received in mid line, not at a line boundary, all data prior to the SIIF in the data stream will be printed using the prior maximum print position value. Data subsequent to the SHF will be printed subject to the new maximum print position value.

Pitch changes must be made prior to maximum print position changes when decreasing pitch or increasing maximum print position. Pitch changes must be made after maximum print position changes when increasing pitch or decreasing maximum print position.

3.6.31.2 Set Vertical Format (SVF)

Set Vertical Format (SVF), X'2BC2NNVV', sets the maximum print line (MPL) on a logical page. The SVF code sets all vertical formatting controls to their specified value with default being a 1-line page.

A one-byte count (NN) follows the SVF code and counts the number of bytes to the end of the SVF string, including the count byte. The minimum sequence that can be sent is SVF with a count of one. The maximum allowable count value is two. A count value of zero or a count greater than two will result in an exception condition (EC = 3).

The first parameter following the count (VV) defines the maximum number of print lines on a page. A value of zero for VV results in a value of one for the maximum print line.

Maximum print line (MPL) is the page length. This value defines the page length to be used in place of the physical device page length. Valid values range from 0 to 255. A value of zero will result in the MPL default value. The MPL default value is one line. An invalid SCS parameter status cannot be generated for the MPL byte.

For 5219-D and 3812 printers,

- Receipt of an SVF control activates the auto page end function which may have been previously deactivated by receipt of the depth parameter in the SPPS (set presentation page size) control
- SVF causes the current line to be considered the first line of the page
- Page depth is recalculated when SVF is received. Page depth is the product of the maximum print line and the line distance.

The maximum supported maximum print line value supported without automatic sheet feed active is 255. With automatic sheet feed active, the maximum value for maximum print line is limited to a value which does not cause the resulting page depth to be greater than 14.3 inches. If an unsupported parameter value is given, it will be detected during any vertical move that causes the sheet feed limit to be exceeded. In this case, the maximum print line will be set to the maximum value for the current line density and an exception condition is recognized (EC = 2) during the vertical move (not during SVF).

3.6.31.3 Set Graphic Error Action (SGEA)

Set Graphic Error Action (SGEA), X'2BC8NNGGUU', sets the unprintable character option and sets the default graphic.

A one-byte count (NN) follows the SGEA code and counts the number of bytes to the end of the SGEA string, including the count byte. The minimum sequence which can be sent is SGEA with a count of one. The maximum allowable count value is three. A count of zero or a count greater than three will result in an exception condition (EC = 3).

The first parameter following the count (GG) is the default graphic to be printed for all unprintable characters. This graphic can be any printable character and is always printed with either of the unprintable character options. If the default graphic is not printable or not included in this control code, it defaults to a hyphen (-).

The next byte (UU) is the unprintable character option. Valid codes are

X'00', X'01', X'02' No stop, no status (ignore)
X'03', X'04' Stop; hard error status (graphic check with unit not available status)

Other values will cause the SGEA control to be ignored and an exception condition (EC = 4).

The default option, if the SGEA had not been sent, is 01; the printer does not stop, no status is returned, and a hyphen is inserted as the substitute character. This is the default if UU is not sent.

Set Initial Conditions (SIC) with an si value of 1 or Set Exception Action (SEA) with an ec parameter of 0 or 1 will cancel the SGEA setting.

The 3197-attached printers will detect no unprintable characters with the exception of Japanese Katakana because the 3197 supports all characters in Code Page 500.

3.6.31.4 Set GCGID through GCID (SCG)

Set GCGID through GCID (SCG), X'2BD10601gcgccpcp', selects the Global Character Set ID that will be used to map subsequent text into printable graphics. This command is valid for 5219-D and 3812 printers only.

- gcgc = a two-byte number specifying the GCGID of the desired character set (ignored by 3812) (default = 101).
- cpcp = a two-byte number specifying the CPGID of the desired character set (default = 256).

On the 5219-D, when the first printable graphic following this command is encountered, a unique value for the current GCGID will be displayed on the operator panel and the printer will go to the not ready state, allowing insertion of a new print font.

Invalid values for gcgc and cpcp will result in the use of the default value and an exception condition (EC = 4).

3.6.31.5 Set FID through GFID (SFG)

Set FID through GFID (SFG), X'2BD10705gfgffwfwfa', selects the Font ID, the Font Width, and the Font Attribute that will be used in printing subsequent text. This command is valid for 5219-D and 3812 printers only.

Page width may be recalculated when this command is received. Page width is the line length multiplied by the character distance. If the current maximum print position exceeds the maximum value for the maximum print position for the new pitch, the maximum print position value is changed to the new value. If the current maximum print position value does not exceed the maximum value for the new pitch, the maximum print position value is not changed.

- gfgf = a two-byte number specifying the type style (GFID) to be used for printing subsequent text. Allowable values are 1 to 255. All other values will cause the value to be ignored and an exception condition (EC = 4). The default values are 11 for data processing mode, and 87 for word processing mode.

On the 3812, only certain font IDs are recognized. If the GFID is not recognized, the 3812 will map to a font with a width that is closest to the font width specified in the command.

- **fwfw** = a two-byte number specifying the Font Width to be used for printing subsequent text. On a 5219-D, allowable values are 96 (15 cpi), 120 (12 cpi), and 144 (10 cpi); all other values will cause an exception condition (EC = 4) and the value to be ignored. On a 3812, all values are acceptable. The defaults are 144 in data processing mode and 120 in word processing mode.
- **fa** = a one-byte number specifying whether the font is monospaced (fa = 1) or proportionally spaced (fa = 2). All other values will cause an exception condition (EC = 4) and the value to be ignored. This parameter is ignored by a 3812.

On the 5219-D the first printable graphic following this command is encountered, a unique value for the current GCGID will be displayed on the operator panel and the printer will go to a not ready state, allowing a new font to be inserted.

3.6.31.6 Set Initial Conditions (SIC)

Set Initial Conditions (SIC), X'2BD20345si', sets and resets internal formatting parameters to their initialization values. Additionally, this command signifies the document boundary. This command implicitly selects either a data processing or word processing environment. This command is valid for 5219-D and 3812 printers only.

si = a one-byte number designating the set of initialization values to be applied to subsequent text. A 1 causes the word processing initialization values to be used; a 255 causes the data processing set of initialization values to be used (default, and the state set on power on and when a Reset command is received). All other values will cause an exception condition (EC = 4) and word processing mode to be assumed. The EAA, if continued processing is allowed, is to apply the word processing initialization values.

Occurrence of this command is restricted to page boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2).

In the word processing environment, a Set Initial Conditions with an **si** value of 1 is used to signify a document boundary.

On the 5219-D, a printwheel change will be requested on receipt of the first graphic following a SIC control that changes the character set or font style to other than that assumed to be currently mounted.

On the 3812, the SIC command sets the following initial values.

Parameter/Condition	DP mode	WP mode
Page width	13.2 inches	8.5 inches
Left Margin	0.0 inches	1.5 inches
Right Margin	13.2 inches	7.5 inches
Top Margin	29 pels	1 inch + 29 pels
Bottom Margin	11 inches	not applicable

Figure 91 (Part 1 of 2). 3812 response to SIC command

¹⁴ The term "jog" refers to the 3812 printer's capability to offset output sheets from each other.

Parameter/Condition	DP mode	WP mode
Font Style	11 (Courier-10)	87 (Letter Gothic)
Auto New Line	Active	Inactive
Auto Page End	Active	Inactive
Page Length	11 inches	11 inches
Lines Per Inch	6	6
jog tray ¹⁴	yes	no

Figure 91 (Part 2 of 2). 3812 response to SIC command

On the 5219-D, the SIC command sets the following initial values.

Parameter/Condition	DP mode	WP mode
Page width	not applicable	8.5 inches
Left Margin	0.0 inches	1.5 inches
Right Margin	13.2 inches	7.5 inches
Top Margin	1/6 inch	7/6 inch
Release left margin	not released	not released
First writing line	1	7
Font Style	11 (Courier-10)	87 (Letter Gothic)
Auto New Line	Active	Inactive
Auto Page End	Active	Inactive
Page Length	not applicable	11 inches
Lines Per Inch	6	6
Line Spacing	single	single
Maximum print lines	1	not applicable
Maximum print position	132	not applicable
Pitch	10	12
Tab stops	cleared	cleared
Indent level	left margin	left margin
Character set registry ID	set at factory	00101 00256
Font attribute	1 = fixed pitch	1 = fixed pitch
Forms control type	paper	paper
Source drawer	1 (bottom)	1 (bottom)
Destination drawer	1	1
Optional ribbon saver mode	switch setting	switch setting
Justification	inactive	inactive

Figure 92 (Part 1 of 2). 5219-D response to SIC command

Parameter/Condition	DP mode	WP mode
Justification percent rule	100%	100%
Continuous underscore function	inactive	inactive
Continuous overstrike function	inactive	inactive
Unprintable character option	no stop, no status	terminate
Substitute character and default graphic	hyphen	hyphen
Exception action (all classes)	terminate	terminate
Feed type	defaults to device installed	defaults to device installed

Figure 92 (Part 2 of 2). 5219-D response to SIC command

3.6.31.7 Set Presentation Color (SPC)

Set Presentation Color (SPC), X'2BD2nn2Dcc', specifies the color that will be used for subsequent printing. This command is supported *only* on 3197-attached printers.

- nn = number of bytes remaining in the command plus 1. The only valid values are 03 and 04.
- cc = color code. If nn = 03, then cc is one byte in length and has the following meaning:
 - X'F0' = Brown
 - X'F1' = Blue
 - X'F2' = Red
 - X'F3' = Pink
 - X'F4' = Green
 - X'F5' = Turquoise
 - X'F6' = Yellow
 - X'F7' = Neutral
 - X'F8' = Orange
 - X'F9' = Color of Medium
 - When cc = X'F9', the subsequent text data will be translated into spaces so that no character is printed out. This translation is to remain in effect until another SPC that specifies another color is encountered.
- If nn = 04, then cc is two bytes in length and has the following meaning:
 - X'0000' = Black or current ribbon color
 - X'0001' = Blue
 - X'0002' = Red
 - X'0003' = Pink/Magenta
 - X'0004' = Green
 - X'0005' = Turquoise/Cyan
 - X'0006' = Yellow
 - X'0007' = White
 - X'0008' = Black
 - X'0009' = Dark Blue
 - X'000A' = Orange
 - X'000B' = Purple
 - X'000C' = Dark Green

- X'000D' = Dark Turquoise
- X'000E' = Mustard
- X'000F' = Grey
- X'0010' = Brown
- X'0011' - X'FFEF' = Reserved
- X'FF00' = Current default
- X'FF01' = Blue
- X'FF02' = Red
- X'FF03' = Pink/Magenta
- X'FF04' = Green
- X'FF05' = Turquoise/Cyan
- X'FF06' = Yellow
- X'FF07' = Black
- X'FF08' = Color of Medium
- X'FFFF' = Current Default
- When cc = X'FF08', the subsequent text data will be translated into spaces so that no character is printed out. This translation is to remain in effect until another SPC that specifies another color is encountered.

3.6.31.8 Set Horizontal Tab Stops (STAB)

Set Horizontal Tab Stops (STAB), X'2BD2nn01ffaltabs', specifies the horizontal tab settings and the alignment characteristics associated with each tab position. This command is valid for 5219-D and 3812 printers only.

- nn = number of bytes remaining in the command plus 1. This value is 03 when only ff is specified, but valid values are 03 through 255. A value of 03 causes all tab settings to be cleared. A value of nn less than 03 causes an exception condition (EC = 3).
- ff = identifies whether the specified tab settings are defined in 1440ths of an inch (fixed tabs, ff = 1), or in character units (floating tabs, ff = 0). In either case, the tab stop setting is relative to the left margin. All other values for ff will cause an exception condition (EC = 4) and the STAB control to be ignored.
- al.tabs = paired parameters specifying the type of alignment to be performed in positioning text at the tab stop (al, 1 byte) and the location of the tab stop (tabs, 2 bytes). As many tabs as necessary may be specified as long as nn does not exceed 255. Tabs must always be specified in "al, tabs" pairs. The "al" values are not used and are not inspected. Valid values for "tabs" are 0 through 32767. All other values will cause an exception condition (EC = 4) and the value to be ignored. A value of 0 causes no tabs to be set. A value of 1 causes a tab stop to be set at the left margin. Fixed tab values (other than 0 and 1) that are not 1/60th of an inch are rounded to the next smaller 1/60th of an inch multiple.

Occurrences of this command is restricted to line boundaries. Failure to adhere to this restriction causes an exception condition (EC = 2).

3.6.31.9 Justify Text Field (JTF)

Justify Text Field (JTF), X'2BD2nn03rerepr', specifies justification of a field of text and the horizontal position to which the text will be justified. This command is valid for 5219-D and 3812 printers only.

This command justifies the following field of text and can be used to accomplish multi-column justification by specifying this command once per column on the line. The "field of text" as used in this command is delimited by the command and the next subsequent occurrence of the command or line ending command (i.e., carriage return, new line, required new line, interchange record separator, index return, form feed, or required form feed).

nn = number of bytes remaining in the command plus 1. Valid values are 04 and 05. An invalid value will cause an exception condition (EC = 3).

- rere = a two-byte number specifying the horizontal position to which the field will be justified. The value is specified in 1440ths of an inch and is always relative to the left margin. If the value specified is not in a multiple of 1/120th of an inch, the value will be rounded down to the next 1/120th multiple. A value of 0 terminates justification at the point of insertion of the command. Valid values are those that are less than or equal to the current right edge of the page as derived from the page width, not less than the effective left margin, and not less than any previous JTF right edge specified in the same line. Invalid values will cause an exception condition (EC = 4) on the 5219-D and the JTF control to be ignored.
- pr = a one-byte number specifying the percentage rule of justification to be performed, where
 - 0 = No change to current percent rule
 - 50 = Use 50% justification
 - 100 = Use 100% justification

The 3812 always uses the 100% rule.

All other values are invalid and will cause an exception condition (EC = 4) and the use of the nearest nonzero value.

This command is not allowed while SJM is active. Failure to adhere to this restriction will cause an exception condition (EC = 2).

Text which exceeds the maximum print position or a change to the current maximum print position which makes the justified text extend past the maximum print position will cause an EC = 2.

Leading spaces are not justified; nor is text to the left of the rightmost HT, IT, LF, vertical PP (absolute or horizontal), or absolute horizontal PP in a field or line. Text containing backspace controls will not be justified.

3.6.31.10 Set Indent Level (SIL)

Set Indent Level (SIL), X'2BD20307il', specifies the indent tab level to be applied to subsequent text. This command is valid for 5219-D and 3812 printers only.

il = a one-byte number specifying the number of tab stops to the right of the left margin at which the indent level is to be set. Valid values are 0 through 84. A value of 0 causes the indent level to be set to left margin. If an undefined tab stop setting (85 through 255) is selected, an exception condition (EC = 2) will result and one space will be used per tab stop past the last defined tab stop.

Occurrence of this command is restricted to the line boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2).

SIL, SIC, RFF, RNL, and IRT reset the indent level.

3.6.31.11 Release Left Margin (RLM)

Release Left Margin (RLM), X'2BD2020B', specifies that any backspace command (i.e., backspace, unit backspace) is permitted to move the print position to the left of the left margin. This command is valid for 5219-D and 3812 printers only.

This command is in effect from its point of appearance until a subsequent Carriage Return, New Line, Interchange Record Separator, Index Return, Required New Line, Form Feed, or Required Form Feed command is encountered. Occurrence of any of these commands while RLM is active always causes the horizontal print position to return to the left margin or current indent level, if any, and deactivates RLM.

This command is ignored by the 3812 except for purposes of justification.

3.6.31.12 Set Justify Mode (SJM)

Set Justify Mode (SJM), X'2BD2nn0Dstpr', specifies the justification of all subsequent lines of text. This command is valid for 5219-D and 3812 printers only.

- nn = number of bytes remaining in the command plus 1. Valid values are 03 and 04. An invalid value will cause an exception condition (EC = 3).
- st = a one-byte number used to indicate whether justification is to be activated or deactivated. A value of 0 deactivates justification and a value of 1 activates justification. All other values are invalid and cause an exception condition (EC = 4).
- pr = a one-byte number specifying the percentage rule of justification to be performed, where:
 - 0 = No change to current percent rule
 - 50 = Use 50% justification
 - 100 = Use 100% justification

The 3812 always uses 100% justification.

All other values are invalid and will cause an exception condition (EC = 4).

When SJM is active the last line of a paragraph will not be justified. Recognition of the following paragraph boundaries is supported (IRS is equivalent to New Line for any of the following controls).

- Two or more New Line or IRS commands
- Required New Line (or Index Return)
- New Line, Line Feed
- New Line, Horizontal Tab
- New Line, Indent Tab
- New Line, Space
- New Line, Numeric Space
- New Line, Required Space
- New Line, Backspace
- New Line, Unit Backspace
- New Line, Carriage Return
- New Line, Release Left Margin
- New Line, Numeric Backspace
- Required Form Feed

In order for two commands to jointly constitute a paragraph boundary, there must not be any intervening one-byte codes above X'40'; intervening multibyte commands and one byte controls (except for those listed above) are ignored when computing paragraph boundaries.

Text which exceeds the right margin cannot be justified and will cause an exception condition (EC = 2).

Occurrence of this command is restricted to line boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 3).

This command is not allowed while JTF is active. Failure to adhere to this restriction will cause an exception condition (EC = 2).

Leading spaces are not justified; nor is text to the left of the rightmost HT, IT, LF, vertical PP (absolute or horizontal), or absolute horizontal PP in a field or line. Text containing backspace controls will not be justified.

3.6.31.13 Set Horizontal Margins (SHM)

Set Horizontal Margins (SHM), X'2BD2nn11fmmrmm', specifies the left and right margins in 1440ths of an inch. Margin settings are always relative to the physical left margin. This command is valid for 5219-D and 3812 printers only.

- nn = number of bytes remaining in the command plus 1. Valid values are 04 through 06. An invalid value will cause an exception condition (EC = 3).
- fmm = a two-byte number specifying in 1440ths of an inch the leftmost print position relative to the physical left margin. Valid values are from 0 to 32767. Other values will cause an exception condition (EC = 4). A value of 0 causes no change to the margin setting. A value of 1 causes a margin of 0 inches. Values that are not an even multiple of 1/120th of an inch will be rounded down to the next even 1/120th multiple. Any value less than 120 is treated as a value 1.
- rmm = a two-byte number specifying in 1440ths of an inch the rightmost print position relative to the physical left margin. Valid values are from 0 to 32767. Other values will cause an exception condition (EC = 4). A value of 0 causes no change to the margin setting. A value of 1 causes a margin of 0

inches. Values that are not an even multiple of 1/120th of an inch will be rounded down to the next even 1/120th multiple. If SJM is active, attempting to justify a line with a right margin setting greater than the page width or maximum print position will result in an exception condition (EC = 2).

Occurrence of this command is restricted to line boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2).

3.6.31.14 Set Line Spacing (SLS)

Set Line Spacing (SLS), X'2BD20309ls', specifies multiple line spacing as the number of half lines to be advanced on execution of a line indexing command (new line, required new line, line feed, interchange record separator, index return). This command is valid for 5219-D and 3812 printers only.

ls = a one-byte number specifying the number of half lines to advance for each line indexing command. Valid values are 2, 3, 4, and 6. All other values will cause an exception condition (EC = 4) and the nearest supported value will be used.

Occurrence of this command is restricted to line boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2).

3.6.31.15 Set Single Line Distance (SSLD)

Set Single Line Distance (SSLD) X'2BD20415ld', specifies the vertical distance to be moved for a single line space. This command is valid for 5219-D, 3812, 4214-2, 4210, and 3197-attached printers only.

ld = a two-byte number specifying in 1440ths of an inch the depth of one line. Default for ld is 240, or X'00F0' (6 lines per inch). The following values are supported on a 5219-D.

001E	48 lines per inch (lpi)
003C	24 lpi
0078	12 lpi
0096	9.6 lpi
00B4	8 lpi
00F0	6 lpi
010E	5.3 lpi
0168	4 lpi
023A	1 cm. This value should be used only with the optional metric line spacing platen and in friction feed.

On the 5219-D, all other values will cause an exception condition (EC = 4) and the nearest supported value will be used.

The 3812 supports values 1 to 32767 and posts EC = 4 for all other values.

Valid values for the 4214-2, 4210, and 3197-attached printers range from X'0001' to X'05A0'. On 3197-attached printers, the line spacing increments will be rounded to the nearest 1/72 of an inch. Other values cause an invalid Printer Data Stream parameter check.

Page depth is recalculated when this command is received, if the auto page end feature is active. Page depth is the product of line distance and maximum print line.

Occurrence of this command is restricted to line boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2) or Invalid PDS parameter status.

3.6.31.16 Set Presentation Page Size (SPPS)

Set Presentation Page Size (SPPS), X'2BD2nn40wdwdpdp', specifies the width and depth of the physical page. This command will always deactivate the auto new line function and deactivates the auto page end function when the dpdp parameter is specified. With the auto new line function deactivated, attempting to print beyond the right extent of the page will cause an exception condition (EC = 1). This command is valid for the 5219-D and 3812 printers only.

- nn = number of bytes remaining in the command plus 1. Valid values are 04 through 06. An invalid value will cause an exception condition (EC = 3).
- wdwd = a two-byte number specifying the horizontal extent of the page in 1440ths of an inch. The left reference is logical left margin. Values of 0 through 19008 are valid. Invalid values will cause an exception condition (EC = 4) and the maximum supported value will be used. A value of 0 causes no change to the current page width (no-op). Values that are not multiples of 1/120th of an inch will be rounded down to the next 1/120th multiple.
- dpdp = a two-byte number specifying the vertical extent of the page in 1440ths of an inch. The top reference is top of form. Valid values are 0 through 32767. Invalid values cause an exception condition (EC = 4) and the maximum supported value will be used. A value of 0 or omitting this parameter causes no change to the page depth.

Note: This parameter cannot be omitted for the 3812.

Values that are not multiples of 1/96th of an inch will be rounded down to the next 1/96th multiple.

Note that an attempt to print beyond the page depth with the auto page end function deactivated will result in an exception condition (EC = 2).

Occurrence of this command is restricted to page boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2).

For the 3812,

This command sets the presentation surface *width*, and optionally the *depth*, in units of 1440ths of an inch. Valid values for width and depth are 0 through 32767. Values of 0 result in no change.

The presentation surface is a different concept from the physical paper size. It describes a maximum area of print on a page, but does not guarantee that that area will be filled with printed characters. It is therefore legal to specify an area larger than the physical paper, as long as no characters are actually printed off the paper.

This command causes the page orientation to be calculated according to the following rules:

1. If the page orientation is not currently "default", that is, if the orientation has been explicitly set by a Set Text Orientation command, then explicit orientation is used.

2. Otherwise, if the configuration switches specify fixed (as opposed to automatic) orientation, the decision is made based on the user-selected setting for the current paper drawer. There are three possible settings for each drawer:
 - a. Computer output reduction (landscape orientation, reduced fonts and spacings).
 - b. Normal portrait orientation.
 - c. Normal landscape orientation.
3. Otherwise, if the configuration switches specify automatic orientation, there are two cases based on the presentation surface size:
 - a. If the presentation surface size is a size larger than the 3812 can feed, the decision is made based on the customer-selected setting for the current paper drawer. If that decision would result in computer output reduction, and quality mode is active (Q = 2 or 3) due to a previous PPM command, normal portrait output is selected instead.
 - b. If the presentation surface size is legal for the 3812 (that is, one dimension is less than or equal to 8.5 inches and the other dimension is less than or equal to 14 inches), then the dimensions are compared. If the shorter dimension is specified as the depth, then landscape is used, otherwise portrait is used.

3.6.31.17 Page Presentation Media (PPM)

Page Presentation Media (PPM), X'2BD2nn48xxxxfcsddoddqdx', specifies presentation media device settings. This command is valid for the 5219-D, 3812, 4214-2, 4210, 4234, and 3197-attached printers only.

- nn = number of bytes remaining in the command plus 1. Valid values are 05 through 10. An invalid value will cause an exception condition (EC = 3) for 5219-D and 3812. The only valid value for 4234 is 9.
- xxxx = a two-byte number that is not inspected by the printer, except that the value must be zero for the 4234.
- fc = a one-byte number specifying the forms selection. Valid values for fc are 0 through 2. The only valid value for the 4234 is zero. The 4210 and 3197-attached printers ignore this parameter.

Value	Effect
0	no change to the form selection.
1	causes the selection of paper as the forms media
2	causes the selection of envelopes as the forms media. This causes the feed selection to be overridden to manual until a PPM control specifies paper as the media. The 3812 does not support envelopes.
3-255	invalid

Invalid values for fc will cause an exception condition (EC = 4) for 5219-D and 3812.

- sd = a one-byte number specifying the source drawer to be used for automatic feeding of cut sheets. It must be zero for the 4234. This parameter is ignored by the 3812 if envelopes are selected by the fc parameter. The 4210 ignores this parameter.

Value	Effect
0	no change to the source drawer selection

- 1 selects drawer 1
- 2 selects drawer 2
- 3 selects drawer 3
- 255 Power-on default (4214-2, 4210, and 3197-attached printers only)

Invalid values cause an exception condition (EC = 4). Attempting to use a drawer that is not installed causes an exception condition (EC = 1) or an invalid SCS control code condition.

- do = a one-byte number that is not inspected by printers other than the 3812 and 4234. For the 3812,

Value	Effect
0	Do not jog output ¹⁵
non-zero	jog output provided one or more pages have been printed since last non-zero "do" value was provided.

The value must be zero for the 4234.

- dd = a one-byte number specifying destination drawer for sheetfeed devices. It will be either 0 (no change) or 1. Any other value will cause an exception condition (EC = 4) at the time a sheetfeed eject is to be executed. On the 5219-D, this parameter is ignored if the feed type is manual or tractor. The 4210 and 3197-attached printers ignore this parameter.
- qq = a one-byte number specifying the print quality. Valid values are shown below. All other values will cause an exception condition (EC = 4) and 1 will be used.

Value	Effect
0	Do not change quality setting.
1	On 5219-D, use the quality setting set on the panel switch. On the 3812, allow computer output reduction mode. On the 4214-2, 4210, and 3197-attached printers use data processing quality. On the 4234, use data processing quality.
2	On 5219-D, selects standard quality without regard to the switch setting on the control panel. On the 3812, do not allow computer output reduction mode regardless of the settings of the configuration mode switches. On the 4214-2, 4210, 4234, and 3197-attached printers use letter processing quality.
3	This value is invalid for the 5219-D and the 4234. It has the same meaning as 2 for the 3812. For the 4214-2, it means draft quality (high speed alphameric printing). For the 4210 and 3197-attached printers it means draft quality.
255	This value is invalid on the 3812 and 5219-D. On the 4214-2, 4210, and 3197-attached printers it means reset to the default or operator selected value. On the 4234, it means reset to the operator selected value.

On the 4210 and 3197-attached printers, print quality selection from the operator panel overrides a previously set print quality selection via the datastream, and print quality selection via the datastream overrides a previously set print quality selection from the operator panel.

The 4214-2 supports near-letter quality in 10 and 12 cpi. The 4210 supports near-letter quality in 5, 10, and 12 cpi.

- dx = a one-byte number that is not inspected by the printer.

¹⁵ The term "jog" refers to the 3812 printer's capability to offset output sheets from each other.

The PPM command causes the 3812 to sense the guides in the paper drawers and determine the physical paper size actually present in the input cassettes.

Occurrence of this command is restricted to page boundaries on the 5219-D and 3812. Failure to adhere to this restriction will cause an exception condition (EC = 2).

3.6.31.18 Set Vertical Margins (SVM)

Set Vertical Margins (SVM), X'2BD2nn49tmtmbmbm', specifies the top and bottom margins on the page. This command is valid for the 5219-D and 3812 printers only.

- nn = number of bytes remaining in the command plus 1. Valid values are 04 through 06. An invalid value will cause an exception condition (EC = 3) on the 5219-D only.
- tmtm = a two-byte number specifying in 1440ths of an inch the distance from the top edge of the page to the baseline of the first print line on the page. Valid values are 0 through 32767. All other values are invalid and will cause an exception condition (EC = 4). A value of 0 causes no change to the top margin setting. The default is 240 in data processing mode and 1680 for word processing.

On a 5219-D, however, if another control is eventually processed that attempts to print in a position in which the first print line would be less than a single line distance below the top edge of the paper, then at that time an exception condition (EC = 1) will be detected and posted prior to printing the first character on the page. This will happen for a range of 1 through 239 for 6 lines per inch (lpi), and 1 through 179 for 8 lpi. It is recommended that a top margin setting equal to at least one line be used for tractor feed and at least 32/96ths of an inch for sheet feed. If the value for tmtm is not a multiple of 1/96ths of an inch, the tmtm value will be rounded to the next smaller 1/96th multiple or next larger multiple if no smaller multiple exists.

- bmbm = a two-byte number that is not inspected by the 5219-D, and is optional for the 3812.

Occurrence of this command is restricted to page boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 3).

3.6.31.19 Set Print Setup (SPSU)

Set Print Setup (SPSU), X'2BD2nn4Cxxpfxsi', specifies the paper feed technique and print setup to be used. This command is valid for the 5219-D and 3812 printers only.

This command is ignored by the 3812.

- nn = number of bytes remaining in the command plus 1 (including the length byte). Valid values are 04 through 65. An invalid value will cause an exception condition (EC = 3).
- xx = a one-byte number that is not inspected by the 5219-D.
- pf = a one-byte number specifying the paper feed mechanism to be used. The following values are valid:

- 00 No change to paper feed
- 01 Select manual feed
- 02 Select tractor feed

03 Select automatic cut sheet feed

With the exception of a requested feed type of manual, the paper feed device installed will be the one used irrespective of the feed type requested. If manual feed is requested, however, manual will be used irrespective of the feed device installed; i.e., a request for manual feed overrides the feed device installed.

All other values will cause an exception condition (EC = 4).

- **si** = a string of EBCDIC values up to 60 bytes in length. The first two bytes of the string will be converted to decimal values to be presented in the two-digit LED display on the printer operator panel. If either of the first two bytes is not in the range X'f0' to X'F9', this parameter will be ignored and a display of X'FF' will result. A **nn** value of 06 will cause the **si** parameter to be ignored and a display of X'FF' will result.

Occurrence of this command is restricted to page boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2).

3.6.31.20 Set Exception Action (SEA)

Set Exception Action (SEA), X'2BD2nn85ecac', specifies the action to be taken upon detection of various text data stream exception conditions. This command is valid for the 5219-D and 3812 printers only.

- **nn** = number of bytes remaining in the command plus 1. Valid values are 04 through 254. An invalid value will cause an exception condition (EC = 3).
- **ecac** = paired one-byte parameters specifying the action to be taken upon detection of various data stream exception conditions. The value for **ec** is the exception condition (EC) value. Valid values for **ec** are 0 through 4. All other values for **ec** will cause an exception condition (EC = 4). A value of 0 causes the paired **ac** value to apply to all exception conditions.

Valid values for **ac**, for the 5219-D, are

- 0 Post soft outstanding status to system
- 1 Ignore error (no status to the system)
- 2 Post invalid Printer Data Stream error to the system (default)
- 3 Post hard outstanding status to system

Valid values for **ac**, for the 3812, are

- 0 Accept - same as Ignore
- 1 Ignore error (no status to the system)
- 2 Terminate - print error, feed form, stop, and signal status to system.
- 3 print error vector and continue

All other values for **ac** will cause an exception condition (EC = 4).

Occurrence of this command is restricted to line boundaries. Failure to adhere to this restriction will cause an exception condition (EC = 2).

SIC with an **si** value of 255 or SGEA cancels any setting made by SEA for exception class 1.

3.6.31.21 Begin Underscore (BUS)

Begin Underscore (BUS), X'2BD4nn0A01bp', activates the continuous underscore function. This command is valid for the 5219-D, 3812, and 4234 printers only.

- nn = number of bytes remaining in the command plus 1. Valid values are 03 and 04. Any other value will cause an exception condition (EC = 3).
- bp = optional one-byte number identifying the graphic characters not to be underscored. Two values are supported. The default value, X'00', means underscore all graphic characters including the space graphic X'40' and the relative horizontal print position control X'34C8'. The other value supported for bp is X'80', which means underscore all graphic characters except the two mentioned for the X'00' value. Any other value for bp will cause an exception condition (EC = 4), and bp will be assumed to be X'00'.

Note: The 3812 printer allows the value of X'01' and will perform the same as X'00'

Receiving BUS while underscore is active results in an exception condition (EC = 1).

3.6.31.22 End Underscore (EUS)

End Underscore (EUS), X'2BD4020E', deactivates the continuous underscore (BUS) function. This command is valid for the 5219-D, 3812, and 4234 printers only.

Receiving EUS while underscore is inactive results in an exception condition (EC = 1).

3.6.31.23 Begin Overstrike (BOS)

Begin Overstrike (BOS), X'2BD4nn72chbpgcgccpcp', activates the continuous overstrike function. This command is valid for the 5219-D and 3812 printers only.

- nn = number of bytes remaining in the command plus 1. Valid values are 03 through 08. An invalid value will cause an exception condition (EC = 3).
- ch = a one-byte number specifying the character code point to be used as the overstrike character. Valid values are characters printable in the currently selected character set in the range of X'40' to X'FE' (X'FF' for the 3812). If an invalid code point is selected, an exception condition (EC = 4) will result. A character set change subsequent to the BOS control may cause the previously printable graphic to become unprintable in which case an exception condition (EC = 1) will result prior to starting the overstrike operation.
- bp = an optional one-byte number identifying the graphic characters not to be overstruck. Two values are supported. The default value, X'00', means overstrike all graphic characters including the space graphic X'40' and the relative horizontal presentation position control X'34C8'. (The 3812 will overstrike all graphic characters except spaces due to tab controls.) The other value supported for bp is X'80', which means overstrike all graphic characters except the two mentioned for the X'00' value. Any other value for bp will cause an exception condition (EC = 4).

Note: The 3812 printer allows the value of X'01' and will perform the same as X'00'

- `gcbc` = optional two-byte number that is not supported by the 5219-D but must be zero. Any other value will cause an exception condition (EC = 4) on the 5219-D. This parameter is ignored by the 3812.
- `cpcp` = optional two-byte number that is not supported by the 5219-D but must be zero. Any other value will cause an exception condition (EC = 4) on the 5219-D. This parameter is ignored by the 3812.

Receiving BOS while overstrike is active results in an exception condition (EC = 1).

3.6.31.24 End Overstrike (EOS)

End Overstrike (EOS), X'2BD40276', deactivates the continuous overstrike (BOS) function. This command is valid for the 5219-D and 3812 printers only.

Receiving EOS while overstrike is inactive results in an exception condition (EC = 1).

3.6.31.25 Begin Emphasis (BES)

Begin Emphasis, X'2BD1038Aca', activates the continuous emphasis function. This command is valid for the 3812 printer only. The 3812 prints emphasized characters by overlaying them with the same pel pattern displaced by two pels horizontally. The recommended emphasis technique for the 3812 is for the user to switch to a bold or italic font as desired.

- `ca` = character appearance, a one-byte hexadecimal value that describes the desired results when the indicated text is emphasized. The 3812 printer ignores this parameter value.

Receiving BES while emphasis is active results in an exception condition (EC = 1).

3.6.31.26 End Emphasis (EES)

End Emphasis, X'2BD1nn8E:xx', deactivates the continuous emphasis (BES) function. This command is valid for the 3812 printer only.

- `nn` = number of bytes remaining in the command plus 1. Valid values are 02 through 03.
- `xx` = one byte reserved field. The 3812 printer ignores this parameter value.

Receiving EES while emphasis is inactive results in an exception condition (EC = 1).

3.6.31.27 Set Line Density (SLD)

Set Line Density (SLD), X'2BC6nnd', specifies the vertical distance to be moved for a single line space.

This command is valid for all printers except the 5256 and the 5262. It is always valid for the 4245 only when not in 5256 emulation mode. It is valid for the 5262 on the System/38 only.

- `nn` = the number of bytes remaining in the command plus 1. This value is 02 when `ld` is specified, but valid values are 01 and 02. If `nn` is 01, `ld` defaults to X'0C'. An invalid value causes `ld` to default to X'0C' and an exception condition (EC = 3).

- `ld` = the number of 1/72 inch increments to be moved for each vertical index, with a maximum of 18. All values of `ld` are valid. The following shows the relationship between the value of `ld` and the lines per inch print density for the 5219.

1 to 6	12 lines per inch
7 to 8	9.6 lines per inch
9 to 11	8 lines per inch
12	6 lines per inch. If <code>ld</code> is 0, 12 is used.
13 to 17	5.3 lines per inch
18	4 lines per inch
19 to 255	12 lines per inch

On the 3812, if Computer Output Reduction Mode is active, 70% of the `ld` value is used.

The 4214-2 has 1/120 inch increments for fan fold forms and 1/108 inch increments for cut sheet forms. The valid values for `ld` on the 4214-2 are between 1 and 72. Values between 73 and 255, inclusive, will cause a Printer Data Stream parameter check.

The 4210 moves in 1/72 inch steps only.

Page depth may be recalculated when this control is sent. See the SVF control for more information.

The new line density does not take effect until the next line end or indexing control (CR, NL, IRS, RNL, IRT, FF, RFF, LF, absolute vertical PP, or relative vertical PP). Vertical displacements for subscripts and superscripts on the current line are unaffected by SLD.

3.6.31.28 Set Coded Graphic Character Set through Local ID (SCGL)

Set Coded Graphic Character Set through Local ID (SCGL), `X'2BD1038ld'`, selects one of the sixteen coded graphic character sets as the designated character set.

`id` = codes for the following character sets.

- `X'00'` = Multinational (except 5219-D)
- `X'00'` = International (ASCII) (5219-D only)
- `X'01'` = United States
- `X'01'` = United States/EBCDIC (5219-D only)
- `X'02'` = Austria/Germany
- `X'03'` = Belgium
- `X'04'` = Brazil (*For 3197-attached keyboards, X'04' represents the printer default, .ie. the language defaulted by the 3197 keyboard*)
- `X'05'` = Canadian French (not 4234)
- `X'05'` = United States / Canadian Bilingual (4234 only)
- `X'06'` = Denmark/Norway
- `X'07'` = Finland/Sweden
- `X'08'` = France - 1977 (not 5219-D)
- `X'08'` = France - 1980 (5219-D only)
- `X'09'` = Italy
- `X'0A'` = Japan (English) (*For 3197-attached keyboards, X'0A' represents the printer default, .ie. the language defaulted by the 3197 keyboard*)

X'0B' = Katakana (on 5219-D, translates to ASCII, ID = X'00') X'0B' represents US/Canada for 3197-attached printers.
 X'0C' = Portuguese
 X'0D' = Spain
 X'0E' = Spanish Speaking
 X'0F' = United Kingdom
 X'6S' = Spanish Word Processing (3812 only)
 X'FF' = Default character set

All other values cause the default character set to be selected.

On the 5262, this command is accepted, but does nothing.

3.6.31.29 Set Character Distance (SCD)

Set Character Distance (SCD), X'2BD2042900pp', specifies the number of characters to be printed per inch. Note that anytime the current maximum print position value (as set via the SHF command) is greater than 132 and this command is used to select 10 cpi, the maximum print position value will be set to 132 by the printer.

This command is valid for all printers except the 5256 and 5262. It is always valid for the 4245 but not sent to it when it is emulating a 5256.

Page width is recalculated when this command is received. Page width is the product of the maximum print position and the character distance.

pp:

X'00' no-op - no change to current density
 X'05' 5 cp (4214-2, 4210, and 3197-attached printers only)
 X'0A' 10 cpi
 X'0B' proportional spacing (5219-D and 3812)
 X'0C' 12 cpi (5219-D, 3812, 4214-2, 4210, and 3197-attached printers only)
 X'0F' 15 cpi (On 4210 and 3197-attached printers, this is done as 17.1 cpi with a maximum print position of 198)
 X'10' 16.7 cpi (4214-2, 4210, and 3197-attached printers) (on 4210 and 3197-attached printers this is done as 17.1 cpi with a maximum print position of 220)
 X'FF' 10 cpi

The 4245 accepts only the X'0A' value.

3.6.31.30 Load Alternate Characters (LAC)

Load Alternate Characters (LAC), X'2BFEnnmnceil...in', loads single or double-byte character codes at specified EBCDIC or ideographic addresses. This command is valid for the 5224, 5225, 4214-2, and 4234 printers only.

- nn = number of bytes remaining in the command plus 1. This value must not exceed 255.

mm value	nn value required
01	= 2 plus 10 times the number of character images
02	= 2 plus 11 times the number of character images

03 = 2 plus 22 times the number of character images
 04 = 2 plus 56 times the number of character images
 05 = 2 plus 62 times the number of character images

- mm = character matrix size as follows:

01 8 high by 9 wide
 02 8 high by 10 wide (5224-12, 5225-11, 5225-12, and 4214-2)
 03 16 high by 10 wide (5224-12, 5225-11, 5225-12)
 04 18 high by 18 wide (5224-12, 5225-11, 5225-12)
 05 18 high by 20 wide (5224-12, 5225-11, 5225-12)
 09 8 high by 12 wide (4234 at 15 cpi only)
 00, 0A-FF invalid

- ee is a single byte code for mm = 01 or 02; ee is double byte code for mm = 03, 04, and 05.
- il-in = a field of vertical slice data that defines the character pattern, when mm = 01, 02, or 03. If mm = 04 or 05, then the field is horizontal slices.

Note: The 4210 and 3197-attached printers, though they emulate the 4214-2 in general, do not support this control and will reject it with Invalid SCS Control Code in the next poll response.

3.6.31.31 Set Text Orientation (STO)

Set Text Orientation (STO), X'2BD3nnF6ccccpppp', controls the orientation of the characters on a page. This command is valid for the 3812 printer only.

- nn is a one byte count of the number of bytes remaining in the command, plus one.

For the 3812, the only valid value is 6. Invalid values will cause an EC = 4 exception.

- cccc is two bytes specifying the character rotation angle. It is ignored by the 3812.
- pppp is text line rotation (two bytes). On the 3812, it has these meanings.

X'0000'	Normal "portrait" (upright) orientation
X'2D00'	Landscape left (270 degrees clockwise rotation of text)
X'5A00'	"portrait" upside down orientation (180 degrees rotation of text)
X'8700'	Landscape right (90 degrees clockwise rotation of text)
X'FFFE'	Select Computer Output Reduction Mode
X'FFFF'	Default. This causes the orientation to be calculated based on the rules given in 3.6.31.16, "Set Presentation Page Size (SPPS)" on page 135.
all others	invalid; will cause EC = 4 exception.

3.6.31.32 Execute PMP

Execute PMP, X'2BCAnnpm', causes the 3812 to execute a set of "primitive" 3812 commands. This command is valid for the 3812 printer only.

PMP is "Page Map Primitives", the machine level language for the 3812. PMP provides the ability to use such functions as vector graphics, reverse image printing, user-generated characters, and print macro modification.

The publication S544-3343 includes the following warning:

WARNING: PMP is a language unique to the 3812. Programs coded with PMP instructions will not be compatible with other current or possibly future IBM printers. Thus, moving a PMP-coded application to a different printer will most likely require reprogramming.

- nn is a one byte count of the number of bytes remaining in the command, plus one.
- pm is one or more PMP command bytes. The PMP commands are not documented in this manual. Refer to the following.
 - *Using the IBM Pageprinter 3812 with an IBM System/36 or System/38*, S544-3343.
 - *Using the IBM S/36 Printer Application Program Interface PRPQ (PRPQ P84073, (5799-BYX))*, shipped with the PRPQ.
 - *IBM 3812 Pageprinter Programming Reference*, S544-3268. This manual describes the interface between the 3812 and the IBM PC. It includes descriptions of the primitive commands used to perform the additional functions.

3.7 Internal Processing Queue

Data and commands are received via a twinaxial cable. A work area large enough to hold 16 frames of commands or associated data is used as a queue. Commands and associated data will be processed from this queue area on a first in-first out basis. Commands that require a following Activate shall be placed last on the queue and no more commands other than Poll or EOQ will be accepted until after the Activate has been received. When a "nonbusy" status is returned (after the Activate), the queue is empty and all commands that were placed on it have been executed; the queue is available again for up to 16 commands and associated data frames.

The queue loading process must be completed by issuing a command that designates the end of queue. This designator may be either a command requiring activation, or an EOQ command (delimiter). Once an EOQ designator has been transmitted, no commands except Poll will be processed until a nonbusy status is returned to a Poll command.

If all 16 queue entries are loaded, no EOQ designator need be issued. However, if all 16 queue locations are loaded, the last frame sent cannot contain all '1' bits in frame bits 7 through 14. A X'FF' code in the command byte is invalid.

It is sufficient to terminate all queues with the EOQ delimiter, but not necessary after a command requiring activation is loaded to the queue.

Commands which are queueable are as follows:

- Clear
- Set mode (with one data frame)
- Reset
- Write Control Data (with one data frame)
- Read Device ID
- End of Queue Delimiter
- Read Status
- Write Data

Commands which must be placed last on the queue are as follows:

- End of Queue Delimiter
- Read Status
- Write Data
- Read Device ID

Once the queue is not empty, a "busy" status is set. The Activate commands, while not stored in the queue, will cause a busy status to be sent as well. The printer remains busy until an Activate command has been completed and status has been updated, or the queue is emptied. Note that printers go not busy after an activate command, unlike display stations.

3.8 Command Response Timing

The printer responds with "busy" status after any cable command. It will continue to respond with "busy" status until the command has been processed.

The maximum time the printer will stay busy is 8.16 seconds after an EOQ delimiter, activate command, the 16th frame that fills up the queue, or any command requiring an activate. The minimum time for the printer to stay busy is 500 microseconds.

No two commands may follow one another closer than 30 microseconds from the transmission of the last bit of the last frame of the first command until the first bit in the bit synchronization pattern of the second command.

3.9 Data Codes

All 256 possible byte values are used. All codes from X'00' through X'3F' are either valid or invalid SNA character string control codes. All codes from X'40' through X'FF' are either printable or unprintable data codes.

3.9.1 Character Sets

EBCDIC is the standard code in the basic character set consisting of 96 (94 for 5219-D) characters. Katakana uses a 128 character set. The character sets are shown in illustrations on the following pages. Undefined character codes (in columns 4 through F) are printed as the default graphic as specified by the SCS SGEA control code. If the default graphic is not specified, a - (hyphen) is printed as the substitute character.

3.9.1.1 Printable Character Set

First Hex Char	0	1	4	5	6	7	8	9	A	B	C	D	E	F	
0			&	-	ø	ø	°	μ	c	|	|	\	0		
1			é	/	É	a	i	~	£	A	J			1	
2			â	ê	Â	Ê	b	k	s	¥	B	K	S	2	
3			ä	ë	Ä	Ë	c	l	l	℞	C	L	T	3	
4			à	è	À	È	d	m	u	f	D	M	U	4	
5			á	í	Á	Í	e	n	v	§	E	N	V	5	
6			ã	ï	Ã	Ï	f	o	w	¶	F	O	W	6	
7			ä	ï	Ä	Ï	g	p	x	¼	G	P	X	7	
8			ç	ï	Ç	Ï	h	q	y	½	H	Q	Y	8	
9			ñ	ß	Ñ	ß	i	r	z	¾	I	R	Z	9	
A			[	]	|	:	«	»	ı	—	—	≈	=	ı
B			.	s	,	#	»	ı	ı	|	ô	ü	ô	ü	
C			ı	<	*	%	@	d	æ	ð	≠	ö	ü	ö	ü
D			(	)	_	'	≤	≥	↑	..	ó	ú	ó	ú
E			+	;	>	=	P	R	p	'	ó	ú	ó	ú	
F			!	^	?	"	±	π	⊗	=	ö	ü	ö	ü	

Figure 93. Multinational Character Set.

1. Shaded positions are valid codes reserved for use by IBM.
2. Blank positions are invalid codes which may or may not print a character.
3. Codes with a first hexadecimal digit of 2 or 3 are reserved for display attributes.
4. These codes are unique to the 5250 Information Display System and do not necessarily conform to EBCDIC standards.
5. The following characters print as blanks.
 - X'40' (Space)
 - X'41' (Required Space)
 - X'E1' (Numeric Space)

World Trade Variations of the Printable Character Set

For the countries shown, characters are identical to the printable character set except as noted.

Hex:	4A	4C	4F	5A	5B	5F	6A	79	7B	7C	A1	C0	D0	E0
U.S. and Canada	c		l	l		7								
Multinational														
Austria/Germany	Ä			ü			ö			ø	ß	ä	ü	Ö
Belgium							ù			à	..	é	è	ç
Brazil	É			ç	ç		ç	ã	õ	ã		õ	é	
Canada (French)	à			'	,		ù				..	é	è	ç
Denmark/Norway	#			Å	Å		ø		Æ	Ø	ü	æ	å	
Finland/Sweden	ø			Å	Å		ö	é	Ä	Ö	ü	ä	å	É
France	ø			ø			ù		£	à	..	é	è	ç
Italy	ø			é			ó	ù	£	ø	1	à	è	ç
Japan (English)	£		l	l	≠	7					—			ç
Portugal		ç					ø		ã	õ	ç	ã		ç
Spain			l		Prs	7	ç		ñ	ñ	..			
Spanish-Speaking			l			7	ç		ñ	ñ	..			
United Kingdom	ç		l	l	£	7					—			

Figure 94. World Trade Variations

Standard Katakana Printable Character Set

		First Hexadecimal Character															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Second Hexadecimal Character	0					Sp	&	-			ソ						0
	1					。	／			プ	グ	-			A	J	1
	2					フ	ズ			イ	チ	ハ			B	K	2
	3					、	↑			ウ	ツ	ク			C	L	3
	4					、	↓			エ	テ	マ			D	M	4
	5					・	♪			キ	リ	エ			E	N	5
	6					ヲ	ソ			カ	ジ	ム			F	O	6
	7					フ				フ	ニ	ノ			G	P	7
	8					、	-			コ	又	モ			H	Q	8
	9					ウ				コ	ズ	チ			I	R	9
	A					エ	！		：	コ	ノ	！	ル				
	B					・	¥		、	#				□			
	C					<	*	%	@	リ		ヨ	フ				
	D					(	)	-	'	ヲ	ハ	ラ	ン				
	E					・	;	>	=	ス	ヒ	リ	"				
	F					！	フ	、	"	ヒ	フ	ル	・				

Figure 95. Katakana Character Set

3.10 Twinaxial Cable Performance Requirements

See 1.0, "Physical Characteristics of the Twinaxial Cable" on page 1 for information on data transmission rates and characteristics.

An interframe interval of greater than 240 microseconds might cause invalid command exception status. When a poll or activate read command is received, the printer will initiate a turnaround within 45 (± 15) microseconds. The Poll or Activate Read response time is measured from the time the parity bit is received at the printer until the sync bit of the first response frame is transmitted. Transmission from the printer will be at a 1 MHz ($\pm 2\%$) bit rate. The interframe interval may be adjusted from zero to approximately 240 microseconds in increments of eight microseconds, as specified by the Set Mode command.

Before command transmission, the transmission system must be conditioned to ensure that bit and frame synchronization can be achieved. This requires the transmission of a five bit pattern which synchronizes the receiver clocks to the incoming pulses, and a three-bit frame synchronization pattern that delimits the start of a command message sequence. No two commands may follow one another closer than 30 microseconds from the transmission of the last bit in the first command until the first bit of the bit synchronization pattern of the second command. Following the transmission of a Set Mode command frame, the data frame must be transmitted within 256 microseconds of the preceding command frame. Similarly, the same requirement is made for the data frame following a Write Control Data command.

3.11 4214-2 — 4210 Differences

The 4210 emulates the 4214-2 with the following differences. These differences and operational considerations are discussed in *IBM 4210 Printer Product and Programming Description*, SC31-3784.

- The 4210 does not support the Load Alternate Character SCS control.
- The 4210 does not support the Transparent SCS control.
- The 4214-2 uses steps of 1/120 or 1/108 to move paper, depending on the type of paper feed. It emulates movement of 1/72 inch. The 4210 moves paper in 1/72 inch steps only.
- The 4214-2 uses character sizes of 5, 10, 12, 15, and 16.7 cpi. The 4210 uses character sizes 5, 10, 12, and 17.1 cpi. When the 4210 receives instructions to set 15 cpi, it uses 17.1 cpi with a maximum print position of 198. When the 4210 receives instructions to set 16.7 cpi, it uses 17.1 cpi with a maximum print position of 220.
- The 4214-2 supports near-letter quality printing in 10 and 12 cpi. The 4210 supports near-letter quality printing in 5, 10, and 12 cpi.
- The 4214-2 has an auto sheet feed mechanism and uses the drawer selection capabilities of the Page Presentation Media control. The 4210 has no such mechanism and ignores the drawer selection parameters of Page Presentation Media.
- The 4210 uses the last print quality selection it receives from the operator panel or the data stream; the last one takes precedence.

- The 4210 may delay up to 20 seconds in turning on the Check light when it reports a Graphic Check to the host.
- The 4210 sets Print Complete in the poll response when it receives data, not when it has printed the data. This requires special host handling of print data in order to avoid data loss if a printer error occurs.
- After operator recovery from a forms jam or end-of-forms condition, the 4210 completes printing the page it was printing. If only a partial page is printed, forms alignment may be lost.
- The 4210 will finish printing the data in its internal buffers before stopping, even if a Clear command is sent.

3.12 4214-2 – 3197-Attached Printer differences

The 3197 display station supports the 4201, 4202 and 5201 PC printers via a PC Parallel Interface. This section deals with the 4201, 4202, and 5201 differences from the 4214-2 when 4214-2 emulation is selected via the 3197.

- The 3197-Attached Printers do not support the Load Alternate Character SCS control.
- The 3197-Attached Printers do not support the Transparent SCS control.
- The 3197-Attached printers support the ASCII Transparent (ATRN) control and Set Presentation Color (SPC) control. For more information on these controls, see 3.6, "Control Character String" on page 116.
- The 4214-2 uses steps of 1/120 or 1/108 to move paper, depending on the type of paper feed. It emulates movement of 1/72 inch. The 3197-Attached Printers move paper in 1/72 inch steps only.

Note: Since spacing will be converted to the nearest 1/72 of an inch, it is recommend the Set Single Line Density SCS Control parameter be expressed in multiples of 20/1440ths to insure accurate placement of printing on the page.

- The 4214-2 uses character sizes of 5, 10, 12, 15, and 16.7 cpi. The 3197-Attached printers use character sizes of 5, 6, 8.55, 10, 12, and 17.1 cpi. When the 3197-Attached printer receives instructions to set 15 or 16.7 cpi, it substitutes with 17.1 cpi.
- The 4214-2 supports near-letter quality printing in 10 and 12 cpi. The 3197-attached printers support near-letter quality printing in 5, 10, and 12 cpi.
- The 3197-attached printers use the last print quality selection received from the operator panel or data stream; the last one taking precedence.
- The 3197-attached printers set Print Complete in the poll response when receiving data, not when the data has been printed. This requires special host handling of print data in order to avoid data loss if a printer error occurs.
- After operator recovery from a forms jam or end-of-forms condition, 3197-attached printers complete printing the current page. If only a partial page is printed, forms alignment may be lost.

- 3197-attached printer will finish printing the data in its internal buffers before stopping, even if a Clear command is sent.

4.0 5251 Model 12 Interface

In this configuration, a controller, similar to that in the System Unit, is located in the 5251 Model 12. Work stations interface with the Model 12 through the Cluster feature. The Model 12 interface to the System Unit is through a communications interface.

4.1 Communications Interface

Refer to the 5251 Model 12 Maintenance Information Manual for detailed information about the following communications features:

- EIA Interface - provides for attaching an external modem meeting RS232C/CCITT V.24/V.28 for operation on a switched or non-switched communication line.
- 1200 bps Integrated Modem - is available in four versions: non-switched operation (U.S. and Canada) manual answer switched (for U.S. and Canada), non-switched (for World Trade countries), and switched (for World Trade countries). The Internal Clock feature on 5251 Model 12 is needed with all versions. A CDT type of data access arrangement, or an FCC certified equivalent in the U.S., is needed for attachment to switched lines in the U.S. and Canada. A line plate, with functions similar to a CBS type data coupler, is provided with the switched line version for World Trade countries.
- 2400 bps Integrated Modem - is compatible with the IBM 3863 Integrated Modem and equivalent modems. The line speed is 2400 bps with half speed backup 1200 bps on either switched or non-switched lines. The modem operates in half duplex mode on switched lines and as tributaries on multipoint non-switched lines.
- 4800 bps Integrated Modem - is compatible with the IBM 3864 and equivalent modems. The line speed is 4800 bps with half speed backup on switched or non-switched lines. The modem operates in half duplex mode on switched lines and as tributaries on multipoint non-switched lines.

Both the 2400 and 4800 bps modems can operate in full duplex mode on non-switched point-to-point lines. Line speeds on switched lines in the US and on all non-switched lines are selected at the host system. In World Trade countries, the 2400 bps integrated modem may be manually switched to half speed.

Both the 2400 and 4800 bps modems are connected to the public switches network (PSN) by:

- Integrated protective coupler (IPC) in the US.
- Coupler adapter with external coupler (CBS or equivalent) in Canada.

- World Trade coupler in World Trade countries.
- Digital Data Service Adapter - provides for attaching to the AT&T Dataphone Digital Service network or equivalent, via an AT&T Channel Service Unit, or equivalent.

4.2 Communication Protocol

The IBM 5251 Model 12 uses System Network Architecture (SNA) protocol for the transfer and management of data. Synchronous Data Link Control (SDLC) is used for control of the data link.

General information about SNA and SDLC is in the following manuals:

- *IBM Synchronous Data Link Control General Information, GA27-3093*
- *IBM Systems Network Architecture Concepts and Products, GC30-3072*
- *IBM Systems Network Architecture Format and Protocol Reference Manual, SC30-3112*

Specific information about SNA and SDLC as used in the 5251 Model 12 is in the following manuals:

- *IBM 5250 Information Display System Functions Reference Manual, SA21-9247*
- *IBM 5251 Display Station Models 2 and 12 Maintenance Information Manual, SY31-0463*

4.2.1 Data Link Control

The 5251 Model 12 operates synchronously using a subset of SDLC. Refer to the Maintenance Information Manual and the Functions Reference Manual for information on the implementation of SDLC in the 5251 Model 12. Refer to the Synchronous Data Link Control General Information Manual for additional SDLC information.

4.2.2 Path Control, Connection Point Manager

Transmission subsystem profile 7 is used.

4.2.3 Data Flow Control

Function management profile 7 is used.

4.2.4 Presentation Services

These are defined in this manual and in the Functions Reference Manual.

4.2.5 Information Transfer

SNA LU types 4 and 7 are used to transfer information and commands between the host and controller.

5.0 5251 Model 11 to 5251 Model 12 Interface

The interface between the 5251 Model 11 and the 5251 Model 12 is the same as the interface between 5251 Model 11 and the System Unit with the exceptions described below.

Although individual commands and the expected responses are equivalent for both the local and remote attachments, the sequences and intercommand timing may differ.

5.1 Physical Characteristics of Twinaxial Cable

The section having the same title at the beginning of this document applies except that connections are to ports on the Cluster feature of the Model 12 instead of on the System Unit. For added information about connecting work stations to the Model 12 refer to *IBM 5250 Information Display System Functions Reference Manual*, SA21-9247.

5.2 Display Attributes

Added information about the field (display) attributes used between the Model 11 and the Model 12 is in *IBM 5250 Information Display System Functions Reference Manual*, SA21-9247.

5.3 Command Matrix

The two following commands are modified:

- Read Data
- Read Device ID

5.4 Specific Formats

All commands pass from the controller in the 5251 Model 12 (rather than the controller in the System Unit) to the 5251 Model 11.

5.4.1 Read Data Command (Code = 01000 Base or -1000 Feature)

This command is addressed to a specific device on a specific station.

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	Station Address
7-14	Read Data Command (00001000)
15	Stop bit; always 1.

Figure 96. Read Data Command for 5151-11 from 5251-12

It starts the transfer of one byte of data from the base device, or a 16 byte block for Read Data commands addressed to a specific feature device. The address counter is incremented once for each byte transferred from the base regen buffer. An activate command is needed before data transfer starts. The Read Data command will not result in the invalid device address exception condition if a device address of an uninstalled or undefined feature is presented with the command. Rather, 16 data bytes of all zeros is returned with no exception condition.

If the address counter register contains a value larger than the limit of installed storage, for read to the base machine, an invalid register value exception condition results.

5.4.2 Read Device ID Command (Code = 01100)

Bit	Purpose
0.1.2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4.5.6	Station Address
7-14	Read Device ID Command (00001100)
15	Stop bit; always 1.

Figure 97. Read Device ID for 5151-11 from 5251-12

This command starts the transfer of one data word from the addressed device. The device ID word from the base contains information about the characteristics of the station. Other special feature devices return an ID word with the device characteristics of the installed special feature. If a special feature device is not installed, bits 7 through 14 of the returned frame are zero. A Read Device ID command to the indicators returns a field of zeros. An Activate command is needed before data transfer will start.

See 2.4.8.1, "Base ID Word" on page 53 for the format of the response of the Read Device ID command addressed to the base device.

5.4.3 Keyboard ID Word

This is the same as the keyboard response to the System Unit workstation controller (see 2.4.8.3, "Keyboard ID Word" on page 55), except that only 5251-11 keyboard values are supported.

5.4.4 Printer ID Word (Printer Response)

See 6.0, "Printer (5219, 5224, 5225, and 5256) to 5251 Model 12 Interface" on page 161 for information on the interface between printers and the 5251 model 12.

5.4.5 Activate Commands

Add Read Data (addressed to base) to the list of preactivate commands.

5.5 Performance Measurement

5.5.1 Preactivate Commands

Add:

Command	Preactivate (milliseconds)	Post-Activate Recovery (milliseconds)
Read Device ID (Base)	3.4	2.4

6.0 Printer (5219, 5224, 5225, and 5256) to 5251 Model 12 Interface

This interface is similar to that described in 3.0, "Printer Interface" on page 85 except that the controller is in the 5251 Model 12 instead of in the System Unit. However, although individual commands and the expected responses are equivalent for both the local and remote attachments, the sequences and intercommand timing may differ. The additions listed below also apply.

6.1 Commands Matrix

Name	Bits 7 through 14
Read Device ID ¹⁶	0000 1100

¹⁶ Requires an Activate Read command.

6.2 Specific Formats

6.2.1 Read Device ID Command (0000 1100)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7-14	Read Device ID Command (00001100)
15	Stop bit; always 1.

Figure 98. Read Device ID for 5151-11 from 5251-12

This command initiates the transfer of one ID word from the printer. The ID word from the printer contains information describing the characteristics of the printer. An Activate Read command is required before the printer will respond with the printer ID byte.

6.2.2 Printer ID Word (Printer Response)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	End Of Message (111)
7-14	Device identification information
15	Stop bit; always 1.

Figure 99. Printer ID word for 5251-12 attachment

- Bits 7 and 8 (5256 Only)
 - 00 = 40 cps
 - 01 = 80 cps
 - 10 = 120 cps
 - 11 = Reserved
- Bits 7 and 8 (5224 Models 1 and 2)
 - 00 = 1 actuator group
 - 01 = 2 actuator groups
- Bits 7 and 8 (5224 Model 12)
 - 00 = 2 actuator groups
 - 01 = Reserved
 - 10 = Reserved
 - 11 = Reserved

- Bits 7 and 8 (5225 Models 1 through 4)

- 00 = 2 actuator groups
- 01 = 4 actuator groups
- 10 = 6 actuator groups
- 11 = 8 actuator groups

- Bits 7 and 8 (5225 Models 11 and 12)

- 00 = 2 actuator groups
- 01 = 4 actuator groups
- 10 = 6 actuator groups
- 11 = 8 actuator groups

- Bits 7 and 8 (5219-D)

- 00 = 5219 Models D01 and D02
- 01 = Reserved
- 10 = Reserved
- 11 = Reserved

- Bits 9 and 10 Printer/Display Identification (All Except 5225 Models 11 and 12)

- 00 = Display
- 01 = Reserved
- 10 = Printer
- 11 = Reserved

- Bits 9 and 10 Printer/Display Identification (5225 Models 11 and 12)

- 00 = 4 actuator groups
- 01 = 7 actuator groups
- 10 = Reserved
- 11 = Reserved

- Bits 11, 12, 13, and 14 Type of Printer

- 0000 = 5256
- 0100 = 5224 Models 1 and 2
- 0110 = 5224 Model 12 (non-U.S. only)
- 1000 = 5225 Models 1 through 4
- 1010 = 5225 Models 11 and 12 (non-U.S. only)
- 1101 = 5219 Models D01 and D02

7.0 5291 Interface

This interface is the same as that described in 2.0, "5251 Model 11 Interface" on page 11 except for the differences noted below.

The 5291 comes in two models - the 5291 model 1 and the 5292 model 2. They respond identically to the controller.

7.1 Keyboards

The 5291 does not support data entry keyboards.

7.2 Cable through

Cable through is standard on the 5291.

7.3 Magnetic Stripe Reader

The Magnetic Stripe Reader is not supported by the 5291.

7.4 Device Addressing

The 5291 does not support the feature format for the Magnetic Stripe Reader.

7.5 Keyboard Clicker and Audible Alarm

The 5291 has no electronic keyboard "clicker". Audible response to key action is a mechanical function of the keyboard and not a function of the controller.

An audible alarm is provided that will sound for approximately 1 second when started by the controller. The alarm may indicate that the keyboard is inactive if keys, other than the cursor movement keys, are pressed when an "input inhibited" condition exists.

7.6 Poll Command (Code = 10000)

Modified from 5251 Model 11 as follows.

Change the time in which the base status is returned to the controller after reception of the last bit in the Poll command from 45 ± 15 microseconds to 60 ± 20 microseconds.

If a Poll command arrives at the display station within 105 microseconds of the last bit of the last data frame of an Activate Write command, the response will be delayed by the amount of the time difference.

Also,

- A Poll command with bits 8 and 9 set to 1 will respond with the former response frame. (A 5251 with these bits on will respond with the updated response, if it is available.)
- A two-frame poll response is always returned for a Poll command (regardless of bit 9) following the execution of a Set Mode command at power-on time.

7.7 Poll Response to the Controller

7.7.1 Poll Response Byte 1

Bit 8 is the Line Parity Error Detected bit. In the 5251 model 11, parity is checked for even parity over bits 3 through 15 of every frame. In the 5291, the parity expected is even parity over bits 0 through 15 of every frame.

7.7.2 Poll Response Byte 2

- The display station enables the alarm when an overrun condition occurs at the display station.
- When enabled, the alarm will sound for all keystrokes. The alarm will remain enabled until the controller disables it via the Write Control Data command.
- Keystrokes during an overrun condition will be accessible to the controller. When the station is polled and sends the next keystroke to the controller, the overrun condition is terminated until another keystroke is detected that cannot be stored at the station.

7.8 Write Control Data Command (Code = 00101)

The following bit description is changed for the 5291.

Bit 13

- 0 = Disable audible alarm on keystroke
- 1 = Enable audible alarm on keystroke

7.9 Set Mode Command (Code = 10011)

The following table shows the differences between the 5251 Model 11 and the 5291.

The numbers given are in bits of fill at one microsecond per bit as measured from bit 0 of a given frame until the sync bit (bit 15) of the next frame. Observed times may differ from stated times by ± 1 microsecond.

For bits 7 through 11 of the data frame, see Figure 100 on page 168. Type 1 activates are not terminated by attributes in the data stream. Type 2 activates are terminated by attributes found in the data stream. Type 2 activates are preceded by a Read Immediate Field preactivate command.

Bit 12 - must be zero.

Bits 13 and 14

00	Normal display mode
01	Inhibit user limit checking (see below)
10	Reserved
11	Reserved

When bits 13 and 14 equal 01, the user accessible limit checking is disabled, allowing access to any installed storage areas.

Bits 7 - 11 Set Mode Fill Count	Poll Response 5251 Fill	Poll Response 5291 Fill	Activate Read Type 1	Activate Read Type 2
0	0	1	7	9-19 ¹⁷
1	8	11	12	9-19 ¹⁷
2	16	21	17	9-19 ¹⁷
3	24	26	27	29
4	32	36	32	34
5	40	41	42	44
6	48	51	52	49
7	56	61	57	59
8	64	66	67	69
9	72	76	72	74
10	80	81	82	84
11	88	91	92	89
12	96	101	97	99
13	104	106	107	109
14	112	116	112	114
15	120	121	122	124
16	128	131	132	129
17	136	141	137	139
18	144	146	147	149
19	152	156	152	154
20	160	161	162	164
21	168	171	172	169
22	176	181	177	179
23	184	186	187	184
24	192	196	192	194
25	200	201	202	204
26	208	211	212	209
27	216	221	217	219
28	224	226	227	224
29	232	236	232	234
30	240	241	242	244

Figure 100. 5291 Set Mode Command

7.10 Responses and Data from an IBM 5291

The Poll and Activate Read commands will respond in 60 (± 20) microseconds.

¹⁷ The time is determined by the content of each frame transmitted and may vary on a frame-by-frame basis throughout the range specified.

8.0 5292 and 3179 Model 2 Interface

The 5292 interface is the same as that described in 2.0, "5251 Model 11 Interface" on page 11, except for the differences identified below.

The 5292 comes in two models: 5292 model 1 and 5292 model 2. The 5292 model 1 is a color display with no graphics capability. The 5292 model 2 is a color display with vector graphics. The two models have the same interface to the controller in that they have the same addressing characteristics and they accept the same commands. The graphics capability of the 5292 model 2 is controlled via the data stream; the 5292 model 2 accepts more data stream orders than the 5292 model 1. See *IBM 5250 Information Display System Functions Reference Manual*, SA21-9247, for information on the the 5292 model 2 graphics data stream.

The 3179 model 2 (3179-2) has an interface similar to the 5292 model 1. See 8.11, "3179 Model 2: Differences from 5292 Model 1" on page 176 for the differences between the 5292-1 and the 3179-2.

8.1 Cable Through

Cable through is standard on the 5292.

8.2 Keyboard Clicker and Alarm

The 5292 keyboard provides a mechanical, audible feedback for each keystroke. This feedback is not controllable from system controllers nor is it adjustable at the display station.

The 5292 audible alarm is separate from the keyboard and is controlled by the attaching system. The alarm will sound for approximately 1 second. On the 5292, the audible alarm may indicate that the keyboard is inactive if keys, other than the cursor movement keys, are pressed when an "input inhibited" condition exists.

8.3 Display Attributes

The 5292 display station supports the normal attributes supported by the 5251 Model 11. In addition, field attributes are used to control the seven colors for display on a field basis. The attribute is in effect until another attribute is encountered. A chart correlating hexadecimal codes with both the normal and color attributes follows.

Normal Attributes	Hex Code	7-Color Attributes
Green data (normal screen)	20	Green data
Reverse image (green background)	21	Green reverse image
White data	22	White data
White reverse image	23	White reverse image
Green data, underscore	24	Green data, underscore
Green reverse image, white underscore	25	Green reverse image, underscore
White data, underscore	26	White data, underscore
No display (blank screen)	27	No display (blank screen)
Blink, green data	28	Red data
Blink, green reverse image	29	Red reverse image
White data, blink	2A	Red data, blinking
Blink, white reverse image	2B	Red reverse image, blinking
Blink, green data and underscore	2C	Red data, underscore
Blink, green reverse image, white underscore	2D	Red reverse image, underscore
Blink, white data, blue underscore	2E	Red data, underscore, blinking
No display	2F	No display
Green data, blue column separators	30	Turquoise data, column separators
Green reverse image, blue column separators	31	Turquoise reverse image, column separators
White data, blue column separators	32	Yellow data, column separators
White reverse image, blue column separators	33	Yellow reverse image, column separators
Green underscore, column separators	34	Turquoise data, underscore, column separators ¹⁸
Green reverse image and underscore, column separators	35	Turquoise reverse image, underscore, column separators ¹⁸
White underscore, column separators	36	Yellow data, underscore, column separators ¹⁸
No display	37	No display
Blink, green data, blue column separators	38	Pink data

Figure 101 (Part 1 of 2). 5252 Display Attribute Characters

¹⁸ A dash underscore (_ _) results when column separators and underscore are selected together.

Normal Attributes	Hex Code	7-Color Attributes
Blink, green reverse image, blue column separators	39	Pink reverse image
Blink, white data, white column separators	3A	Blue data
Blink, white reverse image, white column separators	3B	Blue reverse image
Blink, green data, green underscore, column separators	3C	Pink data, underscore
Blink, green reverse image, white underscore, column separators	3D	Pink reverse image, underscore
Blink, white data white underscore, column separators	3E	Blue data, underscore
No display	3F	No display

Figure 101 (Part 2 of 2). 5252 Display Attribute Characters

Notes:

1. *Underscore and column separators are always blue and never blink for 7-color attributes.*
2. *Column separators are dots, not vertical lines. Column separators are suppressed when the option to suppress line space is selected.*

8.4 Reset Command (Code = 00010, -0010)

The Reset command operates differently than for the 5251 Model 11 as follows.

The Reset command takes the station off-line (no poll response) for approximately six seconds instead of the five seconds for the 5251 model 11.

Note that the 5292 does not have a CE Test switch. Therefore, the reference to Test position is not applicable.

8.5 Set Mode Command (Code = 10011)

The following table shows the differences between the 5251 Model 11 and the 5292.

The numbers given are in bits of fill at one microsecond per bit as measured from bit 0 of a given frame until the sync bit (bit 15) of the next frame. Observed times may differ from stated times by ± 1 microsecond.

Type 1 activates are not terminated by attributes in the data stream. Type 2 activates are terminated by attributes found in the data stream. Type 2 activates are preceded by a Read Immediate Field preactivate command.

Bits 7-11 Set Mode Fill Count	Poll Response 5251 Fill	Poll Response 5291 Fill	Activate Read Type 1	Activate Read Type 2
0	0	1	7	9-19 ¹⁹
1	8	11	12	9-19 ¹⁹
2	16	21	17	9-19 ¹⁹
3	24	26	27	29
4	32	36	32	34
5	40	41	42	44
6	48	51	52	49
7	56	61	57	59
8	64	66	67	69
9	72	76	72	74
10	80	81	82	84
11	88	91	92	89
12	96	101	97	99
13	104	106	107	109
14	112	116	112	114
15	120	121	122	124
16	128	131	132	129
17	136	141	137	139
18	144	146	147	149
19	152	156	152	154
20	160	161	162	164
21	168	171	172	169
22	176	181	177	179
23	184	186	187	184
24	192	196	192	194
25	200	201	202	204
26	208	211	212	209
27	216	221	217	219
28	224	226	227	224
29	232	236	232	234
30	240	241	242	244

Figure 102. 5292 Set Mode Command

¹⁹ The time is determined by the content of each frame transmitted and may vary on a frame-by-frame basis throughout the range specified.

8.6 Write Control Data Command (Code = 00101)

5292 bit assignments.

- Bit 8
 - 0 = Normal display
 - 1 = Suppress interrow space

- Bit 11
 - 0 = Normal display
 - 1 = Reverse Screen on 5251; on 5292, unused

- Bit 13
 - 0 = Disable audible alarm on keystroke
 - 1 = Enable audible alarm on keystroke

8.7 Poll Command (Code = 10000)

Modified from 5251 Model 11 as follows.

Change the time in which the base status is returned to the controller after reception of the last bit in the Poll command from 45 ± 15 microseconds to 60 ± 20 microseconds of the last bit of the last data frame of an "active write" command, the response will be delayed by the amount of the time difference.

Also,

- A Poll command with bits 8 and 9 set to 1 will respond with the former response frame. (A 5251 with these bits on would respond with the updated response, if it was available.)

- A two-frame poll response is always returned for a Poll command (regardless of bit 9) following the execution of a "set mode" command at power-on time.

8.7.1 Poll Response to the Controller

8.7.1.1 Poll Response Byte 1

Bit 8 is the Line Parity Error Detected bit. In the 5251 model 11, parity is checked for even parity over bits 3 through 15 of every frame. In the 5292, the parity expected is even parity over bits 0 through 15 of every frame.

8.7.1.2 Poll Response Byte 2

- The display station enables the alarm when an overrun condition occurs at the display station. When enabled, the alarm will sound for all keystrokes. The alarm will remain enabled until the controller disables it via the Write Control Data command.
- Keystrokes during an overrun condition will be inaccessible to the controller. When the station is polled and sends the next keystroke to the controller, the overrun condition is terminated until another keystroke is detected that cannot be stored at the station.

8.8 Automatic Reset Procedure

The 5292 does not have a status switch. However, the function of the Status switch on the 5251 in Test position is under control of an operator "online Select mode" option on the 5292. When this option is set on, no automatic reset action occurs.

8.9 Responses and Data From an IBM 5292

The Poll and Activate Read commands will respond in 60 ± 20 microseconds.

The interframe interval may be adjusted from zero to approximately 240 in increments of 5 to 10 microseconds with the Set Mode command.

8.10 Command Execution

The station will be capable of responding with the proper scan code available in its status response in no greater than 44 milliseconds after a key is depressed (typical is less than 22 milliseconds) and when no other key is stored in the station.

5292 command performance execution times will differ from the 5251 Model 11 noted times. Certain commands will execute quicker on the 5292 than on the 5251 and vice versa. However, 5292 times are all within the figures quoted for the 5251 Model 11 maximum allowable times.

8.11 3179 Model 2: Differences from 5292 Model 1

The 3179-2 may have a keyboard identifier different from that returned by the 5292-1 when Read Device ID is issued to the keyboard device ID. See 2.4.8.3, "Keyboard ID Word" on page 55 for more information on the codes returned by Read Device ID.

The 3179-2 supports two keyboards:

- a keyboard identical to the 3180-2 keyboard
- the IBM Enhanced Keyboard.

With the 3180-2 style keyboard, the 3179-2 emulates the scan codes returned by the 5251-11, and does not return scan codes for blank keytops. That is, the 3179-2 will process a key and return the scan code or scan codes that the 5251 model 11 would return. For example,

- COMMAND key code will be sent before a command key
- shift make will be sent before a key that was shifted on the 5251 model 11, with a following shift break if necessary
- keys with front-face symbols will be sent as "shift-HELP, key" sequences, as on the 5251 model 11

See 12.2, "3180-2 Keyboards" on page 184 for more information on the layout of 3180-2 style keyboards.

See 19.0, "IBM Enhanced Keyboard" on page 257 for more information on the IBM Enhanced Keyboard.

The 3179-2 displayable character set is the same as the 3180-2 displayable character set.

The 3179-2 does not have cable through. The 3179-2 attaches to twinaxial cable through a "T-connector" which provides cable through capability. The T-connector is provided with the 3179-2 unit. The 3179-2 provides the ability to set its twinaxial cable address.

9.0 PC/5250 Emulation Feature

The IBM PC (Personal Computer)/5250 Emulation Feature is attached to the System Unit with an addressable multidrop line using dual signal conductor twinaxial cable. A maximum of 1525 meters (5000 feet) separation is allowed between the host system and the most distant work station.

There is no RAM or ROS supplied with the emulation feature. All control code is IPLed from the microcode diskette. Other required resources of the PC that are used by the 5250 feature are two DMA channels (1 and 3) and interrupt level 5 of the PC microprocessor.

Any PC feature that requires these resources cannot operate concurrently with the emulation feature although it can co-reside with it. The feature microcode can make use of the auto batch DOS facility of the PC to start and IPL. When exiting terminal mode to resume DOS operations, the interrupt X'20' vector is used.

Any time after 5250 emulation has started, you can switch back and forth between emulation mode and PC operation by pressing ALT, followed by pressing ESC.

The emulation cards and programs can return anything they are programmed to return in response to Read Device ID. The programs select the proper responses based on the type of device that they are emulating.

9.1 Interface

The interface is the same as that described in 2.0, "5251 Model 11 Interface" on page 11 except for the differences noted below.

9.1.1 Displayable Characters

The PC/5250 emulation feature supports only the character sets (language groups) supported by the Personal Computer (see *5250 Emulation Program User's Guide*).

Since the IBM Personal Computer uses the ASCII character set, the emulation program has to convert the EBCDIC character codes for each country to the ASCII codes (see *5250 Emulation Program User's Guide*).

9.1.2 Keyboard Clicker and Audible Alarm

The PC/5250 emulation feature provides an audible, controllable sound for keystrokes similar to that used on the 5251 Model 11. The audible alarm functions similarly to that used on the 5291.

9.2 References

Refer to *Enhanced 5250 Emulation Program User's Guide*, G570-2202, and *Enhanced Display Station Emulation Adapter Hardware Maintenance and Technical Reference*, G570-2200, for more information on the Enhanced 5250 Emulation program.

Refer to *5250 Emulation Program User's Guide*, part number 6092654, and *Display Station Emulation Adapter Hardware Maintenance and Technical Reference*, part number 7034652, for more information on the 5250 Emulation program.

10.0 5294 Control Unit Interface

The 5294 Control Unit is a remote workstation controller interfacing SNA/SDLC protocol to twinax protocol. The 5294 is similar to the controller in the System Unit and the 5251 Model 12 Display Station.

The major differences between the 5294 and the 5251 Model 12 are

- the 5294 does not support integrated modems
- the 5294 supports additional devices

For more detailed information, see *IBM 5294 Control Unit Maintenance Library*, SY31-0653 and *IBM 5250 Information Display System Functions Reference Manual*, SA21-9247.

11.0 5394 Remote Control Unit Interface

The 5394 Remote Control Unit is a remote workstation controller that is an enhanced follow-on to the 5294 Control Unit. The 5394 supports SNA as well as SDLC, X.21, and X.25 communication protocols. The 5394 has models that supports the EIA 232D and the CCITT X.21 physical interfaces.

The major differences between the 5394 and 5294 are

- The 5394 supports more devices
- The 5294 features are integrated into the base 5394
- The 5394 does not support DDSA
- The 5394 supports some new function (described in the manuals below)

For more detailed information, refer to *IBM 5394 Remote Control Unit Maintenance Library*, SY27-0311 and *IBM 5394 Remote Control Unit Functions Reference*, SC30-3488.

12.0 3180 Model 2 Interface

The 3180 Model 2 interface is the same as the 5251 Model 11 interface except for the following differences.

The 3180 model 2 may also be referred to as the 3180-2.

12.1 Summary of Differences Between the 3180-2 and the 5251 Model 11

- The command performance execution times will be within those established for the 5251 Model 11 display station when similar work is performed.
- The response for the Read Device ID command to the model ID is different than for a 5251 model 11. See 2.4.8.2, "Model ID Word" on page 54 for more information.
- The Read Data command may also be addressed to the model ID feature address in the 3180-2. See 12.4.3, "Read Data Command (Code = 01000)" on page 212.
- The Read Registers command addressed to the indicators returns 29 bytes of information, rather than 6 bytes. See 12.4.2, "Read Registers to Indicators (Code = 11100)" on page 211.
- Once a preactivate queue load has been successfully executed, any command other than Poll, EOQ, and Reset, addressed to the base (first queue position only), or the correct Activate command will result in an Activate exception.
- A maximum fill count of 31 may be specified in the Set Mode command.
- The Write Control Data command includes two data frames which invokes some new function, including
 - display of word processing character symbols
 - selection of the screen size
 - display of the message buffer

See 12.4.4, "Write Control Data Command (Code = 00101)" on page 214.

- The attribute or null exception has been changed to operation exception and its function has been expanded.

- The alarm requests via the Write Control Data command are not accumulative as are on the 5251 Model 11.
- The cursor right and left movement keys repeat at a faster rate than other typamatic keys.
- The single CMD key on the 5251 has been expanded to 24 separate keys on the 3180-2.
- The keyboard layout and scan code assignment is different. The controller to which the 3180-2 is attached must have a compatible translate table.
- A dedicated Message line is provided on the 3180-2 immediately just below the data field and just above the dedicated Status line. This line is used by the attaching controller or host system to display error messages or help text. Adequate storage must be provided at the end of the data area to accommodate the message buffer (80 or 132 characters, depending on the screen size). Display of the Message line data is made via the Write Control Data command. See 12.4.4, "Write Control Data Command (Code = 00101)" on page 214.
- Reset-to-base time is 9 to 11 seconds for the 3180-2.
- Cable Through is standard and line termination is automatic on the 3180-2.
- 3180-2 supports 2 screen sizes, 27 rows by 132 columns and 24 rows by 80 columns. The screen size is selected by the Write Control Data command (see 12.4.4, "Write Control Data Command (Code = 00101)" on page 214).
- 3180-2 supports a shadow cursor.
- A new search general command is supported.
- Additional character symbols for word processing are supported. All or part of these characters on a screen may be displayed. This function is selected by the Write Control Data command (see 12.4.4, "Write Control Data Command (Code = 00101)" on page 214).

12.2 3180-2 Keyboards

The 3180-2 keyboards are shown in Figure 103 on page 185 and Figure 104 on page 185. There are four basic styles:

- basic data processing
- basic data entry
- Katakana data processing
- Katakana data entry

The only basic data entry keyboards supported are U. S., Canadian French, and U. K.

The numbers on the key tops in the figures are in reference to the Scan Code tables following the figures.

12.2.1 Keyboard Operation

For differences in keyboard operation, refer to the *IBM 3180 Display Station Model 2 User's Guide*, GA21-9469.

The keyboards used on the 3180-2 (also on the 3196) are shown in Figure 103 on page 185 and Figure 104 on page 185.

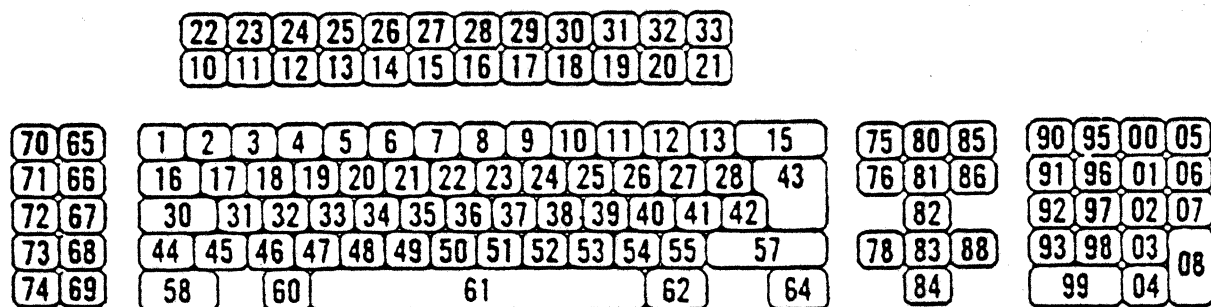


Figure 103. 3180-2 and 3196 Keyboard Data Processing Layout with Associated Key Numbers. The numbers for the top two rows of keys must be prefaced by a "1" (for keys 110 - 121 and 122 -133), as are the numbers for the keys in the right hand two columns (keys 100 - 108).

This is also the keyboard layout for the Data Entry keyboard for 3180-2.

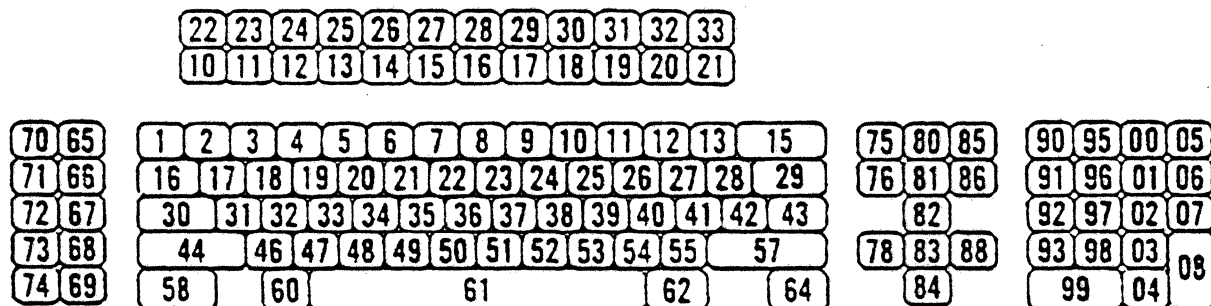


Figure 104. 3180-2 and 3196 Keyboard (Katakana) Layout with Associated Key Numbers. The numbers for the top two rows of keys must be prefaced by a "1" (for keys 110 - 121 and 122 -133), as are the numbers for the keys in the right hand two columns (keys 100 - 108).

This is also the keyboard layout for the Katakana Data Entry keyboard for 3180-2.

12.2.2 Scan Codes

The following tables show the scan codes generated by the 3180-2 and 3196 keyboards.

The function codes are as follows.

- T Typamatic key. When typamatic keys are held down for more than 600 milliseconds, they repeats at 10 keys per second, except for horizontal cursor keys, which repeat at 20 keys per second. This is a function of the terminal; the controller sees only repeated keys, as if the user pressed the key repeatedly.
- MB Make/Break key. These keys return the scan code shown in the table when they are pressed, and the same scan code with bit 0 (the high order bit) turned on when they are released.
- M Make Only. These keys return their scan code when they are pressed, do not repeat (no matter how long they are held down), and do not return a scan code when released.
- B Blank key. These keys are also typamatic.
- L Whether this key is labelled or blank depends on the language that the keyboard is set up for.

The note codes are as follows.

- 0 Ensure the actual shift state you want, then send this code.
- 1 Ensure a lower shift state, then send this code.
- 2 Ensure an upper shift state, then send this code.
- 3 Prefix with a CMD key scan code (X'6F') and ensure the lower shift state. then send this code.
- 4 Prefix with a CMD key scan code (X'6F') and ensure the upper shift state, then send this code.
- 5 Prefix with a CMD key scan code (X'6F') and ensure the actual shift state that you want, then send this code.
- 6 Restore actual shift state and send scan code using lock key emulation.
- 7 Restore actual shift state and send scan code using Katakana lock key emulation.

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
1	L	0	3E	5	51
2	T	0	31	5	51
3	T	0	32	5	51
4	T	0	33	5	51
5	T	0	34	5	51
6	T	0	35	5	51
7	T	0	36	5	51
8	T	0	37	5	51
9	T	0	38	5	51
10	T	0	39	5	51
11	T	0	3A	5	51
12	T	0	3B	5	51
13	T	0	3C	5	51
15	T	0	3D	5	51
16	T	0	20	5	20
17	T	0	21	5	21
18	T	0	22	5	22
19	T	0	23	5	23
20	T	0	24	5	24
21	T	0	25	5	25
22	T	0	26	5	26
23	T	0	27	5	27
24	T	0	28	5	28
25	T	0	29	5	29
26	T	0	2A	5	2A
27	T	0	2B	5	2B
28	T	0	2C	5	2C
30	MB	0	54	0	54
31	T	0	11	5	11
32	T	0	12	5	12
33	T	0	13	5	13
34	T	0	14	5	14
35	T	0	15	5	15

Figure 105 (Part 1 of 4). 3180-2 and 3196 Keyboard - Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
36	T	0	16	5	16
37	T	0	17	5	17
38	T	0	18	5	18
39	T	0	19	5	19
40	T	0	1A	5	1A
41	T	0	1B	5	1B
42	T	0	1C	5	1C
43	M	0	2D	5	2D
44	MB	0	57	5	57
45	T	0	0E	5	0E
46	T	0	01	5	01
47	T	0	02	5	02
48	T	0	03	5	03
49	T	0	04	5	04
50	T	0	05	5	05
51	T	0	06	5	06
52	T	0	07	5	07
53	T	0	08	5	08
54	T	0	09	5	09
55	T	0	0A	5	0A
57	MB	0	56	0	56
58	M	0	7E		
60	MB				
61	T	0	0F	5	0F
62	MB				
64	M	0	68	5	68
65	M	0	75	5	3D
66	M	0	67	5	67
67	M	0	7D	3	3E
68	M			3	3D
69	M			5	6B
70	M	0	7C	5	7C
71	B	0	66	5	66

Figure 105 (Part 2 of 4). 3180-2 and 3196 Keyboard - Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
72	M	0	6E	5	6E
73	B	0	78	5	78
74	M			5	7B
75	T	0	4B	5	4B
76	T	0	0C	5	0C
78	T	0	72	5	72
80	T	0	4C	5	4C
81	M	1	6C	5	6C
82	T	0	71	5	71
83	M	0	60	1	6D
84	T	0	70	5	70
85	B	0	62	5	62
86	T	2	6C	5	6C
88	T	0	73	5	73
90	B	0	1D	5	1D
91	T	0	47	5	47
92	T	0	44	5	44
93	T	0	41	5	41
95	B	0	1E	5	1E
96	T	0	48	5	48
97	T	0	45	5	45
98	T	0	42	5	42
99	T	0	40	5	40
100	B	0	4F	5	4F
101	T	0	49	5	49
102	T	0	46	5	46
103	T	0	43	5	43
104	T	0	4A	5	4A
105	B	0	50	5	50
106	M	0	4E	5	4E
107	B	0	55	5	55
108	M	0	4D	5	4D
110	M	3	31	5	51

Figure 105 (Part 3 of 4). 3180-2 and 3196 Keyboard - Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
111	M	3	32	5	51
112	M	3	33	5	51
113	M	3	34	5	51
114	M	3	35	5	51
115	M	3	36	5	51
116	M	3	37	5	51
117	M	3	38	5	51
118	M	3	39	5	51
119	M	3	3A	5	51
120	M	3	3B	5	51
121	M	3	3C	5	51
122	M	4	31	5	51
123	M	4	32	5	51
124	M	4	33	5	51
125	M	4	34	5	51
126	M	4	35	5	51
127	M	4	36	5	51
128	M	4	37	5	51
129	M	4	38	5	51
130	M	4	39	5	51
131	M	4	3A	5	51
132	M	4	3B	5	51
133	M	4	3C	5	51

Figure 105 (Part 4 of 4). 3180-2 and 3196 Keyboard - Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
1	B	0	3E	5	51
2	T	0	31	5	51
3	T	0	32	5	51
4	T	0	33	5	51
5	T	0	34	5	51
6	T	0	35	5	51
7	T	0	36	5	51
8	T	0	37	5	51
9	T	0	38	5	51
10	T	0	39	5	51
11	T	0	3A	5	51
12	T	0	3B	5	51
13	T	0	3C	5	51
14	T	0	61	5	51
15	T	0	3D	5	51
16	T	0	20	5	20
17	T	0	21	5	21
18	T	0	22	5	22
19	T	0	23	5	23
20	T	0	24	5	24
21	T	0	25	5	25
22	T	0	26	5	26
23	T	0	27	5	27
24	T	0	28	5	28
25	T	0	29	5	29
26	T	0	2A	5	2A
27	T	0	2B	5	2B
28	T	0	2C	5	2C
29	M	0	2D	5	2D
30	MB	0	57	0	57
31	T	0	11	5	11
32	T	0	12	5	12
33	T	0	13	5	13

Figure 106 (Part 1 of 4). 3180-2 and 3196 Keyboard - Katakana Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
34	T	0	14	5	14
35	T	0	15	5	15
36	T	0	16	5	16
37	T	0	17	5	17
38	T	0	18	5	18
39	T	0	19	5	19
40	T	0	1A	5	1A
41	T	0	1B	5	1B
42	T	0	1C	5	1C
43	MB	0	56	5	56
44	MB	0	53	6	53
46	T	0	01	5	01
47	T	0	02	5	02
48	T	0	03	5	03
49	T	0	04	5	04
50	T	0	05	5	05
51	T	0	06	5	06
52	T	0	07	5	07
53	T	0	08	5	08
54	T	0	09	5	09
55	T	0	0A	5	0A
56	T	0	0C	5	0C
57	MB	0	52	7	52
58	M	0	7E		
60	MB				
61	T	0	0F	5	0F
62	MB				
64	M	0	68	5	68
65	M	0	75	4	61
66	M	0	67	5	67
67	M	0	7D	3	3E
68	M			3	61
69	M			5	6B

Figure 106 (Part 2 of 4). 3180-2 and 3196 Keyboard - Katakana Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
70	M	0	7C	5	7C
71	B	0	66	5	66
72	M	0	6E	5	6E
73	B	0	78	5	78
74	M			5	7B
75	T	0	4B	5	4B
76	T	0	63	5	63
78	T	0	72	5	72
80	T	0	4C	5	4C
81	M	1	6C	5	6C
82	T	0	71	5	71
83	M	0	60	1	6D
84	T	0	70	5	70
85	B	0	62	5	62
86	T	2	6C	5	6C
88	T	0	73	5	73
90	B	0	1D	5	1D
91	T	0	47	5	47
92	T	0	44	5	44
93	T	0	41	5	41
95	B	0	1E	5	1E
96	T	0	48	5	48
97	T	0	45	5	45
98	T	0	42	5	42
99	T	0	40	5	40
100	B	0	4F	5	4F
101	T	0	49	5	49
102	T	0	46	5	46
103	T	0	43	5	43
104	T	0	4A	5	4A
105	B	0	50	5	50
106	M	0	4E	5	4E
107	B	0	55	5	55

Figure 106 (Part 3 of 4). 3180-2 and 3196 Keyboard - Katakana Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
108	M	0	4D	5	4D
110	M	3	31	5	51
111	M	3	32	5	51
112	M	3	33	5	51
113	M	3	34	5	51
114	M	3	35	5	51
115	M	3	36	5	51
116	M	3	37	5	51
117	M	3	38	5	51
118	M	3	39	5	51
119	M	3	3A	5	51
120	M	3	3B	5	51
121	M	3	3C	5	51
122	M	4	31	5	51
123	M	4	32	5	51
124	M	4	33	5	51
125	M	4	34	5	51
126	M	4	35	5	51
127	M	4	36	5	51
128	M	4	37	5	51
129	M	4	38	5	51
130	M	4	39	5	51
131	M	4	3A	5	51
132	M	4	3B	5	51
133	M	4	3C	5	51

Figure 106 (Part 4 of 4). 3180-2 and 3196 Keyboard - Katakana Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
1	T	0	3E	5	0B
2	T	0	31	5	0D
3	T	0	32	5	1F
4	T	0	33	5	5A
5	T	0	34	5	51
6	T	0	35	5	51
7	T	0	36	5	59
8	T	0	37	5	51
9	T	0	38	5	51
10	T	0	39	5	51
11	T	0	3A	5	51
12	T	0	3B	5	51
13	T	0	3C	5	51
14	T	0	61	5	51
15	T	0	3D	5	51
16	T	0	20	5	20
17	T	0	21	5	21
18	T	0	22	5	22
19	T	0	23	5	23
20	T	0	24	5	24
21	T	0	25	5	25
22	T	0	26	5	26
23	T	0	27	5	27
24	T	0	28	5	28
25	T	0	29	5	29
26	T	0	2A	5	2A
27	T	0	2B	5	2E
28	T	0	2C	5	2F
29	T	0	2D	5	2D
30	MB	0	54	0	54
31	T	0	11	5	11
32	T	0	12	5	12
33	T	0	13	5	13

Figure 107 (Part 1 of 4). 3180-2 and 3196 Keyboard - Spanish Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
34	T	0	14	5	14
35	T	0	15	5	15
36	T	0	16	5	16
37	T	0	17	5	17
38	T	0	18	5	18
39	T	0	19	5	19
40	T	0	1A	5	1A
41	T	0	1B	5	3F
42	T	0	1C	5	58
43	M	0	2D	5	2D
44	MB	0	57	5	57
45	T	0	0E	5	0E
46	T	0	01	5	01
47	T	0	02	5	02
48	T	0	03	5	03
49	T	0	04	5	04
50	T	0	05	5	05
51	T	0	06	5	06
52	T	0	07	5	07
53	T	0	08	5	08
54	T	0	09	5	09
55	T	0	0A	5	0A
56	T	0	0C	5	0C
57	MB	0	56	0	56
58	M	0	7E		
60	MB				
61	T	0	0F	5	0F
62	MB				
64	M	0	68	5	68
65	M	0	75	5	3D
66	M	0	67	5	67
67	M	0	7D	3	3E
68	M			3	3D

Figure 107 (Part 2 of 4). 3180-2 and 3196 Keyboard - Spanish Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
69	M			5	6B
70	M	0	7C	5	7C
71	B	0	66	5	66
72	M	0	6E	5	6E
73	B	0	78	5	78
74	M			5	7B
75	T	0	4B	5	4B
76	T	0	0C	5	0C
78	T	0	72	5	72
80	T	0	4C	5	4C
81	M	1	6C	5	6C
82	T	0	71	5	71
83	M	0	60	1	6D
84	T	0	70	5	70
85	B	0	62	5	62
86	T	2	6C	5	6C
88	T	0	73	5	73
90	B	0	1D	5	1D
91	T	0	47	5	47
92	T	0	44	5	44
93	T	0	41	5	41
95	B	0	1E	5	1E
96	T	0	48	5	48
97	T	0	45	5	45
98	T	0	42	5	42
99	T	0	40	5	40
100	B	0	4F	5	4F
101	T	0	49	5	49
102	T	0	46	5	46
103	T	0	43	5	43
104	T	0	4A	5	4A
105	B	0	50	5	50
106	M	0	4E	5	4E

Figure 107 (Part 3 of 4). 3180-2 and 3196 Keyboard - Spanish Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
107	B	0	55	5	55
108	M	0	4D	5	4D
110	M	3	31	5	51
111	M	3	32	5	51
112	M	3	33	5	51
113	M	3	34	5	51
114	M	3	35	5	51
115	M	3	36	5	51
116	M	3	37	5	51
117	M	3	38	5	51
118	M	3	39	5	51
119	M	3	3A	5	51
120	M	3	3B	5	51
121	M	3	3C	5	51
122	M	4	31	5	51
123	M	4	32	5	51
124	M	4	33	5	51
125	M	4	34	5	51
126	M	4	35	5	51
127	M	4	36	5	51
128	M	4	37	5	51
129	M	4	38	5	51
130	M	4	39	5	51
131	M	4	3A	5	51
132	M	4	3B	5	51
133	M	4	3C	5	51

Figure 107 (Part 4 of 4). 3180-2 and 3196 Keyboard - Spanish Data Processing

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
1	L	0	3E	5	51
2	T	0	31	5	51
3	T	0	32	5	51
4	T	0	33	5	51
5	T	0	34	5	51
6	T	0	35	5	51
7	T	0	36	5	51
8	T	0	37	5	51
9	T	0	38	5	51
10	T	0	39	5	51
11	M	0	3A	5	51
12	M	0	3B	5	51
13	T	0	3C	5	51
15	T	0	3F	5	51
16	T	0	5F	5	5E
17	T	0	21	5	21
18	T	0	22	5	22
19	T	0	23	5	23
20	T	0	24	5	24
21	T	0	25	5	25
22	T	0	26	5	26
23	T	0	27	5	27
24	T	0	28	5	28
25	T	0	29	5	29
26	T	0	2A	5	2A
27	T	0	2B	5	2B
28	T	0	2E	5	2E
30	T	0	10	0	10
31	T	0	11	5	11
32	T	0	12	5	12
33	T	0	13	5	13
34	T	0	14	5	14
35	T	0	15	5	15

Figure 108 (Part 1 of 4). 3180-2 Keyboard - Data Entry

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
36	T	0	16	5	16
37	T	0	17	5	17
38	T	0	18	5	18
39	T	0	19	5	19
40	T	0	1A	5	1A
41	T	0	1B	5	1B
42	T	0	1C	5	1C
43	M	0	2D	5	2D
44	MB	0	57	5	57
45	T	0	0E	5	0E
46	T	0	01	5	01
47	T	0	02	5	02
48	T	0	03	5	03
49	T	0	04	5	04
50	T	0	05	5	05
51	T	0	06	5	06
52	T	0	07	5	07
53	T	0	08	5	08
54	T	0	09	5	09
55	T	0	0A	5	0A
57	MB	0	56	0	56
58	M	0	7E		
60	MB				
61	T	0	0F	5	0F
62	MB				
64	M	0	68	5	68
65	M	0	75	5	3D
66	M	0	67	5	67
67	M	0	7D	3	3E
68	M			3	3D
69	M			5	6B
70	M	0	7C	5	7C
71	B	0	66	5	66

Figure 108 (Part 2 of 4). 3180-2 Keyboard - Data Entry

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
72	M	0	6E	5	6E
73	B	0	78	5	78
74	M			5	7B
75	T	0	20	5	20
76	T	0	63	5	63
78	T	0	72	5	72
80	T	0	65	5	65
81	M	1	6C	5	6C
82	T	0	71	5	71
83	M	0	60	1	6D
84	T	0	70	5	70
85	B	0	62	5	62
86	T	2	6C	5	6C
88	T	0	73	5	73
90	B	0	1D	5	1D
91	T	0	47	5	47
92	T	0	44	5	44
93	T	0	41	5	41
95	B	0	1E	5	1E
96	T	0	48	5	48
97	T	0	45	5	45
98	T	0	42	5	42
99	T	0	40	5	40
100	B	0	4F	5	4F
101	T	0	49	5	49
102	T	0	46	5	46
103	T	0	43	5	43
104	T	0	4A	5	4A
105	B	0	50	5	50
106	M	0	2C	5	2C
107	B	0	55	5	55
108	M	0	4D	5	4D
110	M	3	31	5	51

Figure 108 (Part 3 of 4). 3180-2 Keyboard - Data Entry

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
111	M	3	32	5	51
112	M	3	33	5	51
113	M	3	34	5	51
114	M	3	35	5	51
115	M	3	36	5	51
116	M	3	37	5	51
117	M	3	38	5	51
118	M	3	39	5	51
119	M	3	3A	5	51
120	M	3	3B	5	51
121	M	3	3C	5	51
122	M	4	31	5	51
123	M	4	32	5	51
124	M	4	33	5	51
125	M	4	34	5	51
126	M	4	35	5	51
127	M	4	36	5	51
128	M	4	37	5	51
129	M	4	38	5	51
130	M	4	39	5	51
131	M	4	3A	5	51
132	M	4	3B	5	51
133	M	4	3C	5	51

Figure 108 (Part 4 of 4). 3180-2 Keyboard - Data Entry

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
1	B	0	3E	5	51
2	T	0	31	5	51
3	T	0	32	5	51
4	T	0	33	5	51
5	T	0	34	5	51
6	T	0	35	5	51
7	T	0	36	5	51
8	T	0	37	5	51
9	T	0	38	5	51
10	T	0	39	5	51
11	M	0	3A	5	51
12	M	0	3B	5	51
13	T	0	30	5	51
14	T	0	3D	5	51
15	T	0	3F	5	51
16	T	0	20	5	20
17	T	0	21	5	21
18	T	0	22	5	22
19	T	0	23	5	23
20	T	0	24	5	24
21	T	0	25	5	25
22	T	0	26	5	26
23	T	0	27	5	27
24	T	0	28	5	28
25	T	0	29	5	29
26	T	0	2A	5	2A
27	T	0	2B	5	2B
28	T	0	2D	5	2D
29	M	0	1C	5	1C
30	MB	0	57	0	57
31	T	0	11	5	11
32	T	0	12	5	12
33	T	0	13	5	13

Figure 109 (Part 1 of 4). 3180-2 Keyboard - Katakana Data Entry

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
34	T	0	14	5	14
35	T	0	15	5	15
36	T	0	16	5	16
37	T	0	17	5	17
38	T	0	18	5	18
39	T	0	19	5	19
40	T	0	1A	5	1A
41	T	0	1B	5	1B
42	T	0	1F	5	1F
43	MB	0	56	5	56
44	MB	0	53	6	53
46	T	0	01	5	01
47	T	0	02	5	02
48	T	0	03	5	03
49	T	0	04	5	04
50	T	0	05	5	05
51	T	0	06	5	06
52	T	0	07	5	07
53	T	0	08	5	08
54	T	0	09	5	09
55	T	0	0A	5	0A
56	T	0	0C	5	0C
57	MB	0	52	7	52
58	M	0	7E		
60	MB				
61	T	0	0F	5	0F
62	MB				
64	M	0	68	5	68
65	M	0	75	4	61
66	M	0	67	5	67
67	M	0	7D	3	3E
68	M			3	3D
69	M			5	6B

Figure 109 (Part 2 of 4). 3180-2 Keyboard - Katakana Data Entry

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
70	M	0	7C	5	7C
71	B	0	66	5	66
72	M	0	6E	5	6E
73	B	0	78	5	78
74	M			5	7B
75	T	0	20	5	20
76	T	0	63	5	63
78	T	0	72	5	72
80	T	0	65	5	65
81	M	1	6C	5	6C
82	T	0	71	5	71
83	M	0	60	1	6D
84	T	0	70	5	70
85	B	0	62	5	62
86	T	2	6C	5	6C
88	T	0	73	5	73
90	B	0	1D	5	1D
91	T	0	47	5	47
92	T	0	44	5	44
93	T	0	41	5	41
95	B	0	1E	5	1E
96	T	0	48	5	48
97	T	0	45	5	45
98	T	0	42	5	42
99	T	0	40	5	40
100	B	0	4F	5	4F
101	T	0	49	5	49
102	T	0	46	5	46
103	T	0	43	5	43
104	T	0	4A	5	4A
105	B	0	50	5	50
106	M	0	2C	5	2C
107	B	0	55	5	55

Figure 109 (Part 3 of 4). 3180-2 Keyboard - Katakana Data Entry

Key	Action	ALT Key Up Note	ALT Key Up Scan Code	ALT Key Down Note	ALT Key Down Scan Code
108	M	0	4D	5	4D
110	M	3	31	5	51
111	M	3	32	5	51
112	M	3	33	5	51
113	M	3	34	5	51
114	M	3	35	5	51
115	M	3	36	5	51
116	M	3	37	5	51
117	M	3	38	5	51
118	M	3	39	5	51
119	M	3	3A	5	51
120	M	3	3B	5	51
121	M	3	3C	5	51
122	M	4	31	5	51
123	M	4	32	5	51
124	M	4	33	5	51
125	M	4	34	5	51
126	M	4	35	5	51
127	M	4	36	5	51
128	M	4	37	5	51
129	M	4	38	5	51
130	M	4	39	5	51
131	M	4	3A	5	51
132	M	4	3B	5	51
133	M	4	3C	5	51

Figure 109 (Part 4 of 4). 3180-2 Keyboard - Katakana Data Entry

12.2.3 ALT Key Definition

The ALT (alternate) keys are make/break keys and are used to select an alternate state for the keys on the keyboard. The ALT keys generate no scan code to the controller but causes a sequence of codes to be sent to generate the desired alternate character. The ALT key is active when in the down position and generally results in prefixing the scan code for the key pressed by a X'6F'. The ALT keys affect all the keys on the keyboard except the shift keys. On the Katakana data processing keyboard, the Latin lower and Katakana lower shift keys are affected by ALT.

12.3 Displayable Characters

The following code points are different from 5251 in all character sets.

Hex Graphic Code	
01 =	↓
02 =	→
03 =	→
05 =	→
06 =	→
09 =	↓
0C =	▼

Figure 110. 3180-2 Displayable Characters. Differences from 5251 model 11

The following code points are different from the 5251 multinational character set for the 3180-2.

Hex Graphic Code	
1E =	-
1F =	■
8D =	-----γ
AD =	γ
BC =	-
DA =	1

Figure 111. 3180-2 Displayable Characters (Multinational). Differences from 5251 model 11

The following code points are different from the 5251 Katakana graphic character set for the 3180-2.

Hex Graphic Code	
1C =	✳
1E =	-
1F =	■

Figure 112. 3180-2 Displayable Characters (Katakana). Differences from 5251 model 11

The code points that are different from the 5251 specific language group variations are shown on the following page.

Language Group	Code Point (Hex - Char)	Language Group	Code Point (Hex - Char)
Austria/Germany	43 - {	Finland/Sweden	43 - {
	59 - ~		47 - }
	63 - [		51 - '
	B5 - @		63 - #
	CC - |		67 - \$
	DC - }		71 - \
	EC - \		9F -]
	FC -]		B5 - [
Belgium	44 - @	France	CC - |
	48 - \		DC - ~
	51 - {		EC - @
	54 - }		44 - @
	BD - ~		48 - \
	DD - |		51 - {
Denmark/Norway	47 - }	54 - }	
	67 - \$	79 - μ	
	70 - |	90 - [
	80 - @	A0 - '	
	9C - [	B1 - #	
	9E - [	B5 -]	
	9F -]	BD - ~	
	DC - ~		

Language Group	Code Point (Hex - Char)	Language Group	Code Point (Hex - Char)
Italy	44 - {	Spanish Speaking	49 - |
	48 - \		69 - #
	51 -]		BA - ^
	54 - }		BB - !
	58 - ~		BD - ~
	90 - [	United Kingdom	BI - [
	B1 - #		BA - ^
	B5 - @		BB -]
	CD - |		BC - ~
	DD - '		
Portugal	46 - {	U.S./Canada	B0 - ^
	48 - ~		BA - [
	66 - #		BB -]
	68 - \		
	BE - }		
	CF - |		
	EF - @		
	4C - <		

12.4 Specific Commands

12.4.1 Read Device ID Command

Add the following response information to the 5251 description.

12.4.1.1 Base ID Word

The response from a 3180-2 to a Read Device ID command addressed to the base (000) is the same as the response from a 5251 model 11.

12.4.1.2 Model ID Word

See 2.4.8.2, "Model ID Word" on page 54 for the response from a 3810-2 to a Read Device ID addressed to the Model ID feature address.

| 12.4.2 Read Registers to Indicators (Code = 11100)

| The 3180-2 returns 29 bytes of information from the diagnostics logout area, and is formatted as follows:

- | • Frames 1-5 same as 5251-11.
 - | • Machine Type - 4 frames containing EBCDIC machine type number: F3 F1 F8 F0.
 - | • Model Number - 2 frames containing EBCDIC model number: F0 F2.
 - | • EC Number - The last 18 frames contains the EC number(s) of the ROS modules. The numbers are right justified in the field and padded with X'40' on the left.
- | The actual data transfer begins upon receipt of an Activate Read command.

12.4.3 Read Data Command (Code = 01000)

In the 3180-2, this command is used to initiate a workstation to controller data transfer from the addressed device. The actual data transfer begins upon receipt of an Activate Read command. The command uses two different formats: Normal and Feature.

12.4.3.1 Normal Format

When addressed to the Base, this command initializes a one-byte data transfer. The byte pointed to by the address counter is sent to the controller upon receipt of the Activate Read command. The address counter is then incremented by one. An invalid register exception is indicated if the address counter is outside bounds of the addressable space.

12.4.3.2 Feature Format - Model ID

When the Read Data command is addressed to the Model ID, it initiates the transfer of 16 bytes of extended ID information from the workstation. Data transfer begins upon receipt of an Activate Read command. If a feature other than Model ID is addressed, 16 bytes of zeros will be transferred to the controller.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address; End Of Message (111) in last frame.
7-14	identification information
15	Stop bit; always 1.

Figure 113. 3180-2 Read Data Command to Model ID - Response Frames

The following is the description of bits 7 through 14 of the response frames.

- Frame 1 - Model ID

0010 0000

- Frame 2 - Style Data

This frame contains 1111111T, where T is

0 = data entry

1 = data processing

- Byte 3 - Language Option

M1111111 = U.S./Canada

M1111110 = Austria/Germany & Cyrillic

M1111101 = Belgium

M1111011 = Canadian (French) & Hebrew

M1111010 = Denmark & Greek

M1111001 = France (Azerty) & Turkish

M1110111 = Arabic X/Basic
M1110110 = Italy
M1110101 = Thai
M1110100 = Japan Katakana & Icelandic
M1110011 = Norway & Yugoslav
M1110010 = Portugal & Latin/2 ROECE
M1110001 = Spain
M1110000 = Spanish Speaking
M1101111 = Finland/Sweden
M1101110 = Swiss (German)
M1101101 = Swiss (French)
M1101100 = United Kingdom
M1101011 = Netherlands

where M = Multinational character set option

0 = Selected

1 = Not selected

- Bytes 4 through 16

All zeros

12.4.4 Write Control Data Command (Code = 00101)

For the 3180-2, this command is followed by one or two (optional) data frames formatted as follows.

12.4.4.1 First Data Frame

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address; End Of Message (111) if last frame.
7	<ul style="list-style-type: none"> 0 = cursor displayed 1 = cursor not displayed
8	<ul style="list-style-type: none"> 0 = last data frame of command 1 = not last data frame of command <p>This bit must be one if the second data frame is used.</p>
9	<ul style="list-style-type: none"> 0 = do not blink cursor 1 = blink cursor
10	Reserved; must be zero.
11	<ul style="list-style-type: none"> 0 = normal image 1 = reverse image
12	<ul style="list-style-type: none"> 0 = no action 1 = reset exception status
13	<ul style="list-style-type: none"> 0 = enable keyboard clicker 1 = disable keyboard clicker
14	<ul style="list-style-type: none"> 0 = no action 1 = enable audible alarm
15	Stop bit; always 1.

Figure 114. 3180-2 Write Control Data Command - First Data Frame

12.4.4.2 Second Data Frame (Optional)

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	End Of Message (111)
7-9	Reserved; must be zero
10	<p>Text assist symbol display format</p> <ul style="list-style-type: none"> 0 = under cursor only 1 = for entire screen <p>The System/38 always sets this bit to 0.</p>

Figure 115 (Part 1 of 2). 3180-2 Write Control Data Command - Second Data Frame

Bit	Purpose
11	Display format <ul style="list-style-type: none"> • 0 = 80 characters wide by 24 lines • 1 = 132 characters wide by 27 lines
12	Text assist symbols <ul style="list-style-type: none"> • 0 = no display • 1 = display The System/38 always sets this bit to 0.
13	Reserved; must be zero
14	Message line display. <ul style="list-style-type: none"> • 0 = disable; do not display • 1 = enable; display
15	Stop bit; always 1.

Figure 115 (Part 2 of 2). 3180-2 Write Control Data Command - Second Data Frame

12.4.5 Shadow Cursor

The shadow cursor is a secondary cursor that shows the workstation operator in which column the primary cursor is located. The shadow cursor may reside on any row within the Data Area or on the Message Line. The controller specifies which row the shadow cursor will reside via the Load Shadow Cursor Register command. Once the row has been designated, no other controller attention is required to maintain the shadow cursor.

The shadow cursor is not supported on the System/38.

The shadow cursor is generated by moving an intensified reversed image effect across the row specified by the Shadow Cursor Register such that the effect remains vertically aligned with the cursor. Characters on or adjacent to the shadow cursor will always be visible.

Note: The shadow cursor will disappear when it is positioned at the start or end of a field which is reversed image. Both the shadow cursor and the field will disappear when the shadow cursor is moved into a one position reversed imaged field.

The shadow cursor will not be displayed under the following conditions.

1. The Shadow Cursor Register has not been explicitly loaded since the workstation was powered on or reset.
2. The row specified by the Shadow Cursor Register does not fall within the Data Area or the Message Line.
3. The cursor is not displayed.

12.4.6 Load Shadow Cursor Register

The Load Shadow Cursor Register command is used to specify the row where the shadow cursor is to reside. The format of the command is as follows.

The Load Shadow Cursor Register command is not supported on the System/38.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7-14	Load Shadow Cursor Register Command (00001111)
15	Stop bit; always 1.

Figure 116. 3180-2 Load Shadow Cursor Register Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Shadow Cursor Register value
15	Stop bit; always 1.

Figure 117. 3180-2 Load Shadow Cursor Register Parameter Frame

The Load Shadow Cursor Register command with its associated parameter may appear anywhere within a queue load and overrides the effect of any previous Load Shadow Cursor Register command.

The number of the row where the shadow cursor is to be displayed is specified in the parameter frame, which must immediately follow the command frame (without a frame synchronization sequence). Bits 7 through 14 of the parameter frame are loaded into the Shadow Cursor Register.

If the row specified does not fall within the Data Area or the Message Line of the display the shadow cursor will not be displayed; however, no error will be reported to the controller.

Row one specifies the top row of the display. Specifying a row of zero will always turn off the shadow cursor.

The Load Shadow Cursor Register command must be addressed to the Base. Any other device address will result in an Invalid Command/Device Address Exception.

12.4.7 Search General

This command will cause the workstation to perform a general search through user accessible memory. The command is valid for the Base only; addressing any device other than the Base will result in an Invalid Command/Device Address Exception.

The Search General command is not supported on the System/38.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7-14	Load Shadow Cursor Register Command (00001101)
15	Stop bit; always 1.

Figure 118. 3180-2 Search General Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7,8	Stop condition for search 00 - stop on match 01 - stop on mismatch 10 - reserved 11 - reserved
9,10	Target register 00 - Address Counter 01 - Reference Counter 10 - Cursor Register 11 - reserved
11,12	Stop register 00 - Address Counter 01 - Reference Counter 10 - Cursor Register 11 - reserved
13,14	Start register 00 - Address Counter 01 - Reference Counter 10 - Cursor Register 11 - reserved

Figure 119 (Part 1 of 2). 3180-2 Search General Command First Parameter Frame

Bit	Purpose
15	Stop bit; always 1.

Figure 119 (Part 2 of 2). 3180-2 Search General Command First Parameter Frame

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7-14	Search object
15	Stop bit; always 1.

Figure 120. 3180-2 Search General Command - Second Parameter Frame

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Mask
15	Stop bit; always 1.

Figure 121. 3180-2 Search General Command - Third Parameter Frame

The command is processed as follows.

1. An Invalid Command/Device Address Exception is posted if a reserved start, stop, or target register specification is made; command execution is terminated.
2. If the start register points outside of the presentation space, an Invalid Register Exception is indicated and no further processing takes place.
3. If the stop register points outside of the presentation space, an Invalid Register Exception is indicated and no further processing takes place.
4. An Invalid Command/Device Address Exception will be indicated if a reserved stop condition is specified; no further processing will take place.
5. The search address is set equal to the start register.
6. The byte pointed to by the search address is EXCLUSIVE ORed against the search object (frame 2 of the command) and then ANDed against the specified mask (frame 3 of the command). If the result is zero, a match had occurred.
7. The command is terminated if a match occurred and stop on match was requested. The target register will be set equal to the search address.

8. The command is terminated if no match occurred and stop on mismatch was requested. The target register will be set equal to the search address.
9. The command is terminated and an Operation Exception indicated if the search address is equal to the stop address (target register will not be updated).
10. The search address is incremented if the search address is less than the stop address or decremented if the search address is greater than the stop address.
11. Go to step 6 on page 219.

12.4.8 Text Assist Symbols

The workstation has the capability of displaying a set of symbols which are meaningful in text processing. The workstation can be commanded to show these symbols over the entire screen or just above the cursor. The code points and description of these symbols are as follows.

These symbols are not supported on the System/38.

Code Point	Description
X'01'	half index down
X'02'	required tab
X'03'	carrier return
X'05'	tab
X'06'	required carrier return
X'09'	half index up
X'0C'	page end
X'41'	required space

Note: Text assist symbols are not available on Katakana workstations.

For more information see 12.4.4, "Write Control Data Command (Code = 00101)" on page 214.

13.0 3196 Interface

The interface to the 3196 display station is the same as the interface to the 3180-2 display station (described in 12.0, "3180 Model 2 Interface" on page 183), with the following exceptions.

- The response from the 3196 to the Read Device ID command issued to the model ID feature address is X'10'. See 2.4.8.2, "Model ID Word" on page 54.
 - The 3196 does not support a dedicated message line.
 - The 3196 does not support a 132 character by 27 row screen size. It supports only a 80 column by 24 row screen.
 - The Write Control Data command does not support the following.
 - Selection of screen size - bit 11 in the second parameter frame for Write Control Data must be zero.
 - Display of the message buffer (dedicated message line) - Bit 14 in the second parameter frame for Write Control Data must be zero.
- The 3196 does support the second parameter frame for Write Control Data.
- The 3196 supports a different displayable character at X'B3', which is a large dot in the middle of the character cell [•] (called a middle dot).
 - The 3196 does not support data entry keyboards.
 - The response to the Read Data command to the model ID feature address is different for the 3196.

The following is the description of bits 7 through 14 of the changed response frames.

- Frame 1 - Model ID

This frame contains 0001 0000 (X'10').

- Frame 2 - Style Data

This frame contains 11111111 (X'FF').

Response frames 3 through 16 do not change from the 3180-2.

- The transmission rate used by the 3196 is 1.0368 megahertz, $\pm 0.01\%$.

All equipment that is to be attached to a twinaxial cable to which a 3196 is to be attached must be checked for compatibility with this data rate (so that the device does not signal false parity errors, for example).

All IBM devices supported on the local workstation controllers and on the 5294 are compatible with the data rate used by the 3196.

- The 3196 does not have cable through or line termination. It is to be attached to a twinaxial line with a "T-connector" which provides cable through and line termination. Refer to the 3196 installation instructions for more information.
- The 3196 supports the 3180-2 style keyboard exactly like the 3180-2 does (see 12.2, "3180-2 Keyboards" on page 184). The 3196 also supports the IBM Enhanced keyboard. See 19.0, "IBM Enhanced Keyboard" on page 257 for more information on the IBM Enhanced Keyboard.

14.0 3197 Interface

The interface to the 3197 display station is the same as the interface to the 3180-2 display station (described in 12.0, "3180 Model 2 Interface" on page 183), with the following exceptions.

- The 3197, Model D and C, is a "Dual Address" terminal having two station addresses that communicated with a controller independently; address 1 and address 2. Address 1 is dedicated to a display. Address 2 can be configured for either an additional display session or for a printer attached via the built-in PC Parallel Interface.

- If address 2 is a display:

Active display sessions may be alternately (both models) or concurrently viewed (model D and only with 24 line x 80 character screen format) via local "hot key" sequences. The extended display mode of 27 rows by 132 columns is available only on the 3197 Model D.

- If address 2 is a printer:

The printers supported on the 3197 are the 4201, 4202, and 5201 PC printers. The 3197 will allow an attached printer to emulate an IBM 4214-2 printer or an IBM 5256 printer with the exception that the Transparent (TRN) Command and Load Alternate Characters (LAC) Command are received properly but discarded and an error (Invalid PDS Control Code) reported to the host system.

In addition to supporting the 4214-2 and 5256 SCS commands, the 3197 also supports the non-SCS ASCII Transparent (ATRN) Command and the SCS Set Presentation Color (SPC) control. For more information regarding these commands, see 3.6, "Control Character String" on page 116.

For more information on "Dual Address" usage, display configuration, display session viewing, and 3197 attached printers, see the *IBM 3197 Model D Display Station User's Guide GA18-2545* or the *IBM 3197 Model C Display Station User's Guide GA18-2559*.

- The response from the 3197 Model D to the Read Device ID command issued to the model ID feature address is X'24'. See 2.4.8.2, "Model ID Word" on page 54.
- The response from the 3197 Model C to the Read Device ID command issued to the model ID feature address is X'50'. See 2.4.8.2, "Model ID Word" on page 54.
- The 3197 Model C does not support a 132 character by 27 row screen size. It supports only a 80 column by 24 row screen. The 3197 Model C has a color monitor whereas the 3180 Model 2 is strictly monochrome.
- The Write Control Data command on the 3197 Model C does not support the following.

- Selection of screen size - Bit 11 in the second parameter frame for Write Control Data must be zero.
- Display of the message buffer (dedicated message line) - Bit 14 in the second parameter frame for Write Control Data must be zero.
- The 3197 Model D does support the selection of screen size and dedicated message line - Bits 11 and 14 in the second parameter frame for Write Control Data.
- The 3197 supports a different displayable character at X'B3', which is a large dot in the middle of the character cell [•] (called a middle dot).
- The 3197 does not support data entry keyboards.
- The response to the Read Data command to the model ID feature address is different for the 3197.

The following is the description of bits 7 through 14 of the changed response frames.

- Frame 1 - Model ID

This frame contains 0010 0100 (X'24') for the 3197 Model D.

This frame contains 0101 0000 (X'50') for the 3197 Model C.

- Frame 2 - Style Data

This frame contains 11111111 (X'FF').

Response frames 3 through 16 do not change from the 3180-2.

- The 3197-D does not have cable through or line termination. It is to be attached to a twinaxial line with a "T-connector" which provides cable through and line termination. Refer to the 3197 Setup Instructions for more information.
- The 3197 supports the 122/124 key typewriter keyboard that attaches to the 3180-2 (see 12.2, "3180-2 Keyboards" on page 184). The 3197 also supports the IBM Enhanced keyboard. See 19.0, "IBM Enhanced Keyboard" on page 257 for more information.

| 15.0 IBM InfoWindow 3476 Interface

| The interface to the 3476 display station is the same as the interface to the 3196 display station (described in | 13.0, "3196 Interface" on page 221), with the following exceptions.

- | • The 3476 has two models, EGx (green monitor) and EAx (amber monitor).
- | • The 3476 supports the Data Entry keyboard.
- | • The 3476 supports three new indicators:
 - | - Type ahead indicator - Right double angle brackets in column 13 on Status Line.
 - | - Layer 100 indicator - Plus sign in column 35 on Status Line.
 - | - Caps Lock indicator - Capital A in column 38 on Status Line.
- | • The 3476 supports the Read Info and Write Control Data to the Indicators commands, which are | described in detail below.

| *Note:* The 3476 supports the same data transmission rate as the 3196; 1.0368 MHz.

15.1.1 Read Info

This command allows the controller to read additional device specific information (such as Vital Product Data (VPD)) from the device. There is one parameter frame following the Read Info command that indicates what device information to be read. If no bits are turned on in this frame, no information will be returned.

Actual data transfer will begin upon the receipt of an Activate Read command. The format of the command and the data returned in response to the Activate Read is given below.

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Station Address
7,8,9	Device Address (Base = 000)
10-14	Read Info Command (01011)
15	Stop bit; always 1.

Figure 122. Read Info Command

Bit	Purpose
0,1,2	Fill bits: always zero.
3	Parity bit: set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Device information being requested Bit 7: Request Vital Product Data (VPD) Bits 8-14: Reserved, must be 0
15	Stop bit: always 1.

Figure 123. Read Info Command First Parameter Frame

Format of VPD data returned (64 bytes):

- Machine Type (EBCDIC, 4 bytes): F3F4F7F6
- Model Number (EBCDIC, 3 bytes)
- Load Identifier (4 bytes)
- Part Number (12 bytes)
- Serial Number (7 bytes)
- Manufacturing Identification (4 bytes)
- ROS Identification (15 bytes)
- Alterable ROS Identification (1 byte)
- Monitor characteristics (2 bytes), consisting of:
 - Bit 0: Color (OFF for 3476)
 - Bit 1: Wide Screen (OFF for 3476)
 - Bit 2: Separate Error Message Line (OFF for 3476)
 - Bit 3: Text Symbols (ON for 3476)
 - Bit 4: Shadow Cursor (ON for 3476)

- | - Bit 5 - Bit 15: Reserved, must be 0
- | • Other (12 bytes, reserved, padded with zero (X'00'))

15.1.2 Write Control Data - Indicators

Write Control Data command addressed to the Indicators command can be used to activate additional indicators on 3476 that are not accessible by the Write Data Load Cursor command addressed to the Indicators. Either one or two parameter frames may be specified with the command, as indicated in Frame 1. Frame 1 is mandatory and must be sent. Frame 2 is optional and is sent only if Bit 14 in Frame 1 is set to 1. The format of the command and the two parameter bytes are given below.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7,8,9	Device Address (Indicators = 010)
10-14	Write Control Data Command (00101)
15	Stop bit; always 1.

Figure 124. Write Control Data Command - Indicators

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Indicators Bit 7: Caps Lock indicator (ON = activated) Bit 8: Layer 100 indicator (ON = activated) Bit 9: Reserved (must be 0) Bit 10: Type Ahead indicator (ON = activated) Bit 11: Reserved (must be 0) Bit 12: Reserved (must be 0) Bit 13: Reserved (must be 0) Bit 14: Last Frame (ON = Frame 2 also sent)
15	Stop bit; always 1.

Figure 125. Write Control Data to Indicators - First Parameter Frame

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Additional indicators Bits 7 - 14: reserved, must be 0

Figure 126 (Part 1 of 2). Write Control Data to Indicators - Second Parameter Frame

Bit	Purpose
15	Stop bit: always 1.

Figure 126 (Part 2 of 2). Write Control Data to Indicators - Second Parameter Frame

16.0 IBM InfoWindow 3477 Interface

The interface to the 3477 display station is the same as the interface to the 3197 display station (described in 14.0, "3197 Interface" on page 223), with the following exceptions.

- The 3477 has 4 models:
 - FGx - 14 inch green
 - FAX - 14 inch amber
 - FCx - 14 inch color
 - FDx - 15 inch green
- The extended display mode of 27 rows and 132 columns is available on all models.
- The 3477 supports three new indicators:
 - Type ahead indicator - Right double angle brackets in column 13 on Status Line.
 - Layer 100 indicator - Plus sign in column 35 on Status Line.
 - Caps Lock indicator - Capital A in column 38 on Status Line.
- The 3477 will allow an attached printer to emulate an IBM 5219, IBM 4214-2, or an IBM 5256 printer.
In addition to supporting the 5219 SCS commands, page rotation and bold as emphasis (BES/EES) is supported.
- The response from the 3477 to the Read Device ID command issued to the model ID feature address is the same as 3197 Model D for the monochrome models, and 3197 Model C for the color model. See 2.4.8.2, "Model ID Word" on page 54.
- The Write Control Data command on the 3477 Model FCx does not support reverse display image. Therefore, Bit 11 in the first parameter frame for Write Control Data must be zero.
- The 3477 does not support data entry keyboards.
- The 3477 supports additional device addressing for the Extended Character Buffer (ECB) for some commands, which is described in detail below.
- The 3477 supports additional commands. Escape, Read Info, and Write Control Data to the Indicators, as well as the Enhanced Queue Load commands, all of which are described in detail below.

16.1.1 Extended Character Buffer

An Extended Character Buffer (ECB) is a buffer equal in size to the Presentation Space. The ECB contains characters which control how characters in the Presentation Space are displayed on the screen (such as underscored). ECB characters do not occupy a screen position. Multiple ECBs are supported for various attribute affects.

The following ECBs are supported:

- Monochrome monitor
 - Primary ECB
 - Text ECB
- Color monitor
 - Primary ECB
 - Text ECB
 - Foreground Color ECB

The effect of a character in the ECB will be retained on the screen until the next non-propagate (not X'00') character in the ECB is encountered, and so forth, until the end of the Presentation Space is reached. The effect of the ECB character does not "wrap" from the last position on the PS to the first position on the PS. The upper left-hand corner of the ECB defaults to normal display.

The ECB character effect begins on the PS character located immediately in "front" of the ECB character (this PS character will be referred to as the "immediate" PS character).

ECB attributes, as a general rule, take precedence over PS attributes. In other words, the attribute in the ECB will cause the subsequent PS characters to be displayed as affected by the ECB attribute rather than the PS attribute.

Note: The PS field attribute code points (X'20' - X'3F') will continue to be supported if these code points are written to the Presentation Space.

16.1.1.1 Primary Extended Character Buffer

The Primary Extended Character Buffer (the Primary ECB) supports the same attribute capabilities as the PS attributes.

- Non-display
- Column separator
- Blink
- Underscore
- High intensity
- Reverse image

However, unlike the PS field attributes, all combination of attribute capabilities are supported. The Primary ECB is the first ECB and ECB number is 1.

16.1.1.2 Text Extended Character Buffer

The Text Extended Character Buffer (the Text ECB) supports the following attribute capabilities which are useful in text.

- Word underscore
- Half index up
- Half index down

The Text ECB is the second ECB and ECB number is 2.

16.1.1.3 Foreground Color Extended Character Buffer

The Foreground Color Extended Character Buffer (the Foreground Color ECB) supports the following attribute capabilities which control foreground color of PS characters on a color monitor.

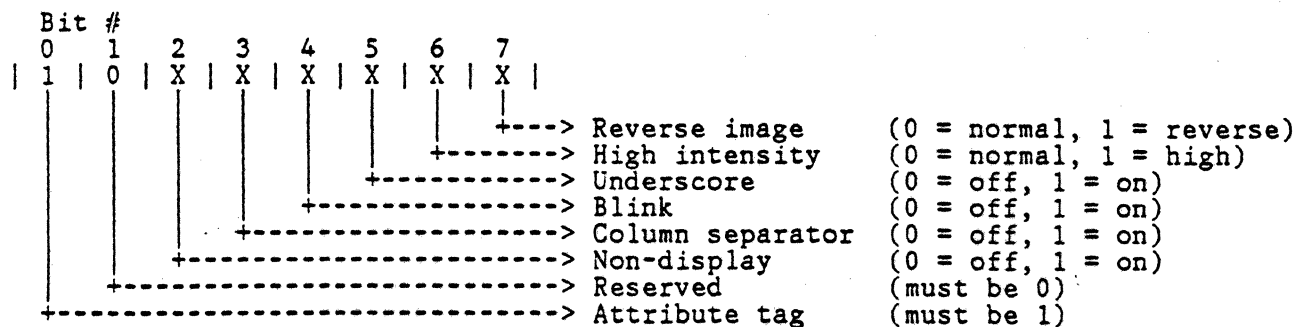
- Red
- Green
- Blue
- White (Red + Green + Blue)
- Turquoise (Green + Blue)
- Pink (Red + Blue)
- Yellow (Red + Green)
- Brightness

The Foreground Color ECB is the third ECB and ECB number is 3.

16.1.1.4 Primary ECB Field Attributes

Primary ECB field attributes are defined to be equal to the PS attribute definition, except for non-display and the attribute tag. All ECB attributes will use the high order bit (X'8X') as the attribute tag. The normal display attribute is defined as X'80' (just like the other ECBs definition). The propagate attribute is X'00'. All combinations of attribute capabilities are supported.

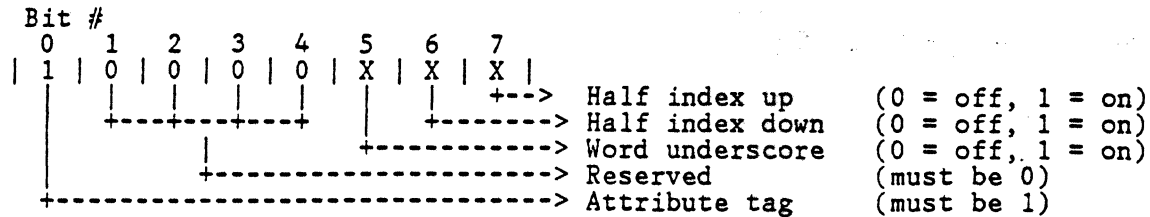
Primary ECB field attributes are defined as follows:



16.1.1.5 Text ECB Field Attributes

Those attributes typical to word processing and not supported in the primary ECB are attributes supported by the Text ECB. The normal display Text ECB attribute is X'80', while the propagate attribute is X'00'. All combinations of attribute capabilities are supported, including combinations between Text ECB attributes and those attributes of any other attribute plane.

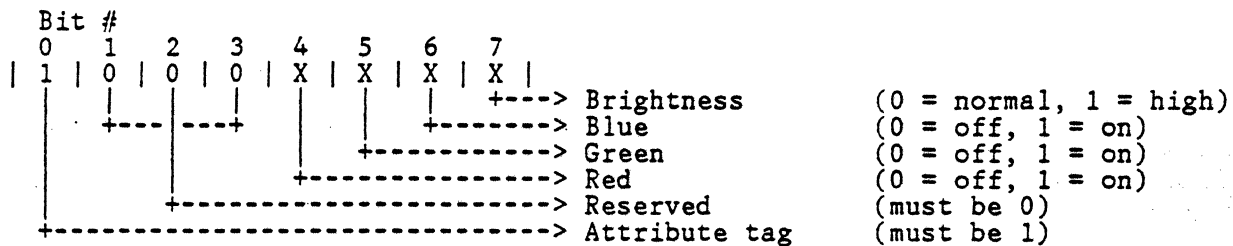
Text ECB attributes are defined as follows:



16.1.1.6 Foreground Color ECB Field Attributes

The foreground color ECB field attributes control the color of the PS characters. The normal display foreground color attribute is X'80', while the propagate attribute is X'00'. All combinations are supported between foreground color ECB attributes and those attributes of any other attribute plane.

Foreground color ECB field attributes are defined as follows:



16.1.1.7 PS and multiple ECB Attribute Relationships

ECB attributes, as a general rule, take precedence over PS attributes when they are not normal attributes (not X'80'). In other words, the attributes in the ECB will cause the subsequent PS characters to be displayed as affected by the ECB attribute rather than the PS attribute.

- If Primary ECB field attribute in effect is normal display (X'80'), PS attribute, Text ECB attribute, and Foreground Color ECB attribute give total attribute effect.
- If Primary ECB attribute in effect is not normal display (not X'80'), the Primary ECB attribute is substituted for PS attribute. The Primary ECB attribute, Text ECB attribute, and Foreground Color ECB attribute give total attribute effect.

16.1.2 Additional Device Addressing

3477 supports additional device addressing for the Extended Character Buffer (ECB) or for both the Presentation Space (PS) and ECB (Both). The Extended Character Buffer is an additional buffer which contains attribute controls, such as underscore, removing them from the Presentation Space (screen buffer).

Device addressing supported by 3477 is:

- B'000' - Base (Presentation Space (PS))
- B'001' - Keyboard
- B'010' - Indicators
- B'011' - Extended Character Buffer (ECB)
- B'111' - PS and ECB (Both)

Only certain commands can be addressed to device address Both. If a command is addressed to Both, the same exact operation will be performed on the PS and ECB buffers. The starting and ending locations as specified in the command, as well as the length of data, will be applied to both the PS and the ECBs. When the command is complete, the registers will be updated as if the command had been addressed to the PS and ECB separately.

Commands which can be addressed to ECB or Both are listed below. The commands perform the same function as described previously, however they perform the function on the ECB (if device address B'011') or on the PS and the ECB identically (if device address B'111').

- Escape - Both

Identifies that a following Enhanced Queue Load commands should be addressed to Both the PS and ECB. See 16.1.6, "Enhanced Queue Load Command Set" on page 243 for a description of the Enhanced Queue Load commands.

- Search General - ECB

Searches the specified ECB (if ECB addressing mode is non-zero) or all ECBs (if ECB addressing mode is zero) for the specified character. See 16.1.2.2, "Extended Character Buffer Addressing Modes" on page 237 for a description of ECB addressing modes.

- Write Data Load Cursor - ECB, Both

Writes data to either the ECBs or to Both (PS and ECB). See 16.1.2.1, "Rules for Reading or Writing to Device Address Both" on page 236 for the rules of writing to device address Both.

- Clear - ECB, Both

Clears either the ECBs or Both (PS and ECB).

- Read Between Limits - ECB

Reads between limits to the specified ECB (if ECB addressing mode is non-zero) or to all ECBs (if ECB addressing mode is zero). See 16.1.2.2, "Extended Character Buffer Addressing Modes" on page 237 for a description of ECB addressing modes.

- Write Data - ECB, Both

Writes data to either the ECBs or to Both (PS and ECB). See 16.1.2.1, "Rules for Reading or Writing to Device Address Both" on page 236 for the rules of writing to device address Both.

16.1.2.1 Rules for Reading or Writing to Device Address Both

If a write command is addressed to both PS and ECB (B'111'), the display will write code points encountered within the data which are immediately preceded by the ECB attribute escape character (X'10') and the ECB number (1,2,3) to the appropriate ECB. All other code points will be written to the Presentation Space. Similarly, if a read command is addressed to both, the display will return ECB characters immediately preceded by the ECB attribute escape character and ECB number (the display puts in the escape character (X'10') and ECB number), along with any PS characters within the limits of the read.

Writing data to or reading data from the ECBs when using a device address of both requires 3 bytes. Format for writing to or reading from the ECBs is:

- ECB attribute escape character - Character to distinguish between PS and ECB characters. Always X'10'. Used in data associated with device address of ECB (B'011') or Both (B'111'). Can be used as a data character only if device address of Base (B'000') is used.
- ECB number - Character to distinguish which ECB the attribute should be written to.

ECB numbers are assigned as follows:

- X'01' - Primary ECB
- X'02' - Text ECB
- X'03' - Foreground color ECB (color monitors only)
- Character to be written : The display does not determine if this is a valid character for the designated ECB (i.e., reserved bits on). Unexpected results may occur if an invalid character is written to a particular ECB.

16.1.2.1.1 Rules for write addressed to both PS and ECB: When a write command addressed to device address Both (B'111') is received, it will process the data associated with the command as follows.

The next byte of data is always written to the specified ECB, if the character was immediately preceded by the ECB attribute escape character (X'10') and the ECB number. The data address will not be advanced until a character is written to the PS. If another ECB character is encountered within the data, it will be written to the next higher address in the ECB (at current data location + 1) only if the ECB number is equal to the ECB number just written to or if a PS character was just written. All ECBs and the PS will be written to before the data address is advanced by 1. If 2 ECB characters for the same ECB exist beside each other (no PS character or other ECB character given between those 2 ECB characters in the data), the missing PS locations and ECB locations will remain unchanged.

16.1.2.1.2 Rules for read addressed to both PS and ECB: When a read command addressed to device address Both (B'111') received, the display will return the data associated with the command as follows.

The first ECB location for all ECBs is always checked for a readable ECB character (any non-propagate ECB character (not X'00') is readable). The ECBs are checked in order, from 1 to n. If no readable character (a X'00') exists in any ECB at that point, only the PS character will be read at that location. The data address will not be advanced until the character is read from the PS.

| If a readable ECB character exists in any ECB at that point, the ECB attribute escape character (X'10'), plus the ECB number, followed immediately by the readable ECB character will be returned in the data.

| PS characters are read until another readable character within the ECBs is encountered. If another readable character is encountered within any ECB, it will be returned, in the data, along with the ECB attribute escape character and ECB number.

| 16.1.2.2 Extended Character Buffer Addressing Modes

| If a device address of ECB (B'011') is specified, the current ECB addressing mode will determine which ECB is addressed and the format of the data associated with the command. The following ECB addressing modes are supported:

| **Mode 0** All ECBs are addressed in this addressing mode. Data will be sent to the display in the identical fashion as for device addressing of Both. The data to be written to the ECB will be preceded immediately by the attribute escape character (X'10') and the ECB number (1.2.3). All data is assumed to be multiple ECB data (3 byte format) except for a place holder (X'00'). Failure to provide data in the correct format will cause unexpected results. The data location pointer is incremented either when a place holder (X'00') is encountered in the data, or the same ECB number is specified as was previously written to at this data location. Not all ECBs must be written to for each position data location. The place holder (X'00') is written to neither ECB nor PS.

| Data will be returned (read) in the same format as write except that the place holder (X'00') is always required when the data location pointer is incremented.

| **Mode 1-n** Only the specified ECB is addressed when using ECB addressing mode 1-n (where, n = number of ECB being addressed). Any data associated with a command addressed to device address of ECB (B'011') will be written to the specified ECB. Neither attribute escape character (X'10') nor ECB number is in the data. Only ECB characters are included in the data when using this ECB addressing mode.

16.1.3 Escape

This command is a new command in the Base command set. The Escape command is used to escape from the Base command set into the Enhanced Queue Load command set. The Escape command indicates that the next byte(s) of the queue load is a command belonging to the Enhanced Queue Load command set. The Escape command must be used prior to *each* enhanced command in a queue load, otherwise the command will be interpreted as part of the Base command set and unexpected results can occur. The Escape command can be addressed to either the Base (B'000') or Both (B'111') device address. The device address in the Escape command indicates to which device (Base or Both) that the following Enhanced Queue Load command is directed. See 16.1.6, "Enhanced Queue Load Command Set" on page 243 for specific details on the Enhanced Queue Load commands.

If Escape is addressed to any device other than the Base or Both, an Invalid Command/Device Address Exception will result.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7,8,9	Device Address (Base = B'000' or Both = B'111' are valid)
10-14	Escape Command (01001)
15	Stop bit; always 1.

Figure 127. 3477 Escape Command

16.1.4 Read Info

This command allows the controller to read additional device specific information (such as Vital Product Data (VPD)) from the device. There is one byte following the Read Info command that indicates what device information to be read. If no bits are turned on in this byte, no information will be returned.

Actual data transfer will begin upon the receipt of an Activate Read command. The format of the command and the data returned in response to the Activate Read is given below.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7,8,9	Device Address (Base = 000)
10-14	Read Info Command (01011)
15	Stop bit; always 1.

Figure 128. Read Info Command

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Device information being requested Bit 7: Request Vital Product Data (VPD) Bits 8-14: Reserved, must be 0
15	Stop bit; always 1.

Figure 129. Read Info Command First Parameter Frame

Format of VPD data returned (64 bytes):

- Machine Type (EBCDIC, 4 bytes): F3F4F7F7
- Model Number (EBCDIC, 3 bytes)
- Load Identifier (4 bytes)
- Part Number (12 bytes)
- Serial Number (7 bytes)
- Manufacturing Identification (4 bytes)
- ROS Identification (15 bytes)
- Alterable ROS Identification (1 byte)
- Monitor characteristics (2 bytes), consisting of:
 - Bit 0: Color (ON for 3477 Model FCx)
 - Bit 1: Wide Screen (ON for 3477)
 - Bit 2: Separate Error Message Line (ON for 3477)
 - Bit 3: Text Symbols (ON for 3477)
 - Bit 4: Shadow Cursor (ON for 3477)
 - Bit 5: Reserved, must be 0

- | - Bit 6: Extended Character Buffer (ON for 3477)
- | - Bit 7 - Bit 15: Reserved, must be 0
- | • Other (12 bytes, reserved, padded with zero (X'00'))

16.1.5 Write Control Data - Indicators

Write Control Data command addressed to the Indicators command can be used to activate additional indicators on 3477 that are not accessible by the Write Data Load Cursor command addressed to the Indicators. Either one or two parameter frames may be specified, as indicated in Frame 1. Frame 1 is mandatory and must be sent. Frame 2 is optional and is sent only if Bit 14 in Frame 1 is set to 1. The format of the command and two parameter bytes are given below.

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address
7,8,9	Device Address (Indicators = 010)
10-14	Write Control Data Command (00101)
15	Stop bit; always 1.

Figure 130. Write Control Data Command - Indicators

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Indicators Bit 7: Caps Lock indicator (ON = activated) Bit 8: Layer 100 indicator (ON = activated) Bit 9: Reserved (must be 0) Bit 10: Type Ahead indicator (ON = activated) Bit 11: Reserved (must be 0) Bit 12: Reserved (must be 0) Bit 13: Reserved (must be 0) Bit 14: Last Frame (ON = Frame 2 also sent)
15	Stop bit; always 1.

Figure 131. Write Control Data to Indicators - First Parameter Frame

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	Station Address, or End Of Message (111) if last frame
7-14	Additional indicators Bits 7 - 14: reserved, must be 0

Figure 132 (Part 1 of 2). Write Control Data to Indicators - Second Parameter Frame

Bit	Purpose
15	Stop bit; always 1.

Figure 132 (Part 2 of 2). Write Control Data to Indicators - Second Parameter Frame

16.1.6 Enhanced Queue Load Command Set

All commands described in this section, just like the Base command set, must be sent as part of a Queue Load. An Escape command (see 16.1.3, "Escape" on page 238) must immediately precede any of these commands in the Queue Load. Mixtures of Enhanced Queue Load commands and Base commands are supported. There may also be multiple Enhanced Queue Load commands in the queue as long as the length of the queue is not exceeded.

16.1.6.1 Move Block

This command will move a block of data within the Presentation Space and ECB to the specified location. The Escape command will designate Both; the PS and ECB will be moved identically.

If the source block and the destination block are specified overlapping each other, the data in the source block will be copied to the destination block and the overlapped part of the source block will be overlaid with the destination block.

If either the start or end locations of the data block to be moved are not within the boundaries of the PS, an Operation Exception will be returned. Also, if the destination location is not within the boundaries of the PS, or if the data to be moved would be moved so that part of it is outside the PS, an Operation Exception will be returned.

Note: PSH = Presentation Space Height; PSW = Presentation Space Width

Frame #	Content	Valid values	Description
0	Escape	B'11101001'	Escape command (addressed to Both)
1	Command	X'01'	Command code point
2,3	Start location ²⁰	0-(PSH-1), 0-(PSW-1)	Start location of the data to be moved (row-1, column-1 format).
4	# rows in block - 1	0-(PSH-1)	Number of rows - 1 in the block to be moved, including the start location.
5	# cols in block - 1	0-(PSW-1)	Number of columns - 1 in the block to be moved, including the start location.
6,7	Destination location ²⁰	0-(PSH-1), 0-(PSW-1)	Destination of the data to be moved (row-1, column-1 format).

Figure 133. Format of Move Block Command

²⁰ Start and destination locations refer to the upper left-hand corner of the block to be moved.

16.1.6.2 Write Repeated

This command will write a specified character to a block area within the Presentation Space and within the ECB. The device address specified in the Escape command will designate Both. The PS character and the ECB character to be written must be specified.

If the area to write the character is not within the boundaries of the PS, an Operation Exception will be returned.

Note: PSH = Presentation Space height; PSW = Presentation Space width

Frame #	Content	Valid values	Description
0	Escape	B'11101001'	Escape command (addressed to Both)
1	Command	X'02'	Command code point
2,3	Start location	0-(PSH-1), 0-(PSW-1)	Start location where the data is to be written (row-1, column-1 format).
4	# rows in block - 1	0-(PSH-1)	Number of rows - 1 in the block to be written to, including the start location.
5	# cols in block - 1	0-(PSW-1)	Number of columns - 1 in the block to be written, including the start location.
6	PS character to write	X'00' - X'FE'	EBCDIC code point of character to be written to PS
7	ECB character to write	X'00', X'80' - X'FE'	EBCDIC code point of character to be written to ECB

Figure 134. Format of Write Repeated Command

16.1.6.3 Display PS character/ECB

This command will display PS characters, Text Assist symbols in PS, Text Assist symbols in Text ECB, and Begin/End attribute symbols in other ECBs on the screen. The command specifies what should be displayed at the cursor location and elsewhere on the entire screen.

Note: If X'00' is specified in the frame 2, a PS character or a Text Assist symbol in PS, as specified by the Write Control Data command, will be displayed under the cursor. If X'00' is specified in the frame 3, PS characters or Text Assist symbols in PS, as specified by the Write Control Data command, will be displayed elsewhere on the full screen.

If an invalid value is detected while processing this command, the command has no affect and an Operation Exception will be returned.

Frame #	Content	Valid values	Description
0	Escape	B'00001001'	Escape command (addressed to Base)
1	Command	X'03'	Command code point
2	Display under cursor	<ul style="list-style-type: none"> • X'00' • X'01' • X'02' • X'03' 	<ul style="list-style-type: none"> • Display Text Assist symbols in PS • Display Text Assist symbols in Primary ECB • Display Text Assist symbols in Text ECB • Display Text Assist symbols in Foreground Color ECB
3	Display on full screen	<ul style="list-style-type: none"> • X'00' • X'01' • X'02' • X'03' 	<ul style="list-style-type: none"> • Display Text Assist symbols in PS • Display Text Assist symbols in Primary ECB • Display Text Assist symbols in Text ECB • Display Text Assist symbols in Foreground Color ECB

Figure 135. Format of Display PS character/ECB Command

Note: Special Text symbols will only overlay PS characters where a readable ECB character (not propagate attribute (X'00')) exists behind that PS character location. All other PS characters on the screen are unaffected by this command.

16.1.6.4 Write to Row with Pad

This command will write data to the PS and ECB on a row by row basis. If the data to be written does not take up the entire row, the specified PS pad character and ECB pad character will be padded to the end of the current row.

The data will be given to the display as one continuous string. A X'FF' character within the data will designate the end of the current row.

Note: If a X'FF' ECB attribute is given in the data, it will be immediately preceded by the ECB attribute escape character (X'10') and ECB number (1,2,3). This will distinguish the X'FF' ECB character from the X'FF' end of row character.

The next character in the string (after X'FF') will be the first character written to the next row. If the last PS or ECB position on a row is written to, a X'FF' end of row character must still be appended to the data for that row.

The actual transmission of the data occurs upon the receipt of an Activate Write command. The Write to Row with Pad command must be the last command of a queue load. All queueable commands sent after a Write to Row with Pad command has been received, but before it has been serviced (station busy) will be flushed; no error will be indicated. Any queueable command sent after Write to Row with Pad has been serviced (station not busy), except Reset addressed to the ECB or End of Queue, will cause an Activate Exception to be posted and Activate processing to be disabled.

The Escape command will designate device address of Both. Rules for doing a write command addressed to address "both" will apply.

If the start location or the end location are not within the PS or ECB, or if the end of the row is encountered before a X'FF' end of row character is found within the data, an Operation Exception will be returned.

Frame #	Content	Valid values	Description
0	Escape	B'11101001'	Escape command (addressed to Both)
1	Command	X'04'	Command code point
2,3	Start location	0-(PSH-1), 0-(PSW-1)	Start location where the data is to be written (row-1, column-1 format). Start location must be between left and right limits.
4	Left limit	0-(PSW-1)	Leftmost column position - 1 on a row where data is to start being written. The start location may be equal to or right of this value. All subsequent rows will be written starting at the left limit, however.

Figure 136 (Part 1 of 2). Format of Write to Row with Pad Command

Frame #	Content	Valid values	Description
5	Right limit	0-(PSW-1)	Rightmost column position - 1 on a row where data is to start being written. The start location may be equal to or left of this value. All rows (including the start row) will be written ending at the right limit.
6	PS pad character	X'00' - X'FE'	EBCDIC code point of PS pad character.
7	ECB pad character	X'00', X'80' - X'FE'	EBCDIC code point of ECB pad character.

Figure 136 (Part 2 of 2). Format of Write to Row with Pad Command

16.1.6.5 Read from Row with Ender

This command will read data from the PS and ECB on a row by row basis. The end of row character (X'FF') will be appended to the last character read from the row, even if the data read takes up the entire row in the PS.

The data will be given to the display as one continuous string. The X'FF' character within the data will designate the end of the current row.

Note: If a X'FF' ECB attribute is given in the data, it will be immediately preceded by the ECB attribute escape character (X'10') and ECB number (1,2,3). This will distinguish the X'FF' ECB character from the X'FF' end of row character.

The next character in the data returned (after X'FF') will be the first character read from the next row.

Any trailing pad characters in the PS and trailing pad characters in the ECB, as specified in the command, will not be returned in the data. Trailing pad characters are continuous pad characters at the end of a row (no non-pad PS characters exist on the line and no non-pad ECB characters exist beyond the pad characters). Only trailing pad characters are not returned.

The first 2 bytes of data returned are always the total length of the data being read between the start and end locations (including the length bytes, plus any PS characters, ECB characters, ECB attribute escape characters (X'10'), ECB number (1,2,3), and line ender characters (X'FF') in the data). If a block size of 2 is specified in the command, only the length will be returned. If the Controller fails to read the total length of the data, no error will be returned. If the Controller specifies more data than what will be returned (block size greater than the total length), the data returned will be padded with nulls after the last row ender character in order to return the requested block size. Only data within the left and right limits and between the start and end locations will be returned.

The actual transmission of the data occurs upon the receipt of an Activate Read command. The Read from Row with Ender command must be the last command of a queue load. All queueable commands sent after a Read to Row with Ender command has been received, but before it has been serviced (station busy) will be flushed; no error will be indicated. Any queueable command sent after Read to Row with Ender has been serviced (station not busy), except Reset addressed to the ECB or End of Queue, will cause an Activate Exception to be posted and Activate processing to be disabled.

The Escape command will designate device address of Both. Rules for doing a read command addressed to address "both" will apply.

If the start location or the end location are not within the PS or ECB, an Operation Exception will be returned.

Frame #	Content	Valid values	Description
0	Escape	B'11101001'	Escape command (addressed to Both)
1	Command	X'05'	Command code point

Figure 137 (Part 1 of 2). Format of Read from Row with Ender Command

Frame #	Content	Valid values	Description
2,3	Start location	0-(PSH-1), 0-(PSW-1)	Start location where the data is to be read (row-1, column-1 format). Start location must be between left and right limits.
4	Left limit	0-(PSW-1)	Leftmost column position - 1 on a row where data is to start being read. The start location may be equal to or right of this value. All subsequent rows will be read starting at the left limit, however.
5	Right limit	0-(PSW-1)	Rightmost column position - 1 on a row where data is to start being read. The start location may be equal to or left of this value. All rows (including the start row) will be read ending at the right limit.
6,7	End location	0-(PSH-1), 0-(PSW-1)	End location where the data is to be read (row-1, column-1 format). End location must be equal to or left of the right limit.
8,9	Data length	X'01' - X'07FF'	Block size of data to be returned per Read Activate.
10	PS pad character	X'00' - X'FE'	EBCDIC code point of PS pad character (not returned in data).
11	ECB pad character	X'00', X'80' - X'FE'	EBCDIC code point of ECB pad character (not returned in data).

F 37 (Part 2 of 2). Format of Read from Row with Ender Command

16.1.6.6 Set ECB Buffer Addressing Mode

This command is used to set which ECB buffer should be addressed whenever a command addressed to the ECB (B'011') is received. The ECBs may be addressed in two modes. Mode 0 addresses all the ECBs whenever a device address of ECB (B'011') is given. This means that the data supplied with the command must contain the ECB escape character, plus ECB number to distinguish which ECB the character is for. Mode 1 - n addresses the specified ECB, where n = ECB number. This means that the data supplied with the command contains only the ECB data, and does not contain any ECB escape characters or ECB numbers. The addressing mode at POR is set to mode 0. Upon receipt of this command, the addressing mode is set until the next occurrence of this command or until the next POR.

Frame #	Content	Valid values	Description
0	Escape	B'00001001'	Escape command (addressed to Base)
1	Command	X'07'	Command code point
2	Addressing mode	<ul style="list-style-type: none"> • X'00' • X'01'-X'03' 	Addressing mode indicator <ul style="list-style-type: none"> • Addressing mode 0 - all ECBs addressed • Addressing mode specifying specific ECB (1,2,3) to be addressed

Figure 138. Format of Set ECB Addressing Mode Command

17.0 Data Transfer Passthru Display Interface

A Data Transfer Passthru display is supported only by the AS/400, and is *not* supported by S/36 or S/38. Personal Computers (PCs and PS/2s) attached to AS/400 via twinax function as Data Transfer Passthru devices when the AS/400 PC Support program is used.

A Data Transfer Passthru display is an intelligent display. It processes data sent to it, processes keystrokes, and formats data to be returned to the host. The Controller acts as a data transfer device; it simply passes data between the host and the Data Transfer Passthru display.

In general, the Controller communicates with the Data Transfer Passthru display by reading and writing into the display's I/O buffers and by polling the display. When the Controller receives data for the Data Transfer Passthru display from the host, the Controller writes the data to the Write I/O buffer in the display. When the Data Transfer Passthru display has data for the host, the display waits for the SNA Change Direction flag byte to indicate that it may send data to the host. When the SNA Change Direction flag indicates data may be sent, the display indicates that it has data to send by a non-zero poll response.

For a Data Transfer Passthru display the poll response is not a Scan code, but rather is a Status Pending indicator which causes the Workstation Controller to read data from the Read I/O buffer in the display. The value of the Status Pending indicator is the approximate length of the data to be sent to the host. For both the Write I/O Buffer and the Read I/O Buffer, the first 2 bytes of data in the buffer is the length of the data to be written or read. The length is a zero-origin value, with a maximum value of 20,479.

The Write I/O Buffer, Read I/O Buffer, and SNA Change Direction flag byte are at assigned addresses within the Data Transfer Passthru display, as summarized below.

Data Area	Address	Length
Read I/O Buffer	X'4000'	20,480
Write I/O Buffer	X'9000'	20,480
SNA Change Direction Flag	X'F000'	1
	Values:	
	<ul style="list-style-type: none">• X'00' Device allowed to send data to host• X'01' SNA session disconnected• X'02' Device not allowed to send data to host	

Figure 139. Data Transfer Passthru display Data Areas

The twinax interface to the Data Transfer Passthru display is the same as the interface to the 5291-1 or 2 or 3196 display stations (described in 2.0, "5251 Model 11 Interface" on page 11 and 13.0, "3196 Interface" on page 221), with the following exceptions.

- The response from the Data Transfer Passthru display to the Read Device ID command issued to the base device address is X'C8'. See 2.4.8, "Read Device ID Command (Code = 01100 and -1100)" on page 52.
- The installed user accessible storage for the Data Transfer Passthru display is 64K bytes.
- The second byte of the response from the Data Transfer Passthru display to the Poll command is not a Scan code, but is a Status Pending indicator as described below.

Poll Response Byte 2 from Data Transfer Passthru display:

Bit	Purpose
0,1,2	Fill bits; always zero.
3	Parity bit; set for even parity in the frame
4,5,6	End of Message (111)
7-14	Status Pending indicator <ul style="list-style-type: none"> • X'00' = No information to be sent • X'01' = 2 - 64 bytes to be sent • X'02' = 65 - 128 bytes to be sent • X'03' = 129 - 192 bytes to be sent • X'04' = 193 - 256 bytes to be sent • X'05' = 257 - 320 bytes to be sent • X'06' = 321 - 384 bytes to be sent • X'07' = 385 - 448 bytes to be sent • X'08' = 449 - 512 bytes to be sent • X'09' = 513 - 576 bytes to be sent • X'0A' = 577 - 640 bytes to be sent • X'0B' = 641 - 704 bytes to be sent • X'0C' = 705 - 768 bytes to be sent • X'0D' = 769 - 832 bytes to be sent • X'0E' = 833 - 896 bytes to be sent • X'0F' = 897 - 960 bytes to be sent • X'10' = 961 - 1024 bytes to be sent • X'11' = 1024 plus bytes to be sent • X'FF' = A passthru interface error was detected by the display
15	Stop bit; always 1.

Fig 40. Poll Response byte 2 (Status Pending Frame)

Bits 7 through 14 contain the Status Pending indicator. A null (X'00') Status Pending indicator means that the Data Transfer Passthru display does not have any information to be sent to the host. A non-zero Status Pending indicator means that the Data Transfer Passthru display wants to send data to the host. The value of the Status Pending indicator indicates the approximate length of the data to be sent to the host. An invalid Status Pending indicator value or a value of X'FF' will cause the Controller to send an error response to the host indicating a Passthru Interface error.

18.0 5259 Migration Data Link

The 5259 Migration Data Link presents interfaces to host systems and attached devices the same as described elsewhere in this document. However, to facilitate the transfer of data from one system to another, the following special interfaces exist.

- File migration
- Read ID

Note: These interfaces exist only for addresses configured in the 5259 for data transfer.

18.1 File Migration Mode

In the file migration mode, the data transfer between systems will take place as follows:

1. The source system initializes all displays by clearing them and using the Read ID sequence described in 18.2, "Read ID Mode" on page 256.
2. The source system writes data (in transparent mode) to the emulated display. The character at row 1, column 2 must be X'10' to indicate to the 5259 that the data is to be transferred.
3. The source system causes the input inhibited indicator to be turned off for the emulated display. The source system then repeats the process for the next display configured in the 5259 for data transfer, starting at step 2.
4. The source system turning off the input inhibited indicator on the emulated display causes the 5259 to set the value of the character at row 1, column 2 to X'00', and to send the Enter key scan code to the target system for the equivalent emulated display.

The 5259 will send the Enter key scan code to the source system after both of the following conditions are satisfied:

- a. Data from previous operations on the target systems is complete.
- b. The input inhibited indicator is turned off on both systems.

Note: In file migration mode, the 5259 uses two buffers for each emulated display.

5. The received Enter key scan code causes the target system to turn on the input inhibited indicator for the emulated display. It also allows the target system to read the data (in transparent mode) from the display. The character at row 1, column 2 will be X'00'.

6. When the data has been successfully read, the target system turns off the input inhibited indicator for the emulated display. This causes the 5259 to examine the character at row 1, column 2 and if X'00', to send the Enter key scan code to the source system for the equivalent emulated display. At this point, the target system returns to step 4 to wait for the next Enter key scan code. If the character at row 1, column 2 is the transfer mode command X'10', (i.e., written by the target system before the input inhibited indicator was turned off), the 5259 will process the command in the same manner as if the command had been given from the source system.
7. The received Enter scan code received causes the source system work station controller to turn on the input inhibited indicator for the emulated display. This causes the source system to repeat the process, starting with step 2.

18.2 Read ID Mode

The Read ID mode of data transfer allows either the source or the target system to verify that a 5259 is attached and configured for data transfer at a specific address. In this mode, the sequence will take place as follows:

1. The system writes X'13' to row 1, column 2 of the emulated display, then causes the input inhibited indicator to be turned off.
2. The system turning off the input inhibited indicator causes the 5259 to examine the row 1, column 2 character and, determining that the value is X'13' writes X'F5F2F5F9' to the emulated screen starting at row 1, column 3. The 5259 will also set the value of the character at row 1, column 2 to X'00' and send the Enter key scan code to the system.
3. Upon receipt of the Enter key, the system may read the model ID from the emulated screen.

The Read ID command is also used to stop any ongoing data transfer and setup the 5259 to accept new data transfer operations. It is therefore recommended that you use the Read ID command before starting data transfer operations.

19.0 IBM Enhanced Keyboard

The IBM Enhanced Keyboard is supported on the 3179-2 and the 3196. It comes in typewriter (data processing) and Katakana styles. The IBM Enhanced Keyboard does not have a data entry version.

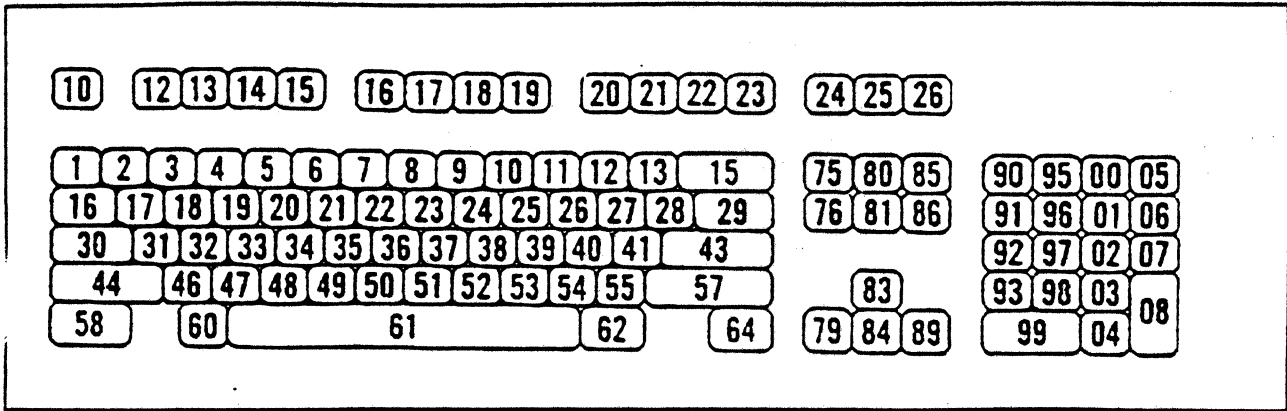


Figure 141. IBM Enhanced Keyboard - Layout with Associated Key Numbers (US). The numbers for the top row of keys are prefaced by a "1" (for keys 110 - 126), as are the numbers for the keys in the right hand two columns (keys 100 - 109).

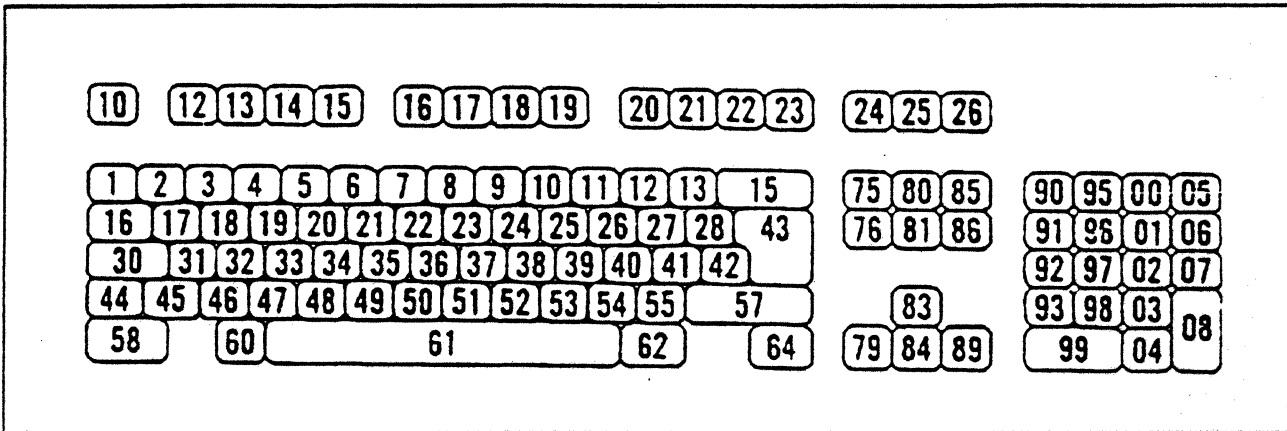


Figure 142. IBM Enhanced Keyboard - Layout with Associated Key Numbers (World Trade). The numbers for the top row of keys are prefaced by a "1" (for keys 110 - 126), as are the numbers for the keys in the right hand two columns (keys 100 - 109).

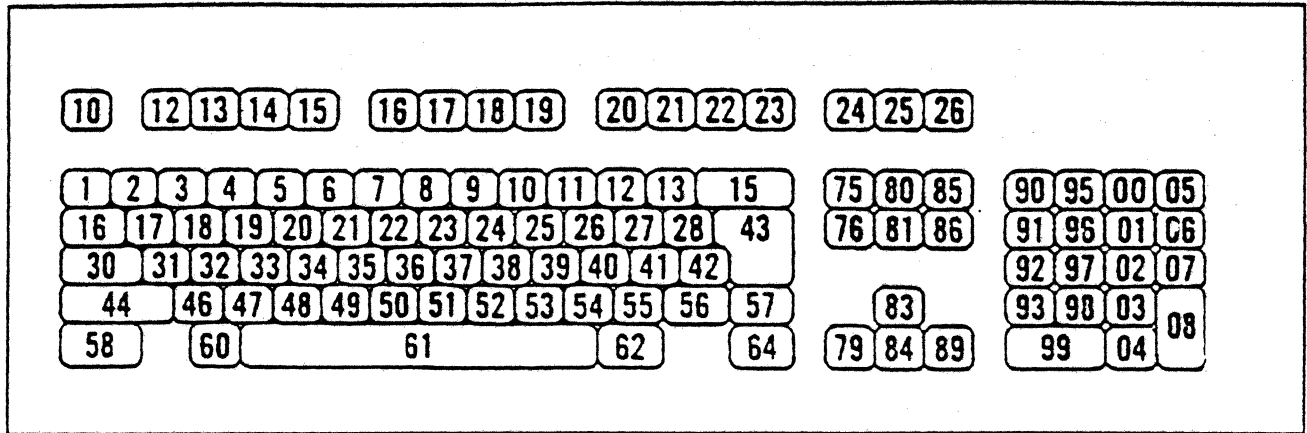


Figure 143. IBM Enhanced Keyboard - Layout with Associated Key Numbers (Katakana). The numbers for the top row of keys are prefaced by a "1" (for keys 110 - 126), as are the numbers for the keys in the right hand two columns (keys 100 - 109).

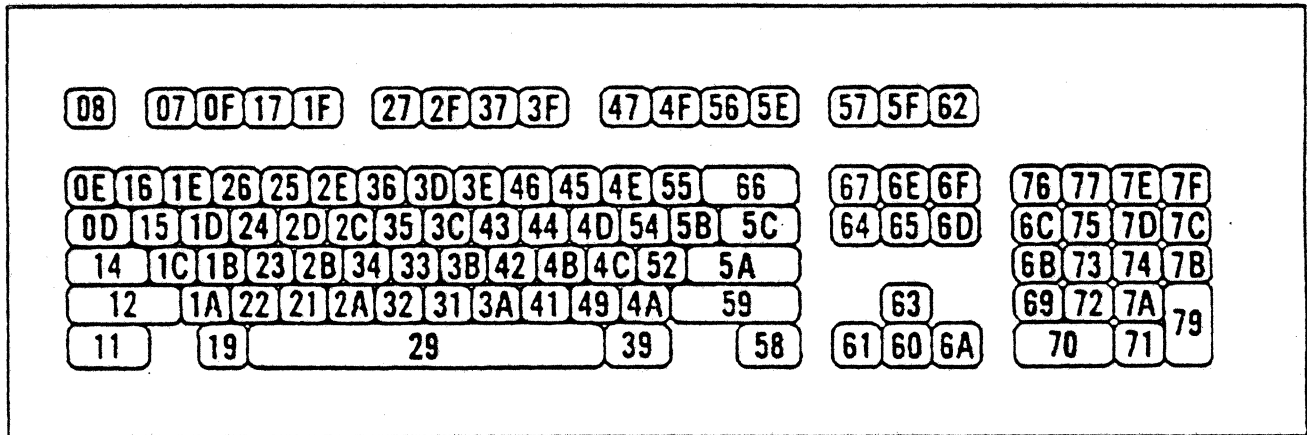


Figure 144. IBM Enhanced Keyboard - Layout with Associated Scan Codes (US Version). Scan codes are represented as hexadecimal.

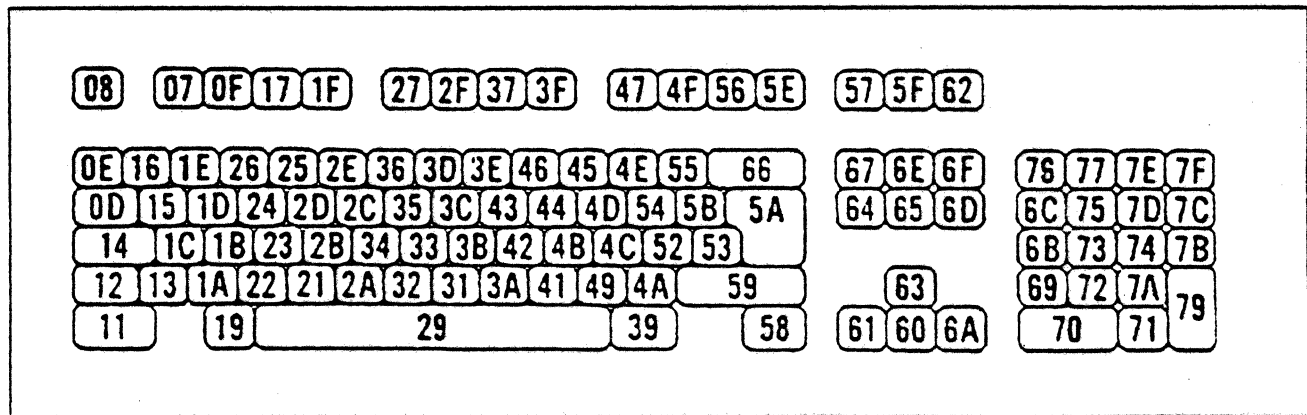


Figure 145. IBM Enhanced Keyboard Layout with Associated Scan Codes (World Trade). Scan codes are represented as hexadecimal.

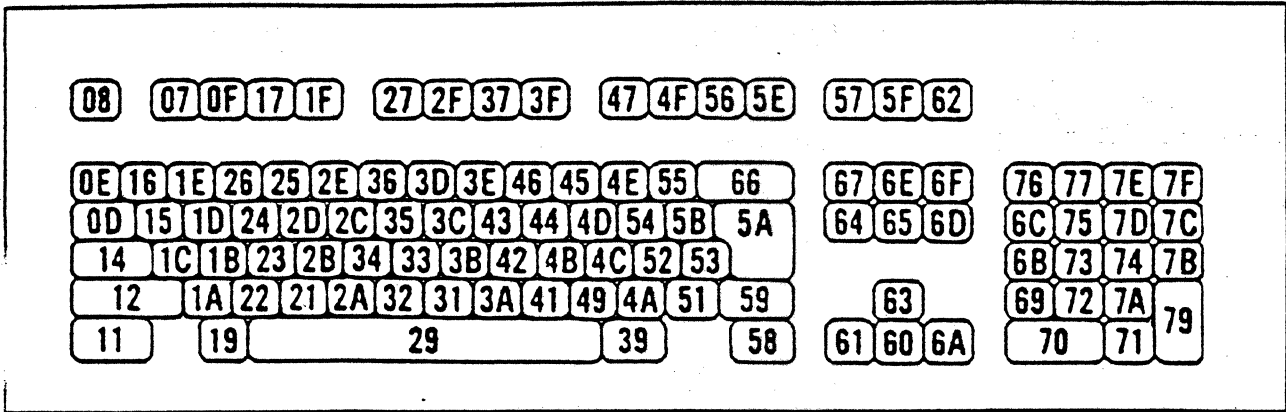


Figure 146. IBM Enhanced Keyboard Layout with Associated Scan Codes (Katakana). Scan codes are represented as hexadecimal.

Figure 147 on page 262 shows scan codes, graphics, and functions of the IBM Enhanced Keyboard by key number.

In the table headers,

- “unshift” refers to the key without shifting
- “shift” refers to the key with shifting
- “Alt” refers to the key with the ALT key pressed

Scan codes are in hexadecimal notation.

“-Pad” means that this key is part of the numeric pad.

The functions in the table are for the U. S. keyboard only.

The column labelled “US” shows the key “action” on U. S. keyboards. The column labelled “World Trade” gives the key action for World Trade keyboards. The column labelled “Katakana” gives the key action for Katakana keyboards.

The key action codes are as follows.

- T Typamatic key. When typamatic keys are held down for more than 600 milliseconds, they repeats at 10 keys per second, except for horizontal cursor keys, which repeat at 20 keys per second. This is a function of the terminal; the controller sees only repeated keys, as if the user pressed the key repeatedly.
- MB Make/Break key. These keys return the scan code shown in the table when they are pressed, and the same scan code with bit 0 (the high order bit) turned on when they are released.
- M Make Only. These keys return their scan code when they are pressed, do not repeat (no matter how long they are held down), and do not return a scan code when released.
- N No scan code generated.
- B Blank key
- BN Blank key. No scan code generated.
- L Whether this key is labelled or blank depends on the language that the keyboard is set up for.

²¹ Function supported by the display. No scan code is reported to the system when this key is pressed.

Key	Scan Code	US	World Trade	Katakana	U. S. Function Unshift	U. S. Function Shift	Function ALT
1	0E	T	L	BN	Accent	Tilda	
2	16	T	T	T	1	!	
3	1E	T	T	T	2	@	
4	26	T	T	T	3	#	
	25	T	T	T	4	\$	
	2E	T	T	T	5	%	
7	36	T	T	T	6	€	
8	3D	T	T	T	7	&	
9	3E	T	T	T	8	*	
10	46	T	T	T	9	(
11	45	T	T	T	0)	
12	4E	T	T	T	Dash	-	
13	55	T	T	T	=	+	
14	5D	N	N	T			
15	66	T	T	T	Back Space	Back Space	
16	0D	T	T	T	Right Tab	Left Tab	
17	15	T	T	T	q	Q	
18	1D	T	T	T	w	W	
19	24	T	T	T	e	E	
20	2D	T	T	T	r	R	
21	2C	T	T	T	t	T	
22	35	T	T	T	y	Y	
23	3C	T	T	T	u	U	
24	43	T	T	T	i	I	
25	44	T	T	T	o	O	
26	4D	T	T	T	p	P	
27	54	T	T	T	~	Left Brace	
28	5B	T	T	T	|	Right Brace	
29	5C	T	N	N	\	|	
30	14	MB	MB	MB	Cap Lock	Cap Lock	
	1C	T	T	T	a	A	
	1B	T	T	T	s	S	
33	23	T	T	T	d	D	
34	2B	T	T	T	f	F	

Figure 147 (Part 1 of 4). IBM Enhanced Keyboard - Key Numbers and Associated Scan Codes

Key	Scan Code	US	World Trade	Katakana	U. S. Function Unshift	U. S. Function Shift	Function ALT
35	34	T	T	T	g	G	
36	33	T	T	T	h	H	
37	3B	T	T	T	j	J	
38	42	T	T	T	k	K	
39	4B	T	T	T	l	L	
40	4C	T	T	T	:	:	
41	52	T	T	T	'	"	
42	53	N	T	T			
43	5A	M	M	M	Field Exit	New Line	
44	12	MB	MB	MB	Left Shift	Left Shift	
45	13	N	T	T			
46	1A	T	T	T	z	Z	
47	22	T	T	T	x	X	
48	21	T	T	T	c	C	
49	2A	T	T	T	v	V	
50	32	T	T	T	b	B	
51	31	T	T	T	n	N	
52	3A	T	T	T	m	M	
53	41	T	T	T	,	<	
54	49	T	T	T	.	>	
55	4A	T	T	T	/	?	
56	51	N	N	T			
57	59	MB	MB	MB	Right Shift	Right Shift	
58	11	M	M	M	Reset	Reset	
60	19	MB	MB	MB	ALT	ALT	
61	29	T	T	T	Space Bar	Space Bar	
62	39	MB	MB	M	ALT	ALT	
64	58	M	M	M	Enter	Enter	
75	67	T	T	T	Insert	DUP	
76	64	T	T	T	Delete		
79	61	T	T	T	Cursor Left	Cursor Left	Fast Cursor Left
80	6E	M	M	M	Home		Text On.Off ²¹
81	65	M	M	M			Erase Input
83	63	T	T	T	Cursor Up	Cursor Up	

Figure 147 (Part 2 of 4). IBM Enhanced Keyboard - Key Numbers and Associated Scan Codes

Key	Scan Code	US	World Trade	Katakana	U. S. Function Unshift	U. S. Function Shift	Function ALT
84	60	T	T	T	Cursor Down	Cursor Down	
85	6F	T	T	T	Page Up		
86	6D	T	T	T	Page Down		
89	6A	T	T	T	Cursor Right	Cursor Right	Fast Cursor Right
90	76	B	B	B			
91	6C	T	T	T	7-Pad	7-Pad	
92	6B	T	T	T	4-Pad	4-Pad	
93	69	T	T	T	1-Pad	1-Pad	
95	77	B	B	B			
96	75	T	T	T	8-Pad	8-Pad	
97	73	T	T	T	5-Pad	5-Pad	
98	72	T	T	T	2-Pad	2-Pad	
99	70	T	T	T	0-Pad	0-Pad	
100	7E	T	T	T	.-Pad	.-Pad	
101	7D	T	T	T	9-Pad	9-Pad	
102	74	T	T	T	6-Pad	6-Pad	
103	7A	T	T	T	3-Pad	3-Pad	
104	71	T	T	T	.-Pad	.-Pad	
105	7F	M	M	M	Field -	Field -	
106	7C	T	T	T	Right Tab-Pad	Right Tab-Pad	
107	7B	M	M	M	Field	Field	
108	79	M	M	M	Enter-Pad	Enter-Pad	
110	08	M	M	M	ATTN	Set Up ²¹	
112	07	M	M	M	F1	F13	
113	0F	M	M	M	F2	F14	
114	17	M	M	M	F3	F15	
115	1F	M	M	M	F4	F16	Record ²¹
116	27	M	M	M	F5	F17	Play ²¹
117	2F	M	M	M	F6	F18	
118	37	M	M	M	F7	F19	Hex
119	3F	M	M	M	F8	F20	
120	47	M	M	M	F9	F21	

Figure 147 (Part 3 of 4). IBM Enhanced Keyboard - Key Numbers and Associated Scan Codes

Key	Scan Code	US	World Trade	Katakana	U. S. Function Unshift	U. S. Function Shift	Function ALT
121	4F	M	M	M	F10	F22	
122	56	M	M	M	F11	F23	
123	5E	M	M	M	F12	F24	
124	57	M	M	M	Print		Sys Req
125	5F	M	M	M	Help		Test
126	62	M	M	M	Clear		

Figure 147 (Part 4 of 4). IBM Enhanced Keyboard - Key Numbers and Associated Scan Codes

Appendix A. Device Error Codes

Several hardware related errors which are directly related to 5250 display stations and printers are given in this section. Some of the errors are detected by the attached device and some by the Workstation Controller.

Display Error Code	Printer Error Code	Error Description
0100	0200	No response (SERDES) timeout
0101	0201	Transmit (driver) activity check
0103	0203	Receive parity error
0104	0204	Line parity error
0105	0205	Workstation not accessible
0106	0206	Receive length check
0107	0207	Wrong station responded
0108	0208	Power-on transition
0109	0209	Activate command failure
0111	----	Invalid keyboard scan code
----	021x	Printer machine check
0120	0220	Invalid command or device ID
0121	----	Invalid register value
----	0221	Invalid exception status
0122	0222	Input queue or storage overrun
0123	----	Null or attribute exception error
----	0223	Activate lost
0124	0224	Invalid activate
0125	0225	Invalid exception status
0126	----	Pass thru interface error
----	0226	Graphics check
----	0228	Invalid SCS command
----	0229	Invalid SCS parameter
----	023x	Print check
----	024x	Forms check
0149	0249	Undefined error
----	0250	End of forms
----	0251	Unit not available or not ready
----	0258	End of ribbon for 5219-D
----	026x	Printer datastream error
----	028x	Printer machine, print, or ribbon check
0181	----	Magnetic Stripe Reader error
0182	----	Invalid device type (Base ID response)
0183	----	Incorrect display size

Figure 148 (Part 1 of 2). Error Codes for Device Hardware Errors

Display Error Code	Printer Error Code	Error Description
0184	----	Incorrect keyboard ID
0185	----	Keyboard - translate table mismatch
0186	----	Feature not installed or loaded
0189	----	False outstanding status
0190	0290	Even/odd status timeout
0191	0291	Busy timeout
----	0292	Clear command timeout

Figure 148 (Part 2 of 2). Error Codes for Device Hardware Errors

Appendix B. Operator Error Codes

Errors which are the result of an operator action are given in this section.

Error Code	Description
0000	Help Key not allowed
0001	Keyboard overrun
0002	Invalid scan code received from keyboard
0003	Key not valid following depression of CMD key
0004	Keyboard data entered in MSR data input field
0005	Keystroke valid only in an input field; cursor not presently positioned in an input field
0006	Key not valid following depression of SYS REQ key
0007	Data not entered into Mandatory Enter field
0008	Non-alpha character attempted in Alpha Only field
0009	Non-numeric character attempted in Numeric Only field
0010	Character other than 0-9 or DUP attempted in Signed Numeric field
0011	Attempt to enter a character in the sign position of Signed Numeric field
0012	Attempt to insert character in last position of field or last position of field is not null
0013	Field may not be exited before Insert Mode is reset
0014	Mandatory Fill field contains a null
0015	Check digit error (Modulus 10/11)
0016	Field minus key pressed in field which is not Signed Numeric, Numeric Only, or Digits Only
0017	Field exit, field minus, or field plus key pressed in Mandatory Fill field and cursor is not in first or last position of field
0018	Field exit, field minus, or field plus required to leave field
0019	DUP key not allowed in field
0020	AID request key pressed in Right Adjust field after data entered, but before right adjust has occurred (field exit, field minus, or field plus required to continue)
0021	Field exit, field minus, or field plus are not allowed in Mandatory Enter field from first position or any position if no data keyed first
0022	Parity check on Insert or Delete operation
0023	Invalid character entered in Hex Mode
0024	Non-numeric character attempted in Digits Only field
0026	Field minus key pressed in Numeric Only field which has other than 0-9 or a null in units position

Figure 149 (Part 1 of 2). Error Codes for Operator Errors

Error Code	Description
0027	Blank key pressed
0029	Invalid character entered in Diacritic Mode
0031	Format Table overflow
0032	Line parity check on read MSR command
0033	Secure MSR data sent to non-secure field
0034	MSR data too large for field
0035	Error associated with MSR data transmitted
0036	Selector Light Pen usage is not allowed
0037	Selector Light Pen tip switch operation error
0038	MSR data not allowed in this field or mode
0040	DCE not ready
0041	Received line idle
0042	Receive clock failed
0043	Data Set ready line active
0044	30 second timeout
0045	Data Set will not activate
0046	Frame reject received
0047	DM/DISC received
0050	Clear to send error
0051	Transmit clock failed
0052	Transmit hardware error
0053	T1 timer retry count expired
0054	Command reject sent
0055	XLCA card error
0070	Word spill failure
0071	Attempt to start Copy, Move, or Delete operation when one has already been started
0072	Key not valid in current area of screen
0073	Attempt to delete or replace protected character
0074	Invalid key during General Prompt
0075	Locate failed to find character
0076	Continuous Insert failed - waiting on host to read screen
0077	Function key undefined in present mode
0078	Scale line not defined to Workstation Controller
0097	Test Request function not supported by host system
0099	Key not allowed in Free Key Mode

Figure 149 (Part 2 of 2). Error Codes for Operator Errors

Glossary

controller. The processor that interprets scan codes, writes the graphic results of keys to the terminal, reads and writes terminal screens, sends data to workstation printers, and controls all aspects of the operation of workstations and workstation printers.

cpi. characters per inch

data entry keyboard. A workstation keyboard that is similar to a model 029 card punch keyboard. On some workstations, this means that the keyboard is almost identical to the 029 keyboard; on other workstations it means that the keyboard looks like the data processing keyboard for the workstation, but has the keys rearranged like the 029 keypunch.

data processing keyboard. A workstation keyboard similar to a typewriter keyboard. Used interchangeably with "typewriter keyboard".

keypress. The act of pressing a key.

lpi. lines per inch

lpc. link protocol converter A device that converts one communication protocol into another.

maximum print position. The number of printed characters that will fit on a line for a particular printer with a particular cpi value.

proof option. On a data entry keyboard, this means that the numeric pad keys are inverted. They send the same scan codes as the non-proof keyboard; the controller must translate.

pad. (1) On terminals with a set of numeric keys to the right of the main portion of the keyboard, that set of numeric keys. (2) On data entry keyboards, the set of keys that produce numeric characters when the numeric shift is pressed.

scan code. The code returned by a workstation in the response to a Poll command when a key is pressed. This code has no relationship to the graphic (if any) that is to be entered or displayed on the terminal as a result of the keypress it represents. It must be translated and acted on by the workstation controller.

typewriter keyboard. A workstation keyboard similar to a typewriter keyboard. Used interchangeably with "data processing keyboard".

workstation. A display terminal. Sometimes also applied to workstation printers.

workstation printer. A printer attached to twinaxial cable.